Clinical Features. Acute pyelonephritis is often associated with the following:

- *Urinary tract obstruction,* either congenital or acquired
- *Instrumentation* of the urinary tract, most commonly catheterization
- *Vesicoureteral reflux*
- *Pregnancy.* Between 4% and 6% of pregnant women develop bacteriuria sometime during pregnancy, and 20% to 40% of these eventually develop symptomatic urinary infection if not treated.
- *Gender and age.* After the first year of life (when congenital anomalies in males commonly become evident) and up to around age 40 years, infections are much more frequent in females. With increasing age the incidence in males rises as a result of prostatic hypertrophy and instrumentation.
- *Preexisting renal lesions,* causing intrarenal scarring and obstruction
- *Diabetes mellitus,* in which increased susceptibility to infection, neurogenic bladder dysfunction, and more frequent instrumentation are predisposing factors
- *Immunosuppression and immunodeficiency*

Acute pyelonephritis usually presents with a sudden onset of pain at the costovertebral angle and systemic evidence of infection, such as fever and malaise. There are often indications of bladder and urethral irritation, such as dysuria, frequency, and urgency. The urine contains many leukocytes (pyuria) derived from the inflammatory infiltrate, but pyuria does not differentiate upper from lower urinary tract infection. The finding of leukocyte *casts*, typically rich in neutrophils (pus casts), indicates renal involvement, because casts are formed only in tubules. The diagnosis of infection is established by quantitative urine culture.

Uncomplicated acute pyelonephritis follows a benign course, and symptoms disappear within a few days after the institution of appropriate antibiotic therapy. Bacteria, however, may persist in the urine, or there may be recurrence of infection with new serologic types of *E. coli* or other organisms. Such bacteriuria then either disappears or may persist, sometimes for years. In the presence of unrelieved urinary obstruction, diabetes mellitus, or immunodeficiency, acute pyelonephritis may be more serious, leading to repeated septicemic episodes. The superimposition of *papillary necrosis* may lead to acute renal failure.

An emerging viral pathogen causing pyelonephritis in kidney allografts is *polyomavirus.* Latent infection with polyomavirus is widespread in the general population, and immunosuppression of the allograft recipient can lead to reactivation of latent infection and the development of nephropathy resulting in allograft failure in up to 5% of kidney transplant recipients. This form of pyelonephritis, now referred to as polyomavirus nephropathy, is characterized by infection of tubular epithelial cell nuclei, leading to nuclear enlargement and intranuclear inclusions visible by light microscopy (viral cytopathic effect). The inclusions are composed of virions arrayed in distinctive crystalline-like lattices when visualized by electron microscopy (Fig. 20-30). An interstitial inflammatory response is invariably present. Treatment consists of a reduction in immunosuppression.

Chronic Pyelonephritis and Reflux Nephropathy

Chronic pyelonephritis is a disorder in which chronic tubulointerstitial inflammation and scarring involve the calyces and pelvis (Fig. 20-31). Although several diseases produce chronic tubulointerstitial alterations (Table 20-8), only chronic pyelonephritis and analgesic nephropathy affect the calyces, making pelvocalyceal damage an important diagnostic clue. Chronic pyelonephritis at one time accounted for 10% to 20% of patients in renal transplant or dialysis units, until predisposing conditions such as reflux became better recognized. This condition remains an important cause of kidney destruction in children with severe lower urinary tract abnormalities.

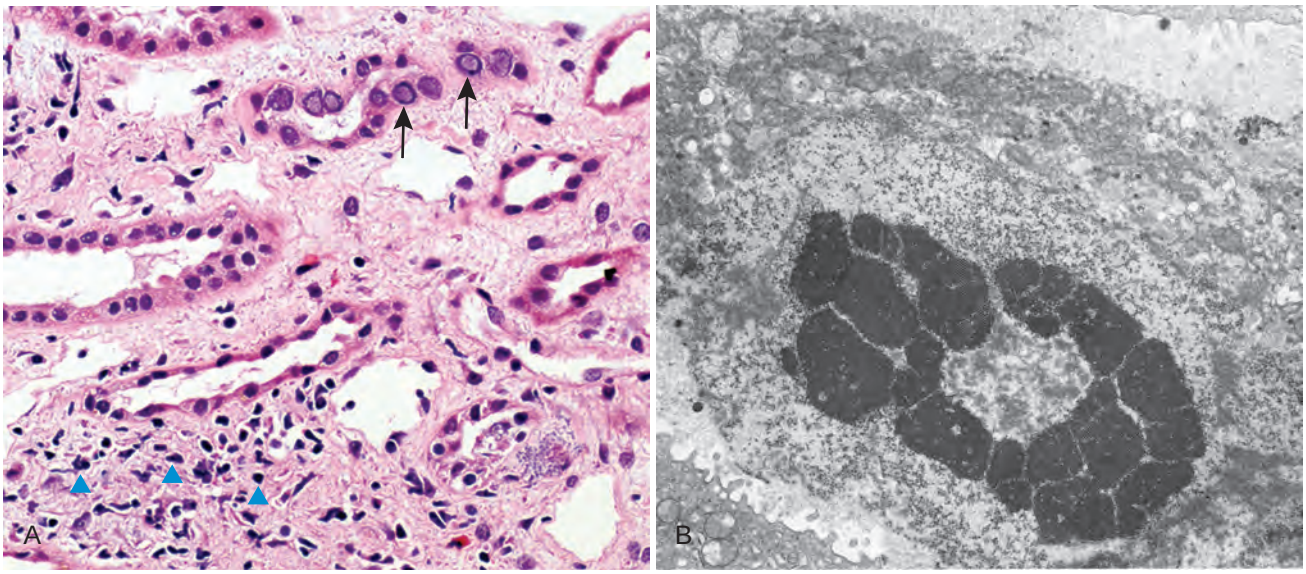

Figure 20-30 Polyomavirus nephropathy. **A,** The kidney shows enlarged tubular epithelial cells with nuclear inclusions *(arrows)* and interstitial inflammation *(arrowheads).* **B,** Intranuclear viral inclusions visualized by electron microscopy. (Courtesy Dr. Jean Olson, Department of Pathology, University of California San Francisco, San Francisco, Calif.)