Cylinders

Cases - Glomerulonephritis

Prompt

Renal Function & Urinalysis

Clinical Laboratory Scientist

Contributors

Nancy A. Brunzel, MS, CLS (NCA)

Pam Kieffer, MS, CLS (NCA)

Renal Function & Urinalysis

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1. Renal Anatomy and the Urinary System
   - 1.1. Kidney
     - 1.1.1. Macroscopic anatomy
       - 1.1.1.1. Describe macroscopic characteristics (Level 1)
         - 1.1.1.1.1. shape
         - 1.1.1.1.2. size
         - 1.1.1.1.3. placement in the abdominal cavity
       - 1.1.1.2. Diagram (Level 2) and state (Level 1) the function of each structure
         - 1.1.1.2.1. cortex (glomeruli)
         - 1.1.1.2.2. medulla
           - 1.1.1.2.2.1. pyramids
           - 1.1.1.2.2.2. papilla
           - 1.1.1.2.2.3. calyces
           - 1.1.1.2.2.4. pelvis
       - 1.1.1.3. Diagram renal blood circulation (Level 2) and explain its role in renal function (Level 2)
     - 1.1.2. Microscopic anatomy
       - 1.1.2.1. Diagram (Level 2) and state (Level 1) the function of each portion of the nephron
         - 1.1.2.1.1. Bowman's capsule
         - 1.1.2.1.2. proximal convoluted tubule
         - 1.1.2.1.3. loop of Henle
           - 1.1.2.1.3.1. descending limb
           - 1.1.2.1.3.2. ascending limb
         - 1.1.2.1.4. distal convoluted tubule (macula densa)
         - 1.1.2.1.5. collecting tubule/duct
       - 1.1.2.2. Diagram (Level 2) the glomerulus and state (Level 1) the function of each component
         - 1.1.2.2.1. mesangium
         - 1.1.2.2.2. capillary endothelium
         - 1.1.2.2.3. basement membrane
         - 1.1.2.2.4. podocytes (epithelium)
       - 1.1.2.3. Describe renal blood circulation of nephrons in the renal cortex and medulla (Level 1)
         - 1.1.2.3.1. afferent and efferent arterioles
         - 1.1.2.3.2. glomerulus
         - 1.1.2.3.3. peritubular capillaries
         - 1.1.2.3.4. vasa recta
   - 1.2. Ureters
     - 1.2.1. Describe anatomical structure, location, and function (Level 1)

1.2.2. Describe anatomical composition (e.g., epithelium) and mechanism of action (Level 1)

1.3. Bladder

1.3.1. Describe anatomical structure, location, and function (Level 1)

1.3.2. Describe anatomical composition (e.g., epithelium) and mechanism of action (Level 1)

1.4. Urethra

1.4.1. Describe anatomical structure, location, and function (Level 1)

1.4.1.1. Female

1.4.1.2. Male

1.4.2. Describe anatomical composition (e.g., epithelium) and mechanism of action (Level 1)

1.4.2.1. Female

1.4.2.2. Male

2. Renal Physiology

2.1. Glomerular function

2.1.1. Describe the process of glomerular filtration

2.1.1.1. Describe the role of hydrostatic and oncotic forces (Level 1)

2.1.1.2. Describe the role of glomerular filtration barrier (GFB) (Level 1)

2.1.1.2.1. capillary endothelium

2.1.1.2.2. basement membrane

2.1.1.2.3. podocyte filtration diaphragms

2.1.1.3. Explain the role of the GFB "shield of negativity" (Level 2)

2.1.2. Describe (Level 1) and calculate (Level 2) the glomerular filtration rate (i.e., renal clearance)

2.2. Tubular function

2.2.1. Describe the process of urine formation

2.2.1.1. Describe the mechanisms involved in tubular reabsorption and secretion (Level 1)

2.2.1.1.1. active transport

2.2.1.1.2. passive transport

2.2.1.2. State the solutes that are reabsorbed and secreted by the nephron (Level 1)

2.2.1.3. Identify the nephron location and mechanism of reabsorption or secretion for each solute (Level 1)

2.2.1.4. Summarize and explain the changes in solute composition as the ultrafiltrate passes through the nephron (Level 2)

