part of AIN. Granuloma formation and interstitial inflammation occur with certain drugs such as anticonvulsants and sulfonamides, systemic diseases such as sarcoidosis, tubulointerstitial nephritis with uveitis, and idiopathic granulomatous interstitial nephritis. The glomeruli and vasculature are spared until very late in the disease. If kidney biopsy is not possible, gallium scanning or positron emission tomography of the kidneys may help with diagnosis, especially when the differential diagnosis is primarily between AIN and ATN.

Early diagnosis of AIN, coupled with rapid drug withdrawal before advanced tubulointerstitial fibrosis develops, maximizes successful renal recovery. Steroid therapy is controversial but may reduce the duration of AKI and perhaps improve recovery of kidney function in patients with severe AKI if it is used early (within 2 weeks of diagnosis).

Before development of antibiotics and other drugs that have been associated with AIN, interstitial infection was the major cause of tubulointerstitial nephritis. Microbial agents such as staphylococci, streptococci, mycoplasma, diptheroids, and legionella are well-described causes of AIN. Several viral agents including cytomegalovirus, Epstein-Barr virus, human immunodeficiency virus (HIV), Hantaan virus, parvovirus, and rubeola also are associated with AIN. In addition, infectious agents that cause rickettsial diseases, leptospirosis, and tuberculosis also invade the renal interstitium.

The renal interstitium is the target of a number of systemic illnesses. Sarcoidosis causes a lymphocyte-dominant AIN, which can be associated with noncaseating granulomas. AKI and urine sediment containing WBCs and WBC casts point to this disease, along with other systemic findings. Steroids reduce the severity of AIN, but CKD is a potential long-term complication. Systemic lupus erythematosus is more commonly associated with various forms of proliferative GN; AIN may coexist with glomerular disease, or, in rare instances, it may be present in isolation. The interstitial inflammatory lesion is caused by immune complex deposition in the tubulointerstitium. AIN usually responds to the cytotoxic therapy given for lupus nephritis. Sjögren's syndrome also causes a lymphocyte-dominant AIN; it appears to be another immune complex–mediated disease of the renal interstitium.

Patients with HIV infection may develop interstitial disease that appears immune related. Diffuse infiltrative lymphocytosis syndrome (DILS) is a Sjögren-like syndrome associated with multivisceral infiltration of CD8-positive T lymphocytes. DILS appears to be a host-determined response to HIV. Immune reconstitution inflammatory syndrome (IRIS) is another multivisceral disease characterized by an interstitial infiltrate. This disease occurs when combination antiretroviral therapy reconstitutes the immune system in the setting of a previous or occult opportunistic infection. An exuberant immune reaction results in T cell infiltration of several organs, including the kidneys, which develop AIN. Therapy involves treatment of the opportunistic infection. Occasionally, steroids are required to suppress the inflammatory response.

Infiltration of the kidney by cancer is an uncommon cause of AKI. Autopsy studies confirm a high rate of asymptomatic renal infiltration. The malignancies most often associated with interstitial infiltration are the lymphomas and leukemias. Lymphomatous infiltration of the kidney parenchyma can occur in the form of discrete nodules or diffuse interstitial infiltration. Lymphoma may cause massive kidney enlargement (nephromegaly) and AKI. Leukemic infiltration also causes nephromegaly, AKI, and, rarely, renal potassium wasting from either tubulointerstitial damage or lysozyme production. Successful treatment of the underlying malignancy typically improves the infiltrative lesion; however, irradiation of the kidneys may provide additional benefit. Exclusion of obstructive uropathy from bulky retroperitoneal lymph node disease is also required.

Postrenal AKI

AKI can develop when obstruction to urine flow occurs along the genitourinary system (E-Table 31-5). The process causing postrenal AKI is called *obstructive uropathy*, whereas the dilated urinary collecting system identified on imaging is termed *hydronephrosis*. Tubular defects with AKI that results from urinary obstruction is called *obstructive nephropathy*. AKI can develop only when obstruction is bilateral, involving both ureters or the bladder, or unilateral in a person with a single functioning kidney. Importantly, either complete or partial obstruction can cause AKI. In general, complete obstruction is associated with more severe AKI and hypertension, intravascular volume overload, hyperkalemia, metabolic acidosis, and hyponatremia.

A wide variety of disorders, originating anywhere from the renal calyces to the urethra, can cause AKI due to urinary obstruction. The most common causes of obstructive uropathy in the upper urinary tract are stones and retroperitoneal disease; in the lower tract, at the level of the bladder and below, prostatic hyperplasia and bladder dysfunction most often obstruct urinary flow. Obstructive uropathy should be considered in many patients with AKI, especially those with a history suggesting risk. A history of nephrolithiasis or certain cancers, along with flank pain, suggests upper tract disease; a history of prostate or bladder disease, together with symptoms of prostatism and urinary retention, points to lower tract obstruction. A directed physical examination of the flanks, suprapubic area, and prostate for flank tenderness, a palpable bladder, or prostatic enlargement is required. Large residual urine demonstrated on straight catheterization of the bladder bespeaks lower tract obstruction.

Ultrasonography of the kidneys and retroperitoneum is the most appropriate initial test to evaluate the patient with AKI and possible urinary tract obstruction. The sensitivity and specificity of renal ultrasonography for the detection of urinary obstruction are approximately 90%. Several processes blunt dilatation of the collecting system and the formation of hydronephrosis, including acute obstruction of less than 48 to 72 hours' duration, severe intravascular volume depletion superimposed on obstruction, and retroperitoneal disease involving the kidneys and ureters that encases the collecting system. If ultrasonographic findings are equivocal or negative but high suspicion for urinary obstruction persists, a CT scan may provide more information. One of the major benefits of CT imaging is the ability to detect stones, tumor, enlarged lymph nodes, and other processes causing obstruction despite the absence of hydronephrosis. As last resort, if obstruction as the cause of AKI is still considered likely, retrograde pyelography may provide a diagnosis of upper tract obstruction.