

VOLGOGRAD STATE MEDICAL UNIVERSITY

**DEPARTMENT OF GENERAL SURGERY WITH
COURSE OF UROLOGY**

**MANUAL FOR PRACTICAL CLASSES IN
UROLOGY FOR FOURTH -YEAR STUDENTS OF
GENERAL MEDICINE IN THE ENGLISH-
SPEAKING MEDIUM**

ACUTE PYELONEPHRITIS

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VOLGOGRAD, 2010

Theme: Acute pyelonephritis.

Objective: To teach students to diagnose acute pyelonephritis and principles of treatment of this disease.

Pyelonephritis is a wide-spread disease. Acute pyelonephritis during pregnancy is noted in 1,5-2,5% of pregnant women. In elder people this disease is noticed in 100 patients out of 10 000 people.

Syllabus for practical classes:

1. Anatomy, physiology of kidneys.
2. Symptoms and causes of acute pyelonephritis.
3. X-ray, instrumental, laboratory, functional and endoscopic studies used to diagnose nephritis.
4. Acute pyelonephritis treatment.

Student's Independent Activities.

I. Practical skills

1. Classification of pyelonephritis.

1. Unilateral and bilateral; a-Acute /purulent, serous/ b-chronic; c-relapsing course.
2. Mode of bacteria pathway: a- haematogenous /descending/;

b. Urogenic /ascending/; c- urolithiasis /infected urinary calculi/; d- tuberculosis of the kidneys; e- other renal diseases.

Depending on age, state of the body we differ: 1- pyelonephritis in newborn; 2 – pyelonephritis in senile; 3- pyelonephritis in pregnant women; 4- pyelonephritis in patients with diabetes mellitus.

Acute pyelonephritis may be complicated by purulent nephritis, renal carbuncle, renal abscess, and renal insufficiency.

2. Pyelonephritis etiology and pathogenesis.

Pyelonephritis arises due to bacteria passage into the kidneys and inflammation development within the interstitial tissue, renal pelvis and calyces.

Etiologic Spectrum. The spectrum of etiologic agents is similar in uncomplicated upper and lower urinary tract infection, we come across *Escherichia coli* as a pathogen in approximately 70–95% and *Staphylococcus saprophyticus* in over 5% of the cases. Occasionally, other Enterobacteriaceae, such as *Proteus mirabilis* and *Klebsiella* species or enterococci, are isolated. In about 10–15% of symptomatic patients, bacteriuria cannot be detected by routine methods. Now-a-days the etiologic role of viruses and fungus is also evident.

Due to urine pH changes or antibiotic instillations bacteria is transformed into L-forms and protoplasts. When

conditions become better they acquire their vegetative form. That's why there is not any evidence of growth in the culture sample on laboratory tests and we don't see any effect in common treatment. The peculiarity of pyelonephritis nowadays is the link of infection with resistant bacterial strains.

For practical clinical reasons, urinary tract infections (UTIs) and male genital tract infections are classified according to entities with predominating clinical symptoms:

- (1) uncomplicated lower UTI (cystitis);
- (2) uncomplicated pyelonephritis;
- (3) complicated UTI with or without pyelonephritis;
- (4) urosepsis;
- (5) urethritis;
- (6) prostatitis, epididymitis, orchitis.

3. Acute primary pyelonephritis (clinical signs, diagnosis).

Generalized symptoms are chill associated with intermittent fever accompanied by moderate to excessive sweating, headache, myalgia, arthralgia, nausea, vomiting, patients appear to be seriously ill. Local signs are pain in the lumbar region that irradiates to the upper portion of the abdomen, to the back. Percussion over the costovertebral angle overlying the affected kidney is rather painful; it is a "positive percussion symptom". Overlying muscular spasms, abdominal distensions may be pronounced. The enlarged

painful kidney may also be palpated on first days. The laboratory findings play the most essential role.

Significant bacteriuria in adults:

1. 10^3 uropathogens/ml of midstream urine in acute uncomplicated cystitis in female;
2. 10^4 uropathogens/ml of midstream urine in acute uncomplicated pyelonephritis in female;
3. 10^5 uropathogens/ml in midstream urine of women or 10^4 uropathogens/ml of midstream urine in men (or in straight catheter urine in women) with complicated UTI.

In a suprapubic bladder puncture specimen any count of bacteria is relevant.

Asymptomatic bacteriuria (ABU). ABU is defined as two positive urine cultures taken more than 24 h apart with 10^5 uropathogens/ml of the same bacterial strain (mostly only the species is available).

