

ODESSA NATIONAL MEDICAL UNIVERSITY

Department of urology and nephrology

GUIDELINES  
the practical lesson for students:

Academic discipline “Urology”

Lesson №15 Acute and chronic renal insufficiency.

Academic discipline “Urology”

**Level of higher education:** Second (Master’s)

**Knowledge field:** 22 "Health Care"

**Specialty:** 222 "Medicine"

**Program of professional education:** Medicine

Approved  
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Head. Chair prof. F.I. Kostev

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## **Theme of the lesson : «Acute and chronic renal insufficiency»**

### 1. Actuality of the theme.

Kidneys belong to the organs, which regulate continuous state of the organism; they are responsible for excretion of end (final) products of metabolism, regulation of water-electrolyte balance, osmotic pressure of plasma, maintaining of base-acid balance, level of hormones and vitamins, as well as for erythrocytes formation. That is why in development of renal insufficiency all functions of kidneys are disturbed; this is caused by lesion of all parts of nephrons, which are followed by stable changes of homeostasis.

Renal insufficiency may be acute and chronic. Development of acute renal insufficiency is favored by pre-renal, renal and post-renal factors, while chronic renal insufficiency is a final outcome of numerous diseases, which are related to different spheres of medicine. General morbidity makes up about 190 persons by 1 million of population annually. Of them, the most capable to work age (18-50 years old) makes up about 100 persons by 1 million of population; all this causes social significance of the disease.

Chronic diffuse glomerulonephritis, chronic pyelonephritis, renal polycystic disease, systemic lupus erythematosus, nodular periarteritis (Alport`s syndrome, nephronophthisis), Balkanian nephropathy, etc. are the most often diseases, which lead to development of chronic renal insufficiency.

Timely diagnostics of the basic disease and purposeful adequate treatment allows to better patients` state, to prolong their life in a number of cases. Besides, even in case of advanced chronic renal insufficiency, knowledge of uremia symptoms allow to prevent development of specific complications from the side of other organs, to timely refer patient for substitutive organotherapy (hemodialysis, kidney transplantation); this sometimes allows to prolong patients` life for decades.

### 3. Aim of the lesson:

#### 3.1. General aims:

To learn issues of etiopathogenesis, symptoms, diagnostics and treatment of acute and chronic renal insufficiency, ability to make differential diagnostics with other diseases, in case of necessity to be able to give primary medical aid to patients.

3.2. Виховні aims: Психологічні та економічні аспекти тривалого заміщення ниркової функції. Етичні та юридичні аспекти забору органів з метою їх трансплантації від однієї

людини до іншої. Поняття про рівень біологічної та соціальної реабілітації хворих на хронічному гемодіалізі та після проведення трансплантації нирки.

### 3.3. Concret aims:

Students must know:

1. Role of kidneys in maintaining homeostasis and to learn developing pathologic processes in gradual loss of basic renal functions.
2. Etiology, pathogenesis, pathologic anatomy and clinical course of acute renal insufficiency.
3. Morphologic-functional disorder of organism in case of lesion of renal function (by systems).
4. Stages of acute renal insufficiency.
5. Standard diagnostic algorithm of examination of patients with ARI.
6. Up-to-day principles of ARI treatment.
7. Principles and methods of emergent medical aid rendering to patients with ARI.

### 3.4. Student must be able to:

1. To distinguish anurhea from acute urine delay while conducting objective examination of a patient and by using additional methods of analysis.
2. To determine the phase of AKI by the quantity of urine secreted by a patient.
3. To interpret the results of biochemical analysis of blood (electrolytic composition, acid-alkaline reaction in order to determine the phases of AKI and CKI).
4. To define the evidence for the kind of treatment of a patient: conservative therapy, hemodialysis or kidney transplantation.

