

**MINISTRY OF HEALTH OF UKRAINE
NATIONAL MEDICAL UNIVERSITY
named O.O. BOGOMOLTS**

**METHODOLOGICAL RECOMMENDATIONS
to practical classes for students**

<i>Academic discipline</i>	Propaedeutics of pediatrics including nursing practice, basic medical skills in the pediatric department
<i>Direction preparation</i>	22 "Health Care" , II (Master's) educational and qualification level
<i>Specialty</i>	222 "Medicine"
<i>Chair</i>	Pediatrics No. 2
<i>Content module 2</i>	Anatomical and physiological features of organs and systems in children, clinical examination techniques. Semiotics of syndromes affecting each system and the most common diseases.
<i>Topic:</i>	Anatomical and physiological features, methods of examination of the urinary system organs in children. Laboratory and instrumental methods of examination. Semiotics of syndromes of urinary system lesions.
<i>Course</i>	3

Approved at the meeting of the Department of Pediatrics No. 2 dated " 2_ " August 202 6 , protocol number 1

Reviewed and approved: CMC for pediatric disciplines dated " 2_ " August 202 6 , protocol No. 1

Goal: formation of professional competencies to achieve program learning outcomes in anatomical and physiological features, physical examination techniques and semiotics of urinary system diseases in children , namely:

student's acquisition of knowledge about:

- ✓ anatomical and physiological features of the urinary system in children depending on age and their clinical significance;
- ✓ features of the embryogenesis of the urinary system in children on the origin of congenital anomalies of the development of the kidneys and ureters;
- ✓ evaluation of the results of a general urinalysis, urine analysis according to Nechyporenko, Zimnitsky, urine analysis for bacteriuria in children of different ages.

student acquisition of skills in:

- ✓ collecting a medical history from a sick child or his/her parents, identifying complaints of extrarenal and renal origin;
- ✓ examination of the urinary system and analyze the results obtained;
- ✓ performing palpation and percussion of the kidneys;
- ✓ changes in individual indicators of laboratory research methods.

2. Competencies:

- ✓ drawing up a diagnostic algorithm for children with urinary system pathology;
- ✓ Interpretation of laboratory results and methods of examination of children with urinary system pathology.

Equipment – textbook, computer, mannequin.

Lesson plan and organizational structure

Stage name	Stage description	Levels of absorption*	Time (min)

*

Preparatory stage	Organizational events Setting learning goals, motivating students	*	2 0
Main stage	Test control on the topic of the lesson, verification and announcement of results.	**	20
	- theoretical survey;	*, **, ***	55
	- demonstration of practical skills, clarification of the most important points regarding evaluation of urine test results in children (general urine test, urine test according to Nechyporenko and Zimnytsky, bacteriological examination of urine); - students' work on acquiring skills in clinical examination of children with urinary system pathology . Solving problems on the topic of the lesson.	*****	2 5
Summary	Analysis and evaluation of student work results. Announcement of the topic of the next lesson, an indicative map for independent work with literature.	*	15
	Total of 3 academic hours		1 3 5 min

Familiarization, **reproduction, *** reconstructive, ***** creative levels of assimilation.

3. Content of the training material

3.1. List of basic terms, parameters, and characteristics that a student must learn in preparation for the class:

No. of the company	Term	Definition
1.	pollakiuria	Increased frequency of urination
2.	oliguria	With a decrease in the number of urinations
3.	enuresis:	Enuresis
4.	polyuria	increase in daily diuresis by 2 times
5.	nocturia	decreased daytime diuresis and increased nighttime diuresis
6.	Ishuria	Not all urine is released from the bladder or the inability to urinate when there is an urge to do so.
7.	oliguria	daily diuresis is $\frac{1}{4}$ or less of the normal volume

8.	anury	complete cessation of urination during the day or a decrease in the amount of urine excreted to 5%;
9.	stigma and dysembryogenesis	anomalies of the shape of the skull, ears, eyes, wide nose bridge, impaired tooth growth, polydactyly, etc.
10.	ascites	accumulation of transudate in the abdominal cavity
11.	hydrothorax	Accumulation of transudate in the pleural cavity
12.	hydropericardium	Accumulation of transudate in the pericardial cavity
13.	anasarca	Widespread subcutaneous edema
14.	phimosis	Pathological narrowing of the foreskin opening, which does not allow the glans penis to be exposed
15.	cryptorchidism	Absence of one or both testicles in the scrotum
16.	hyposthenuria	Decreased urine specific gravity
17.	hypersthenuria	Increased urine specific gravity
18.	isosthenuria	Monotonically low relative density of urine, equal to the relative density of blood plasma

Anatomical and physiological features

Kidneys	The sizes of newborns are relatively larger and they are lower than in adults. The right kidney is located below the left one. The capsule in newborns is very thin. Insufficient development of the ligaments that fix them	Ability to palpate the kidneys Significant physiological mobility, possibility of nephroptosis development
Nephron:	In the postnatal period, it retains signs of morphological immaturity; Not fully differentiated and have a small diameter, the epithelium is cylindrical Relatively small length and width Incompletely differentiated and have a small diameter	
Globules		
Tubules	Relatively small length and width	Reduced functionality Possibility of urine stagnation and the appearance of an inflammatory process
Kidney bowls	Relatively large in size, poorly developed elastic and muscle fibers, which causes their hypotonicity	
Ureter	Short length of the intravesical segment;	Possibility of vesicoureteral reflux The possibility of inflammatory processes, the basis for the

