Abnormal Urinalysis

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Disclosures

- None
Objectives

- Recognize situations where a screening urinalysis is indicated
- Avoid misinterpretation of false positive results
- Identify when to refer to pediatric nephrology
Screening Urinalyses

- AAP removed routine UA from health supervision section for asymptomatic children in 2007

- Why?
  - Routine UAs have many false positive results leading to expensive and sometimes invasive procedures to further evaluate with low positive yield
So which asymptomatic children should I screen?

- Any (toilet trained) child with renal disease
  - Structural, inflammatory
- Diabetes mellitus
- Sickle cell disease or trait
- Consider for:
  - Obese children
  - Prematurity (<32 weeks)
  - Strong family history of nephrolithiasis
In what non-urinary complaint should I screen?

- **Henoch Schönlein Purpura**
  - 90% of children who develop nephritis do so in first 2 months; 97% in first 6 months
  - Screening recommendations vary:
    - Weekly for four weeks (month 1)
    - Every two weeks for eight weeks (month 2-3)
    - Monthly for 12 weeks (months 4-6)

- **Child with periorbital edema**
  - Could be allergies
  - OR could be new onset nephrotic syndrome
Specimen Collection Methods

- **Clean-catch or clean-voided midstream**
  - Method of choice for obtaining non-contaminated specimens
  - Clean external genitalia
  - Start voiding then collect sample

- **Catheterization for non-toilet trained children**

- **Urine Collection Bag (Not for UTI Rule Out)**

- **Suprapubic Aspiration**
Reagent Testing Strip

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**Characteristic**

- **Color**: Yellow
- **Appearance**: Cloudy
- **Leukocyte Esterase**: 3+
- **Nitrite**: Pos
- **pH**: 6.5
- **Protein**: Neg
- **Blood**: Neg
- **Specific Gravity**: 1.015
- **Ketones**: Neg
- **Glucose**: Neg
- **Bilirubin**: Neg
Reagent Strip Testing

- Specimen should be tested within 1 hour or refrigerated
Scenarios: Abnormal Urine Color

- **Red Urine**
  - Hematuria
  - Myoglobinuria
  - Hemoglobinuria
  - Food
    - Beets, Blackberries, Rhubarb
  - Medication Side Effect
    - Rifampin, Pyridium, Senna

- **Orange Urine**
  - Medication Side Effect (3)
    - Pyridium, Azulfidine, Laxatives, Rifampin
  - Liver Dysfunction
  - Dehydration
Scenarios: Abnormal Urine Color

• **Dark Brown or Black Urine**
  – Alkaptonuria
  – Urine has been standing or alkalinized
  – Rhabdomyolysis
  – Medication Side Effect
    • Metronidizole, Chloroquine, Nitroguantoin

• **Blue/Green Urine**
  – Food Dyes
  – Medication Side Effect
    • Amitriptyline, Indomethacin, Propofol
  – Familial Benign Hypercalcemia (Blue Diaper Syndrome)
  – Pseudomonas UTI
Take Away Points with Abnormal Urine Color

- Take a good history of eating habits, activity, and medications
- Look for presence of red blood cells, bilirubin, and signs of infection
Appearance: When “Cloudy” is Normal

- Normal crystals in acidic urine
  - Uric acid
  - Amorphous urates
  - Calcium oxalates

- Phosphaturia
  - Excess phosphate in the urine
  - Precipitates out with calcium
  - Can be seen following certain meals
Urine pH ranges between 5.0-8.0 in normal health.

Western diets result in urinary pH ~6.0.

Urine pH is increased in vegetarian diets and high dairy intake.

Urine pH is helpful in situations of metabolic acidosis or in kidney stone formation.
**pH**

**Persistent acidity**
- Acidifying drugs
- Dehydration
- Diabetes
- Diarrhea
- Fever
- Gout
- High protein diets

**Persistent alkalinity**
- Alkaline drugs
- AKI and CKD
- Diuretics
- Renal tubular acidosis (distal)
- UTIs
Metabolic Acidosis

- If urine pH is ‘inappropriate,’ then consider underlying renal disease
  - Distal renal tubular acidosis: Inability to acidify the urine in the setting of metabolic acidosis
    - Failure to thrive, hypercalciuria, nephrocalcinosis
  - Chronic Kidney Disease
Specific Gravity

- Specific gravity = \( \frac{\text{Weight of urine}}{\text{Weight of water}} \)

- Normal 1.000-1.035

- Fixed specific gravity \( \leq 1.010 \) indicates issue with urinary concentrating ability
Is it a urinary concentrating defect?

