POST-TRANSPLANT IMMUNIZATION GUIDELINES

SOLID ORGAN TRANSPLANT

December 2022

SickKids®

TABLE OF CONTENTS

1.0 INTRODUCTION 3

2.0 POST-TRANSPLANT: INACTIVE VACCINES 4

2.1 DIPHTHERIA, PERTUSSIS, TETANUS, POLIO AND HAEMOPHILUS INFLUENZA B 5

2.2 MENINGOCOCCAL 7

2.3 PNEUMOCOCCAL 9

2.4 HEPATITIS A 11

2.5 HEPATITIS B 13

2.6 HUMAN PAPILLOMA VIRUS 15

3.0 POST-TRANSPLANT: LIVE VACCINES 16

3.1 MEASLES, MUMPS, RUBELLA 17

3.2 VARICELLA 18

3.3 ROTAVIRUS 19

4.0 POST-TRANSPLANT: INFLUENZA VACCINES 20

4.0 INFLUENZA VACCINES 21

5.0 POST-TRANSPLANT: TRAVEL VACCINES 23

5.1 ENTEROTOXIGENIC E COLI 24

5.2 HEPATITIS A 25

5.3 HEPATITIS B 26

5.4 JAPANESE ENCEPHALITIS 28

5.5 RABIES 29

5.6 TYPHOID (SALMONELLA TYPHI) 30

5.7 YELLOW FEVER 31

1.0 INTRODUCTION

POST-TRANSPLANT IMMUNIZATION GUIDELINES:

The following tables are suggested immunization schedules for solid organ transplant recipients. They are meant as a guide only and may not be applicable to all patients. Please consult Infectious Diseases as appropriate for patient specific issues. Vaccines listed are those that are licensed for use in children <18 yrs of age. Please consult your local pharmacy for current cost of vaccines that are not covered by the Ontario Ministry of Health and Long Term Care (MOHLTC).

POST-TRANSPLANT CONSIDERATIONS:

- LIVE vaccines (eg. MMR, varicella, rotavirus) are contraindicated in the majority of transplant recipients.
- Routine vaccination should be restarted 12 mths post-transplant to ensure optimal response, with some exceptions as noted below:
  - Pneumococcal and meningococcal vaccination may be started as early as 6 mths post-transplant
  - Influenza seasonal vaccine may be started as early as 1 mth post-transplant. In the event of an outbreak, consult Infectious Diseases.
- Serological monitoring post vaccination is recommended for certain immunizations. Please refer to tables for specific recommendations.

SIBLINGS AND OTHER FAMILY MEMBERS:

All siblings should be vaccinated per routine guidelines. It is also safe for siblings of solid organ transplant recipients to receive LIVE vaccines.

TRAVEL VACCINES:

- Prior to travel, all transplant recipients should consult Infectious Diseases/Travel Clinic for recommended vaccinations. Travel Clinic consultations are not covered by the Ontario Ministry of Health and Long Term Care. Most travel vaccines are also not covered. Families will need to budget for the cost of consultation and vaccination. Some vaccines need to be administered several wks prior to travel in order to provide adequate protection. Families will need to plan consultations well ahead of their travel date.

2.0 POST-TRANSPLANT: INACTIVE VACCINES

2.1 INACTIVE VACCINES: DIPHTHERIA, PERTUSSIS, TETANUS, POLIO AND HAEMOPHILUS INFLUENZA B – POST-TRANSPLANT GUIDELINES

NAME OF VACCINE PRODUCTS AVAILABLE IN CANADA	ROUTINE SCHEDULE (ONTARIO)	MINIMUM AGE FOR 1ST DOSE	MINIMUM INTERVAL BETWEEN DOSES	NUMBER OF DOSES REQUIRED	POST-TRANSPLANT SCHEDULE OR BOOSTER DOSES?	SEROLOGY PRE/POST VACCINATION	COVERAGE IN ONTARIO
DTaP-IPV-Hib Pediacel®/Pentacel® Infanrix® IPV/Hib	2, 4, 6 and 18 mths[6]	6 wks[1]	**Doses 1, 2, 3** Minimum interval is 4 wks[6] **Dose 3 to 4** Minimum interval is 6 mths (accelerated) but must be given at or after 12 mths for sustained immunity[1, 2, 4, 6]	As per routine schedule	**NOT vaccinated or incomplete series Pre-Transplant** Start series 1 yr* post-transplant per ON MOHLTC catch-up schedule https://www.health.gov.on.ca/en/pro/programs/immunization/docs/Publicly_Funded_ImmunizationSchedule.pdf *May start 3-6 mths post-transplant based on risk profile and degree of immuno-suppression[3] (consult Transplant Team) **Vaccinated Pre-transplant (Booster)** 1 yr post-transplant and >5 yrs DTaP-IPV-Hib (Pediacel®/Pentacel®)[1] or single entity Hib vaccine x1 4-5 yrs post-transplant: Age appropriate tetanus-diphtheria vaccine per ON MOHLTC[6]	NOT done routinely	Covered under MOHLTC
Tdap-IPV Boostrix® Polio Adacel® Polio	4-6 yrs x1 dose[6]						
Tdap Adacel® Boostrix®	14 yrs: 1 dose +booster in 10 yrs	4 yrs[6, 12, 13]					

NOTES:

- D=diphtheria toxoid high dose; d=diphtheria toxoid low dose; ap or aP=acellular pertussis; T=tetanus toxoid; IPV or Polio=inactivated polio; Hib=haemophilus influenza type b; HB=hepatitis B.
- DTap-HB-IPV-Hib: Infanrix-hexa® is not part of the Ontario routine immunization schedule and is NOT covered by MOHLTC.
- Act-HIB® and Hiberix® are single entity haemophilus influenza b vaccines licenced for use in patients 2 mths and older.

CONCOMITANT ADMINISTRATION OF VACCINES LISTED IN THIS TABLE:

- The National Advisory Committee on Immunization (NACI) states that administering the most widely used live and inactivated vaccines during the same patient visit has produced seroconversion rates and rates of adverse reactions similar to those observed when the vaccines are administered separately.[1]
- NACI recommends that vaccines administered simultaneously should be given using separate syringes at separate sites.[1]
- DTaP-IPV-Hib (Pediacel®) can be given at the same time as other routine vaccinations such as meningococcal C conjugate and hepatitis B as long as it is administered in a separate site.[9]

REFERENCES:

1. National Advisory Committee on Immunization (NACI). Canadian Immunization Guide. Accessed June 22, 2022. http://www.phac-aspc.gc.ca/publicat/cig-gci/index-eng.php#toc.
2. Rubin LG, Levin MJ, Ljungman P, Davies EG, Avery R, Tomblyn M, *et al.* 2013 IDSA clinical practice guideline for vaccination of the immunocompromised host. *Clinical Infectious Diseases* 2014; 58: e44-100.
3. Danziger-Isakov L, Kumar D, AST Infectious Diseases Community of Practice. Vaccination in solid organ transplant candidates and recipients. *Clin Transplant*. 2019; 33(9) e13563.
4. Abuali MM, Arnon R, Posada R. An update on immunizations before and after transplantation in the pediatric solid organ transplant recipient. *Pediatric Transplant* 2011; 15: 770-7.
5. Kawano Y, Suzuki M, Kawada J, Kimura H, Kamei H, Ohnishi Y, Ono Y, Uchida H, Ogura Y, Ito Y. Effectiveness and safety of immunization with live-attenuated and inactivated vaccines for pediatric liver transplantation recipients. *Vaccine* 2015; 33: 1440-45.
6. Publicly funded immunization schedules for Ontario-June 2022. Accessed September 29, 2022. https://www.health.gov.on.ca/en/pro/programs/immunization/docs/Publicly_Funded_ImmunizationSchedule.pdf
7. CDC. Recommended immunization schedules for persons aged 0 through 18 yrs-2022. Accessed May 18, 2022.https://www.cdc.gov/vaccines/schedules/hcp/imz/child-adolescent.html
8. L'Huillier AG, Kumar D. Immunizations in solid organ and hematopoeitic stem cell transplant patients: A comprehensive review. *Human Vaccines and Immunotherapeutics* 2015; 11: 2852-63.
9. Sanofi Pasteur Ltd. *Product Monograph Pediacel®*. March 2012.
10. GlaxoSmithKline Inc. *Product Monograph Infanrix-IPV®*. September 2014.
11. Sanofi Pasteur Ltd. *Product Monograph Td Adsorbed®*. October 2012.
12. Sanofi Pasteur Ltd. *Product Monograph Adacel®*. December 2021.
13. GlaxoSmithKline Inc. *Product Monograph Boostrix®*. September 2022.
14. Sanofi Pasteur Ltd. *Product Monograph Adacel®* Polio. April 2022.
15. GlaxoSmithKline Inc. *Product Monograph Boostrix®* Polio. September 2022.
16. GlaxoSmithKline Inc. *Product Monograph Infanrix-Hexa®*. January 2021.
17. GlaxoSmith Kline Inc. *Product Monograph Hiberix®*. August 2019.
18. Sanofi Pasteur Ltd. *Product Monograph Act-HIB®*. May 2019.
19. GlaxoSmithKline Inc. *Product Monograph Infanrix® IPV/Hib.* November 2018.

2.2 INACTIVE VACCINES: MENINGOCOCCAL – POST-TRANSPLANT GUIDELINES

NAME OF VACCINE PRODUCTS AVAILABLE IN CANADA	ROUTINE SCHEDULE (ONTARIO)	MINIMUM AGE FOR 1ST DOSE	MINIMUM INTERVAL BETWEEN DOSES	NUMBER OF DOSES REQUIRED	POST-TRANSPLANT SCHEDULE OR BOOSTER DOSES?	SEROLOGY PRE/POST VACCINATION	COVERAGE IN ONTARIO
Meningococcal quadrivalent ACW-135Y conjugate vaccine (Men-C-ACWY) Menactra® Menveo® Nimenrix®	**HIGH RISK*** (>9 mths) Other children: grade 7	**Nimenrix®** 6 wks[1, 15] **Menveo®** 2 mths[1, 7] **Menactra®** 9 mths[1, 6]	**Nimenrix®[15]** 2 mths **Menveo®[7]** 2 mths **Menactra®[6]** 3 mths **Men-C-ACWY** Accelerated schedule[1] ≥12 mths: 4 weeks (reserve for rapid need only)	**HIGH RISK* patients:** number of doses varies with age at inititation	**YES** Transplant recipients are at **HIGH RISK*** of invasive meningococcal disease (IMD) and should receive Men-C-ACWY vaccine.¥ Routine Men-C-C does not need to be administered in addition to quadrivalent vaccine.[1] **NOT vaccinated or Incomplete Series¥** Start vaccination as early as 6 mths post-transplant **Men-C-ACWY[1,Ψ]** **2 -11 mths:** 2-3 doses, 8 wks apart[1], then booster between 12-23 mths and at least 8 wks from previous dose **12-23 mths:** 2 doses, 8 weeks apart[1] **≥24 mths**: 2 doses, 8 weeks apart[1] **Vaccinated Pre-Transplant (Booster)** **6 mths-1 yr post-transplant**: Men-C-ACWY every 3-5 yrs if vaccinated ≤ 6 yrs; every 5 yrs if vaccinated ≥ 7 yrs of age[1]	NOT done routinely	Covered under MOHLTC school program (grade 7) **OR** **HIGH RISK*** (>9 mths)
Serogroup B Meningococcal Vaccine (4CMenB) 4CMenB Bexsero® MenB-fHBP Trumenba® Not interchangeable	For **HIGH RISK*** only (2 mths-17 yrs)[2]	**Bexsero®[10]** 2 mths	**Bexsero®[10]** **2-5 mths:** 1 mth **6-23 mths:** 2 mths **≥2 yrs:** 1 mth	**Bexsero®[10]** **2-5 mths:** 3 doses, + booster **6-11 mths**: 2 doses, + booster **12-23 mths:** 2 doses **≥2 yrs:** 2 doses	**YES** Transplant recipients are considered to be at **HIGH RISK*** for IMD due to concurrent immunosuppresion[1, 2] **NOT vaccinated or Incomplete Series¥** Start vaccination as early as 6 mths post-transplant **2-5 mths**: 3 doses, 1 mth apart then booster at 12-23 mths **AND** 2 mths after 3rd dose **6-11 mths**: 2 doses, 2 mths apart, followed by 3rd dose at 12-23 mths **AND** 2 mths after 2nd dose **12-23 mths**: 2 doses, 2 mths apart, then booster at least 12 mths later **≥ 2 yrs**: 2 doses, 1 mth apart, then consider booster		Covered for **HIGH RISK*** ONLY
		Trumenba®[16] 10 yrs	**Trumenba®[16]** **HIGH RISK*:** **Dose 1 and 2**: 1 mth **Dose 2 and 3**: 4 mths	**Trumenba®[16]** **HIGH RISK*** 3 doses	**Trumenba[16]** **HIGH RISK*** 3 doses, 2nd dose 1-2 mths following the first dose; 3rd dose at least 4 mths after dose 2 and at least 6 mths following first dose		

ΨNimenrix is funded by MOHLTC effective June 2022. At the time of TRMC guideline update, NACI was reviewing its recommendations in view of Nimenrix receiving approval for use in infants as young as 6 wks of age. Previously, Menveo® (Men-CACWY-CRM) was considered the vaccine of choice for children <2 yrs of age per NACI and CPS.

