



核心課程編號：B37

# 尿路感染

# Urinary Tract Infections

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108年01月19日



# 學習目標

尿路感染	PGY
	<p><u>知識</u></p> <ol style="list-style-type: none"><li>1. 腎臟超音波與影像學檢查（如IVP）的適應症和禁忌</li><li>2. 複雜性尿路感染的種類（如長期導尿管置放的尿路感染）</li><li>3. 複雜性尿路感染的治療及預後</li><li>4. 無症狀尿路感染和反覆性尿路感染的處置</li><li>5. 腎盂腎炎、腎膿瘍、尿路結石和攝護腺炎的鑑別診斷</li></ol>



# 考題

- ❖ 純性 (simple urinary tract infection) 及複雜性 (complicated urinary tract infection) 尿路感染定義、原因及常見致病菌種 (至少各3項)? [20分]
- ❖ 以表格簡述腎盂腎炎、腎膿瘍、尿路結石和攝護腺炎的鑑別診斷? [20分]
- ❖ 尿路感染腎臟超音波與影像學檢查 (IVP) 適應症和禁忌? [10分]
- ❖ 單純性尿路感染的治療原則及預後? [10分]
- ❖ 複雜性尿路感染的治療原則及預後? [10分]
- ❖ 腎衰竭時藥物劑量的調整原則? [10分]
- ❖ 無症狀尿路感染 (asymptomatic urinary tract infection) 和反覆性尿路感染 (recurrent urinary tract infection) 的定義及處置? [10分]
- ❖ 尿路感染需會診泌尿科的時機及適應症? [10分]



# Introduction

- ❖ Urinary tract infection (UTI) is one of the most common bacterial infections, affecting 20% of women between 20- 56 years of age per annum.
- ❖ Of the women affected 25%–30% will go on to develop recurrent infections ( $\geq 3$  episodes/year) not related to any functional or anatomical urinary tract abnormality.



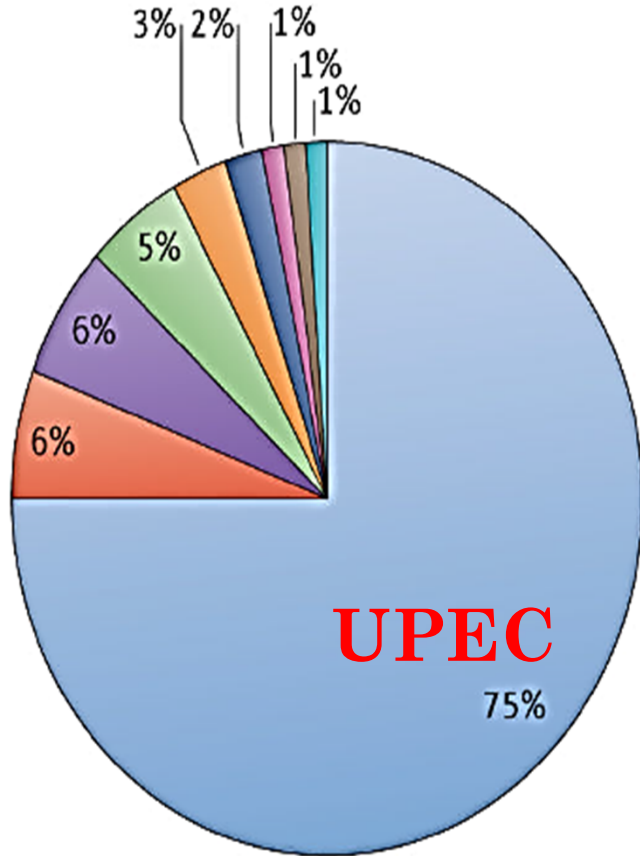
# UTI pathogens & pathogenesis

- ❖ Urinary tract infections (UTIs) are one of the most common bacterial infections with 50% of women experiencing a UTI in their lifetime.
- ❖ Uncomplicated UTI  
UTI in those who are otherwise healthy and have no structural or neurological urinary tract abnormalities.
- ❖ Complicated UTI  
UTIs associated with factors that compromise the urinary tract or host defense, including urinary obstruction, urinary and the presence of foreign bodies.

