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Technical Annex

Immunization Coverage Report for School Pupils in Ontario: 2016–17 School Year

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Public Health Ontario

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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: 2016-17 School Year. Technical information includes an in-depth explanation of the analytic methods used in the report and a description of the limitations of immunization coverage data in Ontario. This detail is not included in the coverage report.

Background

Between 2013 and 2016, all 36 public health units (PHUs) in Ontario 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
- Document consent to receive immunizations
- Transcribe historical immunizations reported to the PHU by parents/guardians
- Document exemptions under the Immunization of School Pupils Act (*ISPA*)
- Upload student lists received from schools and school boards
- Forecast future doses for individuals within the DHIR according to the provincial immunization schedule

Prior to the implementation of Panorama, immunization coverage was calculated by compiling complete-for-age measures generated from IRIS at each PHU into a provincial report prepared by PHO. With the implementation of the Panorama Enhanced Analytical Reporting (PEAR) tool in 2016, PHO was able to extract person-level immunization records for the calculation of up-to-date coverage, the measure used by other jurisdictions within Canada and globally. Coverage estimates using up-to-date measures provide a more accurate representation of population protection compared to complete-for-age measures because they calculate 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. Up-to-date coverage estimates have been used to assess coverage in Ontario for the school years 2013-14 and onwards, including the new estimates provided in this report for the 2016-17 school year. These estimates are not directly comparable to the estimates produced using the complete-for-age measure in IRIS (school years prior to 2013-14). More information on the complete-for-age measure can be found in the Immunization Coverage Report for the 2012–13 School Year.

Methods

Data Source and Extraction

Data used to generate all coverage estimates for the 2016-17 report were extracted from the DHIR using the PEAR tool on September 1, 2017. Extracted data included demographic information (e.g., gender and date of birth), immunization records, education records (e.g., location and dates of school attendance), special consideration records (e.g., exemptions), and school information for students in the 7-, 12-, 13- and 17-year-old age cohorts for the 2016-17 school year (September 1, 2016 to August 31, 2017). Data were compiled and analyzed to derive up-to-date coverage estimates using the statistical software program SAS® version 9.4.

Age Cohorts

Cohorts of students that correspond to coverage assessment milestone ages[1] were identified using the calendar year of birth (i.e., students who had turned the milestone age by December 31, 2016 were included in the age cohort). For example, those children who had their 7th birthday between January 1 and December 31, 2016 are represented in the 7-year-old cohort for the 2016-17 school year. This method ensures that all children included in our assessment have reached the age milestone at the time of assessment (August 31, 2017). This age-based approach was used for all immunization programs under assessment. Although eligibility for school-based programs is determined by school grade, age cohorts were used to represent grades due to concerns regarding the completeness of the school *Grade* field in the DHIR. Age cohorts of 12 and 13 years were used in place of grades 7 and 8 respectively as children in these grades have typically turned these ages by December 31st of the school year. Table 1 outlines the birth years corresponding with the cohorts assessed in the report for the 2016-17 school year.

Table 1. Age cohorts and corresponding birth years for the 2016–17 school year

Age cohort*	Birth Year
7 years	2009
12 years	2004
13 years	2003
17 years	1999

*Age as of December 31, 2016

Immunization Data

Student immunization information is collected from parents and guardians at the time of school enrolment and/or 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. Parents and guardians submit immunization information to the PHU where their child attends school, which the PHU then enters into the DHIR. Parents may choose to report their child's immunizations electronically using Immunization Connect Ontario (ICON), a web-based portal for the public to securely report immunization data to PHUs and review their child's immunization records within the DHIR. For school-based immunization programs delivered by PHUs, PHU staff members enter immunization information directly into the DHIR using the Panorama application. This typically occurs at the time of immunization; however entry practices may vary by PHU.

Immunization information was extracted for analysis to derive coverage estimates for the following antigens:

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

Only immunizations administered on or before the assessment date (August 31, 2017) are included in the calculation of coverage estimates. 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 using the following formula:

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

Denominator: All students in the specified age cohort with an active client record and at least one school record during the 2016–17 school year.