	Relatively longer and wider, more sinuous, the muscular elements of the shell are weakly expressed, elastic fibers are absent; The mucous membrane has a characteristic fold.	development of megaloureter, hydronephrosis
Bladder	located above; Muscle and elastic fibers of the wall are underdeveloped ; the mucous membrane is tender and loose poorly developed muscle fibers of the ureteral sphincters	Development of inflammatory processes Creating conditions for the development of vesicoureteral reflux
Glomerular filtration	Lower and is 30-50% of the size of adults	
Tubular reabsorption	Imperfect, reaches adult values by 10-12 years of age. Immaturity of tubular glucose reabsorption Sodium reabsorption is more efficient than in adults	Physiological glycosuria Tendency to edema formation
Stabilization of the KOS	Tubular immaturity to ammonia synthesis and low phosphate content in primary urine	Prone to nutritional and endogenous acidosis
Water-retaining function	Imperfect.	High diuresis is characteristic, but when it is administered in small portions
Concentration function	Limited. Short loop of Henle, reduced sensitivity of distal tubules to the action of antidiuretic hormone The first days – 1006-1012	up to 3 months old, children are not able to produce hypertonic urine
Urine specific gravity indicators	Breast age – 1002-1006 2-5 years – 1010-1015 Over 5 years old – 1010 - 1025	A high protein load in the diet negatively affects the concentration function of the kidneys.
Daily diuresis	1 month – 300 ml; 6 months – 400 ml; 1 year – 600 ml 1-10 years: $V = 600 + 100 (n - 1)$, where n is the number years of the child	
Number of urinations	Significant daily diuresis and small bladder capacity, lack of conscious regulation of urination The first 3 days – 5-6 times; 2 weeks – 6 months – 20-25 times; 1 year – 10-15 times; 3 – 10 years – 6-8 times over 10 years old – 5-6 times	Increased urination

Examination methodology

Medical history (harmful effects on the mother's body during pregnancy, previous infectious diseases, taking medications), hereditary history.

The presence of infectious diseases in the child 2 weeks before the appearance of complaints from the urinary system.

Complaints

Real:

I. Pain:

1. Localization:

- ✓ in the stomach;
- ✓ in the lumbar region;
- ✓ right, left, on both sides;

2. Character:

- ✓ acute (cutting, burning, cramping);
- ✓ dull (aching, pressing, pulling).

3. Intensity: strong, slight.

4. Onset (sudden, acute, gradual) and under what conditions (physical exertion, change in body position)

5. Duration.

6. Irradiation (along the course of the ureters, to the bladder, genitals, perineum, groin area, thigh).

II. Urination disorders

- ✓ Pain during urination (at the end or beginning)
- ✓ Urination frequency:
 - pollakiuria* – increased frequency of urination;
 - oliguria* – decreased urination;
- ✓ Urinary incontinence – *enuresis* : daytime, nocturnal.
- ✓ Changes in the amount of urine: *polyuria* - an increase in daily diuresis by 2 times; *oliguria* - daily diuresis is ¼ or less of the normal volume; *anuria* - complete cessation of urination during the day or a decrease in the amount of urine excreted to 5%; *nocturia* - a decrease in daytime diuresis and an increase in nighttime diuresis.
- ✓ Urinary retention *ischuria* (complete or incomplete) – the release of less than the entire volume of urine from the bladder or the inability to perform the act of urination despite the urge to do so.

Extrarenal:

- ✓ headache;
- ✓ dizziness, increased fatigue;
- ✓ thirst;
- ✓ palpitations, pain in the heart area;
- ✓ dyspnea;
- ✓ nausea, vomiting;
- ✓ increased body temperature;

- ✓ vision impairment.

Review

- ✓ Consciousness.
- ✓ Physical development.
- ✓ The presence of stigmata of dysembryogenesis (anomalies of the shape of the skull, auricles, eyes, broad nose bridge, impaired tooth growth, polydactyly, etc.).
- ✓ The child's body position in bed: the presence of a forced position (the child lies on his side, legs bent at the knee and hip joints and brought to the torso - a purulent-inflammatory process around the renal fat layer).
- ✓ The child's behavior - with renal colic, the child is agitated and cannot find a place to sit.
- ✓ Skin color – pallor is caused by spasm of blood vessels and compression by edema fluid or is associated with decreased secretion of erythropoietin and the development of anemia.
- ✓ Swelling: under the eyes, on the face, lower limbs, lower back, genitals, in severe cases in cavities (ascites, hydrothorax, hydropericardium) and throughout the body (anasarca).
- ✓ Body asymmetry in the kidney or abdominal area (presence of a kidney tumor).
- ✓ A bulge above the pubis is a sign of significant urinary retention.
- ✓ Examination of the external genitalia (stage of development, developmental anomalies, discharge from the urethra and vagina (varicocele, epididymitis, hydrocele, cryptorchidism, ectopia scrotum, phimosis, paraphimosis).

Palpation and percussion

In healthy children, the kidneys are not palpable. They become accessible when they are mobile, prolapsed, or enlarged .

1. Obratzsov-Strazheska method

- ✓ the child's position is horizontal;
- ✓ the child's legs are slightly bent and apart;
- ✓ palpation of the right kidney: the doctor's left hand is under the torso in the projection of the right kidney,

The doctor's right hand lies with the entire palm outward from the right rectus abdominis muscle (parallel to it), the fingers are located slightly lower than the right costal arch; having assumed this position, against the background of exhalation the right hand moves deeper and deeper inward. At the same time, the palm of the left hand rises up, which helps to bring the kidney closer to the fingers of the right hand. Therefore, in the case of possible palpation of the kidneys, the left hand first feels the lower pole of the kidney. Further, the size, shape, mobility, soreness, density, possible hilliness of the kidney wall are assessed with sliding movements.