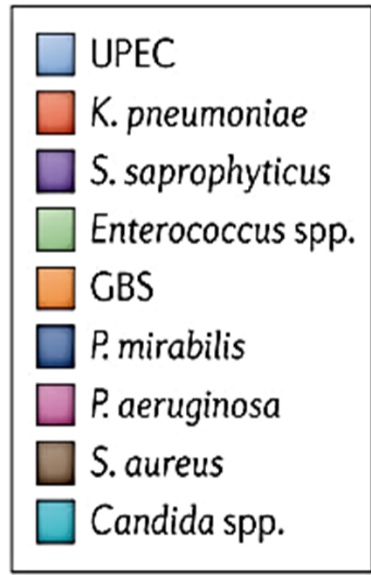
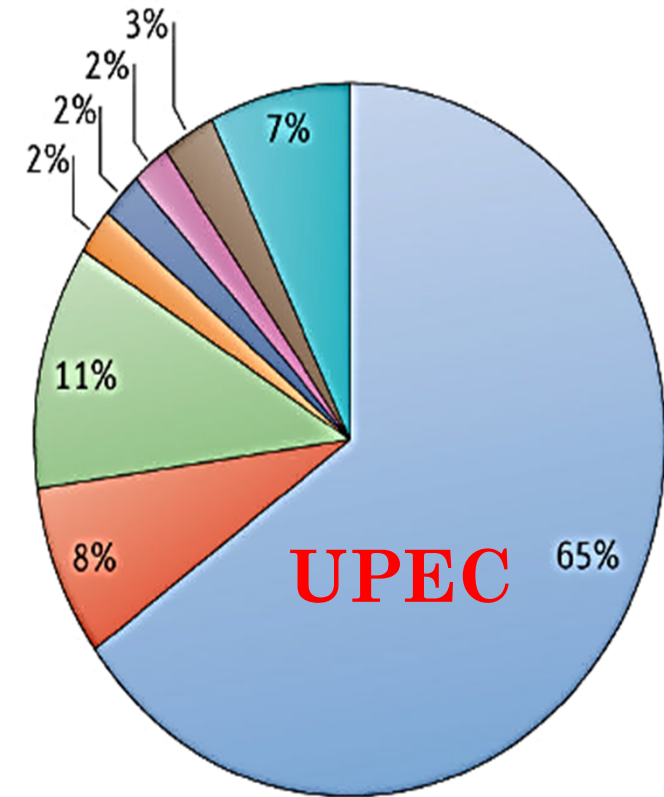


