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PHIMS Immunization: Forecaster

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What is the Forecaster?

The Forecaster is a **decision support tool** that validates recorded immunizations and recommends when future immunizations should be administered to a client.

The Forecaster is **not** a replacement for clinical judgment.

The Forecaster is based on the province of Manitoba's routine immunization schedule and will forecast the next dose in the series.

The Forecaster recommends future immunizations for a client by considering certain information about the client and a set of immunization rules informed by the Manitoba routine immunization schedules. The immunization rules are divided into two types:

- **Schedule Dose Rules** which address the timing of immunizations according to age specific programs.
- **Interaction Rules** that address the interactions between vaccines.

The Forecaster recommends when future immunizations are due according to the Manitoba routine immunization schedule but **does not consider all risk factors**. The only exception to this is the infant high risk hepatitis B vaccine program if perinatal exposure to hepatitis B has been documented as a risk factor.

It is important to note that the same schedule will appear even if there are risk factors that are contraindications to a vaccine or make a client eligible for additional vaccines or additional doses of a vaccine. *For example*, when a client is immuno-compromised, the Forecaster will still forecast for live vaccines unless it is documented as a contraindication. In these situations, clinicians would be expected to use their clinical judgment and NOT administer the vaccine as indicated in the Forecaster. Clinicians would also be expected to document a contraindication to the live vaccines if it is a contraindication.

In all situations, clinicians will be expected to use clinical judgment to determine whether the vaccine indicated in the Forecaster should be administered or not and whether they are eligible for additional vaccines or doses that are currently not forecasted.

What information does the Forecaster use?

The Forecaster uses the following information about the client when validating and recommending future immunizations:

- **Gender and Date of Birth**
 - Used to determine which antigens the client can receive, and which age appropriate schedule should be used.
- **Exemptions and Contraindications**
 - Used to identify when certain antigens should not be recommended for a client.
- **Previous immunization history**
 - Used to determine which doses of an antigen are required next or if the client has a complete series. In some cases the specific product that a client has received previously can affect dosing and will dictate which product they should receive in the future. (The schedule rules use the product information from the previous immunizations to recommend a specific product for future immunization. *For Example; RotaTeq needs 3 doses and Rotarix needs 2 doses.*)

The Forecaster **does not** directly consider the following information:

- Allergies
- Precautions
- Client Warnings
- Deferrals
- Consent or Refused Consent
- Information entered on the Immunization History Interpretation Screen

What rules were used to create the Forecaster?

The Forecaster Working Group created immunization rules to address all vaccines for all age groups covered in the Manitoba routine immunization schedules. These rules were based on the current Manitoba immunization schedule, as well as the Canadian immunization guide. Best practices were also considered, as well as recommendations from other international agencies.

Validation rules have been included in the immunization rules to ensure that in the event that additional vaccines beyond the forecasted agents are provided, they will appear as valid doses as long as they meet basic immunization rules. However, subsequent doses provided in a series will NOT be forecasted.

The Forecaster **does not include rules for all the eligibility criteria** beyond those eligible as part of a routine immunization schedule. As a result, the eligibility criteria must be reviewed if a client has certain

conditions (i.e. risk factors) that may make them eligible for additional vaccines. The only exception to this is the infant high risk hepatitis B vaccine program, which has been included in the rules if perinatal exposure to hepatitis B has been documented as a risk factor.

Clinical judgment must be used for any immunizations that are not part of the Manitoba routine immunization schedules. The following table summarizes the eligibility criteria for publicly funded vaccines in Manitoba:

Manitoba Eligibility Criteria:	Included in the Forecaster	Not Included in the Forecaster
➤ Those eligible as part of a routine immunization schedule	x	
➤ Those eligible due to the infant high risk hepatitis B vaccine program	x	
➤ Those eligible due to defined high-risk conditions		x
➤ Those eligible based on high-risk medical conditions as defined in the Canadian immunization guide		x
➤ Those who are part-way through an immunization series started in another province or territory as part of a publicly-funded program and not part of the Manitoba routine immunization schedules		x
➤ Those who are eligible as part of a communicable disease investigation or outbreak management as defined by a medical officer of health		x

Detailed information pertaining to the specific immunization antigen business rules that were used can be found on the PHIMS Website at: www.phimsmb.ca

Who defined the rules and who will make sure the rules remain current?