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 or vaccine, as appropriate, are outlined in Appendix 1 of this document. The definitions specify the number of doses, minimum intervals between doses and other conditions required for students to be assessed as up-to-date, by age. All minimum intervals less than one year in length were calculated using a 28-day month (one month = 28 days; six months = 168 days). Up-to-date definitions were developed after consulting multiple resources including vaccine product monographs, the Ontario publicly-funded immunization schedule,[2] the *Canadian Immunization Guide*,[3] the *Panorama Ontario Immunization Schedules Logic: Reference Document*[4] and local experts.

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 or 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 (i.e., are up-to-date). Series completion among initiators was calculated for the hepatitis B and HPV school-based programs.

Vaccine Interactions

Immunization information for all live-virus parenteral vaccines including those not assessed for coverage (e.g., yellow fever and Bacillus Calmette-Guérin (BCG) vaccines) were examined for vaccine interactions with other live-virus vaccines. Doses of parenteral live-virus vaccines administered less than 28 days since the receipt of another live-virus vaccine were considered invalid and not counted towards the

dose requirements for up-to-date coverage. Please refer to the antigen-specific tables in Appendix 1 for a list of immunizing agents relevant to vaccine interactions (if applicable) and valid dose assessment.

Evidence of Immunity

Under the *ISPA*, students are granted exemptions from 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 to be protected or 'covered' within our up-to-date coverage estimates, where relevant. Immunization exemption records were examined for the presence of immunity to diseases 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;[3] however, we were not able to confidently identify the age of infection using exemption information. Therefore, we assumed that PHUs only entered varicella exemptions based on history of disease for children with infections that occurred at 12 months of age or later.

It should be noted that exemptions due to prior disease for hepatitis B may under-represent the true number of children with prior immunity to or clinical record of hepatitis B. Hepatitis B is not designated under the *ISPA*; however, if hepatitis B exemption records were recorded by PHUs in Panorama we did include them in the calculation of coverage for hepatitis B.

Receipt of Multiple Vaccines 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 details.

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 2016-17 school year. 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 analyses of coverage only if they had at least one education record that was active at any time during the 2016-17 school year, as determined by the education record's *Effective From* and *Effective To* dates (Table 2). Students without a school record during the 2016-17 school year were removed from the analytic cohort as these students had no evidence of school attendance, and were unlikely to have attended school in Ontario, during the 2016-17 school year.

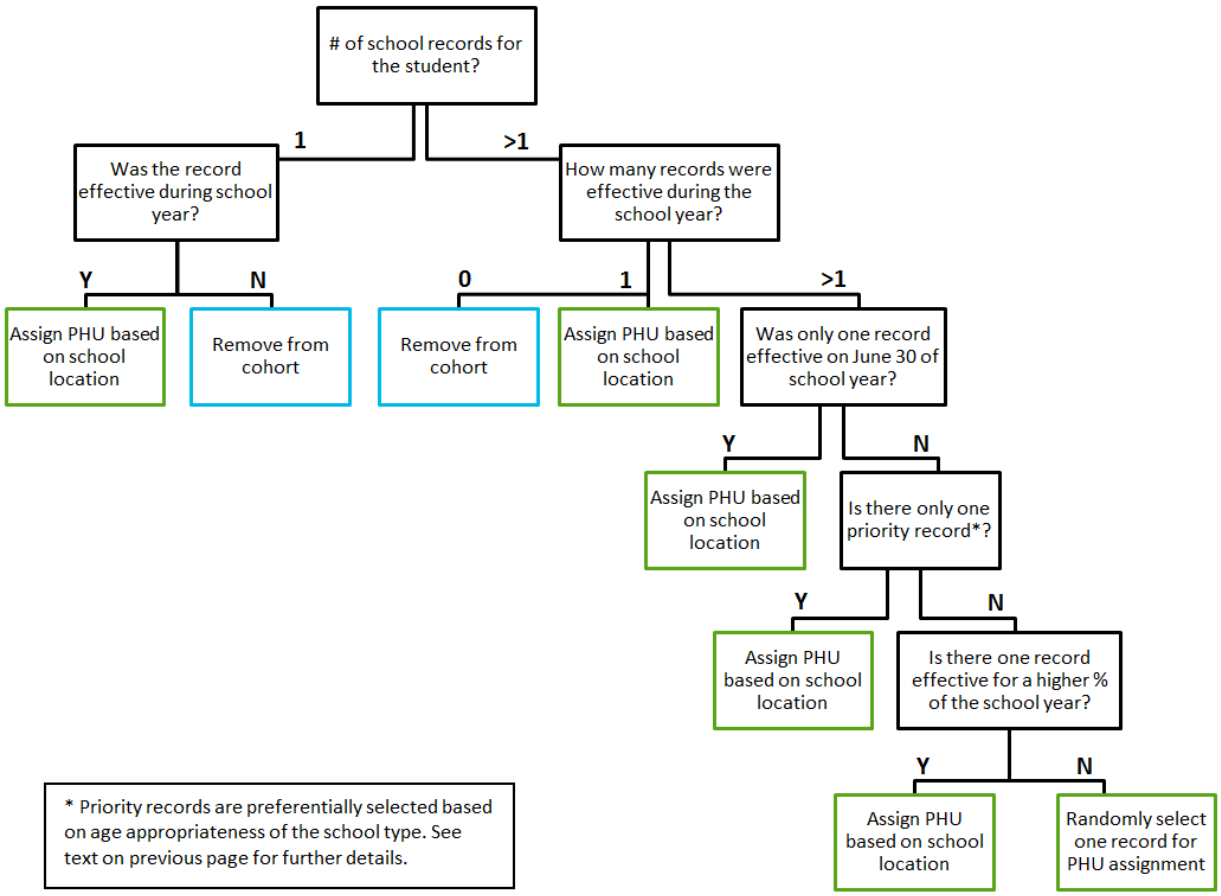
Table 2. Criteria for education records to be considered current for the 2016–17 school year