- ✓ Palpation of the left kidney according to the technique corresponds to the described one with the exception: the left hand is placed under the torso to the projection of the left kidney, the right hand is located outside the left rectus abdominis muscle.

2. Botkin's method - similar to the Obraztsov-Strazheska method except that the patient's position is vertical. This method is more successful with significant kidney mobility, since in the patient's standing position they drop down.

Pasternatsky's symptom (tapping)

To do this, short, light strokes are made with the fingers of the right (or left) hand or the lateral (elbow) edge of the right hand (with the fingers folded together) on the back surface of the fingers of the left hand, placed on the lumbar region. In the presence of inflammation, the patient feels pain. It should be remembered that the Pasternatsky symptom can be positive in myositis, radiculitis. In young children, it is difficult to assess the subjective sensations that arise when determining this symptom.

Palpation of the upper and middle ureteric points

The superior ureteric point is located at the intersection of two such lines: horizontal at the navel level and vertical – three transverse fingers on both sides of it.

The median ureteric point is located at the intersection of two lines - a horizontal line connecting the anterior spines of both iliac bones and a vertical line passing through the pubic tubercle.

Bladder percussion in young children

It is carried out along the midline from the level of the navel towards the pubis. The finger-plesimeter is placed parallel to the pubis. If the bladder is full, when tapping, there is a dullness above the pubis, if it is empty - a boxy sound.

Urine test

1. General urine analysis

For the study, all urine from the first morning urination is used. Urine is collected after thorough washing of the child into a clean (non-sterile) container in which it will be delivered to the laboratory to avoid the destruction of some elements of the urinary sediment. Normative data for general urine analysis

Urine color

- on the first day of a child's life, the urine is colorless;
 - sweat for 2-4 days — dark red (a lot of uric acid is excreted)
 - from the late neonatal period :
 - *with natural feeding* urine is almost colorless , and after the introduction of complementary foods and for LIFE it becomes straw-yellow in color;
 - *when artificially feeding* This straw-yellow color will be present from the first weeks of life.
- Urine color is an important auxiliary indicator both in diseases of the kidneys and urinary tract, and in damage to other organs.
- colorless urine is determined by polyuria ;
 - urine becomes orange if the food contains a lot of carotene;
 - raspberry col and p — if a lot of beets are taken;

— taking some medicinal drugs gives the following color changes:

- red — rifampicin;
- pink — analgin, phenolphthalein, sulfonamides;
- green, blue — methylene blue;
- saffron yellow — nitroxoline

— changes the color of urine due to an increased amount of salts:

- cipo - milky color - phosphates;
- brick-red color - urates, oxalates;

— beer color = dark brown — one of the differential signs of viral hepatitis ; such color is due to a large number of bile pigments ; a characteristic feature is the appearance of yellow foam after shaking this is due to the whiteness of the skin ;

— the color of “meat washings ” (this is the color of water after washing meat) . It occurs in the case of damage to the renal corpuscle and the passage of erythrocytes through the basal membrane, WHICH in this case lose hemoglobin; such erythrocytes are called "leached." This is a sign of acute glomerulonephritis.

— bright red color (like blood) occurs when the urine contains so-called fresh erythrocytes that came directly from the bloodstream — trauma, tuberculosis, acute kidney stones, kidney tumor, cystitis, urethritis;

—dark purple, even black color is a sign of significant hemolysis of erythrocytes in severe poisoning with poisons, drugs, Rh- conflict, transfusion of blood of an incompatible group, etc.;

— pink color is urobilin in chronic hepatitis .

Transparency . Normally , urine can be opaque, that is, cloudy, only in a newborn for a few days , but in a healthy person it is always transparent. The transparency of the blood in the form of turbidity is determined by:

- increased amount of salts in it;
- the presence of bacteria;

The reaction to this varies in children of different ages and depends on the food consumed:

newborn - slightly acidic (pH 5.5-6);

Breastfeeding and breastfeeding period - *slightly* alkaline (pH 7-8);

artificial feeding - slightly acidic (pH 5.5-7);

after 1 year - usually slightly acidic (pH 5-7);

If there is more protein in the food , the urine changes to the acidic side, if there is more plant products , the urine changes to the alkaline side.

An acidic reaction occurs when:

- kidney failure (a diseased kidney does not produce ammonia, which neutralizes urine);
- tuberculosis of the kidneys and urinary tract;
- diabetes mellitus ;
- diathesis of allergic genesis ;
- prolonged fasting

Under the elevation in the side **Alkaline reaction** occurs when :

- taking alkaline medications and mineral waters ;
- urinary tract infections (bacteria destroy urea, resulting in the formation of urea and urease , which leaches into the urine);
- resolving edema and ;
- increased acidity of gastric juice ;
- significant acidic vomiting ;
- metabolic alkalosis.

Specific gravity is an indicator of **the** concentration of dissolved substances in a solution . It depends on the amount of liquid taken , the type of product , and also the age .

Norms no among no yes no :

The first days – 1006-1012

Breast age – 1002-1006

2-5 years – 1010-1015

Over 5 years old – 1010 – 1025

Reduction specific gravity (hyposthenuria) It is important when :

—intake of large amounts of fluids ;

- severe renal failure ;

— reduction of edema ;

— diabetes insipidus .

Increase in specific gravity (hypersthenuria) It occurs when :

— insufficient fluid intake;

— oliguria

— diabetes mellitus (despite the presence of polyuria, since 0.1 g/l of glucose increases the relative density of ce h i by 0.004);

— the secretion of a large amount of proteins (0,4 rprotein increases the specific gravity by 0.001).