# UTI pathogens & pathogenesis

Uncomplicated UTI



Complicated UTI

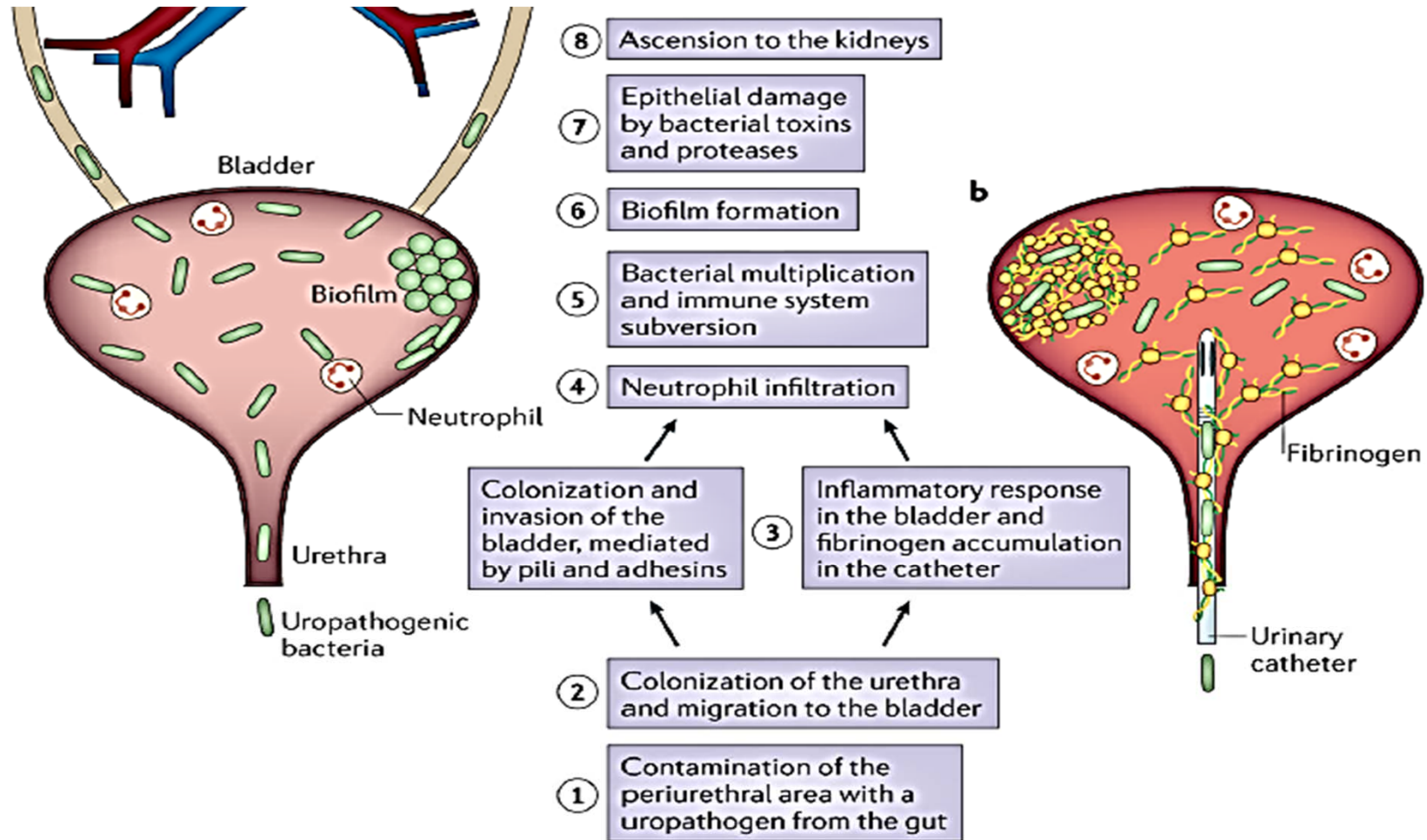


GBS: Group B streptococci

Nat Rev Microbiol. 2015 May ; 13(5): 269–284.



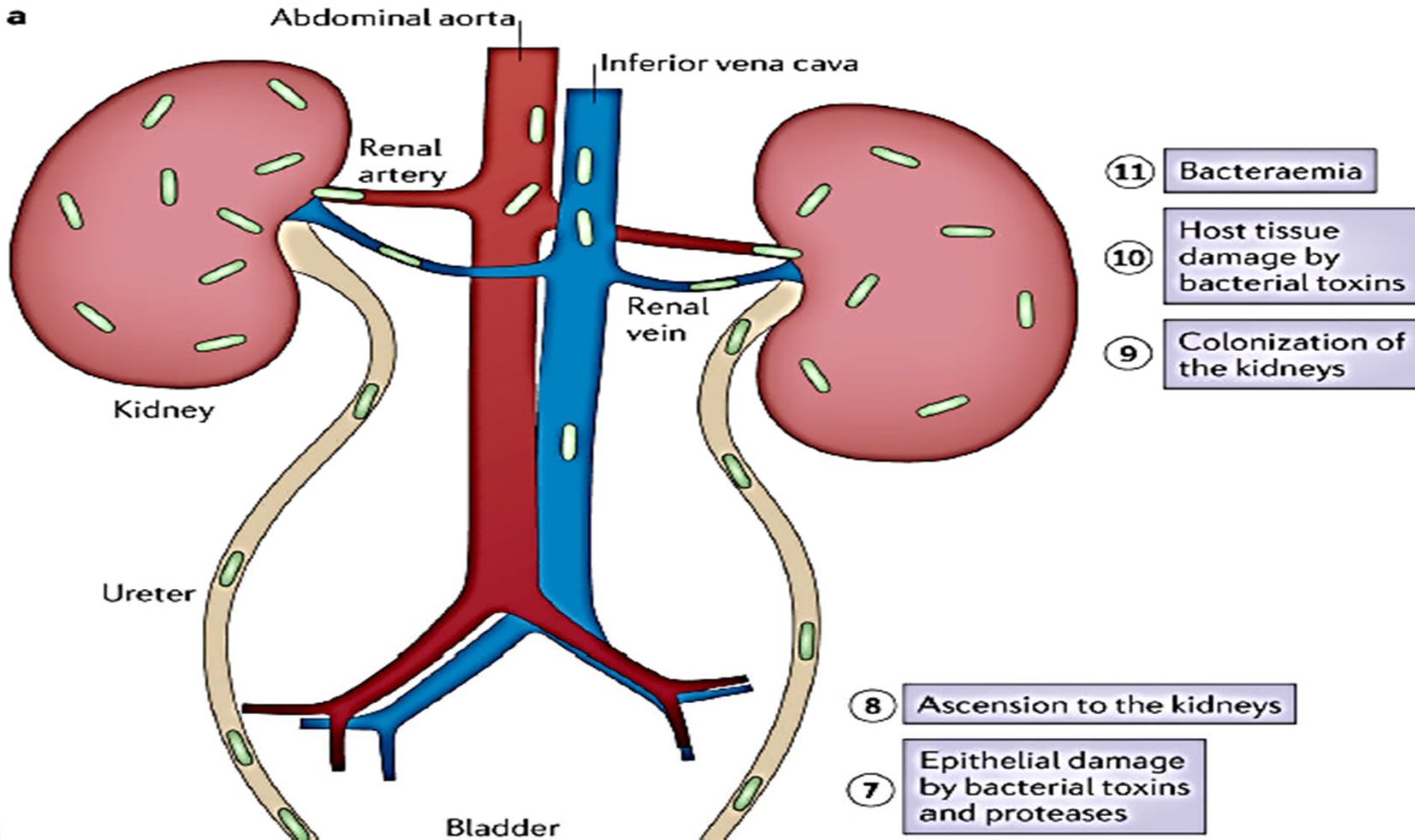
# UTI pathogens & pathogenesis





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# UTI pathogens & pathogenesis



*Nat Rev Microbiol.* 2015 May ; 13(5): 269–284.