School year	Effective To	Effective From
2016-17	On or after September 1, 2016 or missing	On or before August 31, 2017

Several data management steps were undertaken with regards to education records. Education records were 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. For examples, education records were excluded if: there was no school ID, the school name included the term 'holding', the school type was 'other', 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 decision algorithm presented in Figure 1 to assign each student to one PHU per school year. 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. For the remaining 2% of students, when a student had more than one education record during the school year, one record was chosen based on the school attended on June 30, 2017, 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 assessed by preferentially selecting school records that were most plausible based on the student's age. For example, the first 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.

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



Geographic Distribution

PHU-specific coverage estimates for the 2016–17 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.

Limitations

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 process of immunization coverage assessment 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.

The complexity of education records in the DHIR 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 methods may have excluded current students from the analysis or assigned students to a PHU that had not been involved in immunization delivery or *ISPA* assessment activities. We believe that likelihood that these events have introduced error into the coverage estimates is small given that 98% of student assignments were straightforward. Education records in the DHIR are updated by PHUs using school/school board generated student lists at various times throughout the year. Depending on the timing of these updates, new or transferred students may not have been captured in PHU *ISPA* enforcement activities for the school year.

Due to concerns regarding the completeness of the school grade field in the DHIR, age cohorts were used to approximate the school grades at which students are eligible for school-based immunization programs. 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 an extract 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. As a result, coverage may be underestimated as children who are 12 years of age but have not yet reached grade 7 will not have had an opportunity to be vaccinated.

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 originally entered into IRIS and subsequently migrated to the DHIR, as these data were not entered using the standardized terminology/format implemented with Panorama. The specific dates each PHU moved over from using IRIS to the DHIR vary, but most data in the DHIR which was entered prior to and including 2014 was migrated from IRIS (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, but have different dose schedules). 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, during data entry at the PHU or by parents using web-based portals such as ICON may also impact immunization coverage estimates. These errors could include incorrect vaccines administered or documented, incorrect intervals between immunizations, lack of knowledge of updates to the schedule, or errors in transcription of administered doses.

Data Completeness

It is possible that students who are described as being under-immunized within this report may have been appropriately immunized, but the information has not been provided to their local PHU or 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 incorrect information 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 DHIR 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 diseases 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.