## 4. Interdisciplinary integration.

Discipline	To know	To be able to
1. Human anatomy, physiology	1. Macro- and micro-structure of kidney and urinary tract, their basic functions	Describe normal kidney by X-ray picture  To justify by laboratory data normal renal function – clinically and by laboratory data to characterize the most important of them

<p>2. Pathologic anatomy</p> <p>3. Physics</p> <p>4. Pharmacology</p> <p>5. Operative surgery and topographic anatomy</p>	<p>2. Nature of diseases, which lead to ARI and CRI</p> <p>3. Diffuse and convectional processes through semi-preamble membrane</p> <p>4. Principles of action of antibiotics and hemostatic means</p> <p>5. Topographic – anatomic structure of kidneys and urinary ways</p>	
<p>6. Orthopedics</p> <p>7. Therapy</p> <p>8. Surgery</p> <p>9. Nervous diseases</p> <p>10. Nephrology</p> <p>11. Efferent detoxication of blood</p>	<p>6. About possible pain syndrome in the spine</p> <p>7. About «urinary depression» in patients with infra-vesicle obstruction</p> <p>8. About possibility of post-operative ARI about</p> <p>9. About possibility of polyneuralgias, convulsion</p> <p>10. About possibility of ARI and CRI development</p> <p>11. Main conditions of extra-corporal blood circulation</p>	<p>6. To exclude malignant tumor</p> <p>7. To define presence and stage of renal insufficiency</p> <p>8. To define presence of ARI, its stage</p> <p>9. To define absence of organic diseases of nervous system</p> <p>10. To carry differential diagnostics between different stages of CRI and ARI</p> <p>11. On the demonstration table; to choose disposable articles for hemodialysis</p> <p>12. In brief to characterize</p>

12. Immunology	12. Nature of immune response	crisis of rejection
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5. Contents of the theme.

**Acute renal insufficiency (ARI, Acute uremia)** – polyetiologic pathologic syndrome, which develops suddenly and is characterized by total severe disorder of renal function. ARI is observed in 5% of all hospitalized patients and prevails in patients admitted to surgical and obstetric units. In separate groups mortality achieves 80% (pediatric patients, those of elderly age, with poly-organic insufficiency).

In case of ARI excretion of products of protein exchange from the organism stops, azotemia and uremia develops, water-electrolytic balance, osmotic equilibrium and acid-base state is disturbed, role of kidneys in maintenance of normal arterial pressure and erythropoiesis is lost. ARI is characterized by acute disturbance of uropoiesis and urinary excretion with increased content of nitrous slags in the blood.

In child age ARI has a more severe course, than in adults because canaliculus system of a child is morphologically underdeveloped, and ARI may lead to lethal outcome or turn to chronic renal insufficiency.

Acute uremia develops in patients with severe shock of different origin, toxic lesion of kidney, in period of acute severe infection, for example in case of septic abortions as well as in transfusion of incompatible blood, traumatic crush of muscles, urologic diseases which are followed by occlusion of urinary ways.

Three basic groups of etiologic factors of ARI development are distinguished:

- **Prerenal**
- **Renal**
- **Postrenal**

Prerenal factors:

1. Sharp and significant decrease of arterial pressure with reduce of renal blood flow in case of shock, acute blood loss.

2. Hemolysis and myolysis, cased by transfusion of incompatible blood group, acute hemolytic anemia, crush syndrome, spread burns.

3. Big losses of blood and electrolytes in severe exicosis with toxicosis against background of irrepressible vomiting, severe dyspepsia and diuretic medical means.

4. Endogenic intoxication, caused by pancreatitis, peritonitis, hepatic-renal syndrome, intestinal obstruction.

Group of renal etiologic factors is especially numerous and various:

1. poisoning with substance, which have nephritic action (poisoned mushrooms, phosphorus, mercury, chloroform, quadratic-chloric carbon dioxide, etc.)

2. overdose with definite medical means (sulfanilamides, antibiotics, etc.)

3. hemolytic-uremic syndrome and septic shock with development of acute intravascular coagulation.

