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Pyelonephritis

Important!
Doctor's Notes
Only found in females' slides
Only found in males' slides
Extra Notes

" I'm not telling you it's going to be easy. I'm telling you it's going to be worth it."

UTI terminology

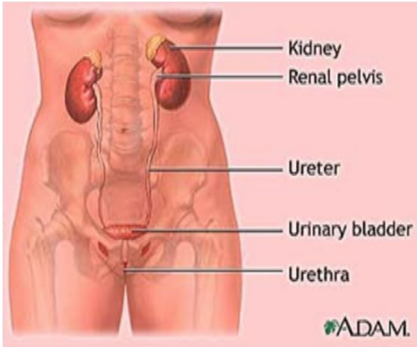
- ➔ Uncomplicated : infection of urinary bladder in host w/out underlying renal or neurologic disease.
- ➔ Complicated : infection in setting of underlying structural, medical or neurologic disease.
- ➔ Recurrent : > 2 symptomatic UTIs within 12 months. following clinical resolution of each previous UTI after therapy.
- ➔ Reinfection : recurrent UTI caused by different pathogen at any time or original infecting strain >13 days after therapy of original UTI.
- ➔ Relapse : recurrent UTI caused by same species causing original UTI within 2 weeks after therapy.

Introduction

- ➔ It is very serious condition that lead to renal scarring, nephric, perinephric abscess formation, sepsis.
- ➔ Clinical presentation is atypical in some patients.
- ➔ Update on the management.
- ➔ Pyelonephritis may be acute or chronic.
  - ◆ Acute pyelonephritis may be unilateral or bilateral.

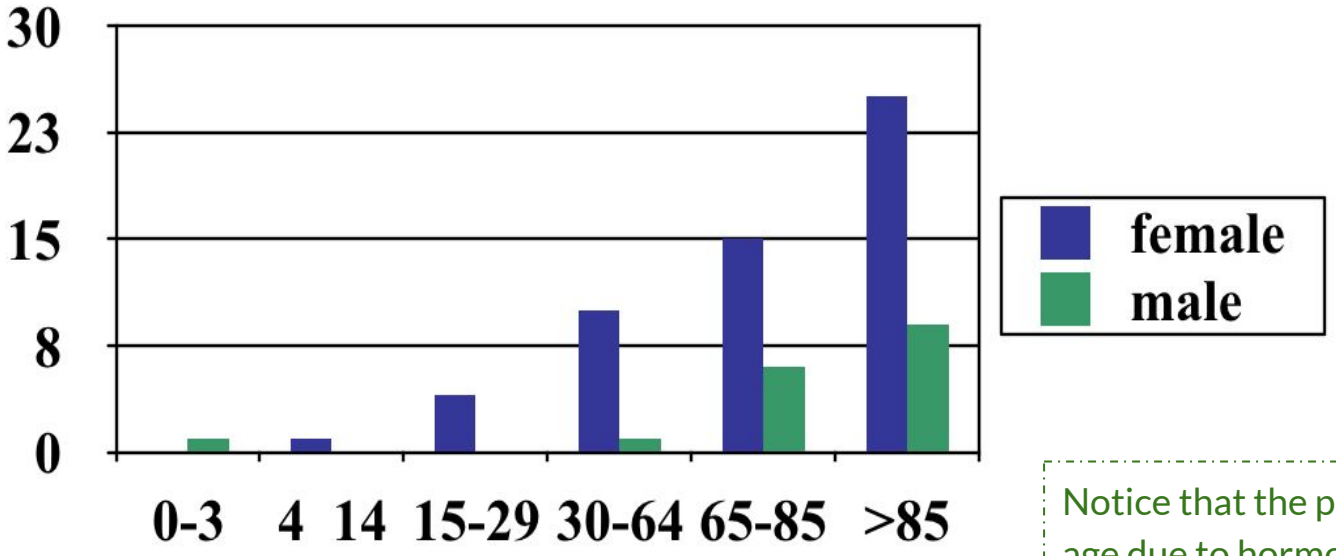
Definition

- ➔ It is Bacterial infection of the renal pelvis, tubules and interstitial tissue of one or both kidneys.
- ➔ Potentially organ- and/or life-threatening infection that characteristically causes some scarring of the kidney with each infection and may lead to significant damage to the kidney that may lead to hypertension.