Data Migration

As the immunization module of the Panorama system has only been fully implemented in Ontario since 2016, 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.[6] This reduces the completeness and usefulness of the *Trade Name* field for analytic purposes. The 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 existing processes is documenting immunization records of 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*[7,8] 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 have a higher risk of complications in younger age groups, especially infants, who are particularly vulnerable. Furthermore, the age of two years is a nationally and internationally defined benchmark to monitor progress towards meeting immunization coverage goals.[1]

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Appendix 1: Up-to-Date Definitions by Antigen

Diphtheria

Parameter	Definition
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: o Received 1st valid dose at <7 years old AND <10 years between 4th valid dose and assessment date o Received 1st valid dose at ≥7 years old (i.e., two primary and two 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 two primary doses and one 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 vaccines	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, DTaP-HB-IPV, d, Td, Td-IPV, Tdap, Tdap-IPV, d-unspecified
Vaccine interactions	None
Multiple vaccines on the same day	Keep any one (no distinction made between D, d, and d-unspecified)
Evidence of immunity	Not applicable
Valid dose definitions	Received relevant immunizing agent in accordance with the following criteria: • 1st valid dose: Received at ≥42 days old • 2nd valid dose: Received ≥28 days after 1st valid dose • 3rd valid dose: One of the following o Received 1st valid dose at <7 years old AND received ≥28 days after 2nd valid dose o Received 1st valid dose at ≥7 years old AND received ≥168 days after

Parameter	Definition
	2nd valid dose • 4th valid dose: One of the following o Received 1st valid dose at <7 years old AND received ≥168 days after 3rd valid dose AND ≥1 year old o 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 • 5th valid dose: One of the following o Received 1st valid dose at <7 years old AND one of the following: - Received 4th valid dose at 1 to <4 years old AND received ≥28 days after 4th valid dose AND ≥4 years old - Received 4th valid dose at ≥4 years old AND received ≥10 years after 4th valid dose - Received 4th valid dose at ≥4 years old AND received ≥28 days after 4th valid dose AND ≥14 years old o Received 1st valid dose at ≥7 years old AND received ≥10 years after 4th valid dose • 6th valid dose: One of the following o 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 o Received 1st valid dose at <7 years old AND received 4th valid dose at ≥4 years old AND received ≥10 years after 5th valid dose o Received 1st valid dose at ≥7 years old AND received ≥10 years after 5th valid dose
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)

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

Hepatitis B

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

Parameter	Definition
	• 2nd valid dose: One of the following o HB, HB (dialysis) or HB-unspecified received ≥28 days after 1st valid dose o HAHB received ≥28 days after 1st valid dose AND ≥1 year old o DTaP-HB-IPV-Hib, DPT-HB, DPT-HB-Hib or DTaP-HB-IPV received ≥28 days after 1st valid dose AND ≥42 days old • 3rd valid dose: One of the following o 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 o 1st valid dose was HAHB AND current dose is HB, HB (dialysis), HB-unspecified, HAHB, 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
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 since *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)

Parameter	Definition
Age assessed	13 years old (females only) 12 years old (females and males) 12 years old (females only) 12 years old (males only)
Up-to-date definition	Must satisfy one of the following criteria: • 3 valid doses in accordance with the three-dose schedule • 2 valid doses in accordance with the two-dose schedule
Relevant vaccines	HPV-2, HPV-4, HPV-9, hpv-unspecified
Vaccine interactions	None
Multiple vaccines on the same day	Use the following hierarchy to keep only one record: HPV-4 > hpv-unspecified > HPV-9 > HPV-2. The hierarchy is guided by giving preference to the publicly-funded vaccine used in Ontario in the 2016–17 school year (HPV-4), and then considering the vaccine offering protection against the greatest number of HPV genotypes. Unspecified HPV vaccines were assumed to be capturing the use of HPV-4 given the high prevalence of HPV-4 vaccines administered during this school year.
Evidence of immunity	Not applicable
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. ***If gender is female:*** <u>Two-dose schedule</u> • 1st valid dose: HPV-2, HPV-4, HPV-9 or hpv-unspecified received at 9 to <15 years old • 2nd valid dose: HPV-2, HPV-4, HPV-9 or hpv-unspecified received ≥168 days after 1st valid dose <u>Three-dose schedule</u> • 1st valid dose: HPV-2, HPV-4, HPV-9, or hpv-unspecified received at ≥9 years old • 2nd valid dose: HPV-2, HPV-4, HPV-9, or hpv-unspecified received ≥28 days after 1st valid dose • 3rd valid dose: HPV-2, HPV-4, HPV-9, or hpv-unspecified AND received ≥84 days after 2nd valid dose AND ≥168 days after 1st valid dose ***If gender is male:*** <u>Two-dose schedule</u>