Pyuria. The requirement for pyuria is 10 white blood cells (leucocytes) per high-power field (E400) in the resuspended sediment of a centrifuged aliquot of urine or per mm³ in unspun urine. For the routine also a dipstick method can be used, including leukocyte esterase test, hemoglobin and probably nitrite reaction.

The quantitative research of culture in 1 ml of urine, kind of pathogen flora, leukocyturia and Sternheimer-Malbin cells are found out. There are other changes that are

typical: erythrocyturia /from 2 to 30-40 in field of vision/, proteinuria /up to 1g/l.

4. Treatment of acute primary pyelonephritis.

The main scheme is based on a diet, bed rest, desintoxication (infusion therapy), and specific antibacterial treatment. Bed rest and hospitalization are required. Difficulties in treatment are bacterial resistance to drugs, change of bacterial strains, sensibilisation of the human body. A diet should be sparing. Energetic support is provided with carbohydrates and plant fats. The protein sources may be cheese, hen eggs, then boiled fish and meat. Spices are forbidden. Vitamins and a lot of fluid are necessary. Salt is limited up to 4-6 grams per a day. Perorate (per os) hydration is 3,0 l of fluid per a day in equal portions. The parenteral hydration means intravenous infusion of isotonic, Ringer-Lokk's, glucose, Polyglycine solutions with vitamins and antibacterial agents. 1,5-2l of a definite solution may be infused twice a day.

Short antimicrobial (uroseptic) courses are highly effective and are desirable due to low price, and low frequency of adverse reactions. Single-dose therapy is generally less effective than long courses with the same antibiotic. In mild cases, fluoroquinolone is recommended orally within 7 days as the first-line drug (antibiotic of 1st choice). If Gram-positive organisms are seen on the initial Gram's stain, aminopenicillin plus BLI may be recommended. More severe cases of acute uncomplicated pyelonephritis should be

admitted to a hospital and treated parenterally. If the patient's condition improves, he can be administered fluoroquinolone orally or TMP/SMZ within 1- or 2-weeks. In increased resistant rate of *E. coli* to fluoroquinolone and in conditions when fluoroquinolone is contraindicated, e.g. in pregnancy, lactation period, adolescence, cephalosporin of the 2nd or 3rd generation orally is recommended. The treatment options are summarized in the table below.

Drug	Daily Dosage (mg/kg)	Route of Administration	Mean Urine Concentration (± SD)
Amikacin	15	Subcutaneous	342 (± 143) µg/mL
Amoxicillin	33	Oral	202 (± 93) µg/mL
Ampicillin	77	Oral	309 (± 55) µg/mL
Cephalexin	55	Oral	500 µg/mL
Chloramphenicol	100	Oral	123.8 (± 39.7) µg/mL
Enrofloxacin	5	Oral	40 (± 10) µg/mL
Gentamicin	6.6	Subcutaneous	107.4 (± 33.0) µg/mL
Netilmicin	77	Oral	300.3 (± 156.1) µg/mL
Kanamycin	11	Subcutaneous	529.6 (± 150.5) µg/mL
Nitrofurantoin	15	Oral	100 µg/mL
Penicillin G	110,000*	Oral	294.9 (± 210.7) U/mL
Penicillin V	77	Oral	148.3 (± 98.5) µg/mL
Sulfisoxazole	66	Oral	1466.3 (± 832.4) µg/mL
Tetracycline	5	Oral	137.9 (± 64.6) µg/mL
Tobramycin	3	Subcutaneous	66.0 (± 39.0) µg/mL
Trimethoprim-sulfadiazine	26	Oral	55.0 (± 19.2) µg/mL

5. Acute secondary pyelonephritis (clinical signs, diagnosis).

The main causes of acute secondary pyelonephritis are urolithiasis, anomalies of the urinary system and neoplasms. The excretory urograms show enlargement of the infected kidney. The outline of the ileopsoas muscle is absent sometimes, the diffuse shadow above the kidney and

moderate scoliosis at the side of the disease are present. There is a slow excretion of the contrast. Calyces are flattered and clubbed; they are filled with contrast more evidently than in normal kidney. The intravenous excretory urogram shows significant atrophy of the parenchyma of the affected kidney, its deformation due to infiltrates and atonia of the ureter. Chromocystoscopy shows the range even sometimes the cause of the functional loss of the urine outflow (nowadays used rarely due to the toxic qualities of the contrast). There can be seen the bullous edema of the uretral opening due to calculus in the intravesical portion, ureterocele, tumour compression.

Non-invasive methods are useful. They are radionuclide scintigraphy, nondirective angiography, and ultrasonic investigation.

