Immunization coverage and exemptions among Ontario’s school pupils for 2011–12: Findings and implications for future information systems

GH Lim, MA McIntyre, S Wilson

PHO Ground Rounds August 20, 2013
Outline

• Overview of immunization coverage assessment in Ontario
• Results from the 2011-12 school year
  • Programs initiated in infancy/early childhood
  • School-based immunization programs
• Limitations
• Opportunities
Immunization delivery in Ontario

- Delivery-predominantly by healthcare providers
  - Exception: 3 school-based programs
- Dynamic publicly-funded immunization schedule
  - Several changes in August 2011

### TABLE 1. Routine Schedule for Children Beginning Immunization in Early Infancy (Starting at 2 months of age)

<table>
<thead>
<tr>
<th>Age at vaccination: Completed months and years</th>
<th>DTap-IPV²-Hib³</th>
<th>Pneu-C-13⁰</th>
<th>Rot-1⁴</th>
<th>Men-C-5⁵</th>
<th>MMR⁶</th>
<th>Var⁷</th>
<th>MMRV⁸</th>
<th>Men-C-ACYW⁹</th>
<th>HB³⁰</th>
<th>HPV-4¹¹</th>
<th>Tdap¹²</th>
<th>Inf¹³</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 months old</td>
<td>■</td>
<td>■</td>
<td>■</td>
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<td></td>
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<tr>
<td>4 months old</td>
<td>■</td>
<td>■</td>
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<tr>
<td>6 months old</td>
<td>■</td>
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<tr>
<td>12 months old</td>
<td>■¹</td>
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<tr>
<td>15 months old</td>
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<tr>
<td>18 months old</td>
<td>■</td>
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</tr>
<tr>
<td>4-6 years old</td>
<td>■¹</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>Grade 7 students</td>
<td></td>
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<tr>
<td>Grade 8 females</td>
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<td></td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>14-16 years old (10 years after 4-6 year old booster)</td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>Every year (in autumn)</td>
<td></td>
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</tr>
</tbody>
</table>

*DTap-IPV preferably given at 4 years of age; administer to children <6 years old, see Schedule 3. ¹For Pneu-C-13 high risk schedule, see Table 3. ²MMRV preferably given at 4 years of age. ³Administered through school-based program. ⁴See Schedule 4 for adult Td immunization. ⁵Previously unimmunized children <9 years receive 2 doses of Inf 4 weeks apart.
Immunization coverage

- Immunization coverage
  - Refers to the proportion of an age-specific population that is appropriately immunized against a specific vaccine-preventable disease (VPD), in a given year

- Why is it important?
  - Establishes temporal trends
  - Program evaluation
  - Provides indirect evidence of population susceptibility to VPDs

- Methods used internationally
  - Immunization registries
  - Administrative data (provider reports, doses distributed)
  - Coverage surveys
Immunization of School Pupils Act\textsuperscript{1}

- Requires annual immunization coverage assessment for school pupils
- Immunization records are collected by Public Health Units (PHUs)
- 6 “designated diseases” under ISPA
  - diphtheria, tetanus, polio, measles, mumps, rubella
- Students require documentation of immunization or a “Statement of Conscience or Religious Belief Affidavit”, or risk school suspension
  - Mandatory choice, not mandatory immunization
**Immunization Records Information System (IRIS)**

- System of de-centralized databases
- Reports to identify “overdue” students
- Coverage reports based on “complete for age” logic\(^1\)
- Immunization data used for numerator
- School board enrollment data forms denominator
- Outdated platform (1992), to be replaced in near future

\(^1\) Ontario Ministry of Health and Long-Term Care. IRIS Immunization: Eligible, Due and Overdue Logic. April, 2012.
IRIS Complete for Age Logic

