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Technical Annex: Immunization coverage report for school pupils in Ontario

2013–14, 2014–15 and 2015–16 school years

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Contents

Purpose

The purpose of this document is to provide technical information to support Public Health Ontario's (PHO's) Immunization coverage report for school pupils: 2013–14, 2014–15 and 2015–16 school years. Technical information includes an in-depth explanation of analytic methods used in the report, and a description of the limitations of immunization coverage data in Ontario. This detail will not be included in the coverage report.

Background

Important changes have occurred within the immunization system in Ontario. Over the course of 2013 to early 2016, all 36 public health units (PHUs) transitioned from maintaining immunization records in the Immunization Records Information System (IRIS), a collection of de-centralized databases in use at each PHU, to using a centralized provincial Digital Health Immunization Repository (DHIR) which is accessible to PHUs through a web-based application called Panorama. To date, the immunization and inventory management modules of Panorama have been implemented in Ontario. Panorama's immunization module allows PHU users to:

- Record immunizations administered at their clinics (including immunizations administered as part of the school-based program) as well as document consent for service
- Transcribe historical immunizations reported by parents/guardians
- Document exemptions under the *Immunization of School Pupils Act (ISPA)*
- Upload student lists from schools and school boards
- Forecast future doses according to the provincial immunization schedule

Prior to the implementation of Panorama, immunization coverage was calculated by compiling IRIS-generated reports created by each PHU into a provincial report by PHO. In July 2016, PHO gained access to the Panorama Enhanced Analytical Reporting (PEAR) tool, which was used to extract person-level immunization records for the calculation of *up-to-date* coverage, the measure used by other jurisdictions within Canada and globally. Consequently, the immunization coverage estimates provided in this report for the 2013–14, 2014–15 and 2015–16 school years, are not directly comparable to the estimates produced in previous reports, which were based on the in-application *complete-for-age* measure in IRIS. Under the *complete-for-age* methodology, children who were *up-to-date* on their immunizations and children who were inadequately protected but not yet overdue for a vaccine dose were both considered *complete-for-age*. More information on the *complete-for-age* measure can be found in the previous immunization coverage report for the 2012–13 school year. *Up-to-date* coverage provides a more accurate representation of population protection by calculating the proportion of children who have received a specified number of valid vaccine doses based on the vaccine or antigen in question and their age at the time of assessment.

Methods

Data used to generate all coverage estimates were extracted from the DHIR using the PEAR tool on September 1, 2016. Extracted data included personal information, immunization records, education records, special consideration records (e.g., exemptions), health region records and school information for students in the 7, 12, 13 and 17-year-old age cohorts for the following school years:

- 2013–14 school year (September 1, 2013 to August 31, 2014)
- 2014–15 school year (September 1, 2014 to August 31, 2015)
- 2015–16 school year (September 1, 2015 to August 31, 2016)

Data were extracted, compiled and analyzed to derive provincial estimates of *up-to-date* coverage using the statistical software program SAS® version 9.4.

Age cohorts

Cohorts of students corresponding to coverage assessment milestone ages were identified using the calendar year of birth. Students who had turned the milestone age for coverage assessment by December 31st of the school year were included in the age cohort (i.e., those who had their 7th birthday between January 1st and December 31st, 2013 are represented in the 7-year-old birth cohort for the 2013–14 school year). This method ensures that all children in a birth cohort have reached the age of assessment by the end of the school year (August 31st). This age-based approach was used for both vaccines started in infancy and early childhood and school-based immunization programs. Although eligibility for school-based programs is determined by grade, age cohorts of 12 years and 13 years were used to represent grades 7 and 8 respectively due to concerns regarding the completeness of the school grade field in the DHIR. Table 1 outlines the birth years corresponding with the age cohorts assessed in the report for each school year.

Table 1. Age cohorts and corresponding birth years assessed by school year (SY)

Age cohort	2013–14 SY	2014–15 SY	2015–16 SY
7 years	2006	2007	2008
12 years	2001	2002	2003
13 years	2000	2001	2002
17 years	1996	1997	1998

Immunization data

Student immunization records are collected from parents and guardians at the time of school enrolment, and when assessment activities are carried out by PHUs. PHUs determine the timing of requests for immunization information based on their student population, staffing complement and current public health priorities. Once immunization information is obtained from parents and guardians, it is uploaded or manually entered into the DHIR. For school-based immunization programs delivered by

PHUs, PHU staff members enter immunization information directly using the Panorama application, typically at the time of immunization, however this may vary by PHU.

Immunization records were extracted for analysis to derive coverage estimates for the following antigens:

- Diphtheria
- *Haemophilus influenzae* type b (Hib)
- Hepatitis B
- Human papillomavirus (HPV)
- Meningococcal C conjugate (MCC)
- Quadrivalent meningococcal conjugate (MCV4)
- Pneumococcal conjugate
- Measles
- Mumps
- Pertussis
- Polio
- Rubella
- Tetanus
- Varicella

Only immunizations administered on or before the assessment date (i.e., August 31st of the school year of analysis) are included in the calculation of coverage estimates. Immunizing agents (i.e., vaccines) contain antigens that confer immunologic protection against one or more diseases. In most instances, our coverage estimates assess the antigen components of combination vaccines separately to derive antigen-specific coverage. For example, we report on measles coverage rather than coverage for the measles, mumps, rubella (MMR) vaccine. In some instances, when a vaccine contains multiple antigens that confer protection against one disease, we report coverage at the level of the vaccine (e.g., MCV4 and pneumococcal conjugate vaccines).

Measure specifications

Up-to-date coverage

Up-to-date coverage was calculated according to the following formula:

$$Coverage = \frac{Numerator}{Denominator} \times 100\%$$

Denominator: all students in the specified age cohort with an active client record and at least one school record during the school year of analysis.

Numerator: the number of students from the denominator that have received the age-appropriate number of valid doses of the specified antigen-containing vaccine (i.e., are *up-to-date*) or have a recorded exemption based on evidence of immunity, where appropriate.

Up-to-date definitions for each antigen are outlined in Appendix 1 of this document which specifies the number of doses, minimum intervals and other conditions required in order for students to be assessed as *up-to-date*, by antigen and age. *Up-to-date* definitions were developed after consulting multiple resources including vaccine product monographs, the Ontario publicly-funded immunization schedule,[1] the *Canadian Immunization Guide*,[2] the *Panorama Ontario Immunization Schedules Logic: Reference Document*[3] and local experts.

Ontario's school-based human papillomavirus (HPV) program changed from a three-dose schedule of quadrivalent HPV (HPV4) vaccine to a two-dose HPV4 schedule starting in the 2015–16 school year. To ensure that a uniform approach to measurement was used across the three school years, students are considered as *up-to-date* if they have satisfied the requirements for either the two-dose or the three-dose HPV schedule, regardless of the school year assessed.

Series initiation

Series initiation (i.e., one-dose coverage) was calculated for varicella, hepatitis B and HPV. This measure is defined as the proportion of the students in the specified age cohort (i.e., same denominator as *up-to-date* coverage) who have received at least one valid dose of the specified antigen-containing vaccine, as defined in Appendix 1.

Series completion among initiators

Series completion among initiators was calculated as the proportion of the series initiators (i.e., those who received at least one valid dose of the specified antigen) who have received all recommended doses of the vaccine (as determined by age). These students have completed the vaccine series for the program they initiated; they are also *up-to-date*. Series completion among initiators was calculated for hepatitis B and HPV.

Vaccine interactions

Immunization records for all live-virus vaccines including those not being assessed for coverage (e.g., yellow fever, smallpox, zoster and Bacillus Calmette-Guérin (BCG) vaccines) were examined for vaccine interactions with other live-virus vaccines. Doses of parenteral live-virus vaccines administered within 28 days of the receipt of another live-virus immunizing agent were considered invalid and not counted toward *up-to-date* coverage. Please refer to the antigen-specific tables in Appendix 1 for a list of immunizing agents (if any) relevant to vaccine interactions and valid dose assessment.