Provincial recommendations may vary based on available vaccine products. Choice of vaccine and recommended schedules vary with age.[1]

¥ Expert opinion

***HIGH RISK:**

1. Functional/anatomic asplenia.
2. Complement, properdin, factor D or primary antibody deficiencies.
3. Cochlear implants (pre/post implant).
4. HIV+.
5. Acquired complement deficiencies due to receipt of the terminal complement inhibitor eculizumab (Soliris™).[1,2]
6. Increased risk of exposure: travelers where meningococcal vaccine is recommended (meningitis belt of Sub-Saharan Africa) or required (pilgrims to Hajj in Mecca).

¥Expert opinion

CONTRAINDICATIONS:

In persons with history of anaphylaxis after a previous dose of the vaccine and in patients with proven hypersensitivity/anaphylaxis to any component of the vaccine or its container.[1]

CONCOMITANT ADMINISTRATION OF VACCINES LISTED IN THIS TABLE:

- The National Advisory Committee on Immunization (NACI) states that administering the most widely used live and inactivated vaccines during the same patient visit has produced seroconversion rates and rates of adverse reactions similar to those observed when the vaccines are administered separately.[1]
- NACI recommends that vaccines administered simultaneously should be given using separate syringes at separate sites.[1]
- Men-C-C products, Menactra® and Bexsero® can be given with other routine childhood immunizations, in a different injection site with a separate needle and syringe[1].
- Per NACI, Menveo® administration at the same time as Tdap may result in a lower immune response to the pertussis antigens than when Tdap vaccine is given alone; however, the clinical significance of this is unknown. Tdap vaccine given one mth after Men-C-ACYW-CRM induces the strongest immunologic response to pertussis antigens.[1]
- Per NACI, Menveo® administration at the same time as Pneu-C-13 requires further study.[1] However, the Menveo® product monograph indicates concomitant administration with other routine childhood immunizations is appropriate (separate injection site and syringe).[9]

REFERENCES:

1. NACI. Canadian Immunization Guide. Accessed May 27, 2021 and June 22, 2022. https://www.canada.ca/en/public-health/services/publications/healthy-living/canadian-immunization-guide-part-4-active-vaccines/page-13-meningococcal-vaccine.html#p4c12t1
2. Publicly funded immunization schedules for Ontario-June 2022. Accessed September 29, 2022. http://www.health.gov.on.ca/en/pro/programs/immunization/docs/immunization_schedule.pdf
3. Danziger-Isakov L, Kumar D, Vaccination of solid organ transplant candidates and recipients: Guidelines from the AST Infectious Diseases Community of Practice. *Clin Transplant* 2019;33e13563
4. Abuali MM, Arnon R, Posada R. An update on immunizations before and after transplantation in the pediatric solid organ transplant recipient. *Pediatric Transplant* 2011; 15: 770-7.
5. Meningococcal B Pilot Project Task Group. The recommended use of the multicomponent meningococcal B (4CMenB) vaccine in Canada: common guidance statement. Pan-Canadian Public Health Network. March 26, 2014. Retrieved Feb 8, 2016. http://publications.gc.ca/collections/collection_2014/aspc-phac/HP40-103-2014-eng.pdf.
6. Sanofi Pasteur Ltd. *Product Monograph Menactra®*. November 2017.
7. Novartis Vaccines and Diagnostics Inc. Product Monograph Menveo™. June 2020.
8. Rubin LG, Levin MJ, Ljungman P, Davies EG, Avery R, Tomblyn M, *et al.* 2013 IDSA clinical practice guideline for vaccination of the immunocompromised host. *Clinical Infectious Diseases* 2014; 58: e44-100.
9. Allen UD. Minimizing infection risks after paediatric organ transplant: advice for practitioners. Canadian Paediatric Society Infectious Diseases and Immunization Committee. *Paediatric Child Health* 2013;18(3): 143-8.
10. Novartis Vaccines and Diagnostics Inc. *Product Monograph Bexsero™*. March 2022.
11. Kumar D. Immunizations following solid-organ transplantation. *Current Opinion in Infectious Disease* 2014; 27: 329-335.
12. L'Huillier AG, Kumar D. Immunizations in solid organ and hematopoeitic stem cell transplant patients: A comprehensive review. *Human Vaccines and Immunotherapeutics* 2015; 11: 2852-63.
13. CDC. Recommended immunization schedules for persons aged 0 through 18 yrs-2021. Accessed May 27, 2021. http://www.cdc.gov/vaccines/schedules/hcp/imz/child-adolescent.html
14. Allen UD, Green M. Prevention and treatment of infectious complications after solid organ transplantation in children. Pediatric Clinics of North America 2010; 57(2): 459-79.
15. GlaxoSmithKline Inc. *Product Monograph Nimenrix®*. September 2020.
16. Pfizer Inc. *Product Monograph Trumenba®*. May 2019.
17. Canadian Pediatric Society. Update on invaseive meningococcal vaccination for Canadian Children and Youth 2020. Accessed June 02, 2021. https://www.cps.ca/en/documents/position/invasive-meningococcal-vaccination

2.3 INACTIVE VACCINES: PNEUMOCOCCAL – POST-TRANSPLANT GUIDELINES

NAME OF VACCINE PRODUCTS AVAILABLE IN CANADA	ROUTINE SCHEDULE (ONTARIO)	MINIMUM AGE FOR 1ST DOSE	MINIMUM INTERVAL BETWEEN DOSES	NUMBER OF DOSES REQUIRED	RECOMMEND PRE-TRANSPLANT	SEROLOGY PRE/POST VACCINATION	COVERAGE IN ONTARIO
Pneumococcal Conjugate Vaccine (Pneu-C) Prevnar® 20 (Pneu-C-20) Vaxneuvance® (Pneu-C-15) Prevnar® 13 (Pneu-C-13) Synflorix® (Pneu-C-10) Dose = 0.5 mL	**HIGH RISK* (2 mths - < 18 yrs)**[2] Pneu-C-20 at 2,4, 6 and 12-15 months[1]	Pneu-C-20 (Prevnar®20): 6 wks[1, 2, 4]	Pneu-C-20 (Prevnar®20): 8 weeks[1, 2]	1-4 doses, depending on age and prior vaccine status[1,2,4]	**Pneu-C-20 (Prevnar®20):** **NOT vaccinated PRE-Transplant:** Vaccination may start as early as 6 mths post-transplant **Age at vaccine initiation:** **2 to < 7 mths**: 4 doses (2, 4, 6 & 12-15 mths) **7 to < 12 mths:** 3 doses (2 doses, 8** weeks apart followed by 3rd dose at 12-15 months, at least 8 weeks after 2nd dose) **12 to < 24 mths**: 2 doses, 8 weeks apart **2 yrs to <18 yrs**: 1 dose Patients with previous pneumococcal conjugate vaccine history: Follow NACI[1] schedule for **HIGH RISK*** (see table next page) Infants who have started series with either Pneu-C-13 or Pneu-C-15 should receive Pneu-C-20 to complete their vaccination series[1]	NOT done routinely	**Pneu-C-20** Covered by MOHLTC ONLY for children with **HIGH RISK*** of invasive pneumo-coccal disease (IPD)
Pneumococcal Polysaccharide Vaccine (Pneu-P) Pneumovax® 23 (Pneu-P-23)	Children who have completed a vaccine series appropriate for age that includes at least one dose of Pneu-C-20 do not require additional doses of Pneu-P-23[1, 2] If Pneu-P-23 dose has been given, it is recommended to wait 1 year before immunizing the child with Pneu-C-20[1,2]. In cases where a patient's risk profile has changed and a dose of Pneu-C-20 may be considered within 1 year of receipt of Pneu-P-23, please consult Infectious Diseases.¥						

NOTES:

*Children at increased risk of IPD *include* those who: are solid organ or hematopoietic stem cell transplant (HSCT) recipients, have chronic medical conditions (example: heart, kidney, liver or lung disease), have sickle cell disease/sickle cell hemoglobinopathies, have other types of functional or anatomic asplenia, have HIV infection, are immunocompromised (eg. primary immunodeficiencies, malignancies, immunosuppressive therapy, use of long-term systemic corticosteroids, nephrotic syndrome), have chronic medical conditions (e.g. diabetes mellitus, neurologic conditions impairing clearance of oral secretions or chronic CSF leak) and children with cochlear implants/receiving cochlear implants.[1] Children living in residential care are also at increased risk of IPD[1]

**In cases where significant acceleration is required, minimum of 4 weeks between first two doses of Pneu-C-20 may be considered as per the manufacturer.[4] Please consult Infectious Diseases in this regard.

¥Expert opinion

CONTRAINDICATIONS:

Prevnar®13, Prevnar®20, Vaxneuvance®: Hypersensitivity to any component of the vaccine, including diphtheria toxoid[4, 5, 10]

CONCOMITANT ADMINISTRATION OF VACCINES LISTED IN THIS TABLE:

- The National Advisory Committee on Immunization (NACI) states that administering the most widely used live and inactivated vaccines during the same patient visit has produced seroconversion rates and rates of adverse reactions similar to those observed when the vaccines are administered separately.[1]
- NACI recommends that vaccines administered simultaneously should be given using separate syringes at separate sites.[1]
- Infants and Children 6 Weeks To 5 years of age: PREVNAR® 20 can be administered concomitantly with any of the following vaccine antigens, either as monovalent or combination vaccines: diphtheria, tetanus, acellular pertussis, Haemophilus influenzae type b, inactivated poliomyelitis, hepatitis B, measles, mumps, rubella (MMR) and varicella vaccines.[4] The vaccine has been safely administered with influenza, rotavirus vaccine and COVID-19 mRNA vaccine.[4] There are no data on the concomitant administration of PREVNAR 20 with other vaccines.[4]

TABLE 1: RECOMMENDED SCHEDULES FOR PNEU-C-20 VACCINE FOR CHILDREN 2 MONTHS TO LESS THAN 18 YEARS OF AGE WITH IPD RISK FACTORS[1]		
AGE AT INITIATION OF PNEU-C-20 VACCINE SERIES	**NUMBER OF PREVIOUSLY RECEIVED PNEUMOCOCCAL CONJUGATE VACCINES**	**RECOMMENDED SCHEDULE FOR PNEU-C-20**
2 to less than 7 months	0 doses	3 doses** + 1 dose at 12-15 months of age
	1 dose	2 doses** + 1 dose at 12-15 months of age
	2 doses	1 dose + 1 dose at 12-15 months of age
7 to less than 12 months	0 doses	2 doses** + 1 dose at 12-15 months of age
	1 dose	1 dose + 1 dose at 12-15 months of age
	2 doses	1 dose at 12-15 months of age
12 to less than 24 months	0 doses	2 doses, 8 weeks apart
	1 dose at less than 12 months of age	
	2 or more doses at less than 12 months of age	1 dose
	0 or 1 dose at less than 12 months of age **AND** 1 dose at 12 months of age or older	
24 to less than 60 months (5 years)	0 doses of Pneu-C-20	1 dose
5 years to less than 18 years	0 doses of Pneu-C-20	1 dose

Adapted from Canadian Immunization Guide: Pneumococcal Vaccines[1] Table 4

**8 wks minimum interval between doses; 4 wks minimum interval recommended by vaccine manufacturer for accelerated course. Consult Infectious Diseases.

