

# Pathology of the renal and urologic systems

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# Signs and symptoms of renal/urinary tract problems

- Urinary frequency / urgency /nocturia
- Urinary incontinence
- Pain (shoulder, back, flank, pelvis, lower abdomen)
- Dysuria (painful urination) – usually urethritis/cystitis
- Hematuria – glomerular injury, tumors, trauma
- Pyuria - infection
- Fever and chills - infection
- Thirst, tiredness, weight gain – chronic renal failure
- Edema (facial, swollen ankles) – acute/chronic glomerular injury

# Signs and symptoms of renal/urinary tract problems

- Hypertension – renal ischemia, sodium + fluid retention
- Oliguria (diminished amount of urine) – renal failure, obstruction, dehydration
- Polyuria (excessive amount of urine) – excessive fluid intake (beer), diabetes mellitus, renal tubular disorder
- Renal (ureteric) colic – passage of stone/blood clot
- Anaemia - ↓ renal production of erythropoetin
- Calcium metabolism problems – metastatic calcifications (arteries, soft tissues, inner organs), bone resorption

# Signs and symptoms of renal/urinary tract problems

- Urine analysis
  - urine production rate
  - concentrating power of kidneys
  - urinary protein – glomerular / tubular lesions
  - urinary casts – hyaline casts (protein)
    - granular casts (inflammatory cells)
    - red cell casts (severe glomerular damage )

# Signs and symptoms of renal/urinary tract problems

- Blood analysis (urea, creatinine, electrolytes) – glomerular filtration rate GFR, general integrity of renal function
- Imaging methods (X-ray, ultrasound, angiography, contrast urography)
- Cystoscopy
- Renal biopsy (histology, immunofluorescence, electron microscopy)

# Signs and symptoms of renal/urinary tract problems

- Asymptomatic hematuria and/or proteinuria – mild glomerular lesion
- Polyuria + nocturia + electrolyte disorders – renal tubular defects
- Bacteriuria + pyuria – urinary tract infection (UTI)
- Renal colic + hematuria - nephrolithiasis

# Signs and symptoms of renal/urinary tract problems

## Uraemia

- **Renal insufficiency** - GFR 20-50% of normal
- **Azotemia** – increase of blood urea and creatinine due to decreased glomerular filtration (20-30%), or extrarenal cause
- **Uraemia** - azotemia together with several clinical and biochemical abnormalities: metabolic, endocrine, ... (uremic gastroenteritis, peripheral neuropathy, fibrinous pericarditis)
- **Renal failure** - GFR less than 20-25%, oedema, uraemia; causes: *prerenal, postrenal, renal (vascular, glomerular, tubulointerstitial)*; acute r.f. (oliguria→anuria) chronic r.f
- **End-stage renal disease** - GFR less than 5% of norm

# Signs and symptoms of renal glomerular problems

- **Nephritic syndrome** due to acute glomerular disease; hematuria + mild proteinuria + hypertension
- **Rapidly progressive glomerulonephritis** – very rapid (days-weeks) nephritic syndrome
- **Nephrotic syndrome**: usually chronic glomerular disease, severe proteinuria (>3,5 g/d) + oedema + hyperlipidemia + lipiduria



# Inborn disorders

- 10% of all people
- hereditary or acquired developmental defect
- decreased volume of renal tissue (e.g. agenesis)
- disorders of differentiation (dysplasia)
- anatomical abnormalities (ectopy – abnormal site)
- metabolic disorders (cystinuria, ...)

# Cystic renal disease

- Hereditary, congenital nonhereditary, acquired
- Pathogenesis: primary defect of tubular epithelial cells and their growth, resulting in tubular dilatation
- Cavity filled with fluid, epithelial lining
- Multiple or solitary
- Solitary cyst may simulate a tumor
- Affects the whole kidney, or mostly cortex or medulla
- Pain, hematuria, hypertension, UTI, stones

# Inborn disorders

- Adult polycystic kidney disease
  - common congenital disease, ↓ of renal function in the 3.- 4. dec., autosomal dominant
  - + liver cysts, arterial berry aneurysms.
  - ↑ risk of renal cancer
  - *gross*: symmetric kidney enlargement – length to 30 cm, weight to 8 kg, multiple cysts 0,5-50mm

# Polycystic kidney



# Inborn disorders - implications

- Worsening of signs/symptoms of a known disorder
- Signs/symptoms suggestive of inborn disorders
- Possible kidney enlargement – atypical findings on palpation

# Urinary tract obstruction

- increased susceptibility to urolithiasis
- increased susceptibility to infection
- risk of hydronephrosis
  
- Combination of inborn + acquired risk factors

# Vesico-ureteric reflux

- Incompetence of the vesico-ureteral valve
- Combination of congenital defect (short intravesical part of ureter, 1-2% of children)
- ↓ ureteral contractility in infection
- acquired in bladder atony (spinal cord injury)

