Bacterial infection is the most common cause of pyelonephritis. Acute complicated pyelonephritis is an acute emergency and needs immediate treatment with intravenous antibiotics. Infection in acute pyelonephritis is usually due to ascending infection, or due to hematogenous infection. The presence of recurrent infections, usually due to structural and functional anomalies in the genitourinary tract is the hallmark of chronic pyelonephritis. Clinical features include fever and abdominal flank pain with or without symptoms of cystitis. WBC casts are the characteristic findings seen in the urine analysis. Fluoroquinolones and cephalosporins are the mainstay in the treatment of pyelonephritis. Prognosis is excellent in uncomplicated pyelonephritis, while it is poor in emphysematous pyelonephritis.

Definition of Kidney Infection

Bacterial infection of the kidney (involving tubules, renal pelvis and interstitium) results in pyelonephritis. Presentation is usually either acute or chronic.

Acute pyelonephritis results either from ascending infection of the urinary tract or from hematogenous spread of systemic infections.
Chronic pyelonephritis generally is due to chronic recurrent infections secondary to urinary reflux, or obstruction in the genitor urinary tract.

Pyelonephritis is a life-threatening infection that can lead to scarring of the kidneys.

Epidemiology of Kidney Infection

Acute pyelonephritis is estimated at a prevalence of 15-17 cases per 10000 among females and 3-4 cases per 10000 among males in the population. It is more common in pregnant females who are diagnosed with asymptomatic bacteriuria.

Incidence of chronic pyelonephritis is common in children as they are associated with vesicoureteral reflux disease.

Pyelonephritis has no racial predilection and its distribution indicates that it is more common in the extremes of ages with two peaks; one at 0-4 years and the other >65 years.

<table>
<thead>
<tr>
<th>Women</th>
<th>Men</th>
<th>Either gender</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk factors similar to acute cystitis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Sexual intercourse</td>
<td>• UTI often complicated</td>
<td>• Urinary tract instrumentation</td>
</tr>
<tr>
<td>• History of previous UTI</td>
<td>• Frequently associated with urologic</td>
<td>• Diabetes mellitus</td>
</tr>
<tr>
<td>• Post-menopausal state</td>
<td>abnormalities</td>
<td>• Immunosuppression</td>
</tr>
<tr>
<td>• Pregnancy</td>
<td>• Anal-insertive sexual intercourse</td>
<td></td>
</tr>
<tr>
<td>• Anatomic or functional abnormality of urinary tract</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Classification/Types of Kidney Infection

**Acute pyelonephritis:** It is an acute medical emergency. If untreated, it can progress to abscess, sepsis and organ failure. Urinary tract infections (UTIs) due to Escherichia coli, Proteus mirabilis, Klebsiella most commonly predispose through ascending route. Hematogenous infection is usually due to Staphylococcus aureus.

**Chronic pyelonephritis:** It is due to recurrent bacterial infections and is seen predominantly in children with anomalies of the genitor-urinary tract. Vesicoureteric reflux in these patients results in chronic infections. Chronic pyelonephritis eventually leads to scarring of the kidney.

Pathophysiology of Kidney Infection

Acute Pyelonephritis
E. coli, Proteus and Pseudomonas are the organisms associated with urinary tract infections. E. coli is the most common organism involved in the acute pyelonephritis. The routes of infection are either a hematogenous route or ascending infection route.

**Ascending Infection**

Ascending infection with E. coli is by far the most common cause of acute pyelonephritis.

Favourable urothelium aids in the attachment of the bacteria. Instrumentation, especially with cystoscopy and catheterization, predisposes ascending infection to the bladder followed by renal pelvis. Short urethra and close proximity of the urethra to the rectum favors the infection. Urine present in the bladder is usually sterile unless ascending infection contaminates it. The infection gradually ascends from the bladder to the renal pelvis and kidney and results in acute pyelonephritis.

**Hematogenous Spread**

Hematogenous spread is usually uncommon. It occurs due to staphylococcus and E. coli infection. It results in the seeding of the bacteria in the kidney, which can result in pyelonephritis.

**Chronic Pyelonephritis**

The causes for pyelonephritis include:

**Vesicoureteric reflux**

Primary vesicoureteric reflux is seen in patients where the pathology is primarily in the urethrovesical junction. In normal individuals, usually, there is normal closure of the intravesical part of the ureter. Incompetent urethrovesical junction leads to the reflux of the urine into the ureters and renal pelvis resulting in the vesicoureteric reflux.

Secondary vesicoureteric reflux develops in patients with neurogenic bladder.

**Urinary tract obstruction**

Lower urinary tract obstruction is the predominant cause of chronic pyelonephritis, which can be due to benign prostatic hyperplasia and renal calculus.
Renal Papillary Necrosis

It is a variant of **pyelonephritis**, which is predominantly seen in **diabetics**. It is characterized by the involvement of the **renal papilla**, called as **papillary necrosis**. It is characterized by the presence of **ischemic** and **suppurative necrosis** at the tip of the renal papilla.

**Conditions showing renal papillary necrosis:**

- Diabetes mellitus
- NSAIDs abuse
- Acute pyelonephritis
- Sickle cell trait

Emphysematous Pyelonephritis

In some **diabetic patients**, there is a severe form of pyelonephritis. It shows **accumulation of gas** in the renal and perinephric patients. Prognosis is poor in **emphysematous pyelonephritis**.

Xanthogranulomatous Pyelonephritis

Chronic infection associated with urinary tract obstruction (usually by **staghorn calculi**), results in **suppurative infection** of the kidney. Histopathological changes show infiltration by lipid laden **macrophages**.