REFERENCES:

1. National Advisory Committee on Immunization (NACI). Canadian Immunization Guide. Accessed April 8, 2024 and July 12, 2024. https://www.canada.ca/en/public-health/services/canadian-immunization-guide.html
2. Ontario's routine immunization schedule. Accessed July 31, 2024. https://www.ontario.ca/page/ontarios-routine-immunization-schedule.
3. Danziger-Isakov L, Kumar D, AST Infectious Diseases Community of Practice. Vaccination of solid organ candidates and recipients. Clin Transplant. 2019; 33(9): e13563.
4. Pfizer Canada Inc. Product Monograph *Prevnar® 20*. November 2023.
5. Merck Canada Inc. Product Monograph *Vaxneuvance®*. June 2024.
6. Kao CM, Michaels MG. Approach to vaccinating the pediatric solid organ transplant candidate and recipient. DOI 10.3389/fped.2023.1271065.
7. CDC. Recommended immunization schedules for persons aged 18 years or Younger, 2024. Accessed August 12, 2024. https://www.cdc.gov/vaccines/schedules/hcp/imz/child-adolescent.html
8. American Academy of Pediatrics (AAP) Committee on Infectious Diseases. Kimberlin DW (ed) Red Book: 2024-2027 Report of the Committee on Infectious Diseases (33rd edition). Itasca, IL: American Academy of Pediatrics.
9. GlaxoSmithKline Inc. Product Monograph *Synflorix®*. March 2024.
10. Pfizer Canada Inc. Product Monograph *Prevnar® 13*. August 2019.
11. Merck Canada Inc. Product Monograph *Pneumovax® 23*. July 2016.

2.4 INACTIVE VACCINES: HEPATITIS A – POST-TRANSPLANT GUIDELINES

NAME OF VACCINE PRODUCTS AVAILABLE IN CANADA	ROUTINE SCHEDULE (ONTARIO)	MINIMUM AGE FOR 1ST DOSE	MINIMUM INTERVAL BETWEEN DOSES	NUMBER OF DOSES REQUIRED	POST-TRANSPLANT SCHEDULE OR BOOSTER DOSES?	SEROLOGY PRE/POST VACCINATION	COVERAGE IN ONTARIO
Hepatitis A Avaxim® Avaxim Ped® Havrix® Havrix Jr® Vaqta® Vaqta Ped® (Can be used interchangeably)	None	6 mths[1]	6 mths	**2 dose schedule** 0 and 6-12 mths[1] *See table 1 for dosing	Recommended for all patients post-transplant, but in particular **HIGH RISK*** **2 doses (0, 6-12 mths)** Vaccination may start as early as 6 mths post-transplant for **HIGH RISK*** patients *See table 1 for dosing **Vaccinated pre-transplant (Booster dosing)** Consider repeat vaccination for **HIGH RISK*** based on serology	May be considered in **HIGH RISK*** patients who were immunized post-transplant	Covered by ON MOHLTC only for patients >1 yr old with chronic liver disease
Combination Hep A Vaccines: Hep A+B: Twinrix® Twinrix® Junior	NACI does NOT recommend the use of Twinrix® or Twinrix® Junior in immunosuppressed patients[1]						

***HIGH RISK** includes liver transplant recipients, travel to endemic countries, residents in native communities, institutionalized patients.

TABLE 1: CANADIAN IMMUNIZATION GUIDE (NACI)- HEPATITIS A DOSING RECOMMENDATIONS FOR MONOVALENT HEPATITIS A VACCINES[1]

VACCINE	ANTIGEN*	VOLUME	SCHEDULE (BOOSTER)	AGE[ł]
Avaxim®	160 antigen units HAV	0.5 mL	0, (6-36) mths	12 yrs and older
Avaxim Ped®	80 antigen units HAV	0.5 mL	0, (6-36) mths	6 mths-<16 yrs
Havrix®	1440 ELISA units HAV	1 mL	0, (6-12) mths[‡]	19 yrs and older
Havrix Jr®	720 ELISA units HAV	0.5 mL	0, (6-12) mths	6 mths-<19 yrs
Vaqta®	50 units HAV	1 mL	0, (6-18) mths	18 yrs and older
Vaqta Ped®	25 units HAV	0.5 ml	0, (6-18) mths	6 mths-<18 yrs

*There is no international standard for HAV measurement. Each manufacturer uses its own units of measurement.

[ł]Ages for which the vaccine is approved.

[‡]Studies have shown that 720 ELISA units provides an effective booster dose in those over 19 yrs of age.

NOTES:

- Comparable to the results reported in clinical trials of children more than 12 mths, all reviewed studies have consistently shown that vaccination of infants 6-12 mths with inactivated HA vaccines is immunogenic and safe.[1]
- Product monographs for Avaxim Ped, Havrix Jr and Vaqta Ped indicate 12 mths as the lower age limit.

CONTRAINDICATIONS:

- In persons with a history of anaphylaxis after previous administration of a HA-containing vaccine and in persons with proven immediate or anaphylactic hypersensitivity to any component of the product or its container.[11]

CONCOMITANT ADMINISTRATION OF VACCINES LISTED IN THIS TABLE:

- The National Advisory Committee on Immunization (NACI) states that administering the most widely used live and inactivated vaccines during the same patient visit has produced seroconversion rates and rates of adverse reactions similar to those observed when the vaccines are administered separately.[1]
- NACI recommends that vaccines administered simultaneously should be given using separate syringes at separate sites.[1]
- Since HAVRIX® is an inactivated vaccine, its concomitant use with other inactivated vaccines is unlikely to result in interference with immune responses. When concomitant administration of other vaccines is considered necessary, the vaccines must be given with different syringes and at different injection sites.[10]

REFERENCES:

1. National Advisory Council on Immunization (NACI). Canadian Immunization Guide. Accessed Nov 28, 2021 and June 22, 2022. https://www.canada.ca/en/public-health/services/publications/healthy-living/canadian-immunization-guide-part-3-vaccination-specific-populations.html
2. Publicly funded immunization schedules for Ontario-December 2022. Accessed September 29, 2022. https://www.health.gov.on.ca/en/pro/programs/immunization/docs/Publicly_Funded_ImmunizationSchedule.pdf.
3. Danziger-Isakov L, Kumar D. Vaccination of solid organ transplant candidates and recipients: guidelines from the AST Infectious Diseases Community of Practice *Clin Transplant* 2019; 33(9).
4. Rubin LG, Levin MJ, Ljungman P, Davies EG, Avery R, Tomblyn M, *et al.* 2013 IDSA clinical practice guideline for vaccination of the immunocompromised host. *Clinical Infectious Diseases* 2014; 58: e44-100.
5. Abuali MM, Arnon R, Posada R. An update on immunizations before and after transplantation in the pediatric solid organ transplant recipient. *Pediatric Transplant* 2011; 15: 770-7.
6. Kumar D. Immunizations following solid-organ transplantation. *Current Opinion in Infectious Disease* 2014; 27: 329-335.
7. L'Huillier AG, Kumar D. Immunizations in solid organ and hematopoeitic stem cell transplant patients: A comprehensive review. *Human Vaccines and Immunotherapeutics* 2015; 11: 2852-63.
8. American Academy of Pediatrics (AAP) Committee on Infectious Diseases. Kimberlin DW (ed) *Red Book: 2021-2024 Report of the Committee on Infectious Diseases* (32nd edition). Itasca, IL: American Academy of Pediatrics.
9. Martin K, Drabble A, Manlhiot C, Dipchand AI. Response to hepatitis A and B vaccination after pediatric heart transplant. *Pediatric Transplant*ation 2012; 16: 699-703.
10. GlaxoSmithKline Inc. Product Monograph Havrix®. March 2021.
11. GlaxoSmithKline Inc. *Product Monograph Twinrix*®. November 2018.
12. Sanofi Pasteur Ltd. *Product Monograph Avaxim Pediatric*®. May 2021.

2.5 INACTIVE VACCINES: HEPATITIS B – POST-TRANSPLANT GUIDELINES

NAME OF VACCINE PRODUCTS AVAILABLE IN CANADA	ROUTINE SCHEDULE (ONTARIO)	MINIMUM AGE FOR 1ST DOSE	MINIMUM INTERVAL BETWEEN DOSES	NUMBER OF DOSES REQUIRED	POST-TRANSPLANT SCHEDULE OR BOOSTER DOSES?	SEROLOGY PRE/POST VACCINATION	COVERAGE IN ONTARIO
Hepatitis B Engerix® B **OR** Recombivax HB® (Can be used interchangeably)	Grade 7 (12 yrs) 2 doses (0, 6 mths)	Newborn[2]	Varied accelerated schedules available **ACCELERATED SCHEDULES** **4 dose** 0, 7, 21-28 days, and booster at 6 mths[1, 12] **3 dose** 0, 1, >2 mths[1]	**3 dose schedule preferred**[1] 0, 1, 6 mths	**Double the microgram dose for age** is recommended in transplant patients.[1] *See Table 2 for dosing May start vaccination 6 mths post-transplant for **HIGH RISK*** (e.g. travel)[¥] NOT vaccinated or INCOMPLETE series pre-transplant: 3 dose schedule: 0, 1, 6 mths preferred **OR** **Accelerated Schedule** **4 dose**: 0, 7, 21-28 days, and booster at 6 mths **3 dose**: 0, 1, >2 mths **Vaccinated Pre-transplant (Boosting)** -if response suboptimal (titre <10 iu/L) at 1 yr post-transplant: repeat series (3-4 doses) x1	**YES** 6-8 wks post series[¥] (range 1-6 mo[1]) Annually post series to assess ongoing immunity If suboptimal response (<10 IU/L) repeat series x1 If non-responsive with repeat series, consult ID	Covered by ON MOHLTC school program (grade 7) -2 doses only Covered <7 yrs age immigrated from countries of high prevalence or exposed to family carriers Doses 2 and 3 covered for patients[2]: -on dialysis or receiving frequent blood products -listed for transplant 3 doses covered for patients with chronic liver disease[2]
Combination Hep B Vaccines: Hep A +B: Twinrix® Twinrix® Junior DTaP-HB-IPV-Hib INFANRIX Hexa™	NACI does NOT recommend the use of Twinrix® or Twinrix® Junior in immunosuppressed patients[1]						

[¥]Expert opinion

TABLE 1: CANADIAN IMMUNIZATION GUIDE (NACI)[1] – HEPATITIS B STANDARD DOSING RECOMMENDATIONS FOR PAEDIATIC PATIENTS (3 OR 4 DOSE SCHEDULE ONLY):

RECIPIENTS	RECOMBIVAX HB®			ENGERIX® B		
	µg	mL	SCHEDULE (MTHS)	µg	mL	SCHEDULE (MTHS)
Infants (regardless of mothers' HBV status)	5	0.5	0, 1, 6**	10	0.5	0, 1, 6 **OR** 0, 1, 2, 12
12 mths-19 yrs	5	0.5	0, 1, 6**	10	0.5	0, 1, 6 **OR** 0, 1, 2, 12

