CRRT Formulas

BASIC DIALYSIS CONCEPTS

Q_B = Blood flow rate (ml/min)
Q_D = Dialysate rate (ml/hr)
Q_{UF} = Ultrafiltration rate (ml/hr)
Q_R = Replacement fluid rate (ml/hr)
Q_E = Effluent rate (ml/hr)

CRRT DOSE:

Recommended minimal effluent dose is 20-25 ml/kg/hr (target 25-30 ml/kg/hr to take into account downtime)

Dose = Effluent Rate (ml/hr) / Patient Weight (kg)

Effluent Rate (ml/hr) definition per CRRT modality:

- CVVH: Total Ultrafiltration (UF) Rate (ml/hr) = Pre-Filter Replacement Fluid Rate (ml/hr) + Post-Filter Replacement Fluid Rate (ml/hr) + Fluid Removal Rate (ml/hr) + Pre-Blood Pump (PBP) Fluid Rate (ml/hr)*
- CVVHD: Dialysate Rate (ml/hr) + Fluid Removal Rate (ml/hr)
- CVVHDF: Total UF Rate (ml/hr) + Dialysate Rate (ml/hr) = Pre-Filter Replacement Fluid Rate (ml/hr) + Post-Filter Replacement Fluid Rate (ml/hr) + Fluid Removal Rate (ml/hr) + Pre-Blood Pump (PBP) Fluid Rate (ml/hr)* + Dialysate Rate (ml/hr)

CRRT DOSE DILUTION FACTOR:

When using Pre-Filter Replacement Fluid and/or Pre-Blood-Pump (PBP) Fluid, the CRRT dose is diluted and therefore decreased. CRRT effluent rate is multiplied by the dilution factor and then divided by patient weight to reflect actual CRRT dose in ml/kg/hr; this takes into account the dilution effect.

Dilution Factor = Plasma Flow Rate (ml/hr) / [Plasma Flow Rate (ml/hr) + Pre-Filter Replacement Fluid Rate (ml/hr) + PBP Fluid Rate (ml/hr)*]

- Plasma Flow Rate (ml/hr) = Blood Flow Rate (ml/min) X 60 (min/hr) X (1-HCT)

CRRT FILTRATION FRACTION (FF):

Filter clotting occurs with FF > 20-25%.

Filtration Fraction (FF) = Total Ultrafiltration Rate / (Plasma Flow Rate + Pre-Filter Replacement Fluid Rate + Pre-Blood Pump (PBP) Fluid Rate*)

- Total Ultrafiltration Rate (ml/hr) = Pre-Filter Replacement Fluid Rate (ml/hr) + Post-Filter Replacement Fluid Rate (ml/hr) + Fluid Removal Rate (ml/hr) + Pre-Blood Pump (PBP) Fluid Rate (ml/hr)*
- Plasma Flow Rate (ml/hr) = Blood Flow Rate (ml/min) X 60 (min/hr) X (1-HCT)
- Note: dialysate rate does NOT factor into the FF equation

**** For all formulas above, PBP Rate only applies if utilizing with Prismaflex device***

CITRATE TOXICITY

Detection

- Rising anion gap, worsening metabolic acidosis
- Falling systemic iCa^{2+}
- Escalating Ca^{2+} infusion requirements
- Total Ca^{2+}:Systemic iCa^{2+} Ratio > 2.5:1 (increased Ca^{2+} gap)**

***To convert Total Calcium in mg/dL to mmol/L, multiply Total Calcium by 0.25*

DYSNATREMIAS

Hyponatremia

1. Add free water into commercial CRRT solution bag

$$V_{add} = \frac{C_i V_i}{C_f} - V_i$$

2. Equivolume exchange of fluid with free water (exchange volume in CRRT solution bag with sterile water)

$$Volume\ to\ exchange\ = V_i - \frac{desired\ [Na^+]}{initial\ [Na^+]} \times V_i$$

3. Use Post filter RF (or add as separate infusion)

D5W can be used as post-filter RF to slowly correct patients who have hyponatremia:
D5W rate = [(140 - target Na) / 140] x desired clearance.

For example, using post-dilution CVVHDF in a patient with initial sodium of 120 mEq/L with target sodium concentration of 130 mEq/L at a desired clearance of 3 L/hr using RF/dialysate with 140 mEq/L of sodium, the D5W infusion rate would be [(140 – 130)] / 140] x 3 L = 0.214 L/hr. So the post filter RF would be 210 ml/hr and the dialysate/pre-filter RF should be 2,790 ml/hr (2.79 L/hr + 0.210 L/hr = 3 L/hr)

Hypernatremia

In patients with cerebral edema who need 3% saline to maintain serum Na concentration in range 150 to 155 mEq/L, 3% saline can be delivered as the post-filter RF.

3% infusion rate = [(target Na – 140) / (513 – 140)] x desired clearance.

For example, in a patient with an initial sodium 140 mEq/L with target sodium concentration of 155 mEq/L at a desired clearance of 3 L/hr, the 3% saline infusion rate would be [(155-140)/513-140)] x 3 = 0.120 L/hr or 120 ml/hr. The dialysate/pre-filter RF should be 2880 ml/hr (2.880 L/hr + 0.120 L/hr = 3 L/hr)

Prediction of Serum Sodium Concentration

$$Na_{(t)} = Na_0 + \left(Na_{dial} - Na_0\right) \times \left(1 - e^{\frac{-Dt}{V}}\right)$$

D = CRRT effluent dose ml/kg/hr
T = Time (ie 24 hr)
V = Volume of distribution