Evidence of immunity

Under the *ISPA*, students are granted exemptions for immunizations for several reasons, including religious or conscientious objection, medical contraindications, or evidence of immunity (i.e., past history of infection). Because those with immunity from previous natural infection contribute to decreasing the overall susceptibility of the population, we considered these individuals as protected or 'covered' and included them within our *up-to-date* coverage estimates, where relevant. Immunization exemption records were examined for the presence of immunity to relevant antigens: those where natural infection confers long-term protection against subsequent infection. For measles, mumps, rubella, varicella and hepatitis B, students with an immunization exemption recorded using the Panorama field values 'Medical - clinical record of disease' and 'Medical - documented immunity' were considered to be *up-to-date*, regardless of immunization history, if the immunization exemption had an *Effective From* date prior to the assessment date. The *Canadian Immunization Guide* (CIG) recommends that children with a history of varicella infection occurring before 12 months of age should still receive

immunization with two doses of varicella-containing vaccine, due to the increased risk of a second episode of varicella;[2] however, we were not able to confidently identify the age of infection using exemption information. Therefore, we assumed that PHUs only entered varicella immunity information for infections that occurred at 12 months of age or later.

Although the *Panorama Data Standards and Best Practices* manual does not direct PHUs to enter exemptions for diseases that are not under the *ISPA*, hepatitis B immunization exemption records with the field values described above were included in the calculation of coverage for hepatitis B;[4-6] however, the use of these field values for hepatitis B may vary by PHU and may under-estimate the true number of children with prior immunity to hepatitis B.

Receipt of multiple immunizing agents on the same day

In the event that multiple doses of a vaccine containing the same antigen had the same administration date, this was assumed to reflect data entry or data migration errors and only one dose from that date was used in subsequent analyses. Please refer to the antigen-specific tables in Appendix 1 for further information about the antigen decisions made for our analyses.

Student assignment to Public Health Unit

Students were assigned to PHUs to calculate PHU-specific estimates of coverage based on the location of the school each student attended during the school year of analysis. The use of school-based PHU assignment, as opposed to assigning students to PHUs on the basis of their residential address, is consistent with the implementation of the *ISPA* and the delivery of school-based immunization programs. Student assignment to individual schools was accomplished using DHIR-extracted education records. Many students had multiple education records, some of which were effective for the same time period. A series of decisions were made to select the most appropriate school record for each student.

A student was included in the analysis only if they had at least one education record that was active at any time during the school year of analysis, as determined by the education record's *Effective From* and *Effective To* dates (Table 2). Students without a school record during the school year of analysis were removed from the analysis specific to the school year's coverage assessment as these students had no evidence of school attendance (and were unlikely to have resided in Ontario) during the school year of interest.

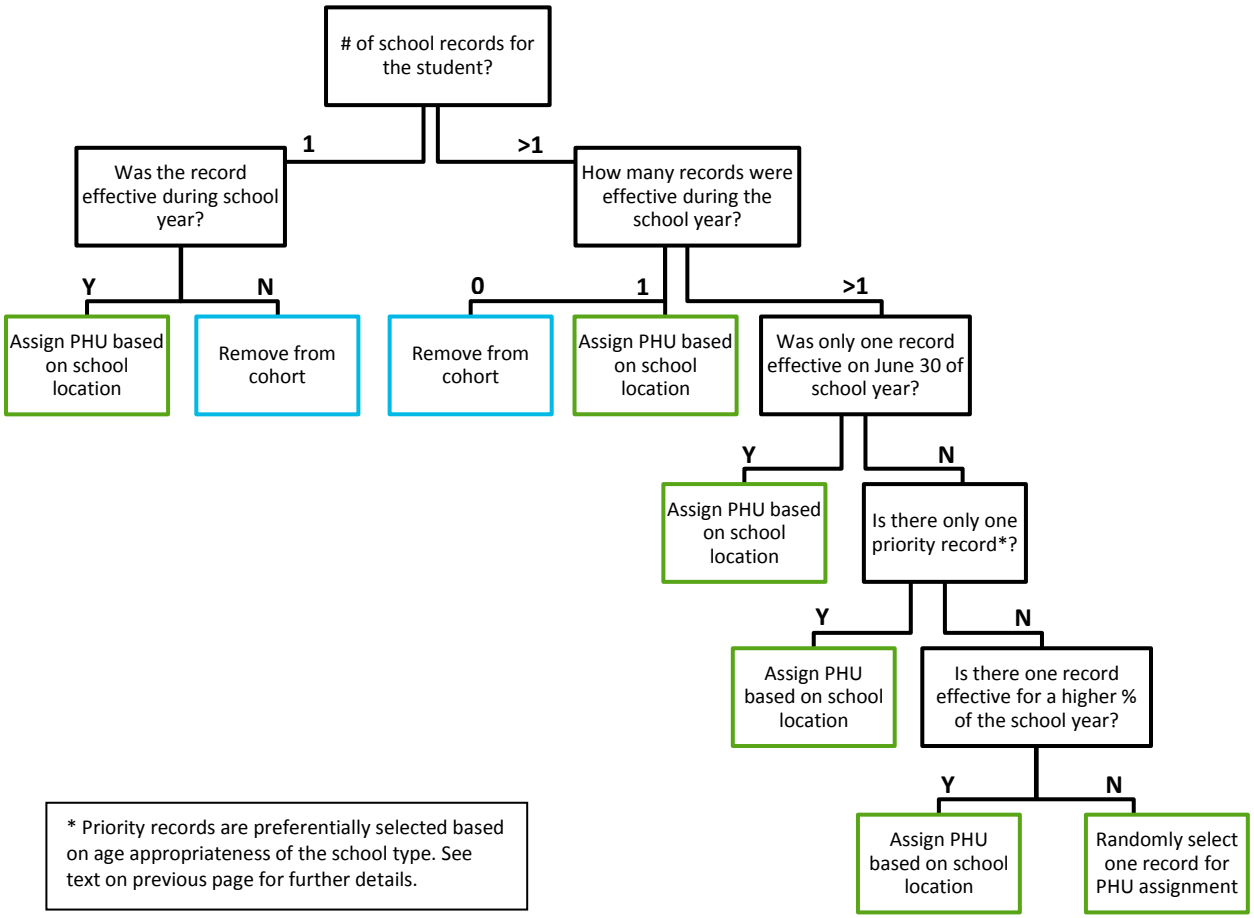
Table 2. Date criteria for school records

School year	Effective To	Effective From
2013–14	≥September 1, 2013 or missing	≤August 31, 2014
2014–15	≥September 1, 2014 or missing	≤August 31, 2015
2015–16	≥September 1, 2015 or missing	≤August 31, 2016

Education records were also excluded due to data quality issues and when their content indicated that records were used to capture workflow or other business practices, and not necessarily school attendance. Education records were excluded if: there was no school ID, the school name included the term 'holding', the school type was 'other', the school board name included the term 'pseudo', or the school was not assigned to one of Ontario's 36 PHUs. School records that conflicted with the student's age were also removed (e.g., the school record for a 17-year-old student with a school type field value of 'elementary school' was excluded).

The remaining education records were processed using the decisions presented in the algorithm in Figure 1 to assign each student to one PHU per school year. When a student had more than one education record during the school year, one record was chosen based on the school attended at the end of the school year (June 30th), the age-appropriateness of the school type, and/or the length of time at the school during the school year. Age-appropriateness of the school was used by preferentially selecting school records that were most plausible based on the student's age. For example, our 1st priority for a 12-year-old student would be any record with a school type field value of 'elementary school', 'elementary & secondary school', 'private school authority' or 'public school board', whereas a 'secondary school' record would be used for PHU assignment if no priority 1 record was present. Across all ages and cohorts, most students had straightforward school records; 98% of students attended only one school during the school year of interest, or attended multiple schools over the school year but only one school at the end of the school year. The more detailed decisions in the algorithm outlined in Figure 1 were only required for 2% of students.

