



POST-TRANSPLANT IMMUNIZATION GUIDELINES

SOLID ORGAN TRANSPLANT

December 2022

SickKids[®]

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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 1 ST 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® 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 immunosuppression ³ (consult Transplant Team) Vaccinated Pre-transplant (Booster) 1 yr post-transplant and >5 yrs DTaP-IPV-Hib (Pediacel®) 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:

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2.2 INACTIVE VACCINES: MENINGOCOCCAL – POST-TRANSPLANT GUIDELINES

NAME OF VACCINE PRODUCTS AVAILABLE IN CANADA	ROUTINE SCHEDULE (ONTARIO)	MINIMUM AGE FOR 1 ST 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	Nimerix® 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 initiation	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		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 Trumenba®¹⁶ 10 yrs	Bexsero®¹⁰ 2-5 mths: 1 mth 6-23 mths: 2 mths >2 yrs: 1 mth Trumenba®¹⁶ HIGH RISK*: Dose 1 and 2: 1 mth Dose 2 and 3: 4 mths	Bexsero®¹⁰ 2-5 mths: 3 doses, + booster 6-11 mths: 2 doses, + booster 12-23 mths: 2 doses >2 yrs: 2 doses Trumenba®¹⁶ HIGH RISK* 3 doses	YES Transplant recipients are considered to be at HIGH RISK* for IMD due to concurrent immunosuppression ^{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	NOT done routinely	Covered for HIGH RISK* ONLY

^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 syringe¹.
- 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 month 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

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2.3 INACTIVE VACCINES: PNEUMOCOCCAL – POST-TRANSPLANT GUIDELINES

NAME OF VACCINE PRODUCTS AVAILABLE IN CANADA	ROUTINE SCHEDULE (ONTARIO)	MINIMUM AGE FOR 1 ST DOSE	MINIMUM INTERVAL BETWEEN DOSES	NUMBER OF DOSES REQUIRED	POST-TRANSPLANT SCHEDULE OR BOOSTER DOSES?	SEROLOGY PRE/POST VACCINATION	COVERAGE IN ONTARIO
Pneumococcal Conjugate Vaccine (Pneu-C) Pevnar® 13 (Pneu-C-13) Vaxneuvance® (Pneu-C-15) Synflorix® (Pneu-C-10)	2, 4, 6 and 12-15 mths for HIGH RISK*	6 wks ^{1,5}	8 wks ^{1,2}	<12 mths: 3-4 doses (schedule dependent on age) 12 mths-<5 yrs: 1-2 doses ^{1,2} Refer to Tables 1 and 2 on next page for more information >5 yrs: 2 doses [†]	NOT vaccinated or incomplete series Pre-Transplant Vaccination may start as early as 6 mths post-transplant <2 yrs: Follow MOHLTC HIGH RISK* schedule; see Tables 1 & 2 on next page >2 yrs: 2 [†] doses Pneu-C, 6-8 wks apart THEN 1 dose Pneu-P, 8 wks after then Pneu-P booster 5 yrs later [†] >5yrs: 2 doses Pneu-C, 6-8 wks apart [†] THEN 1 dose Pneu-P, 8 wks post PCV series; then Pneu-P booster 5 yrs later [†]	NOT done routinely	Covered by MOHLTC 3 doses per routine schedule for ≤5 yrs age ² ; 4th dose for transplant recipients ² Pevnar® 13 only
Pneumococcal Polysaccharide Vaccine (Pneu-P) Pneumovax® 23 (Pneu-P-23)	2 doses for HIGH RISK* ≥2 yrs	2 yrs ^{1,6}	5 yrs ^{1,2}	≥2 yrs: 1 dose, 8 wks after completion of age appropriate Pneu-C series ^{1,2} THEN 2nd dose ≥5 yrs after first dose ¹	Fully Vaccinated Pre-Transplant (Booster dosing): 6 mths-1 yr post tx: Pneu-C x1 dose ^{††} followed by Pneu-P x1 dose 5 yrs later ^{††}		2 doses covered by MOHLTC for transplant recipients ≥2 yrs ²

