

SYNDROMES OF THE URINARY SYSTEM DISEASES

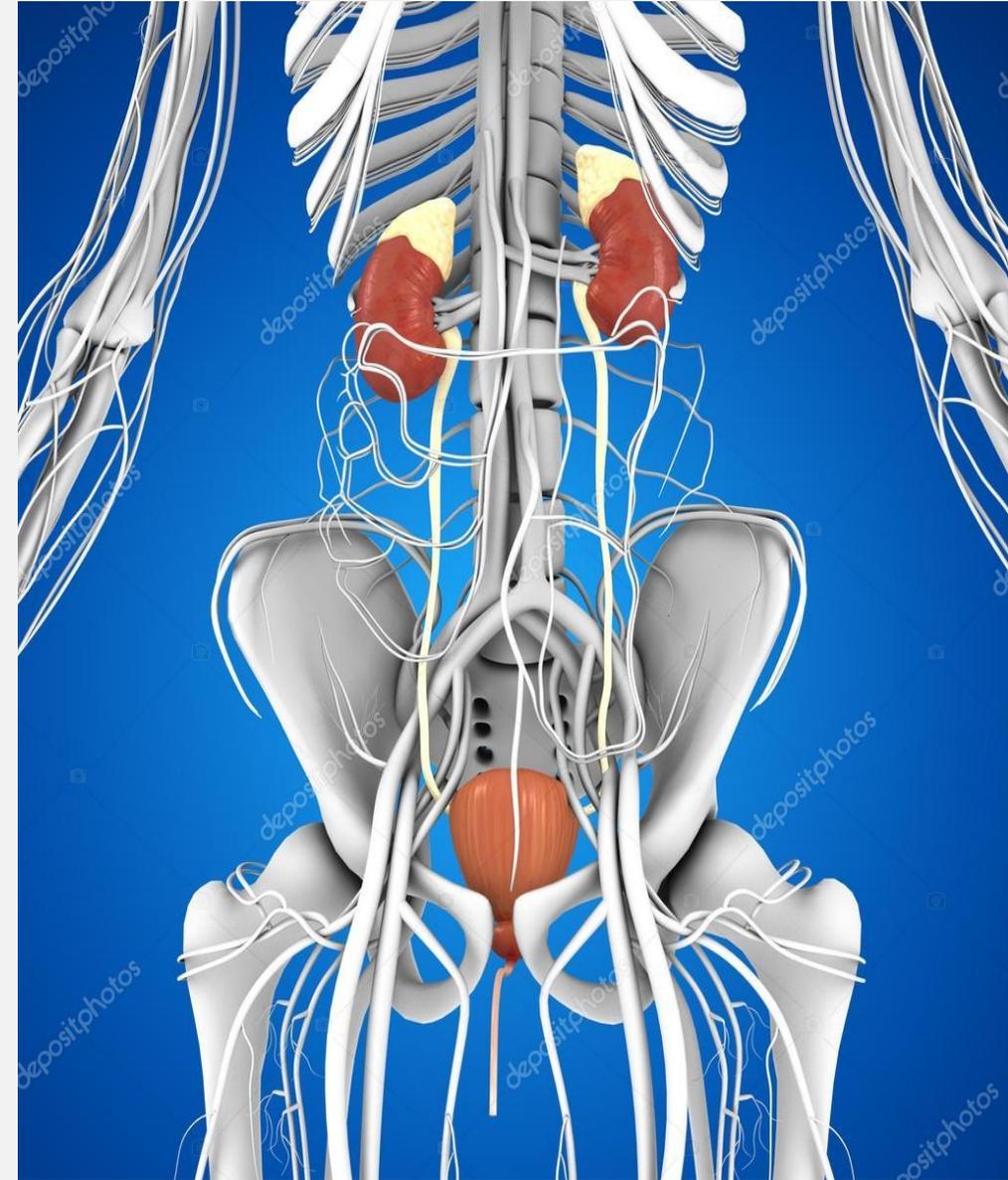
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Kidney (“Ren” lat.) - paired bean-shaped organ, located behind the parietal leaf of the peritoneum in the lumbar region on the sides of the two last thoracic and two first lumbar vertebrae. In an adult, the upper pole of the right kidney usually reaches the level of the 12th intercostal space, the upper pole of the left - of the 11th rib).

Kidneys are the main organs of the excretory system of the human body.



Interesting facts about kidneys:

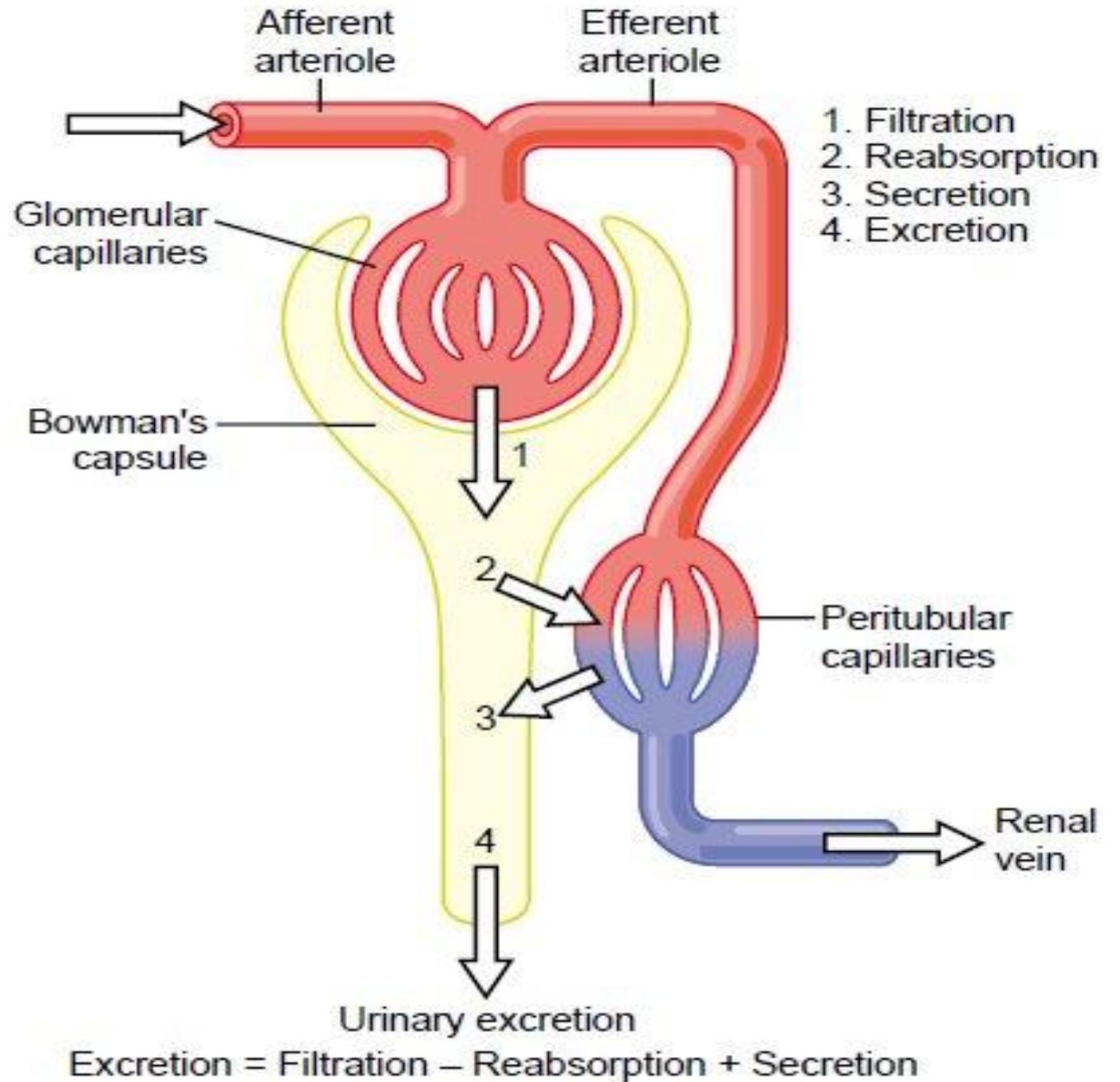
- 1% of body mass
- 25% of cardiac output
- Passes total blood volume every 4-5 minutes
- Filters 180 l per day and reabsorbs 178.5 l of it
- Produces 1.5 l of acidic (pH~6) urine per day
- 5% increase in filtration would generate 9 l urine per day!



- Each kidney is covered with a durable connective tissue fibrous capsule, and consists of a parenchyma, a system of accumulation and excretion of urine.
- The parenchyma of the kidney is represented by the outer layer of the **cortical substance** and the inner layer of the **medulla**.
- The urine accumulation system is represented by **small renal cups**, which merging between themselves by 2-3 and form a **large renal calyx**, which merging and form the **renal pelvis**. The renal pelvis passes directly into the **ureter**. The right and left ureters flow into the **bladder**.



A microscopic structure of the kidney is the **nephron**. In the process of filtration, reabsorption, secretion and excretion of this unit all major kidney functions are performed.



