Implementing therapy-Delivery, dose adjustments and fluid balance.

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March 6, 2018
Objectives

• By the end of this session the learner will be able to:

• Identify the solutions on the machine and their role in CRRT

• Identify types of solutions used to achieve therapy goals

• Describe how fluid is managed on the CRRT machine.
CRRT solutions

• Dialysate

• Pre filter fluid

• Post filter fluid

• Replacement/substitution fluid.
Dialysate

• Electrolyte solution used in the fluid pathway of a dialysis system to create a concentration gradient in order for DIFFUSIVE clearance to occur.

• Prescriptive solution order on the electrolyte/ buffer needs of the patient.

• Dialysate runs counter current to the blood flow to ensure continuous solute clearances along the entire fiber pathway.
DIFFUSION - Movement of **particles** from higher concentration to lower concentration across a semi-permeable membrane

Removes small molecules and is relatively passive
C. DIALYSATE (aka Bath)-

Diffusive fluid

- Bathes fibers in dialyzer
- Continuous flow over fibers to provide for constant concentration gradient allowing for diffusion.
- MD ordered electrolyte solution
- Allows solute removal
- Allows acid/base regulation
- Facilitates septic mediator removal
Hemodialysis: Diffusion

Dialysate In  Dialysate Out
(to waste)

Low Conc  High Conc

Blood In  (from patient)

Blood Out  (to patient)
Dialysate flow rates

- Blood Flows rates range between 0-8000ml/hr

- Typically between 600-1800ml/hour
  - Hemodialysis 800mls/min = 48,000ml/hour
Options for Dialysate

• Wide range of options based on your institutions restrictions

Commercially prepared solutions- Prismasate, normocarb

Commercially prepared solutions with additives-compatibility issues.

Commercially prepared Peritoneal solutions- Dianeal

Custom compounding by the pharmacy- limited use.
Electrolyte and acid base balance

• Dialysate can be manipulated to manage electrolyte imbalances
  • Patient’s with low potassium from NG and other losses
  • Phosphorous losses- Phoxillum
  • Magnesium losses

• Acidotic patients can add bicarbonate to the bag
  • Considerations- compatibility
  • Limit amount that can be added
  • Stability after additions
Replacement fluids

• May also be call pre filter replacement, post filter replacement, substitution or convective fluid

• Purpose is for convection.

• Volume of these fluids is part of CRRT dose.

• Decision to give pre or post is medical decision
Pre filter replacement Advantages

- May help to reduce filter clotting by decreasing the Hct through the filter (45.7 vs 16.1 h)

- Improved filter life may increase solute clearance due to extended filter life.

- UF rate not limited by blood flow rate

- Improved urea elimination from RBCs
Pre filter replacement Advantages

• Can be run at higher rates to drive solute clearance especially if doing CVVH.

• Rates can range between 0-8000ml/hour.
  • Generally between 1000-2000ml/hr for CVVH.
Pre filter replacement-disadvantages

• Dilutes hematocrit and electrolyte concentrations presented to the filter

• Clearances are decreased due to dilution factor

• May confound post filter lab electrolytes.
Options for pre filter solutions

• Most common is 0.9% Normal Saline

• Can be Anticoagulant i.e. citrate solution in CVVHDF

• Other Crystalloids
  • 0.45% Normal Saline
  • Sterile water and Bicarbonate
  • PrismaSol

• May have additives such as bicarbonate. Check for compatibility.
Post filter replacement - advantages

- Clearance of solutes directly related to UF rate
- Higher solute clearance produced
- Delivery of specified solutes and concentrations directly to the patient.

Hoste, E et al, Precision Fluid Management in Continuous Renal Replacement Therapy, Blood Purification, August 2016
Post filter replacement-disadvantages

• UF rate is limited by Blood flow rate- Directly affects the filtration fraction.

• Limited Filtration fraction may limit ability to achieve optimal dose.

• Filter life may be decreased due to increased HCT in filter.
Post filter options

• Medical decision to run post filter replacement

• If using Prismaflex, recommended to use a minimum of 200 mls/hr of post filter fluid to maintain air/blood interface to prevent clotting in de-areation chamber.

• This fluid is part of the dose calculation.

• Machine can deliver 0-8000ml/hr.
Options for post filter solutions

• Most common is 0.9% Normal Saline

• Other Crystalloids
  • 0.45% Normal Saline
  • Lactated Ringers
  • Sterile water and Bicarbonate
  • PrismaSol

• May have additives such as bicarbonate. Check for compatibility
Word of Caution

• Must monitor electrolyte frequently to ensure patient has not been overcorrected.

• Change fluid composition as necessary

• Watch for elevated glucose levels if using Dianeal as it has a glucose concentrations.
Fluid management

• Goals of fluid management post resuscitation

• Remove fluid without compromising cardiac output
• Correct Acid /base imbalances
• Correct electrolyte imbalances
• Provide for nutritional support
• Accommodate fluid given to achieve hemodynamic stability
• Maintain/improve urine output
Fluid assessment

- Hydration state of the patient expressed as total body water
  - Weights?
  - Insensible losses in burns/open wounds

- Capacity of the circulatory system (cardiac output/filling pressures)
  - Resistance (systemic vascular resistance)
  - Compartment distribution

- Osmotic active solutes
CRRT factors affecting goals

• Access
• Pump speed
• Permeability of dialyzer
• Clotting in dialyzer
• Time on machine- i.e. continuous nature of therapy
• Delivered vs ordered dose
Approaches to fluid removal - Level 1

• Estimate fluid removal for 24 hours and determine UF rate for 24h- mimics Intermittent hemodialysis

  • Does not account for changes in fluid intake over 24 hour.
  • Actual removal may vary from desired outcome.
  • Results in minimal fluid control and management

Level 2

• Hourly ultrafiltration is set to be higher than hourly intake. Net balance is achieved by hourly replacement fluid.

  • Greater degree of fluid control
  
  • Patient can be negative, even or positive
  
  • Fluid balance achieve directly correlates to desired hourly outcome.
Level 3

• Uses the concept in Level 2- i.e. remove more fluid than desired and replace to desire outcome

• Adds a fluid titration to a hemodynamic target
  • Mean Arterial pressure- MAP
  • Central venous pressure-CVP
  • Pulmonary Artery Wedge Pressure-PAWP
• Hourly changes in ultrafiltration goal, affect effluent volume which affects the hourly delivered dose.

• Having a constant hourly rate of effluent, provides for a constant GFR, allows for accurate dosing of drugs.

• Adjusting fluid goals on CRRT allows for the procedure to regulate the patient’s volume status with accuracy.
When it goes wrong

• Fluid overload patient status with aggressive fluid removal
  • Patient may not be able to shift fluid to intravascular space
    • Decreased blood pressure and organ perfusion

• Under-estimation of fluid status
  • Inadequate fluid removal and worsening fluid overload.
  • More likely to occur if using a 24 hour goal vs an hourly adjustment of fluid status.
Nurses’ responsibilities

• Obtain accurate daily weights

• Record vitals

• Accurate accounting of ALL fluids in and out.

• Accurate assessment of lungs, and edema
Dose adjustments

• What determines the dose of dialysis?

• What is our target?

• What factors affect dose delivery?