Figure 1. Algorithm to assign PHU to students based on education records



Comparisons with Canada's national coverage goals

We compared Ontario's provincial coverage estimates for the years assessed in this report to Canada's national coverage goals. All but one of the coverage goals cited in this report are the outcome of consensus conferences that occurred in 1996 and 2005 involving federal, provincial and territorial representatives and experts.[7,8] The national coverage goal for HPV was recommended by the Canadian Immunization Committee, a federal, provincial and territorial committee comprised of senior public health leaders in immunization.[9] A process led by the Public Health Agency of Canada is currently underway to review and revise and/or reconfirm Canada's national coverage goals.[10]

Geographic distribution

PHU-specific coverage estimates for the 2015–16 school year were mapped using ArcMap® 10.3 to visualize the geographic distribution of coverage for three vaccine programs: diphtheria (age 7), measles (age 17), and the MCV4 vaccine (age 12). To generate the maps, coverage estimates were grouped into five intervals; the first four intervals were defined for each antigen to identify ranges that best fit the distribution of the data, with a fifth category representing coverage estimates that were equal to or above the relevant national coverage goal. The coverage goals differ by antigen, as outlined above.

Limitations

There are several challenges to establishing accurate immunization coverage estimates for Ontario school pupils. The implementation of a provincial immunization repository in Ontario is an important achievement that has strengthened immunization coverage assessment and immunization program monitoring. However, the immunization coverage analyses presented in this report are subject to a number of limitations.

Cohort assignment

The immunization coverage assessment process in Ontario is school-based and underpinned by the *ISPA*. PHUs must assess and maintain records, as well as report on the immunization status of all students attending both public and private schools in the province, although resources may limit the extent to which PHUs are able to assess the entire population of school children in their areas. Children who are home-schooled or who have dropped out of school may not be fully represented in the numerator or denominator for this report. Although the move to a centralized provincial repository of immunization information accessed using Panorama, from the decentralized database collection of the Immunization Records Information System (IRIS), allows for the identification and resolution of duplicate entries for individual students across PHUs (a function that was not possible with IRIS), duplicate student records may still exist in the data. These factors may account for differences observed between the enrolled student population and census population estimates for the same ages.

The complexity of education records in Panorama and the nature of retrospective analysis required us to develop a series of rules to assign individual students to PHUs. Our decision rules were based on the knowledge of typical school progression and supported by preliminary data analysis; however, it is possible that our decision methods may have excluded students from the analysis or assigned students to a PHU that had not been involved in either their program delivery or *ISPA* assessment activities. We believe that likelihood of these events is small given that 98% of student assignments were straightforward (i.e., only one school record was present anytime during the school year or only one school record was present at the end of the school year).

Due to concerns regarding the completeness of the school grade field in the DHIR, age cohorts were used to approximate the grades at which students are eligible for school-based immunization programs. However, the *Grade* field in Panorama is not system-required and will be updated only if it is available in the school board files. The decision not to use *Grade* to assign age cohorts for this report was based on an internal data quality assessment of DHIR data conducted in 2015, which identified that completeness of *Grade* in the DHIR was below 50% and there was notable variability in the correlation between Grade and the client's birth year.

Data quality

As with any information system, some data quality issues were evident in the data extracted from the DHIR. Data quality issues were noted more frequently in those records that were migrated from IRIS. For most PHUs, migrated data was originally captured in IRIS in 2014 or earlier, although the specific dates vary by PHU, depending on the timing of Panorama implementation. This was expected as Panorama data standards and best practices recommendations were not applicable to data originally entered into IRIS and migrated to the DHIR (see Data migration).

Data quality issues included inaccurate date values such as school records with an *Effective From* date prior to the *Effective To* date and immunization records with an *Administration Date* prior to the students' date of birth. We did not exclude students with these data quality issues from the analysis.

There were also system-level issues that posed limitations on our coverage analysis. One issue is the inability of Panorama to differentiate Twinrix® and Twinrix® Junior at the agent level (both are hepatitis A and hepatitis B combined vaccines). As a result, those two agents can only be differentiated in the presence of a *Trade Name*, which does not have a high level of completeness and/or accuracy especially for the IRIS-migrated data. In order to address this issue, certain assumptions were made in our development of the decision rules for *up-to-date* hepatitis B coverage, based on schedule received and age (see the Hepatitis B section of Appendix 1 for further details). The impact of this limitation on the resulting coverage estimates is unclear.

Errors made by immunization providers or during data entry at the PHU may result in unexpected immunization coverage estimates. These errors could include incorrect vaccines administered or documented, incorrect intervals between immunizations, lack of provider knowledge of updates to the schedule, or incorrect medical assessment of client status in relation to opportunity to vaccinate. Ontario has a complex and dynamic immunization schedule and if immunizers do not practice according to the current schedule, children may miss opportunities for immunization and vaccine coverage may be impacted.

Data completeness

While PHU-delivered immunizations are entered directly into the DHIR through Panorama, most other immunization data must be provided to local PHU staff by parents and/or guardians for subsequent manual entry; however, several PHUs have made arrangements with local providers to receive

immunization records electronically which are then uploaded into the repository. It is possible that many students who are described as being under-immunized within this report have been appropriately immunized, but the information has not been provided to their local PHU. Additionally, the family may have provided the information, but data entry into the DHIR by PHU staff may not have occurred in time to be reflected in the coverage estimates presented within this report. Both of these scenarios would result in underestimating coverage. On the other hand, it is also possible that misinformation could be relayed from families to the local PHU as parents and guardians are asked to provide the date of the immunization event(s), rather than to provide formal documentation from the healthcare provider who administered the vaccine(s). The lack of system integration for the documentation of immunizations and their inclusion within the provincial immunization repository challenges the timeliness and accuracy of immunization coverage assessment. A separate issue is that data completeness may vary by antigen. Data completeness is likely to be higher among antigens designated under the *ISPA,* as documentation of immunization is actively sought for these antigens. Practice variation by Ontario PHUs regarding the frequency of immunization coverage assessment activities including timing of data entry, specific age cohorts assessed and data collection for non-*ISPA* antigens was not assessed as part of this report.

When interpreting the coverage estimates in this report, it must be noted that since data for all three school years were extracted at the same time (September 1, 2016), there was greater opportunity to enter and update data for the earlier school years. Some of the variability in coverage estimates by school year may be attributed to the fact that PHUs had two years after the end of 2013–14 school year to enter and update the immunization records for students captured in our assessment for that school year, resulting in improved data completeness. Correspondingly, the 2014–15 school year would be expected to have more complete data than the 2015–16 school year due the opportunity to update data for a full year following the completion of the school year. Subsequent annual reports will aim to produce coverage estimates with data extracted immediately after the completion of the school year, and will therefore be most comparable with estimates for the 2015–16 school year presented in this report.

Data migration

As the immunization module of the Panorama system has only been recently implemented in Ontario, the majority of immunization records stored in the system are historical data migrated to the DHIR from IRIS. Panorama data standards and best practices recommendations, including drop-down values and field logic, were not applicable to data originally entered into IRIS, therefore several data fields for these migrated data do not adhere to the expected values and data quality standards of Panorama. For example, while the *Trade Name* field is auto-populated for immunization records entered directly into Panorama upon selection of a *Lot Number* (a required field), *Trade Name* is free-text and *Lot Number* is not a required field for historical or transcribed records.[4] This reduces the completeness and usefulness of the *Trade Name* field for analytic purposes. This impact of this limitation will diminish over time, as all new data will be entered directly into Panorama in accordance with data standards and best practice recommendations.