4. combining of pneumonia or pyelonephritis with infection in case anaerobic sepsis or necrotic papillitis.

5. glomerulonephritis or pyelonephritis (ARI as a complication)

6. rejection of kidney, which has been transplanted

7. anomalies in development of kidneys

8. leucosis, lympho-granulomatosis and other malignant timorous diseases

9. collagen diseases with severe lesion of kidneys

Postrenal (subrenal) causes are as follows:

1. Congenital defects of development of urinary ways

2. Difficulties of urine outflow from kidneys in case of calculi of urinary ways, their squeezing with tumor, cicatrices, inflammatory infiltrate in retro-peritoneal area. Therewith, so called excretory anuria develops.

*Pathogenesis:*

Pathogenesis of ARI (and oliguria first of all) is depends on peculiarities of causative factor and individual reaction of an organism on the most. For the development of ARI, lesion of the less then  $2/3$  canaliculi is necessary. In pathologic-histologic investigation structural changes of canaliculi (swelling of epithelium, degeneration and its necrosis, sometimes tubulorrhesis, rupture of basal membrane, dilatation of lumen of canaliculi, presence of cylinders of reddish or brownish color in it), pathologic changes of interstitial tissue (marked edema, blood filling, lymphoid infiltration), as well as of capillaries (their narrowing, microthrombosis). In pathogenesis of ARI the main factor is ischemia and anoxia of renal tissue, which leads to death of the most sensitive epithelial cells with the further full disturbance of reabsorptive ability of renal canaliculi. Besides ischemia, in pathogenesis toxic impacts on renal parenchyma is of great

significance, due to direct impact of various poisons on the latter (in exogenic poisoning as well as at the expense of accumulation of product of nitrous exchange in the organism). There exists possibility of allergenic action of a number of medicinal means on kidneys (sulfanilamides, antibiotics, ect.), product of cellular necrosis and disturbance of protein exchange.

In development of oliguria it is impossible not to take into account decrease of glomerular filtration, caused by a sharp spasm of preglomerular vessels, especially in case of “shock kidney”.

In genesis of anuria, obstruction of canaliculi lumen with cylinders is of definite significance, and in subrenal ARI – disturbance of permeability of urinary excretion ways.

#### *Symptoms, course*

All mentioned-above develop on the background of clinical manifestations of cardinal disease (intoxication, infection, shock). Anuria or oliguria (excretion of less than 400 ml of urine daily) develop in patients.

- Weakness increases, appetite disappears, nausea, vomiting appear, convulsions in muscles, tachycardia develop.
- Anemia, acute psychosis develop in some patient.
- In the blood level of residual nitrogen, creatinine, potassium increase rapidly.
- On EKG there may be signs of hyperpotassemia, arrhythmia.
- After period of oliguria which may last for 5-10 days, amount of urine gradually rises to 2-4 liters and more (polyuria). Period of polyuria may last for some days and leads to dehydration with loss of sodium and potassium with signs of cardio-vascular pathology. In this case azotemia may even grow, achieving great stage.

Later gradual restoration of renal function with complete recovery occurs.

In moderate forms of renal insufficiency, except treatment of the cardinal disease, diuretic means – manitol (10% solution at a rate of 1 g/kg of patient`s body mass) or furosemide (lasix) in sufficient amount are administered. Food must contain a small amount of proteins, intake of fluid must be limited due to danger of development of lung and brain edema. 40-60 ml of 20% solution of glucose with 5-6 UN of insulin is introduced parenterally, as well as 100-200 ml of 4% solution of hydrogen carbonate.

In the more severe cases extra-corporal dialysis or peritoneal dialysis is necessary. These methods give possibility to cleanse organism from accumulation of nitrous slags and to level disturbed mineral and acid-base balance. During polyuria period it is necessary to introduce sufficient amount of fluid (intra or parenterally), and to administer potassium chloride.