Protein in urine **is** usually absent , but a normal amount of **up** to 0.033‰=0.033g/l is assumed (sometimes in the analysis in this case it may be to be written — sl id y).

The excretion of protein in the urine is called proteinuria:

— moderate — up to 1 g/l;

— high (=significant) — more than 1 g/l.

In addition, according to etiology, they distinguish:

— renal = true (organic and functional) proteinuria;

— extrarenal proteinuria.

The cause of renal organic proteinuria is damage to the structure of the renal parenchyma (for example, in glomerulonephritis), when filtration increases and protein reabsorption decreases.

Renal functional proteinuria occurs as a result of increased permeability of the renal filter or slowing of blood flow in response to strong external stimuli:

— albuminuria in a newborn — functionally immature filter and extrarenal loss of large amounts of urine ;

— alimentary proteinuria — from food intake , rich in proteins;

— orthostatic proteinuria — occurs in preschool and school - age children only in a standing position (disappears in a lying position) ;

— severe heart failure , ascites, tumor; however, with prolonged blood stasis , organic kidney damage may develop ;

— infectious diseases accompanied by fever.

Functional renal proteinuria is less pronounced than organic proteinuria and resolves after the factor disappears .

Extrarenal proteinuria is the presence of proteins in the urine that are released during inflammation of the urinary tract and genitals (cystitis , urethritis , vulvovaginitis) .

Microscopic examination of urine sediment

Epithelial cells from the stratified epithelium of the urinary tract in small numbers — up to 2-4 in the field of view — can always be found in a general urine analysis . Polymorphic cells — from the urinary mix , flat — from the urinary bladder.

Since in girls the squamous cells of the urinary tract are similar to the cells of the mucous membrane of the vagina , the result of the analysis of the urinary tract They may not be significant . In boys , they are mandatory. An increase in the number of epithelial cells indicates an inflammatory process: urethritis (flat) and cystitis (polymorphic).

Cells renal epithelium (from the tubules in the kidneys) – round – should not be present in the analysis of a healthy child, they are detected in the urine simultaneously with proteinuria and the presence of cylinders in acute and chronic kidney diseases.

Leukocytes are normal and 1-3 in the field of view, can be up to 5 in the field of view, in girls - up to 10 in the field of view.

An increase in the number of leukocytes in the urine of more than 5-6 in the field of view (in girls - more than 10 the field of view) is called leukocyturia (=pyuria).

Depending on the location of the release of formed elements, leukocyturia occurs in:

— true — a sign of pyelonephritis, cystitis, renal tuberculosis, glomerulonephritis, when leukocytes enter the urinary system from the organ;

— incorrect — leukocytes are detected in the urine, but enter it and from the genitals (vulvovaginitis).

Erythrocytes in urine are absent or 1-2 in the field of view. Erythrocytes in urine have the appearance of rounded formations with pronounced double contours of yellow color. If the urine has an acidic reaction, the contours of erythrocytes are jagged, while in alkaline urine they swell. When erythrocytes lose hemoglobin, they have the appearance of colorless discs (shadows of erythrocytes).

An increase in the number of red blood cells (3 or more in the field of view) is called hematuria.

There are 2 types of hematuria:

— real;

— false (vulvovaginitis, menses in girls).

Depending on the number of red blood cells, hematuria is divided into 2 more types:

— microhematuria — less than 50 in the field of view; in this case, urine should not be red in color, and erythrocytes are detected only by microscopic examination

— macrohematuria — more than 50 in the field of view, urine visually has a red color.

As noted above, based on the characteristics of the red color, it can be assumed that, like erythrocytes in urine, they are FRESH. (bright red color) or leached (color of "meat slop").

Cylinders. *Cylinders are clumps formed in the nephron tubules as a result of the fusion of proteins, shaped elements and epithelial cells that have accumulated there; the clumps have the appearance of straight and winding cylinders of various widths and length.*

In normal and general analysis, there can only be hyaline casts in the amount of not more than 1 per 2-3 the fields of view. Hyaline casts are proteinaceous deposits of the nephron tubules. In acidic urine they are stored unchanged for a long time, and in alkaline they quickly collapse.

Therefore, to assess this indicator, it is necessary to take into account the reaction of urine

Sometimes in the general analysis of the urine there may be cylindroids, which are formed from mucus, also in single quantities. An increase in the number and appearance of pathological cylinders is a serious sign of significant changes in the kidneys themselves or the reaction of the kidneys to a general infection and intoxication. Cylinders are no more than 1 in 2-3 fields of vision. The main pathological types of cylinders are:

— hyaline and cylindroids, if their number exceeds the norm; observed in urine with BC AND X diseases of the kidneys and urinary tract; the number of hyaline casts may also increase with proteinuria, physical exertion, and fever.

— leukocyte — consist of leukocytes; are formed in the kidneys during pyelonephritis;

— epithelial — accumulations of tubular epithelium in the nephron — and granular — are formed from destroyed epithelial cells of the kidneys; they are found in acute and chronic kidney diseases. The appearance of granular cylinders usually indicates a long-term degenerative process in the kidneys.

— wax-like — this is the result of HIGH-QUALITY protein changes in case of severe kidney damage:

— blood (= hemoglobin) — consist of erythrocytes , more often leached, or even of clots blood that has formed in the tubules of the nephron ; this is a sign of glomerulonephritis , renal bleeding. **Salts** . Normally, some salts (oxalates, phosphates) may be present in the general urine analysis . This depends on the composition of the food consumed and, as a result, on the urine reaction (some salts precipitate in acidic urine - calcium phosphate , uric acid, urates, others - in alkaline urine - calcium carbonate and oxalate). The number of salts is normally small. As a rule, the result is indicated by pluses - from " + " to "++++".