2.2.1.5. Summarize and explain the changes in osmolality as the ultrafiltrate passes through the nephron (Level 2)

2.2.2. Explain tubular transport capacity (T_m) and discuss its relationship to renal threshold (Level 2)

2.2.3. Describe three secretory mechanisms used to regulate acid-base equilibrium (Level 1)

2.2.3.1. Hydrogen ion secretion to recover bicarbonate
2.2.3.2. Hydrogen ion secretion and the formation of titratable acids
2.2.3.3. Hydrogen ion secretion and the formation of ammonium ions

2.2.4. Discuss mechanisms that maintain hypertonicity of the renal medulla physiology (Level 1)
2.2.4.1. Countercurrent multiplier mechanism
2.2.4.2. Countercurrent exchange mechanism
2.2.4.3. Urea cycle
2.2.4.4. Role in urine formation and concentration

2.2.5. Describe changes in urine volume and solute composition (Level 1)
2.2.5.1. State the volume and solute composition of normal urine
2.2.5.2. Describe the role of antidiuretic hormone (ADH)/vasopressin in water reabsorption
2.2.5.3. Describe the renin-angiotensin-aldosterone mechanism and its role in sodium reabsorption
2.2.5.4. State physiologic factors involved in determining the volume of urine excreted
2.2.5.4.1. anuria
2.2.5.4.2. oliguria
2.2.5.4.3. polyuria

3. Diseases

3.1. Renal disease

3.1.1. Glomerular disease
3.1.1.1. Describe the pathogenesis of glomerular damage (Level 1)
3.1.1.2. Describe clinical features associated with glomerular disease (Level 1)
3.1.1.3. State the clinical features that characterize the nephrotic syndrome and identify diseases that are associated with this syndrome (Level 1)
3.1.1.4. Compare and contrast typical urinalysis findings (Level 2)
3.1.1.4.1. acute glomerulonephritis
3.1.1.4.2. chronic glomerulonephritis
3.1.1.4.3. nephrotic syndrome

3.1.2. Tubular disease
3.1.2.1. Compare and contrast the mechanism of tubular dysfunction and typical urinalysis findings (Level 2)
3.1.2.1.1. acute tubular necrosis (ATN)
3.1.2.1.2. cystinosis
3.1.2.1.3. cystinuria
3.1.2.1.4. renal glycosuria
3.1.2.1.5. renal tubular acidosis (RTA)
3.1.2.2. State the clinical features that characterize the Fanconi syndrome and identify diseases that are associated with this syndrome (Level 1)

3.1.3. Tubulointerstitial disease and urinary tract infections
3.1.3.1. Compare and contrast the etiology, clinical features, and typical urinalysis

findings (Level 2)
3.1.3.1.1. acute pyelonephritis
3.1.3.1.2. acute interestitial nephritis (AIN)
3.1.3.1.3. lower urinary tract infections (e.g., cystitis)
3.1.3.2. Explain the presence of organisms (e.g., yeast, trichomonads, giardia, etc.) found in urine despite no evidence of urinary tract infection or involvement (Level 2)
3.1.4. Vascular disease
3.1.4.1. Describe the etiology (Level 1)
3.1.4.2. Describe the effect on renal function (Level 1)
3.1.5. Acute and chronic renal failure
3.1.5.1. Explain etiology and clinical features (Level 2)
3.1.5.2. Discuss typical urinalysis results and renal function tests (Level 2)
3.1.6. Renal calculi
3.1.6.1. Define and describe the formation of renal calculi (Level 1)
3.1.6.2. State factors that influence calculi formation (Level 1)
3.2. Extra renal disease
3.2.1. Identify as amino acid disorders and describe typical urinalysis findings (Level 1)
3.2.1.1. Cystinuria and cystinosis
3.2.1.2. Alkaptonuria
3.2.1.3. Maple syrup urine disease (MSUD)
3.2.1.4. Phenylketonuria (PKU)
3.2.1.5. Tyrosinuria and melanuria
3.2.2. Describe the physiologic mechanisms, clinical symptoms, and typical urinalysis findings of carbohydrate disorders (Level 1)
3.2.2.1. Glucosuria
3.2.2.2. Diabetes mellitus
3.2.2.3. Galactosuria
3.2.3. Describe the physiologic mechanisms, clinical features, and typical urinalysis findings of metabolic disorders (Level 1)
3.2.3.1. Diabetes insipidus
3.2.3.2. Porphyrin disorders