*Thimerosal preservative-free preparation is recommended

**Although a schedule of 0, 1 and >2 mths is approved, the preferred schedule is 0, 1, and 6

TABLE 2: HEPATITIS B-REVISED DOSING GUIDELINES FOR TRANSPLANT (ADAPTED FROM CANADIAN IMMUNIZATION GUIDE-NACI)

NOTE: DOSES LISTED ARE DOUBLE THE ROUTINE AGE RECOMMENDED DOSE

RECIPIENTS	RECOMBIVAX HB®			ENGERIX® B		
	µg	mL	SCHEDULE (MTHS)	µg	mL	SCHEDULE (MTHS)
Infants (regardless of mothers' HBV status)	10	1	0, 1, 6**	20	1	0, 1, 6 **OR** 0, 1, 2, 12
12 mths-<16 yrs	10	1	0, 1, 6** **OR** 0, 1, 2, 12	20	1	0, 1, 6 **OR** 0, 1, 2, 12
16 to <20 yrs	10	1	0, 1, 6** **OR** 0, 1, 2, 12	40	2	0, 1, 2, 6

*Thimerosal preservative-free preparation recommended;

**Although schedule of 0, 1 and >2 mths is approved, the preferred schedule is 0, 1, and 6

CONCOMITANT ADMINISTRATION OF VACCINES LISTED IN THIS TABLE:

- The National Advisory Committee on Immunization (NACI) states that administering the most widely used live and inactivated vaccines during the same patient visit has produced seroconversion rates and rates of adverse reactions similar to those observed when the vaccines are administered separately.[1]
- NACI recommends that vaccines administered simultaneously should be given using separate syringes at separate sites.[1]
- According to the National Advisory Committee on Immunization (NACI), RECOMBIVAX HB® (hepatitis B vaccine [recombinant]) may be administered simultaneously with other vaccines at different sites. A separate needle and syringe should be used for each vaccine.[13]

CONTRAINDICATIONS:

- In persons with a history of anaphylaxis after previous administration of a HB-containing vaccine and in persons with proven immediate or anaphylactic hypersensitivity to any component of the product or its container.[12, 13]

REFERENCES:

1. National Advisory Council on Immunization (NACI). Canadian Immunization Guide. Accessed Nov 28, 2021 and June 22, 2022. https://www.canada.ca/en/public-health/services/publications/healthy-living/canadian-immunization-guide-part-4-active-vaccines/page-7-hepatitis-b-vaccine.html
2. Publicly funded immunization schedules for Ontario-June 2022. Accessed September 29, 2022. https: www.health.gov.on.ca/en/pro/programs/immunization/docs/Publicly_Funded_ImmunizationSchedule.pdf.
3. Danziger-Isakov L, Kumar D, Vaccination of solid organ transplant candidates and recipients: guidelines from the AST Infectious Diseases Community of Practice. *Clin Transplant* 2019; 33(9): e13563.
4. Rubin LG, Levin MJ, Ljungman P, Davies EG, Avery R, Tomblyn M, *et al.* 2013 IDSA clinical practice guideline for vaccination of the immunocompromised host. *Clinical Infectious Diseases* 2014; 58: e44-100.
5. Abuali MM, Arnon R, Posada R. An update on immunizations before and after transplantation in the pediatric solid organ transplant recipient. *Pediatric Transplant* 2011; 15: 770-7.
6. Kumar D. Immunizations following solid-organ transplantation. *Current Opinion in Infectious Disease* 2014; 27: 329-335.
7. L'Huillier AG, Kumar D. Immunizations in solid organ and hematopoeitic stem cell transplant patients: A comprehensive review. *Human Vaccines and Immunotherapeutics* 2015; 11: 2852-63.
8. Leung DH, Ton-That M, Economides JM, Healy CM. High prevalence of hepatitis B nonimmunity in vaccinated pediatric liver transplant recipients. *American Journal of Transplantation* 2015; 15: 535-540.
9. Martin K, Drabble A, Manlhiot C, Dipchand AI. Response to hepatitis A and B vaccination after pediatric heart transplant. *Pediatric Transplant*ation 2012; 16: 699-703.
10. GlaxoSmithKline Inc. *Product Monograph Twinrix®*. November 2018.
11. American Academy of Pediatrics (AAP) Committee on Infectious Diseases. Kimberlin DW (ed) *Red Book: 2021-2024 Report of the Committee on Infectious Diseases* (32nd edition). Itasca, IL: American Academy of Pediatrics.
12. GlaxoSmithKline Inc. *Product Monograph Engerix B®*. October 2020.
13. Merck Canada Inc. *Product Monograph Recombivax®*. May 2012.
14. Chong P, Avery R. A comprehensive review of immunization practices in solid organ transplant and hematopoietic stem cell transplant recipients. *Clin Therapeutics* 2017; 39(8): 1581-1598.

2.6 INACTIVE VACCINES: HUMAN PAPILLOMA VIRUS – POST-TRANSPLANT GUIDELINES

NAME OF VACCINE PRODUCTS AVAILABLE IN CANADA	ROUTINE SCHEDULE (ONTARIO)	MINIMUM AGE FOR 1ST DOSE	MINIMUM INTERVAL BETWEEN DOSES	NUMBER OF DOSES REQUIRED	POST-TRANSPLANT SCHEDULE OR BOOSTER DOSES?	SEROLOGY PRE/POST VACCINATION	COVERAGE IN ONTARIO
Human Papilloma Virus Gardasil® 9 (9-valent HPV type 6, 11, 16, 18, 31, 33, 45, 52, 58)	Grade 7 females and males	9 yrs[1, 2] Gardasil® 9 is approved in females between 9 and 45 yrs and in males between 9 and 45 yrs[1, 3]	4 wks between first and second dose 12 wks between second and third dose[1, 2] Third dose at least 24 wks after first dose[1, 2]	**3 doses** 0, 2 and 6 mths[1, 2] If schedule interrupted, series does not need to be restarted[5]. However all 3 doses should be given withn a 1 yr period[4]	**YES** May be started as soon as 3-6 mths post-transplant[10], once stable immuno-suppression and no rejection episodes	NO	Gardasil® 9 is covered under ON MOHLTC school program (grade 7-12) for females and males 3 doses covered for immunocompromised)

NOTES:

- Dose 0.5 mL IM.
- Higher incidence of fainting in younger individuals; observe patients for full 15 minutes post dose.
- Cervarix® (bivalent HPV 2, type 16, 18) **is NOT recommended in transplant recipients.**

CONCOMITANT ADMINISTRATION OF VACCINES LISTED IN THIS TABLE:

- The National Advisory Committee on Immunization (NACI) states that administering the most widely used live and inactivated vaccines during the same patient visit has produced seroconversion rates and rates of adverse reactions similar to those observed when the vaccines are administered separately.[1]
- NACI recommends that vaccines administered simultaneously should be given using separate syringes at separate sites.[1]
- GARDASIL® 9 may be administered concomitantly (at a separate injection site) with Menactra® [Meningococcal (Groups A, C, Y and W-135) Polysaccharide Diphtheria Toxoid Conjugate Vaccine] and Adacel® [Tetanus Toxoid, Reduced Diphtheria Toxoid and Acellular Pertussis Vaccine Adsorbed (Tdap)], and Repevax* [Diphtheria, Tetanus, Pertussis (acellular, component) and Poliomyelitis (inactivated) Vaccine, (adsorbed, reduced antigen(s) content) (Tdap-IPV)].

REFERENCES:

1. National Advisory Council on Immunization (NACI). Canadian Immunization Guide. Accessed May 28 2021 and June 22, 2022. https://www.canada.ca/en/public-health/services/publications/healthy-living/canadian-immunization-guide-part-4-active-vaccines/page-9-human-papillomavirus-vaccine.html#p4c8a6_b
2. Publicly funded immunization schedules for Ontario-June 2022. Accessed September 29, 2022. https://www.health.gov.on.ca/en/pro/programs/immunization/docs/Publicly_Funded_ImmunizationSchedule.pdf
3. Merck Canada Inc. *Product Monograph Gardasil®* 9. April 2022.
4. Abuali MM, Arnon R, Posada R. An update on immunizations before and after transplantation in the pediatric solid organ transplant recipient. *Pediatric Transplant* 2011; 15: 770-7.
5. CDC. Recommended immunization schedules for persons aged 0 through 18 yrs. 2022 Accessed May18, 2022 https://www.cdc.gov/vaccines/schedules/hcp/imz/child-adolescent.html
6. GlaxoSmithKline. *Product Monograph Cervarix®*. February 2019.
7. American Academy of Pediatrics (AAP) Committee on Infectious Diseases. Kimberlin DW (ed) *Red Book: 2021-2024 Report of the Committee on Infectious Diseases* (32nd edition). Itasca, IL: American Academy of Pediatrics.
8. Rubin LG, Levin MJ, Ljungman P, Davies EG, Avery R, Tomblyn M, *et al.* 2013 IDSA clinical practice guideline for vaccination of the immunocompromised host. *Clinical Infectious Diseases* 2014; 58: e44-100.
9. Benden C, Danziger-Isakov LA, Astor T, *et al.* Variability in immunization guidelines in children before and after lung transplantation. *Pediatric Transplant*ation 2007; 11: 882-887.
10. Danziger-Isakov L, Kumar D. Vaccination of solid organ transplant candidates and recipients: Guidelines from the AST Infectious Diseases Community of Practice. *Clin Transplant* 2019; 33: e: 13563
11. Kumar D. Immunizations following solid-organ transplantation. *Current Opinion in Infectious Disease* 2014; 27: 329-335.
12. L'Huillier AG, Kumar D. Immunizations in solid organ and hematopoeitic stem cell transplant patients: A comprehensive review. *Human Vaccines and Immunotherapeutics* 2015; 11: 2852-63.

3.0 POST-TRANSPLANT: LIVE VACCINES

3.1 LIVE VACCINES: MEASLES, MUMPS, RUBELLA – POST-TRANSPLANT GUIDELINES

NAME OF VACCINE PRODUCTS AVAILABLE IN CANADA	ROUTINE SCHEDULE (ONTARIO)	MINIMUM AGE FOR 1ST DOSE	MINIMUM INTERVAL BETWEEN DOSES	NUMBER OF DOSES REQUIRED	POST-TRANSPLANT SCHEDULE OR BOOSTER DOSES?	SEROLOGY PRE/POST VACCINATION	COVERAGE IN ONTARIO
Priorix® (MMR) MMR-II® (MMR)	Live vaccines are NOT recommended for some categories of patients post organ transplantation[2, 3, 4] Refer to Live Vaccines After Pediatric Solid Organ Transplant: Proceedings of a Consensus Meeting[22] for specific recommendations						
Priorix-Tetra® (MMR-V) ProQuad® (MMR-V)[3]							

REFERENCES:

1. Rubin LG, Levin MJ, Ljungman P, Davies EG, Avery R, Tomblyn M, *et al.* 2013 IDSA clinical practice guideline for vaccination of the immunocompromised host. *Clinical Infectious Diseases* 2014; 58: e44-100.
2. Publicly funded immunization schedules for Ontario-June 2022 Accessed September 29, 2022. http://www.health.gov.on.ca/en/pro/programs/immunization/docs/Publicly_Funded_ImmunizationSchedule.pdf
3. Merck Canada Inc. *Product Monograph ProQuad®*. January 2017.
4. National Advisory Council on Immunization (NACI). Canadian Immunization Guide. Accessed November 28, 2021 and June 22, 2022. https://www.canada.ca/en/public-health/services/publications/healthy-living/canadian-immunization-guide-part-4-active-vaccines.html
5. Vaccination of solid organ translant candidates and recipients: Guidelines from the AST Infectious Diseseases Community of Practice. *Clin Transplant* 2019; 33: e13563.
6. Abuali MM, Arnon R, Posada R. An update on immunizations before and after transplantation in the pediatric solid organ transplant recipient. *Pediatric Transplant* 2011; 15: 770-7.
7. L'Huillier AG, Kumar D. Immunizations in solid organ and hematopoeitic stem cell transplant patients: A comprehensive review. *Human Vaccines and Immunotherapeutics* 2015; 11: 2852-63.
8. GlaxoSmithKline Inc. *Product Monograph PRIORIX-TETRA™*. August 2019.
9. GlaxoSmithKline Inc. *Product Monograph PRIORIX®*. August 2019.
10. Merck Canada Inc. *Product Monograph MMR-II®*. March 2021.
11. Kawano Y, Suzuki M, Kawada J, Kimura H, Kamei H, Ohnishi Y, Ono Y, Uchida H, Ogura Y, Ito Y. Effectiveness and safety of immunization with live-attenuated and inactivated vaccines for pediatric liver transplantation recipients. *Vaccine* 2015; 33: 1440-45.
12. Shinjoh M, Hoshino K, Takahashi T, Nakayama T. Updated data on effective and safe immunizations with live-attenuated vaccines for children after living donor liver transplantation. *Vaccine* 2015; 33: 701-707.
13. L'Huillier AG, Posfay-Barbe KM. Live viral vaccines in immunocompromised patients. *Future Virology* 2014; 9: 161-171.
14. Verolet CM, Posfay-Barbe KM. Live Virus Vaccines in Transplantation: Friend or Foe? *Current Infectious Disease Reports* 2015; 17: 472-83.
15. Kumar D. Immunizations following solid-organ transplantation. *Current Opinion in Infectious Disease* 2014; 27: 329-335.
16. CDC. Recommended immunization schedules for persons aged 0 through 18 yrs. *2022 Accessed May 18, 2022 https://www.cdc.gov/vaccines/schedules/hcp/imz/child-adolescent.html*
17. American Academy of Pediatrics. Immunization in immunocompromised children. In: Red Book: 2021-2024 Report of the Committee on Infectious Diseases, 32nd ed, Kimberlin DW (Ed), Brady MT, Jackson MA, Long SS. (Eds), American Academy of Pediatrics, Itasca, IL.
18. Rand EB, McCarthy CA, Whitington PF. Measles vaccination after orthotopic liver transplantation. *Journal of Pediatrics* 1993; 123: 87-9.
19. Kano H, Mizuta K, Sakakihara Y, *et al.* Efficacy and safety of immunization for pre-and post-liver transplant children. *Transplantation* 2002; 74: 543-50.
20. Khan S, Erlichman J, Rand EB. Live virus immunization after orthotopic liver transplantation. *Pediatric Transplant* 2006; 10: 78-82.
21. Shinjoh M, Miyairi I, Hoshino K, *et al.* Effective and safe immunizations with live-attenuated vaccines for children after living donor liver transplantation. *Vaccine* 2008; 26: 6859-63.
22. Suresh S, Upton J, Green M et al. Live vaccines after pediatric solid organ transplant: Proceedings of a consensus meeting. *Pediatr Transplant* 2019; 23(7).

3.2 LIVE VACCINES: VARICELLA – POST-TRANSPLANT GUIDELINES

NAME OF VACCINE PRODUCTS AVAILABLE IN CANADA	ROUTINE SCHEDULE (ONTARIO)	MINIMUM AGE FOR 1ST DOSE	MINIMUM INTERVAL BETWEEN DOSES	NUMBER OF DOSES REQUIRED	POST-TRANSPLANT SCHEDULE OR BOOSTER DOSES?	SEROLOGY PRE/POST VACCINATION	COVERAGE IN ONTARIO
Varivax® III (Varicella only) Varilrix® (Varicella only)	Live vaccines are NOT recommended for some categories of patients post organ transplantation[1, 13, 14] Refer to *Live Vaccines After Pediatric Solid Organ Transplant: Proceedings of a Consensus Meeting*[28] for specific recommendations						
Priorix-Tetra® (MMR-V) ProQuad® (MMR-V)							

REFERENCES:

1. Rubin LG, Levin MJ, Ljungman P, Davies EG, Avery R, Tomblyn M, *et al.* 2013 IDSA clinical practice guideline for vaccination of the immunocompromised host. *Clinical Infectious Diseases* 2014; 58: e44-100.
2. Merck Canada Inc. *Product Monograph ProQuad®*. October 2022.
3. GlaxoSmithKline Inc. *Product Monograph PRIORIX-TETRA™*. August 2019.
4. Shinjoh M, Hoshino K, Takahashi T, Nakayama T. Updated data on effective and safe immunizations with live-attenuated vaccines for children after living donor liver transplantation. Vaccine 2015; 33: 701-707.
5. Kawano Y, Suzuki M, Kawada J, Kimura H, Kamei H, Ohnishi Y, Ono Y, Uchida H, Ogura Y, Ito Y. Effectiveness and safety of immunization with live-attenuated and inactivated vaccines for pediatric liver transplantation recipients. Vaccine 2015; 33: 1440-45.
6. Posfay-Barbe KM, Pittet LF, Sottas C, Grillet S, Wildhaber BE, Rodriguez M, *et al.* Varicella-zoster immunization in pediatric liver transplant recipients: safe and immunogenic. *American Journal of Transplantation* 2012; 12: 2974-85.
7. Pergam SA, Limaye AP, AST Infectious Disease Community of Practice. Varicella zoster virus in solid organ transplant recipients. *Clinical Transplant* 2019; 33(9): e13622.
8. Danziger-Isakov L, Kumar D. Vaccination of solid organ transplant candidates and recipients: Guidelines from the AST Infectious Diseases Community of Practice. *Clin Transplant* 2019;33: e13563.
9. L'Huillier AG, Posfay-Barbe KM. Live viral vaccines in immunocompromised patients. *Future Virology* 2014; 9: 161-171.
10. Abuali MM, Arnon R, Posada R. An update on immunizations before and after transplantation in the pediatric solid organ transplant recipient. *Pediatric Transplant* 2011; 15: 770-7.
11. L'Huillier AG, Kumar D. Immunizations in solid organ and hematopoeitic stem cell transplant patients: A comprehensive review. *Human Vaccines and Immunotherapeutics* 2015; 11: 2852-63.
12. Verolet CM, Posfay-Barbe KM. Live Virus Vaccines in Transplantation: Friend or Foe? *Current Infectious Disease Reports* 2015; 17: 472-83.
13. CDC. Recommended immunization schedules for persons aged 0 through 18 yrs-2022. Accessed May 18, 2022. https://www.cdc.gov/vaccines/schedules/hcp/imz/child-adolescent.html
14. NACI. Canadian Immunization Guide. Accessed November 28, 2021 and June 22, 2022https://www.canada.ca/en/public-health/services/publications/healthy-living/canadian-immunization-guide-part-4-active-vaccines.html
15. Publicly funded immunization schedules for Ontario-January 2022. Accessed September 29, 2022. http://www.health.gov.on.ca/en/pro/programs/immunization/docs/Publicly_Funded_ImmunizationSchedule.pdf
16. American Academy of Pediatrics. Immunization in immunocompromised children. In: *Red Book: 2021-2024 Report of the Committee on Infectious Diseases*, 32nd ed, Kimberlin DW (Ed), American Academy of Pediatrics, Itasca, IL.
17. Kumar D. Immunizations following solid-organ transplantation. *Current Opinion in Infectious Disease* 2014; 27: 329-335.
18. Mizuta K, Urahashi T, Ihara Y, *et al.* Varicella zoster virus disease after pediatric living donor liver transplantation: is it serious? *Transplantation Proceedings* 2012; 44: 780-783.
19. Pittet LF, Posfay-Barbe KM. Immunization in transplantation: review of the recent literature. Current Opinion in Organ Transplantation 2013; 18: 543-548.
20. Danerseau AM, Robinson JL. Efficacy and safety of measles, mumps, rubella and varicella live viral vaccines in transplant recipients receiving immunosuppressive drugs. *World Journal of Pediatrics* 2008; 4: 254-258.
21. Kano H, Mizuta K, Sakakihara Y, *et al.* Efficacy and safety of immunization for pre-and post-liver transplant children. *Transplantation* 2002; 74: 543-50.
22. Zamora I, Simon JM, Da Silva ME, Piqueras AI. Attenuated varicella virus vaccine in children with renal transplants. *Pediatric Nephrology* 1994; 8: 190-2.
23. Weinberg A, Horslen SP, Kaufman SS, *et al.* Safety and immunogenicity of varicella-zoster virus vaccine in pediatric liver and intestine transplant recipients. *American Journal of Transplantation* 2006; 6: 565-8.
24. Donati M, Zuckerman M, Dhawan A, *et al.* Response to varicella immunization in pediatric liver transplant recipients. Transplantation 2000; 70: 1401-4.
25. Merck Canada Inc. *Product Monograph Varivax®* III. November 2020.
26. Glaxo Smith Kline Inc. *Product Monograph Varilix®*. August 2019.
27. Verolet CM, Pittet LF, Wildhaber BE, et al. Long-term seroprotection of varicella-zoster immunization in pediatric liver transplant recipients. Transplantation 2019;103:e355-e364
28. Suresh S, Upton J, Green M et al. Live vaccines after pediatric solid organ transplant: Proceedings of a consensus meeting. Pediatr Transplant 2019; 23(7).

3.3 LIVE VACCINES: ROTAVIRUS – POST-TRANSPLANT GUIDELINES

NAME OF VACCINE PRODUCTS AVAILABLE IN CANADA	ROUTINE SCHEDULE (ONTARIO)	MINIMUM AGE FOR 1ST DOSE	MINIMUM INTERVAL BETWEEN DOSES	NUMBER OF DOSES REQUIRED	POST-TRANSPLANT SCHEDULE OR BOOSTER DOSES?	SEROLOGY PRE/POST VACCINATION	COVERAGE IN ONTARIO
Rotavirus oral vaccine RotaTeq® Rotarix® Not interchangeable	Rotavirus oral vaccine is a live vaccine and should NOT be given post organ transplantation[1, 2, 3, 4]						

REFERENCES:

1. Publicly funded immunization schedules for Ontario-June 2022. Accessed September 29, 2022. https://www.health.gov.on.ca/en/pro/programs/immunization/docs/Publicly_Funded_ImmunizationSchedule.pdf
2. National Advisory Committee on Immunization. (NACI). Canadian Immunization Guide. Accessed November28, 2021 and June 22, 2022. https://www.canada.ca/en/public-health/services/publications/healthy-living/canadian-immunization-guide-part-4-active-vaccines.html
3. CDC. Recommended immunization schedules for persons aged 0 through 18 yrs-2022. Accessed May 18, 2022. https://www.cdc.gov/vaccines/schedules/hcp/imz/child-adolescent.html
4. Glaxo Smith Kline Inc. *Product Monograph. Rotarix®* April 2021.
5. Merck Canada Inc. *Product Monograph. RotaTeq®* January 2018.
6. Suresh S, Upton J, Green M et al. Live vaccines after pediatric solid organ transplant: Proceedings of a consensus meeting. Pediatr Transplant 2019; 23(7).