#### **Structural-logic scheme of contents**

Etiology	- Pre-renal factors	<ul style="list-style-type: none"> <li>- shock</li> <li>- collapse</li> <li>- bleeding</li> <li>- dehydration</li> <li>- burns thrombosis of renal vessels</li> </ul>	
	- Renal factors	<ul style="list-style-type: none"> <li>- transfusion of incompatible blood</li> <li>- Crush – syndrome</li> <li>- Poisoning with salts of heavy metals</li> </ul>	
	- Post-renal	<ul style="list-style-type: none"> <li>- Poisoning with vinegar essence</li> <li>- Septic abortion</li> <li>- Urolithiasis</li> <li>- Ormonds disease</li> <li>- Cervical carcinoma</li> <li>- Ligation of ureters</li> </ul>	
Pathogenesis	Pre-renal ARI  Renal ARI     Post-renal ARI	<ul style="list-style-type: none"> <li>-Kidney hypoxia</li> <li>-Hypotension</li> <li>-Dehydration</li> <li>-Hemolysis, blockade of canaliculi with hemoglobin</li> <li>-Myolysis, blocade of canaliculi with gemoglobini</li> <li>-Renal edema</li> <li>-Anaerobic infection, cortical necrosis</li> <li>-Obstruction of ureters with calculi, squeezing with cicatrices</li> <li>-Infravesical obstruction</li> <li>-Ligation of ureters</li> <li>-Renal-pelvic refluxes</li> </ul>	
Pathologic anatomy of ARI	Squeezing of glomerular arteriols and tubular capillaries Tubular destruction		
Clinical picture according to stages	- Initial stage	Manifestations of ethiologic factors Sudden onset Vomiting	



Diagnostics	<p>- Oligo-anuria stage</p> <p>- Diuretic stage</p> <p>-Stage of recovery Anamnesis X-ray examination Scintigraphy Ultra-sonic examination</p>	<p>High temperature Mental confusion Pain in the lumbar area Reduce of diuresis, of urine density Rapid growth of azotemia Anemia Oliguria, anuria Reduce of urine density Proteinuria, hematuria, cylinderuria Azotemia Leucocytosis with shift of formula Low level of hemoglobin Rise of ESR Dryness of skin and mucosa Thirst Itching Acidosis Hyperhydration Hyperpotassemia, Hyperphosphatemia Hyponatremia Hypocalcemia Hypochloremia</p> <p>Poliuria Hypopotassemia Exicosis Hypotonia Mental confusion Erythrocyturia Hypoalbuminuria Anemia</p>	
Treatment	Treatment of the		

	cardinal disease Initial stage	Fight against shock and hypotension Cardiac glycosides Transfusion of blood substitutes Anti-coagulants Recharge of water and electrolyte loss Intravenously -20-20% glucose solution Mannitol Furosemide with dopamine Oxygen Blood plasma Albumin solutions Rheopolyglucin Glucose with insulin Calcium gluconate Sodium bicarbonate	
	Oligo-anuria stage	Physiologic solution Anabolics Antibiotics Vitamins Dietary nutrition Mineral waters Intestinal dialysis Peritoneal dialysis Hemodialysis Plasmapheresis Hemosorption	

## **6. Questions**

1. Who constructed the first apparatus « artificial kidney » ?
2. What is life span of patients on chronic hemodialysis ?
3. How many people in the world on chronic hemodialysis?

4. Who was the first in the world to transplant kidney from human being to human being and when?

5. Name anatomic characteristics of human kidney.

6. What is nephron structure and function?

7. What is the role of kidney in maintaining of homeostasis?

8. What are endocrine functions of kidney?

### **Typical tasks L=II**

1. To what side does blood pH change in case of uremia?

Answer: to acidosis.

2. Does kidney belong to the organs of vital importance?

Answer : Yes.

3. Is it necessary to replace removed kidney with donor one ?

Answer : No, if another kidney is healthy.