Renal pelvis: **pyelitis**.
Bladder: **cystitis**
Urethra: **Urethritis**.
Renal parenchyma: **pyelonephritis**.

Prevalence of bacteriuria in Different age Groups



Notice that the prevalence increases with age due to hormonal changes in females and prostate problems in males and co-morbidities in both sexes

Pathophysiology & Etiology

- ➔ Escherichia coli, which accounts for 70-90% of uncomplicated UTIs and
- ➔ 21-54% of complicated UTIs. the uropathogenic E coli(UPEC) arises commonly from the phylogenetic groups B2 and D, which express distinctive O, K, and H antigens. UPEC genes encode several postulated virulence factors (VFs), including adhesins P fimbriae pap+genotype family, protectins, siderophores, and toxins.
- ➔ *Staphylococcus saprophyticus*, *Klebsiella pneumoniae*, *Proteus mirabilis*, *Enterococcus*, *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *and Enterobacter species.*
- ➔ Rare candida, viruses, Brucella and TB
- ➔ Host factors

Continue

pathogenesis	bacteria
Infection usually ascends from the urethra most bacterial causes	E.coli
Hospital-acquired infections	may be due to coliforms and Enterococci.
Hematogenous spread is rare	Staph aureus and mycobacterial tuberculosis Exception: neonates with Staph aureus

Frequently due to ureterovesical reflux

Renal parenchyma infections result in inflammatory response to contain infection but contributes to potential scarring.

- **For optimal host defense function, intermittent & complete emptying of bladder must occur.**
  - ✓ Urine is excellent culture medium
  - ✓ Bactericidal secretion from uroepithelial cells and glycoproteins inhibit bacterial adherence

Complicated UTI etiology	%
Escherichia coli	**21 – 54**
Klebsiella pneumoniae	**1.9 – 17**
Enterobacter species	**1.9 – 9.6**
Citrobacter species	**4.7 – 6.1**
Proteus mirabilis	**0.9 – 9.6**
Providencia species	**18**
Pseudomonas aeruginosa	**2 – 19**
Enterococci species	**6.1 – 23**

Found only in females' slides!

Pathogenesis

- Rectal and/or vaginal reservoirs
- Colonization of perianal area
- Bacterial migration to peri-vaginal area
- Bacteria ascend through urethra to bladder
- Intercourse may contribute urethral colonization and ascending infection
- ASB [asymptomatic bacteriuria] in 1st trimester of pregnancy may cause pyelonephritis in 3rd trimester
- Frequently due to ureterovesical reflux

Pathology

- Kidneys enlarge
- Interstitial infiltration of inflammatory cells
- Abscesses on the capsule and at corticomedullary junction
- Result in destruction of tubules and the glomeruli
- When chronic, kidneys become scarred, contracted and non functioning. Scarring is the most serious thing bc it leads to fibrosis and then obstruction and then failure & also high creatinine levels are a very bad bc it indicates that there's a loss of function.

Risk factors (436)

Mechanical:	Constitutional:

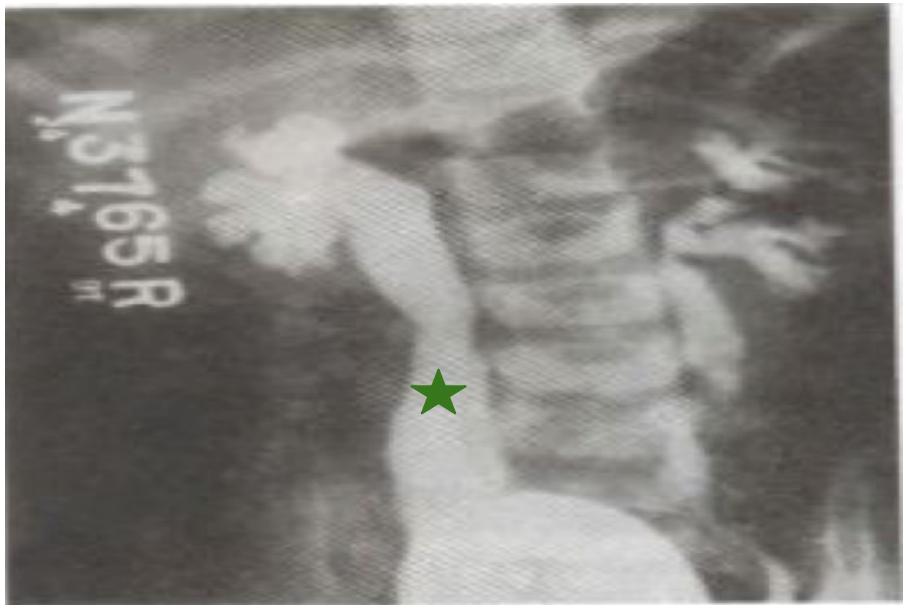
• Structural abnormalities to the kidneys and the urinary tract such as : (urethral strictures)[1]
• vesicoureteral reflux (VUR) especially in young children
• urinary tract catheterization (Catheterized patients)
• nephrostomy[2]
• Pregnancy (half of asymptomatic will develop pyelonephritis if not treated)
• neurogenic bladder (e.g. due to spinal cord damage, spina bifida or multiple sclerosis) and
• Obstruction :
  • prostate disease (e.g. benign prostatic hyperplasia) in eldery men
  • bladder tumors
  • calculi (stones)
1: narrowing of the urethra
2: artificial opening created between the kidney and the skin drains urine from your kidney into a collecting bag
	• diabetes mellitus (10 time more admission)
	• immunocompromised states