6. Treatment of acute secondary pyelonephritis.

Secondary pyelonephritis requires kidney drainage, sometimes even the purulent source removal. Until the urine outflow having been restored, antibacterial drugs especially of wide-spectrum are dangerous. Bacteriotoxic shock may develop, and lethal outcomes are observed in about 75% of such cases.

7. Pyelonephritis in pregnant women (etiology, clinical signs, diagnosis).

An inflammatory process may develop during pregnancy, delivery and puerperal period. Most frequently it is observed in pregnant women (48%) more rare then in puerperal (35%) women. It develops commonly during the 1st pregnancy, it's the 2 trimester. Usually women at aged of 18-25 present a risk group. That is explained by uncompleted adaptation of the female organism to immunologic, hormone changes occurring during pregnancy. It is supposed not to be a primary disease but the activation of latent pyelonephritis. Diagnosis is rather difficult to establish. The enlarged uterine makes the palpation uninformative. The right kidney involvement should be differed from acute appendicitis and cholecystitis. X-ray imaging is forbidden due to its teratogenic side-effect, it can be indicated only under the vital circumstances. The endoscope investigation is also not recommended. In case of purulent process suspicion a complete clinical research is required including chromocystoscopy, ultrasonography.

8. Treatment of pyelonephritis in pregnant women.

Antibiotics shouldn't be harmful for the fetus. The natural and semisynthetic penicillines are recommended during the 1st trimester. Wider choice of antibiotics is at the 2nd and 3rd trimesters because placenta receives its barrier function at that time. The puerperal women may transfer drugs to child with milk. Treatment should be continuous. Nitrofurans are admissible after the 2nd month in dosage 50-

100mg per day. Nalidixone acid is admissible after the 4th month of pregnancy (2g per day for 2-3 weeks). But its administration must be stopped before delivery.

Usually a 7-day course of antibiotics is recommended, but some authors recommend short-term therapy as during acute cystitis. One to 4 weeks after treatment and at least once more before delivery, follow-up cultures should be obtained. Most symptomatic UTIs in pregnant women represent acute cystitis. Short-term therapy is not as well established yet as in nonpregnant women. For acute pyelonephritis cephalosporin of the 2nd or 3rd generation, aminoglycoside or aminopenicillin plus LI can be administered. Quinolones, tetracyclines, trimethoprim in the first trimester and sulfonamides in the last trimester should not be used at all during pregnancy due to their teratogenic side-effect. In cases of delayed defervescence and upper tract dilatation a ureteral stent may be indicated and antimicrobial prophylaxis until delivery should be prescribed. For recurrent UTI low-dose cephalexin (125–250 mg) or nitrofurane (50 mg) at night are recommended for reinfection prophylaxis. Postintercourse prophylaxis may be an alternative approach.

Acute purulent pyelonephritis in pregnant women requires obligate surgical measures. They depend on form of the ailment. They are indicated anyway until delivery.

9. Apostematous pyelonephritis (clinical signs, diagnosis).

There are no changes in the urine analysis initially, but proteinuria, leukocyturia and bacteriuria may appear. Hemogram shows leukocytosis and shift of the formula to the left.

Plain urogram can show kidney enlargement. Excretory urograms reveal kidney dysfunction. Renogram shows abnormalities of vascularisation, secretion, excretion. Renograms may be obstructive, when a pathologic process in the kidney is evident. Its location may be defined by scintigraphy monitoring. There are some focuses of decreased accumulation of radionuclide on scanogram. The primary cause of the disease, calculi of the kidney or ureter may be found during secondary apostematous pyelonephritis on X-ray examination.

10. Treatment of apostematous pyelonephritis.

Urgent surgical measures are required. Subcostal lumbotomy is performed. The kidney is separated from paranephrium and decapsulated. Purulent focuses are incised. The retroperitoneal space should be drained and free output of the urine is provided with nephrostomy or pyelostomy (preferably). Surgical drainage should be applied until the urine output becomes free, inflammation disappears and renal function becomes normal. The postoperative period requires antibacterial and desintoxicative treatment as in case of chronic pyelonephritis.

11. Abscess and carbuncle of kidney (clinical signs, diagnosis).

X-Ray-findings are very important. If the renal outline is visible the plain X-ray can show the kidney enlargement or a bulge of the external renal contour. In perinephral oedema, however, often the renal outline is obliterated and the psoas shadow is indistinct. Concrement shadows may be sometimes seen. One can see deformation and narrowing of the renal pelvis, deviation and indistinct outlines of calyces on excretory urograms and pyelograms. Pyelonephritic changes, urolithiasis can be observed. Delayed pacification may be found. Carbuncle may be confused with tumour sometimes while the X-ray imaging is done. Renal angiography with an ultrasonic investigation usually makes the diagnosis up to 100% evident.

