

URINARY TRACT INFECTION (UTI)

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PATHOGENESIS

Bacterial Entry ■

- 1) **ascending** bacteria into the urinary tract causes most UTI ■, the short nature of the female urethra combined with its close proximity to the vaginal vestibule and rectum likely predisposes women to more frequent UTIs than Men
- 2) **Hematogenous** spread can occur in immunocompromised patients and in neonates. *Staphylococcus aureus*, *Candida* species, and *Mycobacterium tuberculosis* are common pathogens that travel through the blood to infect the urinary tract. □
- 3) **Lymphatogenous** spread through the rectal, colonic, and periuterine lymphatics has been postulated as a cause for UTI □
- 4) **Direct extension** of bacteria from adjacent organs into the urinary tract can occur in patients with intraperitoneal abscesses or vesicointestinal or vesicovaginal fistulas. □

Host Defenses

- **Structural :**
- **1- Urinary flow** causing washout of ascending bacteria .
- **2- Long urethra in men.**
- **3- Urothelial cells** express toll-like receptors (TLRs) that if engaged by specific bacterial components lead to production of inflammatory mediators .
- **4- Competent urterovesical junction valve .**
- **5- The epithelium lining the urinary tract provides a physical barrier.**

Host Defenses

- **Products:**
- 1- Urine's **osmolality, urea concentration, organic acid concentration,** and **pH** inhibit bacterial growth and colonization.
- 2- **Tamm-Horsfall glycoprotein** inhibit bacterial adherence
- 3- serum and urinary **antibodies** produced by the kidney enhance bacterial opsonization and phagocytosis and to inhibit bacterial adherence.
- 4- **soluble compounds,** which normally compete for the same receptors that bind bacterial adhesins.
- 5- The **normal flora** of the periurethral area such as lactobacillus provides a defense against the colonization of bacteria.
- 6- zinc in the **prostatic secretions** has potent antimicrobial activity.

Bacterial Pathogenic Factors

The ability of *E. coli* to adhere to epithelial cells is mediated by ligands located on the tips of the bacterial fimbriae (pili). ■

P pili, which can agglutinate **human blood**, bind to **glycolipid** receptors on uroepithelial cells, erythrocytes (P blood group antigens), and renal tubular cells are observed in over 90% of the *E. coli* strains causing pyelonephritis. ■

Type 1 pili, which can agglutinate **guinea pig** blood, bind to **mannoside** residues on uroepithelial cells type 1 pili may help bacteria to adhere to bladder mucosa. ■

Most uropathogenic *E. coli* have both types of pili ■
The presence of **K antigen** on the invading bacteria protects them from phagocytosis by neutrophils.

CAUSATIVE PATHOGENS

Most UTIs are caused by a single bacterial species. At least 80% of the uncomplicated cystitis and pyelonephritis are due to *E. coli*, with most of pathogenic strains belonging to the O serogroups .

Other less common uropathogens include *Klebsiella*, *Proteus*, and *Enterobacter* spp. and enterococci. In hospital-acquired UTIs, a wider variety of causative organisms is found, including *Pseudomonas* and *Staphylococcus* spp.

UTIs caused by *S. aureus* often result from hematogenous dissemination.

Group B beta-hemolytic streptococci can cause UTIs in pregnant women . *S. saprophyticus*, once often thought of as urinary contaminants, can cause uncomplicated UTIs in young women .

Definitions

- ***Urinary tract infection*** A diagnosis of urinary tract infection (UTI) was based on finding $>10^5$ bacteria/ml of urine, whether or not there were associated symptoms of infection.

UTI is currently defined as the inflammatory response of the urothelium to bacterial invasion. This inflammatory response causes a constellation of symptom

Definitions

- ***Bacteriuria*** is the presence of bacteria in the urine. Bacteriuria may be asymptomatic or symptomatic. Bacteriuria without pyuria indicates the presence of bacterial colonization of the urine, rather than the presence of active infection ('active' implies an inflammatory response to bacterial invasion of the urothelium).
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- ***Pyuria*** is the presence of white blood cells (more than 5 WBC/ HPF) in the urine as an inflammatory response of the urothelium to bacterial infection or, in the absence of bacteriuria (**Abacterial pyuria**), as in carcinoma in situ, TB infection, bladder stones, or other inflammatory conditions.

Definitions

- ***An uncomplicated UTI*** is one occurring in a patient with a structurally and functionally normal urinary tract. The majority of such patients are women who respond quickly to a short course of antibiotics.
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- ***A complicated UTI*** is one occurring in the presence of an underlying anatomical or functional abnormality (e.g. functional problems causing incomplete bladder emptying, such as BPH, stones in the kidney or bladder, fistula between bladder and bowel, etc). Most UTIs in men occur in association with a structural or functional abnormality and are therefore defined as complicated UTIs. Complicated UTIs take longer to respond to antibiotic treatment than uncomplicated UTIs, and if there is an underlying anatomical or structural abnormality they will usually recur within days, weeks, or months.

Urinary tract infection may be **isolated**, **recurrent** or **unresolved**.