Parameter	Definition
	• 1st valid dose: HPV-4, HPV-9 or hpv-unspecified received at 9 to <15 years old • 2nd valid dose: HPV-4, HPV-9 or hpv-unspecified received ≥168 days after 1st valid dose <u>Three-dose schedule</u> • 1st valid dose: HPV-4, HPV-9, or hpv-unspecified received at ≥9 years old • 2nd valid dose: HPV-4, HPV-9, or hpv-unspecified received ≥28 days after 1st valid dose • 3rd valid dose: HPV-4, HPV-9, or hpv-unspecified AND received ≥84 days after 2nd valid dose AND ≥168 days after 1st valid dose
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 • Beginning in the 2016–17 school year, Ontario's HPV vaccination program switched from a program for Grade 8 girls to Grade 7 boys and girls. In the 2016–17 school year, Grade 8 girls were also eligible for the program. Both 12- and 13-year-old age cohorts were assessed in the 2016–17 school year • HPV-2 is not incorporated into the valid dose parameters for coverage in males as it is not authorized for use in males • Among grade 7 students in Ontario in the 2016–17 school year (n=149,110), only 12 students had a gender classification of 'unknown'. This small number prevents reporting on HPV coverage for this gender classification at a PHU-level, due to the very small number of students. For this reason, students of unknown gender are not included in any of the HPV coverage estimates

Measles

Parameter	Definition
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 vaccines	M, MR, MMR, MMR-Var
Vaccine interactions	A minimum interval of 28 days between all live-virus vaccine combinations is required, unless they are administered on the same day. Additional immunizing agents used to assess for vaccine interactions: Mu, R, Var, YF, Sma, Zoster, BCG vaccine.
Multiple vaccines 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)
Valid dose definitions	Received relevant immunizing agent in accordance with the following criteria: • 1st valid dose: Received at ≥1 year old AND both of the following: o Received ≥28 days after any preceding measles-containing vaccine o Received on the same day or ≥28 days after any preceding non-measles containing live-virus vaccine • 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

Meningococcal C conjugate (MCC)

Parameter	Definition
Age assessed	7 years old
Up-to-date definition	≥1 valid dose
Relevant vaccines	Men-C-ACYW135, Men-C-C, Men-C-CY-Hib, Men-C-AC, men-c-unspecified, men-AC unspecified, men-ACYW135 unspecified, men-unspecified
Vaccine interactions	A minimum interval of 168 days (or received on the same day) is required between a meningococcal polysaccharide vaccine followed by a meningococcal conjugate vaccine. 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.
Multiple vaccines 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
Valid dose definitions	Received relevant immunizing agent in accordance with the following criteria: • Valid dose: Received at ≥1 year old AND received on the same day or ≥168 days after any previous meningococcal polysaccharide C-containing dose
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* field in Panorama, product-specific logic could not be developed for quadrivalent meningococcal conjugate (MCV4) records (as different MCV4 products have different dose recommendations and minimum interval requirements). Thus, one valid dose of MCV4 vaccine administered ≥1 year of age is assessed as being sufficient for being up-to-date for MCC at 7 years

Meningococcal conjugate, quadrivalent (MCV4)

Parameter	Definition
Age assessed	12 years old
Up-to-date definition	≥1 valid dose
Relevant vaccines	Men-C-ACYW135, men-ACYW135 unspecified
Vaccine interactions	A minimum interval of 168 days (or received on the same day) is required between a meningococcal polysaccharide vaccine followed by a meningococcal conjugate vaccine. 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.
Multiple vaccines 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
Valid dose definitions	Received relevant immunizing agent in accordance with the following criteria: • Valid dose: Received within five years prior to the assessment date (i.e., received on or after September 1, 2012 for the 2016–17 school year) AND received on the same day or ≥168 days after any previous meningococcal polysaccharide dose
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

