

## Vaccine schedule

### Routinely administered vaccines

<u>Product</u>		<u>Abbreviation</u>	<u>6 months</u>	<u>12 months</u>	<u>13 months</u>	<u>14 months</u>	<u>16 months</u>	<u>18 months</u>	<u>24 months</u>	<u>25 months</u>
<b>Influenza</b>		<b>IIV4 or RIV4</b>	IIV4/RIV4 #1 then annually							
Choose 1	Tetanus, diphtheria, pertussis	<b>DTaP</b>		DTaP #1		DTaP #2	DTaP #3			
		<b>Tdap/Td</b>		Tdap #1		Tdap #2 (or Td #1)	Tdap #3 (or Td #2)			
<b>Pneumococcus</b>		<b>PCV20</b>		PCV20 #1		PCV20 #2	PCV20 #3			
<b>Haemophilus influenzae type b</b>		<b>Hib</b>		Hib #1		Hib #2	Hib #3			
<b>Hepatitis A and Hepatitis B:</b> See table below for details		<b>HepA, HepB</b>		#1		#2	#3			
<b>Human papillomavirus:</b> Through age 26 years; optional for ages 27-45 years.		<b>9vHPV</b>		<i>9vHPV #1</i>		<i>9vHPV #2</i>		<i>9vHPV #3</i>		
Choose 1	<b>Herpes zoster:</b> Administer if VZV IgG+ or other evidence of prior VZV infection. See appendix.	<b>RZV</b>		<i>RZV #1</i>	<i>RZV #2</i>					
	<b>Varicella:</b> Administer if VZV IgG- (VZV uninfected). See appendix.	<b>VAR</b>	<div style="border: 1px dashed black; padding: 2px;"> <b>CAUTION:</b> Live-attenuated vaccines; only given to patients at least 2 years post-BMT, off systemic immunosuppression for at least 1 year, at least 8 months out from prior IVIG, and with no active GVHD.                 </div>						<i>VAR #1</i>	<i>VAR #2</i>
	<b>Measles, mumps, rubella</b>	<b>MMR</b>							<i>MMR #1</i>	<i>MMR #2</i>

<u>Products and abbreviations for viral hepatitis</u>		<u>12 months</u>	<u>13 months</u>	<u>18 months</u>
Combined vaccine product	<b>HepA-HepB</b>	HepA-HepB #1	HepA-HepB #2	HepA-HepB #3
<i>Or</i>				
Administer both products with HepB-alum	<b>HepA</b>	HepA #1		HepA #2
	<b>HepB-alum</b>	HepB-alum #1	HepB-alum #2	HepB-alum #3
<i>Or</i>				
Administer both products with HepB-CpG	<b>HepA</b>	HepA #1		HepA #2
	<b>HepB-CpG</b>	HepB-CpG #1	HepB-CpG #2	

**COVID:** See separate guidelines.

**Monkeypox:** Patients should contact their county public health authorities for guidance.

Prioritize IIV/RIV4, PCV20, and Hib in patients with chronic GVHD. PCV20 and Hib are relatively immunogenic and patients with chronic GVHD are at high risk for infection from encapsulated bacteria. HepA and HepB are likely less immunogenic.

*Doses in italics are indicated in select circumstances and not for all patients; see appendix and notes for details.*

## Vaccines indicated in select circumstances

See appendix 1 for details.

<i>Product</i>	<i>Abbreviation</i>	<i>6 months</i>	<i>12 months</i>	<i>13 months</i>	<i>14 months</i>	<i>16 months</i>	<i>18 months</i>	<i>24 months</i>	<i>25 months</i>
Meningococcus A, C, W, Y	MenACWY		MenACWY #1		MenACWY #2				
Choose 1 Meningococcus B	MenB-4C		MenB-4C#1	MenB-4C#2					
	Or								
	MenB-FHbp		MenB-FHbp #1	MenB-FHbp #2			MenB-FHbp #3		
Poliovirus	IPV		IPV #1	IPV #2				IPV #3	

## Appendix 1: Notes on individual vaccines

### Influenza

- Generally, influenza vaccine should be given at 6 months post-BMT. However, at the discretion of the patient's transplant physician, influenza vaccination can be given as early as 3-4 months post-BMT in select cases, for example if there are high rates of circulating influenza. If influenza vaccine is given before 1 year post-BMT, a 2<sup>nd</sup> dose should be given 1 month later.
- Influenza vaccination is repeated annually, ideally in September or October, but vaccination should continue as long as influenza viruses are circulating, and vaccine supply is available.
- Those age  $\geq 65$  years should preferentially receive quadrivalent high-dose inactivated influenza vaccine (HD-IIV4), quadrivalent recombinant influenza vaccine (RIV4), or quadrivalent adjuvanted inactivated influenza vaccine (aIIV4).
- Live-attenuated influenza vaccine quadrivalent (LAIV4 or FluMist<sup>®</sup> Quadrivalent) should generally not be used after BMT.