Clinical Manifestation of Acute Pyelonephritis (develops rapidly <24hrs)	**Clinical Manifestation of Chronic Pyelonephritis**
Acutely ill	No symptoms of infection unless an acute exacerbation occurs
Flank pain (pain in the costovertebral angle) renal angle tenderness or both, fever >38 & chill	Fatigue
Lower urinary tract symptoms (urgency, frequency and dysuria).	Headache
Confusion in elderly. (old ppl usually have atypical symptoms)	Poor appetite
Leukocytosis	Polyuria
Azotemia can occurred.	Excessive thirst
Pyuria	Weight loss
Bacteriuria	Progressive scarring renal failure
Nausea and vomiting	Elevated BP, vomiting, & diarrhea
Non infectious causes of these symptoms is renal infarct and calculi .	

Diagnosis & Lab Diagnosis

- It is not always straightforward.
- A number of studies using immunochemical markers have shown that women, who were initially present with lower tract symptoms, actually have pyelonephritis. The extremes of age, the presentation may be so atypical in the very young (feeding difficulty or fever). In the elderly, presentation may include mental status change like confusion or fever.
- A clean-catch or catheterized urinalysis with quantitative culture on BAP (blood agar) and selective media and sensitivity identifies the pathogen and determines appropriate antimicrobial therapy. (common: mid-stream urine Sensitive and specific: supra-pubic)
- There are 3 ways to collect the urine 1-MSU 2-Catheter 3-Suprapubic aspiration

Urinalysis	Positive result on leukocyte esterase dipstick test correlates well for detecting >10 WBC/hpf, with a specificity of 65%–95%, and sensitivity of 75%–95%	Positive nitrate dipstick test result for bacteriuria (bacteria reduce nitrate to nitrite) is only moderately reliable; false negative results are common	
Blood culture (15-30%)	Important as this is a systemic infection		
Urine culture	bacteria (10^8/l or 10^5/ml) Dr said you must differentiate between mL and L	RBCS 20-40% in the urine and leukocytosis.	pus >= 10/HPF 90%
BUN & CR	Blood Urea Nitrogen & Creatinine levels of the blood and	urine may be used to monitor kidney function	
Radiological Investigations	IVP (Intravenous Pyelogram X-ray for urinary tract) will Identify the presence of obstruction or degenerative changes caused by the infection process	Radionuclide imaging with gallium citrate and indium -111- labeled WBCs	Ultrasound or CT scan (look for stones, enlargement or deformities)



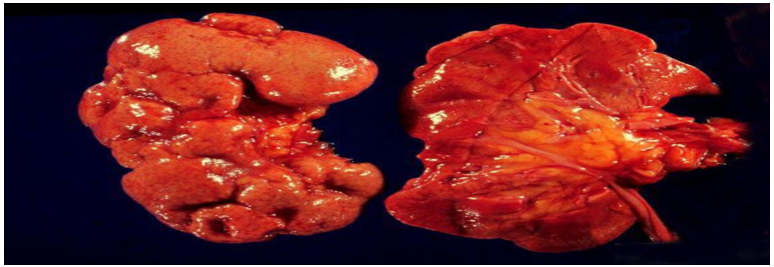
Micturating cystourethrogram (MCW showing bilateral VUR, grade IV on right and grade III on left-side. There is bilateral ureteral and pelvic dilation with blunting of fornices in the right kidney.