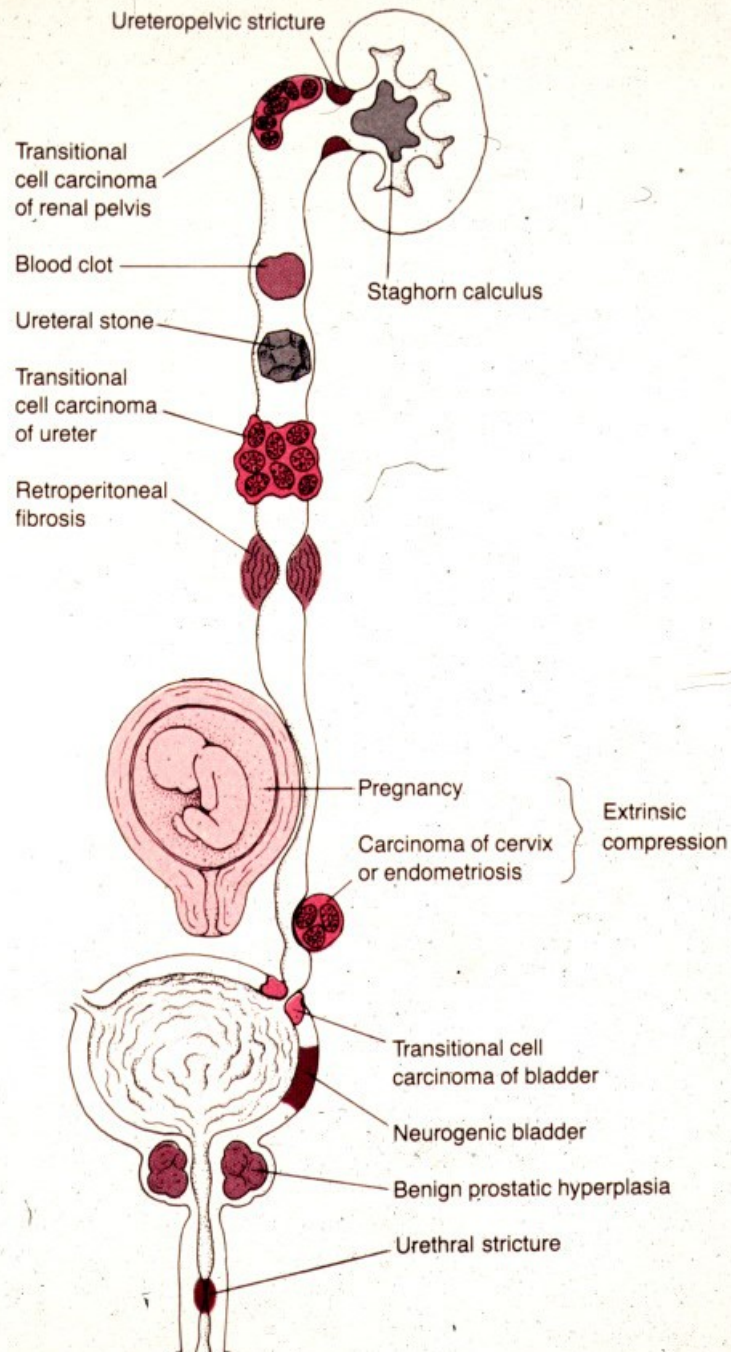
# Obstruction causes

- **Intrinsic** – luminal obstruction (stone, blood clot, necrotic papilla, tumor or its part)
- **Wall stenosis or dysfunction** (inborn, inflammation, postinflammatory, tumor, ...)
- **Extrinsic** – external compression, some causes common for both sexes, some different



# Obstruction causes

- **In males:** prostatic hyperplasia, prostatic ca, urethral stenosis, phimosis + complications
- **In females:** pregnancy, cervical ca (+ therapy), uterine myoma, ovarian tumor, uterine prolapse
- **in both:** chronic inflammation/fibrosis (retroperitoneal fibrosis), tumor (colorectal ca, LN,...), aortic aneurysm