THE KIDNEYS PERFORM A VARIETY OF IMPORTANT FUNCTIONS:

1. They regulate the osmotic pressure (osmolality) of the body fluids by excreting osmotically dilute or concentrated urine.
2. They regulate the concentrations of numerous ions in blood plasma, including Na^+ , K^+ , Ca^{2+} , Mg^{2+} , Cl^- , bicarbonate (HCO_3^-), phosphate, and sulfate.
3. They play an essential role in acid–base balance by excreting H^+ when there is excess acid or HCO_3^- when there is excess base.
4. They regulate the volume of the ECF by controlling Na^+ and water excretion.
5. They help regulate arterial blood pressure by adjusting Na^+ excretion and producing various substances (e.g., renin) that can affect blood pressure.

6. They eliminate the waste products of metabolism, including urea (the main nitrogen-containing end product of protein metabolism in humans), uric acid (an end product of purine metabolism), and creatinine (an end product of muscle metabolism).
7. They remove many drugs (e.g., penicillin) and foreign or toxic compounds.
8. They are the major sites of production of certain hormones, including erythropoietin and 1,25-dihydroxy vitamin D₃.
9. They degrade several polypeptide hormones, including insulin, glucagon, and parathyroid hormone.
10. They synthesize ammonia, which plays a role in acid–base balance.
11. They synthesize substances that affect renal blood flow and Na⁺ excretion, including arachidonic acid derivatives (prostaglandins, thromboxane A₂) and kallikrein (a proteolytic enzyme that results in the production of kinins).

SIGNS AND SYMPTOMS OF THE URINARY SYSTEM DISEASES.

- **Pain** (pain in the lumbar region, along the ureter, above the pubis; dull, aching, constant, congestive kidney, acute, sharp, “renal colic”).
- **Dysuric phenomena** (any changes in normal urination)
- **Oedema**
- Fever
- Weakness, malaise, decreased performance
- Headache
- Nausea, vomiting, dyspepsia
- Skin itch, “uremic frost”
- Arterial hypertension etc.

NORMAL URINATION: ABOUT 1.5-2 LITERS
PER DAY, 3-7 TIMES A DAY, URINATION RATIO
DAY TO NIGHT 3:1

- Polyuria – more than 2000 ml per day
- Oliguria – less than 500 ml per day
- Anuria (secretory or excretory)
- Ishuria – urine retention
- Pollakiuria - frequent
- Isuria
- Nocturia – night urination
- Stranguria – pain during urination



EDEMA: BEGIN WITH FACE, USUALLY IN THE MORNING, WARM TO THE TOUCH, PALE, PALPATION REMAINS FOSSA

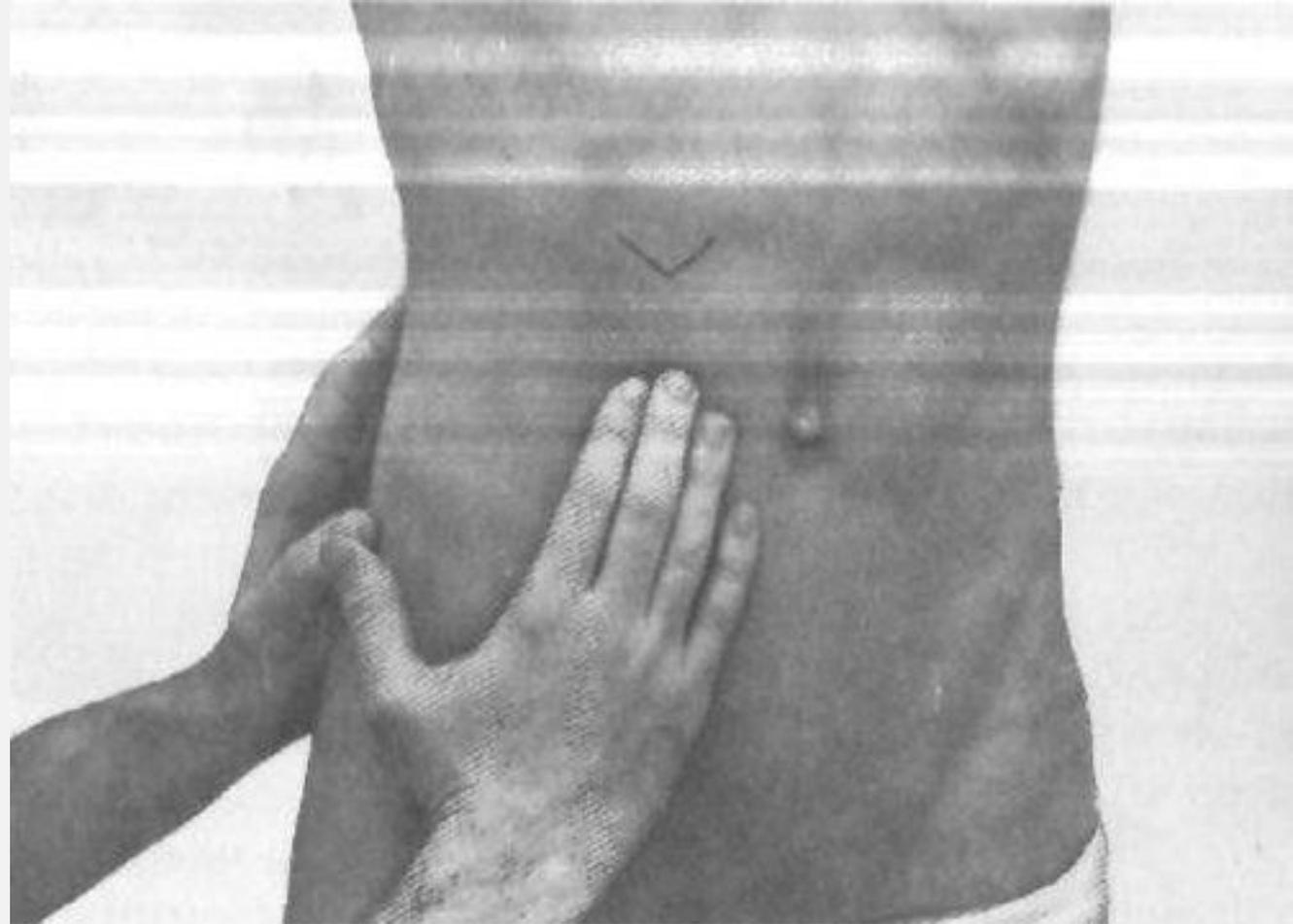


The classical method of palpation of the kidneys is the Obratzsova-Strazhesko method. At the same time using deep bimanual palpation (with two hands). The left hand palm is placed flat on the lumbar region perpendicular to the spine directly below the bottom edge of the seventh rib, and the right hand is perpendicular to the right, then left side flanks 3 cm below the costal arch.

The task of the doctor performing the palpation is to expel in one or several receptions to bring both hands as close as possible, and then with a deep breath, the enlarged or lowered kidney will be in the area of the hands being examined.



For better detection of nephroptosis, especially during mass examinations (for example, in military registration and enlistment offices), palpation of the kidney in the standing position (Botkin method) is widely used. In this case, the patient stands, leaning forward a little. The location of the doctor's hands and all subsequent techniques are the same as with the Obratzsova method.

