Lab - Urinalysis

PFN: 18DLAL04

Hours: 2.0

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Lab - Urinalysis

- **OBJECTIVE:**
  - Action: Perform a complete Urinalysis on 5 separate specimens
  - Condition: Given the necessary equipment
  - Standard: Within 75% accuracy

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Lab - Urinalysis

- References used to develop this Lesson:
  - Laboratory subjects book
  - TM 8-227-4 Clinical Lab Procedures, Urinalysis
Topics

- Describe proper urine collection procedures
- Describe methods of urine preservation
- Describe normal/abnormal urine output
- Given the proper equipment describe and perform a macroscopic and microscopic procedure

Reason

Urinalysis can be an important diagnostic tool providing evidence of the disease process since 25% of the bodies blood flows through the Kidneys each minute

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

- First morning void - specimen of choice for qualitative analysis

- Purpose
  - Routine screening
  - Concentrated

- Container
  - Clean dry container with tight fitting lid

- Method
  - Collect first specimen immediately upon rising

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 Preservative

- Purpose: to prevent changes in urine composition
  - Increased pH
  - Decreased glucose
  - Decreased ketones
  - Decreased bilirubin
  - Decreased urobilinogen
  - Increased nitrite
  - Increased bacteria
  - Increased turbidity
  - Disintegration cellular elements
  - Color changes

Functions of Preservatives

- Prevent oxygen contact with specimen
- Maintains acid pH
- Retard microbial growth
- Fix organized sediment

Types of Urine Preservatives

- Refrigeration
- Toluene
- Formalin
- Boric Acid / HCL
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

CAUTION: Chemicals may cause burns
Sub Summary

- Do chemical preservatives interfere with urine dip stick tests?
  Yes
- What is the most common urine preservative?
  Refrigeration

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

Factors affecting normal urine production

- Temperature
  - Cold (increased)
  - Heat (decreased)

- Diet
  - Liquid (increased)
  - Less (decreased)

- Exercise
  - Sweat (decreased)
Abnormal Urine Volume

- Polyuria
- Oliguria
- Anuria

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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

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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
- Clinical conditions
  - Total renal shutdown
  - Massive fluid loss
  - Heavy metal poisoning
  - Blockage of renal tubules

Sub Summary

- What is increased urine output? Polyurea
- What is normal urine output? Normal void 600 to 2,000 mL/24 hours

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

Sub Summary

- What will cause a normal urine to become cloudy?
  If it sits for more then an hour the pH changes and amorphous sediment builds up

- What are normal urine colors?
  Yellow, straw, amber
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

Clinical significance
- Hyposthenuric - Low specific gravity <1.010
  - Glomerulonephritis
  - Pyelonephritis
  - Diabetes insipidus
  - Large intake of fluids

Hypersthenuric - High specific gravity >1.010
- Hepatic disease
- Congestive heart failure
- Excessive loss of water (dehydration)
- First morning specimen
Specific Gravity

- Isosthenuric - Specific gravity of 1.010 consistently
  - Severe renal damage
  - Indicates loss of both the concentrating and diluting abilities of the kidneys

Specific Gravity Determination

- Refractometer
  - QC
    - Use one or two drops
    - Hold refractometer
    - Read far left scale
    - Reference range 1.000
    - Wipe clean
  - Test sample
    - DI water
Specific Gravity Determination

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
Protein Confirmation

- Sulfosalicylic acid (SSA)
- Confirmation of urinary proteins
- SSA will precipitate protein
- Rules out false positives
- Procedure
  - Equal amounts
  - Turbidity
  - Reactions semi-quantitated

Glucose

- Most common sugar found in urine
- Presence of detectable amounts known as Glycosuria
- Occurs when glucose levels exceed reabsorption capacity
- Clinical significance
  - Diabetes mellitus
  - Renal tubular dysfunction
  - Pregnancy with possible latent gestational diabetes
**Glucose Confirmation**