4. The Urinalysis

4.1. Urine collection techniques and types of specimens
4.1.1. Instruct patients/health care providers in the proper procedure for the collection of urine specimen types (Level 2)
4.1.2. Describe urine specimen collection techniques/procedures (Level 1)
4.1.2.1. Routine void
4.1.2.2. Midstream clean void
4.1.2.3. Catheterization
4.1.2.4. Supra pubic aspiration
4.1.2.5. Pediatric collection bags
4.1.3. Identify urine specimen types (Level 1)

4.1.3.1. Random
4.1.3.2. First morning void
4.1.3.3. Timed
4.1.3.3.1. 2-hour
4.1.3.3.2. 12-hour
4.1.3.3.3. 24-hour
4.1.3.3.4. other
4.1.3.4. Other

4.2. Urine specimen handling and preservation
4.2.1. Evaluate acceptability of urine specimens (Level 3)
4.2.1.1. Verify labeling and patient identification
4.2.1.2. Determine if volume is sufficient
4.2.1.3. Determine if time of collection, handling, and transport conditions are appropriate
4.2.1.3.1. time elapsed since specimen collection
4.2.1.3.2. correctness of time interval, if for timed test
4.2.1.3.3. proper storage conditions
4.2.1.3.3.1. temperature
4.2.1.3.3.2. light
4.2.1.3.3.3. preservatives
4.2.1.4. Examine for visual evidence of contamination (e.g., fecal material) (Level 2)
4.2.1.5. Determine if collection technique and specimen container is appropriate (e.g., midstream clean void in sterile container for microbial culture) (Level 2)
4.2.2. Store specimens appropriately for testing, if necessary (Level 2)
4.2.2.1. Refrigerate (2 to 8° C)
4.2.2.2. Freeze (-24 to -16°C)
4.2.2.3. Room temperature
4.2.2.4. Protect from light
4.2.2.5. Additives for preservation
4.2.3. Communicate to health care providers the criteria for specimen rejection, document unacceptable specimens and action taken, when necessary (Level 2)

4.3. Preparation for testing
4.3.1. Verify acceptability of work area, equipment, reagents, and supplies
4.3.1.1. Assemble worksheets and other documenting materials (Level 2)
4.3.1.2. Observe and record temperatures (Level 2)
4.3.1.2.1. laboratory room
4.3.1.2.2. refrigerated storage level
4.3.1.2.3. freezer storage unit
4.3.1.2.4. heating blocks and water baths
4.3.1.3. Examine reagents for correct storage conditions (Level 2)
4.3.1.3.1. tightly sealed in properly labeled/dated containers
4.3.1.3.2. proper temperature

4.3.1.3.3. stored protected from light, if required
4.3.1.3.4. expiration date not exceeded

4.3.1.4. Prepare calibration and quality control materials (Level 2)
4.3.1.4.1. reagent strip reaction control materials
4.3.1.4.2. refractometer calibrators and/or controls
4.3.1.4.3. microscopic examination control material
4.3.1.4.4. other chemical test control materials

4.3.1.5. Perform and record calibration checks, quality control checks, and maintenance on equipment/instruments (Level 2)
4.3.1.5.1. refractometer
4.3.1.5.2. automated reagent strip reader
4.3.1.5.3. centrifuge
4.3.1.5.4. microscope
4.3.1.5.5. osmometer
4.3.1.5.6. spectrophotometer

4.3.1.6. Investigate and take corrective action when calibration or quality control check fail or equipment malfunctions (Level 3)

4.3.1.7. Document corrective action taken (Level 2)

4.3.1.8. Perform and record quality control checks for reagent strip tests, tablet tests, and other chemical tests (Level 2)