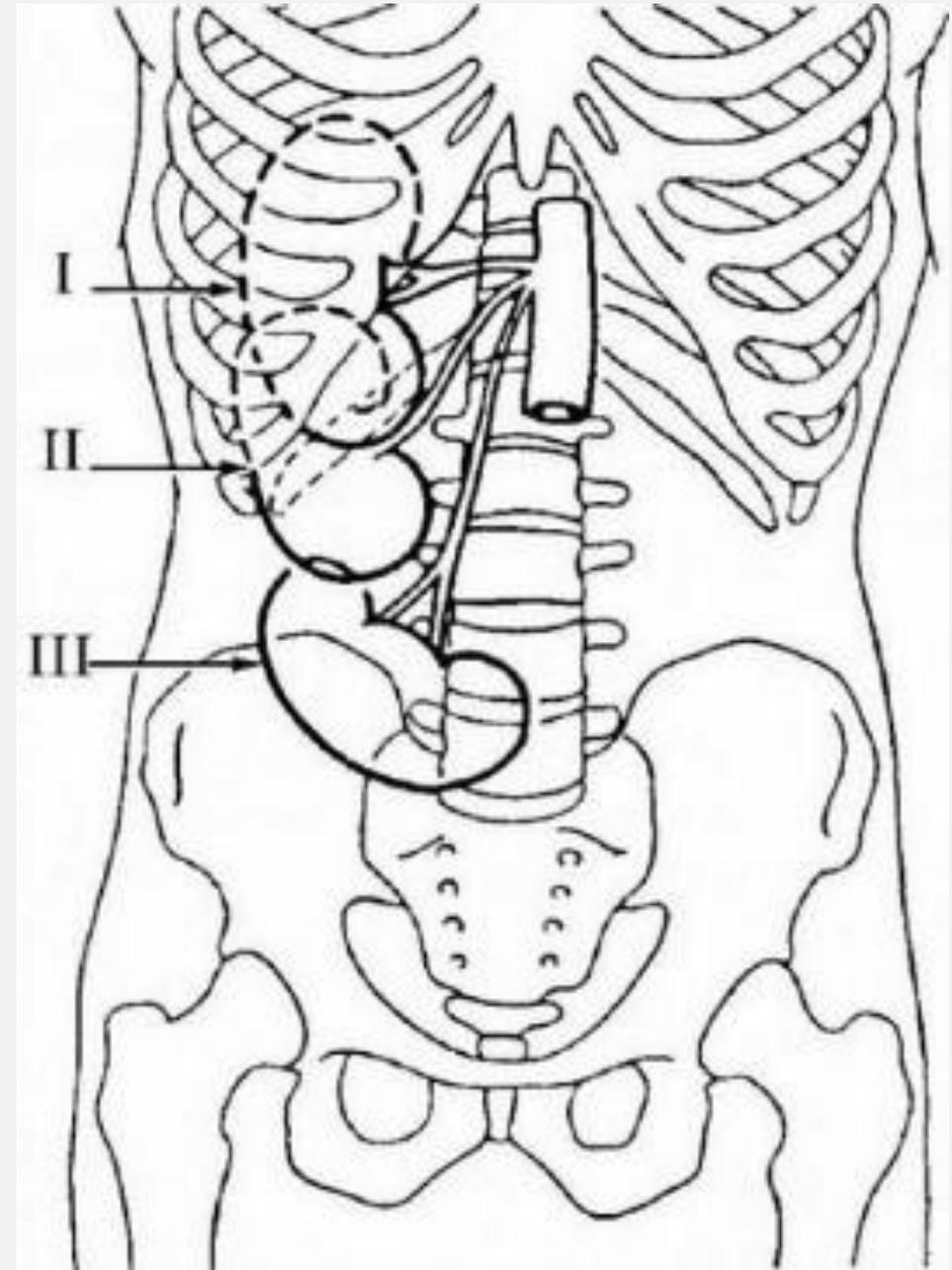


Normally, the kidney is not palpable.

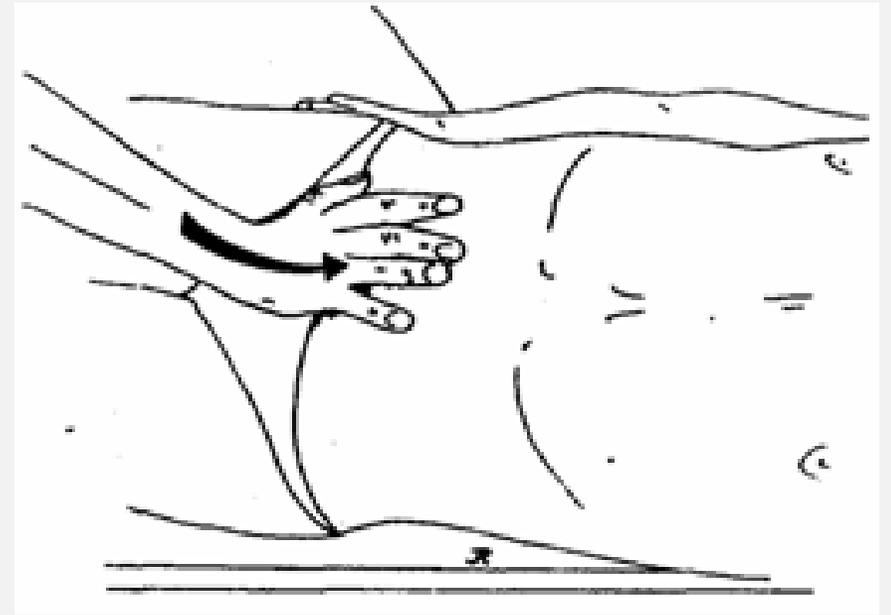
If only the lower pole of the kidney is palpable, this is a sign of kidney prolapse (nephroptosis) of I degree.

In nephroptosis of the II degree, the entire kidney is palpable, but it does not move beyond the midline and the spine (ren mobile).

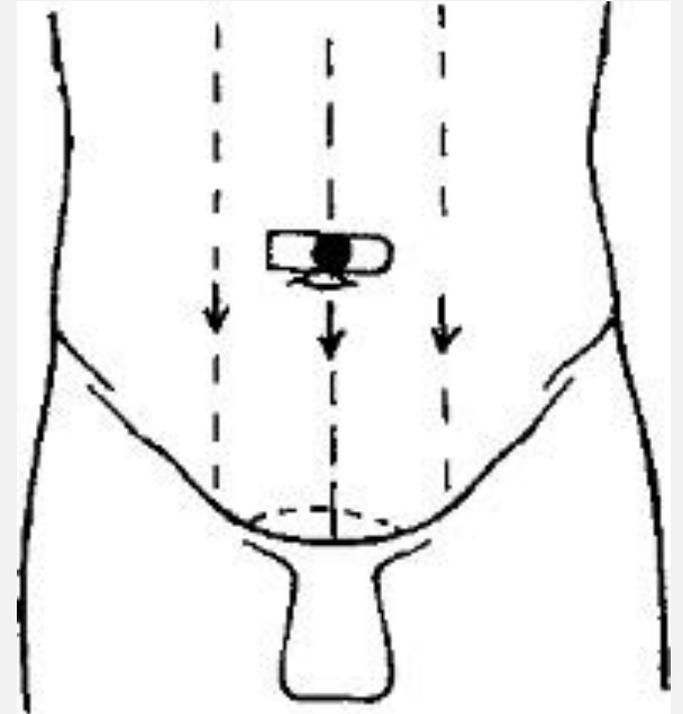
If the palpable kidney is well displaced in different directions (including beyond the middle line), this is nephroptosis of the third degree (ren migrans).

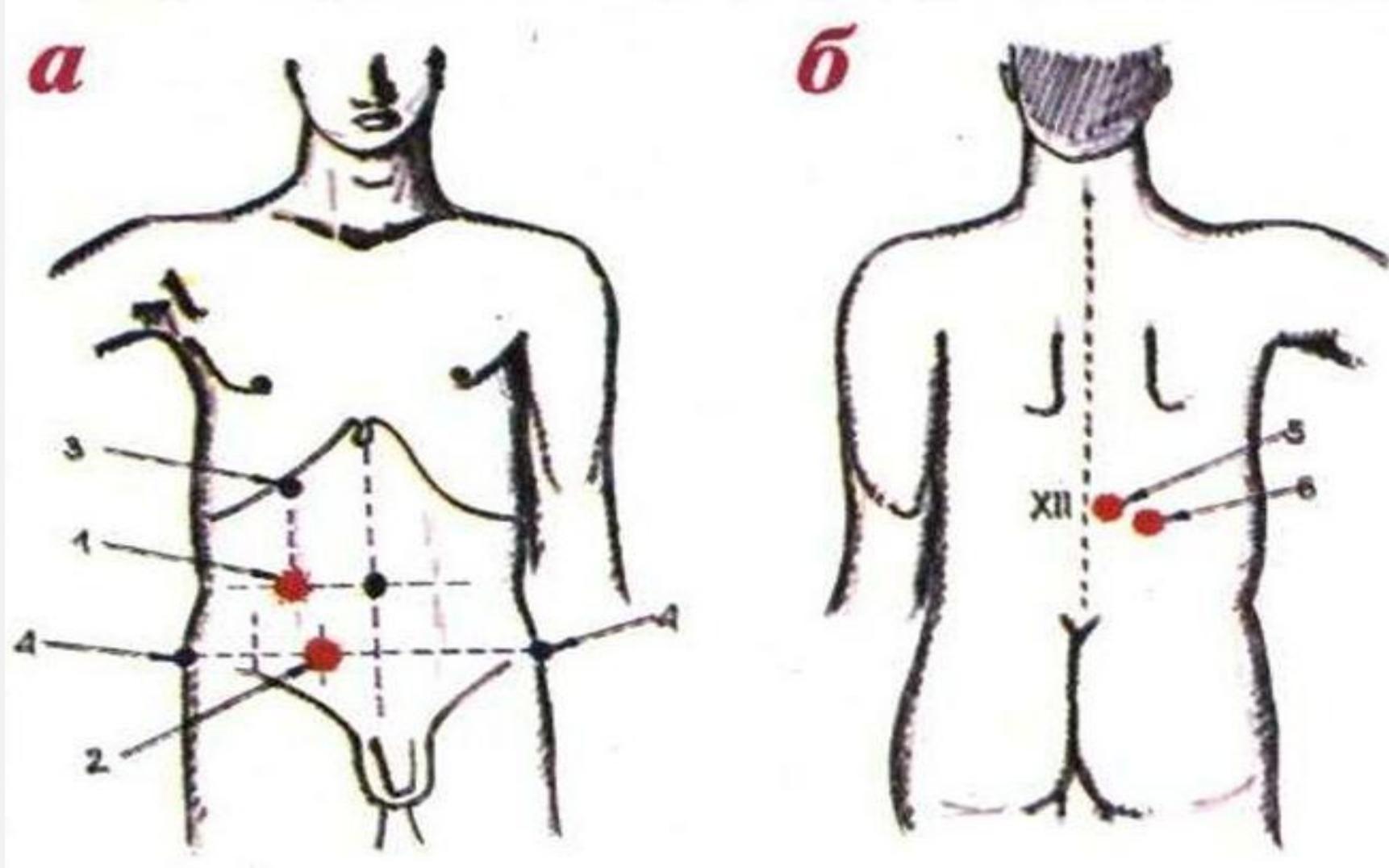


Palpation is also used to study the bladder. With a significant accumulation of urine in it, especially in individuals with a thin abdominal wall, the bladder is palpated above the pubis in the form of an elastic fluctuating formation, with a sharp overflow, its upper limit is determined almost at the navel.



