in activities such as gardening or caving. Prolonged use of central venous catheters for parenteral nutrition (lipids) increases the risk of fungemia with *Malassezia*. Some centers administer prophylactic antifungal agents to these patients. Because of the high and prolonged risk of *Pneumocystis jirovecii* pneumonia (especially among patients being treated for hematologic malignancies), most patients receive maintenance prophylaxis with trimethoprim-sulfamethoxazole (TMP-SMX) starting 1 month after engraftment and continuing for at least 1 year.

PARASITIC INFECTIONS

The regimen just described for the fungal pathogen *Pneumocystis* may also protect patients seropositive for the parasite *T. gondii*, which can cause pneumonia, visceral disease (occasionally), and central nervous system (CNS) lesions (more commonly). The advantages of maintaining HSC transplant recipients on daily TMP-SMX for 1 year after transplantation include some protection against *Listeria monocytogenes* and nocardial disease as well as late infections with *Streptococcus pneumoniae* and *Haemophilus influenzae*, which stem from the inability of the immature immune system to respond to polysaccharide antigens.

With increasing international travel, parasitic diseases typically restricted to particular environmental niches may pose a risk of reactivation in certain patients after HSC transplantation. Thus, in recipients with an appropriate history who were not screened and/or treated before transplantation or in patients with recent exposures, evaluation for infection with *Strongyloides*, *Leishmania*, schistosomes, trypanosomes, or various parasitic causes of diarrheal illness (*Giardia*, *Entamoeba*, *Cryptosporidium*, microsporidia) may be warranted.

VIRAL INFECTIONS

HSC transplant recipients are susceptible to infection with a variety of viruses, including primary and reactivation syndromes caused by most human herpesviruses (Table 169-3) and acute infections caused by viruses that circulate in the community.

TABLE 169-3 HERPESVIRUS SYNDROMES OF TRANSPLANT RECIPIENTS

Virus	Reactivation Disease
Herpes simplex virus type 1	Oral lesions
	Esophageal lesions
	Pneumonia (primarily HSC transplant recipients)
	Hepatitis (rare)
Herpes simplex virus type 2	Anogenital lesions
	Hepatitis (rare)
Varicella-zoster virus	Zoster (can disseminate)
Cytomegalovirus	Associated with graft rejection
	Fever and malaise
	Bone marrow failure
	Pneumonitis
	Gastrointestinal disease
Epstein-Barr virus	B cell lymphoproliferative disease/lymphoma
	Oral hairy leukoplakia (rare)
Human herpesvirus type 6	Fever
	Delayed monocyte/platelet engraftment
	Encephalitis (rare)
Human herpesvirus type 7	Undefined
Kaposi's sarcoma–associated virus	Kaposi's sarcoma
	Primary effusion lymphoma (rare)
	Multicentric Castleman's disease (rare)
	Marrow aplasia (rare)

Abbreviation: HSC, hematopoietic stem cell.

Herpes Simplex Virus Within the first 2 weeks after transplantation, most patients who are seropositive for HSV-1 excrete the virus from the oropharynx. The ability to isolate HSV declines with time. Administration of prophylactic acyclovir (or valacyclovir) to seropositive HSC transplant recipients has been shown to reduce mucositis and prevent HSV pneumonia (a rare condition reported almost exclusively in allogeneic HSC transplant recipients). Both esophagitis (usually due to HSV-1) and anogenital disease (commonly caused by HSV-2) may be prevented with acyclovir prophylaxis. **For further discussion, see Chap. 216.**

Varicella-Zoster Virus Reactivation of VZV manifests as herpes zoster and may occur within the first month but more commonly occurs several months after transplantation. Reactivation rates are ~40% for allogeneic HSC transplant recipients and 25% for autologous recipients. Localized zoster can spread rapidly in an immunosuppressed patient. Fortunately, disseminated disease can usually be controlled with high doses of acyclovir. Because of frequent dissemination among patients with skin lesions, acyclovir is given prophylactically in some centers to prevent severe disease. Low doses of acyclovir appear to be effective in preventing reactivation of VZV. However, acyclovir can also suppress the development of VZV-specific immunity. Thus, its administration for only 6 months after transplantation does not prevent zoster from occurring when treatment is stopped. Administration of low doses of acyclovir for an entire year after transplantation is effective and may eliminate most cases of posttransplantation zoster, even among cord-blood recipients. **For further discussion, see Chap. 217.**

Cytomegalovirus The onset of CMV disease (interstitial pneumonia, bone marrow suppression, graft failure, hepatitis/colitis) usually begins 30–90 days after HSC transplantation, when the granulocyte count is adequate but immunologic reconstitution has not occurred. CMV disease rarely develops earlier than 14 days after transplantation and may become evident as late as 4 months after the procedure. It is of greatest concern in the second month after transplantation, particularly in allogeneic HSC transplant recipients. In cases in which the donor marrow is depleted of T cells (to prevent GVHD or eliminate a T cell tumor) and in cord-blood recipients, the disease may manifest earlier. The use of alemtuzumab to prevent GVHD in nonmyeloablative transplantation has been associated with an increase in CMV disease. Patients who receive ganciclovir for prophylaxis, preemptive treatment, or treatment (see below) may develop recurrent CMV infection even later than 4 months after transplantation, as treatment appears to delay the development of the normal immune response to CMV infection. Although CMV disease may present as isolated fever, granulocytopenia, thrombocytopenia, or gastrointestinal disease, the foremost cause of death from CMV infection in the setting of HSC transplantation is pneumonia.

With the standard use of CMV-negative or filtered blood products, CMV infection should be a major risk in allogeneic transplantation only when the recipient is CMV-seropositive and the donor is CMV-seronegative. This situation is the reverse of that in solid organ transplant recipients. CMV reactivates from latent reservoirs present in the recipient at a time when donor T cells (especially cord-blood T cells) are too immature to control CMV replication. If the T cells from the donor have never encountered CMV and the recipient carries the virus, the patient is at maximal risk of severe disease. Reactivation disease or superinfection with another strain from the donor also can occur in CMV-positive recipients, but clinical manifestations are typically less severe, presumably because of CMV-specific memory in transplanted donor T cells. Most patients infected with CMV who undergo HSC transplantation excrete virus, with or without clinical findings. Serious CMV disease is much more common among allogeneic than autologous recipients and is often associated with GVHD. In addition to pneumonia and marrow suppression (and, less often, graft failure), manifestations of CMV disease in HSC transplant recipients include fever with or without arthralgias, myalgias, hepatitis, and esophagitis. CMV ulcerations occur in both the lower and the upper gastrointestinal tract, and it may be difficult to distinguish diarrhea due to GVHD from that due to CMV infection. The finding of CMV in