THE URINARY TRACT INFECTION

UTI represents a variety of inflammatory diseases of the urinary tract or renal tissue, caused by infection.

**Causes**: 90% Gram negative bacteria:
E.Coli, Klebsiella, Proteus, Enterobacter, Pseudomonas aeruginosa and rarely Gram + bacteria: Streptococcus fecalis.
15 to 20% of the UTI are caused by association of bacteria.

**Bacterial spread**:
- through blood: only in neonates
- step by step progression of the bacteria from the genital organs through urethra, bladder and ureteries to the renal tissue is the most common pattern.

**Population with higher risk for UTI**:
- sex: UTI are more frequent in women for all ages, except the suckling;
- vesicoureteral reflux
- obstructive disease: urinary tract abnormalities, urinary lithiasys, foreign bodies
- unproper hygiene of the genital area, cause for urethritis, balanitis and vulvovaginitis;
- constipation, oxiuriasis

**The vesicoureteral reflux**: is the abnormal backflow of urine from the bladder into the ureter and the kidney. It may be both cause and effect of UTI.

The vesicoureteral reflux may be:
- active (during urination)
- passive (permanent):
  - 1st degree: backwards urine flow during urination, up to the half of the ureteries;
  - 2nd degree: the reversed flow reaches the renal pelvis;
  - 3rd degree: the urine fills the pelvis completely
- 4-th degree: dilatation of the calices, renal pelvis and ureteries

**Intrarenal reflux**: penetration of the urine inside the renal tissue through terminal collector tubules during urination.

**Anatomopathologic presentation**:
- Irritation and oedema of the urinary tract mucosa, neutrophilic infiltrat of the submucosal tissue.
- Acute pielonephritis: the kidney appears red and enlarged. There is a focal inflamation of the interstitium that may lead to formation of small abcesses.
- Chronic pielonephritis: small, atrophic kidney. Deformation and dilatation of the pielocaliceal system.

**Clinical presentation**: varies from mild to life threatening disease.

The symptoms depend on the age:

1) Neonates and infants may present anorexia, vomiting, diarrhoea, fever. After the age of 1 y.o. the child may suggest abdominal pain, the urine may smell badly and may experience frequent urination, dysuria, recurrent or prolonged fever. In severe cases septicaemia is suggested by jaundice, cyanure, meningeal signs and convulsions.
2) Older children are more likely to have specific symptoms such as:
- infectious syndrome: fever, chills, headache, paleness, alteration of the general state of health;
- digestive syndrome: anorexia, nausea, vomiting and diffuse abdominal pain
- urinary symptoms: frequency, urgency, dysuria, enuresis, bloody urines, costovertebral angle tenderness, suprapubic pain, ureteries projection area pain;
- high blood pressure: in rare cases which associate renal tissue affectation
- in some severe cases of recurrent and old UTI associating urinary tract malformations, a growth retardation has been noticed.

**Laboratory findings:**
The diagnosis can only be made by bacteriological culture of a properly collected specimen of urine.

**Urine culture quantity:**
• over 100,000 bacterial colonies per ml of urine means infection;
• under 10,000 = negative
• between 10,000 and 100,000 = the infection is to be suspected. Needs further examination.

The urine sample prelevation necesites proper hygiene of the genital area. The suprapubic bladder punction is a reliable possibility.

As a rule, 3 positive urine cultures for the same bacteria make the diagnosis sure.

**Leukocyturia** (pus in the urine)

**Diagnostic stages for UTI:**
1. Determination of:
   - possible diagnosis
   - the involved bacteria
   - the lochalization: low or high
2. The determining factors:
   - general: diabetes mellitus, malnutrition
   - local: urinary tract malformations, urinary lithiasys
3. Positive dg needs:
   - Urographic examination
   - Cystographic examination during urination
   - Abdominal X ray exam.
   - Sonographic examination
4. Evaluation of the renal function:
   - blood urea, creatinine, uric acid
   - creatinine clearance
   - ability to concentrate the urine
   - leukocytes and cylinders in the urine

**Prognosis** depends on the clinical form.
In adult patients the chronic pielonephritis represents up to 36% of the causes that may lead to chronic renal failure and a possible cause for death. It is the result of the UTI with the onset during childhood.
Treatment is mostly antibacterial under the guidance of the antibiogram results. At least three urine cultures are needed before any treatment is recomanded. Frequently used antibiotic drugs:
-Trimethoprim/Sulphametoxazole (Biseptol, Sutrim, Cotrimoxazol): 8mg/kg/24h
-Ampicillin: 50-100 mg/kg/daily
-Amoxicillin: 50-100 mg/kg/daily
-Nalidixic acid (and new quinolone derived drugs): 50-60 mg/kg/daily (only after 2.5 years old)
-Nitrofurantoin: 5-7 mg/kg/24h in 3-4 divided doses

In special cases:
-Aminoglycosides: gentamicin 3-6 mg/kg/24h in 3 divided doses
-Cefotaxim 100 mg/kg/24 h
The attack cure lasts for 10 to 14 days.
Maintenance cure: 3 to 6 weeks with:
-Biseptol (trimethoprim: 2 mg/kg/24h in 2 divided doses
-Nitrofurantoin: 1-2 mg/kg/daily-single dose
-Nalidixic acid: 30 mg/kg/daily in 4 divided doses.