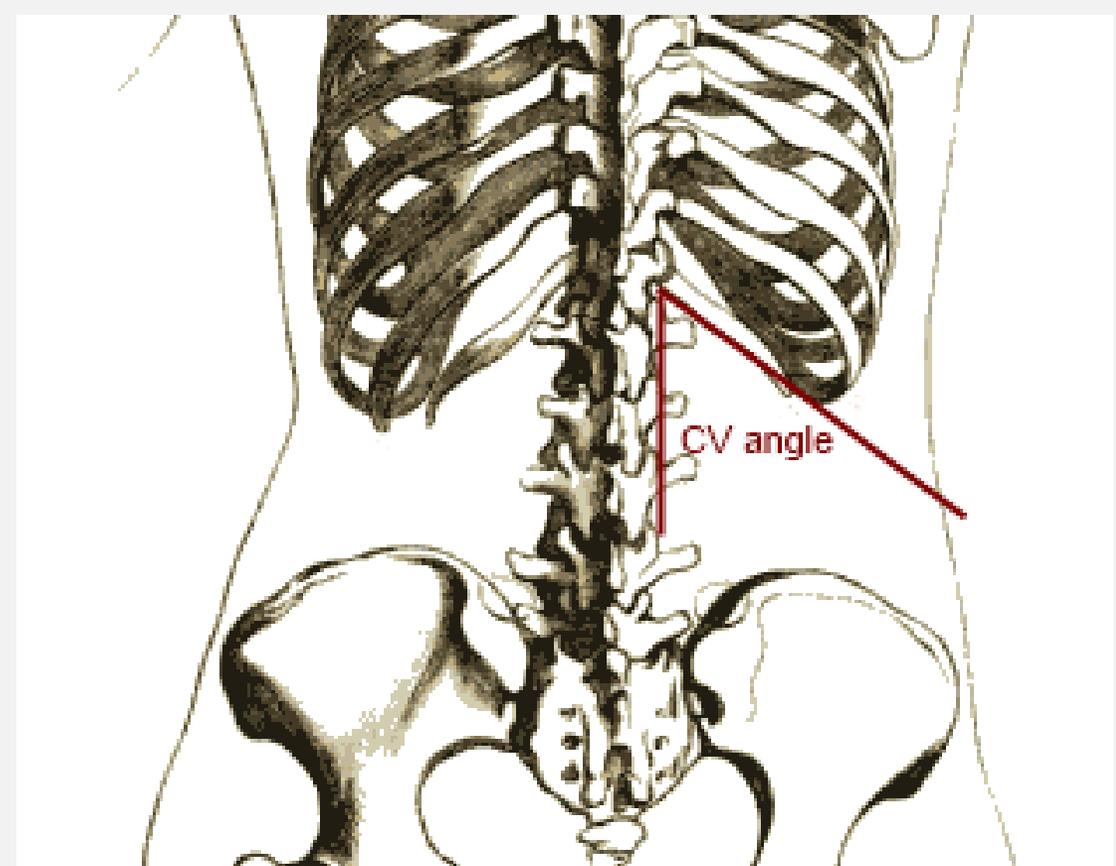
Percussion can also determine the dullness of the sound above the pubis due to the filling of the bladder. Percussion lead from the navel from top to bottom in the midline, the finger-size is laid parallel to the pubis.





1 - UPPER URETERAL POINT; 2 - LOWER URETERAL POINT; 3 - THE OUTER EDGE OF THE RECTUS ABDOMINIS MUSCLES; 4 - SPINA ILIACA ANTERIOR SUPERIOR; 5 - COSTOVERTEBRAL POINT; 6 - COSTOLUMBAR POINT

Costovertebral angle tenderness (CVAT), Murphy's punch sign or Goldflam's sign is a medical test in which pain is elicited by percussion of the back area of the kidney overlying (the costovertebral angle, an angle made by the vertebral column and the costal margin). Because the kidney is directly anterior to this area, known as the costovertebral angle, tapping disturbs the inflamed tissue and causing pain.



Auscultation of the renal arteries.

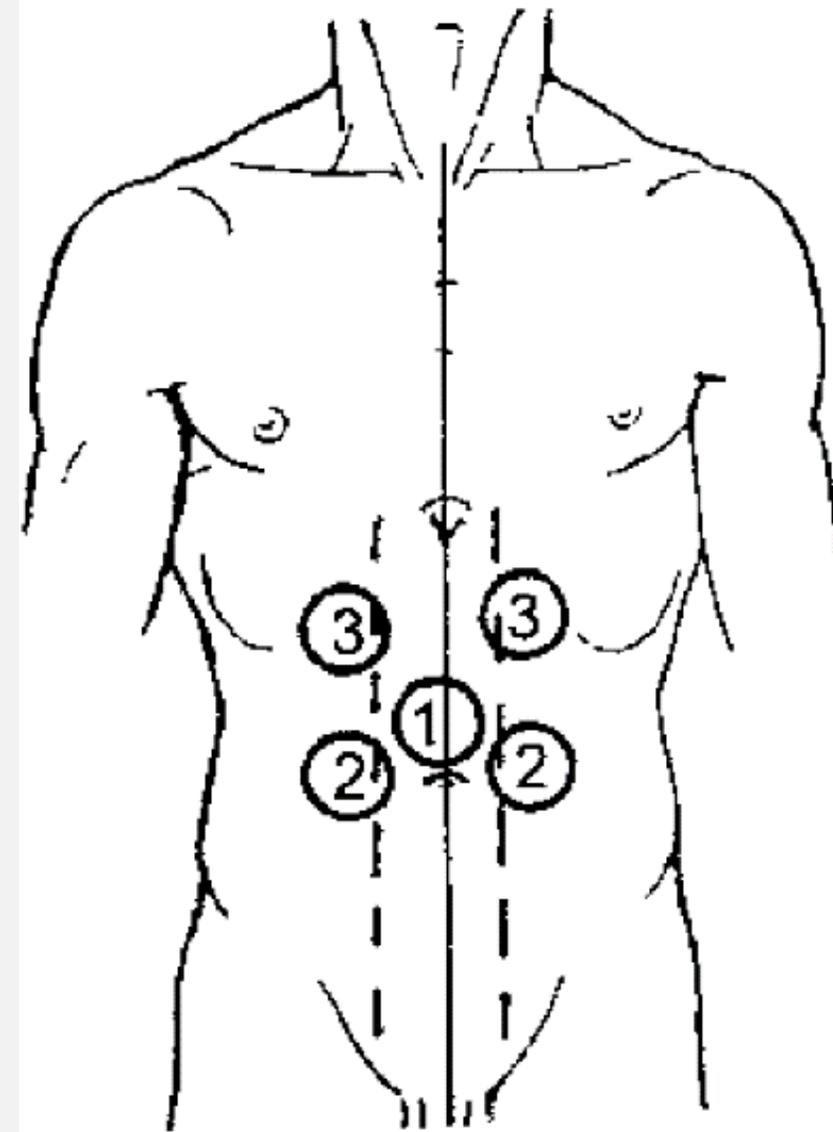
Places of listening: 1) in the depth of the umbilical region to the right and left of the navel during breath holding after a deep expiration; 2) over the transverse processes of the XI-XII thoracic and I-II lumbar vertebrae in the position of the patient on the side with the holding of breath after a deep expiration. In healthy people, tones and noises are not heard.

Places listening to the renal vessels.

1 - 2-3 cm above the umbilicus along the white line;