- • **Isolated UTI**: an interval of at least 6 months between infections.
- • **Recurrent UTI**: >2 infections in 6 months, or 3 within 12 months. Recurrent UTI may be due to *reinfection* (i.e. infection by a different bacterium) or *bacterial persistence* (infection by the same organism originating from a focus within the urinary tract).
- Bacterial persistence is caused by the presence of bacteria within calculi (e.g. struvite calculi), within a chronically infected prostate (chronic bacterial prostatitis), within an obstructed or atrophic infected kidney, or occurs as a result of a bladder fistula (with bowel or vagina) or urethral diverticulum.
- • **Unresolved infection**: implies inadequate therapy and is caused by natural or acquired bacterial resistance to treatment, infection by different organisms, or rapid reinfection.

Risk factors for bacteriuria

Female sex; increasing age; low oestrogen states (menopause); diabetes mellitus; previous UTI; the institutionalized elderly; indwelling catheters; stone disease (kidney, bladder); genitourinary malformation and voiding dysfunction (including obstruction). ■

KIDNEY INFECTION

Acute Pyelonephritis ■

Acute pyelonephritis is defined as inflammation of the kidney and renal pelvis, and its diagnosis is usually made clinically. ■

Patients present with chills, fever, and costovertebral angle tenderness. They often have accompanying lower-tract symptoms such as dysuria, frequency, and urgency. Sepsis may occur. ■

Urinalysis commonly demonstrates the presence of WBCs and red blood cells in the urine. ■

Leukocytosis, increased erythrocyte sedimentation, and elevated levels of C-reactive protein are commonly seen on blood analysis. ■

Bacteria are cultured from the urine when the culture is obtained before antibiotic treatment is instituted. *E. coli* is the most common causative organism, accounting for 80% of the cases. ■

RADIOGRAPHIC IMAGING

- In patients with acute pyelonephritis, renal ultrasonography is important to rule out concurrent urinary tract obstruction but cannot reliably detect inflammation or infection of the kidney.
- CT scan is not necessary unless the diagnosis is unclear or the patient is not responding to therapy. (CT) scans can accurately demonstrate findings, confirming the diagnosis
- Acute bacterial infection causes constriction of peripheral arterioles and reduces perfusion of the affected renal segments. Perfusion defects, which can be segmental, multifocal, or diffuse, are seen as areas of reduced signal density (Figure). Renal enlargement, attenuated parenchyma, and a compressed collecting system are other characteristic findings on CT

Differential diagnosis:

: cholecystitis, pancreatitis, diverticulitis, ■
appendicitis & lower pole Pneumonia.

Risk factors: ■

vesicoureteric reflux (VUR); urinary tract ■
obstruction; calculi; spinal cord injury
(neuropathic bladder); diabetes mellitus; con-
genital malformation; indwelling catheters

MANAGEMENT

depends on the **severity** of the infection , In ■
patients who are not severely ill, **outpatient**
treatment with oral antibiotics is appropriate.
For adults, treatment with fluoroquinolones
or TMP-SMX is well tolerated and effective.
Therapy should continue for 10–14 days.

10–30% of all adult patients with acute ■
pyelonephritis require hospitalization as they
are toxic.



Empiric therapy with intravenous ampicillin and aminoglycosides is effective. Alternatively, amoxicillin with clavulanic acid or a third generation cephalosporin can be used. Non-*E. coli* infections were more commonly found in males who had renal abnormalities and who had received antibiotic therapy in the prior month. Non-*E. coli* uropathogens were often resistant to cephalosporins and aminoglycosides

Fever from acute pyelonephritis may persist for several days despite appropriate therapy. Parenteral therapy should be maintained until the patient defervesces. If bacteremia is present, parenteral therapy should be continued for an additional 7–10 days and then the patient should be switched to oral treatment for 10–14 days.

Some patients in whom acute pyelonephritis develops will require follow-up radiologic examination such as voiding cystourethrogram or cystoscopy

Chronic Pyelonephritis

- Chronic pyelonephritis results from repeated renal infection, which leads to scarring, atrophy of the kidney, and subsequent renal insufficiency.
- The diagnosis is made by **radiologic or pathologic** examination rather than from clinical presentation.



PRESENTATION

Many individuals with chronic pyelonephritis have **no symptoms**, but they may have a history of **frequent UTIs**.

In **children**, there is a strong correlation between renal scarring and recurrent UTIs. The developing kidney appears to be very susceptible to damage, and this susceptibility appears to be age dependent.

- Renal scarring induced by UTIs is rarely seen **in adult** kidneys.
- Patients with chronic pyelonephritis often are asymptomatic, the diagnosis is made incidentally when radiologic investigation is initiated to evaluate for the **complications** associated with renal insufficiency, such as hypertension, visual impairments, headaches, fatigue, and polyuria.

