Intoduction To Urology

By

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Urologic Laboratory Examination

- Examination of specimens of urine, blood, and genitourinary secretions or exudates commonly directs the subsequent urologic workup and frequently establishes a diagnosis.
- Since approximately 20% of patients who visit a primary physician's office have a urologic problem, it is important for the physician to have a broad knowledge of the laboratory methods available to test appropriate specimens.

EXAMINATION OF URINE

- Urinalysis is one of the most important and useful urologic tests available.
- All too often the necessary details are neglected and significant information is overlooked or is interpreted.
- Reasons for inadequate urinalyses include (1) improper collection, (2) failure to examine the specimen immediately, (3) incomplete examination (4) inexperience of the examiner, and (5) inadequate appreciation of the significance of the findings.

EXAMINATION OF URINE

- Patients presenting with urinary tract symptoms or signs, however, should undergo urinalysis.
- Studies also indicate that if macroscopic urinalysis (dip-strip) is normal, microscopic analysis is not necessary.
- If the patient has signs or symptoms suggestive of urologic disease, or the dip-strip is positive for protein, heme, leukocyte esterase, or nitrite, a complete urinalysis, including microscopic examination of the sediment, should be completed

Urine Collection

- **A. TIMING OF COLLECTION:**
- It is best to examine urine that has been properly obtained in the office.
- First-voided morning specimens are helpful for qualitative protein testing in patients with possible orthostatic proteinuria and for specific gravity assessment.
- Urine immediately taken after the patient has eaten or that have been left standing for a few hours become alkaline and thus may contain lysed red cells, disintegrated casts, or rapidly multiplying bacteria.

Urine Collection

- therefore, a freshly voided specimen obtained a few hours after the patient has eaten and examined within 1 hour of voiding is most reliable.
- Timed urine collections may be required for definitive assessment of renal function or proteinuria.
- **B. METHOD OF COLLECTION:**
- Proper collection of the specimen is particularly important when patients have hematuria or proteinuria or are being evaluated for urinary tract infection.

Urine Collection

- Urine obtained from a condom, chronic catheter, or intestinal conduit drainage bag *is not a proper specimen for urinalysis.*
- **1. Men—It is usually simple to collect a clean-voided** midstream urine sample from men.
- Routine instructions includes (1) cleansing of the meatus with benzalkonium chloride or hexachlorophene (2) passing the first part of the stream (15–30 mL) without collection (3) collecting the next or midstream portion (approximately 50–100 mL) in a sterile specimen container, which is capped immediately afterward.

Urine Collection

- **2. Women—**
- (1) the patient is placed on the examining table in the lithotomy position;
- (2) the vulva and urethral meatus are cleansed with benzalkonium chloride or hexachlorophene.
- (3) the labia are separated.
- (4) the patient is instructed to initiate voiding into a container held close to the vulva.
- If a satisfactory specimen cannot be obtained by the method described, one should not hesitate to obtain a specimen by catheterization to eliminate non vaginal sources of abnormal urinary constituents.

Urine Collection

- **3. Children—:**
- Urine for analysis, other than bacterial cultures, can be obtained from males or females by covering the cleansed urethral meatus with a plastic bag.
- a urine specimen for culture may require catheterization or suprapubic needle aspiration.

Macroscopic Examination

- **A. COLOR & APPEARANCE:**
- Normal color is pale yellow .
- Phenazopyridine, rifampin, nitrofurantoin, L-dopa, α-methyldopa, and metronidazole all change the color of the urine.
- Red urine does not always signify hematuria.
- Myoglobinuria due to significant muscle trauma, or hemoglobinuria following hemolysis.
- Cloudy urine is commonly thought to represent pyuria, but more often the cloudiness is due to large amounts of amorphous phosphates.

Macroscopic Examination

- **B. SPECIFIC GRAVITY:**
- The specific gravity of urine (normal, 1.003–1.030) is often important for diagnostic purposes.
- Patients with significant intracranial trauma may be low owing to a lack of antidiuretic hormone (vasopressin).
- patients with extensive acute renal tubular damage is consistently 1.010 (similar to the specific gravity of plasma); and a low specific gravity can be an early sign of renal damage from conditions such as sickle cell anemia.

