TABLE 169-6 VACCINATION OF HEMATOPOIETIC STEM CELL TRANSPLANT (HSCT) AND SOLID ORGAN TRANSPLANT (SOT) RECIPIENTS

	Type of Transplantation	
Vaccine	**HSCT**	**SOT[a]**
Streptococcus pneumoniae, Haemophilus influenzae, Neisseria meningitidis	Immunize after transplantation. See CDC-ACIP recommendations. (For *S. pneumoniae*, a new primary series may be indicated.)	Immunize before transplantation. See CDC-ACIP recommendations. (For *S. pneumoniae*, a booster dose of polysaccharide vaccine after 5 years is recommended.)
Influenza	Vaccinate in the fall. Vaccinate close contacts.	Vaccinate in the fall. Vaccinate close contacts.
Polio	Administer inactivated vaccine.	Administer inactivated vaccine.
Measles/mumps/rubella	Immunize 24 months after transplantation if GVHD is absent.	Immunize before transplantation.
Diphtheria, pertussis, tetanus	Reimmunize after transplantation with primary series, DTaP. See IDSA 2013 recommendations (*www.idsociety.org/Other_Guidelines/#immunizationForthe CompromisedHost).*	Immunize or boost before transplantation with Tdap; give boosters at 10-year intervals or as required.
Hepatitis B and A	Reimmunize after transplantation. See recommendations.	Immunize before transplantation.
Human papillomavirus	Recommendations are pending (*www.cdc.gov/std/hpv/stdfact-hpv-vaccine-hcp.htm*).	Recommendations are pending.

[a]Immunizations should be given before solid organ transplantation whenever possible.

Abbreviations: CDC, Centers for Disease Control and Prevention; ACIP, Advisory Committee on Immunization Practices; DTaP, full-level diphtheria and tetanus toxoids and acellular pertussis, adsorbed; GVHD, graft-versus-host disease; Tdap, tetanus toxoid, reduced diphtheria toxoid, and acellular pertussis; IDSA, Infectious Diseases Society of America.

Note: Recommendations from the CDC should be checked regularly as they frequently change upon receipt of new clinical information and new formulations of specific vaccines.

in adequate numbers. However, cancer patients (particularly those with Hodgkin's disease, in whom vaccination has been extensively studied) who are undergoing chemotherapy do not respond normally to immunization, and titers of antibodies to infectious agents fall more rapidly than in healthy individuals. Therefore, even immunosuppressed patients who have not undergone HSC transplantation may need booster vaccine injections. If memory cells are specifically eliminated as part of a stem cell "cleanup" procedure, it will be necessary to reimmunize the recipient with a new primary series. Optimal times for immunizations of different transplant populations are being evaluated. Yearly immunization of household and other contacts (including health care personnel) against influenza benefits the patient by preventing local spread.

In the absence of compelling data as to optimal timing, it is reasonable to administer the pneumococcal and *H. influenzae* type b conjugate vaccines to both autologous and allogeneic HSC transplant recipients beginning 12 months after transplantation. A series that includes both the 13-valent pneumococcal conjugate vaccine (Prevnar) and the 23-valent pneumococcal polysaccharide vaccine (Pneumovax) is now recommended (according to CDC guidelines). The pneumococcal and *H. influenzae* type b vaccines are particularly important for patients who have undergone splenectomy. The *Neisseria meningitidis* polysaccharide conjugate vaccine (Menactra or Menveo) also is recommended. In addition, diphtheria, tetanus, acellular pertussis, and inactivated polio vaccines can all be given at these same intervals (12 months and, as required, 24 months after transplantation). Some authorities recommend a new primary series for tetanus/diphtheria/pertussis and inactivated poliovirus vaccines beginning 12 months after transplantation. Vaccination to prevent hepatitis B and hepatitis A (both killed vaccines) also seems advisable. A formal recommendation regarding immunization with the tetravalent HPV virus-like particle vaccine (Gardasil) after HSC transplantation has not been issued. However, HPV vaccination, which can prevent genital warts as well as specific cancers, is recommended through age 26 for healthy young adults who previously have not been vaccinated or have not received the full series. Live-virus measles/mumps/rubella (MMR) vaccine can be given to autologous HSC transplant recipients 24 months after transplantation and to most allogeneic HSC transplant recipients at the same point if they are not receiving maintenance therapy with immunosuppressive drugs and do not have ongoing GVHD. The risk of spread from a household contact is low for MMR vaccine. In parts of the world where live poliovirus vaccine is used, patients as well as contacts should be advised to receive only the killed vaccine. In the rare setting where both donor and recipient are VZV naïve and the recipient is no longer receiving acyclovir or ganciclovir prophylaxis, the patient should be counseled to receive varicella-zoster immune globulin (VariZIG) up to 10 days after an exposure to a person with chickenpox or uncovered zoster; such patients should avoid close contact with persons recently vaccinated with Varivax. A formal recommendation regarding Varivax immunization of such patients is not currently available. Neither patients nor their household contacts should receive vaccinia vaccine unless they have been exposed to smallpox virus. Among patients who have active GVHD and/or are taking high maintenance doses of glucocorticoids, it may be prudent to avoid all live-virus vaccines.

In the case of SOT recipients, administration of all the usual vaccines and of the indicated booster doses should be completed before immunosuppression, if possible, to maximize responses. For patients taking immunosuppressive agents, the administration of pneumococcal vaccine should be repeated every 5 years. No data are available for the meningococcal vaccine, but it is probably reasonable to administer it along with the pneumococcal vaccine. *H. influenzae* conjugate vaccine is safe and should be efficacious in this population; therefore, its administration before transplantation is recommended. Booster doses of this vaccine are not recommended for adults. SOT recipients who continue to receive immunosuppressive drugs should not receive live-virus vaccines. A person in this group who is exposed to measles should be given measles immune globulin. Similarly, an immunocompromised patient who is seronegative for varicella and who comes into contact with a person who has chickenpox should be given varicella-zoster immune globulin as soon as possible (optimally within 96 h; up to 10 days after contact); if this is not possible, a 10- to 14-day course of acyclovir therapy should be started immediately. Upon the discontinuation of treatment, clinical disease may still occur in a small number of patients; thus vigilance is indicated. Rapid re-treatment with acyclovir should limit the symptoms of disease. Household contacts of transplant recipients can receive live attenuated VZV vaccine, but vaccinees should avoid direct contact with the patient if a rash develops. Virus-like particle vaccines have been licensed for the prevention of infection with several HPV serotypes most commonly implicated in cervical and anal carcinomas and in anogenital and laryngeal warts. These vaccines are not live; however, no information is yet available about their immunogenicity or efficacy in transplant recipients.

Immunocompromised patients who travel may benefit from some but not all vaccines **(Chaps. 148 and 149)**. In general, these patients should receive any killed or inactivated vaccine preparation appropriate to the area they are visiting; this recommendation includes the vaccines for Japanese encephalitis, hepatitis A and B, poliomyelitis, meningococcal infection, and typhoid. The live typhoid vaccines are not recommended for use in most immunocompromised patients, but an inactivated or purified polysaccharide typhoid vaccine can be used. Live yellow fever vaccine should not be administered. On the other hand, primary immunization or boosting with the purified-protein hepatitis B vaccine is indicated. Inactivated hepatitis A vaccine should also be used in the appropriate setting **(Chap. 148)**. A vaccine is now available that provides dual protection against hepatitis A and hepatitis B. If hepatitis A vaccine is not administered, travelers should consider receiving passive protection with immune globulin (the dose depending on the duration of travel in the high-risk area).