*Image: “CD68 immunohistochemical staining of macrophages and giant cells in a case of xanthogranulomatous pyelonephritis.” by Nephron. License: CC BY-SA 3.0*
Clinical Examination and Symptoms of Kidney Infection

Acute Uncomplicated Pyelonephritis

Classic triad of symptoms of acute uncomplicated pyelonephritis includes:

- Fever
- Costovertebral tenderness
- Nausea/vomiting

It is usually associated with symptoms of cystitis, which include increased frequency, urgency, dysuria and supra pubic tenderness.

Children present with additional features of difficulty in feeding and failure to thrive while elderly patients present with additional features of altered mental status and general disorientation.

Acute Complicated Pyelonephritis

Uncomplicated pyelonephritis, in the presence of any of the following associations, is considered as complicated pyelonephritis:

- A recent history of urinary tract instrumentation
- Diabetes
- Pregnancy
- Multi-drug resistant pathogens
- Urinary tract obstruction
- Recent history of hospitalization

Renal abscess, emphysematous pyelonephritis and papillary necrosis results due to complicated pyelonephritis.

Chronic Pyelonephritis

A past history of acute pyelonephritis is usually present. Chronic and recurrent infections can predispose to hypertension in children. In children, symptoms such as fever, lethargy, flank pain and nausea may be present.

Overview of sign and symptoms of pyelonephritis and perinephric abscess

<table>
<thead>
<tr>
<th>Children</th>
<th>Women</th>
<th>Men</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-specific</td>
<td>Fever (sign of sepsis)</td>
<td>Presence of fever may indicate prostatitis or pyelonephritis</td>
</tr>
<tr>
<td>Fever</td>
<td>Frequent, painful urination of small amounts of turbid urine</td>
<td>All cases of pyelonephritis or perinephric abscess need urologic evaluation.</td>
</tr>
<tr>
<td>Failure-to-thrive</td>
<td>Suprapubic heaviness or pain (occasional)</td>
<td></td>
</tr>
<tr>
<td>Vomiting</td>
<td>Costovertebral angle tenderness</td>
<td></td>
</tr>
</tbody>
</table>

Diagnosis & Laboratory Investigations of Kidney
Infection

Blood and Urine Examination in Pyelonephritis

- Acute pyelonephritis classically shows the presence of **WBC casts**, **hematuria** along with **pyuria** and **bacteriuria**.
- **Blood** investigations show increased serum creatinine levels. A complete blood picture shows the characteristic increase in the number of **eosinophils**.

Gross and Histopathology Findings in Pyelonephritis

**Acute Pyelonephritis**

It is characterized by the presence of a focal abscess formation in the cortex and medulla. The lower pole of the kidney is relatively spared; renal tubules show characteristic micro abscess.

**Chronic Pyelonephritis**

Scarring of the **glomeruli** and tubular atrophy are characteristic of chronic pyelonephritis. Presence of increased **eosinophilic substance** in the tubules (due to atrophy) is seen. This characteristically resembles the **thyroid tissue** on histopathological examination. This process of deposition of eosinophilic substance in the tubule is called as **thyroidisation**.

Radiological Investigations

- Voiding cystourethrogram helps in the diagnosis of the **vesicoureteric reflex**.
- CT scanning is the investigation of choice whenever there is suspicion of any obstruction or the presence of any congenital anomalies.
- On intravenous pyelogram, typical **cortical scars** with blunt calyces are seen.

Treatment of Kidney Infection

**Treatment of Acute Pyelonephritis**

**Acute complicated pyelonephritis** requires treatment with intravenous **cephalosporins**, followed by oral **fluoroquinolones**. **Oral fluoroquinolones** would, alone, be sufficient in **uncomplicated pyelonephritis**.

**Treatment of Chronic Pyelonephritis**

Prevention of the **reflux uropathy** in childhood forms the cornerstone in the management of chronic pyelonephritis. It might require surgical correction, based on the grade of the vesicoureteric reflex. Almost all cases of VUR should be tried on medical therapy. **Hypertension** should be treated by the administration of angiotensin receptor blockers.
Prognosis of Kidney Infection

**Acute uncomplicated pyelonephritis** has excellent prognosis and complete recovery is seen. **Emphysematous pyelonephritis** in diabetics shows very poor prognosis irrespective of the treatment. Chronic pyelonephritis in children, due to **vesicoureteric reflux**, usually resolves spontaneously and only a few need surgical correction. Complications of chronic pyelonephritis includes **focal glomerulosclerosis, renal scarring** which progress gradually to end-stage renal failure.

**Review Questions**

The answers are below the references.

1. **The most common cause of acute pyelonephritis is?**
   - A. Ascending infection with E. coli
   - B. Pseudomonas
   - C. Listeria
   - D. Clostridium perfringens
   - E. Salmonella

2. **Renal papillary necrosis is predominantly seen in?**
   - A. Alcoholics
   - B. Diabetics
   - C. Tuberculosis patients
   - D. Melanoma patients
   - E. Hypertensive patients

3. **Which of the following class of drug is most appropriate in uncomplicated pyelonephritis?**
   - A. Fluoroquinolones
   - B. NSAIDs
   - C. Tetracyclines
   - D. Beta blockers
   - E. Penicillins

**References**


Acute complicated cystitis and pyelonephritis via uptodate.com

Xanthogranulomatous pyelonephritis via uptodate.com

Chronic Pyelonephritis Clinical Presentation via emedicine.medscape.com

**Correct answers:** 1A, 2B, 3A

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