Macroscopic Examination

- The specific gravity of urine may affect the results of other urine tests: in dilute urine, a pregnancy test may be falsely negative.
- The specific gravity of urine may be falsely elevated by the presence of glucose, protein, artificial plasma expanders, or intravenous contrast agents.

Macroscopic Examination

- **C. CHEMICAL TESTS:**
- Chemically impregnated reagent strips are accurate and have simplified routine urinalysis greatly.
- The dip-strips are reliable only when not outdated and when used with *room temperature* urine.
- **1. pH**—The pH of urine is important in a few specific clinical situations.

C. CHEMICAL TESTS:

- Patients with uric acid stones rarely have a urinary pH over 6.5 (uric acid is soluble in alkaline urine).
- Patients with calcium stones, nephrocalcinosis, or both may have renal tubular acidosis and will be unable to acidify urine below pH 6.0.
- **2. Protein—** Dip-strips containing bromphenol blue can be used to determine the presence of >10 mg/dL protein in urine.
- but persistent proteinuria detected in this manner requires quantitative protein testing for confirmation.

CHEMICAL TESTS

- Prolonged fever and excessive physical exertion are also common causes of transient proteinuria.
- Persistently elevated protein levels in the urine (>150 mg/24 h) may indicate significant disease.
- **3. Glucose—** The glucose oxidase-peroxidase tests used in dip-strips are quite accurate and specific for urinary glucose.
- False-positive results may be obtained when patients have ingested large doses of aspirin, ascorbic acid, or cephalosporins.

CHEMICAL TESTS

- **4. Hemoglobin—**The dip-strip test for hemoglobin is not specific for erythrocytes and should be used only to *screen for hematuria*
- Free hemoglobin or myoglobin in the urine may give a positive reading.
- **5. Bacteria and leukocytes—**Test strips to determine the number of bacteria (nitrite) or leukocytes (leukocyte esterase) as predictors of bacteriuria are as accurate as microscopic sediment analysis in studies using quantitative urine cultures as the standard.

CHEMICAL TESTS

- **The nitrite reductase test depends on the conversion of nitrate to nitrite.**
- When the nitrite test is positive, it suggests the presence of >100,000 organisms per ml.
- The nitrite test is positive only for coagulase-splitting bacteria and thus when used alone is only 40–60% accurate.
- Urine must be in the bladder for a sufficient time before sampling for the reduction of nitrate to occur (>4 hours); therefore, this test is most likely to be positive when first voided morning urine is tested.

Microscopic Examination

- the microscopic sediment examination should be done personally by an experienced physician or technician.
- **1. Bacteria—**
- A presumptive diagnosis of bacterial infection may be made on the basis of results of microscopic examination of the urinary sediment.
- If several bacteria per high-power field are found in a urine specimen obtained by suprapubic aspiration or catheterization in a woman or in a properly obtained clean-voided midstream specimen from a man, a provisional diagnosis of bacterial infection can be made and empiric treatment started.

Microscopic Examination

- Finding several bacteria per high-power field in a voided specimen from a woman is of little significance.
- **2. Leukocytes—**
- Just as the presence of bacteria in the sediment is not an absolute indication of infection, neither is the finding of pyuria.
- In the sediment from clean-voided midstream specimens from men and those obtained by suprapubic aspiration or catheterization in women, a finding of more than 5 leukocytes per high-power field is generally considered abnormal (pyuria).

Microscopic Examination

- in female patients with symptoms of urinary tract infection, 60% of those with pyuria will have no bacterial growth from bladder urine obtained by catheterization or suprapubic aspiration emphasizing the need for confirmation by bacterial cultures.
- Renal tuberculosis can cause “sterile” acid-pyuria and should be considered in any patient with persistent pyuria and negative results on routine bacterial cultures.

Microscopic Examination

- Urolithiasis can also cause pyuria. In patients with persistent pyuria.
- **3. Erythrocytes—**
- The presence of even a few erythrocytes in the urine (hematuria) is abnormal and requires further investigation.
- gross hematuria is more alarming to the patient but microscopic hematuria is no less significant.