# Epidemiology

❖ Catheter-associated (or nosocomial) infections and non-catheter-associated (or community-acquired) infections

❖ Symptomatic or

- vast majority involve young women, unusual in men under the age of 50

**Asymptomatic**

- rare among men under 50 but common among women between 20 and 50, quite common among elderly men and women



# Overview of epidemiology of UTI by age group

Age group	Females		Males	
	Prevalence (%)	Risk factors	Prevalence (%)	Risk factors
Neonate	1	Anatomic or functional urologic abnormalities	1	Anatomic or functional urologic abnormalities
1-5	4-5	Congenital abnormalities V-U reflux	0.5	
5-15	4-5	V-U reflux	0.5	
16-35	20	sexual	0.5	
35-65	35	Gynecologic surgery, bladder prolapse, estrogen lack, incontinence, residual urine	20	BPH, obstruction, catheterization, surgery
Over 65	40	As above, plus incontinence, chronic catheterization	35	As above, plus incontinence, chronic catheterization



## 泌尿道感染之致病機轉

- ❖ 寄生於尿道口周圍(**periurethral area**)區段的微生物上行性感染泌尿道,造成感染。
- ❖ 其次,血行性感染路徑造成泌尿道感染為較少見之機轉。



# Urinary Tract Infection Physiologic Changes

## Physiologic changes with aging in the urinary tract

	<u>Men</u>	<u>Women</u>
Decreased bladder capacity and increased urine production (especially at night)	✓	✓
Decreased voided volume	✓	✓
Decreased estrogen w/menopause leads to thinning of vaginal & urethral mucosa		✓
Decreased lower urinary tract sensory threshold		✓

Palmer, 2004



## Risk factors

- ❖ Women: past UTI hx, sexual intercourse, spermicides or diaphragm use, parity, DM, sickle cell anemia; estrogen loss, abnormal GU tract (incomplete emptying).
- ❖ Men: lack circumcision, homosexual, AIDS, abnormal GU tract.
- ❖ Both sex: neurological disease.



# Classification of UTI

## Uncomplicated UTI

- ❖ lower tract infection
- ❖ no functional or structural abnormal of urinary tract
- ❖ Most women
- ❖ Short duration (3 days)

## Complicated UTI

- ❖ functional or structural abnormal of urinary tract including nephrolithiasis, DM, catheter, pregnancy, renal transplantation, sickle cell anemia.
- ❖ Longer therapy ( $\geq 10$  days)



## 泌尿道感染：症狀

### ❖ 下泌尿道感染

尿路疼痛

尿路灼熱感

頻尿 **frequency**

急尿 **urgency**

### ❖ 上泌尿道感染

發燒

腰痛

可以併發下泌尿道  
感染之症狀及徵  
候



# Asymptomatic bacteriuria

- ❖ Presence of 100,000 microorganisms per milliliter of urine without clinical symptoms
- ❖ no treatment is needed
- ❖ Treatment of positive cultures is recommended for pregnant women in the first trimester





# Prevalence of Asymptomatic Bacteriuria

Population	Prevalence, %
Healthy, premenopausal women	1.0–5.0
Pregnant women	1.9–9.5
Postmenopausal women aged 50–70 years	2.8–8.6
Diabetic patients	
Women	9.0–27
Men	0.7–11
Elderly persons in the community <sup>a</sup>	
Women	10.8–16
Men	3.6–19
Elderly persons in a long-term care facility	
Women	25–50
Men	15–40
Patients with spinal cord injuries	
Intermittent catheter use	23–89
Sphincterotomy and condom catheter in place	57
Patients undergoing hemodialysis	28
Patients with indwelling catheter use	
Short-term	9–23
Long-term	100

<sup>a</sup> Age,  $\geq 70$  years.



# Uncomplicated UTIs

- ❖ Cystitis symptoms
- ❖ Normal urinary tract anatomy
- ❖ No fever
- ❖ No kidney disease
- ❖ No contributing medical problems such as diabetes, neurogenic bladder, or renal stones



## Uncomplicated UTI

- ❖ Cystitis in nonpregnant young adult to middle-aged women without underlying anatomic (structural) abnormality or neurologic dysfunction.
- ❖ The largest single group with UTI.
- ❖ Usually 3-day therapy, no need for culture and no need for GU tract study



# Characteristic symptoms of Cystitis

- ❖ **Dysuria**
- ❖ **Urgency**
- ❖ **Increased frequency**
- ❖ **Pyuria**
- ❖ **Bacteriuria on urinalysis**
- ❖ **Sometimes suprapubic pain, fullness**
- ❖ **Hematuria**



## Differential diagnosis for uncomplicated UTI

- ❖ **Acute urethritis: sexually transmitted infections (STIs), often *Neisseria gonorrhoea* or *Chlamydia trachomatis*.**
- ❖ **Irritative voiding symptoms: urethral syndrome, interstitial cystitis, recurrent UTI, vaginitis, vulvovaginitis, or dysmenorrhea**



# Acute Cystitis

- ❖ Affects at least 20% of
- ❖ dysuria, frequency and urgency.
- ❖ suprapubic discomfort and occasionally there is frank haematuria.
- ❖ Fever is unusual and there are rarely any systemic signs.