Gaps

The focus of Ontario's enabling legislation and infrastructure is on immunization coverage among school-aged students; as a result, timely coverage assessment of infants and pre-school children is challenging and there is limited information on coverage in other groups, including adults and individuals with high risk medical conditions. Although the *Child Care and Early Years Act* [11,12] sets out the requirement for daycare operators to receive proof of immunizations for children who are enrolled in their child care program as defined in the Act, not all young children in Ontario attend child care facilities. Children may not be regularly assessed for coverage until they are enrolled in an Ontario school and fall under the authority of the *ISPA*. Pre-school aged children (including infants and toddlers) are an important group to monitor, because most vaccine-preventable diseases (VPDs) have an age-dependent risk of complications with younger age groups, especially infants, being particularly vulnerable. Furthermore, the age of two years is a nationally defined benchmark to monitor progress towards meeting Canada's immunization coverage goals.[13]

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Appendix 1: *Up-to-date* definitions by antigen

Diphtheria

Ages assessed	7 and 17 years old

***Up-to-date* definition**	7-year-olds must satisfy one of the following criteria:
	• ≥ 5 valid doses
	• 4 valid doses (only if received 1st valid dose at <7 years old AND received 4th valid dose at ≥ 4 years old)
	
	17-year-olds must satisfy one of the following criteria:
	• ≥ 6 valid doses
	• 5 valid doses (only if received 1st valid dose at <7 years old AND received 4th valid dose at ≥4 years old)
	• 4 valid doses and only if satisfies one of the following:
	  ○ Received 1st valid dose at <7 years old AND <10 years between 4th valid dose and assessment date
	  ○ Received 1st valid dose at ≥7 years old (i.e., 2 primary and 2 booster doses)
	• 3 valid doses (only if received 1st valid dose ≥7 years old AND <10 years between 3rd valid dose and assessment date)*
	
	* PHO considers receipt of 2 primary doses and 1 'booster' dose for individuals who start their series late (i.e., ≥7 years old) as the minimum requirement to be considered *up-to-date*, as long as less than 10 years have elapsed between the last (booster) dose and the date of assessment.

Relevant immunizing agents	D, D-Hib, DPT, DPT-HB, DPT-Hib, DPT-HB-Hib, DPT-IPV, DPTP, DPTP-Hib, DT, DT-IPV, DTaP, DTaP-HB-IPV-Hib, DTaP-IPV, DTaP-IPV-Hib, d, Td, Td-IPV, Tdap, Tdap-IPV, d-unspecified, DTaP-HB-IPV
Vaccine interactions	None

Valid dose definitions	Received relevant immunizing agent in accordance with the following criteria:
	1) 1st valid dose: Received at ≥42 days old
	2) 2nd valid dose: Received ≥28 days after 1st valid dose
	3) 3rd valid dose – one of the following:
	• Received ≥28 days after 2nd valid dose AND received 1st valid dose at <7 years old
	• Received ≥168 days after 2nd valid dose AND received 1st valid dose at ≥7 years old
	4) 4th valid dose – one of the following:
	• Received ≥168 days after 3rd valid dose AND ≥1 year old AND received 1st valid dose at <7 years old
	• Received 1st valid dose at ≥7 years old AND one of the following:
	  ○ Received ≥10 years after 3rd valid dose
	  ○ Received ≥28 days after 3rd valid dose AND ≥14 years old
	5) 5th valid dose – one of the following:

	• Received 1st valid dose at <7 years old AND one of the following:
	  ○ Received ≥28 days after 4th valid dose AND ≥4 years old AND received 4th valid dose at 1 to <4 years old
	  ○ Received ≥10 years after 4th valid dose AND received 4th valid dose at ≥4 years old
	  ○ Received ≥28 days after 4th valid dose AND ≥14 years old AND received 4th valid dose at ≥4 years old
	• Received ≥10 years after 4th valid dose AND received 1st valid dose at ≥7 years old
	6) 6th valid dose – one of the following:
	• Received 1st valid dose at <7 years old AND received 4th valid dose at 1 to <4 years old AND one of the following:
	  ○ Received ≥10 years after 5th valid dose
	  ○ Received ≥28 days after 5th valid dose AND ≥14 years old
	• Received ≥10 years after 5th valid dose AND received 1st valid dose at <7 years old AND received 4th valid dose at ≥ 4 years old
	• Received ≥10 years after 5th valid dose AND received 1st valid dose at ≥7 years old

Addressing multiple relevant immunizing agents received on the same day	Keep any one (no distinction made between D, d, and d-unspecified)
Evidence of immunity	Not applicable
Additional notes	• All immunizing agents containing the respective antigens were considered valid (i.e., D or d) as long as they met the minimum age and minimum interval requirements. • Although an accelerated schedule is not specified in the CIG chapter on diphtheria for children who initiate the series when ≥7 years old, the minimum intervals outlined between doses of the primary series for infants were also applied to older children.

Haemophilus influenzae type b (Hib)

Age assessed	7 years old
***Up-to-date* definition**	Must satisfy one of the following criteria: • ≥4 valid doses • 3 valid doses (only if received 1st valid dose at 7–11 months old) • 2 valid doses (only if received 1st valid dose at 12–14 months old) • 1 valid dose (only if received 1st valid dose at ≥ 15 months old)
Relevant immunizing agents	D-Hib, DPT-HB-Hib, DPT-Hib, DPTP-Hib, DTaP-HB-IPV-Hib, DTaP-IPV-Hib, Hib, Men-C-CY-Hib
Vaccine interactions	None
Valid dose definitions	Received relevant immunizing agent in accordance with the following criteria: 1) 1st valid dose: Received at ≥42 days old 2) 2nd valid dose – one of the following: • Received ≥28 days after 1st valid dose AND received 1st valid dose at <12 months old • Received ≥56 days after 1st valid dose AND received 1st valid dose at ≥12 months to <15 months old 3) 3rd valid dose – one of the following: • Received ≥28 days after 2nd valid dose AND received 1st valid dose at <7 months old • Received ≥56 days after 2nd valid dose AND ≥1 year old AND received 1st valid dose at ≥7 months to <12 months old 4) 4th valid dose: Received ≥56 days after 3rd valid dose AND ≥1 year old AND received 1st valid dose at <7 months old
Addressing multiple relevant immunizing agents received on the same day	Keep any one
Evidence of immunity	Not applicable
Additional notes	• Doses administered after the 5th birthday but before the assessment date for 7-year-old age cohorts are considered valid if they satisfy the criteria for valid dose assessment. • Consistent with pertussis, an accelerated schedule for those initiating a series at 2–6 months was accepted. This differs from the recommended schedule in the CIG for those initiating a series at 7–11 months where a 2-month interval is recommended. • Specific to Hib, a 2-month interval between completion of the primary series and booster dose was applied.

Hepatitis B

Age assessed	12 years old
***Up-to-date* definition**	Must satisfy one of the following criteria: • 3 valid doses in accordance with the 3-dose schedule • 2 valid doses in accordance with the 2-dose schedule • Have a documented exemption for evidence of immunity
Relevant immunizing agents	HB, DPT-HB, DPT-HB-Hib, DTaP-HB-IPV-Hib, HAHB, HB (dialysis), HB-unspecified, DTaP-HB-IPV
Vaccine interactions	None
Valid dose definitions	All students are assessed using two different schedules: a two-dose schedule and a three-dose schedule. A student is assessed as being *up-to-date* if at least one schedule is satisfied. Two-dose schedule for Engerix®-B series (applied only if all doses received by the student are HB or HB-unspecified with an Engerix®-B trade name) 1) 1st valid dose: HB or HB-unspecified received at 11 to <16 years old 2) 2nd valid dose: HB or HB-unspecified received ≥168 days after 1st valid dose AND received at 11 to <16 years old Two-dose schedule for non Engerix®-B series (applied to those not assessed based on the two-dose schedule for Engerix®-B) 1) 1st valid dose: (HB, HB-unspecified or HAHB) received at 11 to <16 years old 2) 2nd valid dose: Received at 11 to <16 years old AND one of the following: • 1st valid dose was HB or HB-unspecified AND one of the following: o HB or HB-unspecified received ≥112 days after 1st valid dose o HAHB received ≥168 days after 1st valid dose • 1st valid dose was HAHB AND current dose is HB, HB-unspecified or HAHB received ≥168 days after 1st valid dose Three-dose schedule (all students) 1) 1st valid dose – one of the following: • HB, HB (dialysis) or HB-unspecified received at ≥0 year old • HAHB received at ≥1 years old • DTaP-HB-IPV-Hib, DPT-HB, DPT-HB-Hib or DTaP-HB-IPV received ≥42 days old 2) 2nd valid dose – one of the following: • HB, HB (dialysis) or HB-unspecified received ≥28 days after 1st valid dose • HAHB received ≥28 days after 1st valid dose AND ≥1 year old • DTaP-HB-IPV-Hib, DPT-HB, DPT-HB-Hib or DTaP-HB-IPV received ≥28 days after 1st valid dose AND ≥42 days old 3) 3rd valid dose – one of the following: • 1st valid dose was HB, HB (dialysis), HB-unspecified, DTaP-HB-IPV-Hib,