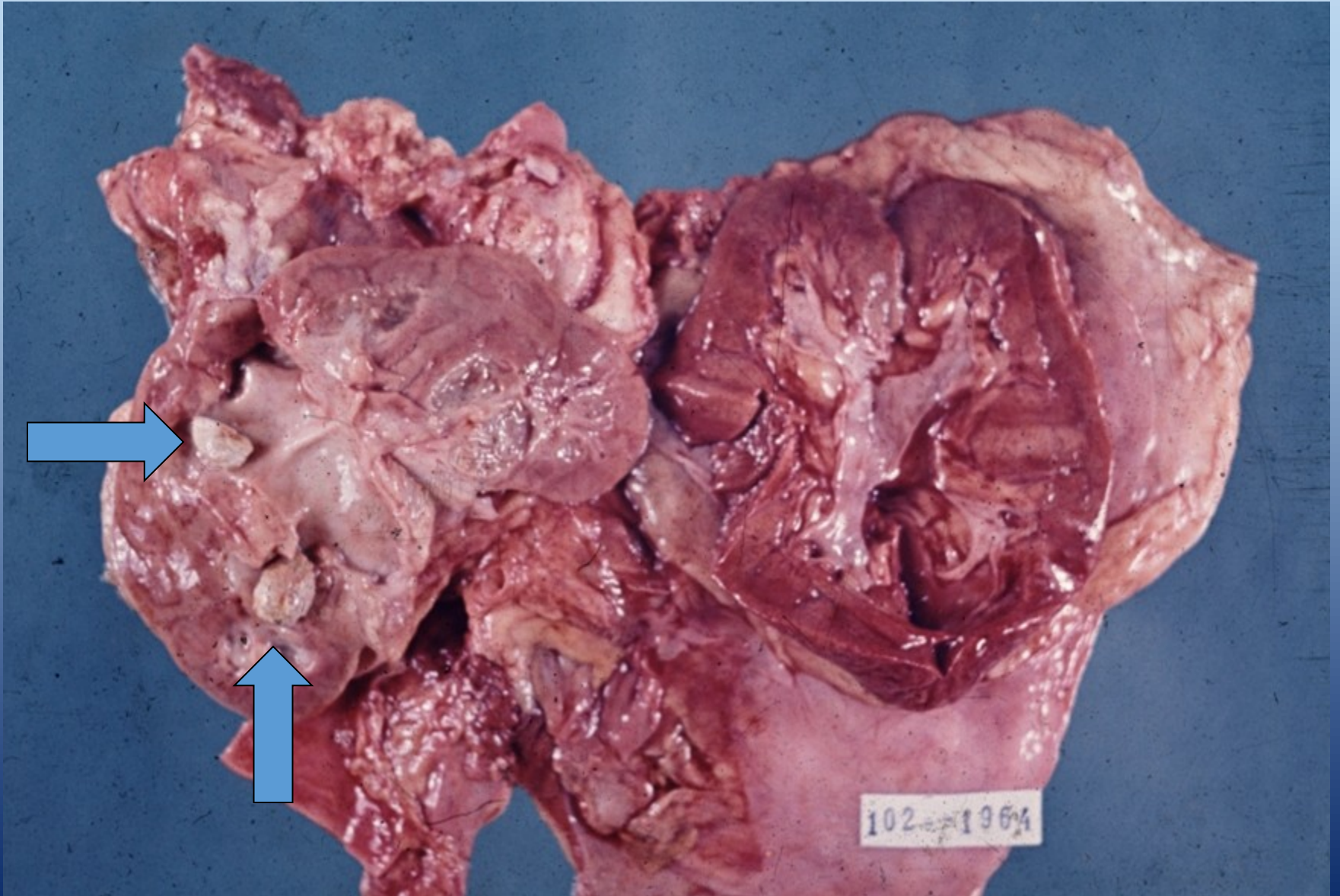
# Renal – urinary calculi

- 5% of adults, recurrence common
- Usually of renal origin
- Stones  $> 5$  mm cannot pass into ureter
- Small stones -  $\uparrow$  risk of obstruction
- Renal colic – pain + spasms during the passage of a stone along the ureter, hematuria
- Chronic dull pain lumbal – lower pelvic region
- Recurrent infection - possible presentation

# Urinary calculi

- **Calcium** containing stones: commonest, laid down in an acid urine.
- **Complex triple phosphate** stones: often associated with urinary infection, in an alkaline urine.
- **Mixture of uric acid and urate-uric acid stones**, 20% of patients with gout, in an acid urine.
- **Cystine stones**: in primary (inborn) cystinuria, important in childhood.

# Pyelolithiasis in situ





# Urocystolithiasis



# Renal calculi - implications

- Differential diagnosis of less severe/intermittent pain x joint or muscle pain, incl. back pain
- Vigilance for signs of concurrent infection (fever, chills, sweats) necessary

# Urinary tract infections

- Most commonly urethritis + cystitis
- Risk factors:
  - Females (short urethra, proximity to vagina, rectum)
  - Immobility /inactivity (impaired bladder emptying)
  - Increased sexual activity
  - Urinary catheter, instrumentation
  - Urinary obstruction
  - Constipation
  - Pregnancy
  - Immune deficiency



# Urinary tract infections

- Mostly ascending infection
- Usually of bacterial origin (fecal – E.coli, sexually transmitted)
- Less commonly fungal (Candida), parasitic (Schistosoma)

# Urinary tract infections

- Complicated – more difficult diagnosis/treatment:
  - small children (atypical signs)
  - elderly adults (less pronounced signs, confusion)
  - pregnancy (asymptomatic UTI possible)
  - patients in hospitals, long term care
  - diabetes and/or other risk factors
  - Relapse (due to low-level persisting infection) or recurrence (new infection) common
- Uncomplicated – otherwise healthy people

# Urinary tract infections

- Signs:
  - Frequency
  - Urgency
  - Dysuria
  - Nocturia
  - Enuresis in children
  - Pain (suprapubic, lower abdomen, groin, lumbar)
  - Possible cloudy, bloody, foul smelling urine
  - Possible systemic signs (fever, malaise, chills)

# Acute cystitis

- highly common in females (short urethra, perineal connection with anus)
- mostly fecal bacteria, mixed flora
- risk factors – urine pH, hormonal status, iatrogenic
- usually purulent (leucocytes, blood in urine), urging, pain; may have systemic signs
- complications – ureteral spread, ulcers, rare phlegmona, pseudomembranous inflammation

# Chronic cystitis

- in obstruction (prostatic hyperplasia, indwelling catheter)
- acute exacerbations, stone formation
- may be risk factor for neoplasia
- diff. dg. x neoplasia