# Cystitis, urethritis, & vaginitis

- ❖ not possible to distinguish cystitis from urethritis in women;
- ❖ vaginitis may also cause dysuria.
- ❖ Men: exclude concurrent prostate disease.
- ❖ Vaginitis should be suspected when patients complain of perineal, labial, or external dysuria, which may be accompanied by odor, itching, or vaginal discharge.



## Complicated UTI

- ❖ Occur at sites other than the bladder (e.g., PN) and those in children, most men, and pregnant women, as well as UTIs associated with obstruction, foreign body (e.g., catheter), elevated postvoiding residual volume, renal transplant recipients, and surgically created ileal loop.
- ❖ At least 10-14 days therapy, need for culture and GU tract study





# Complicated Urinary Tract Infections

- ❖ **Anatomically abnormal urinary tract**
- ❖ **Significant medical or surgical comorbidities**



# Characteristics of complicated UTI

- ❖ **Usually ascending**
- ❖ **Defined susceptible population**
- ❖ **Drug resistance common**
- ❖ **Prolonged therapy**



# Complicating factors

- ❖ **Indwelling catheter**
- ❖ **Obstruction**
- ❖ **Male gender**
- ❖ **Age**
- ❖ **Diabetes mellitus**
- ❖ **Renal insufficiency**
- ❖ **Immunosuppression**
- ❖ **Urolithiasis**
- ❖ **Surgery**
- ❖ **Voiding dysfunction**
- ❖ **Valves**
- ❖ **Reflux**
- ❖ **Pregnancy**
- ❖ **Nosocomial**



# Diagnostic Testing

- ❖ **urine dipstick testing: positive for leukocyte esterase or nitrite**
- ❖ **urine microscopy for white and red blood cells and nitrites**
- ❖ **Urine : positive for bacteriuria**  
**Isolation of no more than two microorganisms, each with at least 100,000 cfu/mL, from a clean voided midstream urine sample**



# 尿液培養 - 一般原則

- 易受尿道前端低菌量菌叢污染
- 培養次數
  - 有症狀患者，一次即可；治療後48到72小時追蹤一次
  - 無症狀者 - 兩至三次培養
  - 疑似泌尿道結核感染 - 連續三天早晨第一次尿液
- 24小時收集的尿液不適定量培養
- 取得之尿液最好在30分鐘內接種，否則應置4°C冰箱，在24小時內接種
- 檢驗單：說明取尿方式，症狀有無，治療有無



# Diagnosis

## ❖ Voided Urine, clean caught

- Female: 1 spp.  $>100,000$  cfu/mL x 2 (B-II)
- Male : 1 spp.  $>100,000$  cfu/mL x 1 (B-III)

## ❖ Catheterized Urine

- Female or Male
  - 1 spp.  $>100$  cfu/mL x 1 (A-II)



# Laboratory Diagnosis of UTI

## ❖ Microscopic examination of urine

### ● Pyuria

- WBC count of  $10 \text{ cells/mm}^3$  by counting chamber
- More than 10 WBC/HPF in spun urine
- Leukocyte esterase dipstick: 75-95% sensitivity

### ● Bacteriuria

### ● Nitrite test

## ❖ Urine culture



## Diagnosis: esterase

Esterase test : + = 8 WBC/HF.

### False negative :

elevated specific gravity, glycosuria, ketonuria, proteinuria, some oxidizing drugs (cephalexin, nitrofurantoin, tetracycline, gentamicin), vitamin C.

### False positive :

trichomonas, imipenem and augmentin.





# Nitrite test in urine dipsticks

- Dietary nitrate + bacterial nitrate reductase = nitrite
- For G(-) bacteriuria in first morning urines
- Sensitivity: 35-85%; Specificity: 92-100%
- False-negative: lack of dietary nitrate or organisms without nitrate reductase, *Staphylococcus*, *Enterococcus*, *Pseudomonase spp.*



# Other Laboratory Tests

## Complete Blood Count with Differential

- Indicated to R/O bacterial infection supports treatment plan
- Careful evaluation of WBC & differential (left shift)