- Assessed based on student date of birth, immunization history (including date of immunization delivery)
- 3 classifications in IRIS: eligible, due, overdue
- Students are assessed as complete until they become overdue
- Examples of “complete for age”
  - Students who have received an age-appropriate number of doses
  - Students who have received an incomplete series, but who are not yet overdue for their next dose
  - Students who are unimmunized but who are not yet at the overdue age
  - Students who are unimmunized but who are no longer eligible for a vaccine
Ontario Immunization Coverage: Current Context

• Responsibility for immunization coverage surveillance
  • Transferred to Public Health Ontario July 2011
  • Previously Ontario Ministry of Health and Long-Term Care

• PHU-MOHLTC accountability agreements
  • Have included school-based immunization coverage estimates

• Immunization module of Panorama
  • To be implemented August 2013 in 6/36 Public Health Units
  • Remaining PHUs will implement in 2014
Scope of 2011/12 immunization coverage assessment

**ISPA antigens**
- Diphtheria
- Tetanus
- Polio
- Measles
- Mumps
- Rubella

**Programs not referenced in ISPA**
- Pertussis
- *Haemophilus influenzae* type b (Hib)
- Varicella
- Meningococcal
  - MenC in toddlers
  - MCV4 in grade 7
- Pneumococcal
- Human papillomavirus (HPV)
- Hepatitis B
Immunization coverage:
Programs initiated in infancy and early childhood
Scope of 2011/12 immunization coverage assessment

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- Pneumococcal
  - Human papillomavirus (HPV)
  - Hepatitis B
Methods

• June 2012 – PHUs contacted to request coverage data from IRIS
• Coverage reports included immunizations administered as of June 30, 2012
• Assessed for each antigen and selected birth cohort(s)
• Historical exemptions data were used to describe temporal trends for selected antigens
• SAS version 9.2 used to convert IRIS text files and analysis
• November 2012 – compiled data provided to PHUs for review and validation
IRIS complete-for-age logic

- Coverage estimates based on IRIS forecaster logic to identify students as “complete-for-age”:
  - Students who have completed a full series of immunizations
    - e.g. 2 doses of varicella-containing vaccine
  - * Students not yet overdue *
    - e.g. Received 1 dose of varicella-containing vaccine, not yet overdue for 2nd dose

Eligible / Due for 1st dose

Eligible / Due for 2nd dose

* Complete for Age (IRIS)

Complete for Age (IRIS)

Overdue (IRIS)
Immunization coverage in Ontario among 7 and 17 year old students, ISPA antigens + pertussis, 2011/12

<table>
<thead>
<tr>
<th>Immunization</th>
<th>7-year-olds</th>
<th>17-year-olds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measles (2 doses)</td>
<td>89.1%</td>
<td>94.8%</td>
</tr>
<tr>
<td>Mumps (2 doses)</td>
<td>88.6%</td>
<td>92.9%</td>
</tr>
<tr>
<td>Rubella (1 dose)</td>
<td>95.1%</td>
<td>96.8%</td>
</tr>
<tr>
<td>Diphtheria</td>
<td>79.7%</td>
<td>82.6%</td>
</tr>
<tr>
<td>Tetanus</td>
<td>79.7%</td>
<td>82.6%</td>
</tr>
<tr>
<td>Polio</td>
<td>79.2%</td>
<td>93.5%</td>
</tr>
<tr>
<td>Pertussis</td>
<td>76.0%</td>
<td>67.7%</td>
</tr>
</tbody>
</table>
Immunization coverage in Ontario among 5, 7 and 17 year old students, non-ISPA antigens, 2011/12