### Tetanus, diphtheria, pertussis

- DTaP is likely more immunogenic; if available, consider using this formulation but if not readily available, use any of the options listed here.
- Tdap and/or Td vaccines should be spaced out by  $\geq 4$  weeks.
- A single repeat dose of Td or Tdap should be administered every 10 years thereafter.

### Pneumococcus

- The 1<sup>st</sup> dose of PCV20 can be given as early as 6 months after BMT if the individual not on significant immunosuppression, has not received B-cell depleting antibodies within 6 months, has no history of GVHD, has no ongoing lymphopenia, and has no ongoing hypogammaglobulinemia.
- PCV20 doses should be spaced out by  $\geq 4$  weeks.
- Primary pneumococcal vaccination series involves either 3 or 4 doses of a conjugate vaccine. The benefit of a 4<sup>th</sup> dose of PCV20 in BMT recipients is unknown.
- Instead of PCV20, vaccination against pneumococcus can also be performed using 3 doses of PCV15 followed by one dose of PPSV23. However, PPSV23 is poorly immunogenic in many BMT patients and the PCV15/PPSV23 regimen has no advantages over PCV20.

### *Haemophilus influenzae* type b

- Hib doses should be spaced out by  $\geq 4$  weeks.

### Hepatitis A and hepatitis B

Choose to vaccinate with either separate HepA and HepB vaccines or a combined HepA-HepB vaccine.

- If using separate vaccines, HepA is given as 2-dose series spaced  $\geq 6$  months apart. Two types of HepB vaccines are available to use in combination with HepA: HepB-alum and HepB-CpG:
  - HepB-alum is given as a 3-dose series. The first 2 doses of HepB-alum should be spaced out by  $\geq 4$  weeks. The 3<sup>rd</sup> dose of HepB-alum



is given  $\geq 8$  weeks after the 2<sup>nd</sup> dose and  $\geq 16$  weeks after the 1<sup>st</sup> dose. (Typically, HepB-alum is given at 0, 1, and 6 months).

- HepB-CpG is given as a 2-dose series spaced out over  $\geq 4$  weeks.
- If using the combined HepA-HepB vaccine, the first 2 doses are spaced out by  $\geq 4$  weeks and the 3<sup>rd</sup> dose should be spaced out by  $\geq 5$  months from the 2<sup>nd</sup> dose.

## Human papillomavirus

- 9vHPV is indicated through age 26 years and is optional for those aged 27-45 years.
- The first 2 doses should be spaced out by  $\geq 4$  weeks. The 3<sup>rd</sup> dose should be spaced out by  $\geq 12$  weeks from the 2<sup>nd</sup> dose and  $\geq 5$  months from the 1<sup>st</sup> dose.

## Herpes zoster and varicella vaccines

- Administer herpes zoster vaccine (RZV) for patients with positive VZV IgG or other evidence of prior VZV infection/exposure.
  - RZV series can be started as early as 9 months after allogeneic BMT or 50 days after autologous BMT and is given as 2 doses spaced out by  $\geq 4$  weeks.
  - If patients are still on antiviral prophylaxis (typically acyclovir), this can be stopped 2-3 months after the 2<sup>nd</sup> dose of RZV based on the discretion of the patient's transplant physician.
- Administer varicella vaccine (VAR) to patients who are VZV IgG negative and with no other evidence of prior infection or immunization.
  - VAR should only be given when individuals are at least 2 years post-BMT, off systemic immunosuppression for at least 1 year, at least 8 months out from prior IVIG doses, and without active GVHD.
  - VAR doses should be spaced out by  $\geq 4$  weeks.

## Measles, mumps, rubella

- MMR should only be given when individuals are at least 2 years post-BMT, off systemic immunosuppression for at least 1 year, at least 8 months out from prior IVIG doses, and without active GVHD.
- A 2<sup>nd</sup> dose of MMR (given  $\geq 4$  weeks after the first dose) is recommended for students in post-secondary educational institutions; international travelers; and household or close, personal contacts of immunocompromised persons who themselves have no evidence of immunity to measles, mumps, or rubella.