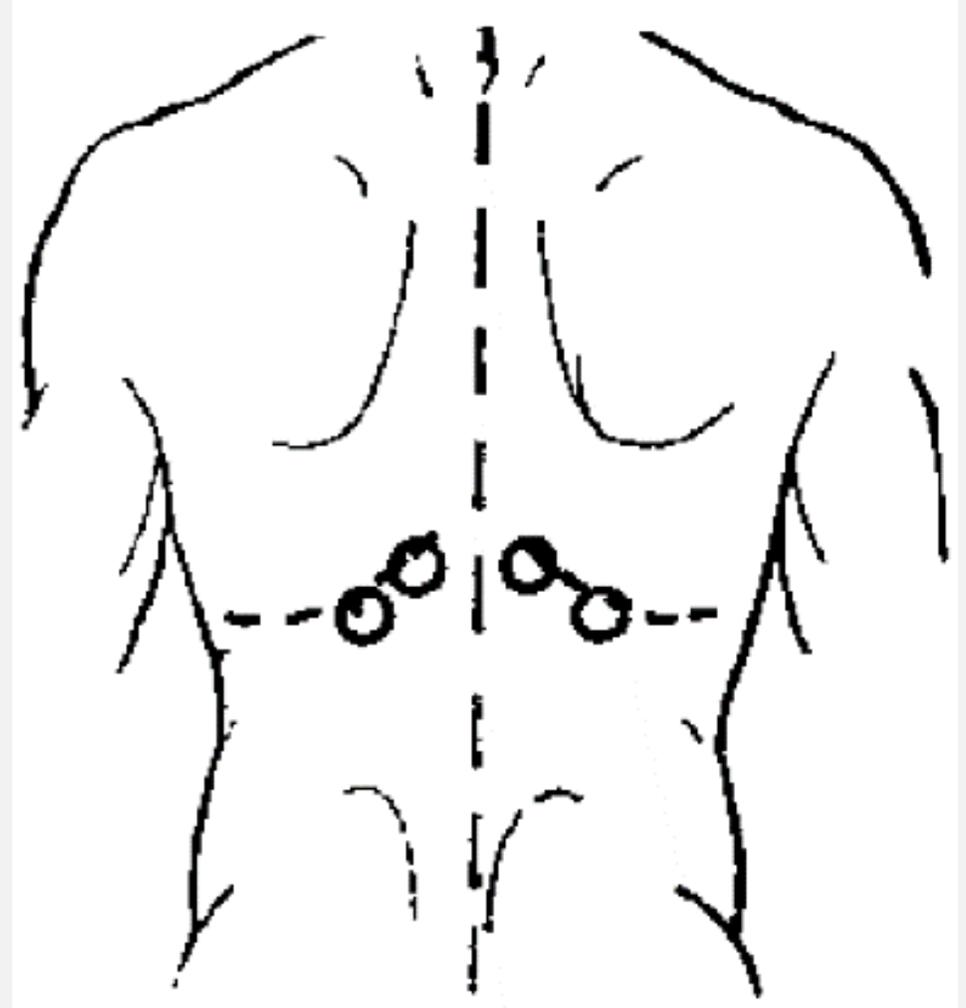
2 - 2-3 cm outward from the umbilicus at the edges of the rectus abdominis muscles;

3- at the outer edges of the rectus muscles at the midpoint of the distance from the xiphoid process to the umbilicus.



The patient should be in a sitting position when listening to the renal arteries from behind. The stethoscope is placed under the 12th rib near its free edge. The identification of systolic murmur at the points indicates a possible stenosis of the renal arteries or of the aorta in this area.

Pasternatsky's symptom is a sign of kidney disease (particularly renal colic): a combination of painful sensations and the appearance or increase in the number of red blood cells in the urine after tapping the lumbar region in the projection of the kidneys. This is a more accurate method for diagnosing kidney disease, rather than a symptom of tapping, which is often positive for many non-urological diseases.



NEPHROTIC SYNDROME

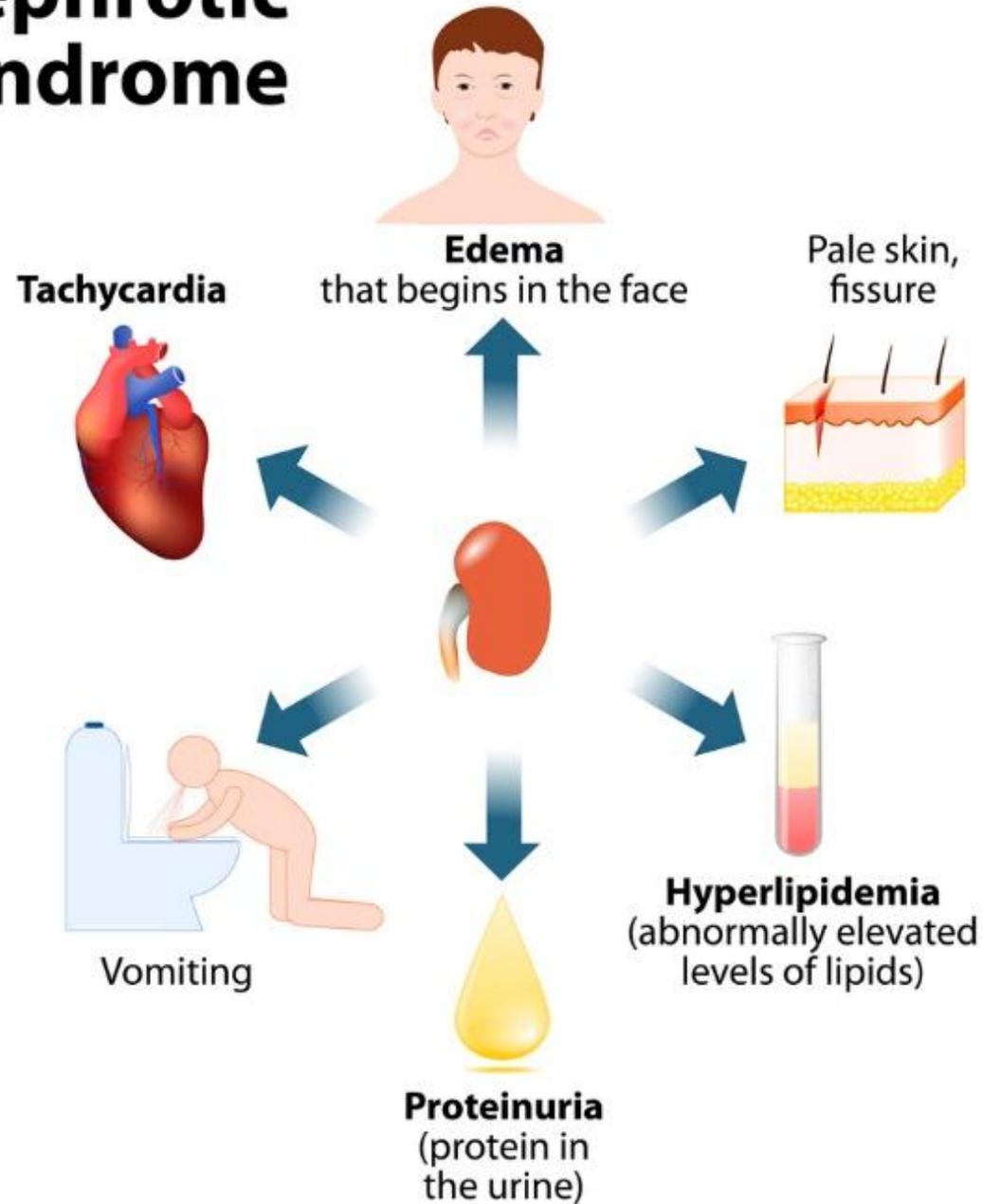
- generalized edema,
- massive proteinuria (above 50 mg * kg/day or above 3.5 g/day), hypoproteinemia and hypoalbuminemia (less than 20 g/l),
- hyperlipidemia (cholesterol above 6.5 mmol/l).

Characterized for the defeat of a kidney's glomerular apparatus!

- Fluid in the pleural cavity causing pleural effusion.
- Fluid in the peritoneal cavity causing ascites.
- Generalized edema known as anasarca.
- Most of the patients are normotensive.
- Anaemia (iron-resistant microcytic hypochromic type).
- Dyspnea.
- Erythrocyte sedimentation rate is increased due to increased fibrinogen & other plasma contents.
- Some patients may notice foamy or frothy urine due to a lowering of the surface tension by the severe proteinuria.
- Muehrcke's nails; white lines (leukonychia).



Nephrotic syndrome



There are primary and secondary nephrotic syndrome:

Primary occurs in the initial disease of the kidneys themselves. Possible causes are various glomerulonephritis and glomerulopathy, which are differentiated only after a biopsy of the renal tissue.

A - membranous nephropathy,

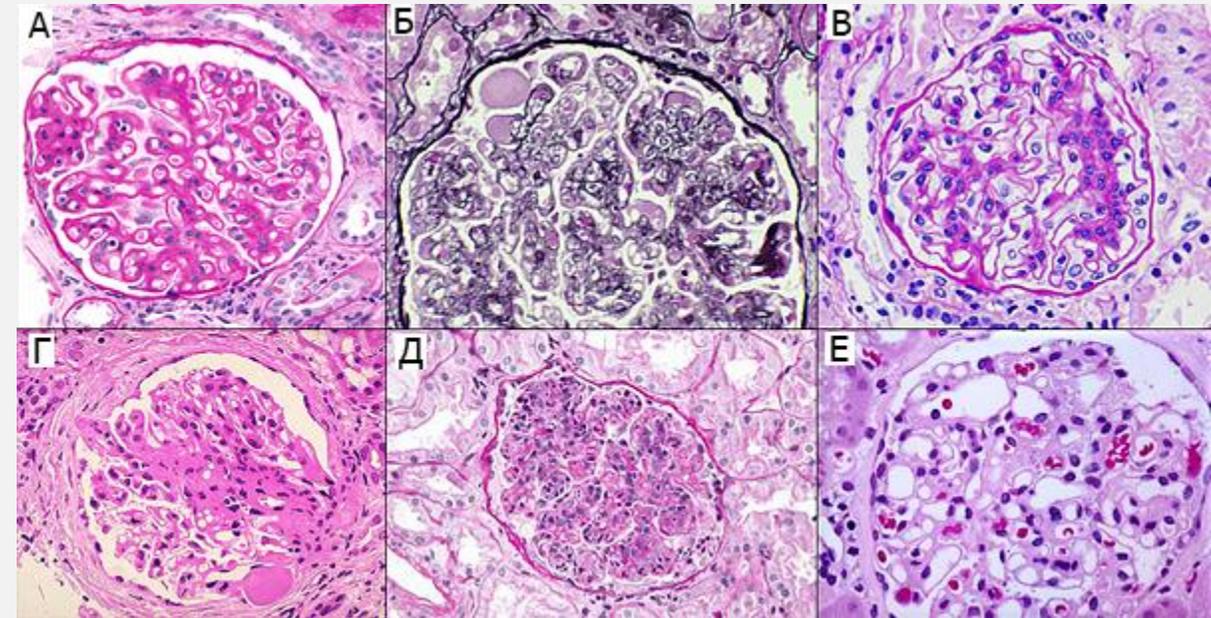
Б - membranoproliferative glomerulonephritis,

В - mesangioproliferative non-IgA
glomerulonephritis,

Г - focal segmental glomerulosclerosis,

Д - acute proliferative glomerulonephritis,

Е - disease of minimal changes.