12. Treatment of abscess and carbuncle of the kidney.

Treatment includes urgent surgical measures. Lumbotomy is performed. Then decapsulation of the kidney and cone-shaped excision of the carbuncle are done. Incision, curettage and draining of the kidney or enucleating of the carbuncle with its incision may be performed too. The cone-shaped excision is an organ preserving surgical operation. The cross-shaped incision is made up to the healthy tissues just after decapsulation (nuding) of the kidney and revision of its surface. Its depth shouldn't be more than 0,5 cm. Then an assistant pulls out the internal angles by means of miniature

acute hooks. The surgeon using an ophthalmic scalpel removes gradually necrotic masses by circular incisions. But the surgeon gets it out from the surface and from underlying tissues (kidney's parenchyma), orientating to (paying attention) the colour of the tissues and bleeding range. Moderate venous diffusion makes evident the demarcating of necrosis zone from the healthy tissues. The cone-shaped hollow cavity is formed after the extraction. Moderate tight tamponade with gauze favours haemostasis and outflow of the vulnus secretion.

The postoperative period requires antimicrobial treatment, which is prescribed taking into consideration the urine cultural test and renal tissue cultural.

II. Tests and Self-assessment

Multiple choice. Choose a correct answer/statement:

1. First change in urine which will prove acute primary hematogenic pyelonephritis:
 - A. Bacteriuria.
 - B. Leukocyturia.
 - C. Proteinuria.
 - D. Haematuria.
 - E. Hyaline casts.

2. What study should we have to do first to diagnose pyelonephritis in a pregnant woman?
 - A. Ultrasonic investigation.
 - B. Excretory urography.
 - C. Cystoscopy.
 - D. Radiologic examination.
 - E. Chromocystoscopy.

Clinical situational tasks :

1. A woman, aged 23, with clinical findings of acute pyelonephritis at right side (body temperature is 38°C - 40 °C; there are constant pains in the right lumbar area, leucocytes in analysis of urine) is hospitalised to the urological department. What methods of diagnostic we should use? What is the tactics of treatment?

2. Patient K., aged 31, complaints of pains in left lumbar region with the temperature of the body 39,2°C within 2 days; he is shivering and weak. Anamnesis: calculi in the left kidney were diagnosed two years ago. What complications of the urinary calculi disease appear in this patient? What methods of examination should we carry on? What is the tactics of treatment?

III. Answers to self-assessment.

Keys to tests:

1. A.
2. A.

keys to clinical situational tasks :

1. We should carry on an ultrasonic investigation. In case of observing some destructive processes we should perform excretory urograms and prepare the patient for an urgent surgery.

2. Acute secondary (calculi-obstructive?) pyelonephritis. We should carry on ultrasound screening, retrograde and excretory urography. The operative treatment is indicated if we observe calculi-obstructive pyelonephritis.

Visual and Material items:

1. Slides (chronic pyelonephritis, x-rays of pyelonephritis).
2. Excretory urologramms.
3. Retrograde and antegrade pyeloureterogramms.

SKILLS TO BE ACQUIRED (requirements to the students):

Students must know:

1. Pyelonephritis (etiology, pathogenesis).
2. Classification of pyelonephritis.

3. Acute Primary pyelonephritis (clinical signs, diagnosis).

4. Treatment of acute primary pyelonephritis.

5. Differential diagnosis of acute primary pyelonephritis with tuberculosis of the urinary system, with acute diseases of the organs in the abdominal cavity.

6. Acute Secondary pyelonephritis (clinical signs, diagnosis).

7. Treatment of acute secondary pyelonephritis.

8. Pyelonephritis in pregnant women.

9. Treatment of pyelonephritis in pregnant women.

10. Forms of acute pyelonephritis (clinical signs, diagnosis, and treatment).

11. Apostematous pyelonephritis (clinical signs, diagnosis, treatment).

12. Abscess and carbuncle of the kidney (clinical signs, diagnosis, treatment).

Students should be able to:

1. Suspect acute pyelonephritis basing on patient's complaints and anamnesis (life history).
2. Make a plan of investigation.
3. Carry on a differential diagnosis.
4. Present a treatment-plan to the patient suffering from acute pyelonephritis.
5. Evaluate analyses of blood, urine; biochemical analysis of blood; x-ray, radio-isotope and vascular examination.

PREFERABLE LITERATURE:

1. Text-book of Urology, reviewed by David M. Davis, USA, 2005
2. Campbell's Urology, D. Walsh, USA, 2007
3. Smith's General Urology, D. Smith, USA. 1999