4.3.1.9. Perform and record quality control check for microscopic examination (Level 2)

4.3.1.10. Determine and apply protocol and confidence levels for quality control procedures (Level 3)

4.3.1.11. Evaluate quality control values to determine presence of analytical errors (e.g., shifts, trends) and implement corrective action when necessary (Level 3)

4.3.1.12. Perform and record troubleshooting on equipment/instruments (Level 2)

4.3.1.13. Perform method evaluation and select most appropriate method for laboratory needs (Level 3)

4.3.2. Prepare specimen for analysis (Level 2)
4.3.2.1. Mix specimen
4.3.2.2. Aliquot specimen for macroscopic (i.e., physical and chemical examinations) and microscopic examinations and special tests
4.3.2.3. Make dilutions of specimens, when necessary
4.3.2.4. Prepare aliquot of specimen for microscopic examination and/or other tests, as necessary
4.3.2.4.1. centrifuge sample, according to protocol
4.3.2.4.2. remove supernatant while retaining appropriate volume for sediment resuspension, according to protocol
4.3.2.4.3. resuspend sediment until homogeneous

4.3.2.5. Prepare sediment for microscopic examination
4.3.2.5.1. stain sediment, if needed
4.3.2.5.2. transfer sediment to a standardized commercial slide

4.3.2.5.3. dispense a standardized volume to glass microscope slide and apply appropriate coverslip (size defined in protocol), if necessary

4.4. Performance of macroscopic examination (i.e., physical and chemical examinations) of urine

4.4.1. Physical examination

4.4.1.1. Ensure appropriate conditions for testing (Level 2)

4.4.1.1.1. adequate room illumination

4.4.1.1.2. homogenous specimen

4.4.1.1.3. urine specimen at room temperature

4.4.1.2. Observe and record specimen color using established terminology

4.4.1.2.1. note any color that differs from established (Level 2) "reference/normal" values

4.4.1.2.2. correlate color with specimen concentration (i.e., specific gravity) (Level 3)

4.4.1.2.3. correlate color with patient medications, if necessary (Level 3)

4.4.1.2.4. correlate color and substances that produce them with clinical significance (Level 3)

4.4.1.3. Observe and record specimen clarity (i.e., transparency) using established protocol and terminology

4.4.1.3.1. correlate urine clarity with microscopic examination (Level 3)

4.4.1.3.2. state substances that affect urine clarity and indicate those that are clinically significant (Level 1)

4.4.1.4. Determine specimen concentration/density

4.4.1.4.1. perform specific gravity (SG) measurements using refractometry, reagent strips, or instrument technologies (Level 2)

4.4.1.4.2. perform osmolality measurements using osmometry (Level 2)

4.4.1.4.3. compare and contrast the principles employed in each method of concentration measurement (Level 2)

4.4.1.4.3.1. osmolality

4.4.1.4.3.2. refractometry

4.4.1.4.3.3. reagent strip SG

4.4.1.4.3.4. harmonic oscillation densitometry

4.4.1.4.4. correlate normal, high, low, or fixed values of urine concentration to clinical significance (Level 3)

4.4.1.5. Observe and comment on abnormal urine odor, if apparent

4.4.1.5.1. distinguish between normal urine odor and that associated with old, unpreserved urine (Level 2)

4.4.1.5.2. identify clinically significant conditions that are associated with abnormal urine odor (Level 1)

4.4.2. Chemical examination

4.4.2.1. Perform and record qualitative/semi-quantitative reagent strip chemical tests
- 4.4.2.1.1. dip reagent strips in urine appropriately and correctly time and read reactions (Level 2)
- 4.4.2.1.2. define limitations (Level 1) and establish protocol (Level 3) for reagent strip chemical reactions utilizing specificity and sensitivity criteria provided by manufacturer/clinical studies

4.4.2.2. Perform and record qualitative/semi-quantitative tablet or alternate chemical tests (Level 2); define limitations (Level 1) and establish protocol (Level 3)
- 4.4.2.2.1. sulfosalicylic acid test for protein
- 4.4.2.2.2. copper reduction tests for glucose
- 4.4.2.2.3. diazo tablet test for bilirubin
- 4.4.2.2.4. nitroprusside tablet test for ketone
- 4.4.2.2.5. other