<table>
<thead>
<tr>
<th></th>
<th>5-year-olds</th>
<th>7-year-olds</th>
<th>17-year-olds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hib</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pneumococcal</td>
<td>96.8%</td>
<td>96.9%</td>
<td></td>
</tr>
<tr>
<td>Meningococcal</td>
<td></td>
<td></td>
<td>72.0%</td>
</tr>
<tr>
<td>Varicella (≥1 dose)</td>
<td></td>
<td></td>
<td>75.0%</td>
</tr>
<tr>
<td>Varicella (2 doses)</td>
<td></td>
<td></td>
<td>5.3%</td>
</tr>
</tbody>
</table>

www.oahpp.ca
# 2011/2012 immunization coverage as compared to Canadian targets

<table>
<thead>
<tr>
<th>Antigen</th>
<th>7-year-olds (2004 birth year)</th>
<th>17-year-olds (1994 birth year)</th>
<th>Target $^{1,2}$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Designated diseases under the ISPA</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diphtheria</td>
<td>79.7</td>
<td>82.6</td>
<td>99</td>
</tr>
<tr>
<td>Tetanus</td>
<td>79.7</td>
<td>82.6</td>
<td>99</td>
</tr>
<tr>
<td>Polio</td>
<td>79.2</td>
<td>93.5</td>
<td>99</td>
</tr>
<tr>
<td>Measles</td>
<td>89.1</td>
<td>94.8</td>
<td>99</td>
</tr>
<tr>
<td>Mumps</td>
<td>88.6</td>
<td>92.9</td>
<td>99</td>
</tr>
<tr>
<td>Rubella</td>
<td>95.1</td>
<td>96.8</td>
<td>97</td>
</tr>
<tr>
<td><strong>Diseases not designated under the ISPA</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pertussis</td>
<td>76</td>
<td>67.7</td>
<td>85-95</td>
</tr>
<tr>
<td>Hib</td>
<td>96.8</td>
<td>97.8</td>
<td>97</td>
</tr>
<tr>
<td>Pneumococcal</td>
<td>96.9</td>
<td>n/a</td>
<td>90</td>
</tr>
<tr>
<td>Meningococcal</td>
<td>72</td>
<td>n/a</td>
<td>97</td>
</tr>
<tr>
<td>Varicella</td>
<td>5.3*</td>
<td>n/a</td>
<td>85*</td>
</tr>
</tbody>
</table>

* National target for varicella reflects 1-dose coverage, whereas 2-dose coverage among 7-year olds is presented.

## Variability in 2011/12 coverage estimates among PHUs

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>Designated diseases under the ISPA</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diphtheria</td>
<td>55.6</td>
<td>46.5</td>
</tr>
<tr>
<td>Tetanus</td>
<td>55.6</td>
<td>46.4</td>
</tr>
<tr>
<td>Polio</td>
<td>55.2</td>
<td>27.3</td>
</tr>
<tr>
<td>Measles</td>
<td>44.9</td>
<td>19.5</td>
</tr>
<tr>
<td>Mumps</td>
<td>45.0</td>
<td>19.6</td>
</tr>
<tr>
<td>Rubella</td>
<td>38.0</td>
<td>8.4</td>
</tr>
<tr>
<td><strong>Diseases not designated under the ISPA</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pertussis</td>
<td>55.8</td>
<td>47.1</td>
</tr>
<tr>
<td>Hib</td>
<td>31.4</td>
<td>5.7</td>
</tr>
<tr>
<td>Pneumococcal</td>
<td>31.4</td>
<td>n/a</td>
</tr>
<tr>
<td>Meningococcal</td>
<td>41.1</td>
<td>n/a</td>
</tr>
<tr>
<td>Varicella</td>
<td>40.2</td>
<td></td>
</tr>
</tbody>
</table>
Reasons for exemptions among children 7 years old for ISPA antigens, 2011/12

<table>
<thead>
<tr>
<th></th>
<th>Diphtheria</th>
<th>Tetanus</th>
<th>Polio</th>
<th>Measles</th>
<th>Mumps</th>
<th>Rubella</th>
</tr>
</thead>
<tbody>
<tr>
<td>Religious/Conscientious</td>
<td>1.6</td>
<td>1.6</td>
<td>1.8</td>
<td>1.4</td>
<td>1.1</td>
<td>1.1</td>
</tr>
<tr>
<td>Prior Immunity</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.1</td>
<td>0.0</td>
<td>0.1</td>
</tr>
<tr>
<td>Medical</td>
<td>0.4</td>
<td>0.4</td>
<td>0.6</td>
<td>0.2</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>
Temporal trends in exemptions due to religious beliefs and conscientious objection among children 7 years old
Interpretation and significance