4.0 POST-TRANSPLANT: INFLUENZA VACCINES

4.0 INFLUENZA VACCINES: POST-TRANSPLANT GUIDELINES

NAME OF VACCINE PRODUCTS AVAILABLE IN CANADA	ROUTINE SCHEDULE (ONTARIO)	MINIMUM AGE FOR 1ST DOSE	MINIMUM INTERVAL BETWEEN DOSES	NUMBER OF DOSES REQUIRED	POST-TRANSPLANT SCHEDULE OR BOOSTER DOSES?	SEROLOGY PRE/POST VACCINATION	COVERAGE IN ONTARIO
Influenza Vaccine availability may vary annually Quadrivalent Inactivated: Flulaval® Tetra Fluzone® Quad Flucelvax Quad Influvac Tetra Afluria Tetra (>5 yrs) Trivalent Inactivated, Adjuvanted: Fluad Pediatric™ (age 6-23 mths)[1]	Yearly	6 mths[1]	Annual	**6 mths-9 yrs, previous influenza vaccination:** 1 dose[1] **6 mths-9 yrs, no previous influenza vaccination:** 2 doses, 4 wks apart[1, 2, 5] **>/=9 yrs:** 1 dose[1]	Annual vaccination recommended.[1] Consider immunizing as early as 1 mth[2, 3, 5, 10], post-transplant in the following situations: a) patient transplanted just prior to flu season b) influenza outbreak Otherwise may start as early as 4 mths[¥] post-transplant if stable degree of immuno-suppression Consult ID in an influenza outbreak	No	Covered by MOHLTC for all patients at risk
Live-attenuated Influenza Vaccine (LAIV) quadrivalent: FluMist® (>2 yrs)	*Intranasal Live attenuated vaccine should NOT be given post-transplant[1, 2]						

[¥]Expert opinion

NOTES:

- If a quadrivalent vaccine is not available, any of the available trivalent vaccines licensed for the pertinent age group should be used.[1]
- Concomitant Administration of Vaccines Listed in this Table: The National Advisory Committee on Immunization (NACI) states that administering the most widely used live and inactivated vaccines during the same patient visit has produced seroconversion rates and rates of adverse reactions similar to those observed when the vaccines are administered separately.[1] NACI recommends that vaccines administered simultaneously should be given using separate syringes at separate sites.[1]
- As a precaution, siblings who have been vaccinated with LAIV should avoid contact with recently transplanted patients who are still in hospital for one wk following LAIV dose.[8]

CONTRAINDICATIONS:

- Persons who have developed an anaphylactic reaction to a previous dose of influenza vaccine or any of its components (with the exception of egg*), have developed Guillain-Barre Syndrome (GBS) within 6 wks of influenza vaccination.[1]
- *Egg allergic individuals can be vaccinated with influenza vaccine with inactivated TIV and QIV or LAIV without an influenza skin test and with the full dose of the vaccine.[1]
- Consult individual product monographs for specific warnings in this regard.

REFERENCES:

1. National Advisory Committee on Immunization (NACI). ADDENDUM. Advisory committee Statement (ACS). Canadian Immunization Guide chapter on influenza and statement on seasonal influenza vaccine for 2022-2023 Accessed September 29, 2022. https://www.canada.ca/ en/public-health/services/publications/vaccines-immunization/canadian-immunization-guide-statement-seasonal-influenza-vaccine-2020-2021.html
2. Publicly funded immunization schedules for Ontario-June 2022 Accessed May 18, 2022. http://www.health.gov.on.ca/en/pro/programs/immunization/docs/Publicly_Funded_ImmunizationSchedule.pdf
3. Kumar D, Blumberg EA, Danziger-Isakov L, Kotton CN, Halasa NB, Ison MG, *et al.* Influenza Vaccination in the Organ Transplant Recipient: Review and Summary of Recommendations. *American Journal of Transplantation* 2011: 11; 2020-2030.
4. Abuali MM, Arnon R, Posada R. An update on immunizations before and after transplantation in the pediatric solid organ transplant recipient. *Pediatric Transplant* 2011; 15: 770-7.
5. CDC. Recommended immunization schedules for persons aged 0 through 18 yrs-2022 Accessed June 22, 2022. https://www.cdc.gov/vaccines/schedules/hcp/imz/child-adolescent.html
6. Gavalda J, Cabral E, Perez-Romero P, Len O, Aydillo T, Campins M *et al.* Immunogenicity of pandemic influenza A H1N1/2009 adjuvanted vaccine in pediatric solid organ transplant recipients. *Pediatric Transplant*ation 2013; 17: 403-406.
7. GiaQuinta S, Michaels MG, McCullers JA, Wang, L, Fonnesbeck C, O'Shea A *et al.* Randomized, double-blind comparison of standard-dose vs. high-dose trivalent inactivated influenza vaccine in pediatric solid organ transplant patients. *Pediatric Transplant*ation 2015; 19: 219-228.
8. Rubin LG, Levin MJ, Ljungman P, Davies EG, Avery R, Tomblyn M, *et al.* 2013 IDSA clinical practice guideline for vaccination of the immunocompromised host. *Clinical Infectious Diseases* 2014; 58: e44-100.
9. Benden C, Danziger-Isakov LA, Astor T, *et al.* Variability in immunization guidelines in children before and after lung transplantation. *Pediatric Transplant*ation 2007; 11: 882-887.
10. Danziger-Isakov L, Kumar D. Vaccination of solid organ transplant candidates and recipients: Guidelines from the AST Infectious Diseases Community of Practice. *Clin Transplant* 2019; 33: e13563.
11. Kumar D. Immunizations following solid-organ transplantation. *Current Opinion in Infectious Disease* 2014; 27: 329-335.
12. L'Huillier AG, Kumar D. Immunizations in solid organ and hematopoeitic stem cell transplant patients: A comprehensive review. *Human Vaccines and Immunotherapeutics* 2015; 11: 2852-63.
13. L'Huillier AG, Posfay-Barbe KM. Live viral vaccines in immunocompromised patients. *Future Virology* 2014; 9: 161-171.
14. Martin ST, Torabi MJ, Gabardi S. Influenza in solid organ transplant recipients. *The Annals of Pharmacotherapy* 2012; 46: 255-264.
15. Cordero E, Manuel O. Influenza vaccination in solid-organ transplant recipients. Current Opinion in Organ *Transplantation* 2012; 17: 601-608.
16. AstraZeneca Canada Inc. *Product Monograph FluMist® Quadrivalent* April 2022.
17. Avery RK. Influenza vaccines in the setting of solid-organ transplantation: are they safe? *Current Opinion in Infectious Disease*s 2012; 25: 464-468.
18. Moore DL, Canadian Pediatric Society, Infectious Disease and Immunization Committee. Vaccine recommendations for children and youth for the influenza season. Accessed June 02, 2021. https://www.cps.ca/en/documents/position/vaccine-recommendations-2020-2021-influenza-season
19. Haller W, Buttery J, Laurte K, Beyerle K, Hardikar W, Alex G. Immune response to pandemic H1N1 2009 influenza a vaccination in pediatric liver transplant recipients. *Liver Transplantation* 2011; 17: 914-920.
20. Kumar D, Morris MI, Kotton CN, *et al.* Guidance on novel influenza A/H1N1 in solid organ transplant recipients. *American Journal of Transplantation* 2010; 10: 18-25.
21. Grohskopf LA, Sokolow LZ, Broder KR, *et al.* Prevention and Control of Seasonal Influenza with Vaccines. MMWR Recomm Rep 2016; 65: 1.
22. Sanofi Pasteur Ltd. *Product Monograph Fluzone®*. February 2014.
23. GlaxoSmithKline Inc. *Product Monograph Fluviral®*. September 2020.
24. American Academy of Paediatrics Committee on Infectious Diseases; Kimberlin DW (ed). RedBook 2021-2024 Report of the Committee on Infectious Diseases 32nd edition. Itasca IL.
25. Seqirus Canada Inc. Product Monograph Flucelvax® Quad. May 2022.
26. BGB Pharma ULC. *Product Monograph Influvac® Tetra*. May 2022.
27. Seqirus Canada Inc. *Product Monograph Afluria® Tetra* May 2022.

5.0 POST-TRANSPLANT: TRAVEL VACCINES

5.1 ENTEROTOXIGENIC E COLI – POST-TRANSPLANT TRAVEL GUIDELINES

NAME OF VACCINE PRODUCTS AVAILABLE IN CANADA	MINIMUM AGE FOR 1ST DOSE	MINIMUM INTERVAL PRIOR TO TRAVEL	NUMBER OF DOSES REQUIRED	MINIMUM INTERVAL BETWEEN DOSES	INDICATION POST-TRANSPLANT	SEROLOGY REQUIRED PRE/POST VACCINATION	COVERAGE IN ONTARIO
Enterotoxigenic E coli *Dukoral®* (Oral, inactivated)	2 yrs[1,2]	2 wks[1,2]	**Primary immunization** **2 doses*** 1st dose 2 wks before departure; 2nd dose 1 wk following first dose and at least 1 wk before departure[1,2] **Booster** 1 dose every 3 mths if in area of ongoing risk[1,2] If more than 5 yrs have passed since primary immunization or last booster dose, repeat primary series[1,2]	1 wk[1,2]	**YES** If indicated However an adequate response may not be achieved	NO	Not routinely covered by ON-MOHLTC

***NOTES:**

*If 6 wks elapses between doses patient will need to repeat the primary series.[1,2]

Dukoral dose is prepared differently for younger children.[1] See below:

- Open the white sachet of powder and pour into 150 ml (5 oz) of cool water.
- Stir gently with spoon to dissolve.
- Do not use any other liquid.
- For children aged 2–6 yrs, pour away half of the powder/water mixture before adding the vaccine component.[1]

REFERENCES

1. Valneva Canada Inc. Product Monograph Dukoral® October 2020.
2. NACI: Canadian Immunization Guide. Cholera and enterotoxigenic escherichia coli (ETEC) travellers' diarrhea vaccine. Accessed Nov 28, 2021, and June 17, 2022. https://www.canada.ca/en/public-health/services/publications/healthy-living/canadian-immunization-guide-part-4-active-vaccines/page-3-cholera-enterotoxigenic-escherichia-coli-travellers-diarrhea-vaccine.html
3. Buchan C, Kotton C. Travel medicine, transplant tourism and the solid organ transplant recipient. Guidelines from the AST Infectious Disesases Community of Practice. *Clin Transplant* 2019; 33(9).
4. CDC Yellow Book 2020: Immunocompromised travelers-severe immunosuppression (non HIV-related; adult).
5. Abuali M, Arnon R and Posada R. "An Update on Immunizations before and after Transplantation in the Pediatric Solid Organ Transplant Recipient." *Pediatric Transplant*ation 2011; 15: 770-77.
6. Danziger-Isakov, L., and D. Kumar. "Vaccination of solid organ transplant candidates and recipients: Guidelines from the AST Infectious Diseases Community of Practice. *Clin Transplant* 2019; 33: e13563.
7. Patel RP, Liang SY, Koolwal P and Kulhmann FM. "Travel Advice for the Immunocompromised Traveler: Prophylaxis, Vaccination, and Other Preventive Measures." *Therapeutics and Clinical Risk Management TCRM* (2015): 217.

5.2 HEPATITIS A – POST-TRANSPLANT TRAVEL GUIDELINES

NAME OF VACCINE PRODUCTS AVAILABLE IN CANADA	MINIMUM AGE FOR 1ST DOSE	MINIMUM INTERVAL PRIOR TO TRAVEL	NUMBER OF DOSES REQUIRED	MINIMUM INTERVAL BETWEEN DOSES	INDICATION POST-TRANSPLANT	SEROLOGY REQUIRED PRE/POST VACCINATION	COVERAGE IN ONTARIO
Hepatitis A AVAXIM® AVAXIM® PED HAVRIX® HAVRIX® JR VAQTA® VAQTA® PED (Interchangeable) *IM inj*	6 mths[2]	**2-4 wks** Vaccination up until the day of travel may still provide some protection If departing in <21 days, monovalent hepatitis A and hepatitis B vaccines should be used and administered separately, with completion of schedule upon return[2]	**2**[2] Refer to dosing table below	6 mths	**YES** Recommended for ALL patients post-transplant	NO	Not routinely covered by ON MOHLTC except for **HIGH RISK*** individuals.
Combination Hep A+Hep B Vaccine Twinrix® Twinrix® Junior	NACI and CDC do not recommend using Twinrix® or Twinrix Jr® in immunosuppressed patients.[2]						

TABLE 1: CANADIAN IMMUNIZATION GUIDE (NACI)- HEPATITIS A DOSING RECOMMENDATIONS FOR MONOVALENT HEPATITIS A VACCINES[2]

VACCINE	ANTIGEN*	VOLUME	SCHEDULE (BOOSTER)	AGE†
Avaxim®	160 antigen units HAV	0.5 mL	0, (6-36) mths	12 yrs and older
Avaxim Ped®	80 antigen units HAV	0.5 mL	0, (6-36) mths	6 mths-<16 yrs
Havrix®	1440 ELISA units HAV	1 mL	0, (6-12) mths‡	19 yrs and older
Havrix Jr®	720 ELISA units HAV	0.5 mL	0, (6-12) mths	6 mths-<19 yrs
Vaqta®	50 units HAV	1 mL	0, (6-18) mths	18 yrs and older
Vaqta Ped®	25 units HAV	0.5 ml	0, (6-18) mths	6 mths-<18 yrs

*There is no international standard for HAV measurement. Each manufacturer uses its own units of measurement.