	DPT-HB, DPT-HB-Hib or DTaP-HB-IPV AND one of the following: ○ HB, HB (dialysis), HB-unspecified, DTaP-HB-IPV-Hib, DPT-HB, DPT-HB-Hib or DTaP-HB-IPV received ≥112 days after 1st valid dose AND received ≥28 days after 2nd valid dose ○ HAHB received ≥168 days after 1st valid dose AND received ≥28 days after 2nd valid dose AND ≥1 year old • 1st valid dose was HAHB AND current dose is HB, HB (dialysis), HB-unspecified, DTaP-HB-IPV-Hib, DPT-HB, DPT-HB-Hib or DTaP-HB-IPV received ≥168 days after 1st valid dose AND received ≥28 days after 2nd valid dose
Addressing multiple relevant immunizing agents received on the same day	Use the following hierarchy to keep only one record: DTaP-HB-IPV-Hib > DTaP-HB-IPV or DPT-HB-Hib > DPT-HB > HAHB > HB (dialysis) > HB > HB-unspecified This hierarchy is guided by the inclusiveness of the agent (i.e., keep the agent that includes the largest number of antigens).
Evidence of immunity	Include evidence of immunity records for following: Hepatitis B (HB), Hepatitis B (HB-regular), Hepatitis B (HB-dialysis), Hep B antibody
Additional notes	• If a series involves at least two different immunizing agents, the validity of the current dose is assessed based on the logic corresponding to the 1st valid dose. An exception is for HAHB, where a 168-day interval is required between the first and last doses in the series whenever HAHB is administered as either the 1st valid dose or the last dose in the series. • For the Engerix®-B two-dose schedule, all variations of 'Engerix-B' are considered as Trade Name is a free-text field for historical immunizations. • Trade name is not considered for validation of the three-dose schedule. • Since Twinrix® and Twinrix® Junior are not differentiated at the agent level, all HAHB doses are assumed to be Twinrix® for the two-dose schedule and assumed to be Twinrix® Junior for the three-dose schedule. A more conservative age requirement (11-16 years) is imposed for the two-dose schedule. • For the two-dose schedules, doses given before 11 years of age do not affect the validity of doses given ≥ 11 years of age (e.g., doses administered before 11 years of age are not reviewed as part of valid dose assessment for HB two-dose coverage). • The HB component of DTaP-HB-IPV-Hib is validated even if administered on or after the age of 7 years. • HB (dialysis) is validated using the HB logic, but only under the three-dose schedule. • DPT-HB, DPT-HB-Hib and DTaP-HB-IPV are validated using the logic for DTaP-HB-IPV-Hib.

Human papillomavirus (HPV)

Age assessed	13 years old (females only)
***Up-to-date* definition**	Must satisfy one of the following criteria: • 3 valid doses in accordance with the 3-dose schedule • 2 valid doses in accordance with the 2-dose schedule
Relevant immunizing agents	HPV-2, HPV-4, HPV-9, hpv-unspecified
Vaccine interactions	None
Valid dose definitions	All students are assessed using both the two- and three-dose schedules. A student is assessed as being *up-to-date* if at least one schedule is satisfied. <u>2-dose schedule</u> 1) 1st valid dose: HPV-2, HPV-4 or hpv-unspecified received at 9 to <15 years old 2) 2nd valid dose – one of the following: • 1st valid dose was HPV-4 or hpv-unspecified AND current dose is HPV-2, HPV-4, or hpv-unspecified received ≥168 days after 1st valid dose • 1st valid dose was HPV-2 AND current dose is HPV-2, HPV-4 or hpv-unspecified received ≥140 days after 1st valid dose <u>3-dose schedule</u> 1) 1st valid dose: Received at ≥9 years old 2) 2nd valid dose: Received ≥28 days after 1st valid dose 3) 3rd valid dose – one of the following : • 1st valid dose was HPV-4, HPV-9, or hpv-unspecified AND current dose is received ≥84 days after 2nd valid dose • 1st valid dose was HPV-2 AND current dose is received ≥140 days after 1st valid dose
Addressing multiple relevant immunizing agents received on the same day	Use the following hierarchy to keep only one record: HPV-4 > hpv-unspecified > HPV-2 > HPV-9. The hierarchy is guided by probability of students having received the publicly-funded vaccine product and the availability of the HPV vaccine products in Ontario over the school years assessed.
Evidence of immunity	Not applicable
Additional notes	• If a series involves more than two different immunizing agents, the current dose is validated based on the logic corresponding to the 1st valid dose. • Ontario's HPV vaccination program switched from a 3-dose to a 2-dose schedule in September 2015. For coverage assessment, girls are assessed against both schedules and are considered as being *up-to-date* if they meet the *up-to-date* criteria for either of the schedules, regardless of the schedule used for program implementation in the school year of analysis.

Measles

Ages assessed	7 and 17 years old
***Up-to-date* definition**	Must satisfy one of the following criteria: • ≥2 valid doses • Have a documented exemption for evidence of immunity
Relevant immunizing agents	M, MR, MMR, MMR-Var
Vaccine interactions	Additional immunizing agents used to assess for vaccine interactions: Mu, R, Var, YF, Sma, Zoster, BCG vaccine. A minimum interval of 28 days between all live virus vaccine combinations is required, unless they are administered on the same day.
Valid dose definitions	Received relevant immunizing agent in accordance with the following criteria: 1) 1st valid dose: Received at ≥1 year old AND both of the following: • Received ≥28 days after any preceding measles-containing vaccine • Received on the same day or ≥28 days after any preceding non-measles containing live virus vaccine 2) 2nd valid dose: Received ≥28 days after any preceding measles-containing vaccine AND received on the same day or ≥28 days after any preceding non-measles containing live virus vaccine
Addressing multiple relevant immunizing agents received on the same day	• If multiple measles-containing agents are received on the same day, keep any one. • If multiple non-measles containing live virus vaccines are received on the same day, keep any one. • If a mix of measles- and non-measles containing live virus vaccines is received on the same day, keep one of each.
Evidence of immunity	Include evidence of immunity records for: Measles (M)

Meningococcal C conjugate (MCC)

Age assessed	7 years old
***Up-to-date* definition**	≥1 valid dose
Relevant immunizing agents	Men-C-ACYW135, Men-C-C, men-c-unspecified, men-AC unspecified, men-ACYW135 unspecified, men-unspecified, Men-C-CY-Hib
Vaccine interactions	Meningococcal polysaccharide C-containing agents: Men-P-ACYW135, men-p-AC unspecified, men-p-unspecified Doses of meningococcal polysaccharide agents administered <2 years of age are ignored as potential vaccine interactions due to the poor immune response generated by infants and toddlers to polysaccharide vaccines.
Valid dose definitions	Received relevant immunizing agent in accordance with the following criteria: 1) Valid dose: Received at ≥1 year old AND received on the same day or ≥168 days after any previous meningococcal polysaccharide C-containing dose
Addressing multiple relevant immunizing agents received on the same day	• If multiple MCC-containing vaccines (i.e., relevant immunizing agents) are received on the same day, keep any one. • If multiple meningococcal polysaccharide C-containing vaccines are received on the same day, keep any one. • If a mix of meningococcal conjugate and polysaccharide C-containing vaccines is received on the same day, keep one of each.
Evidence of immunity	Not applicable
Additional notes	• Only doses administered ≥1 year of age are assessed as being valid. No minimum interval is imposed between dose(s) administered prior to the first birthday for valid dose assessment of the dose administered on/after 1 year of age (i.e., doses administered prior to the first birthday are not reviewed as part of valid dose assessment for MCC coverage). • Due to the low completeness of the Trade Name data field in Panorama, product-specific logic could not be developed for MCV4 records. Thus, one valid dose of MCV4 vaccine administered ≥1 year of age is assessed as being sufficient for being *up-to-date* for MCC antigen at 7 years.

