- Wacharee Seeherunvong, M.D.

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CRRT: Blood Prime & Transfers

Basic Knowledge

- Priming volume should not exceed 10% of total blood volume to prevent hypotension in critical care patients.
- Total blood volume is estimated to be 80 mL/kg
  - A 10 kg child will have estimated blood volume of 800 mL
  - If extracorporeal circuit (filter + tubing) > 80 mL, thus patient should receive blood prime, not saline prime

CRRT Filter

Filter	Membrane	Surface area	Blood volume
HF 20	PAES	0.42	60 mL
M60	AN 69	0.6	97 mL
M100	AN 69	0.9	152 mL
HF 1000	PAES	1.1	165 mL
TPE 2000	Plasma filter		125 mL

AN69 Membrane - Acrylonitrile-sodium methallyl sulfonate

PAES Membrane - Polyarylethysulfone membrane

Smaller CRRT Circuit

- Prismaflex M-60: the smallest CRRT circuit in the US
  - An AN-69 membrane: The risk of the bradykinin release response
  - A ***membrane hypersensitivity reaction:*** causing hypotension, tachycardia, vasodilation and potentially death
  - **Characteristics:** occurs early in the course of treatment – within 15 minutes after venous catheter connection
  - Typically unresponsive to volume expansion, but resolves quickly after discontinuation of extracorporeal circulation
    - Improves with bicarbonate administration (0.5-1 mEq/kg)

Prevention Methods

- Alternative membrane
- Bypass technique
- Buffering techniques

Preventive

- Alternative filter
- Using HF 2000 filter
- Need blood prime at the first circuit
- Consider transfer the blood from the old circuit to the new circuit to minimize antigen exposure
  - Machine to Machine Transfer

Sequential Therapies – "Two primes???"

- CRRT ↔ CRRT Machine to machine transfer
  - Avoidance of additional membrane reaction
  - Avoidance of exposure to additional antigens

1. Prepare second machine/modality – Primed with saline
2. Connect patient's "arterial" port to a saline bag, preparing to return blood
3. Connect patient's "venous" port to 2nd machine's "arterial" access;
   - blood from 1st machine will go to the second machine, instead of patient

4. Once 2nd machine is primed, stop the pump.
5. Connect to patient and proceed with therapy.

Sequential Therapies – "Two primes???"

Double transfer (Machine to Patient to Machine) - Alternative option

1. Prepare second machine/modality – Primed with saline.
2. Connect 1st machine's "arterial port" to a saline bag, preparing for return blood.
3. Keep 1st machine's "venous port" to patient's "venous access" for blood return.
4. Connect patient's "arterial access" to the 2nd machine's "arterial port" – sending blood to the new circuit.
5. Connect the 2nd machine's "venous port" to the saline bag, to waste the "saline primed" .
6. Once all lines are connected as above : RETURNS blood from the 1st machine to the patient, at same time, blood flow from patient to the 2nd machine as blood primed; set rate at 50 mL/min. This process should take only 3-5 minutes.
7. Once blood reaches NSS bag of the 2nd machine, stop the blood pump
8. Disconnect patient from the 1st machine and complete connection the 2nd machine's "venous port to the patient's "venous access" and proceed with treatment

Prevention Methods

- Bypass: Transfuse “blood prime” post hemofilter
  - Patient receives same amount of pRBC as with a blood-primed circuit, yet no direct blood-bank blood and membrane contact occurs (Brophy, *et al*. Am J Kid Dis, 2001)
    - At initiation, pRBC infusion rate (mL/hr) post-filter is equilibrated to blood flow rate (mL/min) of saline-primed circuit
    - Short-lived, high rate of pRBC administration requires monitoring of ionized calcium

Recommended Method for Prevention of Bradykinin Release Syndrome

1. Prepare blood
   i. Order reconstituted pRBC from blood bank
      - Reconstitution to 40% hematocrit with plasma
   ii. Add Heparin 200 units/150 mL blood
   iii. Add $NaHCO_3$ 30 mEq/L = 3 mEq/100mL

2. Set up CRRT circuit (PRISMAFLEX) with normal saline initial priming solution + 1000 units/L Heparin

3. Set “limits” for treatment
   - Gain/loss fluid limit must be changed to maximum of 200mL/3 hours

Recommended Method for Prevention of Bradykinin Release Syndrome

4. Disconnect (blue) venous/return line from effluent bag and connect to “y-line” of the prime saline bag

5. Connect (yellow) effluent line to effluent bag

6. Clamp (green) dialysate line

7. “Enter Flow Rates” screen: Set blood flow rate to 50 mL/min
   - Blood will go into normal saline bag as the circuit is primed

8. Press “STOP” when blood is entering saline bag via the venous line

Recommended Method for Prevention of Bradykinin Release Syndrome

9. Transfer venous line from saline bag to pRBC bag via Y connector piece
10. "RESUME" with the following prescription, to *wash* the blood :
    i. Blood flow rate 100-200mL/min
    ii. Replacement 500 mL/hr (post)
    iii. Dialysis 500-1000 mL/hr
    iv. PBP 0
    v. Patient removal 100-400mL/hr

    Blood flow may be increased if needed to prevent "circuit disconnection" alarms

Recommended Method for Prevention of Bradykinin Release Syndrome

11. Allow blood to *wash* for approximately 15 minutes, then draw sample from post-filter (blue) port on circuit using a 23g needle and assess pH, ionized calcium and potassium
    i. Goal pH 7.2 – 7.4
    ii. Goal ionized calcium 2.8 – 4.4 mg/dL (0.7-1.1 mmol/L)
    iii. Goal potassium 2 – 3.5 mmol/L
    iv. Goal hematocrit 30-40%

12. Repeat 15 minute cycle if necessary to better approximate target values

Management of Bradykinin Release Syndrome

- In spite of prophylactic efforts, some patients develop the acute response.
  - Youngest/smallest patients
  - Acidotic patients
- Continuous monitoring of vital signs is essential – particularly early in course of treatment
- Pressor medication may be necessary, and should be available/prepared prior to connection of extracorporeal circuit
- Should tachycardia/hypotension develop, pressors should be used at discretion of critical care team
- **Always remember: BRS is NON-responsive to volume expansion!**