## Electrolytes

- R/O dehydration & if IV fluids replacement needed

## BUN, Creatinine

- Determine ↓ renal function for nephrotoxic medications

## Blood Culture

- Identify bacteremic organism in suspected urosepsis



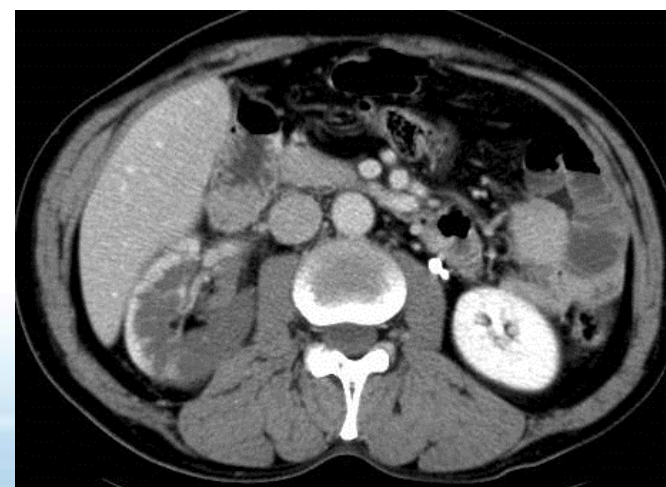
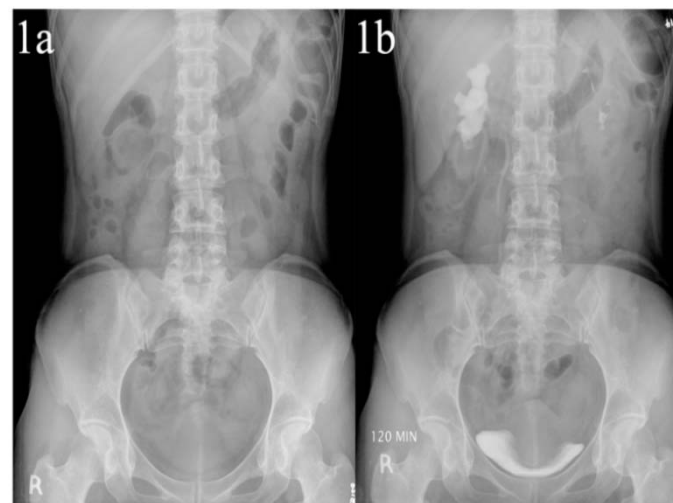
## Diagnosis: image study

- ❖ For all men, children and infants; women with treatment failure.
- ❖ May identify complicating factors such as anatomic abnormalities, obstruction, acute bacterial nephritis (localized, nonliquified interstitial inflammation), or subjacent infections such as appendicitis, cholecystitis, or perinephric abscess.
- ❖ Options include plain radiography of the kidneys, ureter, and bladder; renal ultrasonography; CT scan; MRI and intravenous pyelography.



# 腎臟之影像檢查

1. 腹部X光(KUB)
2. 腹部超音波 (sono)
3. 電腦斷層 (CT)
4. 腎臟腎盂攝影 (IVP+PV)
5. 核子共振 (MRI)
6. 核子醫學掃描 (ERPF, GFR)





# Indication of sonography

- ❖ Azotemia-Obstruction or pre-renal azotemia
- ❖ Hematuria—stone or malignancy
- ❖ Pyranchemal disorder-ADPKD.  
Medullary sponge kidney
- ❖ Knocking pain..Rull out pyelonephritis



## Diagnosis: urine culture

- ❖ Routine urine cultures are not necessary in uncomplicated cystitis .
- ❖ Midstream urine specimens.
  - Asymptomatic women : 2 samples ( 24 hours apart ) with  $10^5$  CFU/ml.
  - Symptomatic women with pyuria : one sample with  $10^2$  to  $10^4$  /ml.
  - Males, G(+) and fungi :  $> 10^3$  /ml.
- ❖ Catheter. or suprapubic aspirate:  $10^2$  to  $10^4$  /ml.
- ❖ False (+) : delay processing.
- ❖ Low organism number: lower UTI, early infection, urethritis, vaginitis, high urea, high osmolarity, low pH.
- ❖ False (-) : obstruction, antimicrobial, diuresis.



# 尿液培養

- 自解尿
  - 最佳檢體: 早晨第一泡中段尿
  - 中段尿衛教: 女性外陰清洗
  - 一般肥皂或殺菌藥皂
  - 由前往後清洗
  - 不適做厭氧菌培養
- 留置尿管尿液
  - 不用引流袋內尿液或Foley尿管前端作培養
  - 長期留置尿管使用者, 不作常規尿液培養
  - 取尿方法: 夾住尿管(時間不宜超過30分鐘);酒精消毒; 由尿管塑橡部份抽取尿液



## 恥骨上方尿液抽取

- 可避免尿道前端或外陰菌叢的汙染
- 適應症
  - 厭氧菌感染
  - 小兒科患者
  - 脊髓受傷者
- 抽取位置漲尿後恥骨縫合處上方**2**公分中線位置





