Acute Renal Failure

I. Definition:
   a. abrupt decline in renal function resulting in inability to excrete metabolic wastes and maintain proper fluid and electrolyte balance
   b. decrease in GFR of >75% from baseline, or urine output of <0.3ml/kg for >24 hours, or anuria for more than 12 hours.

II. 3 Types

1. Prerenal- decrease in effective arterial blood volume
   a. Hypovolemia: GI, urinary, skin losses, bleed, third spacing, decrease CO
   b. Hypotension: sepsis, anesthesia-induced, hepatorenal, relative hypotension
   c. Pharmacologic:
      i. NSAIDS: vasoconstricts preglomerular arterioles
      ii. ACE-I: vasodilate post glomerular efferent arterioles
   d. Large vessel: thrombosis, embolus, dissection
      - FENa <1%
      - Urine NA <20 meq/L
      - Urine Osmolality > 500 mosm/kg
      - Bun/Cr ratio usually > 20:1

2. Intra-renal
   a. Tubular- acute tubular necrosis
      i. continuation of prerenal azotemia leading to ischemia
      ii. nephrotoxins
          • aminoglycosides
          • acyclovir
          • cocaine
          • myeloma light chains
          • NSAIDS
          • amphotericin
          • cisplatin
          • radiocontrast
          • pentamidine, foscarnet, mannitol/sucrose
          • heme pigments
      iii. last 1 to 3 weeks
      iv. no therapy to hasten recovery
      v. Urine Na >40meq/L
      vi. Urine Osmolality below 350 to 450 mosm/kg
      vii. FENa >2%
      viii. BUN/Cr ratio usually normal at 10-15:1

b. Interstitial- acute interstitial nephritis
   i. allergic reaction to a drug, sometimes with fever, rash,
      - Allopurinol
      - Cephalosporins
      - Cimetadine
      - Cipro
      - Lasix
      - NSAIDS
      - PCN’s
      - Phenytoin
      - Rifampin
      - Sulfonamides
      - Thiazide diuretics
      - Trimethoprim
   - serum and urine eosinophils
   - autoimmune diseases
   - infection

c. Glomerular
   i. Nephritic- active urine sediment with red cells, white cells, granular
   ii. Nephritic- proteinuria, inactive urine sediment

d. Vascular-
   i. vasculitis, hus, ttp,

3. Post-renal- obstructive
   a. BPH, catheters, tumors, strictures, crystals

III. Studies
1. Urinalysis
   a. Muddy brown granular casts and epithelial casts- atn
   b. Red cell casts or heavy proteinuria or lipiduria- vasculitis or glomerulonephritis
   c. pyuria with white cell or waxy casts- suggests interstitial nephritis or obstruction
   d. sterile pyuria: renal TB or tubulo-interstitial disease
   e. FENa is most accurate screening test to differentiate between prerenal and atn
      -Low FENa also seen in glomerulonephritis, vasculitis, acute urinary tract obstruction, contrast nephropathy, myoglobinuria, hemoglobinuria, early atn

2. Radiology- Renal u/s
3. Renal biopsy- when noninvasive evaluation unsuccessful
   Indications:
   - Isolated glomerular hematuria with proteinuria
   - Nephritic syndrome
   - Acute nephritic syndrome
   - Unexplained acute or subacute renal failure

IV. Indications for dialysis
   a. Refractory fluid overload
   b. Hyperkalemia (> 6.5 or rapidly rising)
   c. Metabolic acidosis (pH < 7.1)
   d. Azotemia (BUN > 80-100 mg/dl)
   e. Signs of uremia (pericarditis, neuropathy, decline in MS)
   f. Severe dysnatremias (>155 or <120)
   g. Hyperthermia
   h. Overdose with dialyzable drug/toxin

V. Use of Dopamine and Diuretics in ATN
   a. no evidence that that administration of dopamine or diuretics reduces risk of adverse outcomes in patients with ATN
   b. loop diuretics can still help with volume management

VI. Use of N-acetylcysteine
   a. no conclusive evidence of benefit for preventing occurrence of contrast induced nephropathy
   b. 1 randomized trial: NNT of 5, 40 patients ion each group
   c. Randomized trial for angioplasty NNT 12
   d. Another study showed no benefit or harm

**Box. Risk Factors for Contrast-Induced Nephropathy**

**Patient Related**
- Chronic kidney disease\(^{3,15-19}\)
- Diabetes mellitus\(^{13,16,17,19}\)
- Urgent/ elective procedure\(^6\)
- Intra-aortic balloon pump\(^{16,17,20}\)
- Congestive heart failure\(^{13,15,17,20}\)
- Age\(^{2,17}\)
- Hypertension\(^{21,22}\)
- Low hematocrit\(^{17,21}\)
- Hypotension\(^{7,22}\)
- Left ventricular ejection fraction <40%\(^{22}\)

**Not Patient Related**
- Contrast properties
  - High osmolar contrast\(^{7,24}\)
  - Ionic contrast\(^{25,28}\)
  - Contrast viscosity\(^{26,30}\)
  - Contrast volume\(^{3,13,16,19,21-34}\)

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**Figure. Strategy for Management of Patients With Risk Factors for Contrast-Induced Nephropathy**

- **Patient With Risk Factor(s)** for Contrast-Induced Nephropathy (CIN)
  - Are Alternative Imaging Procedures That Do Not Require Use of Contrast Suitable and Available?
    - Yes: Perform Alternative Procedure
    - No:
      - Does Patient Have ≥2 Risk Factors for CIN?
        - Yes: Consider N-acetylcysteine 600-1200 mg Orally Twice Daily for 2 Doses Before Procedure and 2 Doses After Procedure or Ascorbic Acid 3 g Orally 2 h Before Procedure and 2 g Orally Twice Daily the Day After Procedure
        - No: Intravenous Hydration Before Procedure With Careful Monitoring for Fluid Overload Intravenous Normal Saline 1 mL/kg per h for 6-12 h Before Procedure or Intravenous 5% Dextrose and Water Plus Sodium Bicarbonate 154 mEq/L, 3 mL/kg for 1 h Before Procedure With Monitoring for Metabolic Alkalosis
      - Use Minimum Possible Volume of Iso-Osmolar or Low-Osmolar Contrast During Procedure
        - Intravenous Hydration After Procedure With Careful Monitoring for Fluid Overload Intravenous Normal Saline 1 mL/kg per h for 6-12 h or Intravenous 5% Dextrose and Water Plus Sodium Bicarbonate 154 mEq/L, 1 mL/kg for 6 h With Monitoring for Metabolic Alkalosis

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*See Box for listing of risk factors for contrast-induced nephropathy.

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