Lab - Urinalysis
PFN: 18DLAL04

Hours: 1.0

Terminal Learning Objective

- OBJECTIVE:
  - Action: Analyze a urine sample and interpret the findings
  - Condition: Given a laboratory subject’s book, laboratory procedures book, a power point presentation under the instruction of a laboratory technician, and inside a laboratory classroom environment.
  - Standard: Identified normal or abnormal urinalysis findings IAW the laboratory subjects book and the laboratory procedures book, scored a 75% or above on the laboratory subject’s computer based exam, and passed the urinalysis macroscopic/microscopic practical test.

References

- References used to develop this Lesson:
  - Laboratory Subjects Book
  - Laboratory Procedures Handout
Reason
Urinalysis can be an important diagnostic tool providing evidence of the disease process since 25% of the body's blood flows through the kidneys each minute.

Agenda
- Identify the types of urine specimen collection.
- Describe types, purpose, and functions of urine preservation.
- Describe normal urine output.
- Identify abnormal urine production to include polyuria, oliguria, and anuria.
- Differentiate between normal and abnormal urine appearance.
- Define specific gravity.

Agenda
- Describe the significance and use for the tests conducted using a chemical exam to include glucose, bilirubin, ketone, specific gravity, blood, pH, protein, urobilinogen, nitrite, and leukocytes.
- Identify the characteristics and significance of elements that may be found in a microscopic examination of a urine specimen to include: WBC's, RBC's, epithelial cells, squamous cells, and transitional cells.
- Identify the characteristics and significance of casts that may be found in a microscopic examination of a urine specimen to include: hyaline casts, epithelial cell casts, hemoglobin casts, granular casts, waxy casts, and fatty casts.
Agenda

- Identify the characteristics and significance of parasites, bacteria, yeasts, and spermatozoa that may be found in a microscopic examination of a urine specimen.
- Identify the characteristics and significance of other artifacts that may be found in a microscopic examination of a urine specimen to include: fiber, hair, talcum powder, and skin cells.
- Identify the characteristics and significance of urine crystals in an acidic urine sample to include: amorphous urates, uric acid, calcium oxalate, and sodium urate.

Agenda

- Identify the characteristics and significance of urine crystals in an alkali urine sample to include: amorphous phosphates, triple phosphate, ammonium urates, calcium carbonate, and calcium phosphate.
- Identify the characteristics and significance of abnormal urine crystals in an acidic urine sample to include: leucine, tyrosine, cystine, cholesterol, and sulfa crystals.

Types of Urine Specimen Collection

- Random - most commonly received specimen
  - Purpose
    - Routine screening
    - Inadequate for microbiological exam
  - Container
    - Clean dry container with tight fitting lid
  - Method
    - Void directly into container or bedpan
Types of Urine Specimen Collection

- Midstream clean-catch
  - Purpose
    - Most commonly used for bacteriological exam
    - Alternative to catheterized specimens
  - Container
    - Sterile container
  - Method
    - Clean area around urethra and discard initial stream

Types of Urine Specimen Collection

- Catheterized
  - Purpose
    - Bacterial culture
    - Routine urinalysis
    - Collection
  - Container
    - Same as midstream clean-catch
  - Method
    - Collected under sterile conditions from catheter

Types of Urine Specimen Collection

- Suprapubic aspiration
  - Purpose
    - Bacterial culture
    - Cytological exam
  - Container
    - Same as clean catch
  - Method
    - External introduction of a needle into the bladder
Types of Urine Specimen Collection

- Two-hour postprandial
  - Purpose
    - Monitoring insulin therapy (diabetes mellitus)
    - Used to compare fasting specimen results
  - Container
    - Clean and dry with tight fitting lid
  - Method
    - Void, Consume meal, collect specimen 2 hours later

Types of Urine Specimen Collection

- Twenty-four hour urine
  - Purpose
    - To measure exact amount of urine chemicals
    - Specimen of choice for quantitative chemical testing
  - Container
    - Clean, dark, dry container designed to hold large volume
  - Method
    - Void first morning, collect all other voids to include day 2 first morning void

Urine Preservation

- Purpose - to prevent changes in urine composition after one hour room temperature
  - Increased Ph
  - Decreased glucose
  - Decreased ketones
  - Decreased bilirubin
  - Decreased urobilinogen
  - Increased nitrite
  - Increased urobilinogen
  - Increased bacteria
  - Increased turbidity
  - Disintegration cellular elements
  - Color changes
Types of Urine Preservatives

- Refrigeration
- Freezing
- Formalin
- Hydrochloric Acid
- Boric Acid / HCL
- Methanol is not a common preservative

Refrigeration

- Short term preservation of chemical and cellular elements
- Advantages and disadvantages
  - Easiest and most common
  - No interference
  - Acceptable for urine culture