# Acute pyelonephritis

- Common purulent renal inflammation, bacterial infection
- **Ascending** infection by urine reflux in urinary tract inflammation
- **Descending (haematogenous)** infection in septicaemia, rare
- Systemic signs (abrupt, high fever, chills, malaise, headache, lumbar pain, nausea, vomiting)
- **May lead to sepsis+renal failure - urosepsis**

# Acute pyelonephritis

- Facilitated by DM, gout, all causes of obstructive uropathy (e.g. nephrolithiasis, tumors, urinary tract anomalies incl. vesicoureteric and intrarenal reflux)
- Instrumental interventions (cathetrization, cystoscopy)
- Gross: enlarged kidney, cortical and medullary abscesses

# Acute pyelonephritis





# Chronic pyelonephritis

- Uni- or bilateral chronic renal (tubules + interstitium) inflammation with scarring
- Progression to end-stage kidney (renal failure)
- **Obstructive PN** - repeated infections
- **Reflux nephropathy**

# Chronic pyelonephritis



# Urinary tract infections - implications

- Recognition of early/worsening symptoms – referral to physician – prevention of possible permanent damage
- Catheter care – diminishing risk of infections

# Chronic kidney diseases (CKD)

- Alteration of kidney function/structure for  $\geq 3$  months
- Non-healing acute disorder (i.e. acute glomerulonephritis), or slow progression of chronic lesion
- Variable causes, most common:
  - Diabetes mellitus
  - Hypertension
  - Glomerulopathy
  - Chronic UTI
  - Cystic kidney disorders
  - Other systemic disorders (SLE)
  - Drugs (NSAIDs) – analgesic nephropathy

# Chronic kidney diseases

- Common problem
- May be asymptomatic initially – incidental finding in laboratory tests
- Gradual onset of symptoms common
- Slow decrease of glomerular filtration rate
- May progress to kidney failure (GFR <5%)
- Correct diagnosis necessary
- In some types treatment possible

# Chronic kidney diseases

**Uremia**: internal intoxication – failure of toxin excretion, maintaining the fluid, pH, electrolyte balance

Loss of important hormone secretion (renin, vitamin D, erythropoetin)

# Chronic kidney diseases

## Complications + consequences:

- Cardiopulmonary:
  - Coronary artery disease
  - Hypertension
  - Pulmonary edema
  - Congestive heart failure
  - Pericarditis
- Hematologic:
  - Anemia
  - Impaired platelet function

# Chronic kidney diseases

## Complications + consequences:

- GIT
  - Nausea and vomiting
  - Anorexia
  - Bleeding
- Central nervous system
  - Headache
  - Irritability, impaired judgment, inability to concentrate
  - Sleep disturbances
  - Seizures
  - Lethargy/coma



# Chronic kidney diseases

## Complications + consequences:

- Peripheral nervous system
  - Loss of deep tendon reflexes
  - Impairment of motor nerve conduction velocity
  - Burning, tingling sensations
  - Tremor
  - Muscle cramps, muscle twitching
  - weakness
- Skin
  - Itching + scratching
  - Altered skin color (pallor, brownish tint, bruises)

# Chronic kidney diseases

## Complications + consequences:

- Skeletal system
  - Bone demineralization
  - Joint pain / calcification
  - Myopathy

# Glomerular diseases

- Variable causes (immunological x non-immunological incl. inborn)
- Variable clinical / histologic picture – variable classifications according to the changes
- Damage to the glomerular permeability → nephrotic syndrome
- Glomerular inflammation and necrosis → leakage of blood + protein into urine → nephritic syndrome
- Permanent injury → sclerosis, hyalinosis – loss of functional glomeruli, end-stage kidney with renal failure

# Glomerular diseases

## Glomerulonephritis

- Glomerular injury due to abnormal immune responses and/or complement system
- May be primary (antibodies against antigens of glomerulus, SLE), secondary (postinfectious – poststreptococcal, IgA, with deposition of circulating immune complexes in the glomerulus)

# Chronic kidney diseases

## Diabetes mellitus

- Most common cause of end-stage kidney disease in developed countries
- Slowly progressive course (15 years) in type I DM, variable in type II DM
- Variable combination of changes
- Diabetic nephropathy – microvascular changes incl. glomeruli
- Accelerated arteriosclerosis
- UTI incl. pyelonephritis, papillary necrosis