### **Tests L=II**

I. What stage of chronic renal insufficiency does blood creatinine level at 800  $\mu\text{mol/l}$  characterize?

a. Latent

b. Compensated

c. Intermittent

\*d. Terminal

2. What analysis of urine characterizes renal function?

a. General analysis of urine

b. Nechiporenko's test

c. Zimnitsky's test

- d. Bacterial cultures in urine
- e. Analysis of daily urine for protein

Correct answer is c - Zimnitsky's test

3. Which uremic complication is in the basis of aggravation of kidney endocrine function?

- a. Arterial hypertension
- b. Anemia
- c. Pericarditis
- d. Oliguria
- e. Acidosis

Correct answer is **b** – anemia

4. Which characteristics is typical for intermitting stage of chronic renal insufficiency?

- a. Under the action of small loading function of kidneys is compensated, but after treatment it returns to the initial level.
- b. Decompensation of renal function without any loading.
- c. Aggravation of renal function which passes independently after liquidation of loading.
- d. Aggravation of renal function are constant, but not essential for moderate activity.

Correct answer is **a** – under the action of small loading.

**Structure of the lesson**

Main tasks	Directions	Answers
Etiology	Name etiologic factors a) with isolated lesion of kidneys; b) with lesion of other organs.	
Pathogenesis	Reveal formation of uremia syndrome	
Pathologic morphology	Reveal macro- and microstructure of affected kidney	
Clinical course	Reveal, describe 4 stages of disease	
Diagnostics	Name diagnostic methods:	

	<ul style="list-style-type: none"> <li>a) clinical;</li> <li>b) laboratory;</li> <li>c) instrumental;</li> <li>d) X-ray-radionuclide;</li> <li>e) USI.</li> </ul>
Complications	To make table of complications by organs and systems. To underline dangerous for life
Treatment	Describe, name: <ul style="list-style-type: none"> <li>a) conservative, symptomatic;</li> <li>b) substitutional – efferent methods of detoxication;</li> <li>c) kidney transplantation.</li> </ul>

### Atypical tasks L=III

1. Female patient D., has been on chronic hemodialysis for 5 years. Patient was admitted in interdialysis day in severe state, caused bradycardia (pulse rate – 52 bpm), arrhythmia and fall of arterial pressure to 75/40 mm Hg. What threatening complication causes patient's state?

Answer: hyperpotassemia.

2. What factors cause myocardial dystrophy in case of uremia?

Answer: hypertonia, anemia, hyperhydration.

3. What are absolute contraindication to transplantation of kidney?

### Tasks L=III

1. How to characterize disorders of acid-base balance which have the following laboratory findings:  $pCO_2 = 30$  mm Hg,  $pH = 7,25$ ?

Answer: metabolic acidosis, compensated by respiratory alkalosis.

2. What disease, which caused ARI, allows to live on hemodialysis for a long period of time?

- a. Diabetes mellitus
- b. Amyloidosis
- c. Myelogenic disease
- d. Chronic glomerulonephritis

- e. Systemic lupus erythematosus

Answer: chronic glomerulonephritis, as an isolated lesion of kidneys only.

3. What physical process is in the basis of urea transport through dialysis membrane?

- a. diffusion
- b. osmosis
- c. ultra-filtration
- d. dialysis
- e. convention

Answer: a – diffusion

4. What complication is characteristic for long-living patients on dialysis?

- a. arterial hypertension
- b. dialysis hypersplenism
- c. normochromic anemia
- d. osteodystrophy
- e. hepatomegaly

Answer: d – osteodystrophy.