†Ages for which the vaccine is approved.

‡Studies have shown that 720 ELISA units provides an effective booster dose in those over 19 yrs of age.

NOTE:

- Comparable to the results reported in clinical trials of children more than 12 mths, all reviewed studies have consistently shown that vaccination of infants 6-12 mths with inactivated HA vaccines is immunogenic and safe.

REFERENCES:

1. GlaxoSmithKline Inc. Product Monograph. Havrix® March 2021.
2. NACI: Immunization of Immunocompromised Persons: Canadian Immunization Guide. Accessed 18 May, 2022.
3. Buchanan C, Kotton C. Travel medicine, transplant tourism and the transplant recipient. Guidelines from AST Infectious Diseases Community of Practice. *Clin Transplant* 2019; 33(9).
4. CDC Yellow Book: Immunocompromised travelers-severe immunosuppression (non HIV-related; adult).
5. Trubiano J, Johnson D, Sohail A, Torresi J. Travel vaccination recommendations and endemic infection risks in solid organ transplant recipients. J *Travel Medicine* 2016, 1-15.
6. Abuali M, Arnon R and Posada R. "An Update on Immunizations before and after Transplantation in the Pediatric Solid Organ Transplant Recipient." *Pediatric Transplant*ation 15 (2011): 770-77.
7. Danziger-Isakov, L., and D. Kumar. "Vaccination of solid organ transplant candidates and recipients: Guidelines from the AST Infectious Diseases Community of Practice. *Clin Transplant*. 2019; 33: e13563.
8. Patel RP, Liang SY, Koolwal P and Kulhmann FM. "Travel Advice for the Immunocompromised Traveler: Prophylaxis, Vaccination, and Other Preventive Measures." *Therapeutics and Clinical Risk Management TCRM* (2015): 217.
9. GlaxoSmithKline Inc. Product Monograph. Twinrix®. September 2018.
10. Sanofi Pasteur Ltd. Product Monograph. Avaxim® Pediatric. June 2019.

5.3 HEPATITIS B – POST-TRANSPLANT TRAVEL GUIDELINES

NAME OF VACCINE PRODUCTS AVAILABLE IN CANADA	MINIMUM AGE FOR 1ST DOSE	MINIMUM INTERVAL PRIOR TO TRAVEL	NUMBER OF DOSES REQUIRED	MINIMUM INTERVAL BETWEEN DOSES	INDICATION POST-TRANSPLANT	SEROLOGY REQUIRED PRE/POST VACCINATION	COVERAGE IN ONTARIO
Hepatitis B RECOMBIVAX HB® **OR** ENGERIX® B (interchangeable) *IM inj* For routine schedule refer to Publicly Funded Immunization Schedules for Ontario	Newborn[2]	Accelerated schedule available given on Days 0, 7, 21 with booster at 6-12 mths (upon return from travel)[¥, 11]	**3 dose schedule preferred** If travel not imminent[2] Various dosing schedules available, refer to dosing table below	7 days after first dose, 14 days after second dose[¥, 11]	**YES** **Double the microgram dose for age** is recommended for post-transplant patients[2] (*see table below for doses*) May immunize as early as 6 mths post-transplant for travel[¥]	**YES** 6-8 wks post series[¥] (range 1-6 mo[2]) If immunized pre-transplant, confirm serology post-transplant, prior to travel. Repeat series if antibody response is suboptimal (< 10 IU/L) (Ensure double the microgram for age dose used for repeat[2]) If non-responsive with repeat series, consult ID	Covered under ON MOHLTC school program (grade 7) 2 doses only Doses 2 and 3 covered for patients -receiving dialysis or frequent blood products -listed for liver transplant 3 doses covered for patients with chronic liver disease
Hepatitis A+B TWINRIX® TWINRIX Junior®	NACI and CDC do NOT recommend using Twinrix® or Twinrix Jr® in immunosuppressed patients.[2, 3]						

[¥]Expert opinion

TABLE 1: CANADIAN IMMUNIZATION GUIDE (NACI)- HEPATITIS B STANDARD DOSING RECOMMENDATIONS FOR PAEDIATIC PATIENTS (3 OR 4 DOSE SCHEDULE ONLY):

RECIPIENTS	RECOMBIVAX HB®			ENGERIX® B		
	µg	mL	SCHEDULE (MTHS)	µg	mL	SCHEDULE (MTHS)
Infants (regardless of mothers' HBV status)	5	0.5	0, 1, 6**	10	0.5	0, 1, 6 **OR** 0, 1, 2, 12
12 mths-19 yrs	5	0.5	0, 1, 6**	10	0.5	0, 1, 6 **OR** 0, 1, 2, 12

*Thimerosal preservative-free preparation is recommended.

**Although a schedule of 0, 1 and >2 mths is approved, the preferred schedule is 0, 1, and 6.

TABLE 2: HEPATITIS B-REVISED DOSING GUIDELINES FOR TRANSPLANT (ADAPTED FROM CANADIAN IMMUNIZATION GUIDE-NACI) NOTE: DOSES LISTED ARE DOUBLE THE ROUTINE AGE RECOMMENDED DOSE

RECIPIENTS	RECOMBIVAX HB®			ENGERIX® B		
	µg	mL	SCHEDULE (MTHS)	µg	mL	SCHEDULE (MTHS)
Infants (regardless of mothers' HBV status)	10	1	0, 1, 6**	20	1	0, 1, 6 **OR** 0, 1, 2, 12
12 mths-<16 yrs	10	1	0, 1, 6**OR** 0, 1, 2, 12	20	1	0, 1, 6 **OR** 0, 1, 2, 12
16 <20 yrs	10	1	0, 1, 6**OR** 0, 1, 2, 12	40	2	0, 1, 2, 6

*Thimerosal preservative-free preparation recommended.

**Although schedule of 0, 1 and >2 mths is approved, the preferred schedule is 0, 1, and 6

REFERENCES:

1. Publicly funded immunization schedules for Ontario-June 2022. Accessed September 29, 2022. http://www.health.gov.on.ca/en/pro/programs/immunization/docs/Publicly_Funded_ImmunizationSchedule.pdf
2. National Advisory Committee on Immunization. (NACI). Canadian Immunization Guide. Accessed September 29, 2022. http://www.phac-aspc.gc.ca/publicat/cig-gci/index-eng.php#toc.
3. CDC. Recommended immunization schedules for persons aged 0 through 18 yrs-2022. Accessed September 29, 2022. https://www.cdc.gov/vaccines/schedules/hcp/imz/ child-adolescent.html.
4. NACI: Immunization of Travellers: Canadian Immunization Guide.
5. Buchan C, Kotton C. Travel medicine, transplant tourism and the solid organ transplant recipient.Guidelines from the AST Infectious Diseases Community of Practice. *Clin Transplant*. 2019; 33(9).
6. CDC Yellow Book 2020: Immunocompromised travelers-severe immunosuppression (non HIV-related; adult).
7. Trubiano J, Johnson D, Sohail A, Torresi J. Travel vaccination recommendations and endemic infection risks in solid organ transplant recipients. J Travel Medicine 2016; 1-15.
8. Abuali M, Arnon R and Posada R. "An Update on Immunizations before and after Transplantation in the Pediatric Solid Organ Transplant Recipient." *Pediatric Transplant*ation 2011; 15: 770-77.
9. Danziger-Isakov, L., and D. Kumar. "Vaccination of solid organ transplant candidates and recipients: Guidelines from the AST Infectious Diseases Community of Practice. *Clin Transplant* 2019; 33: e13563.
10. Patel RP, Liang SY, Koolwal P and Kulhmann FM. "Travel Advice for the Immunocompromised Traveler: Prophylaxis, Vaccination, and Other Preventive Measures." *Therapeutics and Clinical Risk Management TCRM* (2015): 217.
11. GlaxoSmithKline Inc. Product Monograph Engerix B®. October 2020.
12. Merck Canada Inc. Product Monograph Recombivax®. May 2012.
13. GlaxoSmithKline Inc. Product Monograph Twinrix®. September 2018.
14. Chong P, Avery R. A comprehensive review of immunization practices in solid organ transplant and hematopoietic stem cell transplant recipients. *Clin Therapeutics* 2017; 39(8): 1581-1598.

5.4 JAPANESE ENCEPHALITIS – POST-TRANSPLANT TRAVEL GUIDELINES

NAME OF VACCINE PRODUCTS AVAILABLE IN CANADA	MINIMUM AGE FOR 1ST DOSE	MINIMUM INTERVAL PRIOR TO TRAVEL	NUMBER OF DOSES REQUIRED	MINIMUM INTERVAL BETWEEN DOSES	INDICATION POST-TRANSPLANT	SEROLOGY REQUIRED PRE/POST VACCINATION	COVERAGE IN ONTARIO
Japanese encephalitis IXIARO® (Inactivated) *IM inj*	2 mths[3, 5, 8]	Consult travel clinic	**2**[3, 8] Children younger than 3 yrs of age receive half of the adult dose[8] If primary series given >1 yr ago, booster dose should be given prior to potential re-exposure or if patient is at continued risk (example endemic area) for JEV infection[2, 8]	28 days[1, 3, 8]	**YES** If indicated[1, 3, 5]	NO	Not covered routinely by ON-MOHLTC

NOTES

Children receive 2 doses, 28 days apart[8]:

- 2 mths-<3 yrs of age: 0.25 mL per single dose. Refer to product monograph for Special Handling Instructions for preparing a 0.25 mL dose.
- 3 yrs-<18 yrs of age: 0.5 mL per single dose.

REFERENCES:

1. NACI: Canadian Immunization Guide: Japanese Encephalitis. Accessed September 29, 2022 https://www.canada.ca/en/public-health/services/publications/healthy-living/canadian-immunization-guide-part-4-active-vaccines/page-11-japanese-encephalitis-vaccine.html
2. Buchan C, Kotton C. Travel medicine, transplant tourism and the solid organ transplant recipient.Guidelines from the AST Infectious Diseases Community of Practice. *Clin Transplant* 2019; 33(9).
3. Tubiano J, Johnson D, Sohail A, Torresi J. Travel vaccination recommendations and endemic infection risks in solid organ transplantation. *J Travel Medicine* 2016; 1-15.
4. Abuali M., Arnon R, and Posada R. An update on immunizations before and after transplantation in the pediatric solid organ transplant recipient. *Pediatric Transplantation* 2011; 15: 770-77.
5. Danziger-Isakov, L., and Kumar D. Vaccination of solid organ transplant candidates and recipients: Guidelinesfrom the AST Infectious Diseases Community of Practice. *Clin Transplant* 2019; 33: e13563.
6. Patel R, Liang S, Koolwal P, and Kulhmann M. Travel Advice for the immunocompromised traveler: Prophylaxis, vaccination, and other preventive Measures. *Therapeutics and Clinical Risk Management TCRM* (2015): 217.
7. Bally S, Caillard S, and Moulin B. Prévention des pathologies du voyageur chez le transplanté rénal. *Néphrologie & Thérapeutique* 2009; 5: 265-79.
8. Valneva Austria. *Product Monograph. Ixiaro®*. March 2018.

