Urinary tract infections (UTI)

DEFINITION

INTRODUCTION

ACQUISITION AND ETIOLOGY OF UTI

PATHOGENESIS

CLINICAL FEATURES AND COMPLICATIONS

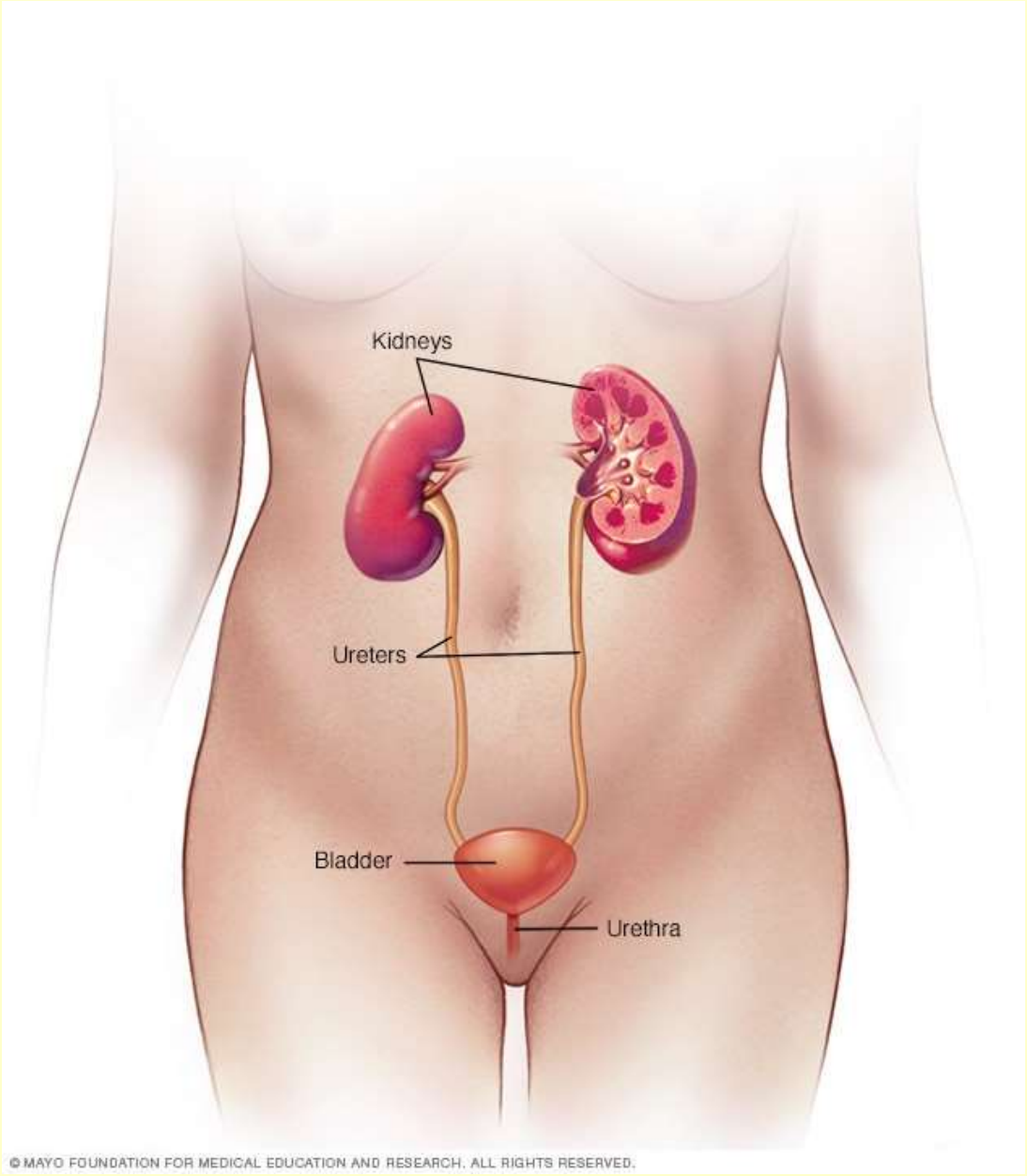
LABORATORY DIAGNOSIS

TREATMENT OF UTI

PREVENTION

URINARY TRACT INFECTION (UTI) – DEFINITION

- UTI result from the presence of infectious agents in the urine, from their multiplication in one or more organs of the urinary tract with the risk of possible penetration into the tissues, their surroundings and into the blood
- UTI results form pathogenic organisms gaining access to the urinary tract and not being effectively eliminated