Microscopic Examination

- Infrequent causes of hematuria include strenuous exercise (long-distance running), vaginal bleeding, and inflammation of organs near or directly adjoining the urinary tract, for example, diverticulitis or appendicitis.
- In patients with microscopic hematuria, a 3-container method for collection of urine can provide information on the site of origin of erythrocytes.

Microscopic Examination

- **4. Epithelial cells—**
- Squamous epithelial cells in the urinary sediment indicate contamination of the specimen from the distal urethra in males and from the introitus in females.
- **5. Casts—**
- Casts are formed in the distal tubules and collecting ducts and, for the most part, are not seen in normal urinary sediment; therefore, they commonly signify intrinsic renal disease.

Microscopic Examination

- Although **leukocyte casts have been considered suggestive** of pyelonephritis, they are not an absolute indicator and should not be used as the sole criterion for diagnosis.
- Erythrocyte casts are pathognomonic of underlying glomerulitis or vasculitis.
- Hyaline casts probably represent a mixture of mucus and globulin congealed in the tubules; in small numbers, they are not significant.

Microscopic Examination

- Granular casts most commonly represent disintegrated epithelial cells, leukocytes, or protein; they usually indicate intrinsic renal tubular disease.
- **6. Other findings—**
- The finding of crystals in urine can be helpful in some instances, but the mere presence of crystals does not indicate disease.

Microscopic Examination

- **BACTERIAL CULTURES:** The presumptive diagnosis of bacterial infection based on microscopic examination of the urinary sediment should be confirmed by culture.
- Cultures are particularly important in patients with recurrent or persistent infections, renal insufficiency, or drug allergies.
- The concept that urinary tract infection is present only when the urine specimen contains 10^5 or more bacteria per milliliter is not an absolute rule; a lower count does not exclude the possibility of an infection, particularly in a symptomatic patient.

Microscopic Examination

- Cultures with growth of multiple organisms usually signify contamination.
- **Other Urine Tests:**
- **A. UROTHELIAL CANCER TESTS:**
- **1. Urine cytology**—The evaluation of voided or bladder wash (barbotage) urine for bladder urothelial cancer cells has been quite successful for higher grade transitional cell cancers.

Other Urine Tests

- **2. Bladder tumor antigen** The bladder tumor antigen test is an assay for the qualitative detection of bladder tumor antigen in the urine.
- **3. Nuclear matrix protein 22**—The nuclear matrix protein 22 test (NMP22) is an immunoassay.
- Normal subjects will have low levels of NMP22 in the urine, whereas patients with active transitional cell carcinoma may have high levels of urinary NMP22.

Other Urine Tests

- **4. QUANTICYT** The QUANTICYT System is a computer-based cytologic image analysis system.
- This system evaluates 50 randomly selected images containing 100–500 nuclei for DNA content and nuclear shape.
- **B. HORMONAL STUDIES**
- Tests for abnormalities in adrenal hormone secretion are important in the workup of patients with suspected adrenal tumors.

Other Urine Tests

- **C. STUDIES OF STONE CONSTITUENTS**
- Patients with recurrent urolithiasis may have an underlying abnormality of excretion of calcium, uric acid, oxalate, magnesium, or citrate. Samples of 24-hour urine collections can be tested to determine abnormally high levels of each.

RENAL FUNCTION TESTS

- **Urine Specific Gravity** With diminished renal function, the ability of the kidneys to concentrate urine lessens progressively until the specific gravity of urine reaches 1.006–1.010.
- **Serum Creatinine** Creatinine, the end product of the metabolism of creatine in skeletal muscle, is normally excreted by the kidneys.
- Serum creatinine levels remain within the normal range (0.8–1.2 mg/dL in adults; 0.4–0.8 mg/dL in young children).

RENAL FUNCTION TESTS

- the serum creatinine level generally is not influenced by dietary intake or hydration status.
- **Endogenous Creatinine Clearance**
- Renal clearance of creatinine is essentially equal to the glomerular filtration rate.
- The endogenous creatinine clearance test has thus become the most accurate and reliable measure of renal function available without resorting to infusion of exogenous substances such as radionuclides.