# Pathogens

<i>Microbial organism</i>	<i>Acute uncomplicated cystitis (%)*</i>	<i>Acute uncomplicated pyelonephritis (%)</i>	<i>Complicated UTI (%)</i>	<i>Catheter-associated UTI (%)</i>
<i>Escherichia coli</i>	68	89	32	24
<i>Staphylococcus saprophyticus</i>	8	0	1	0
Proteus	6	4	4	6
Klebsiella	4	4	5	8
Enterococci	3	0	22	7
Pseudomonas	0	0	20	9
Mixed	3	5	10	11
Yeast	0	0	15	8

*Ramakrishnan K. American Family Physician 2005; 71, 933-42*



# Acute Pyelonephritis

- ❖ Fever, rigors and pain and tenderness in the costovertebral angle
- ❖ Associated with the symptoms and signs of lower UTI.
- ❖ Nausea, vomiting



# Classification of acute renal infections

1. Acute pyelonephritis (**APN**): Most common
2. Acute bacterial nephritis (**ABN**): **Pre-abscess**  
*Am J Med 1992 ; 93:289-298.*
3. Renal abscess: Cortical, cortico-medullary
4. Peri-/para-renal/retrofacial (Iliopsoas) abscess  
*J Inf 2000; 40: 248-55.*
5. Emphysematous pyelonephritis (**EPN**): Severe  
*Arch Intern Med 2000; 160: 797-805.*
6. **Pyonephrosis** or infected **cyst**: Drainage



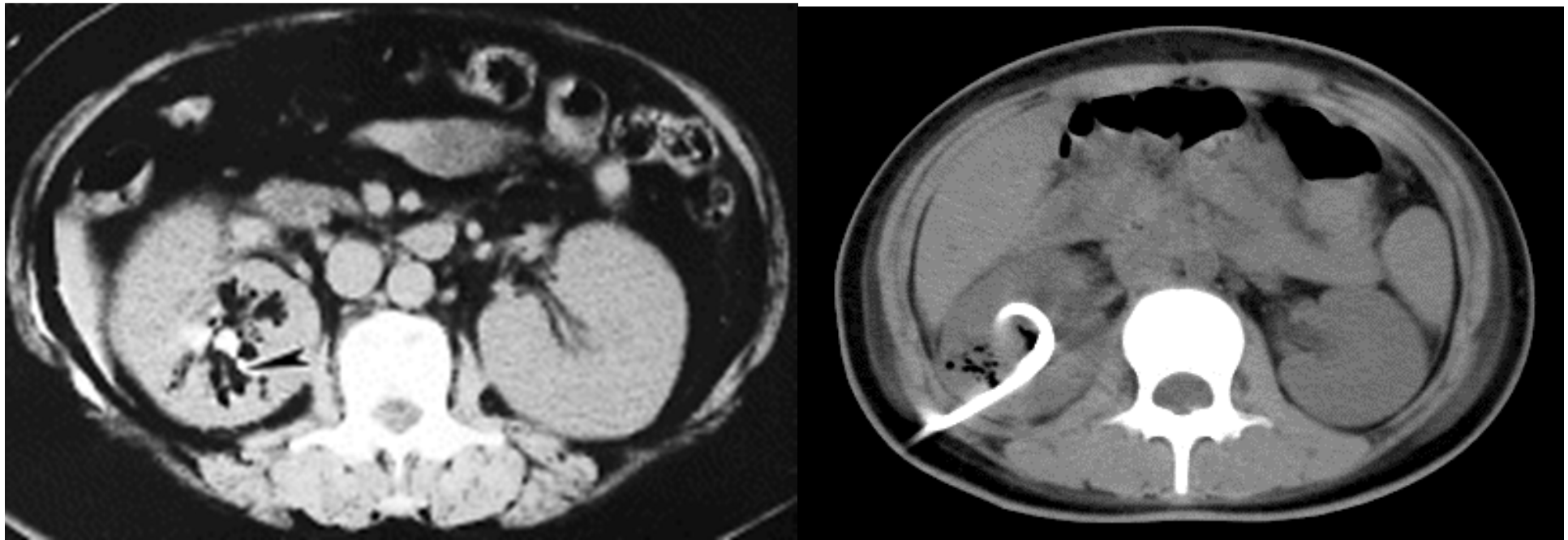
# Acute Pyelonephritis

- ❖ Casts containing white blood cells in the urinary sediment: these are formed in the renal tubules and collecting ducts and thus signify involvement of the kidney.
- ❖ Bacteraemia complicates up to 40% of cases of acute pyelonephritis.
- ❖ The kidney: usually enlarged and edematous with many polymorphonuclear leucocytes in the tubules and interstitial areas





# Emphysematous Pyelonephritis



Gas within the right renal parenchyma and a right renal stone (arrowhead).