Anatomy of urinary tract

URINARY SYSTEM

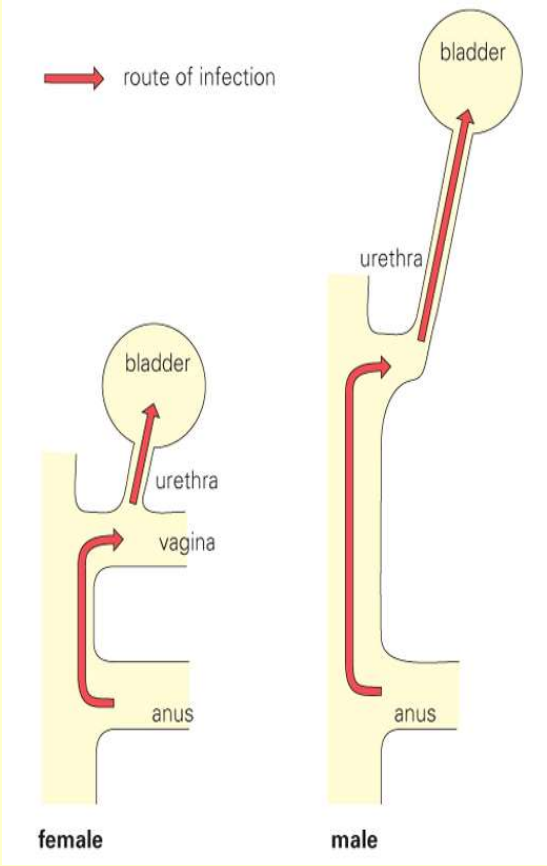
Only the final part of the urethra was colonized to a depth of about 2 cm

Female urethra is shorter and in closer proximity to the rectum

In women, the possibility of ascending colonisation - urinary tract infections (*Escherichia coli,* staphylococci, others)

Bladder catheterization - a risk factor for infection (biofilm)

Sterile urine, middle stream collection



Mims´ Medical Microbiology

INTRODUCTION

* The second most common infectious disease in the body

* Women – up to 20% have UTI at some time in their life and a significant number of recurrent infections

ACQUISITION AND ETIOLOGY OF UTI

* Ascending: urethra – bladder – kidney.
Occasionally bacteria infecting the UTI invade the bloodstream to cause septicemia (urosepsis).
* Hematogenous: spread from any organ to the kidney.

UTI BY LOCALISATION

- **Acute cystitis uncomplicated**

  Acute complicated cystitis (acute cystitis in men and recurrent cystitis in women and children)

  Acute, recurrent pyelonephritis

  Acute epididymitis

  Prostatitis

BACTERIAL ETIOLOGIC AGENS

ASCENDING INFECTIONS

*** Community acquired: *Escherichia coli*, other enterobacteria (e.g. *Proteus mirabilis* – often associated with urinary stones, it produce urease to produce ammonia, rendering the urine alkaline.) *Staphylococcus saprophyticus* – young sexually active women**

*** Health-care associated: e.g. *Klebsiella, Serratia, Pseudomonas, Enterococcus* their resistence favours their selection**

HEMATOGENOUS SPREAD: *S. aureus, Salmonella Typhi,, Mycobacterium tuberculosis*

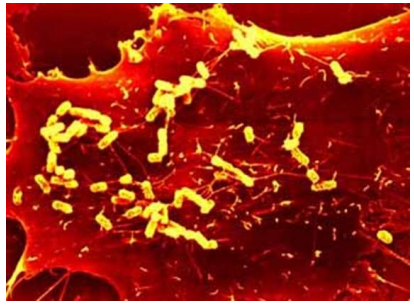
ETIOLOGY OF UNCOMPLICATED URINARY TRACT INFECTIONS (COMMUNITY ACQUIRED)

- Bacterial monoculture:
  E.coli (approx. 80 - 90%)
  Other enterobacteria (*Proteus* spp., *Klebsiella* spp., *Enterobacter* spp.…)
  Staphylococcus saprophyticus (women of childbearing age)
  Enterococcus spp

CHARACTERISTICS OF UROPATHOGENIC *E.COLI*

- increased adherence to uroepithelial cells
  - increased invasiveness
  - resistance to the bactericidal effect of serum
  - K antigen production

  hemolysin production
  - the ability to survive intracellularly in a "biofilm like" form



ETIOLOGY OF COMPLICATED URINARY TRACT INFECTIONS

E.coli
Klebsiella spp.
Enterobacter cloaceae
Proteus mirabils
Pseudomonas aeruginosa
Enterococcus spp
Candida spp.

