Guidelines for Vaccination of Adult Bone Marrow Transplant (BMT) Candidates and Recipients

A. VACCINATION SCHEDULE FOR BMT PATIENTS

Vaccine Type	Vaccine Abbreviation	Months post-transplant							Minimum interval between doses
		6	12	13	14	18	24	25	
Influenza	**IIV** (inactivated influenza vaccine)	Annually starting at 6 months							
Pneumococcal	**PCV13/PPSV23**[a]		#1	#2	#3	#4			[b]
Meningococcal Group A	**MenACWY** (Menveo)		#1		#2				8 weeks
Haemophilus	**Hib**		#1	#2	#3				4 weeks
Diptheria/tetanus/pertussis	**DTaP** (or Tdap x1, then Td x2)		#1	#2	#3				4 weeks
Hepatitis	**HepA-HepB**		#1	#2		#3[c]			[d]
Papillomarivurus	**9vHPV** (if ≤ 45 years old)		#1	#2		#3			[e]
Measles, mumps, rubella	**MMR**[f]						#1	#2	4 weeks
Varicella	**VAR**[f] (if VZV IgG negative)						#1	#2	4 weeks

[a] Doses 1-3 should be with PCV13 (not PPSV23). PCV13 #1 can be given as early as 6 months if no GVHD, hypogammaglobulinemia, or significant lymphopenia, in which case PCV #2 and PCV #3 can be given after minimum intervals of 4 weeks. For dose #4, PPSV23 is typically given except if the patient has GVHD and is unlikely to respond, in which case a 4th dose of PCV13 should be given instead.
[b] 4 weeks, except 8 weeks between #3 and #4
[c] 1-2 months after last dose, check anti-HBs; if < 10 mIU/mL repeat series and re-check anti-HBs
[d] 4 weeks between #1 and #2; 8 weeks between #2 and #3 (and 6 months between #1 and #3)
[e] 4 weeks between #1 and #2; 12 weeks between #2 and #3 (and 5 months between #1 and #3)
[f] If ≥ 2 years out from BMT, ≥ 1 year since immunosuppression, ≥ 8 months after last dose of IVIG, and no active GVHD

B. VACCINE ADMINISTRATION, SCHEDULING AND OTHER DETAILS

1. Recommendations contained in this document are largely based on previously published guidelines and practices.[1-5] This document focuses on early post-transplant vaccinations; after this early period, most BMT patients (who do not have GVHD) should generally be vaccinated according to the standard adult schedule, except that most live-attenuated vaccines remain contraindicated.
2. Patients with complex medical conditions not discussed in these recommendations (including asplenia and complement deficiencies) and those with unique risk factors associated with travel or occupation (including contact with animals or work with pathogens) should be referred to infectious diseases to determine optimal immunization strategies.
3. See http://www.cdc.gov/vaccines/pubs/pinkbook/downloads/genrec.pdf and http://www.cdc.gov/vaccines/hcp/acip-recs/general-recs/downloads/general-recs.pdf for more information than is contained in this document.
4. Vaccines have minimum intervals between doses (which can be found at http://www.cdc.gov/vaccines/pubs/pinkbook/downloads/appendices/a/age-interval-table.pdf) but no maximum intervals. There is no need to restart a series due to delayed administration of a vaccine in a series.
5. Live-attenuated vaccines (MMR and VAR) can be given the same day but if not given the same day, they should be separated by at least 4 weeks.
6. Multiple vaccines can be given at the same visit, with 2 exceptions:
    a. PCV13 and PPSV23 should not be given together and need to be spaced apart.
    b. PCV13 and Menactra (not on formulary at Stanford Health Care) should not be given together. Menveo (on formulary at Stanford Health Care) can be given at the same visit as PCV13
7. Vaccine contraindications and precautions are too extensive to list separately, but can be found at http://www.cdc.gov/vaccines/hcp/acip-recs/general-recs/contraindications.html.
8. Vaccines supplied in vials or syringes containing latex can be found at http://www.cdc.gov/vaccines/pubs/pinkbook/downloads/appendices/B/latex-table.pdf.
9. Administration of blood products and immunoglobulins can reduce the effectiveness of MMR and VAR. Specific recommendations on this topic can be found in Table 2-04 of http://wwwnc.cdc.gov/travel/yellowbook/2018/the-pre-travel-consultation/general-recommendations-for-vaccination-immunoprophylaxis.
10. In general, patient self-reporting of vaccination history should not be accepted as valid. If documentation of a vaccine is not available, the individual should be assumed to be unvaccinated for that dose. (An exception is that patient self-report can be accepted as valid for influenza and pneumococcal polysaccharide vaccines).