RENAL FUNCTION TESTS

- Determination of creatinine clearance requires only the collection of a timed (usually 24-hour) urine specimen and a serum specimen.
- The resulting clearance is expressed in milliliters per minute, with 90–110 mL/min considered normal.
- **Blood Urea Nitrogen**
- Urea is the primary metabolite of protein catabolism and is excreted entirely by the kidneys.
- The blood urea nitrogen (BUN) level is therefore related to the glomerular filtration rate.

RENAL FUNCTION TESTS

- BUN is influenced by dietary protein intake, hydration status, and gastrointestinal bleeding.

Other lab test

- **Prostate Cancer Markers**
- Prostate-specific antigen (PSA) is an extremely important prostate cancer marker.
- PSA is prostate-specific but not cancer specific.
- Serum elevation >4.0 ng/mL is correlated with prostatic cancer; however, serum levels vary with prostate volume, inflammation, and amount of cancer within the gland.

Other lab test

- The percentage of free PSA (ratio of unbound to total PSA) in the serum is useful for increasing the specificity of PSA for diagnosing prostate cancer.
- If the percentage of free PSA is <10%, approximately 60% of men will have prostate cancer, whereas if the percentage of free PSA is >25%, only 8% will have it.
- **Hormonal Studies**
- Serum parathyroid hormone, renin, beta-subunit of hCG and of alpha-fetoprotein.

Radiology of the Urinary Tract

- Imaging of the urinary tract has become more precise, with new procedures offering a great selection of options, and new imaging algorithms being implemented.
- Ultrasonography, computed tomography (CT), and magnetic resonance imaging (MRI) provide higher soft-tissue contrast resolution than conventional radiography.

Radiology of the Urinary Tract

- ■ **RADIOGRAPHY:** X-rays are electromagnetic waves with photon energies that typically fall between those of gamma rays and ultraviolet radiation.
- Radiography is possible because tissues differ in their ability to absorb x-rays.
- A radiopaque contrast medium is frequently employed to enhance soft-tissue contrast.
- The basic types of uroradiologic studies are plain (conventional) abdominal films, (also known as KUB, which stands for kidney, ureter, bladder)

Radiology of the Urinary Tract

- intravenous urograms (IVU), cystourethrograms, urethrograms, and angiograms.
- **Contrast media—Radiographic contrast media** used in uroradiology are water-soluble iodinated compounds that are radiopaque.
- Significant advances in water-soluble contrast media occurred with the introduction of low-osmolality (nonionic) organic iodine-containing compounds.

Radiology of the Urinary Tract

- **Adverse reactions—All procedures using intravascular** contrast media carry a small but definite risk of adverse reactions. The overall incidence of adverse reactions is about 5%. Reactions in nonintravenous use (ie, cystograms) are extremely rare but have been reported,
- In a large meta-analysis, the incidence of death due to intravascular injection of contrast media was 0.9 deaths/ 100,000 injections.

Radiology of the Urinary Tract

- Nephrotoxicity caused by intravascular contrast agents is another concern. The pathogenesis of contrast nephropathy (CN) likely involves medullary ischemia due to contrast- induced vasoconstriction and direct tubular injury.
- ***1. Plain Film of the Abdomen:*** A plain film of the abdomen, frequently called a KUB film.
- Is usually taken with the patient supine.
- The average adult kidney is about 12–14 cm long.

Radiology of the Urinary Tract

- **2. Urography:**
- **Intravenous Urography:** The IVU, also known as excretory urography (EU), or intravenous pyelography (IVP), can demonstrate a wide variety of urinary tract lesions, is simple to perform, and is well tolerated by most patients.
- dehydration is to be avoided in infants, debilitated and elderly patients, and patients with diabetes mellitus, renal failure, multiple myeloma, or hyperuricemia.