Meningococcal conjugate, quadrivalent (MCV4)

Age assessed	12 years old
***Up-to-date* definition**	≥1 valid dose
Relevant immunizing agents	Men-C-ACYW135, men-ACYW135 unspecified
Vaccine interactions	Meningococcal polysaccharide agents: Men-P-ACYW135, men-p-AC unspecified, men-p-unspecified, men-p-A unspecified Doses of meningococcal polysaccharide agents administered < 2 years of age are ignored as potential vaccine interactions due to the poor immune response generated by infants and toddlers to polysaccharide vaccines.
Valid dose definitions	Received relevant immunizing agent in accordance with the following criteria: 1) Valid dose: Received within five years prior to the assessment date (i.e., received ≥September 1, 2009 for the 2013–14 school year) AND received on the same day or ≥168 days after any previous meningococcal polysaccharide dose
Addressing multiple relevant immunizing agents received on the same day	• If multiple MCV4 vaccines (i.e., relevant immunizing agents) are received on the same day, keep any one. • If multiple meningococcal polysaccharide vaccines are received on the same day, keep any one. • If a mix of MCV4 and polysaccharide vaccines is received on the same day, keep one of each.
Evidence of immunity	Not applicable
Additional notes	• Extrapolating from the booster dose intervals recommended for children with high risk medical conditions (CIG recommends a booster dose every five years for those vaccinated at 7 years of age and older), PHO considers MCV4 doses administered in the five-year interval preceding eligibility in grade 7 as meeting the *up-to-date* criteria for adolescent MCV4 coverage.

Mumps

Ages assessed	7 and 17 years old
***Up-to-date* definition**	Must satisfy one of the following criteria: • ≥2 valid doses • Have a documented exemption for evidence of immunity
Relevant immunizing agents	Mu, MMR, MMR-Var
Vaccine interactions	Additional immunizing agents used to assess for vaccine interactions: M, MR, R, Var, YF, Sma, Zoster, BCG vaccine. A minimum interval of 28 days between all live virus vaccine combinations is required, unless they are administered on the same day.
Valid dose definitions	Received relevant immunizing agent in accordance with the following criteria: 1) 1st valid dose: Received at ≥1 year old AND both of the following: • Received ≥28 days after any preceding mumps-containing vaccine • Received on the same day or ≥28 days after any preceding non-mumps containing live virus vaccine 2) 2nd valid dose: Received ≥28 days after any preceding mumps-containing vaccine AND received on the same day or ≥28 days after any preceding non-mumps containing live virus vaccine
Addressing multiple relevant immunizing agents received on the same day	• If multiple mumps-containing agents are received on the same day, keep any one. • If multiple non-mumps containing live virus vaccines are received on the same day, keep any one. • If a mix of mumps- and non-mumps containing live virus vaccines is received on the same day, keep one of each.
Evidence of immunity	Include evidence of immunity records for: Mumps (Mu)

Pertussis

Ages assessed	7 and 17 years old

***Up-to-date* definition**	7-year-olds must satisfy one of the following criteria:
	• ≥5 valid doses
	• 4 valid doses (only if received 1st valid dose at <7 years old AND received 4th valid dose at ≥4 years old)
	
	17-year-olds must satisfy one of the following criteria:
	• ≥6 valid doses
	• 5 valid doses (only if received 1st valid dose at <7 years old AND received 4th valid dose at ≥4 years old)
	• 4 valid doses and only if satisfies one of the following:
	  ○ Received 1st valid dose at <7 years old AND <10 years between 4th valid dose and assessment date
	  ○ Received 1st valid dose at ≥7 years old (i.e., 2 primary and 2 booster doses)
	• 3 valid doses (only if received 1st valid dose ≥7 years old AND <10 years between 3rd valid dose and assessment date)*
	
	* PHO considers receipt of 2 primary doses and 1 'booster' dose for individuals who start their series late (i.e., ≥7 years old) as the minimum requirement to be considered *up-to-date*, as long as less than 10 years have elapsed between the last (booster) dose and the date of assessment.

Relevant immunizing agents	aP, DTaP, DTaP-HB-IPV-Hib, DTaP-IPV, DTaP-IPV-Hib, ap, Tdap, Tdap-IPV, ap-unspecified, DPT, DPT-HB, DPT-HB-Hib, DPT-Hib, DPT-IPV, DPTP, DPTP-Hib, pertussis-unspecified, wP, DTaP-HB-IPV
Vaccine interactions	None

Valid dose definitions	Received relevant immunizing agent in accordance with the following criteria:
	1) 1st valid dose: Received at ≥42 days old
	2) 2nd valid dose: Received ≥28 days after 1st valid dose
	3) 3rd valid dose – one of the following:
	• Received ≥28 days after 2nd valid dose AND received 1st valid dose at <7 years old
	• Received ≥168 days after 2nd valid dose AND received 1st valid dose at ≥7 years old
	4) 4th valid dose – one of the following:
	• Received ≥168 days after 3rd valid dose AND ≥1 year old AND received 1st valid dose at <7 years old
	• Received 1st valid dose at ≥7 years old AND one of the following:
	  ○ Received ≥10 years after 3rd valid dose
	  ○ Received ≥28 days after 3rd valid dose AND ≥14 years old
	5) 5th valid dose – one of the following:
	• Received 1st valid dose at <7 years old AND one of the following:
	  ○ Received ≥28 days after 4th valid dose AND ≥4 years old AND received 4th valid dose at 1 to <4 years old

	○ Received ≥10 years after 4th valid dose AND received 4th valid dose at ≥4 years old ○ Received ≥28 days after 4th valid dose AND ≥14 years old AND received 4th valid dose at ≥4 years old • Received ≥10 years after 4th valid dose AND received 1st valid dose at ≥7 years old 6) 6th valid dose – one of the following: • Received 1st valid dose at <7 years old AND received 4th valid dose at 1 to <4 years old AND one of the following: ○ Received ≥10 years after 5th valid dose ○ Received ≥28 days after 5th valid dose AND ≥14 years old • Received ≥10 years after 5th valid dose AND received 1st valid dose at <7 years old AND received 4th valid dose at ≥4 years old • Received ≥10 years after 5th valid dose AND received 1st valid dose at ≥7 years old
Addressing multiple relevant immunizing agents received on the same day	Keep any one (no distinction between aP, ap, pertussis-unspecified and wP)
Evidence of immunity	Not applicable
Additional notes	• All immunizing agents containing the respective antigens were considered valid (i.e., P or p) as long as they met the minimum age and minimum interval requirements. • Although an accelerated schedule is not specified in the CIG chapter on pertussis for children who initiate the series when ≥7 years old, the minimum intervals outlined between doses of the primary series for infants were also applied to older children.

Polio

Ages assessed	7 and 17 years old
***Up-to-date* definition**	Must satisfy one of the following criteria: • 4 valid doses • 3 valid doses (only if received 3rd valid dose at ≥4 years old)
Relevant immunizing agents	OPV, DPT-IPV, DT-IPV, DTaP-HB-IPV-Hib, DTaP-IPV, DTaP-IPV-Hib, IPV, T-IPV, Td-IPV, Tdap-IPV, DPTP, DPTP-Hib, p-unspecified, DTaP-HB-IPV
Vaccine interactions	None
Valid dose definitions	Received relevant immunizing agent in accordance with the following criteria: 1) 1st valid dose: Received at ≥42 days old 2) 2nd valid dose: Received ≥28 days after 1st valid dose 3) 3rd valid dose – one of the following: • Received ≥168 days after 2nd valid dose AND ≥1 year old • Received ≥168 days after 2nd valid dose AND ≥4 years old 4) 4th valid dose: Received ≥28 days after 3rd valid dose AND ≥4 years old AND received 3rd valid dose at <4 years old
Addressing multiple relevant immunizing agents received on the same day	Keep any one
Evidence of immunity	Not applicable
Additional notes	• IPV and OPV containing immunizing agents were considered interchangeable (while OPV is not used in Canada, it is still used elsewhere in the world). • In contrast to CIG, the dose administered at ≥4 years old does not need to be IPV (i.e., can be either IPV or OPV).