Bilateral reflux extending into the pelvicalyceal systems of the kidney without dilatation of the calyces or ureters.
(Note catheter in bladder)

★ The white color means there is urine and it should normally be black but because there's VUR

Chronic Pyelonephritis

- Repeated bouts of acute pyelonephritis may lead to chronic pyelonephritis that damages the kidney and cause hypertension.
- Assessment and Diagnostic findings:
  - IVP
  - Serum creatinine
  - Blood urea
  - Culture and sensitivity
- Complications
  - End Stage Renal Disease (ESRD)
  - Hypertension
  - Kidney stones



Fibrosis, scarring, shrinkage, and pus.

Destruction of approximately 70% of the kidney. Numerous dilated calyces with yellow-brown calculi. The central necrotic areas are surrounded by dense fibrosis.

Treatment Guidelines

Acute Pyelonephritis

- Treated as outpatients if there is no nausea, vomiting or dehydration and other signs and symptoms of sepsis
- Very ill patients and all pregnant women are hospitalized at least for 2 to 3 days for parenteral therapy
- 2 weeks course
- Bactrim
- Ciprofloxacin
- Gentamicin with or without amoxicillin
- Another 6 weeks course if relapse
- Follow up urine culture 2 weeks after completion of therapy

Chronic Pyelonephritis

- Fluid balance – I / O chart
- Fluids encouraged unless contraindicated
- 4th hourly temp
- Antibiotics
- Bedrest
- Teach how to prevent recurrent infections
- Adequate fluids, emptying the bladder regularly and performing recommended perineal hygiene taking antibiotics as prescribed

Treatment Guidelines: Acute Uncomplicated Pyelonephritis

Mild or Moderate

Outpatient treatment (total of 7–14 days) oral treatment:

- ➔ Fluoroquinolone
- ➔ TMP/SMX, if uropathogen is known to be susceptible.
- ➔ If Gram-positive pathogen: amoxicillin or amoxicillin-clavulanate

Hospitalized patients

Antibiotic first 48–72 hours followed by 7 days of oral antibiotic therapy:

- ➔ Fluoroquinolone IV, then PO
- ➔ Aminoglycoside ± ampicillin IV, then TMP/SMX PO
- ➔ 3rd gen. cephalosporin IV, then TMP/SMX PO

Ambulatory patients*

7–14 days of PO therapy with one of the antimicrobials above.

*Capable of walking; not bedridden.

Differential Diagnosis

- A differential diagnosis is the distinguishing of a particular disease or condition from others that present similar clinical features.
- One fifth of the patients
- Acute pelvic inflammatory disease
- Ectopic pregnancy (must be distinguished by history, last menstrual period and pregnancy tests)
- Diverticulitis (inflammation of colon)
- Renal calculi

Complications

- Hypertension, septic shock, multi organs failure, death
- Renal or perinephric abscesses
- Metastatic infection
- Papillary necrosis
- Acute renal failure
- Emphysematous pyelonephritis
- Renal gangrene
- Localized or generalized atrophy/permanent loss of function

Management

- In mild cases: 10-14 days , oral in home & in severe cases: 14 days, iv and then oral in hospital
- Patients with mild signs and symptoms may be treated on an outpatient basis with antibiotics for 7-14 days
- Hospitalization in severe cases
- Empirical treatment is TMP-SMX (Resistance around 50%), fluoroquinolones is alternative
- Ampicillin with aminoglycoside or third generation cephalosporins, piperacillin or carbapenems in severe cases
- Antibiotics are selected according to results of urinalysis culture and sensitivity and may include broad-spectrum medications

Prevention

- Antimicrobial prophylaxis
- TMP-SMX or fluoroquinolones 3/week or nitrofurantoin daily
- Intravaginal estradiol
- 300 ml of cranberry juice
- Removal the urinary catheter as soon as possible or use condom catheter

Prognosis

- Prognosis is dependent upon early detection and successful treatment.
- Baseline assessment for every patient must include urinary assessment because pyelonephritis may occur as a primary or secondary disorder.