VIRAL ETIOLOGIC AGENS

Polyomaviruses BK and **JC** are **ubiquitous viruses** with high seroprevalence rates in general population. Following primary infection, polyomaviruses BK and JC **persist latently** in different sites, particularly in the **reno-urinary tract.** Reactivation from latency may occur in normal subjects with asymptomatic viruria, while it can be associated to **nephropathy (polyomavirus-associated nephropathy, PVAN) in kidney transplantat recipients**. PVAN may occur in 1%-10% of renal transplant patients with loss of the transplanted organ in 30% up to 80% of the cases. Etiology of PVAN is mainly attributable to BK virus, although approximately 5% of the cases may be due to JC.

Hantaviruses – reservoir/rodents – benign or serious (fatality 10%)

OTHER ETIOLOGIC AGENS

Other bacteria

***Leptospira* –** reservoir/rodents, febrile infection, damage epithelium of blood vessels, renal and hepatic failure, **Dg**- serology, **therapy** - doxycycline

***M. tuberculosis* –** irregular leukocyturia, Dg- culture, PCR

Yeast, fungi

***Candida* spp.** etiology around 7% of UTI.

All invasive fungi (e.g., *Cryptococcus neoformans*, *Aspergillus sp, Mucoraceae sp, Histoplasma capsulatum, Blastomyces sp, Coccidioides immitis*) may infect the kidneys as part of systemic or disseminated mycotic infection. Their presence alone indicates infection.

Parasites

Schistosoma hematobium result in inflamation of the bladder and commonly hematuria. The eggs penetrate the bladder wall (obstruction of the ureter can lead to hydronephrosis)

FACTORS FAVOURING UTI

Bacterial attributes

1.Capsular antigens
2. Hemolysins
3. Urease
4. Adhesions to uroepitelium - P fimbriae *E. coli*

Host factors

1. Renal calculi
2. Ureteric reflux (tumors, pregnancy, bladder stones, neurologic disordres – residual urine)
3. Prostatic hypertorphy
4. Short uretra
5. Catheterization

PATHOGENESIS OF UTI

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UTI SYMPTOMS

Adult : dysuria

- frequency
- urgency
- nocturia
- suprapubic pain
- ± back pain
- ± hematuria
- ± cloudy urine
- ± enuresis

LABORATORY DIAGNOSIS OF UTI

Specimen collection

Distal uretra is colonized commensal –periurethral and faecal organisms

Specimen transport – middle stream urine after cleaning of external genitalia with water and soap, should be processed within 1 hour or held at 4C for not more than 18 hours

Significant bacteriuria – result and interpretation

$< 10^3$ ml contamination (not infection), $> 10^5$ ml significant bacteriuria (infection), **exception** – this number is modified by the clinical situation, the sampling technique and the identity of the suspected pathogen, for example a CFU of 10^2 is considered significant when urine is sampled by suprapubic puncture, **upper urinary tract infections** – pyelonephritis, could be lower bacterial number ($< 10^3$ ml) and because systemic infection also **hemoculture** should be collected.

TARGETS BACTERIOLOGICAL EXAMINATION

- Detection of culturable UTI bacterie in persons with symptoms or in asymptomatic individuals
- determination of the quantitative concentration of bacteria in the urine
- elimination of contaminating microflora
- determination of antimicrobial susceptibility test
- control of treatment efficacy

INTERPRETATION OF QUANTITY IN URINE SAMPLE SPONTANEOUSLY URINATED

- significant bacteriuria - 10^5 per 1 ml of urine
- 10^4 - physiological in women;

…suspected in men and young children; during pregnancy, at risk of pyelonephritis and renal abscess

- numerous bacterial flora - occurrence of two or more species of bacteria in the quantity of 10^5 and more in 1ml - suspected contamination

SUSPECTED CONTAMINATION OF URINE SAMPLE

- Culture > 1 bacterial species in uncomplicated infections
- Low quantity $<10^3 - 10^4$ / ml
- Detection of saprophytic flora