The normal number is considered to be | (+) — (++). |In some laboratories words are used — a small number .

In addition to the above - mentioned indications of the amount of salts , the analysis should state which salts were detected (oxalates , urates) .

The presence of salts (+++) and (++++) is considered pathological , it can be written - in capital letters. how much and .

Some examples of pathological indicators are :

- calcium oxalate is a sign of kidney stones;
- cholesterol crystals — also stones , but made of cholesterol;
- bilirubin crystals — are found in hepatitis and others ;
- phosphate crystals — in significant quantities in cystitis and burns , vomiting , metabolic disorders , functional disorders of the central nervous system , etc.

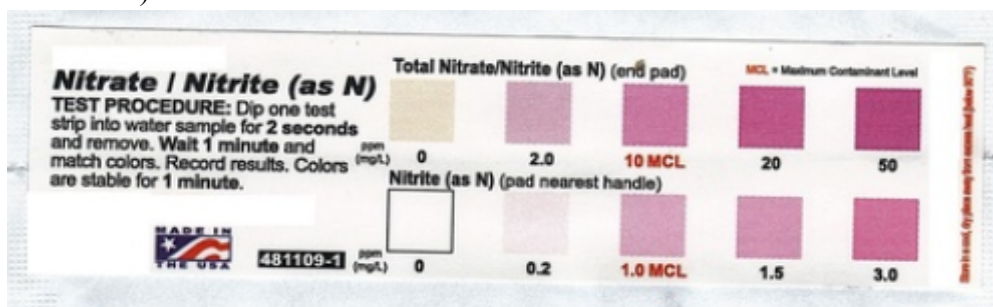
Mucus can normally be present in small amounts in the urine of only a newborn baby .

Presence of mucus and bacteria in the urine is a sign of an inflammatory process. However, for a more accurate diagnosis, it is necessary to prescribe a special urine test for bacteria in the urine .

2. Rapid tests

Nitrite test is a mandatory element of mastering **screening diagnostics of urinary tract infections** . Express diagnostics is based on the chemical reaction of Griess: gram-negative bacteria produce the enzyme *nitrate reductase* , which reduces nitrates (which come with food) to nitrites. **Patient preparation:** Thorough toilet of the external genitalia. An average portion **of the first morning urine is collected** (it is important that the urine is in the bladder for at least 4 hours to undergo an enzymatic reaction). The test strip is immersed with the indicator zone in fresh urine for 1–2 seconds, after which the excess liquid is removed on the edge of the container or a napkin. The indicator color is evaluated exactly after **60 seconds** (compared with the color scale on the bottle).

Interpretation of results: A positive result (Nitrite: Positive) is a direct marker of bacteriuria . It indicates the presence of urinary tract infections (pyelonephritis, cystitis, asymptomatic bacteriuria).



Test : Rapid **detection of leukocyturia (pyuria)** - the main marker of inflammation in the urinary system. Express diagnostics is based on the detection of the enzyme *esterase* , which is contained in the lysosomes of granulocytes (neutrophils). **Preparation and collection of urine:** A thorough toilet of the external genitalia is performed. An average portion of fresh urine is collected. The

test strip is immersed with the indicator zone in urine for 1–2 seconds. Excess liquid is removed by the edge of the container. The indicator color is evaluated strictly after **2 minutes** according to the color scale on the bottle. **A positive result (LE: Positive** - the appearance of a pink-violet color of varying intensity indicates the presence of leukocyturia.



In pediatric practice, these tests are never evaluated in isolation. Only a combined analysis of both parameters has high clinical value.

Test results	Sensitivity / Specificity	Tactics
Both (+)	Specificity $\approx$ 99	The diagnosis of urinary tract infection has been confirmed.
Both (-)	Negative predictive value $\approx$ 95	Urinary tract infection is unlikely.
Esterase only (+)	Sensitivity $\approx$ 85	Screening is positive. Referral for microscopy and culture.

3. Methods for quantitative determination of formed elements. They allow to more accurately establish the degree of leukocyturia, erythrocyturia, cylindruria. Their implementation is indicated in the following situations: 1) the general urine analysis is normal or there are minor changes, and the clinical picture indicates pathology of the kidneys or urinary tract; 2) after the treatment, the general urine analysis indicators have normalized, but the positive result must be confirmed.

Nechiporenko method

- determination of the number of casts in 1 ml of urine. At least 10 ml of urine from the middle portion of morning urination is collected in a clean dry container (prevention of casts from the lower parts of the urinary system and genitals). The method is simple and convenient to use.

4. Zimnitsky test.

This is a method of determining the functional ability of the kidneys to osmotic concentration and osmotic dilution. Rules for conducting:

- normal diet without fluid restriction;
- first urination at 6:00 a.m., urine is not collected;
- after that, starting at 9:00, every 3 hours (9:00, 12:00, 15:00, 18:00, 21:00, 24:00, 3:00, 6:00) the child urinates in turn into each clean dry container for which the time is indicated;
- if the child has the need to urinate between the specified times, he or she should void into the next container;
- if at some point the child does not urinate, the container remains empty;
- all 8 containers are sent to the laboratory a day later and tested:

1. The total amount of daily diuresis, which should be 65-75% of the volume of fluid consumed.

2. The ratio of daytime (first 4 portions of urine) and nighttime (last 4 portions) diuresis, which is normally 2:1.

3. Determination of the **specific gravity** of urine and its fluctuations during the day. Normally, the difference between the maximum and minimum values should be at least 7. If this difference is 7 or less, this phenomenon is called **isosthenuria** (in this case, the **specific gravity** of urine can be equal to the relative density of blood plasma) and this indicates a decrease in the concentration function of the kidneys and occurs in renal failure.