Parameter	Definition
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 vaccines	Mu, MMR, MMR-Var
Vaccine interactions	A minimum interval of 28 days between all live virus vaccine combinations is required, unless they are administered on the same day. Additional immunizing agents used to assess for vaccine interactions: M, MR, R, Var, YF, Sma, Zoster, BCG vaccine.
Multiple vaccines 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)
Valid dose definitions	Received relevant immunizing agent in accordance with the following criteria: • 1st valid dose: Received at ≥1 year old AND both of the following: o Received ≥28 days after any preceding mumps-containing vaccine o Received on the same day or ≥28 days after any preceding non-mumps containing live virus vaccine • 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

Pertussis

Parameter	Definition
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: o Received 1st valid dose at <7 years old AND <10 years between 4th valid dose and assessment date o Received 1st valid dose at ≥7 years old (i.e., two primary and two 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 two primary doses and one '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 vaccines	aP, DTaP, DTaP-HB-IPV-Hib, DTaP-IPV, DTaP-HB-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
Vaccine interactions	None
Multiple vaccines on the same day	Keep any one (no distinction between aP, ap, pertussis-unspecified and wP)
Evidence of immunity	Not applicable
Valid dose definitions	Received relevant immunizing agent in accordance with the following criteria: • 1st valid dose: Received at ≥42 days old • 2nd valid dose: Received ≥28 days after 1st valid dose • 3rd valid dose: One of the following o Received 1st valid dose at <7 years old AND received ≥28 days after 2nd valid dose o Received 1st valid dose at ≥7 years old AND received ≥168 days after 2nd valid dose • 4th valid dose: One of the following o Received 1st valid dose at <7 years old AND received ≥168 days after 3rd valid dose AND ≥1 year old

Parameter	Definition
	o 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 • 5th valid dose: One of the following o Received 1st valid dose at <7 years old AND one of the following: - Received 4th valid dose at 1 to <4 years old AND received ≥28 days after 4th valid dose AND ≥4 years old - Received 4th valid dose at ≥4 years old AND received ≥10 years after 4th valid dose - Received 4th valid dose at ≥4 years old AND received ≥28 days after 4th valid dose AND ≥14 years old o Received 1st valid dose at ≥7 years old AND received ≥10 years after 4th valid dose • 6th valid dose: One of the following o 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 o Received 1st valid dose at <7 years old AND received 4th valid dose at ≥4 years old AND received ≥10 years after 5th valid dose o Received 1st valid dose at ≥7 years old AND received ≥10 years after 5th valid dose
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

Parameter	Definition
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 vaccines	OPV, DPT-IPV, DT-IPV, DTaP-HB-IPV-Hib, DTaP-IPV, DTaP-HB-IPV, DTaP-IPV-Hib, IPV, T-IPV, Td-IPV, Tdap-IPV, DPTP, DPTP-Hib, p-unspecified
Vaccine interactions	None
Multiple vaccines on the same day	Keep any one (no distinction between OPV and IPV)
Evidence of immunity	Not applicable
Valid dose definitions	Received relevant immunizing agent in accordance with the following criteria: • 1st valid dose: Received at ≥42 days old • 2nd valid dose: Received ≥28 days after 1st valid dose • 3rd valid dose: Received ≥168 days after 2nd valid dose AND ≥1 year old • 4th valid dose: Received 3rd valid dose at <4 years old AND received ≥28 days after 3rd valid dose AND ≥4 years old
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

Parameter	Definition
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 two-dose schedule • 1 valid dose in accordance with the one-dose schedule
Relevant vaccines	Pneu-C-7, Pneu-C-10, Pneu-C-13, pneu-unspecified, pneu-c-unspecified
Vaccine interactions	A minimum interval of one year (or received on the same day) is required between a pneumococcal polysaccharide vaccine followed by a pneumococcal conjugate vaccine. 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.
Multiple vaccines 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
Valid dose definitions	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</u> • 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 • 2nd valid dose: Received ≥28 days after 1st valid dose AND received on the same day or ≥1 year after any preceding polysaccharide dose • 3rd valid dose: Received ≥28 days after 2nd valid dose AND received on the same day or ≥1 year after any preceding polysaccharide dose • 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</u> • 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