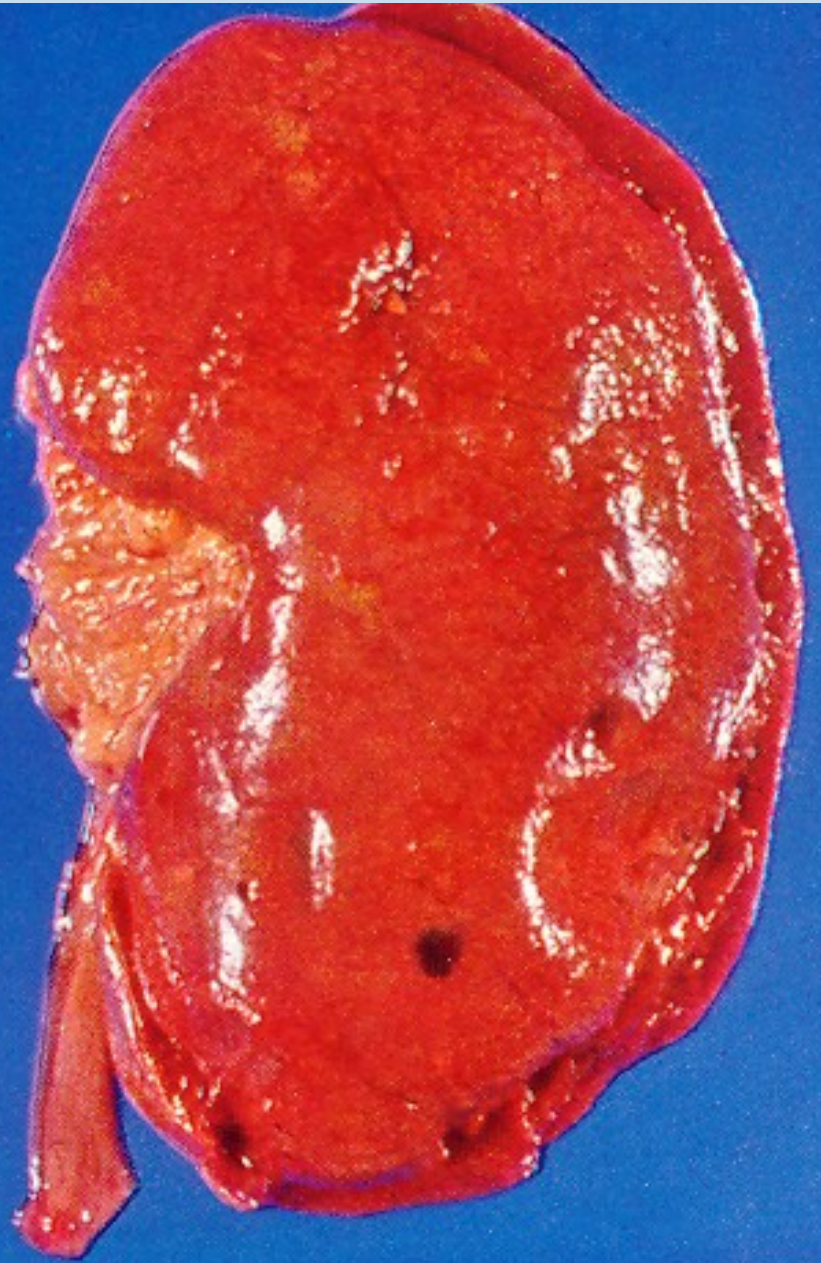
# Chronic glomerulonephritis

- End stage of variable glomerular disease
- Different rate of progression in different diseases
- Focal segmental glomerulosclerosis (commonly the result of hyperfiltration in residual glomeruli due to glomerular/renal tissue loss – nephrectomy; obesity, hypertension; drugs) 50-80%
- Rapidly progressive glomerulonephritis ~ 50%
- Poststreptococcal 1-2%

# Chronic glomerulonephritis

- Shrank kidney with granular surface
- Thin cortex
- Obliterated glomeruli, arterio- and arteriolosclerosis (hypertension), tubular atrophy

Chronic GN – end-stage kidney





# Chronic kidney diseases - implications

- Knowledge of association of glomerular diseases with systemic disorders – DM, hypertension, vasculitis, systemic lupus, ...
- Presence of clinical signs (edema, signs of uremia, ...) – referral to a physician
- Side effects of therapy (diuretics – fatigue, muscle cramps, weakness, headache, ↑frequency of urination + incontinence, depression)

# Chronic kidney diseases - implications

## Nephrogenic systemic fibrosis

In patients with chronic kidney diseases

- Firm erythematous skin plaques, itchy
- Fibrosis +/- calcification of soft tissue incl. muscles
- Pain in joints, bones
- Muscle contracture, loss of function
- Massage, joint manipulation, exercise, swimming

# Renal failure

Renal replacement therapy necessary

- Dialysis
- Renal transplantation:
  - Cheaper than long-term dialysis
  - Limited availability of organ grafts
  - Life-long immunosuppression
  - Variable complications

# Dialysis

- Removal/diffusion of waste products, excess fluid + electrolytes
- Peritoneal dialysis
  - Catheter implanted in the peritoneal cavity
  - Sterile dialyzing solution instilled /drained
  - Several times daily, possible during sleep
  - Independent at home procedure
  - Infectious complications, dehydration
- Hemodialysis (HD): external machine
  - Usually 3x weekly 3-4 hours
  - Rapid changes in blood constituents – severe signs possible
  - Commonly patients immobile
  - Low-intensity exercise program during the first half beneficial