Pneumococcal conjugate

Age assessed	7 years old
***Up-to-date* definition**	Must satisfy one of the following criteria: • 4 valid doses in accordance with the 3+1 schedule • 3 valid doses in accordance with the 2+1 schedule • 2 valid doses in accordance with the 2-dose schedule • 1 valid dose in accordance with the 1-dose schedule
Relevant immunizing agents	Pneu-C-7, Pneu-C-10, Pneu-C-13, pneu-unspecified, pneu-c-unspecified
Vaccine interactions	Polysaccharide pneumococcal agents: Pneu-P-23, pneu-p-unspecified Doses of pneumococcal polysaccharide agents administered <2 years of age are ignored as potential vaccine interactions due to the poor immune response generated by infants and toddlers to polysaccharide vaccines.
Valid dose definitions	Several schedules were considered based on age at receipt of 1st valid dose and reflect the fact that 7-year-old cohorts in the schools years assessed would have been eligible for a 3+1 or a 2+1 schedule, depending on their year of birth. A child is assessed according to multiple schedules and is considered *up-to-date* if at least one of the following schedules is satisfied. <u>3+1 schedule (if received 1st valid dose at <7 months old)</u> 1) 1st valid dose: Received at ≥42 days to <7 months old AND received on the same day or ≥1 year after any preceding polysaccharide dose 2) 2nd valid dose: Received ≥28 days after 1st valid dose AND received on the same day or ≥1 year after any preceding polysaccharide dose 3) 3rd valid dose: Received ≥28 days after 2nd valid dose AND received on the same day or ≥1 year after any preceding polysaccharide dose 4) 4th valid dose: Received ≥56 days after 3rd valid dose AND ≥1 year old AND received on the same day or ≥1 year after any preceding polysaccharide dose <u>2+1 schedule (if received 1st valid dose at <1 year)</u> 1) 1st valid dose: Received at ≥42 days to <1 year old AND received on the same day or ≥1 year after any preceding polysaccharide dose 2) 2nd valid dose: Received ≥28 days after 1st valid dose AND received on the same day or ≥1 year after any preceding polysaccharide dose 3) 3rd valid dose: Received ≥56 days after 2nd valid dose AND ≥1 year old AND received on the same day or ≥1 year after any preceding polysaccharide dose <u>2-dose schedule (if received 1st valid dose at ≥1 year to <2 years)</u> 1) 1st valid dose: Received at ≥1 year to <2 years old AND received on the same day or ≥1 year after any preceding polysaccharide dose 2) 2nd valid dose: Received ≥56 days after 1st valid dose AND received on the same day or ≥1 year after any preceding polysaccharide dose

	<u>1 dose schedule (if received 1st valid dose at ≥2 years)</u> 1) 1st valid dose: Received at ≥2 years old AND received on the same day or ≥1 year after any preceding polysaccharide dose
Addressing multiple relevant immunizing agents received on the same day	• If multiple conjugate pneumococcal vaccines are received on the same day, keep any one. • If multiple polysaccharide pneumococcal vaccines are received on the same day, keep any one. • If a mix of conjugate and polysaccharide pneumococcal vaccines is received on the same day, keep one of each.
Evidence of immunity	Not applicable
Additional notes	• No distinction is made between serotype components of conjugate pneumococcal vaccine – any conjugate pneumococcal vaccine will be considered. • Several discrepancies were noted with respect to minimum ages and minimum intervals between the CIG chapter on pneumococcal vaccines and vaccine-specific product monographs. In general, the interval that would allow for the greatest number of valid doses was selected when discrepancies were noted.

Rubella

Ages assessed	7 and 17 years old
***Up-to-date* definition**	Must satisfy one of the following criteria: • ≥1 valid dose • Have a documented exemption for evidence of immunity
Relevant immunizing agents	R, MR, MMR, MMR-Var
Vaccine interactions	Additional immunizing agents used to assess for vaccine interactions: M, Mu, Var, YF, Sma, Zoster, BCG vaccine. A minimum interval of 28 days between all live virus vaccine combinations is required, unless they are administered on the same day.
Valid dose definitions	Received relevant immunizing agent in accordance with the following criteria: 1) 1st valid dose: Received at ≥1 year old AND both of the following: • Received ≥28 days after any preceding rubella-containing vaccine • Received on the same day or ≥28 days after any preceding non-rubella containing live virus vaccine
Addressing multiple relevant immunizing agents received on the same day	• If multiple rubella-containing agents are received on the same day, keep any one. • If multiple non-rubella containing live virus vaccines are received on the same day, keep any one. • If a mix of rubella- and non-rubella containing live virus vaccines is received on the same day, keep one of each.
Evidence of immunity	Include evidence of immunity records for: Rubella (R)

Tetanus

Ages assessed	7 and 17 years old

***Up-to-date* definition**	7-year-olds must satisfy one of the following criteria:
	• ≥5 valid doses
	• 4 valid doses (only if received 1st valid dose at <7 years old AND received 4th valid dose at ≥4 years old)
	
	17-year-olds must satisfy one of the following criteria:
	• ≥6 valid doses
	• 5 valid doses (only if received 1st valid dose at <7 years old AND received 4th valid dose at ≥4 years old)
	• 4 valid doses and only if satisfies one of the following:
	  ○ Received 1st valid dose at <7 years old AND <10 years between 4th valid dose and assessment date
	  ○ Received 1st valid dose at ≥7 years old (i.e., 2 primary and 2 booster doses)
	• 3 valid doses (only if received 1st valid dose ≥7 years old AND <10 years between 3rd valid dose and assessment date)*
	
	* PHO considers receipt of 2 primary doses and 1 'booster' dose for individuals who start their series late (i.e., ≥7 years old) as the minimum requirement to be considered *up-to-date*, as long as less than 10 years have elapsed between the last (booster) dose and the date of assessment.

Relevant immunizing agents	DPT, DPT-HB, DPT-HB-Hib, DPT-Hib, DPT-IPV, DPTP, DPTP-Hib, DT, DT-IPV, DTaP, DTaP-HB-IPV-Hib, DTaP-IPV, DTaP-IPV-Hib, T, T-IPV, Td, Td-IPV, Tdap, Tdap-IPV, DTaP-HB-IPV
Vaccine interactions	None

Valid dose definitions	Received relevant immunizing agent in accordance with the following criteria:
	1) 1st valid dose: Received at ≥42 days old
	2) 2nd valid dose: Received ≥28 days after 1st valid dose
	3) 3rd valid dose – one of the following:
	• Received ≥28 days after 2nd valid dose AND received 1st valid dose at <7 years old
	• Received ≥168 days after 2nd valid dose AND received 1st valid dose at ≥7 years old
	4) 4th valid dose – one of the following:
	• Received ≥168 days after 3rd valid dose AND ≥1-year-old AND received 1st valid dose at <7 years old
	• Received 1st valid dose at ≥7 years old AND one of the following:
	  ○ Received ≥10 years after 3rd valid dose
	  ○ Received ≥28 days after 3rd valid dose AND ≥14 years old
	5) 5th valid dose – one of the following:
	• Received 1st valid dose at <7 years old AND one of the following:
	  ○ Received ≥28 days after 4th valid dose AND ≥4 years old AND received 4th valid dose at 1 to <4 years old

	○ Received ≥10 years after 4th valid dose AND received 4th valid dose at ≥4 years old ○ Received ≥28 days after 4th valid dose AND ≥14 years old AND received 4th valid dose at ≥4 years old • Received ≥10 years after 4th valid dose AND received 1st valid dose at ≥7 years old 6) 6th valid dose – one of the following: • Received 1st valid dose at <7 years old AND received 4th valid dose at 1 to <4 years old AND one of the following: ○ Received ≥10 years after 5th valid dose ○ Received ≥28 days after 5th valid dose AND ≥14 years old • Received ≥10 years after 5th valid dose AND received 1st valid dose at <7 years old AND received 4th valid dose at ≥4 years old • Received ≥10 years after 5th valid dose AND received 1st valid dose at ≥7 years old
Addressing multiple relevant immunizing agents received on the same day	Keep any one
Evidence of immunity	Not applicable
Additional notes	• Although an accelerated schedule is not specified in the CIG chapter for tetanus for children who initiate the series when ≥7 years old, the minimum intervals outlined between doses of the primary series for infants were also applied to older children.