4.4.2.3. Compare and contrast principles and limitations of chemical reactions/methods on reagent strips, tablet test, and other chemical tests (Level 2)
- 4.4.2.3.1. pH
  - 4.4.2.3.1.1. reagent strip
  - 4.4.2.3.1.2. pH meter
  - 4.4.2.3.1.3. indicator papers
- 4.4.2.3.2. heme moiety by reagent strip
  - 4.4.2.3.2.1. blood
  - 4.4.2.3.2.2. myoglobin
- 4.4.2.3.3. leukocyte esterase by reagent strip
- 4.4.2.3.4. nitrite by reagent strip
- 4.4.2.3.5. protein
  - 4.4.2.3.5.1. reagent strip
  - 4.4.2.3.5.2. precipitation
  - 4.4.2.3.5.3. immunochemical
  - 4.4.2.3.5.4. electrophoresis
- 4.4.2.3.6. carbohydrates
  - 4.4.2.3.6.1. reagent strip
  - 4.4.2.3.6.2. copper reduction
  - 4.4.2.3.6.3. enzymatic
  - 4.4.2.3.6.4. thin layer chromatography
- 4.4.2.3.7. ketone bodies
  - 4.4.2.3.7.1. reagent strip
  - 4.4.2.3.7.2. nitroprusside tablet
- 4.4.2.3.8. bilirubin
  - 4.4.2.3.8.1. reagent strip
  - 4.4.2.3.8.2. diazo tablet

4.4.2.3.9. urobilinogen
- 4.4.2.3.9.1. reagent strip
- 4.4.2.3.9.2. azo-coupling reaction
- 4.4.2.3.9.3. Ehrlich's reaction
- 4.4.2.3.9.4. Hoesch
- 4.4.2.3.9.5. Watson-Schwartz test

4.4.2.3.10. ascorbic acid by reagent strip

4.4.2.3.11. micro albumin by reagent strip

4.4.2.3.12. creatinine by reagent strip

4.4.2.4. Perform and record confirmatory tests and qualitative screening tests for substances associated with metabolic disease

4.4.2.4.1. define limitations (Level 1) and establish protocol (Level 3) for confirmatory tests
- 4.4.2.4.1.1. copper reduction test for urinary sugars
- 4.4.2.4.1.2. cyanide-nitroprusside test for cystine
- 4.4.2.4.1.3. diazo test for sulfonamide
- 4.4.2.4.1.4. Watson-Schwartz test for porphobilinogen/urobilinogen
- 4.4.2.4.1.5. other

4.4.2.4.2. define limitations (Level 1) and establish protocol (Level 3) for qualitative metabolic screening tests
- 4.4.2.4.2.1. Hoesch test for porphobilinogen
- 4.4.2.4.2.2. Watson-Schwartz test
- 4.4.2.4.2.3. other

4.4.2.4.3. discuss principles and limitations of confirmatory and qualitative metabolic screening tests
- 4.4.2.4.3.1. identify qualitative results as positive or negative for substance of interest (Level 1)
- 4.4.2.4.3.2. identify substance(s) detected and correlate with stated/possible metabolic disease (Level 3)
  - 4.4.2.4.3.2.1. branched-chain amino acids
  - 4.4.2.4.3.2.2. cystine
  - 4.4.2.4.3.2.3. homocystine
  - 4.4.2.4.3.2.4. homogentisic acid
  - 4.4.2.4.3.2.5. melanin
  - 4.4.2.4.3.2.6. phenylpyruvate and metabolites
  - 4.4.2.4.3.2.7. porphobilinogen
  - 4.4.2.4.3.2.8. tyrosine

4.4.2.5. Design (Level 3) and use (Level 2) established terminology for reporting chemical examination test results

4.4.2.6. Correlate chemical examination results obtained by different procedures/reactions for acceptability and clinical significance (Level 3)

4.4.2.7. Select most appropriate chemical method for clinical situation (Level 3)

4.4.3. Design (Level 3) and apply (Level 3) criteria for results that require confirmatory testing, alternate chemical testing, and/or dilutions

