Untangling the web of Acute Kidney Injury (AKI)

Kevin Harned, MD
University of Kentucky Medical Center
Division of Nephrology, Bone and Mineral Metabolism
November 3, 2009

First things first...
- Common things happen commonly
  - Don't go for your Zebra lasso right out of the gate!!
- A thorough history is essential in any field of medicine
- If something is found that doesn't make sense, DON'T DISMISS IT...you MUST explain it.
  - Wrong information is worse than no information

Etiologies of AKI:
- Pre-renal/Pre-“tubular”
- Intrinsic renal pathology
- Post-renal

Pre-renal AKI:
- The most common cause of AKI
- Intravascular volume depletion
  - Insufficient oral/IV intake
  - Hemorrhage
  - GI losses
  - Renal wasting (Diabetes Insipidus, adrenal insufficiency, drug or osmotic diuresis)
  - 3’ spacing
  - Severe insensible losses (burns, fever)

Pre-renal AKI (cont):
- Decreased cardiac output
  - Also, “CardioRenal Syndrome”
- Intrinsic Renal vasoconstriction
  - Bilateral Renal Artery Stenosis
  - Calcineurin inhibitor toxicity (Prograf, Cyclosporine)
  - Sepsis/SIRS
  - HepatoRenal Syndrome
  - “Pressors” (Levophed, Vasopressin)
Normal Renal Physiology:

- Adenosine
- Epinephrine
- Angiotensin II
- Endothelin-1
- CNI's

Pre-renal AKI (cont):

- "Normotensive Ischemic Nephropathy"
  - ACEI +/- ARB in setting of RAS
  - NSAIDs
  - Cirrhosis
  - Elderly
  - Concurrent diuretics

Pre-renal AKI (cont):

- Abdominal Compartment Syndrome
  - Elevated intra-abdominal pressure causing compression of renal VEINS thereby not letting blood out of the kidney, pressure backs up and cannot perfuse the kidney

Pre-renal AKI (cont):

- Abdominal Compartment Syndrome (cont)
  - Seen in:
    - Cirrhosis w/ large ascites
    - Recent intra-abdominal surgery
    - Trauma w/ intra-abdominal hemorrhage
    - Retroperitoneal hemorrhage
    - Ileus
    - Massive fluid resuscitation w/ intra-abdominal anisarca
    - Pneumoperitoneum

Pre-renal AKI (cont):

- Abdominal Compartment Syndrome (cont)
  - Physiologic effects:
    - ↓ CO
    - ↑ CVP, PCWP
    - ↑ SVR
    - ↑ peak airway pressures
    - Oliguria/Anuria, deteriorating renal fxn

Pre-renal AKI (cont):

- D x:
  - Urinary bladder pressure > 20mmHg or > 27cmH2O on 3 separate measurements
  - Short report
  - ABG's
  - Single/Multiple organ system failure
  - White blood count, platelets, metabolic panel

Pre-renal AKI (cont):

- Signs:
  - ↓ Capillary refill time
  - ↑ CRP
  - ↑ LFT's
  - ↑ BUN/Creatinine
  - ↑ Procalcitonin
Intrinsic AKI:

- 4 structures involved
  - Tubules
  - Interstitium
  - Glomerulus
  - Vasculature

- Acute Tubular Necrosis (ATN)
  - 80-90% of intrinsic AKI
  - Pre-renal → ATN
  - Medications
  - Rhabdomyolysis/"Pigment-induced" ATN
  - Sepsis/SIRS
  - Hyperuricemia
  - Hyperbilirubinemia

- May or may not be oliguric
  - Proximal tubule = Non-oliguric
  - Loop of Henle or Distal tubule = Oliguric
  - ”Muddy brown casts” on UA classic for ATN
  - Usually Urine Na >10, Urine Cr < 100
  - Rx = "Tincture of Time"

- Acute/Allergic Interstitial Nephritis (AIN)
  - 15% of Intrinsic AKI
  - Defined by histopathology as inflammation and edema of the interstitium of the kidneys
  - Caused by:
    - Medications (PCN’s, NSAIDS, sulfa’s)
    - Infections (Legionella, BK polyoma virus, mycobacterium)
    - Anti-tubular basement membrane Ab’s

- AIN (cont)
  - Triad:
    - Fever
    - Rash
    - AKI
  - Rx:
    - Remove the offending agent
    - Steroids if no signif improvement 1 wk after cessation of med OR consider at presentation if dialysis-dependent

