Kidney Pearls for the Hospitalist from a Recovering Hospitalist

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AKI

• Complications of AKI
  – CKD
  – CAD
  – ? nephrology follow up

• Indications for dialysis

• Early dialysis not associated with better outcomes
**Stage 1:**
- Increase in SCr by 1.5–1.9 x baseline
- Increase in SCr by 0.3 mg/dl
- Urine output 0.5 ml/kg/hour for 6–12 hours

**Stage 2:**
- Increase in SCr by 2.0–2.9x Baseline
- Urine output 0.5 ml/kg/hour for 12 hours

**Stage 3:**
- Increase in SCr by 3x baseline
- Increase in SCr to 4.0 mg/dl
- Initiation of RRT

Furosemide stress test predicts severity of AKI

- Single dose of furosemide 1 mg/kg-1.5 mg/kg
- 2-hour urine output below 200 ml had 87% sensitivity and 84% specificity to predict progression to stage 3 AKI
- May aid in decision for nephrology consult in hospitalized patient with AKI

AKI as risk factor for CKD/ESRD

• In individuals with AKI, the pooled incidence of CKD and ESRD was 25.8 per 100 person-years and 8.6 per 100 person-years, respectively
• More severe AKI was associated with an increased risk of these adverse outcomes
• People with normal baseline eGFR, an episode of AKI was associated with a greater risk of CKD and ESRD compared with those with baseline CKD

Kidney Disease Improving Global Outcomes (KDIGO) AKI guidelines recommend that physicians “[e]valuate patients 3 months after AKI for resolution, new onset or worsening of preexisting CKD” (Guideline 2.3.4)
Low rate of nephrology follow up after AKI

• Incidence of nephrology referral after AKI ranges from 8-13%
• Not every patient with AKI needs nephrology follow up
• Consider nephrology referral for patient with
  – severe AKI (stage 2 or 3)
  – AKI >7 days
  – multiple episodes of AKI
  – older age, diabetes, and proteinuria
• Prediction model for risk of stage 4 CKD includes age, albumin, peak creatinine and duration of AKI
  – Has not been validated but in future may aid referring patient with AKI to nephrology

USRDS 2013
Dialysis for AKI

• No benefit to initiate dialysis early
  – BUN 70 vs initiate when indication arises
• BUN level is not indication for starting dialysis
• Decision to initiate dialysis for AKI should be based on
  – Volume overload unresponsive to diuretics
  – Hyperkalemia unresponsive to medical management
  – Acidosis unresponsive to medical management
  – Poisonings

Management of Acute Acidosis
Bicarbonate therapy is not without risk

- Ionized calcium decreases with a rise in blood pH
- Carbon dioxide increases during the buffering process
- Bicarbonate worsens intracellular acidosis
  - cell is more permeable to CO2 than HCO3
  - rapid entry of CO2 leads to intracellular hypercapnia and subsequent acidosis
  - compromises cellular function

Bicarbonate does not improve hemodynamics

Surviving Sepsis Campaign

- Not to use sodium bicarbonate therapy for the purpose of improving hemodynamics or reducing vasopressor requirements in patients with hypoperfusion-induced lactic acidemia with pH ≥7.15 (grade 2B).

Fluid resuscitation
Trial of Early, Goal-Directed Resuscitation for Septic Shock

Paul R. Mouncey, M.Sc., Tiffany M. Osborn, M.D., G. Sarah Power, M.Sc., David A. Harrison, Ph.D., M. Zia Sadique, Ph.D., Richard D. Grieve, Ph.D., Rahi Jahan, B.A., Sheila E. Harvey, Ph.D., Derek Bell, M.D., Julian F. Bion, M.D., Timothy J. Coats, M.D., Mervyn Singer, M.D., J. Duncan Young, D.M., and Kathryn M. Rowan, Ph.D., for the ProMISe Trial Investigators*
No benefit to early goal directed therapy

Figure 2. Kaplan–Meier Survival Estimates.
Shown is the probability of survival for patients with severe sepsis receiving early, goal-directed therapy (EGDT) and those receiving usual care at 90 days.