The Forecaster working group was established to create and adjust the rules to reflect the Manitoba routine immunization schedule during the 'project' phase (the initialization of PHIMS in Manitoba). Currently the PHIMS support team at Manitoba eHealth works collaboratively with the PHIMS Operations Committee as well as the PHIMS Users Group to ensure the Forecaster remains updated when any changes to the Manitoba routine immunization schedule occur.

When does the Forecaster validate and invalidate immunizations?

The Forecaster validates immunizations that have been recorded either as historical immunizations provided by another provider or as immunizations administered by a public health nurse. When an immunization is recorded in PHIMS (either by an interface with other systems or by a PHIMS user), the Forecaster automatically assesses certain information about the client (age, gender, and immunization history) and the

dose (including interactions with other immunizations) to determine if the dose is valid according the rules.

When all antigens within an agent have been validated, the Forecaster 'rolls up' the antigens into the agent they were administered as. The agent is then displayed on the client's record with an overall status. When one or more of the antigens within an agent is invalid, the overall status of the agent is displayed as invalid and visually marked with an "X".

Doses are marked as "invalid" when the antigen dose breaks an immunization rule and may not be protective. For example when:

- **A minimum interval is not met**
- **A minimum age is not met**
- **A client should not have received the product** based on their age and/or dose history
- **An interaction rule is broken**

Minimum interval is the shortest acceptable duration between doses. For inactive antigens, minimum intervals are calculated from the last valid dose. For live antigens, minimum intervals are calculated from the date of the last valid OR invalid dose.

Interaction rules define minimum intervals between different agents. For example, if a dose of yellow fever vaccine is provided to a client, it will push out the "eligible" and "due" dates by 4 weeks for other live antigens due such as MMRV.

Minimum intervals for all agents are calculated in weeks (e.g. 4 weeks = 28 days, 8 weeks = 56 days). For eligibility due to age, either calendar months (i.e. interval between January 3, February 3, March 3...regardless of the number of days in a month), or calendar years are used. In some situations additional rules have been created to validate doses given a short time prior to minimum age rules. For example, MMRV will be validated if given up to 7 days prior to one year of age.

Invalid doses are not counted towards the series when planning future doses. However, invalid doses may be considered when calculating minimum intervals for planned doses (typically this affects live antigens only). For invalid doses, the "Immunization Agent" section will show an "X" beside the date the immunization was received.

Immunizations Save Reset More Log Print Help Close Active

Alerts **Notes**

Client ID: 1 Info Person Name (Last, First Middle) / Gender: Ron, Johnny / Male Health Card No: 123234345 Date of Birth / Age: 2016 Nov 28 / 3 years 0 months

Phone Number: Primary Home: 204-326-1111 Health Region Organization: Manitoba Additional ID Type / Additional ID: Manitoba Personal Health Identification Number / -

Immunization Details Checkmark Up Arrow

Immunization History - Summary Grid Info

Agent	Date Administered					
BAtx	2019 Nov 04					
BCG	2016 Nov 30					
DTaP-IPV-Hib	2017 Jan 28	2017 Mar 31	2017 May 31			
HB	2019 Jul 14 (O)	2019 Sep 02 (O)	2019 Nov 25 (O)			
Men-C-C	2017 Nov 28					
MMRV	2017 Nov 28	2017 Dec 01 (X)				
Pneu-C-13	2017 Jan 28	2017 Mar 31	2017 Nov 28			
Pneu-C-7	2018 Aug 22					

More specific information about valid and invalid doses can be found by looking in the "Antigen Count" section:

Update Immunization Apply Reset Print Close

Status Details Checkmark Up Arrow

Override Status Reset Status

Agent	Dose Number	Status
MMRV		Invalid

Override Status Reset Status

Antigen	Dose Number	Status
Measles virus antigen		Invalid
Mumps virus antigen		Invalid
Rubella virus antigen		Invalid
Varicella antigen		Invalid

Immunization Details Checkmark Up Arrow

Historical Non-Provider Recorded Provider Recorded

* Date Administered: 2017/12/01 Calendar hh:mn CDT Age at Administration: 1 years 0 months 0 days

Reason for Immunization: Routine Information Source: Other - specify

Provider: e.g. Provider Last Name, First Name Info Search Verification Status: Requested Not Requested Completed

Organization: e.g. Organization Display Name Info Search Service Delivery Location: e.g. SDL Display Name Info Search

The Forecaster will invalidate an immunization when:

1. **The same agent is administered to the same client on the same day.**

If 2 doses of the same agent/antigen are given on the same day, and one dose was valid, the other dose is considered invalid. Note: All the antigens within the invalid dose will be marked as invalid.

2. **An additional dose results from the use of a multi antigen agent.**

When multi-antigen agents, or combination vaccines, are used, extra doses of some antigens are often given as convenience doses, even though the antigen is not required. For example, IPV vaccine is not required at 6 months of age for a complete primary series of polio vaccine; however, it is acceptable to give the additional dose of IPV vaccine in a combination vaccine for convenience of administration. A rule for "Extra Dose Safe" is available in the Forecaster, and has been programmed for most situations that occur routinely. However, there may be some situations where an extra dose has been given which is marked as invalid. In this situation the provider must review the schedule and determine if the extra dose is valid. If it is valid, the provider can manually validate the antigen in the invalidate vaccines tab, and document Extra Dose Safe (EDS) as the reason.

3. **The administered date is less than the eligibility date or greater than the maximum age for eligibility.**

This is what will be seen most often – meaning that a minimum interval, minimum age, or maximum age was not met.

4. **An interaction rule is broken.**

Interaction rules define minimum intervals between different agents. For example, if a dose of yellow fever vaccine is provided to a client less than 4 weeks after receiving another live vaccine such as MMRV it would be invalidated.

When determining if the dose is valid, the Forecaster looks at the individual antigens within an agent (i.e.; Measles within the MMR agent) and determines if it is valid according to the immunization schedule dose rules. If an antigen dose is determined to be invalid, it is marked as invalid. The Forecaster then reviews that antigen dose against other immunizations the client has received to determine whether there are any interactions (interaction rules).

When all antigens within an agent have been validated, the Forecaster 'rolls up' the antigens into the agent they were administered as. The agent will then be displayed on the client's record with an overall status. When one or more of the antigens within an agent is invalid, the overall status of the agent is displayed as invalid and visually marked with an "X". e.g. Measles given at 9 months of age would be invalid as the minimum age is 1 year. To view which of the antigens caused the agent to be invalid and the reason why, the "Invalid/Uncounted Immunizations" section must be expanded in the Client Immunization Profile.

How does the Forecaster recommend future doses?

The Forecaster recommends future doses based on the same set of Schedule Dose Rules and Interaction Rules that are used during the validation process.

- During the first stage of the process the Forecaster determines the list of antigens that the client is eligible to receive based on the Schedule Dose Rules as well as the recommended dates and then reviews any Interactions and Exemptions that would apply to the antigens, to adjust the lists of antigens if appropriate.
- In the second stage of the process the Forecaster determines which of the antigens can be 'rolled up' and administered to the client as an agent. The Forecaster determines the list of agents that the client is eligible to receive based on the list of antigens from the first stage, and also reviews the Interaction Rules and Exemptions that may apply to determine the best agent to be selected.