4.4.4. Design (Level 3) and use (Level 3) protocol to identify discrepant and/or contradictory results and action to be taken before results are reported

4.4.5. Design (Level 3) and use (Level 3) protocol for identifying and handling sources of error and action to be taken before results are reported

4.4.5.1. Preanalytical errors

4.4.5.1.1. incomplete timed specimen collection

4.4.5.1.2. use of or lack of a preservative during specimen collection and/or storage

4.4.5.1.3. exposure of specimen to light

4.4.5.1.4. mislabeled specimen

4.4.5.2. Analytical errors

4.4.5.2.1. interfering substance present in specimen

4.4.5.2.1.1. ascorbic acid

4.4.5.2.1.2. bilirubin

4.4.5.2.1.3. medications

4.4.5.2.1.4. other

4.4.5.2.2. deteriorating reagents

4.4.5.2.3. instrumentation maladjustment and/or malfunction

4.4.5.3. Postanalytical errors (e.g., transcription errors)

4.4.6. Correlate results of macroscopic examination, physical and chemical, with the microscopic examination (Level 3)

4.4.7. Establish (Level 3) and apply (Level 2) protocol for initiation of microscopic examination based on macroscopic examination results

4.4.8. Explain purpose of macroscopic examination tests to health care personnel (Level 2)

4.5. Performance of microscopic examination of urine

4.5.1. Prepare microscope for optimized viewing (Level 2)

4.5.1.1. Clean ocular and objectives appropriately

4.5.1.2. Adjust light source for proper illumination level

4.5.1.3. Place filters (e.g., neutral density) in light path appropriately

4.5.1.4. Protect microscope from dust when not in use (i.e., dust cover)

4.5.2. Select type of microscopy and adjust appropriately for optimum viewing (brightfield, phase contrast, polarizing, interference contrast) (Level 2)

4.5.2.1. Optimize condenser position

4.5.2.1.1. height

4.5.2.1.2. centration

4.5.2.2. Adjust diaphragms appropriately

4.5.2.2.1. field iris

4.5.2.2.2. condenser aperture

4.5.2.3. Check and perform phase ring alignment for phase microscopy (Level 2)

4.5.2.4. Place polarizing filters in light path correctly for polarizing microscopy (Level 2)

4.5.3. Use microscope (i.e., place, focus, and scan mounted specimen) (Level 2)
- 4.5.3.1. Secure microscope slide on mechanical stage
- 4.5.3.2. Check and perform interpupillary and diopter adjustments
- 4.5.3.3. Select and interchange objectives
- 4.5.3.4. Use coarse and fine adjustments
- 4.5.3.5. Use mechanical stage adjustment knobs to scan mounted specimen

4.5.4. Identify and determine the type and amount of cellular elements (Level 2)
- 4.5.4.1. Red blood cells, using high power magnification (400X)
  - 4.5.4.1.1. typical form (i.e., biconcave disc)
  - 4.5.4.1.2. ghost forms
  - 4.5.4.1.3. crenated forms
- 4.5.4.2. White blood cells, using the high power magnification (400X)
  - 4.5.4.2.1. typical forms
    - 4.5.4.2.1.1. neutrophils
    - 4.5.4.2.1.2. lymphocytes
    - 4.5.4.2.1.3. macrophages
  - 4.5.4.2.2. forms showing degenerative changes
    - 4.5.4.2.2.1. fusion of lobed nuclei
    - 4.5.4.2.2.2. bleb formation
    - 4.5.4.2.2.3. myelin filaments
  - 4.5.4.2.3. forms with absorbed fat (i.e., oval fat bodies)
  - 4.5.4.2.4. stained with special stains to identify and enumerate cell type
    - 4.5.4.2.4.1. eosinophils
    - 4.5.4.2.4.2. lymphocytes
    - 4.5.4.2.4.3. others
- 4.5.4.3. Epithelial cells
  - 4.5.4.3.1. squamous epithelial cells, using low power magnification (100X)
  - 4.5.4.3.2. transitional epithelial cells, using high power magnification (400X)
  - 4.5.4.3.3. renal tubular epithelial cells, using high power magnification (400X)
    - 4.5.4.3.3.1. collecting duct cells
    - 4.5.4.3.3.2. convoluted tubular cells
    - 4.5.4.3.3.3. cell with absorbed fat (i.e., oval fat bodies)
- 4.5.4.4. Abnormal/atypical cells