NOTES:

- [†]Expert opinion based on local study data; differs from NACI recommendation that (patients >5 yrs receive 1 dose of Pneu-C-13 followed by 2 doses of Pneu-P-23, the first given >8 wks after Pneu-C-13 and the 2nd >5 yrs after the first.¹)
- ^{††}Expert opinion based on local data; NACI does not recommend Pneu-C booster.
- *NACI guidelines, children aged 2 mths to less than 18 yrs who are at increased risk of invasive pneumococcal disease (IPD) should receive pneumococcal conjugate (Pneu-C-13) vaccine, with pneumococcal polysaccharide (Pneu-P-23) vaccine used as a booster dose in this age group to increase the serotype coverage. Transplant recipients are at increased risk of IPD.¹
- At the time of TRMC guideline update, NACI was reviewing Pneu-C-15 data in paediatrics and had not yet issued guidance.

CONTRAINDICATIONS:

- Pevnar® 13: Hypersensitivity to any component of the vaccine, including diphtheria toxoid.
- Pneumovax® 23: 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 Pevnar® 13 can be given 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, meningococcal serogroup C, measles, mumps, rubella and varicella.

TABLE 1: CHILDREN <5 YEARS AT HIGH RISK OF INVASIVE PNEUMOCOCCAL DISEASE (IPD) AND NOT PREVIOUSLY IMMUNIZED	
AGE AT FIRST DOSE	PREVNAR® 13 (PNEU-C-13) MINIMUM INTERVALS
6 wks-6 mths	Dose 1: age ≥6 wks ^{1,5} Dose 2: 8* wks after 1st dose Dose 3: 8* wks after 2nd dose Dose 4: 8 wks after 3rd dose AND at age ≥12 mths
7-11 mths	Dose 1: Day 0 Dose 2: 8 wks after 1st dose Dose 3: 8 wks after 2nd dose AND at age ≥12 mths
12-23 mths	Dose 1: Day 0 Dose 2: 8 wks after 1st dose
24-59 mths (2- <5 yrs)	1 dose only

Adapted from Publicly Funded Immunization Schedules for Ontario² Table 17.

*4 wks minimal interval between doses with vaccine manufacturers but CIG (NACI) recommends minimal interval to be 8 wks.

TABLE 2: CHILDREN <5 YRS AT HIGH RISK OF INVASIVE PNEUMOCOCCAL DISEASE (IPD) AND WHO HAVE INTERRUPTED OR INCOMPLETE VACCINATION WITH PNEUMOCOCCAL CONJUGATE VACCINE		
CURRENT AGE	NUMBER OF PNEU-C-13 DOSES PREVIOUSLY RECEIVED	NUMBER OF PNEUC-13 DOSES REQUIRED TO COMPLETE SERIES
2-6 mths	1 dose	Dose 2: 2 mths after 1st dose Dose 3: 2 mths after 2nd dose Dose 4: 2 mths after 3rd dose AND at age ≥12 mths
	2 doses	Dose 3: 2 mths after 2nd dose Dose 4: 2 mths after 3rd dose AND at age ≥12 mths
7-11 mths	1 dose	Dose 2: 2 mths after 1st dose Dose 3: 2 mths after 2nd dose AND at age ≥12 mths
	2 doses	Dose 3: 2 mths after 2nd dose AND at age ≥12 mths
12-23 mths	1 dose at age <12 mths	Dose 2: 2 mths after 1st dose Dose 3: 2 mths after 2nd dose
	1 dose at age ≥12 mths	Dose 2: 2 mths after 1st dose
	1 dose at age <12 mths AND 2nd dose at age ≥12 mths	Dose 3: 2 mths after 2nd dose
	2 or more doses at age <12 mths	1 dose, 2 mths after the most recent dose
24-59 mths (2-<5 yrs)	Any incomplete series	1 dose, 2 mths after the most recent dose

Adapted from Publicly Funded Immunization Schedules for Ontario² Table 23.