In order to accommodate school based schedules (for grade 6 and grade 8/9), the following ages were defined for each grade:

Grade	Minimum Date	Due Date	Overdue Date
Grade 6	- HBV - no min, - Men C-ACYW-135, - 10 years of age and 4 weeks after previous valid dose - HPV-9, -9 years	10 years + 8 months	12 years
Grade 8/9	Tdap -12 years + 8 months and 26 weeks after previous valid dose	12 years + 8 months	16 years

For example: a client will show as "eligible" for HPV at 9 years and will show as "due now" at 10 years + 8 months.

For schedules that are not school based, "overdue" dates have been set at:

- "Due date" + 1 month for the infant vaccines series < =1 year of age
- 6 months after the due date for the 18 month vaccines
- 6 years of age for preschool vaccines (4- 6 years of age)

When antigens are 'rolled up' into an agent, the Forecaster may make the following adjustments, where appropriate, to ensure the recommended agent is the most appropriate for the client:

- Adjust the specific dates of an antigen to allow it to group better with the other antigens in the agent.
- Recommend an additional antigen to facilitate delivery of an agent – for example includes the 2nd rubella in the 2nd MMR, additional polio in a DTaP-IPV.

All of the antigens that can be delivered as part of an agent are recommended in the 'agent forecast' for the client. The remaining antigens that did not get recommended in the agent forecast are recommended as single antigen agents.

All recommended immunizations are displayed with a "Recommended (Due) Date" and "Minimum (Eligible) Date". The details of the forecast can be seen in the "Immunization Forecast (by Agent)" section of the Immunization Client Profile.

How is the Client's forecast kept up to date?

The Forecaster runs each time a client is created or if:

- Date of Birth is Updated
- Gender is Updated
- Risk Factor is Added or Removed
- Exemption or Contraindications are Added or Removed
- Each time an immunization is recorded in Panorama
- The "Refresh Forecast" button is clicked

The Forecaster also runs each time a client approaches the earliest of the minimum and maximum dates for forecasted dose for any forecasted Agent. Milestone dates have been established for the forecaster to run in order to update the forecast at ages when a schedule changes or a new agent is recommended. For example, the milestone date for Rotavirus has been set at a maximum age of 8 months. Therefore the Forecaster will automatically rerun when the client turns 8 months old, and will remove it from the forecast.

Clients **are not** automatically re-forecasted when the immunization record is viewed (meaning when the imms profile is opened) because PHIMS assumes that the client's forecast is accurate as of the last automatic reforecast. However, this may not necessarily be true because a client's forecast (specifically the agents that would be administered) may change over time as a client ages into an older age cohort. For example, Hib is not needed once the client reaches 5 years of age. Many of the milestone dates set will rerun the forecaster to account for schedule changes, but it is still possible that there may be some situations where the forecaster is not up to date. Best practice dictates that users should always refresh the forecaster.

How is the "refresh forecast" done and when should it be used?

The immunization forecast section displays the date that the forecast was last run for the client and beside it there is a "Refresh Forecast" button. When the "Refresh Forecast" button is clicked, the forecast will be

computed immediately and the updated data displayed. The “refresh forecast” is always available unless client information is missing and the client is not forecastable (no DOB, Deceased or Inactive).

The “**refresh forecast**” functionality allows a user to trigger an immediate update of the client’s forecast. Best practice is to refresh the Forecaster each time users open a client record to determine their immunization status to ensure that it is current as of today. The refresh forecast functionality applies to one client at a time and is immediate.

