

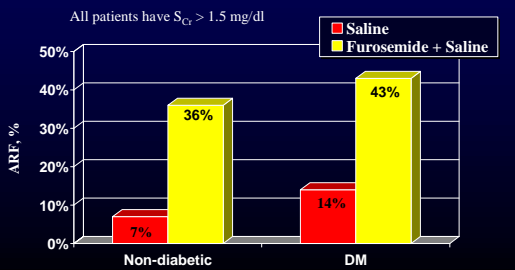
Acute Renal Failure in the ICU

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Risk Factors for ARF

- ♦ Excessive dose of a nephrotoxic drug
 - ♦ Aminoglycosides
 - ♦ Iodinated radiocontrast agents
- ♦ Chronic kidney disease
 - $GFR = (140 - \text{Age}) \times \text{Wt (kg)} / (72 \times S_{Cr})$
 - Adjustments
 - Female: 0.85x
 - Example:
 - 100 lb, 80 y/o female, Cr 1.3 mg/dl
 - $GFR = 24 \text{ ml/min}$

Furosemide *worsens* contrast nephropathy



Prevention of radiocontrast nephropathy

Intravascular volume expansion
 $\frac{1}{2}$ NS at 1 ml/kg/hr for 12 hours prior to contrast and
12 hours after
Mucomyst™
600 mg bid, the day before and the day of the
procedure

Does dopamine prevent ARF?

- ♦ Prophylaxis in patients with CRI before radiocontrast dye - no benefit over saline (*Renal Failure* 15:61, 1993)
- ♦ CABG patients - no effect on either renal function or preventing ARF (*Anaesth Intensive Care* 21:56, 1993).
- ♦ Ongoing ATN - no effect on either survival or need for dialysis (*Am J Med* 101:49, 1996)

Does dopamine *worsen* ARF?

- ♦ Contrast-induced ARF
 - Dopamine prolonged course of ARF (*Am J Cardiol* 15:260, 1999)

Do calcium channel antagonists prevent ARF?

- ♦ Radiocontrast dye
 - Nitrendipine prevented changes in GFR at 48 hours (*Nephrol Dial Transplant* 4:1030, 1989)
 - Nifedipine - no effect on post-contrast creatinine in patients with CRI (*Clin Nephrol* 29:215, 1988)
 - Diltiazem - no controlled data
- ♦ Renal transplant patients
 - Multiple studies show benefit

Drugs to be wary of in ARF

- ♦ Nephrotoxic drugs
 - Aminoglycosides
 - Radiocontrast
 - Pentamidine
 - NSAIA
- ♦ Drugs that accumulate
 - PCN - Seizures
 - K-Phos - Potassium
 - Fleets enema - Phosphate
 - MOM, Maalox, etc. - Mg^{+2}
- ♦ Drugs with metabolites that accumulate
 - Demerol - Seizures
 - Procainamide - Torsade, VTach, VFib
 - Imipenem - Seizures

Drugs that make GFR appear worse, but don't

- ♦ Tubular creatinine secretion
 - Trimethoprim
 - Cimetidine
- ♦ Differentiate from ARF by lack of change in BUN

Once the patient has ARF, what do you do?

- ♦ Adjust medications
- ♦ Give nutrition
- ♦ Dialysis

Medications to adjust

- ♦ Too many to cover all
- ♦ Balance risk of overdosing and underdosing
 - Overdose risk = dose-related toxicity
 - Aminoglycosides - nephro- and ototoxicity
 - Penicillin and penicillin analogues - seizures
 - Iodinated radiocontrast agents
 - Underdose risk - ineffectiveness

If on dialysis, pharmacokinetics change

- ♦ Aminoglycosides
 - HD
 - V_D unchanged,
 - Loading dose (mg/kg) = desired peak / 4
 - Clearance with HD, ~2/3
 - Maintenance dose, 2/3 loading dose after each HD
 - CVVH
 - MFR (machine filtration rate) ~40 ml/min
 - V_D unchanged
 - Clearance with half-life of ~6 hours
 - Dose q12 hr, ~3/4 of loading dose
 - Check peak and trough and adjust

If on dialysis, pharmacokinetics change

- ♦ Vancomycin
 - V_D unchanged
 - Loading dose, 15 mg/kg
 - Clearance
 - HD - ~400 mg cleared with HD
 - Maintenance dose ~400 mg
 - CVVH
 - Clearance = (Replacement fluid (3L/hr) + total ultrafiltration rate) * 2/3
 - » (3 L/hr + 400 ml/hr) * 2/3 = 2.2 L/hr
 - If average vancomycin level 20 µg/ml (20 mg/L)
 - » Clearance = ~2 L/hr * 20 mg/L = 40 mg/hr
 - » Maintenance dose ~500 mg q 12 hr

If on dialysis, pharmacokinetics change

- ♦ Potassium
 - Clearance same as aminoglycoside
 - (Replacement fluid rate + total ultrafiltration rate) * 2/3
 - Averages 2 L/hr
 - If [K⁺] = 4 mEq/L, clearance ≈ 8 mEq per hour
- ♦ Phosphate
 - Same clearance
 - But, lab reports as mg/dl ??
 - Trick - 4.1 mg/dl = 1 mEq/L
 - If [phosphate] = 4.1 mg/dl, then
 - Clearance = 1 mEq/L * 2 L/hr
 - Clearance = 2 mEq per hour

If renal failure, diuretic effectiveness changes

- ♦ All diuretics work from luminal (urinary side)
- ♦ Effectiveness proportional to GFR
 - Dose needed inversely proportional to GFR
 - Lasix dose = 10 * creatinine
- ♦ High peaks do not provide proportional benefit
 - Continuous infusion more effective than bolus

Should you use diuretics?

- ♦ Mortality from ARF is related to urine volume
 - High urine volume ⇒ low mortality
 - Low urine volume ⇒ high mortality
- ♦ Does changing urine volume alter outcome?
 - No
 - Maybe

Nutrition

- ♦ Acute renal failure differs from chronic kidney disease
 - Chronic kidney disease
 - Increased protein intake worsens rate of progression of disease
 - Protein restriction used
 - Acute renal failure
 - Protein intake needed for recovery from ATN
 - Protein intake - 1.5 mg/kg/d
- ♦ Caloric needs
 - 35 mg/kg/d of non-protein calories

Nutrition and phosphate handling

- ♦ High caloric and protein loads increase phosphate intake
- ♦ CVVH - not an issue
- ♦ Intermittent HD or not on HD
 - Phosphate binders required
 - Choices - Al⁺³, Ca⁺² or RenaGel
 - Al⁺³ - avoid
 - Ca⁺² -
 - Use as 'calcium elixir' to mix with tube feeds and bind phosphate prior to intake
 - 15 ml / L tube feeds
 - RenaGel
 - Pills only

Dialysis

- ◆ When to start?
 - No clear data
 - Early?
 - Late?

Dialysis access

- ◆ IJ vs. femoral
- ◆ Percutaneous vs. tunneled

Dialysis modality

- ◆ Intermittent vs. continuous
- ◆ If intermittent, what is the optimal frequency?