be associated with the vanishing bile duct syndrome after liver transplantation. Patients respond to treatment with ganciclovir; prophylaxis with oral forms of ganciclovir or high-dose acyclovir may decrease the frequency of disease. A role for HHV-6 reactivation in early posttransplantation fever and leukopenia has been proposed, although the more severe sequelae described in HSC transplantation are unusual. HHV-6 and HHV-7 appear to exacerbate CMV disease in this setting. EBV-LPD after liver transplantation shows a propensity for involvement of the liver, and such disease may be of donor origin. See previous sections for discussion of EBV infections in solid organ transplantation.

PANCREAS TRANSPLANTATION

Pancreas transplantation is most frequently performed together with or after kidney transplantation, although it may be performed alone. Transplantation of the pancreas can be complicated by early bacterial and yeast infections. Most pancreatic transplants are drained into the bowel, and the rest are drained into the bladder. A cuff of duodenum is used in the anastomosis between the pancreatic graft and either the gut or the bladder. Bowel drainage poses a risk of early intraabdominal and allograft infections with enteric bacteria and yeasts. These infections can result in loss of the graft. Bladder drainage causes a high rate of urinary tract infection and sterile cystitis; however, such infection can usually be cured with appropriate antimicrobial agents. In both procedures, prophylactic antimicrobial agents are commonly used at the time of surgery. Aggressive immunosuppression, especially when the patient receives a kidney and a pancreas from different donors, is associated with late-onset systemic fungal and viral infections; thus many centers administer an antifungal drug and an antiviral agent (ganciclovir or a congener) for extended prophylaxis.

Issues related to the development of CMV infection, EBV-LPD, and infections with opportunistic pathogens in patients receiving a pancreatic transplant are similar to those in other SOT recipients.

COMPOSITE TISSUE TRANSPLANTATION

Composite tissue allotransplantation (CTA) is a new field in which, rather than a single organ, multiple tissue types composing a major body part are transplanted. The sites involved have included an upper extremity, the face, the trachea, the knee, and the abdominal wall. The numbers of recipients are limited. The different procedures and the associated infectious complications vary. Nevertheless, some early trends related to infectious complications have become apparent, as very intense and prolonged immunosuppression is typically required to prevent rejection. For example, in the early postoperative period, bacterial infections are especially frequent in facial transplant recipients. Perioperative prophylaxis is tailored to the organisms likely to complicate the different procedures. As in SOT recipients, complicated CMV infections have been observed in several CTA settings, particularly when the recipient is seronegative and the donor is seropositive. In some patients, anti-CMV immune globulin in addition to ganciclovir (as used in HSC transplant recipients with CMV pneumonia) was needed to control disease, and ganciclovir resistance requiring alternative therapies developed in several patients. Infectious complications from reactivation of other members of the human herpesvirus family and other latent viruses also caused significant morbidity, as discussed for SOT recipients. Prophylaxis for CMV infection, *P. jirovecii* infection, toxoplasmosis, and fungal infection is administered for several months on the basis of the limited studies available.

MISCELLANEOUS INFECTIONS IN SOLID ORGAN TRANSPLANTATION

Indwelling IV Catheter Infections The prolonged use of indwelling IV catheters for administration of medications, blood products, and nutrition is common in diverse transplantation settings and poses a risk of local and bloodstream infections. Exit-site infection is most commonly caused by staphylococcal species. Bloodstream infection most frequently develops within 1 week of catheter placement or in patients who become neutropenic. Coagulase-negative staphylococci are the most common isolates from blood. Although infective endocarditis in HSC transplant recipients is uncommon, the incidence of endocarditis in SOT recipients has been estimated to be as high as 1%, and this infection is associated with excessive high mortality in this population. Although staphylococci predominate, the involvement of fungal and gram-negative organisms may be more common than in the general population.

For further discussion of differential diagnosis and therapeutic options, see Chap. 104.

Tuberculosis The incidence of tuberculosis within the first 12 months after solid organ transplantation is greater than that observed after HSC transplantation (0.23–0.79%) and ranges broadly worldwide (1.2–15%), reflecting the prevalence of tuberculosis in local populations. Lesions suggesting prior tuberculosis on chest radiography, older age, diabetes, chronic liver disease, GVHD, and intense immunosuppression are predictive of tuberculosis reactivation and development of disseminated disease in a host with latent disease. Tuberculosis has rarely been transmitted from the donor organ. In contrast to the low mortality rate among HSC transplant recipients, mortality rates among SOT recipients are reported to be as high as 30%. Vigilance is indicated, as the presentation of disease is often extrapulmonary (gastrointestinal, genitourinary, central nervous, endocrine, musculoskeletal, laryngeal) and atypical; tuberculosis in this setting sometimes manifests as fever of unknown origin. Careful elicitation of a history and direct evaluation of both the recipient and the donor prior to transplantation are optimal. Skin testing of the recipient with purified protein derivative may be unreliable because of chronic disease and/or immunosuppression. Cell-based assays that measure interferon γ and/or cytokine production may prove more sensitive in the future. Isoniazid toxicity has not been a significant problem except in the setting of liver transplantation. Therefore, appropriate prophylaxis should be used (see recommendations from the Centers for Disease Control and Prevention [CDC] at *www.cdc.gov/tb/topic/treatment/ltbi.htm*). An assessment of the need to treat latent disease should include careful consideration of the possibility of a false-negative test result. Pending final confirmation of suspected tuberculosis, aggressive multidrug treatment in accordance with the guidelines of the CDC, the Infectious Diseases Society of America, and the American Thoracic Society is indicated because of the high mortality rates among these patients. Altered drug metabolism (e.g., upon coadministration of antituberculous medications and certain immunosuppressive agents) can be managed with careful monitoring of drug levels and appropriate dose adjustment. Close follow-up of hepatic enzymes is warranted. Drug-resistant tuberculosis is especially problematic in these individuals (Chap. 202).

Virus-Associated Malignancies In addition to malignancy associated with gammaherpesvirus infection (EBV, KSHV) and simple warts (HPV), other tumors that are virus-associated or suspected of being virus-associated are more likely to develop in transplant recipients, particularly those who require long-term immunosuppression, than in the general population. The interval to tumor development is usually >1 year. Transplant recipients develop nonmelanoma skin or lip cancers that, in contrast to de novo skin cancers, have a high ratio of squamous cells to basal cells. HPV may play a major role in these lesions. Cervical and vulvar carcinomas, which are quite clearly associated with HPV, develop with increased frequency in female transplant recipients. The frequency of Merkel cell carcinoma associated with Merkel cell polyomavirus is also increased in transplant recipients; however, it is unclear whether recipients infected with HTLV-1 are at increased risk of leukemia. Among renal transplant recipients, rates of melanoma are modestly increased and rates of cancers of the kidney and bladder are increased.

VACCINATION OF TRANSPLANT RECIPIENTS

(See also Chap. 148) In addition to receiving antibiotic prophylaxis, transplant recipients should be vaccinated against likely pathogens (Table 169-6). In the case of HSC transplant recipients, optimal responses cannot be achieved until after immune reconstitution, despite previous immunization of both donor and recipient. Recipients of an allogeneic HSC transplant must be reimmunized if they are to be protected against pathogens. The situation is less clear-cut in the case of autologous transplantation. T and B cells in the peripheral blood may reconstitute the immune response if they are transferred