Varicella

Age assessed	7 years old
***Up-to-date* definition**	Must satisfy one of the following criteria: • ≥2 valid doses • Have a documented exemption for evidence of immunity
Relevant immunizing agents	Var, MMR-Var
Vaccine interactions	Additional immunizing agents used to assess for vaccine interactions: M, MMR, MR, Mu, R, YF, Sma, Zoster, BCG vaccine. A minimum interval of 28 days between all live virus vaccine combinations is required, unless they are administered on the same day.
Valid dose definitions	Received relevant immunizing agent in accordance with the following criteria: 1) 1st valid dose: Received at ≥1 year old AND both of the following: • Received ≥28 days after any preceding varicella-containing vaccine • Received on the same day or ≥28 days after any preceding non-varicella containing live virus vaccine 2) 2nd valid dose: Received ≥28 days after any preceding varicella-containing vaccine AND received on the same day or ≥28 days after any preceding non-varicella containing live virus vaccine
Addressing multiple relevant immunizing agents received on the same day	• If multiple varicella-containing agents are received on the same day, keep any one. • If multiple non-varicella containing live virus vaccines are received on the same day, keep any one. • If a mix of varicella- and non-varicella containing live virus vaccines is received on the same day, keep one of each.
Evidence of immunity	Include evidence of immunity records for following: Varicella (Var), Varicella-zoster antibody, Zoster (Zos)

Appendix 2: Immunization nomenclature in Panorama

Immunizing agent and antigen abbreviations	Description of antigen(s)
aP	Acellular pertussis
ap	Acellular pertussis (reduced)
ap-unspecified	Reduced acellular pertussis-containing agent (agent formulation unknown)
BCG vaccine	Bacillus Calmette-Guérin
D	Diphtheria toxoid
d	Diphtheria toxoid (reduced)
D-Hib	Diphtheria toxoid, *Haemophilus influenzae* type b
DPT	Diphtheria toxoid, tetanus toxoids, whole-cell pertussis
DPT-HB	Diphtheria toxoid, tetanus toxoid, whole-cell pertussis, hepatitis B
DPT-HB-Hib	Diphtheria toxoid, tetanus toxoid, whole-cell pertussis, hepatitis B, *Haemophilus influenzae* type b
DPT-Hib	Diphtheria toxoid, tetanus toxoid, whole-cell pertussis, *Haemophilus influenzae* type b
DPT-IPV	Diphtheria toxoid, tetanus toxoid, whole-cell pertussis, inactivated poliomyelitis
DPTP	Diphtheria toxoid, tetanus toxoid, whole-cell pertussis, poliomyelitis
DPTP-Hib	Diphtheria toxoid, tetanus toxoid, whole-cell pertussis, poliomyelitis, *Haemophilus influenzae* type b
DT	Diphtheria, tetanus
DTaP	Diphtheria, tetanus, acellular pertussis
DTaP-HB-IPV	Diphtheria toxoid, tetanus toxoid, acellular pertussis, hepatitis B, inactivated poliomyelitis
DTaP-HB-IPV-Hib	Diphtheria toxoid, tetanus toxoid, acellular pertussis, hepatitis B, inactivated poliomyelitis, *Haemophilus influenzae* type b
DTaP-IPV	Diphtheria toxoid, tetanus toxoid, acellular pertussis, inactivated poliomyelitis
DTaP-IPV-Hib	Diphtheria toxoid, tetanus toxoid, acellular pertussis, inactivated poliomyelitis, *Haemophilus influenzae* type b
DT-IPV	Diphtheria toxoid, tetanus toxoid, inactivated poliomyelitis
d-unspecified	Diphtheria toxoid-containing agent (agent formulation unknown)
HAHB	Hepatitis A, hepatitis B
HB	Hepatitis B
HB (dialysis)	Hepatitis B (dialysis formulation)
HB-unspecified	Hepatitis B-containing agent (agent formulation unknown)

Immunizing agent and antigen abbreviations	Description of antigen(s)
Hib	*Haemophilus influenzae* type b
HPV-2	Bivalent Human Papillomavirus [types 16, 18]
HPV-4	Quadrivalent Human Papillomavirus [types 6, 11, 16, 18]
HPV-9	Nonavalent Human Papillomavirus [types 6, 11, 16, 18, 31, 33, 45, 52, 58]
hpv-unspecified	Human Papillomavirus-containing agent (agent formulation unknown)
IPV	Inactivated poliomyelitis
M	Measles
men-AC-unspecified	Meningococcal groups A, C-containing agent (agent formulation unknown)
men-ACYW135 unspecified	Quadrivalent meningococcal-agent (agent formulation unknown)
Men-C-ACYW135	Meningococcal conjugate, quadrivalent (groups A, C, Y, W-135)
Men-C-C	Meningococcal conjugate, monovalent (group C)
Men-C-CY-Hib	Meningococcal conjugate (groups C, Y), *Haemophilus influenzae* type b
men-c-unspecified	Meningococcal conjugate agent (agent formulation unknown)
Men-P-AC unspecified	Meningococcal polysaccharide, bivalent (groups A, C)
Men-P-unspecified	Meningococcal polysaccharide agent (agent formulation unknown)
Men-P-ACYW135	Meningococcal polysaccharide, quadrivalent (groups A, C, Y, W-135)
men-p-A-unspecified	Meningococcal polysaccharide group A-containing agent (agent formulation unknown)
men-unspecified	Meningococcal agent (agent formulation unknown)
MMR	Measles, mumps, rubella
MMR-Var	Measles, mumps, rubella, varicella
MR	Measles, rubella
Mu	Mumps
OPV	Live attenuated oral poliomyelitis
p	Polio
pertussis-unspecified	Pertussis-containing agent (agent formulation unknown)
Pneu-C-10	Pneumococcal conjugate, 10-valent
Pneu-C-13	Pneumococcal conjugate, 13-valent
Pneu-C-7	Pneumococcal conjugate, 7-valent
Pneu-c-unspecified	Pneumococcal conjugate agent (agent formulation unknown)
Pneu-P-23	Pneumococcal polysaccharide, 23-valent
Pneu-p-unspecified	Pneumococcal polysaccharide agent (agent formulation unknown)
Pneu-unspecified	Pneumococcal agent (agent formulation unknown)
p-unspecified	Poliomyelitis-containing agent (agent formulation unknown)
R	Rubella
Sma	Smallpox
T	Tetanus
Td	Tetanus toxoid, reduced diphtheria toxoid
Tdap	Tetanus toxoid, reduced diphtheria toxoid, reduced acellular pertussis

Immunizing agent and antigen abbreviations	Description of antigen(s)
Tdap-IPV	Tetanus toxoid, reduced diphtheria toxoid, reduced acellular pertussis, inactivated poliomyelitis
Td-IPV	Tetanus toxoid, reduced diphtheria toxoid, inactivated poliomyelitis
T-IPV	Tetanus toxoid, inactivated poliomyelitis
Var	Varicella
wP	Whole-cell pertussis
YF	Yellow Fever
Zoster	Herpes zoster

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