4. **Urine analysis for bacteriuria and antibiotic sensitivity.**

Diagnosis of urinary tract infections in children requires confirmation of pyuria, which is done by bacteriological culture of urine obtained by collecting a midstream urine sample, bladder catheterization, or bladder puncture (suprapubic aspiration). For children who do not yet have toilet training skills (not toilet trained): catheterization or suprapubic aspiration. For children who are toilet trained, midstream urine (clean voiding sample) is used.

Clinically significant concentration limits of uropathogens and fungi.

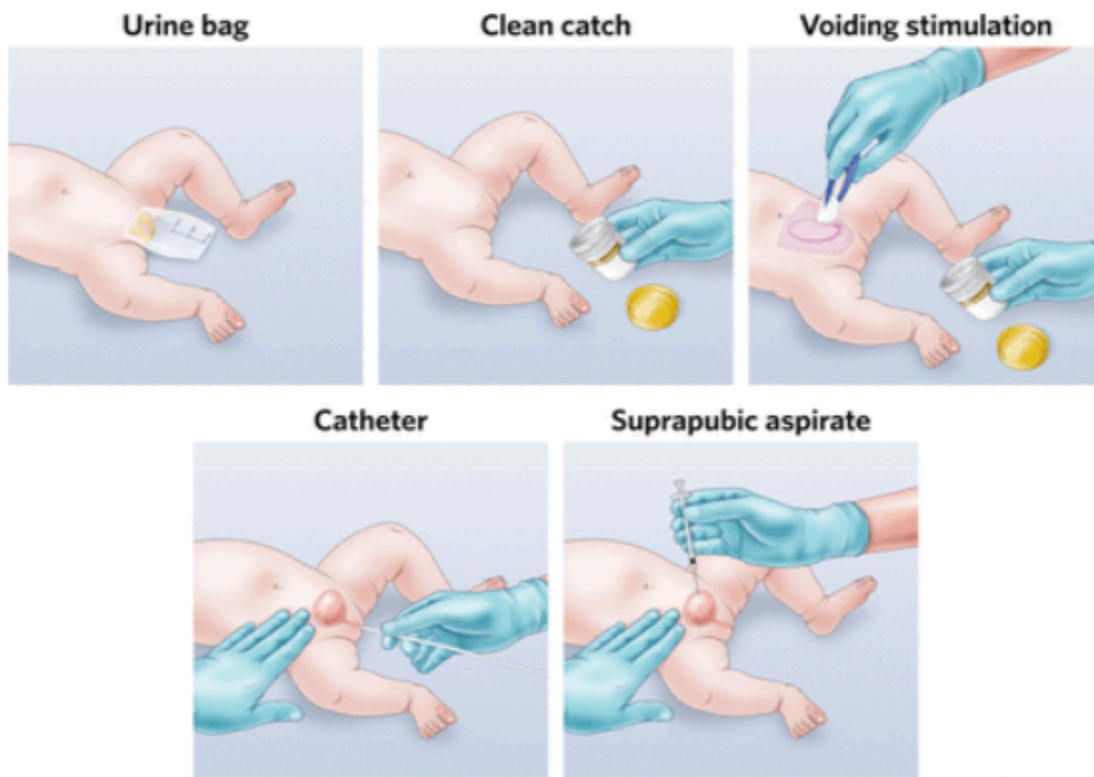
Collecting an average portion of urine	$\geq 100,000$ CFU in 1 ml of urine
Sample taken using a catheter	$\geq 50,000$ CFU in 1 ml of urine
A sample taken by urinary puncture bladder	$\geq 1,000$ CFU in 1 ml of urine

<https://www.update.com/contents/urinary-tract-infections-in-infants-and-children-older-than-one-month-clinical-features-and-diagnosis>

Rules for collecting analysis (collecting an average portion of urine)

- urine is collected in a sterile container;
- the child must be washed thoroughly before collecting urine;
- it is better to take an average portion of urine in an amount of at least 1 ml;
- urine should be tightly closed and urgently delivered to the laboratory to prevent the development of some bacteria during long-term storage (micrococcus, sarcinia).

The research period is 3-7 days.



Pyelonephritis

Complaints:

- ✓ increase in body temperature to febrile figures with chills for 2-4 days, sometimes a single increase to febrile figures and then a decrease to subfebrile and its long-term maintenance. High body temperature figures are most characteristic of young children. Sweating is noted at the beginning and end of the decrease in body temperature.
- ✓ manifestations of intoxication syndrome: headache, lethargy, increased fatigue, decreased appetite, dizziness;
- ✓ Pain syndrome: low back pain, usually mild, worsens during physical activity, sometimes localized in the suprapubic area. In young children, anxiety attacks may be associated with abdominal pain;
- ✓ urination disorders (dysuria, pollakiuria, enuresis, nocturia), sometimes they precede the increase in body temperature.
- ✓ In young children, frequent symptoms of pyelonephritis may include vomiting and loose stools, which can lead to the development of intestinal toxicosis.

Examination: pale skin and mucous membranes, dark circles under the eyes.

Palpation and percussion: an attempt to palpate the kidney causes pain, deep palpation in the area of the ureters and bladder also causes pain. In older children, Pasternak's symptom is positive.