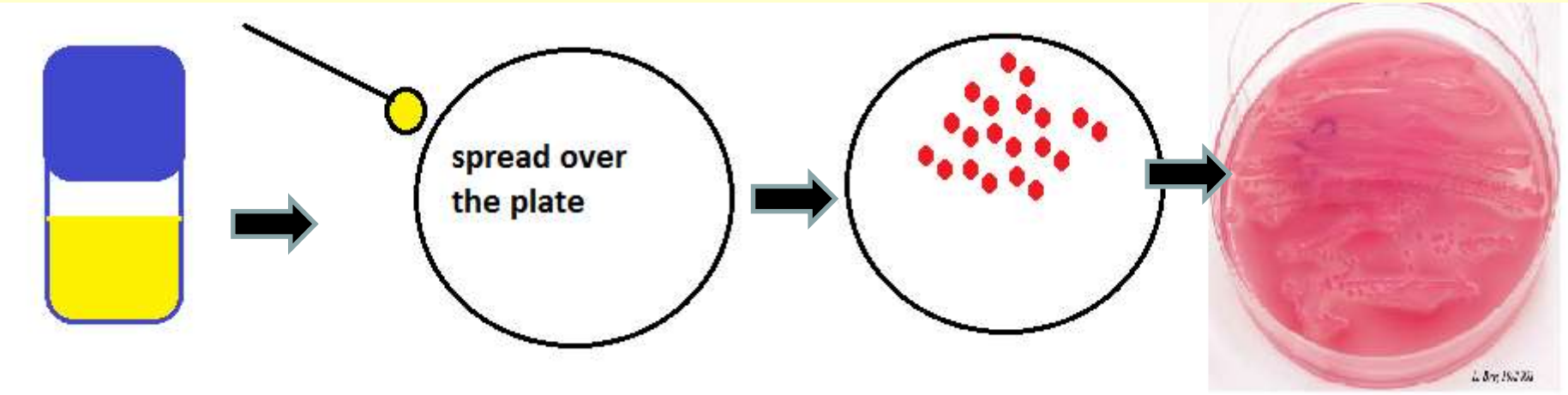
- Recommendations - repeated culture

COMMON CONTAMINANTS IN URINE CULTIVATION

- Mostly in quantities $<10^3$ / ml:

- lactobacilli
  viridans streptococci
  corynebacteria
  coagulase negative staphylococci
  E.coli
  enterococci

LABORATORY DIAGNOSIS OF UTI



Urine agar inoculation 10/3 bacteria/ml 10/5 bacteria/ml

Identifikace (MALDI TOF)

antibiotic susceptibility test

treatment

CAUSES OF FALSE NEGATIVE CULTIVATION

- Antibiotic treatment
- Early stage of infection
- Non-culturable agents - chlamydia, mycoplasma, ureaplasma (urethritis)
- Bacteria with high growth requirements (gonococcus .
- Low urine pH
- Urine collected during the day (too diluted)
- Unsuitable disinfectant
- Hematogenous infections (kidney abscess)

POSSIBILITIES OF MICROBIOLOGICAL OF ROUTINE DIAGNOSTICS OF URINARY TRACT INFECTIONS

- Microscopy: ery, leuko, epi, crystals, quantity, morphology and stainability (sediment)

  Culture on solid media : quantity, identification of bacterial flora

- Automated systems with rapid detection of significant bacteriuria

INTERPRETATION AND COMMUNICATION OF RESULTS

- Negative result
- Significant bacteriuria : pathogen name and quantity and result of susceptibility to antimicrobials
- Pathogen name and insignificant quantity
- Numerous bacterial flora - suspected contaminantion

GENERAL PRINCIPLES OF ANTIMICROBIAL TREATMENT OF UNCOMPLICATED URINARY TRACT INFECTIONS

- If the clinical situation permits it is better to wait and bacteriological results and treat specifically (causative agent knowledge and antibiogram)

TREATMENT OF UNCOMPLICATED URINARY TRACT INFECTIONS

- Initial treatment for acute infections requiring immediate initiation of antibiotic treatment:
- Need to consider:

- spectrum of antibacterial action

- pharmacokinetics - availability of antibiotic in the urinary system

- approximate state of resistance in the most common pathogens

POSSIBILITIES OF ANTIBIOTIC TREATMENT OF UTI

- Nitrofurantoin – *E coli* (resistance less than 3%)
- Cotrimoxazole
- Aminopecillins
- Aminopenicillins with inhibitors
- Cefuroxime
- Fluoroquinolones

TREATMENT OF UTI

Lower UTI

5 days – betalaktams (aminopenicillines, cephalosprins of 1st and 2nd generation) or **nitrofurantoin**
3 days – cotrimoxazol or quinolones

Upper UTI

Pyelonephritis - 2 weeks one of the listed below: cotrimoxazol, quinolones, betalaktams (aminopenicillines, cephalosprins 2nd generation)

CONCLUSION

- The best equipped laboratory is not able to compensate for deficiencies in the collection and transport of the urine sample… …

…the result can be a significant bias of the result with all the consequences for the patient…

The basis of rational effective treatment is the availability of microbiological examination and quality communication between the clinician and the microbiologist…