Parameter	Definition
	• 2nd valid dose: Received ≥28 days after 1st valid dose AND received on the same day or ≥1 year after any preceding polysaccharide dose • 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>Two-dose schedule</u> • 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 • 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>One-dose schedule</u> • 1st valid dose: Received at ≥2 years old AND received on the same day or ≥1 year after any preceding polysaccharide dose
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

Parameter	Definition
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 vaccines	R, MR, MMR, MMR-Var
Vaccine interactions	A minimum interval of 28 days between all live virus vaccine combinations is required, unless they are administered on the same day. Additional immunizing agents used to assess for vaccine interactions: M, Mu, Var, YF, Sma, Zoster, BCG vaccine.
Multiple vaccines 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)
Valid dose definitions	Received relevant immunizing agent in accordance with the following criteria: • 1st valid dose: Received at ≥1 year old AND both of the following: o Received ≥28 days after any preceding rubella-containing vaccine o Received on the same day or ≥28 days after any preceding non-rubella containing live virus vaccine

Tetanus

Parameter	Definition
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: o Received 1st valid dose at <7 years old AND <10 years between 4th valid dose and assessment date o Received 1st valid dose at ≥7 years old (i.e., two primary and two 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 two primary doses and one '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 vaccines	DPT, DPT-HB, DPT-HB-Hib, DPT-Hib, DPT-IPV, DPTP, DPTP-Hib, DT, DT-IPV, DTaP, DTaP-HB-IPV-Hib, DTaP-IPV, DTaP-HB-IPV, DTaP-IPV-Hib, T, T-IPV, Td, Td-IPV, Tdap, Tdap-IPV
Vaccine interactions	None
Multiple vaccines on the same day	Keep any one
Evidence of immunity	Not applicable
Valid dose definitions	Received relevant immunizing agent in accordance with the following criteria: • 1st valid dose: Received at ≥42 days old • 2nd valid dose: Received ≥28 days after 1st valid dose • 3rd valid dose: One of the following o Received 1st valid dose at <7 years old AND received ≥28 days after 2nd valid dose o Received 1st valid dose at ≥7 years old AND received ≥168 days after 2nd valid dose • 4th valid dose: One of the following o Received 1st valid dose at <7 years old AND received ≥168 days after 3rd valid dose AND ≥1-year-old

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

Parameter	Definition
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 vaccines	Var, MMR-Var
Vaccine interactions	A minimum interval of 28 days between all live-virus vaccine combinations is required, unless they are administered on the same day. Additional immunizing agents used to assess for vaccine interactions: M, MMR, MR, Mu, R, YF, Sma, Zoster, BCG vaccine.
Multiple vaccines 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)
Valid dose definitions	Received relevant immunizing agent in accordance with the following criteria: • 1st valid dose: Received at ≥1 year old AND both of the following: o Received ≥28 days after any preceding varicella-containing vaccine o Received on the same day or ≥28 days after any preceding non-varicella containing live virus vaccine • 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

Appendix 2: Immunization Nomenclature in Panorama

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

Abbreviation	Description of antigen(s)	Source
DTaP-HB-IPV	Diphtheria toxoid, tetanus toxoid, acellular pertussis, hepatitis B, inactivated poliomyelitis	Panorama
DTaP-HB-IPV-Hib	Diphtheria toxoid, tetanus toxoid, acellular pertussis, hepatitis B, inactivated poliomyelitis, *Haemophilus influenzae* type b	Panorama
DTaP-IPV	Diphtheria toxoid, tetanus toxoid, acellular pertussis, inactivated poliomyelitis	Panorama
DTaP-IPV-Hib	Diphtheria toxoid, tetanus toxoid, acellular pertussis, inactivated poliomyelitis, *Haemophilus influenzae* type b	Panorama
DT-IPV	Diphtheria toxoid, tetanus toxoid, inactivated poliomyelitis	Panorama
d-unspecified	Diphtheria toxoid-containing agent (agent formulation unknown)	Panorama
HAHB	Hepatitis A, hepatitis B	Panorama
HB	Hepatitis B	Panorama
HB (dialysis)	Hepatitis B (dialysis formulation)	Panorama
HB-unspecified	Hepatitis B-containing agent (agent formulation unknown)	Panorama
Hib	*Haemophilus influenzae* type b	Panorama; coverage assessment
HPV	Human papillomavirus	Coverage assessment
HPV-2	Bivalent human papillomavirus [types 16, 18]	Panorama
HPV-4	Quadrivalent human papillomavirus [types 6, 11, 16, 18]	Panorama
HPV-9	Nonavalent human papillomavirus [types 6, 11, 16, 18, 31, 33, 45, 52, 58]	Panorama
hpv-unspecified	Human papillomavirus-containing agent (agent formulation unknown)	Panorama