Results of laboratory research methods:

1. General urine analysis:

- ✓ cloudy,
- ✓ the reaction may be alkaline;
- ✓ low proteinuria – up to 1 g/l;
- ✓ significant leukocyturia, sometimes leukocytes can cover the entire field of vision
- ✓ single erythrocytes (mostly fresh);
- ✓ sometimes slight cylindruria (leukocytic or granular), indicating involvement of the renal tubules in the inflammatory process;
- ✓ bacteriuria;

2. Positive test for nitrites and leukocyte esterase.

3. Urine analysis for bacteriuria: (before prescribing antibiotic therapy) – the presence of CFU in 1 ml of urine, depending on the method of urine collection.

4. CBC – leukocytosis, shift of the leukocyte formula to the left, acceleration of ESR.

5. Increased CRP (C-reactive protein).

Glomerulonephritis

Complaints:

- ✓ intoxication syndrome: - weakness, lethargy, malaise, decreased appetite;
- ✓ increase in body temperature to subfebrile numbers;
- ✓ edematous syndrome: initially pasty on the face, under the eyes. Edema can also be localized in the scrotum, lower back, lower legs, feet. They usually appear in the morning, increase rapidly, but decrease in the evening if the child does not observe bed rest, usually due to uniform distribution throughout the body under the influence of muscle movements. Ascites, hydrothorax, hydropericardium, even the development of anasarca are characteristic of nephrotic syndrome;
- ✓ increased blood pressure (hypertensive syndrome) for 1-2 weeks. Often, normal systolic blood pressure is accompanied by increased diastolic pressure;
- ✓ urinary syndrome: oliguria, change in urine color – the color of “meat slops”;

Review:

- ✓ facial puffiness or swelling;
- ✓ pale skin

Palpation and percussion:

- ✓ positive Pasternacki symptom;
- ✓ muffled heart sounds, unstable systolic murmur, in the presence of pronounced edematous syndrome - expansion of the boundaries of relative cardiac dullness

Results of laboratory research methods :

General urine analysis :

- ✓ the color of "meat slops";
- ✓ hypersthenuria;
- ✓ proteinuria – can be from insignificant to 3 g/l or more, characterized by a high degree of selectivity;
- ✓ increased amount of exfoliated epithelium;
- ✓ erythrocyturia – there may be microhematuria with mainly leached erythrocytes (35-40 erythrocytes in the field of view) and macrohematuria – the color of “meat slops” appears;
- ✓ cylindruria – mainly erythrocytic and hemoglobinic, rarely leukocytic, in severe cases waxy or epithelial;
- ✓ Leukocyturia is an uncharacteristic symptom, possible in some cases in the first days of the disease, up to 20-30 leukocytes in the field of view, is transient.

2. Urine analysis according to Nechiporenko.

- ✓ significant erythrocyturia;
- ✓ significant cylindruria

3. Complete blood count:

- ✓ rarely normochromic anemia;
- ✓ slight leukocytosis with a slight increase in ESR

4. Biochemical blood test:

- ✓ hypoproteinemia;
- ✓ dysproteinemia – an increase in globulins due to α_2 - and γ -globulins;
- ✓ decrease in the A/G ratio;
- ✓ in the presence of oliguria - an increase in the content of creatinine and urea in the blood plasma, which indicates a violation of the nitrogen excretory function of the kidneys;
- ✓ hypercholesterolemia and hyperlipidemia in nephrotic syndrome.

5. Urine analysis according to Zimnitsky:

in the presence of oliguria – a decrease in daily diuresis, hypersthenuria.

Cystitis

Complaints:

- ✓ symptoms of intoxication are not pronounced

- ✓ dysuric phenomena – imperative urges to urinate, pain during urination, especially at the end, urination in small portions, premature cessation of urination.

Palpation: pain in the suprapubic area;

Results of laboratory research methods:

1. General urine analysis:

- ✓ leukocyturia;
- ✓ erythrocyturia – fresh red blood cells;
- ✓ proteinuria – traces of protein;
- ✓ bacteriuria;

2. Positive test for nitrites and leukocyte esterase.

3. **Urine analysis for bacteriuria:** pathogenic and conditionally pathogenic microflora are isolated in quantities depending on the urine collection.

Differential diagnostic value of urine changes

Indicator	Disease		
	Pyelonephritis	Glomerulonephritis	Cystitis
Color	Straw yellow	"meat slops", except for the nephrotic variant)	Straw yellow
Transparency	Muddy	Transparent	Muddy
Specific gravity	Norm	In acute cases – normal, in chronic cases – often reduced	Norm
Proteinuria	++ (up to 1 g/l)	+++ (more than 1 g/l)	+ - (traces of protein)
Erythrocyturia	+	Leached +++ (except nephrotic variant)	++ (fresh)
Bacteriuria	+++	-	++

Note: +++ significantly expressed; ++ moderately expressed; + weakly expressed; - absent

Acute renal failure is a sudden, severe impairment of various types of kidney function.

The clinic has 4 stages.

Initial (shock) – occurs 1-2 days after the action of the etiological factor, lasts 1-3 days with the following signs:

- ✓ oliguria;
- ✓ hypersthenuria

Oligoanuric stage – lasts 2-2.5 weeks:

- ✓ anury;

- ✓ progressive deterioration of the patient's condition;
- ✓ pallor with an icteric tinge;
- ✓ adynamia, headache, weakness;
- ✓ signs of azotemia and excretion of nitrogenous wastes - nausea, vomiting, itching of the skin, diarrhea, anorexia, stomatitis, colitis, gastritis;
- ✓ changes in the cardiovascular system: first a decrease in blood pressure, then hypertension, heart rhythm disturbances, the appearance of extrasystoles;
- ✓ various types of breathing abnormalities: Cheyne-Stokes, Kussmaul, pulmonary edema;
- ✓ cramps;
- ✓ signs of hyperkalemia – arrhythmias, cardiac arrest, muscle weakness
- ✓ signs of fluid overload – optic nerve head swelling, hypertension, heart enlargement, gallop rhythm, weight gain, pulmonary edema
- ✓ hyposthenuria – 1005-1008;
- ✓ increased urea, creatinine, hyperazotemia

The stage of restoration of diuresis (polyuric) lasts 1-6 weeks.