Probable causes of kidney damage leading to the development of **secondary nephrotic syndrome**:

Infectious diseases: endocarditis, syphilis, leprosy, viral hepatitis, mononucleosis, cytomegalovirus infection, chickenpox, malaria, toxoplasmosis, HIV infection, schistosomiasis.

Side effects of drug use: anti-inflammatory drugs, lithium salts, gold and bismuth, captopril overdose, penicillamine.

Rheumatoid and vascular diseases: lupus, rheumatoid arthritis, dermatomyositis, various vasculitis, amyloid lesions of internal organs, sarcoidosis, ulcerative colitis, cryoglobulinemia, Düring dermatitis.

Metabolic disorders: diabetes, decreased thyroid activity, preeclampsia.

Malignant tumors of the hematopoietic system, melanoma, tumors of the lung, digestive tract, breast, thyroid, kidney, reproductive system.

Allergic diseases and reactions.

Congenital diseases: Alport, Fabry, sickle cell anemia, lack of alpha-1-antitrypsin, renal artery stenosis.

NEPHRITIC SYNDROME

- gross hematuria,
- proteinuria ($< 3.5\text{g/d}$),
- hypertension
- azotemia (increased blood Urea and Creatinine)
- oliguria ($<400\text{ ml/day}$)

Characterized for the inflammatory diseases of the kidneys!

Urine color of meat slops.

Nausea, vomiting, weakness and as a consequence the development of anorexia.

Headache.

Pain in the lower back or stomach.

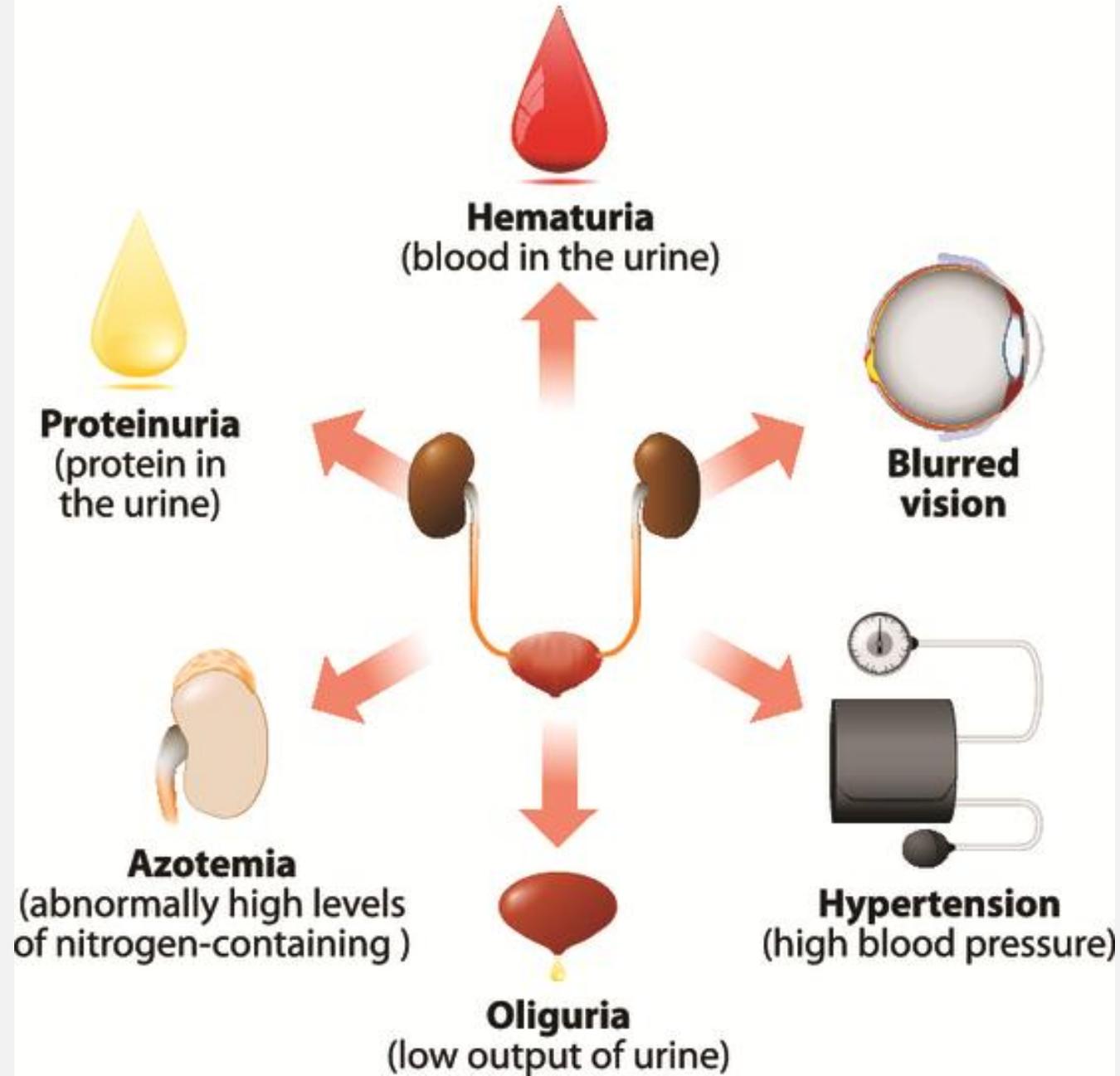
Fever.

Weight gain.

Manifestations of heart failure - frequent heartbeat, shortness of breath, asphyxiation in the prone position.



Nephritic syndrome



In most cases the development of the syndrome is an infectious process caused by the activity of pathogenic bacteria and viruses.

Factors provoking the development of Acute Nephritic Syndrome:

Various diseases of the kidneys: (Berger's disease, mesangiocapillary glomerulonephritis, etc.)

Systemic diseases such as: Systemic lupus erythematosus, Schönlein-Genoch disease, vasculitis, hereditary pulmonary and renal syndrome (Goodpasture syndrome).

Mixed causes, for example: administration of various sera or vaccines, radiation, Hyena-Barre syndrome, etc.

Viral infections include: hepatitis B, infectious mononucleosis, Koksaki viruses, mumps, chicken pox, echoviruses, and so on.

Bacterial: sepsis, typhoid fever, endocarditis, pneumococcal or meningococcal infections and others.

URINARY SYNDROME

- is a complex of changes in the physical, chemical properties and microscopic characteristics of urine sediment in pathological conditions (proteinuria, hematuria, leukocyturia, cylindruria, etc.), which may be accompanied by clinical symptoms of kidney disease (edema, hypertension, dysuria, etc.) or exist in isolation, without any other renal symptoms.

CLINICAL URINE TESTS

Amount: 200-300 ml

Color: Yellow-amber

Urine specific gravity: 1.003-1.030

pH: 5-7

Protein: <0,01 g/l

Glucose: <1,7 mmol/l

Ketone bodies: <1,0 mmol/l

Urobilinogen: <34 mcmol/l

Bilirubin: negative

Nitrite: negative

Hemoglobin: negative

Epithelium flat: <5

Transitional epithelium: <1

Renal epithelium: negative

Leukocytes: <5

Erythrocytes: <2

Cylinders: negative

Salt: negative

Mucus: negative

Bacteria: negative



Proteinuria is most often associated with increased filtration of plasma proteins through the glomerular capillaries. This is the so-called glomerular proteinuria. It is observed in diseases of the kidneys, accompanied by a defeat of the glomerular apparatus - the so-called glomerulopathy.

By glomerulopathy include glomerulonephritis, nephritis and nephropathy, as well as renal lesion in hypertension and hemodynamic disorders involving venous stasis of blood in the kidney and the increase in the hydrodynamic pressure (so-called "*congestive kidney*").

Predominant glomerular in nature is *febrile proteinuria*, observed in acute febrile states, especially in children and the elderly.

It should be borne in mind the possibility of developing ***functional proteinuria***. It includes *orthostatic proteinuria* - the appearance of protein in the urine during prolonged standing or walking and the rapid disappearance in a horizontal position.

In adolescence, *idiopathic proteinuria* can also be observed, which is found in healthy individuals during a medical examination and is absent in subsequent urine tests.

Functional proteinuria, detected in 20% of healthy individuals after physical overstrain and (or) overwork, is characterized by the presence of protein in the first collected urine and is tubular in nature. This type of proteinuria is often observed in athletes.

Hematuria is a frequent, often the first sign of a disease of the kidneys and urinary tract. Distinguish macro and micro hematuria. *Microhematuria* is detected only by microscopic examination of urinary sediment.