Doctor's Notes

- Dr. Ali said: I want you to know the epidemiology, risk factors, the clinical presentation of patients with pyelonephritis and finally the common organisms causing pyelonephritis.
- Why is the duration of treatment prolonged? Because Pyelonephritis can be serious.
- Uncomplicated UTI- mostly lower UTI's- happens to females that are healthy and non-pregnant;
- Otherwise, the infection is classified to be complicated. All females get UTI's at least once in their life.
- It's important to know if the patient has recurrent UTI because then you will give him antibiotics.
- A person is considered to have recurrent UTI's when he gets more than 2 infections within a year.
- Relapse happens when the patient develops an infection within two weeks after the original infection and it happens mostly due to failure of treatment.
- Reinfection usually develops after two weeks with the same organism of the original infection and these patients usually recover.
- Elderly people are more prone to get UTI's. Why? Because they have co-morbidities, structural and functional abnormalities including diabetes, cancer, and Benign Prostatic Hyperplasia in old males
- important to know the differential diagnosis of pyelonephritis

Doctor's Notes

- Why do we care about pregnant females? Because they are highly prone to develop Pyelonephritis. They may present with bacteriuria, if untreated, half of them will progress to Pyelonephritis. So what do you do? You do screening for bacteriuria whether they are symptomatic or asymptomatic.

- Patients with Chronic Pyelonephritis will mainly have malaise and renal impairment and scarring of the kidneys and these patient do not usually present with renal symptoms including dysuria and pyuria.

- Case 1: it's your first day in the ER as a medical intern and female patient presents with severe abdominal pain. What will you do?
  - You take her history:
    - If she tells you she's married then you ask her about the last menstrual period, if she says that her last period was before a month and 3 days then it's possible that she has ectopic pregnancy.
  - What test will you do?
    - Urinalysis
    - CBC
    - Blood culture "mainly for Staph aureus"
    - Pregnancy test "to exclude ectopic pregnancy"
    - Ultrasound is done when the urine has blood, indicating stones.
    - If she was infected with a gram negative then it's possible to find nitrites.
    - When we do microscopy and we find more than 10 pus cells/ hpf then UTI is possible..

Doctor's Notes

Microorganism	Notes
E.Coli , gram – rod lactose fermenter bacilli	more frequent for so many reason, the most important is the virulence factor “P fimbriae” which allows it to adhere to the mucosa.
Other Enterobacteriaceae include proteus, Kleibsella, Enterobacter, .and Citrobacter	
Pseudomonas , Gram – rod non fermenting	.common in hospitals
Staph saprophyticus , gram + cocci in clusters, catalase +, coagulase – novobiocin resistant	"الناس يحبوا السؤال هذا" very common in sexually active females.
- Enterococcus faecalis: gram + cocci, catalase	.common in hospitals
– Staph epidermidis: gram + cocci in clusters, catalase +, coagulase	.Can be the causative agents in patients with catheters
Staph. Aurous:gram + cocci in clusters, catalase +, coagulase +	Does it cause UTI?” very rare cause and but if we see it it’s mainly“ coming from bacteria in the blood and then seeds into the kidneys. If Staph Aurous appears in Urine then you have to do blood culture to .roll out bacteremia
Group B strept: Streptococcus agalactiae, **β** hemolytic catalase - cocci	becoming very frequent and according to some studies it’s the second .most common mainly in diabetic and in pregnant females
:Other rare causes include mycobacterium Tb: used to be very common but Ciprofloxacin .eliminated it Brucella: may cause infection anywhere in the body. candida	

Quiz

1) Which of the following organism most common causes of pyelonephritis?
A- *E.coli*
B- *S.areus*
C- *S.saprophyticus*
D- *Candida*

2) Rare pathogenesis of pyelonephritis?
A-ascending bacterial infection
B-hematogenous spread
C-both A and B
D-kidney enlarge

3) In chronic pyelonephritis patient may show the following symptoms?
A-nausea
B-headache
C-confusion
D-chest pain

4) Which one of the following is not a differential diagnosis of pyelonephritis?
A-Renal stones
B-Ectopic pregnancy
C-Renal artery vasculitis
D-Diverticulitis

5) Which of the following numbers of bacteria is considered as significant bacteriuria?
A-10^8 per L
B-10^6 per ml
C-10^5 per L
D-10^4 per ml

6) Which antibiotic is used as empirical treatment in case of pyelonephritis?
A-Fluoroquinolones
B-Ampicillin
C-3rd generation cephalosporins
D- TMP-SMX

1-A 2-B 3-A 4-C 5-A 6-D

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