## Meningococcus A, C, W, Y

- MenACWY should be given as a 2-dose series spaced  $\geq 8$  weeks apart to those with anatomical or functional asplenia (including chronic GVHD), HIV infection, persistent complement component deficiency, or complement inhibitor use.
- One dose of MenACWY should be given to individuals traveling to select at-risk countries, microbiologists routinely exposed to *Neisseria meningitidis*, first-year college students who live in residential housing, and military recruits.
- Other patients can receive one dose of MenACWY optionally if they are interested in protection from *N. meningitidis*.
- Individuals should be revaccinated every 5 years while they continue to meet above high-risk criteria.
- If Menactra (MenACWY-D) is used, it must be spaced out  $\geq 4$  weeks after or before the pneumococcal conjugate vaccine.

## Meningococcus B

- MenB should be given to those with anatomical or functional asplenia (including chronic GVHD), persistent complement component deficiency, or complement inhibitor use; or for microbiologists routinely exposed to *Neisseria meningitidis*.
- For individuals who remain at risk, a 1-dose MenB booster should be given 1 year after the primary series and every 2-3 years thereafter while risk remains.
- MenB can also be given optionally through age 23 years depending on patient and provider preference. Dosing of MenB depends on the vaccine product:
  - MenB-4C (Bexsero) is given as a 2-dose primary series with doses spaced out over  $\geq 1$  month.
  - MenB-FHbp (Trumenba) is given as a 3-dose primary series at 0, 1-2, and 6 months. (If the 2<sup>nd</sup> dose of MenB-FHbp was given  $\geq 6$  months after the 1<sup>st</sup> dose of MenB-FHbp, no 3<sup>rd</sup> dose is needed.)

## Poliovirus

- IPV should be given to adults traveling to areas with circulating poliovirus. It is optional for others interested in protection from poliovirus.
- The first 2 doses should be separated by 1-2 months. The 3<sup>rd</sup> dose should be given 6-12 months after the second dose.

## Appendix 2: Additional information

### General vaccine guidance

1. Administer recommended vaccines if vaccination history is incomplete or unknown.
2. Do not restart or add doses to vaccine series if there are extended intervals between doses.
3. To protect immunocompromised patients from transmissible diseases, immunocompetent family members and household contacts should be encouraged to receive all age-appropriate vaccinations, particularly an annual influenza vaccine and live-attenuated vaccines such as MMR and VAR. Household contacts should avoid LAIV or, if obtained, avoid contact with the BMT recipient for 7 days. BMT recipients should avoid handling diapers of infants who have been vaccinated with rotavirus vaccine for 4 weeks after vaccination. Uncommonly, VAR recipients can develop a localized or generalized varicella-like rash within 1 month after vaccination. Non-immune BMT recipients should avoid contact with these persons until skin lesions clear.

### References and additional information

- *Complete Advisory Committee on Immunization Practices (ACIP) recommendations:* <https://www.cdc.gov/vaccines/hcp/acip-recs/index.html/>
- *General Best Practice Guidelines for Immunization (including contraindications and precautions):* <https://www.cdc.gov/vaccines/hcp/acip-recs/general-recs/index.html>
- *Travel vaccine recommendations:* <https://wwwnc.cdc.gov/travel>
- *Epidemiology and Prevention of Vaccine-Preventable Diseases online textbook:* <https://www.cdc.gov/vaccines/pubs/pinkbook/>
- *Adult immunization schedule:* <https://www.cdc.gov/vaccines/schedules/hcp/imz/adult.html>
- *Other references:* see PMIDs 33710336, 31287523, 27048212, 24311479

### Vaccine products

Vaccine	Abbreviations	Trade names
<b>Haemophilus influenzae type B vaccine</b>	Hib	ActHIB® Hiberix®
<b>Hepatitis A vaccine</b>	HepA	Havrix® Vaqta®
<b>Hepatitis A and hepatitis B vaccine</b>	HepA-HepB	Twinrix®
<b>Hepatitis B vaccine, alum</b>	HepB-alum	Engerix-B® Recombivax HB® PreHevbrio®
<b>Hepatitis B vaccine, CpG</b>	HepB-CpG	Heplisav-B®
<b>Human papillomavirus vaccine</b>	9vHPV	Gardasil 9®
<b>Inactivated poliovirus vaccine</b>	IPV	Ipol®
<b>Influenza vaccine (inactivated)</b>	IIV4	<i>Many brands</i>
<b>Influenza vaccine (live, attenuated)</b>	LAIV	FluMist® Quadrivalent
<b>Influenza vaccine (recombinant)</b>	RIV4	Flublok® Quadrivalent
<b>Measles, mumps, and rubella vaccine</b>	MMR	M-M-R® II Priorix™
<b>Meningococcal serogroups A, C, W, Y vaccine</b>	MenACWY-D MenACWY-CRM	Menactra® Menveo®
	MenACWY-TT	MenQuadfi®
<b>Meningococcal serogroup B vaccine</b>	MenB-4C MenB-FHbp	Bexsero® Trumenba®
<b>Pneumococcal 20-valent conjugate vaccine</b>	PCV20	Pevnar 20™
<b>Pneumococcal 20-valent conjugate vaccine</b>	PCV15	Vaxneuvance™
<b>Pneumococcal 13-valent polysaccharide vaccine</b>	PPSV23	Pneumovax®23
<b>Tetanus and diphtheria toxoids</b>	Td	Tenivac® Tdvax™
<b>Tetanus and diphtheria toxoids and acellular pertussis vaccine</b>	Tdap	Adacel® Boostrix®
<b>Diphtheria, tetanus, and acellular pertussis vaccine</b>	DTaP	Daptacel® Infanrix®
<b>Varicella vaccine</b>	VAR	Varivax®
<b>Zoster vaccine, recombinant</b>	RZV	Shingrix