Freezing

- Used for bilirubin and urobilinogen
- Advantages and disadvantages
  - Preserves bilirubin and urobilinogen
  - Turbidity occurs upon freezing
Formalin

- Used for sediment preservation
  - Preserves formed elements
- Disadvantage
  - May cause clumping of sediment

Boric Acid

- Used for proteins, uric acid and hormones
- Advantage
  - Acceptable for urine culture

Hydrochloric Acid (HCL)

- Used for calcium, d-aminolevulinic acid, and oxalate testing
- Disadvantages
  - Destroys formed elements
  - Precipitates solutes
Boric acid/HCL

- Test dependent
- Precautions
  - May interfere with some tests
  - When in doubt look it up
  - When shipping - Preserve the specimen as directed by the receiving Laboratory
  - CAUTION: Chemicals may cause burns

Volume

- Normal excretory output of the kidneys
  - Normal void (600 to 2,000) ml/24 hours
  - Normal average void per 24 hours (1200 to 1500) ml/24hrs

Abnormal Urine Volume

- Polyuria
- Oliguria
- Anuria
Polyuria

- Increased urine production - greater than 2,000 mL/24 hrs
- Clinical conditions
  - Diabetes insipidus
  - Diabetes mellitus
  - Nervousness and anxiety
  - Increased fluid intake
  - Diuretic medications
  - Diuretic drinks
  - Chronic renal disease

Oliguria

- Decreased urine production - less than 500 mL/24 hr
- Clinical conditions
  - Decrease fluid intake
  - Increase ingestion of salt
  - Excessive perspiration
  - Dehydration
  - Partial renal shutdown

Anuria

- Cessation of urine flow - 100 mL/24 hr
  - Considered a medical emergency
- Clinical conditions
  - Total renal shutdown
  - Massive fluid loss
  - Heavy metal poisoning
  - Blockage of renal tubules
Color
- Normal color - due to varying amounts of pigment called urochrome
- Straw
- Yellow
- Amber - normal unless caused by the presence of bilirubin
- Colorless - normal if caused by recent fluid consumption

Abnormal Urine Color
- Red - Fresh blood
- Orange - Medications
- Brown - Hemoglobin
- Black - Malaria
- Blue-green - Pseudomonas infections; medications
- Colorless - Due to the absence of urochrome
- Amber - Bilirubin

Appearance
- Clear
  - No turbidity
- Hazy
  - Slightly turbid
- Cloudy
  - Excessive turbidity
Specific Gravity

- Measure of total solids in urine
- Density of urine sample compared to the density of distilled water
- Purpose
  - Measures concentrating and diluting abilities of kidneys
  - Best routine test for total kidney function
- A Refractometer is also used for Specific Gravity as a confirmatory method

pH

- Determines the acidity/alkalinity of urine
- Urine becomes alkaline upon standing
- Useful in identification of crystals
- Used to rule out acidosis/alkalosis

pH

- Clinical significance
- Acidic
  - Diabetic acidosis
  - Gout
  - Dehydration
  - Severe diarrhea
  - High protein diet
  - Certain medication
**pH**

- Clinical significance
  - Alkaline
    - Vomiting
    - Renal tubular acidosis
    - Certain medications
    - Urinary tract infection
    - After meals

**Protein**

- Purpose - best routine test to detect renal disease
- Clinical significance - proteinuria (increase protein)
  - Strenuous physical exercise
  - Emotional stress
  - Pregnancy
  - Infections

**Protein**

- Epithelial cells in urine
- Severe renal disease
- Multiple myeloma
- Leukemia
- Glomerulonephrites
- Hematuria
- Hemoglobinuria
- WBC in urine
Glucose
- Most common sugar found in urine
- Presence of detectable amounts known as Glycosuria
- Occurs when glucose levels exceeds reabsorption capacity
- Clinical significance
  - Diabetes mellitus
  - Renal tubular dysfunction
  - Pregnancy with possible latent gestational diabetes

Ketone Bodies
- Ketonuria
- Intermediate products of fat metabolism
- Presence due to altered carbohydrate metabolism
- Clinical significance
  - Diabetes mellitus
  - Anorexia nervosa
  - Starvation or fad diets

Blood and Hemoglobin
- Hematuria - presence of intact RBC's in the urine
  - Bleeding in the urinary tract
  - Glomerular damage
  - Trauma
- Hemoglobinuria - presence of free hemoglobin in the urine
Blood and Hemoglobin

- Due to intravascular hemolysis
  - Hemolytic anemia
  - Hemolytic transfusion reactions
  - Malaria

- Due to lysis of RBC's in urinary tract
  - Traumatic passage of RBC's thru kidney to bladder
  - Exposure of RBC's to dilute urine in the bladder

Bilirubin

- Bilirubinuria

- Degrades upon standing while exposed to light

- Clinical significance
  - Diagnostic sign of liver disease
  - Possible biliary obstruction
  - Increase in diseases that causes conjugated bilirubin to be increase in bloodstream

Urobilinogen

- Increase in condition with increase bilirubin
  - Hemolytic anemia
  - Malaria

- Increased in conditions that prevents reabsorption
  - Hepatitis
  - Cirrhosis
Nitrites

- Suggests $10^5$ (100,000) or more bacteria per mL of urine
- Indicative of an infection by nitrate reducing bacteria. First morning specimen is preferred.