# Dialysis – implications for the therapist

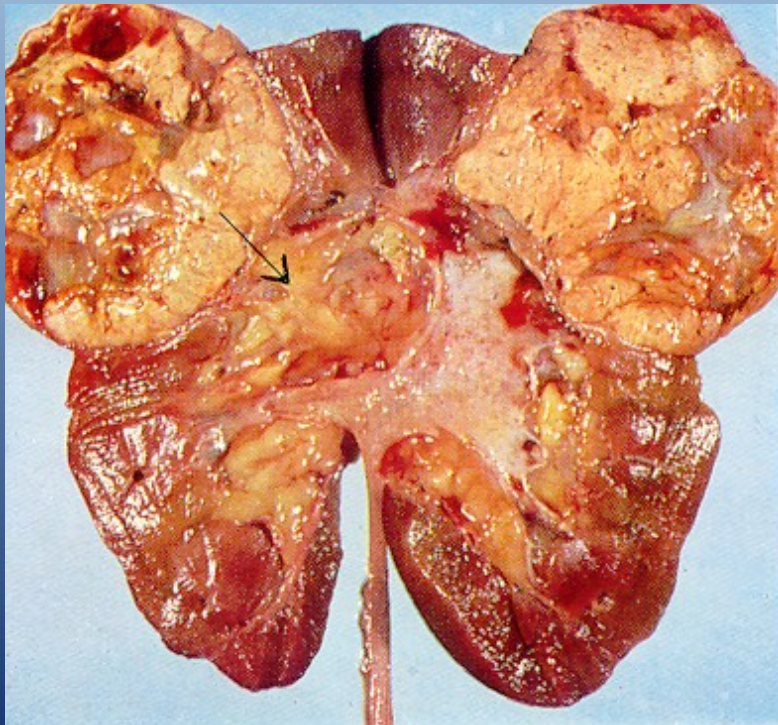
- ↑ susceptibility to infection (!hand hygiene)
- Maintaining the dialysis access site (thrombosis)
- ↑ thirst (limited fluid intake)
- Weight gain (fluid retention), but ↓ lean body mass – muscle loss
- Alternating hypertension (fluid retention) and dialysis hypotension
- Anorexia, ↑ catabolism, ↓ functional capacity (50% in CKD)
- Depression common
- Individual exercise/treatment plan

# Renal cancer

- Renal cell carcinoma (RCC): most common adult renal tumor
- Transitional cell carcinoma of pelvis, ureter
- Benign tumors possible, diff. diagnosis x RCC
- Wilms tumor in children
- Metastatic cancer (primary in the lungs, breast, skin melanoma, ...)

# Renal cell carcinoma

- Conventional clear cell RCC - Grawitz
- 80% of renal malignancies
- Other RCC types less common (papillary RCC)
- Metastasis mostly by hematogenous way