Investigations :

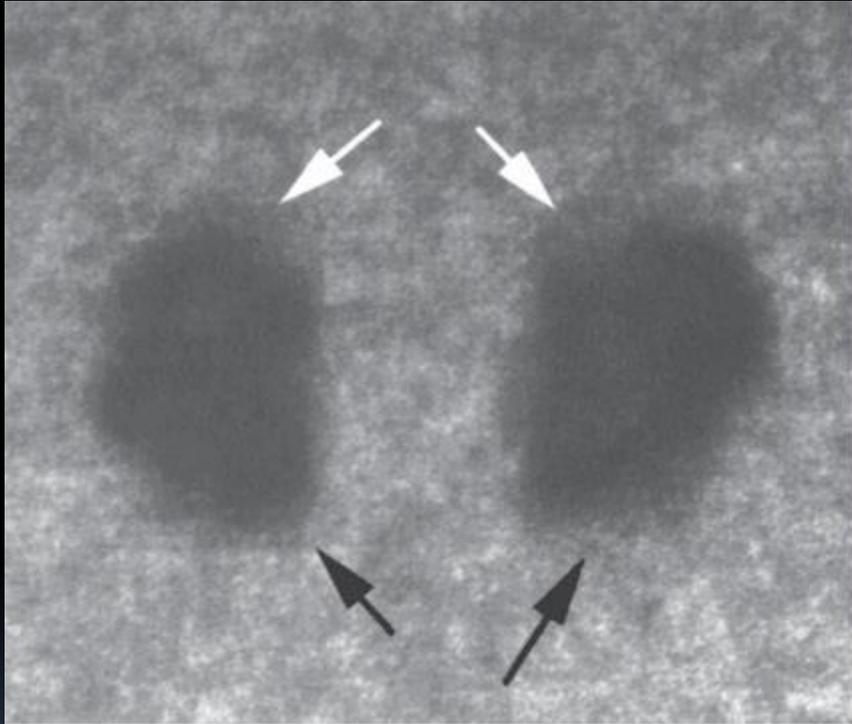
Urinalysis may show leukocytes or proteinuria but is likely to be normal. ■

Serum creatinine levels reflect the severity of the renal impairment. ■

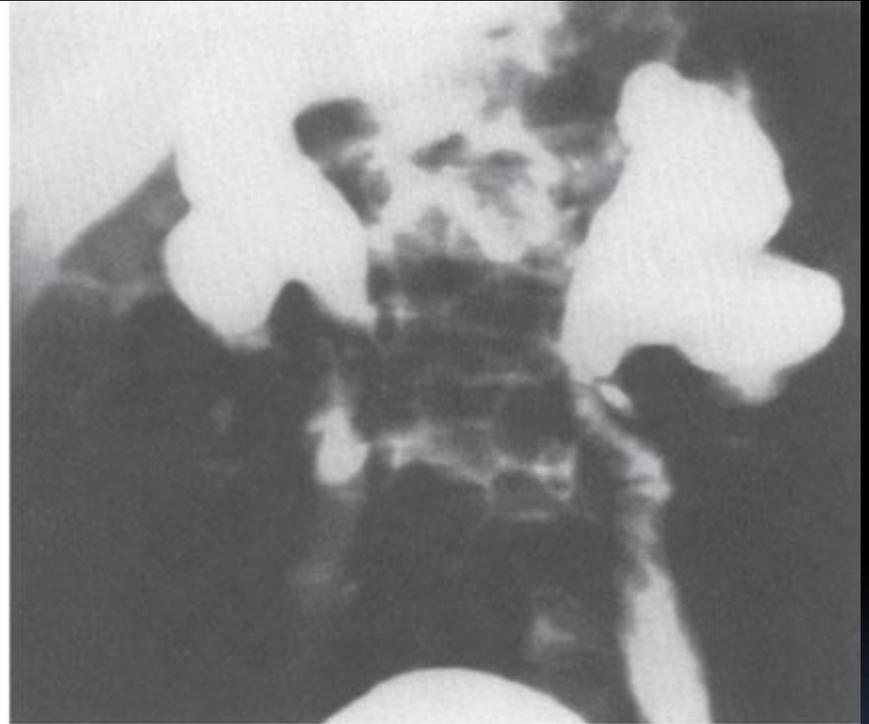
Urine cultures are only positive when there is an active infection. ■

RADIOGRAPHIC IMAGING

- **IVP or CT** urography (scan) can readily demonstrate a small and atrophic kidney on the affected side. Focal coarse renal scarring with clubbing of the underlying calyx is characteristic.
- **U/S** similarly can demonstrate these findings.
- ***Radioisotope is the best imaging modality to look for renal scarring.***



A



B

management

- The management of chronic pyelonephritis is somewhat **limited** because renal damage incurred by chronic pyelonephritis is **not reversible**.
- Eliminating recurrent UTIs and identifying and correcting any underlying anatomic or functional urinary problems such as obstruction or urolithiasis can prevent further renal damage.
- In children, evaluation for **vesicoureteral reflux** with a voiding cystourethrogram is important to eliminate a risk factor for recurrent pyelonephritis and renal scarring.
- Long-term use of continuous **suppressive antibiotic** therapy may be required to limit recurrent UTIs and renal scarring.
- Rarely, **removal of the affected kidney** may be necessary due to hypertension or having a large stone burden in a nonfunctioning kidney.