Radiology of the Urinary Tract

- Immediate" films, which are taken immediately after the rapid (bolus) injection of contrast, typically show a dense nephrogram and permit better visualization of renal outlines.
- Abdominal (ureteral) compression devices temporarily obstruct the upper urinary tract during EU and improve the filling of renal collecting structures.
- Delayed" films, taken hours later or on the following day, can contribute useful information. "Upright" films, taken with the patient standing or partially erect, reveal the degree of mobility and drainage of the kidneys.

Radiology of the Urinary Tract

- **Retrograde Urograms** Retrograde urography is a minimally invasive procedure that requires cystoscopy and the placement of catheters in the ureters.
- **Percutaneous Urograms** Outlining the renal collecting structures and ureters by percutaneous catheter is occasionally done when excretory or retrograde urography has failed or is contraindicated.

Radiology of the Urinary Tract

- **3. Cystography, Voiding, Cystourethrography**
- Direct instillation of contrast media into the urinary bladder (cystography) is preferred over EU for more focused examination of the bladder.
- Voiding cystourethrograms are radiographs of the bladder and urethra obtained during micturition.
- **4. Urethrography:** The urethra can be imaged radiographically by retrograde injection of radiopaque fluid or in antegrade fashion with voiding cystourethrography

Radiology of the Urinary Tract

- **SONOGRAPHY** Medical sonography uses ultrasound to produce images.
- The frequencies commonly used in medical sonography are between 3.5 and 15 MHz.
- Ultrasound is commonly used for the evaluation of the kidney, urinary bladder, prostate, testis, and penis.
- Ultrasound is useful for assessing renal size and growth.
- Renal ultrasound is useful in detection and characterization of renal masses

Radiology of the Urinary Tract

- The differential diagnosis for echogenic renal masses includes renal stones, angiomyolipomas, renal cortical neoplasms (including carcinoma), and, less commonly, abscesses and hematomas.
- Doppler sonography is useful for the evaluation of renal vessels, vascularity of renal masses, and complications following renal transplant.
- It can detect renal vein thrombosis, renal artery stenosis, and ureteral obstruction prior to the development of hydronephrosis, arteriovenous fistulas, and pseudoaneurysms.

Radiology of the Urinary Tract

- Applications of bladder sonography include assessment of bladder volume and wall thickness, and detection of bladder calculi and tumors.
- Ultrasound examination of the testis has become an extension of the physical examination.
- The addition of color Doppler sonography provides simultaneous display of morphology and blood flow.
- It can distinguish between inflammatory processes, inguinal hernias, and acute testicular torsion.

Radiology of the Urinary Tract

- **COMPUTED TOMOGRAPHY SCANNING**
- Renal CT is most commonly used in the evaluation of acute flank pain, hematuria, renal infection (search for abscess) and renal trauma, and in the characterization and staging of renal neoplasm.
- CT evaluation of renal anatomy and pathology generally requires intravenous injection of iodinated contrast media.
- noncontrast scans are needed, however, when renal or perirenal calcification, hemorrhage, or urine extravasation is suspected.

Radiology of the Urinary Tract

- A nephrogram phase with medullary enhancement is reached within 60 seconds.
- Excretion of contrast material into the collecting structures can be expected within 2–3 minutes after initiation of contrast administration.
- In the evaluation of the urinary bladder, CT is used primarily in staging bladder tumors and in diagnosing bladder rupture following trauma.
- Helical CT without oral or intravenous contrast is the preferred imaging modality for patients with renal colic.

Radiology of the Urinary Tract

- For prostate diseases, CT is used for detection of lymphadenopathy and to delineate prostatic abscesses.
- CT is used for detection of the abdominal location of suspected undescended testes.
- for staging of testicular tumors, and in the search for nodal or distant metastasis.

Radiology of the Urinary Tract

- **MAGNETIC RESONANCE IMAGING**
- Applications for MR in renal imaging include demonstration of congenital anomalies, diagnosis of renal vein thrombosis, and diagnosis and staging of renal cell carcinoma.
- MR angiography is useful in evaluating renal transplant vessels, renal vein tumor or thrombosis, and renal artery stenosis.
- The use of contrast media in MRI of the kidney has broadened clinical applications.