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### **Recommended literature.**

#### **Basic:**

1. S.P. Pasechnikov; Urology: textbook/ Ed. S. P. Pasyechnikova, S. A. Voizianov, V. N. Lesovy

- [and others]. - View. 3rd – Vinnytsia: New Book, 2019.
2. Pasechnikov S.P. Modern problems of urology: [manual]: doctor's guide/ S.P. Pasechnikov, V.I. Zaitsev. - Kyiv: L-ry Health of Ukraine; 2017.
  3. Stus V.P. Urology (practical skills for intern doctors) / V.P. Stus, S.P. Pasechnikov. Teaching and methodical manual. - Dnipropetrovsk: Akcent PP LLC, 2016.
  4. Sarychev L.P. Symptoms of urological diseases: method. rec. For teachers / L. P. Sarychev, S. M. Suprunenko, S. A. Sukhomlyn, Ya. V. Sarychev. – Poltava, 2019.
  5. O.V., Lyulko, O.F. Voizianov Textbook "Urology" 3rd edition. Thresholds Dnipropetrovsk. - 2012 p.
  6. "Urology (Methodical development of practical classes for students)" edited by Professor V.P. Stus, second edition, supplemented. / A.P. Stus, Moiseenko M.M., Fridberg A.M., Pollion M.Yu., Barannik K.S., Suvaryan A.L., Krasnov V.M., Kryzhanivskiy O.Yu. - Dnipro: Accent LLC. - 2018. - 336c.
  7. Urology: textbook for students. higher med. academic established: translation from Ukrainian publications / S.P. Pasechnikov, S.A. Voizianov, V.N. Lesovoy, F.I. Kostev, V.P. Stus, et al./ Ed. S.P. Pasechnikov - Edition 2. - Vinnytsia: Novaya Knyga, 2015. - 456 p.: illustr.
  8. Urology: textbook for students of higher medical education Institutions /S.P. Pasechnikov, S.O. Voizianov, V.M. Lesovoy (et at.); ed. by Pasechnikov. / S.P. Pasechnikov, S.O. Voizianov, V.M. Lesovoy (et at.) - Vinnytsia: Nova Knyha, 2016. - 400 p.
  9. EAU Guidelines, edition presented at the 28th EAU Annual Congress, Milan 2021. ISBN 978-90-79754-71-7. EAU Guidelines Office, Arnhem, The Netherlands.
  10. Alan W. Partin, Alan J. Wein, et. all - Campbell Walsh Wein Urology, E-Book (12th ed.) – 2020.
  11. Omar M. Aboumarzouk - Blandy's Urology, 3rd Edition – 2019.
  12. David Thurtle, Suzanne Biers, Michal Sut, James Armitage. - Emergencies in Urology – 2017. 4. Philipp Dahm, Roger Dmochowski - Evidence-based Urology, 2nd Edition – 2018.

Additional:

1. Boyko M.I., Pasechnikov S.P., Stus V.P. and others Clinical andrology // Doctor's guide "Androlog". - K.: LLC "Library "Health of Ukraine", 2013. - 222 p.
2. Sarychev L.P. Clinical anatomy and physiology of organs of the urinary and male reproductive system: method. rec. for teachers / comp. L. P. Sarychev, S. A. Sukhomlyn, S. M. Suprunenko. – Poltava, 2019. – 11 p.
3. Sarychev L.P. Symptoms of urological diseases: method. rec. for teachers / L. P. Sarychev, S. M. Suprunenko, S. A. Sukhomlyn, Ya. V. Sarychev. – Poltava, 2019. – 14 p.
4. Medical student's library. Urology. Edited by F.I. Kosteva. - Odesa, 2004. – 296p.
5. Atlas-guide to urology. Ed. A.F. Voizianova, A.V. Lulko Dnipropetrovsk, 2002.-T. 1,2,3
6. Urology / Ed. Prof. O.S. Fedoruk - Chernivtsi: Bukovyna State Medical University, 2011. - 344p.

**Information resources:**

University website <https://onmedu.edu.ua>

Library [library.odmu.edu.ua](http://library.odmu.edu.ua)

1. <https://uroweb.org/>

2. <https://www.nccn.org/>

3. <https://www.auanet.org>

4. <https://www.inurol.kiev.ua/>

5. <https://www.souu.org.ua/>