A Randomized Trial of Protocol-Based Care for Early Septic Shock

The ProCESS Investigators*
Randomized Trial of Protocol-Based Care for Early Septic Shock

- Randomized to River’s protocol of early goal directed therapy vs protocolized fluid resuscitation without CVC vs usual care (attending’s choice on fluid resuscitation and CVC use)
- EGDT and usual care groups received significantly less fluid
  - Had less AKI than the protocolized fluid resuscitation group that had received more fluids
- No mortality difference between groups
Choice of fluid in volume resuscitation

• Chloride restrictive vs normal saline
  – High chloride solutions associated with iatrogenic metabolic acidosis
No benefit to chloride restrictive strategy

Figure 4. Daily Serum Creatinine for the Buffered Crystalloid vs Saline Groups

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<th>Buffer crystalloid</th>
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When to stop IV fluids?

- Avoid the “fluid creep”  
  J Burn Care Res 2007
- During maintenance phase, avoid progressive volume overload
- Observational data that CVP >8 is associated with worse kidney function
- In children, giving fluid beyond what’s needed for hemodynamic support is associated with poor outcome  

Fluid balance of ~3L is optimal after resuscitation for septic shock

B

**Adjusted Survival Curves**
Fluid Balance Quartiles Day 4

Fluid balance at day 4 in mililiters
1\textsuperscript{st} quartile 1560 (723–3210)
2\textsuperscript{nd} quartile 8120 (6210–9090)
3\textsuperscript{rd} quartile 13,000 (11,800–14,700)
4\textsuperscript{th} quartile 20,500 (17,700–24,500)
IV fluids: More is not better

- EGDT targets CVP 8-12
  - No clear benefit seen in modern randomized trials
- CVP 1-4 is normal
- Probably no benefit to targeting higher CVP outside of what is needed for hemodynamic support
  - May be harm in targeting higher CVP
    - ARDS, GI dysfunction, poor wound healing, intra-abdominal hypertension
Clinical Syndrome of Potassium Intoxication

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Hyperkalemia

- Hospitalized patient that developed acute renal failure
- Potassium measurement became available in 1940’s
- A – patient weak with “mushy” heart sounds
- B – after calcium salts QRS narrow
- C - 45 minutes after calcium p waves re-appear
Hyperkalemia

• Sodium polystyrene sulfonate (SPS) (trade name kayexalate)
  – Approved by FDA in 1958
  – 4 years prior to the requirement that drug be shown to be effective and safe!
• No RTC data on SPS
• Data from 1953 showed that is lowered potassium in 5 patients
• Uncontrolled data from 1961 showed it lowered potassium by 0.4 meq/L in 24 hours
• Additionally, in 1961, small study of 10 patients received either SPS+ sorbitol or sorbitol alone
  – All 10 had decrease in potassium level over 5 days

Hyperkalemia

• SPS alone causes constipation or intestinal impaction
• 1980’s SPS came pre-mixed with sorbitol
• 2009 FDA black box warning that combination SPS with sorbitol increases risk of intestinal necrosis
  – Both in and outpatient pharmacies provide primarily SPS pre-mixed with 30% sorbitol

Acute hyperkalemia

- SPS is not proven therapy and is not benign
- Many prefer loop diuretics +/- saline (depending on patients volume status) for potassium excretion
Chronic Hyperkalemia

- patiromer for oral suspension
- Trade name “Veltassa”
  - “should not be used as an emergency treatment for life-threatening hyperkalemia because of its delayed onset of action”
  - boxed warning because it binds many other orally administered drugs

http://www.fda.gov/NewsEvents/Newsroom/PressAnnouncements/ucm468546.htm
• Sodium Zirconium Cyclosilicate not approved by FDA (maybe in future)

Sodium Zirconium Cyclosilicate in Hyperkalemia

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Chronic hyperkalemia

• Common in CKD and heart failure
  – RAAS blockade (ACEi, ARB, spironolactone)

• Current management is intermittent low dose SPS vs daily low dose diuretic loop diuretic

• New agents may allow patients with CHF/CKD to get optimal RAAS blockade and avoid hyperkalemia