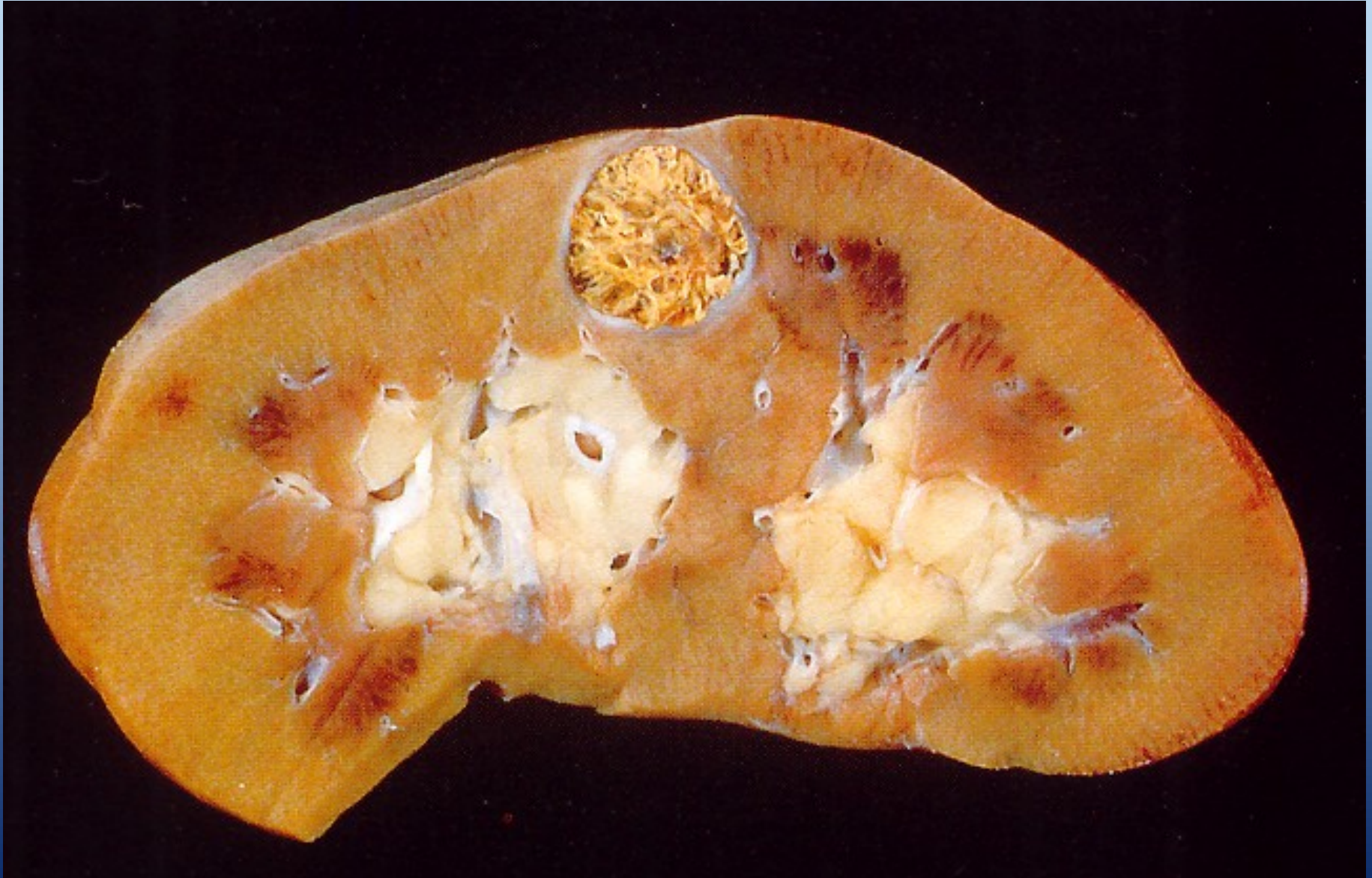


# Renal cell carcinoma

- More common in males; middle-older age
- Risk factors: smoking (25% of RCC), moderate to heavy drinking, obesity (25%), familiar factors incl. cystic disease, industrial pollution, radiation treatment
- Incidental finding in imaging methods
- Hematuria (50%), may be intermittent and/or microscopic
- Flank pain, palpable mass – late sign
- Metastasis - late sign, in ¼ of patients; lung, lymph node, bone, liver
- Prognosis according to the type and stage



# Renal cell carcinoma





# Renal cell carcinoma



# Renal cell carcinoma - implications

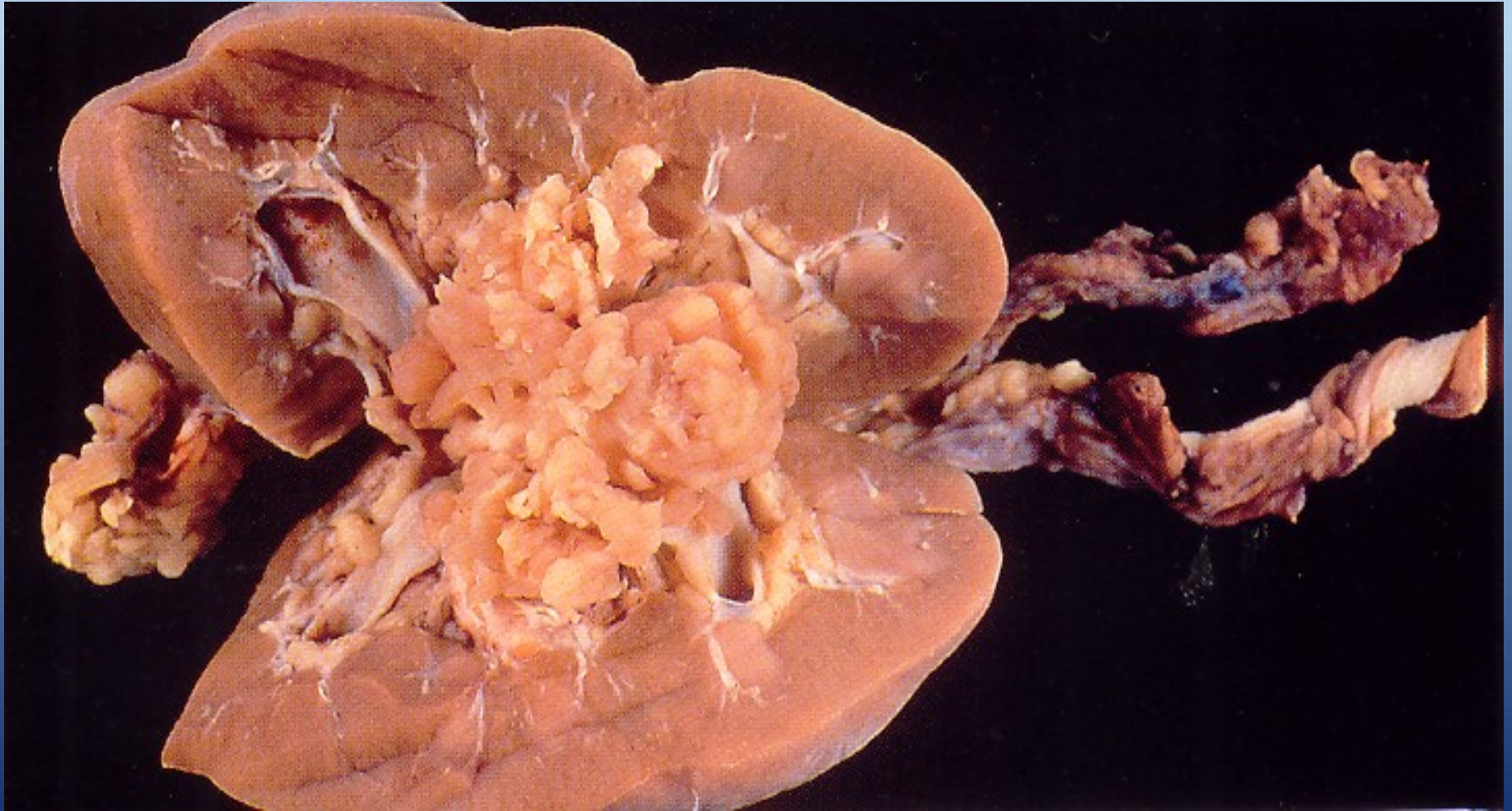
- Mostly in geriatric population
- Awareness/questions of possible signs
- New onset of unexplained abdominal / back pain
- Surgical treatment most important - surgical sites scarring management
- Side effects of targeted therapy