C. VACCINATION OF HOUSEHOLD AND OTHER CONTACTS

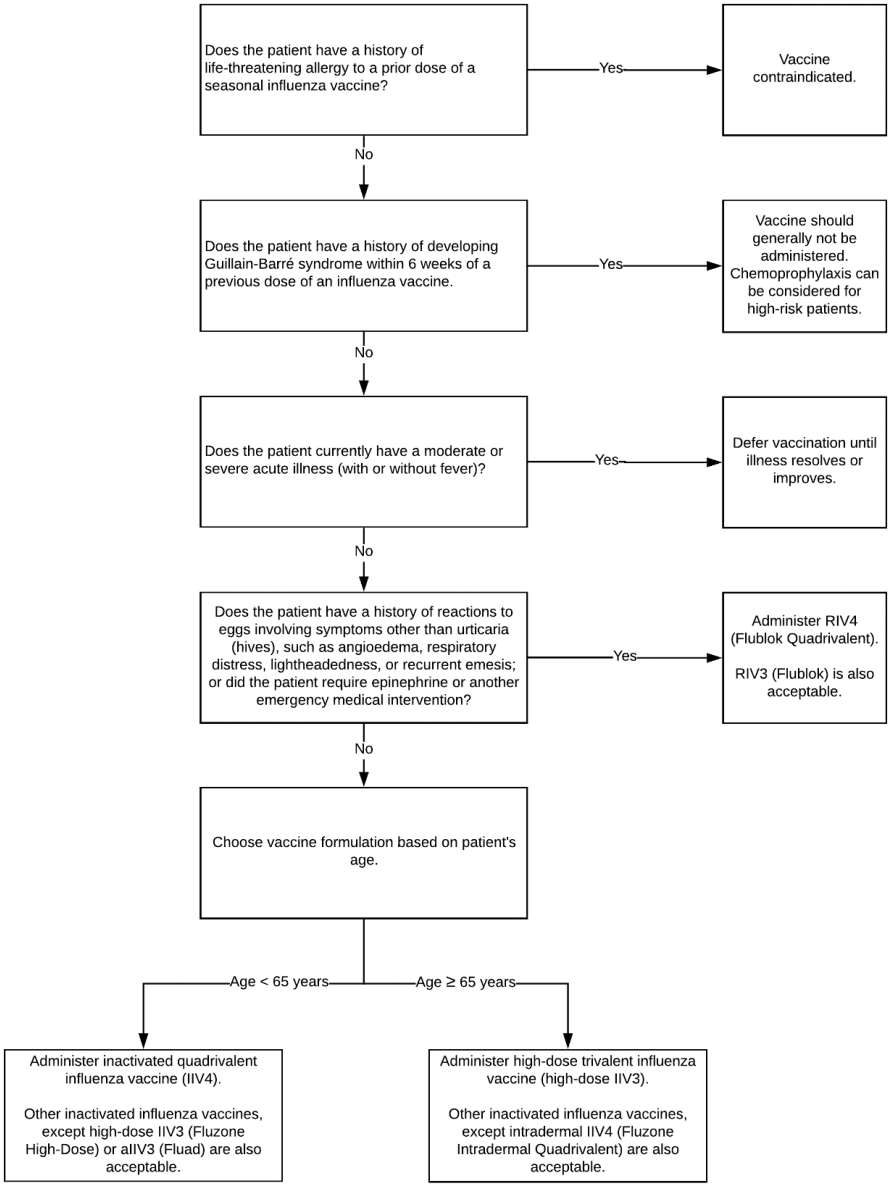
To protect immunocompromised patients from transmissible diseases, immunocompetent family members and household contacts should be encouraged to receive all age-appropriate vaccinations, particularly an annual influenza vaccine and live-attenuated vaccines such as MMR and VAR, with these caveats applicable to household contacts of BMT recipients within 2 months of transplant or with GVHD:

- Live-attenuated influenza vaccine (LAIV): Household contacts should avoid LAIV or, if obtained, avoid contact with the BMT recipient for 7 days.
- Rotavirus: BMT recipients should avoid handling diapers of infants who have been vaccinated with rotavirus vaccine for 4 weeks after vaccination.
- VAR/ZVL [Zostavax]: Uncommonly, VAR or ZVL 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. Except in those rare individuals who develop a varicella-like rash, recipients of VAR or ZVL vaccines are not capable of transmitting varicella zoster virus (VZV) and can interact with BMT recipients without restriction. This issue is not relevant with RZV or when the BMT recipient is already immune to VZV.

D. HERPES ZOSTER VACCINATION

1. The live-attenuated zoster vaccine (ZVL or Zostavax) is contraindicated in BMT recipients.
2. A subunit zoster vaccine (RZV or Shingrix) was FDA-approved in 2017. The vaccine's safety and efficacy have not been established in immunocompromised patients and it cannot be recommended for routine use in BMT recipients, though since it is not a live-attenuated vaccine it is unlikely to pose the major safety challenges of the Zostavax vaccine.