NOTE: **HIGH RISK** patients ≥to 2 yrs of age should also receive 1 dose of pneumococcal polysaccharide vaccine (Pneu-P) ≥8 wks after the last dose of Pneu-C-13 and an additional Pneu-P dose ≥5 yrs after the first Pneu-P dose.²

REFERENCES:

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- 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
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2.4 INACTIVE VACCINES: HEPATITIS A – POST-TRANSPLANT GUIDELINES

NAME OF VACCINE PRODUCTS AVAILABLE IN CANADA	ROUTINE SCHEDULE (ONTARIO)	MINIMUM AGE FOR 1 ST 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 [†]
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.

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

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2.5 INACTIVE VACCINES: HEPATITIS B – POST-TRANSPLANT GUIDELINES

NAME OF VACCINE PRODUCTS AVAILABLE IN CANADA	ROUTINE SCHEDULE (ONTARIO)	MINIMUM AGE FOR 1 ST 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 preferred¹ 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

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

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}

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

NAME OF VACCINE PRODUCTS AVAILABLE IN CANADA	ROUTINE SCHEDULE (ONTARIO)	MINIMUM AGE FOR 1 ST 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 within a 1 yr period ⁴	YES May be started as soon as 3-6 mths post-transplant ¹⁰ , once stable immunosuppression 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)].

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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 1 ST 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}						
Priorix-Tetra® (MMR-V) ProQuad® (MMR-V) ³							

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3.2 LIVE VACCINES: VARICELLA – POST-TRANSPLANT GUIDELINES

NAME OF VACCINE PRODUCTS AVAILABLE IN CANADA	ROUTINE SCHEDULE (ONTARIO)	MINIMUM AGE FOR 1 ST 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 <i>Live Vaccines After Pediatric Solid Organ Transplant: Proceedings of a Consensus Meeting</i> ²⁸ for specific recommendations						
Priorix-Tetra® (MMR-V)							
ProQuad® (MMR-V)							

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3.3 LIVE VACCINES: ROTAVIRUS – POST-TRANSPLANT GUIDELINES

NAME OF VACCINE PRODUCTS AVAILABLE IN CANADA	ROUTINE SCHEDULE (ONTARIO)	MINIMUM AGE FOR 1 ST 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}						

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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 1 ST 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 immunosuppression 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.

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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 1 ST 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 <i>Dukoral</i> ® (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

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5.2 HEPATITIS A – POST-TRANSPLANT TRAVEL GUIDELINES

NAME OF VACCINE PRODUCTS AVAILABLE IN CANADA	MINIMUM AGE FOR 1 ST 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) <i>IM inj</i>	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						

VACCINE	ANTIGEN*	VOLUME	SCHEDULE (BOOSTER)	AGE ¹
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.

¹Ages 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.

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5.3 HEPATITIS B – POST-TRANSPLANT TRAVEL GUIDELINES

NAME OF VACCINE PRODUCTS AVAILABLE IN CANADA	MINIMUM AGE FOR 1 ST 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) <i>IM inj</i> 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 ^y (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}						

^yExpert opinion

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.

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

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5.4 JAPANESE ENCEPHALITIS – POST-TRANSPLANT TRAVEL GUIDELINES

NAME OF VACCINE PRODUCTS AVAILABLE IN CANADA	MINIMUM AGE FOR 1 ST 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) <i>IM inj</i>	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 apart⁸:

- 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.

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5.5 RABIES – POST-TRANSPLANT TRAVEL GUIDELINES

NAME OF VACCINE PRODUCTS AVAILABLE IN CANADA	MINIMUM AGE FOR 1 ST 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: IMO-VAX® 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 Rablg 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 IMO-GAM® (Rabies immune globulin)			Recommended dose of Rablg 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

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

NAME OF VACCINE PRODUCTS AVAILABLE IN CANADA	MINIMUM AGE FOR 1 ST 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® <i>IM</i>	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}

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5.7 YELLOW FEVER – POST-TRANSPLANT TRAVEL GUIDELINES

NAME OF VACCINE PRODUCTS AVAILABLE IN CANADA	MINIMUM AGE FOR 1 ST 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}

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