Gross hematuria should be distinguished from hemoglobinuria, myoglobinuria, uroporphyrinuria, melaninuria. Urine can become red when taking certain products (beets), drugs (phenolphthalein)!

Hematuria is usually divided into renal and non-renal. Allocate initial (at the beginning of urination), terminal (at the end of urination) and total hematuria. The nature of hematuria can be refined using a three-stacked or two-stacked sample.

Initial and terminal hematuria is always of non-renal origin!

Initial hematuria indicates the defeat of the initial part of the urethra due to a urological disease: tumor, ulcerative inflammatory processes, trauma. Terminal hematuria indicates inflammation or swelling of the prostate gland, the cervical bladder or the internal opening of the urethra.

Total hematuria occurs in various diseases of the kidneys, renal pelvis, ureters, bladder, i.e. can be both renal and non-renal. Therefore, when hematuria is detected, urological diseases should be excluded - urolithiasis, tumors, tuberculosis of the kidney.

Erythrocytes change their appearance depending on the reaction of urine and specific gravity. Erythrocytes are found in the urine in the form of *unchanged (fresh)* and *modified (leached)*.

Unchanged red blood cells contain hemoglobin, in a form similar to the disks yellowish-greenish. Unchanged erythrocytes are found in weakly acidic, neutral and alkaline urine.

Altered erythrocytes occur during prolonged stay in acidic urine. They do not contain hemoglobin and are similar in shape to colorless rings. Such red blood cells are called leached. Also, wrinkled erythrocytes, which are found in urine with a high relative density, and in urine with a low relative density, red blood cells increase in diameter. Erythrocytes become altered by prolonged standing of urine.

Leukocyturia. In the urine of a healthy person are contained in the amount of 0 - 3 in p / sp. in men and 0-6 in p / sp. among women. **It should be remembered that leukocytes can enter the urine from the genital tract!**

The increase in the content of leukocytes is observed in inflammatory processes in the kidneys and urinary tract. *Transient leukocyturia* occurs during fever, including non-renal origin. Initial and terminal leukocyturia has a non-renal origin. *Total leukocyturia* with simultaneous presence of leukocyte and granular cylinders in the urinary sediment testifies to the renal origin of leukocyturia. Despite the fact that renal leukocyturia is usually of microbial origin (found in pyelonephritis, kidney tuberculosis), one should bear in mind the possibility of aseptic leukocyturia (in lupus nephritis, amyloidosis, and interstitial toxic immune immune nephritis).

Epithelioury. Cells of the *squamous epithelium* indicate the desquamation of the epithelial cover of the lower urinary tract: the bladder, urethra. If they are changed, swollen, have fatty inclusions in the cytoplasm, this indicates inflammation (urethritis, cystitis), if not changed - more often on irritation - against the background of the use of medications excreted in the urine.

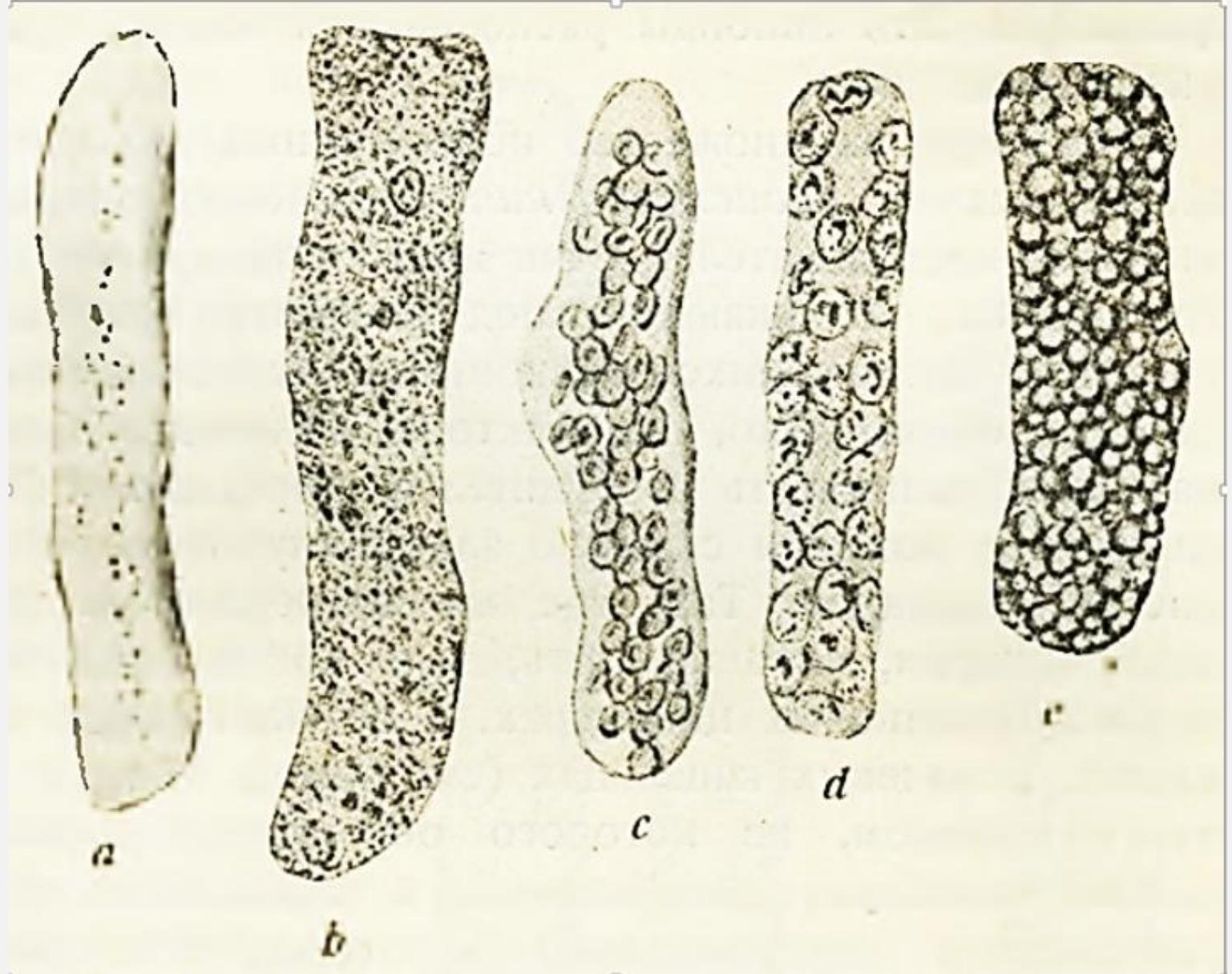
The cells of the *cylindrical epithelium* are cells of the epithelial cover of the renal pelvis or ureter. Their appearance in the urinary sediment indicates an inflammatory process in the pelvis (pyelitis) or ureters. Simultaneous detection of cylindrical and squamous epithelial cells may indicate an ascending urinary tract infection.

Cells of the *renal tubular epithelium* have the greatest diagnostic value when they are found in the composition of epithelial cylinders, or are detected in groups.

Cylindruria. Cylinders are protein casts of tubules.

- Hyaline cylinders - in normal possible detection of single in the preparation. The content increases with all types of proteinuria (see section Proteinuria above);
- Waxy - normally not excreted, they appear in nephrotic syndrome of different origin, amyloidosis, and lipid nephrosis;
- Fibrin - not normally detected, characteristic of hemorrhagic fever with renal syndrome;
- Epithelial - formed from epithelial cells, detected in renal necrosis, viral diseases;
- Erythrocyte - from erythrocytes, detected in acute glomerulonephritis, kidney infarction, malignant hypertension;
- Leukocyte - from leukocytes, found in pyelonephritis, lupus nephritis;
- Granular - with cellular elements that have undergone degenerative decay. Appear with glomerulonephritis, pyelonephritis, nephrotic syndrome.

- a) Hyaline cylinders
- b) Fibrin
- c) Erythrocyte
- d) Leukocyte
- e) Granular



ACUTE KIDNEY INJURY (AKI)

formerly called acute renal failure (ARF), is commonly defined as an abrupt decline in renal function, clinically manifesting as a reversible acute increase in nitrogen waste products—measured by blood urea nitrogen (BUN) and serum creatinine (SCr) levels—over the course of hours to weeks.

SIGNS AND SYMPTOMS OF ACUTE KIDNEY INJURY DIFFER DEPENDING ON THE CAUSE AND MAY INCLUDE:

- Oliguria/anuria
- Swelling in legs, ankles, and around the eyes
- Fatigue or tiredness
- Shortness of breath
- Confusion
- Nausea
- Seizures or coma in severe cases
- Chest pain or pressure

In some cases, AKI causes no symptoms and is only found through tests done!

THE CAUSES OF ACUTE KIDNEY INJURY ARE
COMMONLY CATEGORIZED
INTO *PRERENAL*, *RENAL*, AND *POSTRENAL*.