- Lower than expected coverage
  - **Pertussis**: especially among 17-year-olds (68%)
    - Lack of reporting or data entry as not an ISPA antigen or truly low coverage?
  - **Varicella**: 5% among 7-year olds
    - Reflection of new 2 dose program

- Some coverage estimates suspiciously high
  - **Hib**: 97%-98% for 7- and 17-year-olds
  - **Pneumo**: 97% for 7-year-olds
    - Reviewed programming logic: after age 5 considered “complete-for-age”

- Rate of exemptions low in Ontario
  - Less than 2% for each ISPA antigen
Immunization coverage: School-based programs
Scope of 2011/12 immunization coverage assessment

**ISPA antigens**
- Diphtheria
- Tetanus
- Polio
- Measles
- Mumps
- Rubella

**Programs not referenced in ISPA**
- Pertussis
- *Haemophilus influenzae* type b (Hib)
- Varicella
- Meningococcal
  - MenC in toddlers
    - MCV4 in grade 7
- Pneumococcal
  - Human papillomavirus (HPV)
  - Hepatitis B
Overview of Ontario’s school-based programs

• Hepatitis B vaccine (1994)
  • Delivery in grade 7, extended eligibility until grade 8
  • Overdue age of 15 (IRIS logic)

• Invasive meningococcal disease (2005, MCV4 since 2009)
  • Delivery in grade 7, once eligible, always eligible
  • Overdue age of 13 (IRIS logic)

• Human papillomavirus (HPV, 2007)
  • Delivery to grade 8 girls
  • 2007-8 to 2011-12 school years: extended eligibility until grade 9
  • Overdue age of 14 (IRIS logic)
Methods

• October 2012: PHUs sent survey to request coverage data
  • Immunizations received as of August 31, 2012
  • Survey placed no restriction on data source for coverage estimates

• Survey rationale
  • HPV process evaluation suggested PHUs use non-IRIS data sources
  • IRIS coverage report cannot differentiate between MCV4 and MenC vaccines
  • Survey timing allowed PHUs to capture immunization delivery over summer
## Provincial coverage for school-based immunization programs, 2011/12

<table>
<thead>
<tr>
<th>Program</th>
<th>Target grade</th>
<th>IRIS as data source</th>
<th>Coverage 2011/12</th>
<th>Canadian coverage target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hepatitis B vaccine</td>
<td>Grade 7</td>
<td>35/36</td>
<td>86.6%</td>
<td>95%[^1]</td>
</tr>
<tr>
<td>MCV4</td>
<td>Grade 7</td>
<td>35/36</td>
<td>84.4%</td>
<td>90%[^2]</td>
</tr>
<tr>
<td>HPV vaccine</td>
<td>Grade 8</td>
<td>33/36</td>
<td>70.2%</td>
<td>90%[^3]</td>
</tr>
</tbody>
</table>

* National target for meningococcal vaccine reflects MenC vaccine coverage among 17-year-olds

School-based immunization coverage: 2007/08 to 2011/12

<table>
<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Hepatitis B (Grade 7)</td>
<td>80.0%</td>
<td>78.1%</td>
<td>74.2%</td>
<td>76.6%</td>
<td>86.6%</td>
</tr>
<tr>
<td>Meningococcal (Grade 7)</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HPV (Grade 8 females)</td>
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<tr>
<td>2007/08</td>
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<td></td>
<td>48.0%</td>
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<tr>
<td>2008/09</td>
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<td></td>
<td></td>
<td>52.5%</td>
</tr>
<tr>
<td>2009/10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>55.2%</td>
</tr>
<tr>
<td>2010/11</td>
<td></td>
<td></td>
<td></td>
<td>n/a</td>
<td>58.4%</td>
</tr>
<tr>
<td>2011/12</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>70.2%</td>
</tr>
</tbody>
</table>
A closer look at the IRIS application