Radiology of the Urinary Tract

- The use of contrast media in MRI of the kidney has broadened clinical applications. Using bolus injection of gadolinium and rapid sequence imaging, both anatomy and function of the kidney can be assessed.
- Gadolinium, similar to iodine contrast media, is an extracellular contrast agent primarily excreted by glomerular filtration.
- The use of gadolinium has extended the application of MRI to the evaluation of renal obstruction (MRU may be used when other studies are inconclusive).

Radiology of the Urinary Tract

- Gadolinium enhanced MRA is useful for assessing renal artery stenosis and for evaluating potential renal donors.
- There may be a potential advantage for combined endorectal and surface coil MR staging for bladder carcinoma as well.
- MR urography utilizes the sensitivity of MR imaging to demonstrate fluid (urine), producing urogram- like pictures without the need for contrast media.

NUCLEAR SCINTIGRAPHY

- Radionuclide imaging is the procedure of choice to evaluate renal obstruction and function.
- It is sensitive to changes that induce focal or global changes in kidney function.
- Because neither gadolinium nor iodinated intravenous contrast agents are used, scintigraphy does not damage the kidney, has no lingering toxicity, results in minimal absorbed radiation, and is free from allergic reactions.

NUCLEAR SCINTIGRAPHY

- Once the agent is injected IV, gamma scintillation cameras measure radiation emitted from the radioisotope and digital workstations gather, process, and display the information.
- Technetium 99m-diethylene triamine pentaacetic acid (99mTc- **DTPA**) is primarily a glomerular filtration agent and it is useful for evaluation of obstruction and renal function.
- it is less useful in patients with renal failure because impaired GFR may limit adequate evaluation of the collecting system and ureters.

NUCLEAR SCINTIGRAPHY

- Technetium 99m-dimercaptosuccinic acid (99mTc-**DMSA**) is cleared by both filtration and secretion.
- It is most useful for identifying cortical defects and ectopic or abhorrent kidneys.
- No valuable information on the ureter or collecting system can be obtained with 99mTc-DMSA.
- **It remains a standard for renal cortical imaging.**
- Technetium 99m-mercaptoacetyl triglycine (99mTc-**MAG3**) is an excellent agent for imaging due to its photon emission, 6-hour half-life, and ease of preparation.

NUCLEAR SCINTIGRAPHY

- Because it is extensively bound to protein in plasma, it is limited in its ability to measure GFR but is an excellent choice for patients with renal insufficiency and urinary obstruction.

NUCLEAR SCINTIGRAPHY

- **Diuretic Scintigraphy**
- Nuclear medicine imaging plays a crucial role unmet by CT, MRI, or ultrasonography in the diagnosis of upper tract obstruction and its unique characteristics provide noninvasive information regarding dynamic renal function.
- The diuretic renal scan using 99mTc-MAG3 is able to provide differential renal function and clearance time comparing right and left kidneys, which is pivotal in patient management.

NUCLEAR SCINTIGRAPHY

- The flow phase shows renal uptake, background clearance, and abnormal vascular lesions, which may indicate arteriovenous malformations, tumors, or active bleeding.
- In the second phase the renal phase, time-to-peak uptake is typically between 2 and 4 minutes. The renal phase is the most sensitive indicator of renal dysfunction.
- A diuretic (usually furosemide .5 mg/kg) is administered when maximum collecting system activity is visualized.

NUCLEAR SCINTIGRAPHY

- Transit time through the collecting system in less than 10 minutes is consistent with a normal, nonobstructed collecting system.
- T1/2 of 10 to 20 minutes shows mild to moderate delay and may be a mechanical obstruction.
- A T1/2 of greater than 20 minutes is consistent with a high grade obstruction. Level of obstruction can usually be determined, as can abnormalities such as ureteral duplication.

NUCLEAR SCINTIGRAPHY

- **Nuclear Medicine in Urologic Oncology**
- **Whole Body Bone Scan:**
- The whole body bone scan or skeletal scintigraphy is the most sensitive method for detecting bone metastasis.
- **Positron Emission Tomography:**
- Useful in the detection of primary and metastatic cancer using positron emission tomography (PET).