4.5.5. Identify and determine the type and amount of formed elements present (Level 2)
- 4.5.5.1. Casts, using lower power magnification (100X); confirm type of cast using high power magnification (400X)
  - 4.5.5.1.1. hyaline
  - 4.5.5.1.2. waxy
  - 4.5.5.1.3. cellular inclusion
    - 4.5.5.1.3.1. red blood cells

4.5.5.1.3.2. white blood cells
4.5.5.1.3.3. renal epithelial cells
4.5.5.1.3.4. mixed cells

4.5.5.1.4. other inclusions
4.5.5.1.4.1. finely granular
4.5.5.1.4.2. coarsely granular
4.5.5.1.4.3. fat globules (i.e., fatty)
4.5.5.1.4.4. crystals
4.5.5.1.4.5. hemosiderin

4.5.5.1.5. pigmented
4.5.5.1.5.1. hemoglobin
4.5.5.1.5.2. bilirubin

4.5.5.2. Crystals, using low power magnification (100X)
4.5.5.2.1. Acidic, neutral, basic
4.5.5.2.2. Associated with pathology
4.5.5.2.3. Derived iatrogenically

4.5.5.3. Miscellaneous formed elements, using high power magnification (400X)
4.5.5.3.1. bacteria
4.5.5.3.2. contaminants
4.5.5.3.2.1. starch
4.5.5.3.2.2. fibers
4.5.5.3.2.3. clue cells
4.5.5.3.2.4. fecal material
4.5.5.3.2.5. others

4.5.5.3.3. fat globules
4.5.5.3.4. hemosiderin
4.5.5.3.5. mucus
4.5.5.3.6. parasites (e.g., trichomonads)
4.5.5.3.7. spermatozoa
4.5.5.3.8. yeast

4.5.6. Record microscopic examination results using established protocol and terminology (Level 2)

4.5.7. Correlate microscopic examination results with the macroscopic examination (e.g., specific gravity with the forms/condition of red and white blood cells; pH with crystal type; if fat must also have protein present) (Level 3)

4.5.8. Correlate microscopic examination results with stated/possible condition (Level 3)

4.5.9. Design (Level 3) and use (Level 2) protocol to identify specimens that require confirmatory testing before reporting

4.5.9.1. Check for preanalytical and post analytical errors (e.g., specimen mix-up, transcription errors) and implement corrective action

4.5.9.2. Perform additional testing to resolve conflicting results

4.5.9.3. Perform additional testing for identification purposes (e.g., use polarizing microscopy to differentiate crystals from cells or formed elements; use chemical test to identify hemosiderin or crystals)

4.5.10. Explain purpose of microscopic examination to health care personnel (Level 2)
4.5.11. Describe viewing differences and advantages for each type of microscopy (Level 1)
4.5.11.1. Brightfield
4.5.11.2. Phase contrast
4.5.11.3. Polarizing

4.6. Interpretation and reporting of results
4.6.1. Review test results
4.6.1.1. Determine acceptability of quality control (QC) materials
4.6.1.1.1. verify that results are acceptable; if not acceptable, verify that appropriate action is taken and documented (Level 3)
4.6.1.1.2. evaluate (Level 3) cumulative plot/chart of QC data for evidence of changes in analytical error (i.e., shift, trend); implement corrective action when necessary (Level 2)
4.6.1.2. Determine acceptability of patient specimens
4.6.1.2.1. Evaluate results (Level 3); decide if all procedures are complete including confirmatory tests, when necessary (Level 2)
4.6.1.2.2. Intercept questionable and/or contradictory results; verify that appropriate action is taken and documented before reporting (Level 3)
4.6.1.2.3. Ensure results are recorded in established format and terminology (Level 2)
4.6.2. Evaluate patient results
4.6.2.1. Utilize reference intervals to determine clinical significance (i.e., normal/abnormal) (Level 2)
4.6.2.2. Correlate results with stated/possible condition (Level 3)
4.6.2.3. Correlate results with other test results on the same patient (Level 3)
4.6.2.4. Compare current result with previous results using the same test (Level 2)
4.6.3. Report test results
4.6.3.1. Design (Level 3) and use (Level 2) protocol for identifying and reporting "critical values"
4.6.3.2. Design (Level 3) and use (Level 2) protocol to communicate results
4.6.3.2.1. transcription
4.6.3.2.2. computer entry
4.6.3.2.3. verbal/telephone
4.6.3.2.4. other
4.6.3.3. Maintain daily and cumulative QC documentation (Level 2)
4.6.3.4. Retain result documentation as required for accreditation purposes (Level 2)
4.6.4. Respond to inquiries from health care personnel concerning test results, reference intervals, specimens, etc. (Level 2)