Urine cultures:
•After 48-72 h from the beginning of the antibiotic treatment for efficacy proof
•After 7 days for search for drug resistance;
•7 days after the end of the treatment for recurrent infections

Surgical therapy of the urinary tract malformations.
Infection prevention for at least 1 year after the surgery. After 5 to 7 years from surgery the presence of the vesicoureteral reflux is to be searched. When no surgical cure is possible, the maintenance treatment continues indefinitely. Ciprofloxacin is an alternative agent for resistant microorganisms in patients older than 16-18 years.

The prognosis varies from good to severe.
The long-term prognosis for urinary tract infections is usually excellent provided prompt and adequate treatment is instituted when the diagnosis is established. The main consequences of chronic renal damage caused by pyelonephritis are arterial hypertension and renal insufficiency.
HYPERTENSION

Hypertension is known to be a common finding in children. As in adults, it is often asymptomatic. Diagnosis is usually unsuspected and made during a routine examination, rather than because of specific sign or symptoms related to the raised blood pressure. The recording of blood pressure should be part of the normal examination in children. The blood pressure cuff should cover two-thirds of the upper arm as a smaller cuff will often lead to a falsely high read. The child should be still and not crying.

Normal blood pressure for children varies with age. A child should not be regarded as being hypertensive unless three recording give levels above 95th percentile for that age group. Because systemic blood pressure gradually increases with age and correlate with weight and height throughout childhood and adolescence, reference standards are necessary for interpretation of values obtained during physical examinations.

Etiology
When the cause of the increase in pressure can be explained by an associated disease, the hypertension is referred to as secondary. The term primary or essential hypertension implies that no known underlying disease is present. However, it is recognized that many factors, such as heredity, salt intake, stress and obesity, may play a role in the development of essential hypertension.

Secondary hypertension is more common than essential hypertension in infants and children. The major causes are:

- Renal:
  1. Acute glomerulonephritis
  2. Chronic glomerulonephritis
  3. Reflux nephropathy
  4. Obstructive uropathy
  5. Haemolytic uraemic syndrome
  6. Polycystic syndrome

- Coarctation of aorta
- Renal artery stenosis
- Pheochromocytoma
- Adrenogenital syndrome
The etiology of hypertension varies with age. For example, elevated pressure in the newborn is most often associated with high umbilical artery catheterization and renal artery obstruction due to thrombus formation. Hypertension during childhood is also usually secondary, but primary hypertension occurs with increasing frequency in later childhood and adolescence. The level of blood pressure is also helpful in distinguishing secondary from primary hypertension; in general, adolescents with essential hypertension have diastolic pressures at, or slightly above the 95th percentile for age. The investigation of hypertension should start with a good history and examination. When children are symptomatic, the complaints are generally nonspecific, such as nausea, vomiting, headaches, epistaxis, and abdominal pain. On the other hand, frequently overlooked as related to hypertension are complaints of an altered personality, the sudden onset of deterioration in school performance, and confusion. In any child presenting with catastrophic symptoms such as sudden blindness, seizures, stroke, or coma, malignant hypertensive encephalopathy must be considered. Symptoms of chronic renal disease include polyuria, polydipsia, enuresis and headaches. Hypertension in a parent or an early stroke in a relative may be a pointer to essential hypertension.

Initial screening investigations will include examination of the urine erythrocytes, proteinuria, infection and estimation of serum creatinine electrolyte levels. A cystourethrogram, an intravenous pyelogram, a renal ultrasound will exclude an obstructive uropathy. If renal artery stenosis is suspected (hypertension is severe, the child is young, under 10 years) further investigations with renal angiograms are needed. In acute nephritis elevated ASOT and depressed C₃ complement levels will establish a diagnosis of acute post-streptococcal glomerulonephritis. If a rare form of adrenogenital syndrome (11-hydroxylase or 17-hydroxylase deficiency) is suspected, plasma and urine determination are performed. Estimation of urinary and plasma catecholamines could be a delayed investigation unless a pheochromocytoma or neuroblastoma is suspected clinical. Renal angiography can demonstrate lesions in the main arteries or in the segmental branches; at angiography, venous blood sample should be collected from both renal veins and the inferior vena cava for assay plasma renin activity. Doppler ultrasound may demonstrate arterial and venous blood flow.