- Glomerulonephritis/Vasculitis
  - Usually insidious onset or several wks
  - (1) constitutional sx:
    - Fever/chills
    - Malaise/fatigue
    - Myalgias/Arthralgias
  - (1) change in urine appearance
    - "Tea-colored" = hematuria
    - "Very foamy" = proteinuria
Intrinsic AKI:

- Glomerulonephritis/Vasculitis
  - Anti-Glomerular Basement Membrane
  - Goodpasture’s (+) pulm hemorrhage
  - ANCA-mediated
    - Wegener’s Granulomatosis
    - Microscopic Polyangiitis
    - "Renal-limited" crescentic GN
    - Post-infectious GN
    - Membranoproliferative GN
    - Lupus nephritis

- Vascular/Microvascular events
  - Renal Artery Stenosis
    - Usually very HTN’ive
    - + “Flash pulmonary edema”
    - Usually already on >3 medications for HTN
  - Renal Artery Thrombosis vs Dissection vs Avulsion
    - Usually result of ruptured/dissected AAA

- Vascular/Microvascular events (cont)
  - Renal Vein Thrombosis
    - Usually associated with either:
      - Thrombophilia (Protein C or S Defic, Factor V Liden)
      - Nephrotic syndrome
      - Hematuria, unilateral flank pain
      - Acts like infarcted kidney

- Vascular/Microvascular events (cont)
  - Atheroembolic phenomenon
    - Usually sequel of intravascular manipulation of aorta/renal arteries
      - Causing “showering” of ateroemboli to kidneys
    - Damage usually irreversible
Intrinsic AKI:

- Vascular/Microvascular events (cont)
  - HUS/TTP
  - Malignant HTN
  - Hyperviscosity Syndromes
    - multiple myeloma
    - Waldenstrom macroglobulinemia
  - Scleroderma crisis
  - Toxemia of pregnancy

Post-renal/Obstructive AKI:

- Accounts for <5% of AKI
- We only need 1 kidney, so to have AKI from obstruction:
  - Bilateral ureteral obstruction
    - Cervical Cancer
    - Retroperitoneal fibrosis or hemorrhage
    - Kidney stones or sloughed papillae
  - Urethral obstruction
    - Stricture/Valves
    - Urinary bladder stone or bladder cancer
    - BPH/Prostate Cancer

Work-up for AKI:

- Good history!!!
  - Onset, duration, associated sx's, n/v/diarrhea and PO intake, what measures taken and result, new meds or change in dose, etc
- Physical exam
  - Vitals (febrile, hypotensive, hypertensive)
  - Complete exam (toxic appearing, moist vs dry mucous membranes, tight and distended abd, flank pain, etc)

Work-up for AKI:

- Labs (cont):
  - CBC
    - Eosinophils
    - Suggests parasitic or peripheral cause for schistocytes
    - Peripheral eosinophilia
  - Urinalysis
    - Specific gravity (1.010 = isosthenuric)
      - > 1.025 = concentrated
    - pH = is the patient appropriately excreting acid?
    - Protein and/or blood
    - # RBC's and/or WBC's
      - Dysmorphic RBC's c/w Glomerular injury
    - Casts
      - "Muddy brown", RBC casts, WBC casts

- Labs:
  - Basic Metabolic Panel vs Complete Metabolic Panel
    - Creatinine (if possible, find out baseline)
    - BUN
    - K
    - Acidotic vs Alkalotic
      - ***ALWAYS DOCUMENT THE ANION GAP!!!
    - Total Calcium
    - Bilirubin
    - Total protein/Albumin (and their ratio)

Lab values (cont):

- Total protein/Albumin (and their ratio)
Work-up for AKI:

- Labs (cont):
  - Urine indices
    - Urine Na
    - Urine Urea if on diuretics within 12 hrs
    - Urine Cl
    - Urine Cr
    - Urine Osmo's
    - Serum Osmo's
  - Urine eosinophil smear x 3 separate samples (to increase sensitivity)

- Renal U/S
  - For kidney sizes, morphology, and evaluate for hydronephrosis, stone
  - **Renal Duplex**
    - Only if HYPERTENSIVE!!!
    - Unless you want to look at the veins

Work-up for AKI:

- Must record STRICT I/O's
  - Foley catheter or graduated urinal

- Once initial w/u sent, if still scratching your head...Call Renal!!!