E. INFLUENZA VACCINATION



- Influenza vaccination is typically recommended at 6 months post-BMT. One could consider a dose at 3 months post-BMT in selected patients, though efficacy may be reduced (so a repeat dose 6 months after BMT may be considered).
- To protect BMT patients from influenza, family members and household contacts should be encouraged to receive an annual inactivated influenza vaccine.
- Chemoprophylaxis with oral oseltamivir or inhaled zanamivir should be considered after known or suspected exposure to influenza. Pre-exposure chemoprophylaxis can be also considered in select patients unlikely to respond to vaccination who are at high risk of influenza based on community influenza activity and patient-specific risk factors.
- BMT patients should receive any formulation of influenza vaccine appropriate for their age except the live attenuated influenza vaccine (LAIV).
- Administering the high-dose influenza vaccine (to those under age 65 years) or a two-dose series to BMT patients is likely not harmful, but there is insufficient data supporting increased efficacy, and the doses may not be reimbursed by insurance.

Appendix: Vaccine names and abbreviations

Abbreviation	Name	Example trade names
Influenza vaccines		
IIV3, standard dose	Trivalent inactivated influenza vaccine, standard dose	Afluria, Fluvirin
IIV3, high dose	Trivalent inactivated influenza vaccine, high dose	Fluzone High-Dose
aIIV3	Trivalent inactivated influenza vaccine, adjuvant-containing	Fluad
RIV3	Trivalent inactivated influenza vaccine, recombinant	Flublok
RIV4	Quadrivalent inactivated influenza vaccine, recombinant	Flublok Quadrivalent
IIV4	Quadrivalent inactivated influenza vaccine	FluLaval Quadrivalent, Fluzone Quadrivalent, Fluarix Quadrivalent, Fluzone Intradermal Quadrivalent, Afluria Quadrivalent
ccIIV4	Quadrivalent inactivated influenza vaccine, cell-culture-based	Flucelvax Quadrivalent
LAIV4	Live attenuated quadrivalent influenza vaccine	FluMist Quadrivalent
Other vaccines		
PCV13	Pneumococcal conjugate vaccine (13-valent)	Prevnar 13
PPSV23	Pneumococcal polysaccharide vaccine (23-valent)	Pneumovax 23
MenACWY	Meningococcal (Quadrivalent) Conjugate	Menveo, Menactra
MenB	Serogroup B meningococcal vaccines	Bexsero (MenB-4C), Trumenba (MenB-FHbp)
Hib	Haemophilus influenzae type b conjugate vaccine	ActHIB, Hiberix, PedvaxHIB
DTaP	Diphtheria and tetanus toxoids and acellular pertussis vaccine	Infanrix, Daptacel
Td	Tetanus and reduced diphtheria toxoids	*Generic*
Tdap	Tetanus and reduced diphtheria toxoid, and acellular pertussis vaccine	Boostrix, Adacel
HepA	Hepatitis A vaccine	Havrix, Vaqta
HepB-alum	Hepatitis B vaccine, alum adjuvant	Engerix-B, Recombivax HB
HepB-CpG	Hepatitis B vaccine, CpG 1018 adjuvant	Heplisav-B
HepA-HepB	Hepatitis A and hepatitis B vaccine	Twinrix
IPV	Inactivated poliovirus vaccine	Ipol
9vHPV	Human papillomavirus vaccine (nonavalent)	Gardasil 9
MMR	Measles, mumps, and rubella vaccine	M-M-R II
VAR	Varicella vaccine	Varivax
ZVL	Zoster vaccine live	Zostavax
RZV	Recombinant zoster vaccine	Shingrix

Vaccines in red are on formulary at Stanford Health Care (SHC)

F. REFERENCES:

1. Rubin LG, Levin MJ, Ljungman P, et al. 2013 IDSA clinical practice guideline for vaccination of the immunocompromised host. *Clinical infectious diseases : an official publication of the Infectious Diseases Society of America.* 2014;58(3):e44-100.
2. Carpenter PA, Englund JA. How I vaccinate blood and marrow transplant recipients. *Blood.* 2016;127(23):2824-2832.
3. Grohskopf LA, Sokolow LZ, Broder KR, et al. Prevention and Control of Seasonal Influenza with Vaccines: Recommendations of the Advisory Committee on Immunization Practices - United States, 2017-18 Influenza Season. *MMWR Recommendations and reports : Morbidity and mortality weekly report Recommendations and reports.* 2017;66(2):1-20.
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5. Kim DK, Riley LE, Hunter P. Advisory Committee on Immunization Practices Recommended Immunization Schedule for Adults Aged 19 Years or Older - United States, 2018. *MMWR Morb Mortal Wkly Rep.* 2018;67(5):158-160.

G. DOCUMENT INFORMATION

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