Diseases and conditions that may slow blood flow to the kidneys and lead to kidney injury include:

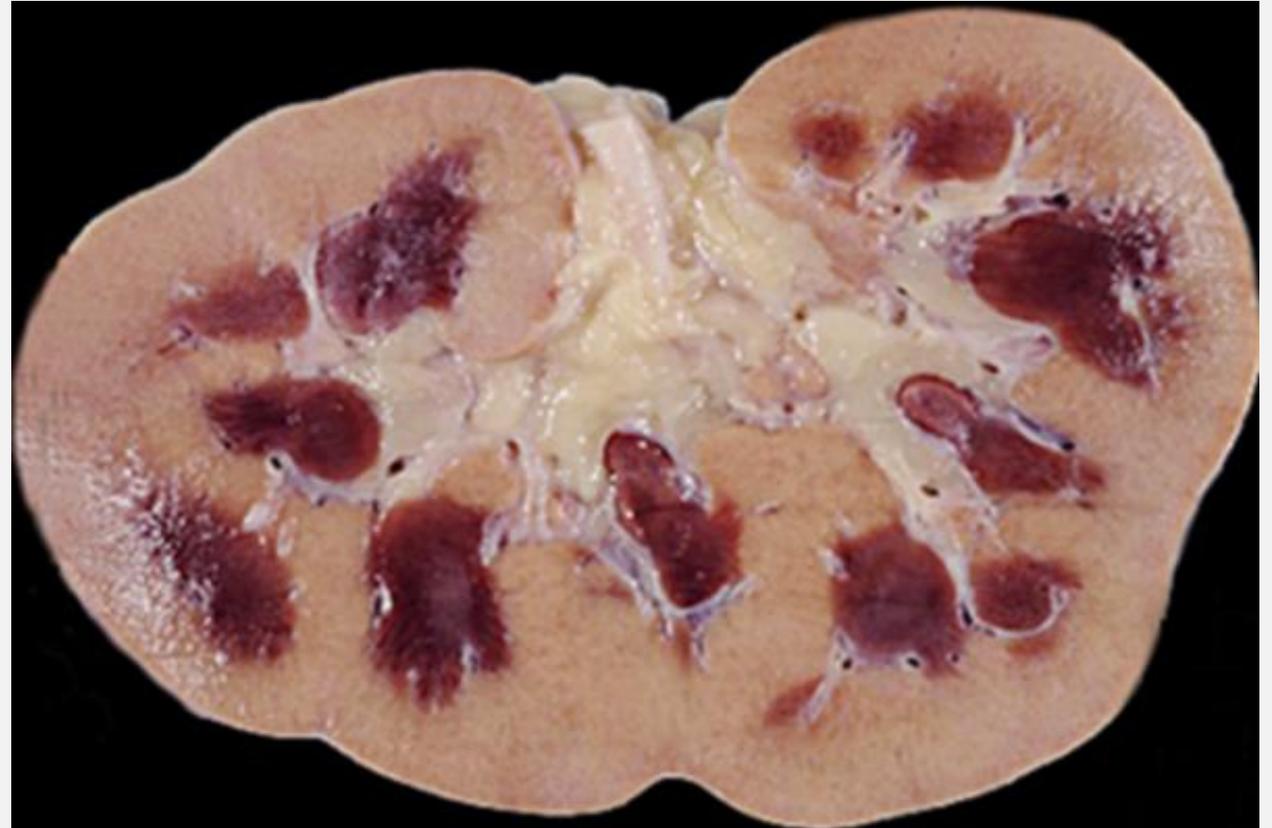
- Blood or fluid loss
- Blood pressure medications
- Heart attack
- Heart disease
- Infection
- Liver failure
- Use of aspirin, ibuprofen (Advil, Motrin IB, others), naproxen sodium (Aleve, others) or related drugs
- Severe allergic reaction (anaphylaxis)
- Severe burns
- Severe dehydration

These diseases, conditions and agents may damage the kidneys and lead to acute kidney failure:

- Blood clots in the veins and arteries in and around the kidneys
- Cholesterol deposits that block blood flow in the kidneys
- Glomerulonephritis (gloe-mer-u-loe-nuh-FRY-tis), inflammation of the tiny filters in the kidneys (glomeruli)
- Hemolytic uremic syndrome, a condition that results from premature destruction of red blood cells
- Infection
- Lupus, an immune system disorder causing glomerulonephritis
- Medications, such as certain chemotherapy drugs, antibiotics and dyes used during imaging tests
- Scleroderma, a group of rare diseases affecting the skin and connective tissues
- Thrombotic thrombocytopenic purpura, a rare blood disorder
- Toxins, such as alcohol, heavy metals and cocaine
- Muscle tissue breakdown (rhabdomyolysis) that leads to kidney damage caused by toxins from muscle tissue destruction
- Breakdown of tumor cells (tumor lysis syndrome), which leads to the release of toxins that can cause kidney injury

Diseases and conditions that block the passage of urine out of the body (urinary obstructions) and can lead to acute kidney injury include:

- Bladder cancer
- Blood clots in the urinary tract
- Cervical cancer
- Colon cancer
- Enlarged prostate
- Kidney stones
- Nerve damage involving the nerves that control the bladder
- Prostate cancer



IN PRACTICAL ACTIVITIES, THE AKI SHOULD BE DETERMINED BY THE RECOMMENDATIONS OF **KDIGO**. IT MUST BE AT LEAST TWO OF THE FOLLOWING CRITERIA:

- Increase in SCr by ≥ 0.3 mg/dl (≥ 26.5 $\mu\text{mol/l}$) within 48 hours; or
- Increase in SCr to ≥ 1.5 times baseline, which has occurred within the prior 7 days; or
- Urine volume < 0.5 ml/kg/h for 6 hours.

Risk, Injury, Failure, Loss of kidney function and End-stage kidney disease (RIFLE) classification

Class	GFR	UO
1 (Risk)	↑ SCr × 1.5 or ↓ GFR >25%	<0.5 mL/kg/h × 6 h
2 (Injury)	↑ SCr × 2 or ↓ GFR >50%	<0.5 mL/kg/h × 12 h
3 (Failure)	↑ SCr × 3 or ↓ GFR >75% or if baseline SCr ≥353.6 μmol/L(≥4 mg/dL) ↑ SCr >44.2 μmol/L(>0.5 mg/dL)	<0.3 mL/kg/h × 24 h or anuria × 12 h
Loss of kidney function	Complete loss of kidney function >4 weeks	
End-stage kidney disease	Complete loss of kidney function >3 months	

GFR - glomerular filtration rate; UO - urine output; SCr - serum creatinine.

Chronic kidney disease (CKD) - kidney damage or a decrease in their function for 3 months or more.

The disease is classified in 5 stages that require treatment and treatment of diseases of terminal renal failure and cardiovascular complications.

Modern classification is based on two indicators

- **Glomerular filtration rate (GFR)** and signs of kidney damage (**proteinuria, albuminuria**).

Depending on their combination, five stages of chronic kidney disease are identified.



The CKD-EPI equation, expressed as a single equation, is:

$$\text{GFR} = 141 * \min(\text{Scr}/K, 1)^\alpha * \max(\text{Scr}/K, 1)^{-1.209} * 0.993^{\text{Age}} * 1.018 \text{ [if female]} * 1.159 \text{ [if negroid race]}$$

Scr is serum creatinine (mg/dL),

K is 0.7 for females and 0.9 for males,

α is -0.329 for females and -0.411 for males,

min indicates the minimum of Scr/K or 1, and

max indicates the maximum of Scr/K or 1.

CKD-EPI Equations for Glomerular Filtration Rate (GFR) ☆

Estimates GFR based on serum creatinine, serum cystatin C, or both.

When to Use ▾ Pearls/Pitfalls ▾ Why Use ▾

Equation	<input type="radio"/> CKD-EPI Creatinine
	<input checked="" type="radio"/> CKD-EPI Cystatin C
	<input type="radio"/> CKD-EPI Creatinine-Cystatin C
Gender	<input type="radio"/> Female <input type="radio"/> Male
Age	<input type="text"/> years
Serum cystatin C	Norm: 0,51 - 0,98 mg/L

**Prognosis of CKD by GFR
and albuminuria categories:
KDIGO 2012**

**Persistent albuminuria categories
Description and range**

A1

A2

A3

Normal to
mildly
increased

Moderately
increased

Severely
increased

<30 mg/g
<3 mg/mmol

30–300 mg/g
3–30 mg/mmol

>300 mg/g
>30 mg/mmol

**GFR categories (ml/min/1.73m²)
Description and range**

G1

Normal or high

≥90

G2

Mildly decreased

60–89

G3a

Mildly to moderately
decreased

45–59

G3b

Moderately to
severely decreased

30–44

G4

Severely decreased

15–29

G5

Kidney failure

<15

STAGES 3–5 CORRESPOND TO THE DEFINITION OF **CHRONIC RENAL FAILURE** (A DECREASE IN GFR OF 60 OR LESS ML/MIN).

STAGE 5 CORRESPONDS TO **TERMINAL CHRONIC RENAL FAILURE** (UREMIA)!

Signs of chronic renal failure often appear very slowly:

- decrease the amount of urine
- swelling of face, arms, legs
- loss of appetite
- itching of the skin
- feeling of chronic fatigue
- high blood pressure



Considering that the development of end-stage chronic renal failure in most cases is unavoidable (in some cases, decades later), the entire period before renal replacement therapy requires **careful dynamic monitoring** of the state of most organs and systems **by a nephrologist and other specialists.**