**Stanford**  
MEDICINE

Division of Blood and  
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*Department of Medicine*

Stanford Health Care Vaccination Subcommittee  
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## Appendix 3: Letter to primary care or referring providers

See following page



Post-BMT Nurse Coordinators  
900 Blake Wilbur Drive  
Stanford, CA 94304  
Fax 650.725.3321

**Dear Doctor,**

Your patient is one-year post-BMT and based on consensus guidelines we recommend the following vaccinations in a schedule similar to childhood vaccines for the developing immune system:

Because recommendations on COVID vaccination are changing rapidly, please consult updated guidelines available from [www.cdc.gov/coronavirus/2019-ncov/vaccines/recommendations/immuno.html](http://www.cdc.gov/coronavirus/2019-ncov/vaccines/recommendations/immuno.html) among other sites. Similarly recommendations for monkeypox vaccination are changing rapidly and are specific to individual public health departments so patients should check with their county public health department.

**6-months post-BMT**

Influenza – Quadrivalent inactivated influenza vaccine (IIV4) or quadrivalent recombinant influenza vaccine (RIV4). Those age  $\geq 65$  years should preferentially receive quadrivalent high-dose inactivated influenza vaccine (HD-IIV4), quadrivalent recombinant influenza vaccine (RIV4), or quadrivalent adjuvanted inactivated influenza vaccine (aIIV4).

    \_ Dose #1 at 6 months post-BMT and every year thereafter, ideally in September or October, but vaccination should continue if influenza viruses are circulating and vaccine supply is available.

**1-year post-BMT**

Tetanus, diphtheria, pertussis: choose 1 option

Option 1: DTaP or Tdap

        \_ Dose #1 at 1-year post-BMT

        \_ Dose #2 at 4-8 weeks after dose #1

        \_ Dose #3 at 4-8 weeks after dose #2, then Td or Tdap every 10 years thereafter

Option 2: Tdap + Td

        \_ Tdap at 1-year post-BMT

        \_ Td dose #1 at 4-8 weeks after Tdap

        \_ Td dose #2 at 4-8 weeks after Td dose #1, then Td or Tdap every 10 years thereafter

Pneumococcus – PCV20

    \_ Dose #1 at 1-year post-BMT,

    \_ Dose #2 at 4-8 weeks after dose #1

    \_ Dose #3 at 4-8 weeks after dose #2

*Haemophilus influenzae* type b – Hib

    \_ Dose #1 at 1-year post-BMT

    \_ Dose #2 at 4-8 weeks after dose #1

    \_ Dose #3 at 4-8 weeks after dose #2

Hepatitis A and B: choose 1 option

Option 1: Separate HepA and HepB-alum (Engerix-B®, Recombivax HB®, or PreHevbrio®) vaccines