4.7. Personnel development
4.7.1. Training
4.7.1.1. Master and instruct others in the performance of urinalysis procedures

and urinalysis instrumentation/equipment use (Level 2)
4.7.1.1.1. automated
4.7.1.1.2. semi-automated
4.7.1.1.3. manual
4.7.1.2. Design teaching protocols (Level 3)
4.7.2. Continuing education and competency
4.7.2.1. Participate in continuing education programs to enhance pertinent knowledge and skills (Level 2)
4.7.2.2. Participate in program to annually document competency in the urinalysis laboratory (Level 2)

5. Renal Function Tests

5.1. Assess glomerular function using renal clearance tests
5.1.1. State the advantages and disadvantages of substances used for the determination of renal clearance (Level 1)
5.1.1.1. Creatinine
5.1.1.2. Inulin
5.1.2. Recognize factors that can influence creatinine clearance results (Level 1)
5.1.2.1. Timing
5.1.2.2. Completeness of collection
5.1.2.3. Body size
5.1.2.4. Other
5.1.3. Describe (Level 1) and use (Level 2) protocol for performing a creatinine clearance test
5.1.4. Calculate creatinine clearance results, including normalization using body surface area (Level 2)
5.2. Interpret and report renal function test results
5.2.1. Review test results
5.2.1.1. Determine acceptability of quality control (QC) materials
5.2.1.1.1. verify that results are acceptable and if not acceptable, verify that appropriate action is taken and documented (Level 3)
5.2.1.1.2. evaluate (Level 3) cumulative plot/chart of QC data for evidence of changes in analytical error (i.e., shift, trend) and implement (Level 2) corrective action, when necessary
5.2.1.2. Determine acceptability of patient specimens
5.2.1.2.1. evaluate results, intercept questionable and/or contradictory results and verify that an appropriate specimen was collected and procedures have been followed (Level 3)
5.2.1.2.2. ensure results are recorded in established format and terminology (Level 2)
5.2.2. Evaluate patient results (Level 3)
5.2.2.1. Utilize reference intervals to determine clinical significance (i.e.,

normal/abnormal) (Level 2)
5.2.2.2. Correlate results with stated/possible condition (Level 3)
5.2.2.3. Correlate results with other test results on the same patient (Level 3)
5.2.2.4. Compare current result with previous results using same test (Level 2)

5.2.3. Report test results
5.2.3.1. Design (Level 3) and use (Level 1) protocol to communicate
5.2.3.2. results
5.2.3.2.1. transcription
5.2.3.2.2. computer entry
5.2.3.2.3. verbal/telephone
5.2.3.2.4. other
5.2.3.3. Maintain daily and cumulative QC documentation (Level 2)
5.2.3.4. Retain result documentation as required for accreditation purposes (Level 2)

5.2.4. Respond to inquiries from health care personnel concerning tests results, reference intervals, specimens, etc. (Level 2)

5.2.5. Explain purpose of each renal function test to healthcare personnel (Level 2)

6. Renal Calculi

6.1. Define and discuss factors that influence calculi formation (Level 1)
6.1.1. Increase in chemical salts
6.1.2. Changes in urinary pH
6.1.3. Urinary stasis
6.1.4. Foreign body seed

6.2. Compare and contrast modes of prevention and treatment (Level 2)