Urine: The Good, The Bad, and The Ugly
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Janet L. Rowe, MD has no relevant financial relationships with commercial interests to disclose.

Learning Objectives
- Understand disorders associated with discolored urine
- Accurately interpret the elements on the dipstick
- Know the basic uses of urine electrolytes
- Understand value of properly collected urine samples
- Avoid common pitfalls in the evaluation of urine samples
Cultural Uses of Urine

- France
  - Sort throats
  - Beauty bathing
- China
  - Urine of young boys curative
  - Protects skin of infants
  - Cures wounds
  - Improves circulation

Cultural Uses of Urine

- Mexico
  - Repairs broken bones
- Rome (Gauls)
  - Whitens teeth

Mythical Uses of Urine

- Cure for colds, flu, gout
- Morning sample boosts immunity
- Cures hangover
- Alleviates calluses
- Anti-cancer agent
Legitimate Use of Urine

- International Space Station
  - Water Recovery System
  - Urine recycled for drinking water

Generation of Urine

Composition of Urine

- Water
- Urea
- Hormones
- Metabolites
- Electrolytes

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Evaluation of Urine

- Appearance
- Urine dipstick
- Microscopic exam
- Electrolytes
- Collection of urine samples

Appearance

- Red-brown
- White
- Green
- Black
- Pink

Red Sediment, Clear Supernatant
Red Sediment, Clear Supernatant

- Hematuria
  - 56% easily identify cause
  - Asymptomatic hematuria usually resolves spontaneously
  - Persistent hematuria
    - Hypercalciuria
    - Stones
    - Glomerular disease

Red Supernatant

- Myoglobinuria
- Hemoglobinuria

Red Supernatant Heme +

- Myoglobinuria
  - Infections
    - Viral myositis
    - Influenza
    - Group A strep
    - EBV
  - Trauma
  - Exertion
  - Drug overdose

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Red Supernatant Heme +

- Hemoglobinuria
  - Acute GN
  - Hemolytic disorders
    - Sickle cell anemia
    - Hemolytic uremic syndrome
  - Burns
  - Paroxysmal nocturnal hemoglobinuria

Red Supernatant Heme -

- Medication
  - Ibuprofen
  - Iron
  - Rifampin

- Food Dyes
  - Beets
  - Blackberries
  - Food Coloring

- Metabolites
  - Bile pigments
  - Melanin
  - Methemoglobin
  - Porphyria
  - Tyrosinosis
  - Uric acid
Dipstick

- Specific gravity
- pH
- Nitrites
- Leukocyte esterase
- Protein
- Blood
- Ketones
- Glucose

Specific Gravity

- Measures solute concentration of a solution
- Definition
  - Weight of solution compared to equal volume of distilled water
  - Proportional to weight and number of particles
- Range 1.010 – 1.030

Osmolality

- Definition
  - Number of particles in urine per kg/water
  - Greater than osmolality of serum
  - Normal 500-800 mOsm/L overnight
  - Helpful in differential diagnosis
    - Hypo and hypernatremia
    - Not on dipstick, related to pH
  - Relationship of SG to osmolality
    - Depends on molecular weight of solutes
Specific Gravity vs Osmolality

Urine pH

- Reflects acidification
- Varies with systemic acid-base balance
- Metabolic acidosis
  - Increase urinary acid excretion
  - Urine pH below 5.0-5.3
  - Abnormal acidification if pH:
    - Adults above 5.3
    - Children 5.6

Nitrites

- Bacteria convert dietary nitrates to nitrites
- Few false positives
  - Urine left at room temperature
  - Elevated bilirubin
  - Ineffective dipsticks
- Many false negatives
  - Need four hours for conversion
  - Polyuria in UTI

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Leukocyte Esterase

- Enzyme found in urinary white cells
- Sign of inflammation
- Not always a sign of infection
- Other disorders with + LE
  - Dehydration
  - Intra-abdominal inflammation
    - Appendicitis
    - Peritonitis
- Negative in children < 1 year with UTI

Protein

- Mainly albumin
- Normal protein < 150 mg/24 hr
  - Filtered and plasma proteins 50%
  - Tam Horsfall protein – 50%
- Transient
- Persistent
  - Orthostatic
  - Renal disease

Protein

- Negative
- Trace — between 15 and 30 mg/dL
- 1+ — between 30 and 100 mg/dL
- 2+ — between 100 and 300 mg/dL
- 3+ — between 300 and 1000 mg/dL
- 4+ — >1000 mg/dL