        \_ HepA dose #1 at 1-year post-BMT

        \_ HepB-alum dose #1 at 1-year post-BMT



- \_ HepB-alum dose #2 at 1 month after HepB-alum dose #1
- \_ HepB-alum dose #3 at 6 months after HepB-alum dose #1 (at least 8 weeks after HepB-alum #2 and at least 16 weeks after HepB-alum #1); check anti-HBs antibody 1-2 months after last dose: if <10 mIU/mL, then repeat series and recheck anti-HBs
- \_ HepA dose #2 at 6-12 months after HepA dose #1
- Option 2: Separate HepA and HepB-CpG (Hepelisav-B®) vaccines
- \_ HepA dose #1 at 1-year post-BMT
- \_ HepB-CpG dose #1 at 1-year post-BMT
- \_ HepB-CpG dose #2 at 4 weeks after HepB-CpG dose #1; check anti-HBs antibody 1-2 months after last dose: if <10 mIU/mL, then repeat series and recheck anti-HBs
- \_ HepA dose #2 at 6-12 months after HepA dose #1
- Option 3: Combined HepA-HepB vaccine
- \_ Dose #1 at 1-year post-BMT
- \_ Dose #2 at 1 month after dose #1
- \_ Dose #3 at 6 months after dose #1 (or 5 months after dose #2); check anti-HBs antibody 1-2 months after last dose: if <10 mIU/mL, then repeat series and recheck anti-HBs
- Human papillomavirus – 9vHPV (if < 26 years old or optionally ages 27-45 years old)
- \_ Dose #1 at 1-year post-BMT
- \_ Dose #2 at 4-8 weeks after dose #1
- \_ Dose #3 at minimum 12 weeks after dose #2 (and minimum 5 months after dose #1)
- Herpes zoster – RZV (Shingrix): if proven history of varicella or herpes zoster or laboratory evidence of immunity (positive VZV IgG) or disease
- \_ Dose #1 at 1-year post-BMT
- \_ Dose #2 at 1-6 months after dose #1
- If the patient is still on antiviral prophylaxis (typically acyclovir), this can be stopped 2-3 months after the 2nd dose of RZV based on the discretion of the patient's transplant physician.

#### **Vaccines indicated in select circumstances**

Meningococcus A, C, W, Y – MenACWY (Menveo, MenQuadfi, or Menactra): Can be given to any patient interested in protection from meningococcus but required in patients with anatomical or functional asplenia (including chronic GVHD), HIV infection, persistent complement component deficiency, complement inhibitor use, individuals traveling to select at-risk countries, microbiologists routinely exposed to *Neisseria meningitidis*, first-year college students who live in residential housing, and military recruits:

- \_ Dose #1 at 1-year post-BMT
- \_ Dose #2 at 8 weeks after dose #1 (only in patients with anatomical or functional asplenia (including chronic GVHD), HIV infection, persistent complement component deficiency, or complement inhibitor use)

*Re-vaccinate with 1 dose every 5 years thereafter if risk for meningococcal infection remains based on above criteria*

Meningococcal serogroup B series – MenB: Indicated in patients with anatomical or functional asplenia (including chronic GVHD), persistent complement component deficiency, or complement inhibitor use; or for microbiologists routinely exposed to *Neisseria meningitidis*. MenB can also be given optionally through age 23 years depending on patient and provider preference.

Option 1: Bexsero® (MenB-4C)

- \_ Dose #1 at 1-year post-BMT



\_ Dose #2 at 4 weeks after dose #1

Option 2: Trumenba® (MenB-FHbp)

\_ Dose #1 at 1-year post-BMT

\_ Dose #2 at 1-2 months after dose #1

\_ Dose #3 at 6 months after dose #1 (not needed if dose 2 has been delayed at least 6 months after dose #1)

*Administer 1 dose 1 year after primary series and re-vaccinate with 1 dose every 2-3 years thereafter if risk for meningococcal serogroup B infection remains based on above criteria.*

Inactivated poliovirus (polio) vaccine – IPV: Can be given to any patient interested in protection from polio. Required if traveling to areas with circulating poliovirus.

\_ Dose #1 at 1-year post-BMT

\_ Dose #2 at 4-8 weeks after dose #1

\_ Dose #3 at 6-12 months after dose #2

## **2 years post-BMT**

**If patient is off all immunosuppression and chemotherapy (maintenance chemotherapy) for at least 1 year, and if it has been at least 8 months since last dose of IVIG, and has no active GVHD:**

Measles, mumps, rubella – MMR (live-attenuated vaccine) 1 dose; repeat dose 4 weeks later for students in post-secondary educational institutions; international travelers; and household or close, personal contacts of immunocompromised persons who themselves have no evidence of immunity to measles, mumps, or rubella

**Only if VZV IgG negative and no proven history of varicella or herpes zoster or laboratory evidence of disease**

**Only if patient is off all immunosuppression and chemotherapy (maintenance chemotherapy) for at least 1 year, and if it has been at least 8 months since last dose of IVIG, and has no active GVHD:**

Varicella – VAR (live-attenuated vaccine) x 2 doses 4 weeks apart.





**A. DOCUMENT INFORMATION**

1. Original Author(s)
  - David Epstein, MD: 07/2018
2. Gatekeeper
  - Stanford Health Care Vaccination Subcommittee
3. Reviews/Revisions
  - David Epstein, MD 08/2018, 11/2021, 11/2022
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