- IRIS working group convened
  - MOHLTC: Immunization Policy and Program Section, I&IT Health Services Cluster, Standards, Practice and Accountability Branch, and PHO

- Parameters of IRIS coverage reports
  - No change in Hepatitis B
  - Change in minimum interval between dose 1 and dose 2 for HPV (May 2012)

- Coverage reports compared from different IRIS versions
  - March 2012 and May 2012: identical HPV estimates
School-based meningococcal conjugate coverage, incl. and excl. extended eligibility, 2007/08 to 2011/12

<table>
<thead>
<tr>
<th>Year</th>
<th>Excluding eligibility in perpetuity doses</th>
<th>Including eligibility in perpetuity doses</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007/08</td>
<td>85.9%</td>
<td>73.6%</td>
</tr>
<tr>
<td>2008/09</td>
<td>86.5%</td>
<td>72.8%</td>
</tr>
<tr>
<td>2009/10</td>
<td>83.3%</td>
<td>n/a</td>
</tr>
<tr>
<td>2010/11</td>
<td>n/a</td>
<td>73.8%</td>
</tr>
<tr>
<td>2011/12</td>
<td>84.4%</td>
<td>n/a</td>
</tr>
</tbody>
</table>

n/a = Not applicable
Assessing school-based coverage using IRIS forecasting logic

Scenario: 1 dose MCV4 program, grade 7
IRIS overdue age of 13

---------|-----------|-------------|---------
11 12 12  |  12 12 12 |  12 13 12  |  12 13 13
12 12 12  |  12 12 12 |  12 12 12  |  12 13 13

Unvaccinated
Vaccinated
Assessing school-based coverage using IRIS forecasting logic

Scenario: 1 dose MCV4 program, grade 7
IRIS overdue age of 13

- Sept 2011: 11/12 Unvaccinated, 12/12 Vaccinated
- Dec. 2011: 12/12 Unvaccinated, 12/12 Vaccinated
- March 2012: 12/12 Unvaccinated, 13/12 Vaccinated
- June 2012: 12/13 Unvaccinated, 13/13 Vaccinated

2 vaccinated (50% coverage) + 2 not overdue = 4 => 100% complete for age (IRIS)
Limitations

• Challenges with duplicate records
• Timing of data entry into IRIS
• Representativeness
• Mismatch between program eligibility (grade-based) and coverage calculation (age-based)
• Inability to distinguish between MenC and MCV4 vaccine programs
• Time-lag between program delivery and coverage assessment
Conclusions

- Use of forecasting logic problematic
  - Proxy for immunization coverage
  - Inability to assess coverage associated with expanded eligibility

- Have altered request for 2012-13 school year based on findings
  - Age cohorts for Hib, pneumococcal conjugate, varicella

- New information system (Panorama) presents opportunities

- Gaps still remain
  - Coverage at age 2 years, high risk groups, adults
Acknowledgements

- Immunization coverage team at PHO
  - Shelley Deeks
  - Jill Fediurek
  - Gillian Lim
  - Margaret McIntyre
  - Chi Yon Seo
  - Sarah Wilson

- Immunization Policy and Programs, MOHLTC
  - Dianne Alexander
  - Tsui Scott
  - Jocelyn Cortes

- IRIS investigation working group
  - Dianne Alexander
  - Zareen Butt
  - Jocelyn Cortes
  - Richard Crosland
  - Lynn Egan
  - Gillian Lim
  - Sarah Wilson

- VPD managers and staff at Ontario’s 36 PHUs