Leukocyte Esterase

- White blood cells release esterases in urine. Test is not designed to be exact on concentration of leukocytes.
- Pyuria - white blood cells in urine
  - Indication of bacteriuria
  - Indirectly indicates UTI

Leukocyte Esterase Determination

- False negatives
  - High levels of glucose and proteins
  - High urine specific gravity
Microscopic Examination

- Stains used in analysis
  - Sternheimer Malbin- Stains protein blue
    - Protein
  - Peroxidase
    - Differentiates WBC's from renal epithelial cells by staining granules in neutrophils blue-black.
  - 3% acetic acid
    - Differentiates RBC's from yeast
  - Sudan III
    - Fat globules will stain orange
  - Iodine
    - Starch globules will stain blue to black

White Blood Cell

- More than 5 WBC/HPF is abnormal (infection or inflammation)

- Identifying characteristics
  - Round to oval shape.
  - Segmented or lobulated nucleus (if visible)
  - Granular cytoplasm

- Report all WBC's as number per high power field (8/HPF)
Red Blood Cell

- More than 3 RBC/HPF is abnormal
- Increased in
  - Internal bleeding
  - UTI
  - Traumatic catheterization
  - Some type of trauma
  - Strenuous exercise
  - Menstruation

Red Blood Cell

- Identifying characteristics
  - Pale, refractive biconcave discs
  - Variation in size
    - In concentrated urine, small and crenated
    - In dilute urine, large and swollen

- Report all RBC’s number per high power field (#/HPF)
Epithelial Cell

- Originate from the genitourinary system

- Three types
  - Squamous
  - Transitional
  - Renal

- Report all epithelial cells number per high power field (#/HPF)

Epithelial Cell

- Squamous
  - From distal of urethra
  - Large, flat irregularly shaped
  - Small central nucleus
  - Abundant cytoplasm
Epithelial Cell

- Transitional
  - From renal pelvis and bladder
  - Round or pear-shaped
  - May have tail-like projections
  - Large, centrally located nucleus
  - May have two nuclei
- May be seen in renal disease

Epithelial Cell

- Renal
  - From renal tubules and nephron
  - Slightly larger than WBC
  - Nucleus usually off-center
  - May be flay, cubodial or columnar
- Suggestive of tubular damage
Casts

- Formation
  - Usually in distal convoluted tubule and collecting duct
  - May also be formed in the ascending loop of Henle

Casts

- Cast formation
  - Aggregation of Tamm-Horsfall protein
  - Attachment of fibrils
  - Interweaving of fibrils
  - Further protein fibril interweaving
  - Possible attachment
  - Detachment of protein fibrils
  - Excretion of cast
Casts

- General identifying characteristics
  - Parallel sides
  - Round to blunt ends

Types of Casts

- Hyaline cast
- White blood cell cast
- Red blood cell cast
- Hemoglobin cast
- Epithelial cell cast
- Granular cast
- Waxy cast
- Fatty cast

Types of Casts

- Hyaline casts consist of
  - Refractive index
  - Normal following strenuous exercise, dehydration, heat exposure and emotional stress
  - Increased in acute glomerulonephritis, pyelonephritis, chronic renal disease, and congestive heart failure
  - Possible basis for all other casts
Types of Casts

- White blood cell cast
  - Refractile and granulated
  - Unless disintegration has begun
  - Indicate infection or inflammation within nephron
Types of Casts

- Red blood cell cast
  - Refractive, yellow to brown
  - May contain RBC’s
  - Primarily associated with glomerulonephrites
  - Other conditions

Types of Casts

- Hemoglobin cast
  - Homogenous
  - Reddish brown color
  - Associated with same conditions as RBC cast
Types of Casts

- Epithelial cell cast
  - Formed by excessive shedding of epithelial cells
  - Indicative of
    - Glomerulonephritis
    - Pyelonephritis
Types of Casts

- Granular cast
  - Contains homogenous granular material
  - Represent stages of degeneration of epithelial cast or WBC casts.
  - May occasionally be seen in normal urine
  - May indicate glomerulonephritis or pyelonephritis

Types of Casts

- Waxy cast
  - Result of granular cast degeneration
  - Refractile
  - Brittle appearance
  - Irregularly shaped
  - Indicative of extreme stasis of urine flow
Types of Casts