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Protein

- Will not detect low molecular weight proteins
- False positives
  - Antiseptic wipes
    - Chlorhexidine
    - Benzalkonium chloride
  - Iodinated contrast agents
  - Concentrated urine
- Additional studies
  - Protein/creatinine
  - 24-hour urine collection

Blood

- 1+ - 4+
- Very sensitive
- Does not correlate with number of cells in urine
- Affected by concentration of urine

Ketones

- End products of fat metabolized
- Dehydration - high false positives
  - Protein
  - Red cells
  - White cells
- Quantify
  - Small <20 mg/dl
  - Moderate between 30-40 mg/dl
  - Large >80 mg/dl
Glucose
- IDDM
- Renal Glycosuria
  - No symptoms
  - Normal or low blood sugar
  - Benign
  - No serious side effects
  - Autosomal recessive

Macroscopic Examination
- Imperative when dipstick positive for blood
- White cell count helpful – not diagnostic for UTI
- Random crystals common – especially in concentrated urine
- Bacteria may be confused with debris – clinical correlation necessary

Urine Electrolytes
- No fixed values
  - Excretion matches net dietary intake and endogenous production
  - Correct interpretation depends on clinical state of patient
- Example
  - Sodium excretion of 125 meq per day
    - Appropriate for subject on regular diet
    - Inappropriate for volume-depleted patient
Sodium

- Urinary sodium estimates volume
  - Concentration below 20 meq/L hypovolemia
- Two major causes of hyponatremia
  - Volume depletion <20 meq/L
  - SIADH >40

Fractional Excretion of Sodium

- FENA(%) =
  \[
  \frac{\text{Quantity of Na excreted}}{\text{Quantity of Na filtered}} \times 100
  \]
  \[
  = \frac{\text{UNa x V x PNa} \times (\text{Ucr x V} / \text{Pcr})}{\text{PNa} \times \text{Ucr}} \times 100
  \]

Fractional Excretion of Sodium

- Acute renal failure
  - Volume depletion Na reabsorption enhanced
    - FENa < 1%
  - Acute tubular damage
    - Tubules damaged
    - FENa >2-3%
- Caveat
  - <1 ATN on volume depletion

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Chloride Excretion

- Reabsorbed with sodium
  - Adds little to clinical information
- If > 15 meq difference in Na and Cl
  - Na excreted with another ion/cation
    - HCO3 or NH4 (metabolic acidosis)
- Metabolic acidosis
- Normal anion gap acidosis

Potassium Excretion

- Varies with intake
- Mediated by aldosterone
- K depletion
  - Urinary K falls 5 to 25 meq/day
  - Low value extrarenal losses
  - >25 meq/day renal K wasting

Collection of Urine

- Clean void
- Supra-pubic aspiration
- Catheter

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Clean Void (Bag)

- Not for culture
  - Unacceptable high rate of false positives
  - 63% vs 9% compared with catheter
- 132/3440 with false + culture
  - Delayed diagnosis
  - Unnecessary
    - Treatment
    - Investigations
    - Hospitalizations

Recommendations AAP

- Bag specimen febrile child
  - Only for urinalysis
  - Doesn’t appear ill
  - Do not give antibiotics
  - Invasive test
    - Positive for nitrites
    - Greater than 5 WBC per HPF (spun)
    - Bacteria on Gram stain (unspun)

Supra-pubic Aspiration

- Safe
- Effective
- Easy to access
- Less than 2 years of age
- Compared to bag and catheter
  - No mixed growth
  - No intermediate growth
  - Any growth significant

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Catheterization

- Safe
- Effective
- Few complications
  - Microscopic hematuria
  - Urethral trauma
  - Iatrogenic infection
- Growth >1000 colonies significant

Be Aware

- Dipsticks sensitive
- False positives for hematuria
- False positives for protein if SG is high
- False positives for nitrites with frequency
- False positives for nitrites if outdated or left open
- Negative nitrites do not negate infection

Be Aware

- Many clinical factors govern sodium excretion
- FENA more accurate determinate of sodium excretion than single urinary sodium
- Free standing chloride not much value
- Much overlap in disorders of K excretion

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Be Aware

- Do not use bag for culture
- May use bag
  - For urinalysis
  - If patient not ill
  - If you are not giving antibiotics
- SA gold standard for ages < 6 months
- Wait 60 minutes after voiding
- Any growth on SA is significant

Summary

- Valuable information
  - Dipsticks
  - Macroscopic examination of urine
  - Urine electrolytes
  - Urine cultures
- Proper diagnosis
  - Proper collection
  - Proper interpretation
  - Proper clinical evaluation