- ‘Poor man’s’ water deprivation test
  – Aim for NPO overnight for 8-10 hours
  – Collect first AM urine
Heme

- Dipstick is VERY sensitive and detects both RBCs and also free hemoglobin
- Transient hematuria is common in healthy children
  - 4% school age children tested positive for heme in at least 1 of 4 serial specimens
  - Of these patients, only 6% tested positive for 4/4
- Testing at least 3 specimens on separate occasions is recommended
• Dipstick also detects free hemoglobin and myoglobin
  – May indicate hemolysis or rhabdomyolysis

• Normal urinalysis should test negative but “trace” heme readings are usually not clinically significant
Hematuria

- **Gross hematuria versus microscopic hematuria**
  - Blood clots indicate lower urinary tract bleeding

- **Painless versus painful**
  - Glomerular disease typically are painless

- **Proteinuria versus no proteinuria**
  - ≥2 is potential ‘red flag’ for glomerular disease
Asymptomatic Microscopic Hematuria: Limited Evaluation

- History and physical
- Family history: Kidney disease, hearing loss, kidney stones
- ROS: Pain, joints, skin, weight loss, fever, hearing loss, edema, urinary symptoms, medications
- Renal ultrasound
- Urine calcium:creatinine ratio
- Labs: Renal panel, CBCP, C3
Protein

- Normal excretion of small amount of albumin and LMW proteins
  - Adults 150 mg/day
  - Children 4 mg/m^2/hour
- Dipstick only detects albumin
Protein

- Urine concentration affects protein testing
- Urine protein:creatinine ratio is semi-quantitative
False positive/negative results

- **False positive**
  - Highly buffered alkaline urine (medications or old urine)
  - Prolonged exposure to the sample
  - Blood

- **False negative**
  - Dilute urines
  - Elevated amounts of proteins other than albumin
Proteinuria

• **Intermittent**
  – Exercise, stress, fever, orthostatic

• **Fixed**
  – Glomerular disease
  – Chronic kidney disease
  – Inflammation (vasculitis, infection)
  – Malignant hypertension
  – Obesity
Orthostatic Proteinuria

- **Benign orthostatic proteinuria**
  - 3-5% of healthy adolescents
  - Three first AM UPCs normal at <0.20
  - Can do ‘split collection’
Leukocyte Esterase and Nitrite

- **Leukocyte esterase**
  - Present only in neutrophils
  - Few neutrophils seen in normal urine

- **Nitrites**
  - Nitrates normally present
  - Nitrates converted to nitrite by bacteria
    - E. coli, Enterobacter, Citrobacter, Klebsiella, Proteus
  - Reaction takes up to 4 hours to complete
Leukocyte Esterase and Nitrites

- Leukocyte esterase: Sensitivity is 88% for UTI
- Nitrites: Sensitivity is 88% for UTI
- When both are positive, the false positive rate is only 4% for UTI
Urine Microscopy

- **RBC casts**
Diagnosis of UTI

- Requires BOTH:
  - Significant bacteriuria
    - >50K CFU/mL (cath)
    - >100,00K CFU/mL (clean catch >2 years)
  - Significant pyuria
    - Any LE on dipstick
    - ≥5 WBC/HPF
Glucose

- Filtered at glomerulus and re-absorbed in proximal tubule
- Usually not present unless threshold levels exceeded $>160-180$ mg/dL
Glucosuria

- Isolated renal glucosuria versus proximal tubular dysfunction
- Isolated renal glucosuria due to mutation in sodium-glucose cotransporter 2 gene
- Part of proximal tubular dysfunction (Fanconi syndrome)
  - Metabolic acidosis, hypophosphatemia, hypokalemia, aminoaciduria, LMW proteinuria
  - Labs: Renal panel, UPC, urine amino acids
What can I see on urine microscopy?

- **Cells**
  - RBC, WBC, Epithelial Cells

- **Casts**
  - Hyaline, RBC, WBC, Tubular Epithelial Cell, Granular, Waxy (Degeneration of Granular)

- **Crystals**

- **Miscellaneous**
Crystalluria

• Urine crystals does not equal kidney stones!

• Many crystals in urine have little clinical significance
  – Except in cases of metabolic disorders and calculus formation

• Crystals seen when:
  – Supersaturation of compound is exceeded
  – Solubility properties of compound are altered
Acidic Urine: Uric acid crystals
Acidic Urine: Calcium Oxalate Crystals
Acidic Urine: Amorphous Urates

Amorphous Crystals

Red Blood Cells
Alkaline Urine: Triple Phosphate
Pathologic Stones: Cystine Stones
Take Away Points

- Don’t do screening UAs on everyone
- If you suspect a UTI in a diapered child, cath for urine sample
- If you suspect a UTI, send urine culture
- Can do preliminary work-up for isolated proteinuria with first AM UPC
- Can do preliminary work-up for isolated asymptomatic microscopic hematuria by repeating 2-3 collections