- ✓ increased diuresis;
- ✓ improvement of the patient's condition;
- ✓ Since the tubular epithelium is defective, the processes of reabsorption and secretion are ineffective: after 1-2 days hypo- and isosthenuria, hyposaltremia (hyponatremia, hypokalemia, hypomagnesemia, hypocalcemia) develop. Polyuria can reach 10 л within 24 hours. Infections are very common.

Recovery period – lasts up to 2 years.

restoration of the concentration function of the kidneys;
disappearance of anemia.

Chronic renal failure

a clinical symptom complex caused by a decrease in the number and change in the function of functioning nephrons, which leads to a violation of the homeostatic function of the kidneys. According to the recommendations of the 1st and 5th European Congress of Pediatric Nephrologists, chronic renal failure should be diagnosed in children with kidney and urinary tract diseases in the presence of:

glomerular filtration rate below 20 ml/min 1,73 m²;
serum creatinine level more than 0.177 mmol/l;
serum urea level more than 8.3 mmol/l

There are 4 stages of chronic kidney disease:

Stage I compensation	The volume of renal function is 80-50% of normal, and the number of functioning nephrons is from 50 to 25% of normal. Absence of clinical symptoms of CKD, minor microproteinuria and elevated blood pressure
Stage II subcompensation	The volume of renal function is 50-25% of normal, and the number of functioning nephrons is less than 30% of normal. Violation of tolerance to food ingredients, calcium absorption. Polyuria, excretion of a significant amount of electrolytes in the urine, decreased concentration ability of the kidneys, development of anemia.
Stage III decompensation	The volume of renal function is less than 30% of normal, and the number of functioning nephrons is less than 15% of normal. Anorexia, increasing neurological changes (apathy, muscle weakness or muscle spasms, headache, blurred vision, seizures), dry and itchy skin, hemorrhages and necrosis on the skin and mucous membranes, dyspepsia, pain in bones and joints, bone deformation, noisy breathing, impaired cardiovascular activity with bradycardia and hypertension.
Stage IV Uremia	Final renal function is less than 5%. Urea odor from the mouth, stomatitis, pharyngitis, pericarditis, pleurisy, pulmonary edema, development of coma

Recommended reading.

Basic:

1. Boyarchuk OR, Kinash MI, editors. Propaedeutics of pediatrics in syndromes: a textbook. Ternopil: Ukrmedknyga; 2022. 352 p.
2. Maidannik VG, Khaitovich MV, Mityuriaeva-Korniyko IO, Hnyloskurenko GV. Propaedeutic Pediatrics. Kyiv: VSV "Medicine"; 2018. 872 p.
3. Berezenko VS, Tyazhka OV, editors. Fundamentals of Child Care. Technique of Medical Procedures and Manipulations: Textbook. 3rd ed. Kyiv: VSV "Medicine"; 2021. 144 p.
4. Katilov OV, Dmitriev DV, Dmitrieva KV, Makarov SYU. Clinical examination of a child. 2nd ed. Kyiv: VSV "Medicine"; 2019. 520 p.
5. Kryuchko TO, Vovk YU, Tkachenko OY, Kushnereva TV, Shpekht TV, Poda OA. Practical skills in propaedeutics of pediatrics: a teaching and methodological manual. Poltava: PDMU; 2023. 156 p.

Auxiliary:

1. Nelson's Fundamentals of Pediatrics / Karen J. Markdante, Robert M. Kligman; translation of the 8th English edition in 2 volumes. Scientific editors of the translation V.S. Berezenko, T.V. Pochynok. Kyiv: VSV "Medicine", -2020.
2. Kliegman RM, St. Geme JW, Blum NJ, Shah SS, Tasker RC, Wilson KM, editors. Nelson Textbook of Pediatrics. 21st ed. Philadelphia: Elsevier; 2020. 4264 p.
3. Zitelli BJ, McIntire SC, Nowalk AJ, Garrison J, editors. Zitelli and Davis' Atlas of Pediatric Physical Diagnosis. 8th ed. Philadelphia: Elsevier; 2022. 1104 p.

5. Questions for student self-preparation for practical classes:

1. Anatomical and physiological features of the kidneys.
2. Anatomical and physiological features of the renal pelvis.
3. Anatomical and physiological features of the ureters.
4. Anatomical and physiological features of the urinary bladder.
5. Daily diuresis, number of urinations, volume of one urination depending on age. What is the normal relative density of urine, what does it depend on?
6. Technique and features of the method of collecting a general urine analysis, rapid tests for leukocyte esterase, nitrites, urine analysis according to Nechyporenko, Zimnytsky, urine analysis for bacteriuria in children of different ages;
7. Features of collecting anamnesis and complaints in children with kidney diseases.
8. Features of examination, palpation , percussion when conducting the method of examination of the urinary system.
9. Clinical and laboratory characteristics of pyelonephritis in children.
10. Clinical and laboratory characteristics of glomerulonephritis in children.
11. Clinical and laboratory characteristics of cystitis in children.
12. Stages of development of acute renal failure in children.
13. Stages of chronic renal failure.
14. Features of caring for children with kidney and urinary tract diseases.

Methodological development is compiled

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