- Clinitest confirmation for glucose
- Non-specific test
- Clinitest procedures
  - Add 5 drops of urine and 10 drops of water
  - Add 1 clinitest tablet
- NOTE: do not touch test tube
  - Shake tube
  - Compare color of liquid
  - Watch for pass through

**Ketone Bodies**

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

**Ketone Bodies Confirmation**

- Acetest
  - Confirmation for ketone
- Procedure
  - Place one drop on tablet
  - Compare color with reaction chart
  - Positive is any purple color
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

Bilirubin Confirmation

- Ictotest
  - Confirmation test for bilirubin in urine
- Procedure
  - Place 10 drops of urine on test mat
  - Place one ictotest tablet on mat
  - Place one drop of water on tablet
  - Wait 5 seconds
  - Add one drop of water
  - After 60 seconds observe area around mat
  - Positive reaction (blue or purple color)
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 a infection by nitrate reducing bacteria

Leukocyte Esterase

- White blood cells release esterases in urine
- 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

Sub Summary

- Which chemical test is indicative of a bacteria infection? Nitrite
- What is the purpose of specific gravity test? To measure the kidneys ability to concentrate urine
Microscopic Examination

- Preparation of specimen
  - Pour specimen
  - Spin
  - Pour off supernatant
  - Resuspend button
  - Place one drop on slide
  - Add cover slip

Microscopic Examination

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

Microscopic Examination

- Examine entire cover slipped area under 10X using subdued light
  - Low power
    - Scan for casts, mucus and even distribution
- Scan 10-15 fields under high power 40X
  - High and Dry power objective
    - Identify and enumerate sedimentary elements
Sub Summary

- How do you differentiate WBC’s from renal-epithelial cells?
  Peroxidase

- How do you differentiate RBC’s from yeast?
  3% acetic acid

White Blood Cell

- More than 5 WBC/HPF is abnormal

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

- Report all WBC’s as number per high power field (#/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

- 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
Sub Summary

- What would cause RBC's in urine?
  Bleeding, UTI, or menstrual cycles for women
- What type of disease would you find transitional cells in?
  Renal

Casts

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

- 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

- 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
    - Pyelonephrites
Types of Casts

- Granular cast
  - Contains homogenous granular material
  - Represent stages of degeneration
  - 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
- Report all casts as number per high power field (LPF)

**Mucous**

- Irregularly shaped
- Low refractive index
- Increased amounts
- Not considered clinically significant
- Report as occasional, few, or many (OFM)
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
Miscellaneous Structures

- Trichomonas Vaginalis
  - 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
  - Enterobius vermicularis
  - Ascaris lumbricoides
  - Giardia lamblia
Miscellaneous Structures

- Report all parasites as present

Miscellaneous Structures

- Bacteria
  - Not normally present in urine
  - May indicate UTI or contamination
- Presence of WBC’s and positive nitrite
- 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
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
  - 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
  - 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
  - Wedge shaped prisms, seen in singles or rosettes
Normal crystal
Alkaline urine

- Calcium phosphate
  - Colorless thin prisms
  - May be found in neutral pH
  - Soluble in dilute acetic acid
Abnormal crystal
Neutral or Acidic urine

- Leucine
  - 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 liver disease
  - Present with leucine
Abnormal crystal
Neutral or Acidic urine

- 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
Crystals

- Report all crystals as occasional, few or many (OFM)

Sub Summary

- Leucine is found in what disease?
  Acute liver disease due to hepatitis

- What causes cholesterol?
  Renal damage
Summary

- What is increased urine output?
  Polyuria

- How long can you refrigerate a urine specimen?
  8 hours

- How could you get a normal cloudy Urine?
  If it sits for more than an hour the pH changes and amorphous sediment builds up

Summary

- Which chemical test is indicative of a bacterial infection?
  Nitrite

- How do you differentiate WBC’s from renal-epithelial cells?
  Peroxidase

- What would cause RBC’s in urine?
  Bleeding, UTI, or menstrual cycles for women

Summary

- What does 3% acetic acid do?
  It lyses RBC’s to differentiate from yeast

- How do you report Sperm?
  Verbally to the Dr
Questions?

Break