- Fatty cast
  - Formed by attachment of lipids
  - Highly refractile
  - Contains yellow brown fat droplets
  - Seen in disorders causing lipiduria
Miscellaneous Structures

- Schistosoma hematobium
  - Common in the Nile valley, Middle East and Mediterranean regions
  - Infection with this parasite occurs from contaminated water
  - The adult worms live in bladder
  - Ovum has terminal spine
  - Rarely seen in United States
  - Report as present

- Trichomonas Vaginalis
  - Most common parasite seen in urine.
  - Results of contamination
    - In fresh specimen
      - Highly motile
      - Multiple flagella
    - Left out specimens
      - Loss of motility
      - Degeneration
  - Report as Trichomonas spp. present
Miscellaneous Structures

- Examples of parasites that can be found in urine as a result of fecal contamination
  - Enterobiosis vermicularis
  - Giardia lamblia
Giardia Lamblia

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**Miscellaneous Structures**

- **Bacteria**
  - Not normally present in urine
  - May indicate UTI or contamination
- Presence of WBC’s and positive nitrite test suggest a UTI
- Report Bacteria as present
Miscellaneous Structures

- Yeast - Candida albicans most common
  - Smooth, colorless, usually ovoid cells
  - Often confused with RBC's
  - Addition of 3% acetic acid will lyse RBC's
  - May show budding or hyphae
  - Found in UTI's
  - Report as present

Hyphae

Spores
**Miscellaneous Structures**

- Spermatozoa
  - Oval bodies with, thin tails
  - Usually found
    - After sexual intercourse
    - Nocturnal emissions
  - Found in female patient due to contact
  - Verbally report spermatozoa as present

**Artifact**

- Many contaminants can be found in urine
  - Cotton threads
  - Hair
  - Starch granules, powder granules, talc granules
  - Plant matter
  - Vegetable fibers
  - Glass fragments

- Must be recognize but not reported
Normal crystals

Acidic urine

- Amorphous urates pH < 7.0
  - Yellow-brown small granules
  - If present in large amounts, may give urine sediment pink color
Normal crystal
Acidic urine

- Uric acid
  - Yellow-reddish-brown
  - Markedly increased levels may have pathogenic cause (Gout, Leukemia)
  - Usually clinically insignificant
  - Normal urine crystals in acidic urine may take on a variety of shapes:
    - Rhombic plates
    - Rosettes
    - Wedges
    - Needles

Normal crystal
Acidic urine

- Calcium oxalate
  - Colorless squares with a prismatic X inside
  - Dumbbell and oval forms also occur
  - May also be seen in neutral urine
Normal crystal

Acidic urine

- Sodium urate
  - Colorless
  - Appears as elongated plates in a Chinese fan arrangement
Normal crystal
Alkaline urine

- Amorphous phosphate pH > 7.0
  - Appear as small irregularly shaped granules
  - When present in large amounts, cause a white turbidity in specimen

Normal crystal
Alkaline urine

- Triple phosphate
  - Three to six sided
  - Often referred to as coffin lids
Normal crystal
Alkaline urine

- Ammonium biurate
  - Yellow-brown color
  - Frequently described as thorny apples
Normal crystal
Alkaline urine

- Calcium carbonate
  - Colorless
  - Small dumbbell and spherical shapes
  - Gas produced with the addition of acetic acid

Note: Abnormal crystals are all found in neutral or acidic urine.
Abnormal crystal
Neutral or Acidic urine

- Leucine (amino acid)
  - Yellow brown spheres with concentric circles with radial striations
  - Seen in liver disease
  - Present in conjunction tyrosine crystals
Abnormal crystal
Neutral or Acidic urine

- Tyrosine
  - Resembles fine silky needles
  - Seen in severe liver disease
  - Present with leucine

- Cystine
  - Appears as colorless hexagonal plates
  - Appear due to inherited inability to reabsorb cystine
  - Indicates potential for renal calculi formation
Abnormal crystal
Neutral or Acidic urine

- Cholesterol
  - Appears as a rectangular plate with notched corners
  - May have a stair step affect
  - Indicative of renal damage
Abnormal crystal
Neutral or Acidic urine

- Sulfonamids (sulfa crystals)
  - Presence due to sulfa drug therapy
  - Many different forms
  - Must know patient drug history to rule out

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  - Condition: Given a laboratory subject’s book, laboratory procedures book, a power point presentation under the instruction of a laboratory technician, and inside a laboratory classroom environment.
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References

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  - Laboratory subjects book
  - TM 8-227-4 Clinical Lab Procedures, Urinalysis

Reason

Urinalysis can be an important diagnostic tool providing evidence of the disease process since 25% of the body's blood flows through the kidneys each minute.

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Questions?