# Renal and Perirenal Abscesses (I)

- ❖ Before antibiotics became available, most abscesses were hematogenous in origin, with *S. aureus* most commonly recovered. Now more than 75% of abscesses arise from an initial UTI.
- ❖ Risk factors: concomitant nephrolithiasis producing local obstruction to urinary flow, other structural abnormalities, a history of urologic surgery, trauma, and DM



## Renal and Perirenal Abscesses (II)

- ❖ The most frequent organisms are *E. coli*, *Proteus* species, and *Klebsiella* species.
- ❖ Non-contaminated polymicrobial bacteriuria may suggest abscess or bladder diverticulum.
- ❖ Presentation is quite nonspecific; fever, pain
- ❖ Renal ultrasonography and abdominal CT scan are the most useful diagnostic modalities
- ❖ Treatment includes drainage of pus and antibiotic therapy



# Guidelines for antimicrobial therapy of UTI in Taiwan

*Continued*

Diagnosis	Drug of choice	Alternative choice
Acute bacterial prostatitis	Ampicillin or amoxicillin 3 <sup>o</sup> cephalosporins Trimethoprim/sulfamethoxazole	Fluoroquinolones <sup>e</sup>
Chronic bacterial prostatitis	Trimethoprim/sulfamethoxazole Fluoroquinolones <sup>e</sup>	—
Nosocomial/catheter-related UTIs	3 <sup>o</sup> or 4 <sup>o</sup> cephalosporins Ureidopenicillins Fluoroquinolones <sup>e</sup> Ampicillin or amoxicillin <sup>f</sup> ± Aminoglycosides	Imipenem or meropenem
UTIs in pregnancy	Ampicillin or amoxicillin <sup>c</sup> Nitrofurantoin 1 <sup>o</sup> or 2 <sup>o</sup> cephalosporins	3 <sup>o</sup> or 4 <sup>o</sup> cephalosporins Ureidopenicillins
UTIs in children	Ampicillin or amoxicillin <sup>c</sup> or 1 <sup>o</sup> or 2 <sup>o</sup> cephalosporins + Aminoglycosides Trimethoprim/sulfamethoxazole	3 <sup>o</sup> or 4 <sup>o</sup> cephalosporins
Suppressive recurrent UTIs	Nitrofurantoin Trimethoprim Trimethoprim/sulfamethoxazole	—





## Treatment in uncomplicated UTIs (1)

- ❖ 3-day antibiotic course is effective and cost-effective in 90% of uncomplicated UTIs



## ***Acute Uncomplicated PN in Women***

- ❖ No accompanying clinical evidence of calculi or urologic disease
- ❖ Caused by *E. coli* in most cases
- ❖ A 14-day course of TMP/SMX, a quinolone, an aminoglycoside, or a 3rd-generation cephalosporin is usually adequate.
- ❖ For at least the first few days of treatment, antibiotics should be given intravenously to most patients, but patients with mild symptoms can be treated with 2 weeks of an oral antibiotic.



# Treatment in uncomplicated UTIs (2)

- ❖ First-line antibiotic:  
trimethoprim/sulfamethoxazole (co-trimoxazole) in communities with resistance rates for *E coli* less than 20%
- ❖ Second-line antibiotics, or first-line in resistant communities: fluoroquinolones
- ❖ Alternates: third-generation cephalosporins, nitrofurantoin, fosfomycin



# Treatment in complicated UTIs

- ❖ AB Rx for at *least* 10 days for institutionalized elderly, as short-term therapy may *not* be as effective.
- ❖ 10-14 days, if indicated, for complicated UTI.  
(recommended for males)
- ❖ Conventional regimen of 7-10 days duration is usually recommended.

Evercare, 2004

Wagenlehner et al. 2005



# Treatment Plan in complicated UTIs

## Complicated UTI

- Can be common in LTC patients
- Associated with azotemia, obstruction, or indwelling foley
- Can lead to bacteremia, life-threatening systemic infection

## Recommended Treatment for Acute Complicated UTI

IV antibiotic therapy--\*consider renal & hepatic elimination, creatinine clearance for dosage adjustment

- 3<sup>rd</sup> generation cephalosporin (Ceftriaxone = Rocephin) Rx 1 gram IV every 24 hours
- Or if fluoroquinolones (Levofloxacin = Levaquin) 250-500 mg IV every 24 hours
- Continue until afebrile, minimum of 48 hrs, then start oral therapy and fluids x 14 days.

Mahan-Buttaro et al., 2006



## ***Prevention of UTIs***

- ❖ Daily or thrice-weekly long-term low-dose antibiotics, such as single dose of TMP/SMX 80/400mg, nitrofurantoin 50mg
- ❖ Women who have more than two infections every 6 months are candidates
- ❖ Sexual intercourse related UTI in women
- ❖ Men with chronic prostatitis
- ❖ Patients undergoing prostatectomy
- ❖ Pregnant women with asymptomatic bacteriuria



## Take home message

- ❖ 大腸桿菌為泌尿道感染常見感染原
- ❖ 非複雜性泌尿道感染-**3** 天療程
- ❖ 複雜性泌尿道感染-**10-14** 天療程
- ❖ 泌尿道感染之預防



感謝聆聽  
敬請指教