# Transitional cell carcinoma

- Cca 10% of renal carcinoma
- Growth in the renal pelvis
- Early presentation with hematuria / urinary tract obstruction
- Multiple concurrent tumors in pelvis /ureter /bladder possible



# Transitional cell ca of the renal pelvis



# Wilms tumor

- 3rd most common malignant pediatric tumor
- Diagnosed mostly in the 1st-4th year of age
- Sporadic, or part of some syndromes
- Clinical: large tumor, palpable, complications due to compression of adjacent organs, hematuria
- Prognosis: good, chemotherapy, (radiotherapy carefully, second malignancies possible)

# Disorders of the bladder and urethra

- Inflammation
  - Infections - UTI
  - Non-infective: interstitial cystitis / painful bladder syndrome: suprapubic pain related to bladder filling + ↑ urgency/frequency (day+night), without other pathology
    - Low back pain, burning, spasm possible
    - Commonly ↑ with stress, acid food, sex
    - Conservative treatment usual – symptom relief, stress management, relaxation treatment

# Disorders of the bladder and urethra – neurogenic bladder

- Voiding dysfunction due to neurologic lesions
- Pelvic lesions: trauma, surgery
- Spinal cord /nerve lesions: diabetes, disc disease, injury
- Cerebral lesions
  - Stroke
  - Trauma
  - Dementia
  - Parkinson's
  - Multiple sclerosis
  - Tumor



# Disorders of the bladder and urethra – neurogenic bladder

- Sensory – efferent nerves dysfunction (diabetes, syphilis, ...), no sensation of the fullness
- Motor paralytic – destruction of afferent parasympathetic motor nerves (pelvic surgery, trauma) – problems in starting/maintaining urine stream
- Reflex – spinal cord injury – loss of sensation + motoric problems
- Neurogenic detrusor overactivity – brain tumors, demyelination, Parkinson – involuntary contractions
- Autonomous – complete separation from upper nervous centres

# Disorders of the bladder and urethra – neurogenic bladder

- Complications: UTI, renal calculi, hydronephrosis
- Differential diagnosis x other lesions (bladder cancer, prostate hyperplasia, ...)
- Exercise – bladder training
- Functional mobility, relaxed sitting

# Disorders of the bladder and urethra - cancer

- Urothelial (transitional cell) carcinoma most common
- Middle to older age
- Manifestation: painless hematuria, frequency, dysuria
- Commonly recurrences / multiple tumors over years
- Important predisposing factors:
  - Smoking (about ½ of bladder cancer cases)
  - Occupational exposures – dyes, diesel exhaust, rubber industry, ...
  - Males
  - Chronic inflammations, incl. permanent catheter, stones, parasites
  - Decreased fluid intake
  - Genetic / inborn defects

# Disorders of the bladder and urethra - cancer

- Flat lesions –
  - Carcinoma in situ – confined to the epithelium
  - Invasive solid carcinoma, worse prognosis
- Mostly exophytic papillary, variable malignant potential
  - Tumor of low malignant potential – borderline malignancy, no invasion, no metastasis, good prognosis, but recurrences possible
  - Low grade carcinoma (non-invasive, invasive)
  - High grade carcinoma (non-invasive, sooner invasive)

# Disorders of the bladder and urethra - cancer

- Other histologic types possible
- Secondary tumors
  - Local progression from surrounding organs not uncommon (prostate, rectum, cervix)
  - Metastasis rare

# Bladder carcinoma



# Disorders of the bladder and urethra – cancer - implications

- High incidence of local recurrence – signs!
- Risk of late radiation sequelae
- Sequelae of surgery (cystectomy) incl. infection, impotence
- Retraining of voiding, pelvic floor muscles

# Urinary incontinence

- Complaints of involuntary urine loss
- Variable categories, commonly mixed UI
- Urgency urinary incontinence – loss of urine + urgency due to overactive bladder, variable triggers (running water, ...)
- Stress urinary incontinence – during increased intraabdominal pressure
  - On effort / physical exertion – lifting weight, ...
  - Coughing, sneezing



# Urinary incontinence

- UI common, more prevalent in women (50%) than males (14%)
- In older adults, particularly nursing home
- Diagnosis! – not a part of the normal aging process
- Consequences:
  - depression, social isolation, limited work opportunities
  - UTI
  - Decreased exercise participation
  - Increased fracture risk (incontinence + postural hypotension → fall)

# Urinary incontinence – risk factors

- Obesity, ↑ BMI
- Age
- Pregnancy (multiple)
- Pelvic surgery (prostate in males, uterus in females)
- Diabetes mellitus
- Constipation
- UTI
- Medications
- Impaired cognitive function, impaired mobility

# Urinary incontinence - implications

- Rehabilitation often possible
  - Pelvic floor muscles exercises
  - Bladder training
  - Biofeedback possible
- Everyone should be asked about urinary problems
  - Esp. peri- postmenopausal women
  - Parous women (who have been pregnant)
  - People > 60 years
  - Person with multiple risk factors