Appendix A: Terms and Definitions

Term	Description
Antigen	Component of an agent; a chemical structure that induces immunity. Example(s): Diphtheria, Measles
Antigen Count	Provides a summary of the number of doses the client has received of each antigen
Agent	Currently available vaccine formulations combining specified antigens. Examples(s): MMRV, Tdap.
Agent Roll Up	Agent "Roll Up": A step in the forecast automation that reviews all required antigens and forecasts the most appropriate agent.
Contraindications	A contraindication is a situation in which a drug, such as a vaccine, should not be used because the risk outweighs any potential therapeutic benefit. http://www.phac-aspc.gc.ca/publicat/cig-gci/p02-02-eng.php#contraindications
Due Date	The specific date recommended based on Manitoba's Routine Immunization Schedule.
Due Now	Time period between the Due Date and the Overdue Date.
Eligible Date	The minimum clinically valid date on which a forecasted agent can be given.
Exemptions	An exemption is a situation where the client does not need the vaccine, as they are already immune. The choices in PHIMS are: <ul style="list-style-type: none"> ▪ Known immunity confirmed by lab result ▪ Known immunity reported
Extra Dose Safe (EDS)	An extra antigen included in the forecast to support the provision of the Agent. Example scenario: A client is complete for Rubella, but needs Measles and Mumps. The Immunization rules will allow MMR to be forecasted, as MR vaccine is not routinely available, and there is no additional safety risk by providing the additional Rubella antigen.
Forecast	The cumulative list of recommended Agents that form a client's future immunization schedule. The Forecast for any given Agent includes the recommended Product and dosage (if defined in the Immunization rules), and relevant date – Eligible, Due and Overdue; and the "Last forecast ran on: [date]" which shows the last time the forecast information was generated.
Interaction Rules	Rules that address the interactions between vaccines.
Invalid	Antigen dose(s) that were given outside the recommended guidelines, and thus may not provide immune protection; these will not be counted when forecasting required future doses. Example: MMRV given at 10 months of age is invalid and will not be counted as dose 1. Dose 1 will be forecast at 1 year of age.
Invalid/Not Counted	Displays any doses that are not considered valid according to the Manitoba Routine Immunization Schedules and the minimum intervals for that antigen dose.
Leftover Forecasted Antigen	Single antigens that are still required, but did not get "rolled up" into a recommended agent in the forecast.
Minimum Interval	Minimum interval is the shortest acceptable time period between doses.
Overdue	A lapse of time from the Due Date as determined by the Manitoba Forecaster working group.

Term	Description
Precautions	A precaution is a condition that may increase the risk of an adverse reaction following immunization or that may compromise the ability of the vaccine to produce immunity. In general, vaccines are deferred when a precaution is present. However, there may be circumstances when the benefits of giving the vaccine outweigh the potential harm, or when reduced vaccine immunogenicity may still result in significant benefit to a susceptible, immunocompromised host. http://www.phac-aspc.gc.ca/publicat/cig-gci/p02-02-eng.php#contraindications
Reforecast – Automated	Reforecast is automatically triggered by: Change in DOB or gender; addition or correction to immunization records; Exemptions and Contraindications (not precautions); specified Risk Factors, and predetermined milestone dates based on age of the client.
Reforecast on Demand	User function allowing re-forecast of a client record by the user. (Refresh Forecast button)
Revised Dose	User function allowing forced override of the system-generated dose number, also automatically sets status of dose to valid. Example scenario: A 18 month old client most likely has received several doses of DTaP-IPV-Hib in another country and but does not have any immunization records. They experience a serious local reaction to the first dose of DTaP-IPV-Hib (dose 1 in system) given here at 18 months, and lab serology indicates immunity to tetanus. The revised dose number is set to 4. The Forecast will now be for the 5th dose of the series.
Schedule Dose Rules	Address the timing of immunizations according to age specific programs. (<u>Note</u> : The Forecaster works with age, not grade.)
Special Considerations	Provides a summary of the Exemptions, Contraindications and Precautions a client has. Only Exemptions and Contraindications will remove an antigen from the forecast.
Up to Date	Not yet due for a specific agent.
Validation	The steps performed by PHIMS to evaluate the client’s immunization history against the Forecaster’s immunization rules.
Valid	Antigen dose(s) that were given within the recommended guidelines (meeting the minimum age / interval requirements). The dose will be counted when forecasting required future doses. Example: MMRV given at 12 months of age is valid and a second dose will be forecasted at 4 years of age.

Appendix B: Immunization Antigen Business Rules

Appendix B can be found on the PHIMS website at www.phimsmb.ca