5.5 RABIES – POST-TRANSPLANT TRAVEL GUIDELINES

NAME OF VACCINE PRODUCTS AVAILABLE IN CANADA	MINIMUM AGE FOR 1ST DOSE	MINIMUM INTERVAL PRIOR TO EXPOSURE/ TRAVEL	NUMBER OF DOSES REQUIRED	MINIMUM INTERVAL BETWEEN DOSES	INDICATION POST-TRANSPLANT	SEROLOGY REQUIRED PRE/POST VACCINATION	COVERAGE IN ONTARIO
Rabies: IMOVAX® RabAvert® (Inactivated vaccine) (Can be used interchangeably) *IM* *Infants/small children: mid lateral aspect of thigh* Older children: Deltoid 1 mL	Newborn[1]	7 days[2, 8, 9]	**Pre-exposure prophylaxis:** **3 doses** Days 0, 7 and between day 21 to 28[2, 9] **Post-exposure prophylaxis** Days 0, 3, 7, 14 and 28[2, 3, 8, 9] with RabIg on Day 0 Patients MUST seek medical attention	Interval varies depending on prescribed prophylaxis	**YES** If indicated[2, 5] For individuals expecting intense animal exposure or who will be distant from medical care[2], pre-exposure rabies vaccination can be started 6-12 mths after transplant[2] Recommended post-transplant, for any patient requiring post-exposure prophylaxis[1]	**Pre Exposure** NO **Post Exposure** Consider serology 7 to 14 days post-completion of series[2, 3] If titre <0.5 re-vaccinate with 2nd series	Pre exposure prophylaxis is not routinely covered by ON MOHLTC Post exposure immunization is covered by OHIP for exposures within Ontario
Rabies Pasteurized immune globulin IMOGAM® (Rabies immune globulin)			**Recommended dose of RabIg** 20 IU/kg body weight for all age groups. Given on Day 0[2, 10]	N/A			

Whenever possible, the complete complement of vaccines should be administered before transplantation. Vaccines noted to be safe for administration after transplantation may not be sufficiently immunogenic after transplantation.

Persons with egg allergies are not necessarily at increased risk of a hypersensitivity reaction to RabAvert®. However, for pre-exposure vaccination, an alternative vaccine, Imovax®, should be used in patients with a history of hypersensitivity reactions to egg or egg products. If an alternative vaccine is not available, post-exposure prophylaxis using RabAvert should be administered with strict medical monitoring. Facilities for emergency treatment of anaphylactic reactions should be available.[2]

REFERENCES:

1. NACI: Immunization of Immunocompromised Persons: Vaccination of solid organ transplant candidates and recipients. Accessed November 28, 2021 and September 29, 2022.
2. NACI: Rabies Vaccine. Canadian Immunization Guide. Accessed November 28, 2021 and September 29, 2022. https://www.canada.ca/en/public-health/services/publications/healthy-living/canadian-immunization-guide-part-4-active-vaccines/page-18-rabies-vaccine.html#p4c17t2
3. Buchan C, Kotton C. Travel medicine, transplant tourism and the solid organ transplant recipient: Guidelines from the AST Infectious Diseases Community of Practice. *Clin Transplant*. 2019; 33(9).
4. CDC Yellow Book 2020: Immunocompromised travelers-severe immunosuppression (non HIV-related; adult).
5. Danziger-Isakov, L., and D. Kumar. "Vaccination of solid organ transplant candidates and recipients: Guidelines from the AST Infectious Diseases Community of Practice. *Clin Transplant* 2019; 33e: 13563.
6. Patel R, Liang S, Koolwal P and Kulhmann F. "Travel Advice for the Immunocompromised Traveler: Prophylaxis, Vaccination, and Other Preventive Measures." *Therapeutics and Clinical Risk Management TCRM* (2015): 217.
7. Cramer C, Shleck V, Thomas S, Kershaw B et al. "Immune Response to Rabies Vaccination in Pediatric Transplant Patients." *Pediatric Transplantation* 2008; 12: 874-77.
8. Sanofi Pasteur Ltd. *Product Monograph. Imovax®* March 2021.
9. Bavarian Nordic Ltd. *Product Monograph. RabAvert®* July 2021.
10. Sanofi Pasteur Ltd. *Product Monograph. Imogam®* December 2015.

5.6 TYPHOID (SALMONELLA TYPHI) – POST-TRANSPLANT TRAVEL GUIDELINES

NAME OF VACCINE PRODUCTS AVAILABLE IN CANADA	MINIMUM AGE FOR 1ST DOSE	MINIMUM INTERVAL PRIOR TO TRAVEL	NUMBER OF DOSES REQUIRED	MINIMUM INTERVAL BETWEEN DOSES	INDICATION POST-TRANSPLANT	SEROLOGY REQUIRED PRE/POST VACCINATION	COVERAGE IN ONTARIO
Salmonella Typhi (Parenteral inactivated) TYPHIM Vi® *IM*	2 yrs[1, 2]	14 days prior to travel[1, 2]	**1 dose**[1, 2]	N/A	**YES** If indicated[2, 3], however an adequate response may not be achieved Re-immunization every 3 yrs if at ongoing risk[1, 2, 3]	Not required[2]	Not covered routinely by ON MOHLTC
Vivotif® (Oral, LIVE attenuated)	**Contraindicated in transplant population**[2, 3, 9] If indicated, use inactivated vaccine[3]						

Whenever possible, the complete complement of vaccines should be administered before transplantation. Vaccines noted to be safe for administration after transplantation may not be sufficiently immunogenic after transplantation.[1, 2, 3]

REFERENCES:

1. Sanofi Pasteur Ltd. *Product Monograph. Typhim Vi®*. June 2021.
2. NACI: Typhoid-I Vaccine. Canadian Immunization Guide. Accessed September 29, 2022 https://www.canada.ca/en/public-health/services/publications/healthy-living/canadian-immunization-guide-part-4-active-vaccines/page-23-typhoid-vaccine.html
3. NACI: Immunization of Immunocompromised Persons: Vaccination of solid organ transplant candidates and recipients. Accessed November 28, 2021 and September 29, 2002.
4. Buchan C, Kotton C. Travel medicine, transplant tourism and the solid organ transplant recipient. Guidelines from the AST Infectious Diseases Community of Practice. *Clin Transplant* 2019; 33(9).
5. CDC Yellow Book 2020: Immunocompromised travelers-severe immunosuppression (non HIV-related; adult).
6. Abuali M, Arnon R and Posada R. "An Update on Immunizations before and after Transplantation in the Pediatric Solid Organ Transplant Recipient." *Pediatric Transplantation* 15 (2011): 770-77.
7. Danziger-Isakov, L., and D. Kumar. "Vaccination of solid organ transplant candidates and recipients: Guidelined from the American society of transplantation infectious diseases community of practice" *Clin Transplant* 2019; 33e: 13563.
8. Patel RP, Liang SY, Koolwal P and Kulhmann FM. "Travel Advice for the Immunocompromised Traveler: Prophylaxis, Vaccination, and Other Preventive Measures." *Therapeutics and Clinical Risk Management TCRM* (2015): 217.
9. Emergent Travel Health Inc. *Product Monograph Vivotif®*. November 2020.

5.7 YELLOW FEVER – POST-TRANSPLANT TRAVEL GUIDELINES

NAME OF VACCINE PRODUCTS AVAILABLE IN CANADA	MINIMUM AGE FOR 1ST DOSE	MINIMUM INTERVAL PRIOR TO TRAVEL	NUMBER OF DOSES REQUIRED	MINIMUM INTERVAL BETWEEN DOSES	INDICATION POST-TRANSPLANT	SEROLOGY REQUIRED PRE/POST VACCINATION	COVERAGE IN ONTARIO
Yellow Fever YF-VAX® (LIVE attenuated) *SC inj*	This Vaccine is CONTRAINDICATED POST-TRANSPLANT[1, 2, 9] in the majority of cases. Consult ID for assessment in patients with lower degree of immunosuppression if travel to endemic areas cannot be avoided.[1, 2]						

REFERENCES:

1. NACI: Immunization of immunocompromised persons: Canadian immunization guide. Accessed May 19, 2021 and September 29, 2022. https://www.canada.ca/en/public-health/services/publications/healthy-living/canadian-immunization-guide-part-3-vaccination-specific-populations/page-8-immunization-immunocompromised-persons.html
2. NACI: Yellow Fever Vaccine. Canadian Immunization Guide. Accessed May 19, 2021 and September 29, 2022. https://www.canada.ca/en/public-health/services/publications/healthy-living/canadian-immunization-guide-part-4-active-vaccines/page-25-yellow-fever-vaccine.html#p4c24a6
3. Buchan C, Kotton C. Travel medicine, transplant tourism and the solid organ transplant recipientGuidelines from the AST Infectious Diseases Community of Practice. *Clin Transplant* 2019; 33(9).
4. CDC Yellow Book 2020: Immunocompromised travelers-severe immunosuppression (non HIV-related; adult).
5. Danziger-Isakov, L., and D. Kumar. "Vaccination of solid organ transplatn candidates and recipients: Guidelines from the AST Infectious Deiseases Society Community of Practice. *Clin Transplant* 2019;33: e13563.
6. Patel R, Liang S, Koolwal P and Kulhmann F. "Travel Advice for the Immunocompromised Traveler: Prophylaxis, Vaccination, and Other Preventive Measures." *Therapeutics and Clinical Risk Management TCRM* (2015): 217.
7. Wyplosz B, Burdet C, Durnbach F, Duclos-Vallee J *et al.* "Persistence of Yellow Fever Vaccine-Induced Antibodies After Solid Organ Transplantation." *American Journal of Transplantation* 2013; 13 (9): 2458-461.
8. Azevedo L, Lasmar E, Contieri F, Boin I *et al.* "Yellow Fever Vaccination in Organ Transplanted Patients: Is It Safe? A Multicenter Study." Transplant Infectious Disease *Transpl Infect Dis* 2011; 14 (3): 237-41.
9. Sanofi Pasteur Ltd. *Product Monograph. YF-Vax®*. April 2019.

The Transplant and Regenerative Medicine Centre's 2017 Pre- and Post-Transplant Immunization Guidelines were revised by the Immunization Working Group, a subgroup of the TRMC Clinical and Education Committee.

We would like to recognize the contribution of the following individuals:

PREPARATION (2017 edition):

Dr. Upton Allen, MBBS, MSc, FRCPC.

Nadya Nalli, BSc. Phm., ACPR., RPh.

Jaspreet Nijjar, PharmD, RPh.

Lu Xuan (Lisa) Sun, Pharm D, RPh.

REVIEW (2017 edition):

Kathryn Breckbill, PMP

Rebecca Casas, RN, BSc.N

Maria De Angelis, MScN, NP-Peds.

Dr. Diane Hebert, MD FRCPC.

Ray Lam, BSc. BScN, MN-ANP, PHC-NP

Dr. Valerie Langlois, MD FRCPC.

Janice Lau, BSc. Phm., PharmD., ACPR., RPh.

Dipti Manchharam, BSc. Pharm., RPh.

Kathy Martin, NP-Pediatrics

Dr. Chia-Wei Teoh, MB BCh BAO, MRCPI, LRCSI, MSc.

James Tjon, BSPhm, PharmD, RPh.

Angela Williams, RN, MS, PHCNP.

Renee Woo, BSc. Phm. ACPR, RPh.

REVISION (2022 edition):

Dr. Upton Allen MBBS, MSc., FRCPC.

Jinsol Kim, Pharm D., RPh.

Nadya Nalli, BSc. Phm., ACPR., RPh.

REVIEW (2022 edition):

Kathryn Breckbill, PMP

Maria De Angelis MSCN, NP-Peds

Dr. Catalina Alvarez Elias, MD, MSc

Ray Lam, DNP, PHC-NP, MN-ANP, CTH(C)

Dipti Manchharam, BSc. Pharm., RPh.

Dr. Melinda Solomon, MD, MSc.,FRCPC

Dr. Chia-Wei Teoh, MB BCh BAO, MRCPI, LRCSI, MSc.

Angela Williams, RN, MS, PHCNP

Renee Woo, BSc. Phm., ACPR., RPh

SickKids®