Abbreviation	Description of antigen(s)	Source
IPV	Inactivated poliomyelitis	Panorama
M	Measles	Panorama
MCC	Meningococcal-C-conjugate	Coverage assessment
MCV4	Quadrivalent meningococcal conjugate	Coverage assessment
men-AC-unspecified	Meningococcal groups A, C-containing agent (agent formulation unknown)	Panorama
men-ACYW135 unspecified	Quadrivalent meningococcal-agent (agent formulation unknown)	Panorama
Men-C-AC	Meningococcal conjugate bivalent (groups A, C)	Panorama
Men-C-ACYW135	Meningococcal conjugate, quadrivalent (groups A, C, Y, W-135)	Panorama
Men-C-C	Meningococcal conjugate, monovalent (group C)	Panorama
Men-C-CY-Hib	Meningococcal conjugate (groups C, Y), *Haemophilus influenzae* type b	Panorama
men-c-unspecified	Meningococcal conjugate agent (agent formulation unknown)	Panorama
Men-P-AC unspecified	Meningococcal polysaccharide, bivalent (groups A, C)	Panorama
Men-P-unspecified	Meningococcal polysaccharide agent (agent formulation unknown)	Panorama
Men-P-ACYW135	Meningococcal polysaccharide, quadrivalent (groups A, C, Y, W-135)	Panorama
men-p-A-unspecified	Meningococcal polysaccharide group A-containing agent (agent formulation unknown)	Panorama
men-unspecified	Meningococcal agent (agent formulation unknown)	Panorama
MMR	Measles, mumps, rubella	Panorama
MMR-Var	Measles, mumps, rubella, varicella	Panorama

Abbreviation	Description of antigen(s)	Source
MR	Measles, rubella	Panorama
Mu	Mumps	Panorama
OPV	Live attenuated oral poliomyelitis	Panorama
p	Polio	Panorama
pertussis-unspecified	Pertussis-containing agent (agent formulation unknown)	Panorama
Pneu-C-10	Pneumococcal conjugate, 10-valent	Panorama
Pneu-C-13	Pneumococcal conjugate, 13-valent	Panorama
Pneu-C-7	Pneumococcal conjugate, 7-valent	Panorama
Pneu-c-unspecified	Pneumococcal conjugate agent (agent formulation unknown)	Panorama
Pneu-P-23	Pneumococcal polysaccharide, 23-valent	Panorama
Pneu-p-unspecified	Pneumococcal polysaccharide agent (agent formulation unknown)	Panorama
Pneu-unspecified	Pneumococcal agent (agent formulation unknown)	Panorama
p-unspecified	Poliomyelitis-containing agent (agent formulation unknown)	Panorama
R	Rubella	Panorama
Sma	Smallpox	Panorama
T	Tetanus	Panorama
Td	Tetanus toxoid, reduced diphtheria toxoid	Panorama
Tdap	Tetanus toxoid, reduced diphtheria toxoid, reduced acellular pertussis	Panorama
Tdap-IPV	Tetanus toxoid, reduced diphtheria toxoid, reduced acellular pertussis, inactivated poliomyelitis	Panorama

Abbreviation	Description of antigen(s)	Source
Td-IPV	Tetanus toxoid, reduced diphtheria toxoid, inactivated poliomyelitis	Panorama
T-IPV	Tetanus toxoid, inactivated poliomyelitis	Panorama
Var	Varicella	Panorama
wP	Whole-cell pertussis	Panorama
YF	Yellow Fever	Panorama
Zoster	Herpes zoster	Panorama

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