Essential hypertension is suggested by the patient's age, level of high pressure, weight, family history and the paucity of signs and symptoms. It is uncommon to make this diagnosis in children younger than 10 yr of age. Excess body weight is associated with essential hypertension.
Treatment of hypertension depends on the severity, presence of symptoms and underlying cause. In the acute hypertensive emergency situation, drugs with a rapid onset action are needed:

- Nifedipine 5-10 mg sublingual
- Hydralazine 0,1-0,5 mg/kg iv or im
- Diazoxide 2-5 mg/kg iv
- Minoxidil 2,5-5 mg oral
- Sodium, nitroprusside 0.5-10 mcg/kg/min, iv
- Furosemid 2 mg/kg iv
- Labetolol 1-3 mg/kg/hr iv

In essential hypertension observation only is indicated unless the diastolic blood pressure is 95 mmHg or more. Advice on a low salt diet, weight reduction and exercise may assist reduction in blood pressure. Intervention techniques such as transluminal angioplasty for renal artery stenosis, resection of coarctation of aorta, and nephrectomy for small scarred kidney may cure a small percentage of children.

The drug treatment of chronic hypertension is similar to that of adult patients. Drugs used include:
- diuretics:
  - hydrochlorothiazide :1-2 mg/kg/24 h
  - furosemide : 1mg/kg/dose iv -2 mg/kg/dose po
- beta-adrenergic blockers:
  - propranolol : 0,25-1 mg/kg/dose
  - atenolol, metoprolol
- vasodilators:
  - hydralazine 0,5-2 mg/kg and increase to max 200mg/24
- calcium channel inhibitors:
  - nifedipine 0,2-0,5 mg/kg, max 10-20 mg
- converting enzyme inhibitors:
  - captopril :0,1-0,3 mg/kg/dose and increase to max 2 mg/kg/dose
  - enalapril :0,005-0,010 mg/kg/dose iv
Conditions associated with transient or intermittent hypertension in children.

**RENAI**

- Acute postinfectious glomerulonephritis
- Anaphylactoid (Henoch-Schonlein) purpura with nephritis
- Hemolytic uremic syndrome
- Acute tubular necrosis
- After renal transplant (immediate and during episodes of rejection)
- Hypervolemia
- After surgical procedures on genitourinary tract
- Pyelonephritis
- Renal trauma
- Leukemic infiltration of kidney
- Obstructive uropathy associated with Crohn disease

**DRUGS AND POISONS**

- Cocaine
- Oral contraceptive
- Sympathomimetic agents
- Amphetamines
- Phencyclidine
- Corticosteroids and ACTH
- Cyclosporine treatment post-transplantation
- Lead, mercury, cadmium, thalium
- Antihypertensive withdrawal (Clonidine, methyldopa, propranolol)
- Vitamin D intoxication

**CENTRAL AND AUTONOMIC NERVOUS SYSTEM**

- Increased intracranial pressure
- Guillain-Barre syndrome
- Burns
- Familial dysautonomia
- Stevens-Johnson syndrome
- Posterior fossa lesions
- Porphyria
- Poliomyelitis
- Encephalitis

**MISCELLANEOUS**

- Pre-eclampsia
- Fractures of long bones
- Hypercalcemia
- Postcoarctation repair
- White cell transfusion
- Extracorporeal membrane oxygenation (ECMO)
- Chronic upper airway obstruction
Conditions associated with chronic hypertension in children

**RENAAL**
- Chronic pyelonephritis
- Chronic glomerulonephritis
- Hydronephosis
- Congenital dysplastic kidney
- Multicystic kidney
- Solitary renal cyst
- Vesicoureteral reflux nephropathy
- Segmental hypoplasia (Ask-Upmark kidney)
- Ureteral obstruction
- Renal tumours
- Renal trauma
- Rejection damage following transplantation
- Postirradiation damage
- Systemic lupus erytematosus (other connective tissue diseases)

**VASCULAR**
- Coarctation of thoracic or abdominal aorta
- Renal artery lesions
- Umbilical artery catheterization with thrombus formation
- Neurofibromatosis (intrinsic or extrinsic narrowing of vascular lumen)
- Renal vein thrombosis
- Vasculitis
- Arteriovenous shunt
- Williams Beuren syndrome

**ENDOCRINE**
- Hyperthyroidism
- Hyperparathyroidism
- Congenital adrenal hyperplasia
- Cushing syndrome
- Primary aldosteronism
- Dexamethasone-suppressible hyperaldosteronism
- Pheochromocytoma
- Other neural crest tumours (neuroblastoma, ganglioneuroblastoma, ganglioneuroma)
- Diabetic nephropathy
CENTRAL NERVOUS SYSTEM
Intracranial mass
Hemorrhage
Residual following brain injury
Quadriplegia

ESSENTIAL HYPERTENSION
Low rennin
Normal rennin
High renin