Untangling the web of Acute Kidney Injury (AKI)

Kevin Harned, MD
University of Kentucky Medical Center
Division of Nephrology, Bone and Mineral Metabolism
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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
  - Aka, “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

Angiotensin II  
Endothelin-1  
Epinephrine

Afferent  
Efferent

PG E$_2$/I$_2$  
NO  
CCB's

ACEI/ARB's  
NO  
PG E$_2$/I$_2$

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 anasarca
    • Pneumoperitoneum

Pre-renal AKI (cont):

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

Pre-renal AKI (cont):

• Abdominal Compartment Syndrome (cont)
  – Dx:
    • Urinary bladder pressure ≥ 20mmHg or ≥ 27cmH$_2$O on 3 separate measurements 4-6hrs apart
      – To convert cmH$_2$O → mmHg, divide by 1.36
    • Single/Multiple organ system failure
Intrinsic AKI:

• 4 structures involved
  – Tubules
  – Interstitium
  – Glomerulus
  – Vasculature

Intrinsic AKI:

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

Intrinsic AKI:

• Acute Tubular Necrosis (ATN)
  – 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”

Intrinsic AKI:

• Acute/Allergic Interstitial Nephritis (AIN)
  – 5-15% 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

Intrinsic AKI:

• 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

Intrinsic AKI:

• Glomerulonephritis/Vasculitis
  – Usually insidious onset of several wks
  – (+) constitutional sx’s
    • Fever/chills
    • Malaise/fatigue
    • Myalgias/Arthralgias
  – (+) change in urine appearance
    • “Tea-colored” = hematuria
    • “Very foamy” = proteinuria
### Intrinsic AKI:

#### Glomerulonephritis/Vasculitis
- Anti-Glomerular Basement Membrane
  - Goodpature’s if (+) pulm hemorrhage
- ANCA-mediated
  - Wegener’s Granulomatosis
  - Microscopic Polyangitis
  - “Renal-limited” crescentic GN
- Post-infectious GN
- Membranoproliferative GN
- Lupus nephritis

#### Vasculitis
- Cryoglobulinemia
- IgA Nephropathy/Henoch-Schonlein Purpura
- Collapsing Focal Segmental Glomerulosclerosis (FSGS)
  - HIV
  - Pamidronate

#### 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

#### Atheroembolic phenomenon
- Usually sequelae of intravascular manipulation of aorta/renal arteries causing “showering” of atheroemboli to kidneys
- Damage usually irreversible
Intrinsic AKI:

- Vascular/Microvascular events (cont)
  - Misc:
    - 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:
  - 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)

Work-up for AKI:

- Labs (cont):
  - CBC
    - Leukocytosis
    - Thrombocytopenia +/- peripheral smear for schistocytes
    - Peripheral eosinophilia

Work-up for AKI:

- Labs (cont):
  - Urinalysis
    - Specific gravity (1.010 = isosthenuric)
    - < 1.009 = dilute
    - > 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
### Work-up for AKI:

- **Labs (cont):**
  - Urine indices
    - Urine Na
    - +/– Urine Urea if on diuretics w/in 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!!!**