Continuous Renal Replacement Therapy (CRRT)

Site Applicability

VCH & PHC ICU and CSICU Care Units

- **ICU:** VGH, LGH, RH, SPH
- **CSICU:** VGH, SPH

Practice Level

RN: Specialized Skill

This is a specialized practice for RNs in ICU/CSICU who have received education and training in CRRT Level 1 Basics and the use of the PRISMAFLEX™ machine.

VGH, LGH and RH:

- Level 1 Training will be reinforced with bedside experience and followed up with the Level II Troubleshooting Course within a year's time.

SPH:

- Level 1 Training will be followed up within 6 months by Level 1.5 Training. Yearly level 2 training is an expectation for all staff for skill maintenance.

Policy Statement

- CRRT must be set up in the CVVHDF mode to maximize flexibility in accessing other modes of treatment.
- RNs must demonstrate an understanding how the PRISMAFLEX™ will assist them in reaching their end goals (i.e. solute +/- fluid removal).
- RNs will follow safe cytotoxic practices when the patient on CRRT is considered cytotoxic.
  - **VCH:** as outlined in Cytotoxic Agents – Administration and Handling.
  - **SPH:** OH&S "Cytotoxic Handling Policy".

Site Specific:

LGH	○ All ICU CRRT will be guided by pre-printed order (PPO) sets written daily by the ICU Attendings. ○ Aseptic technique to be maintained for CVC care as outlined in BD-00-12-40045: Non-Tunnelled CVC (NT-CVC) – Basic Care and Maintenance (Adult).
RH	○ All CRRT orders will be rewritten weekly. ○ Fluid goals will be assessed and written daily. ○ Aseptic technique to be maintained for CVC care as outlined in BD-00-12-40045: Non-Tunnelled CVC (NT-CVC) – Basic Care and Maintenance (Adult).
SPH	○ All CRRT orders will be rewritten weekly. ○ Fluid goals will be assessed and written daily. ○ Follow the procedure in NCS5330: Hemodialysis: Capping off a Hemodialysis Central Venous Catheter (CVC).
VGH	○ All ICU CRRT will be guided by pre-printed order (PPO) sets written daily by the ICU Attendings (Fellow and Clinical Associates must confirm all orders with ICU Attendings). ○ All CSICU orders will be written daily by Anaesthesia. ○ Aseptic technique to be maintained for CVC care as outlined in BD-00-12-40045: Non-Tunnelled CVC (NT-CVC) – Basic Care and Maintenance (Adult).

Need to Know

- **Definition of CRRT:** "Any extracorporeal blood purification therapy intended to substitute for impaired renal function over an extended period of time and applied for or aimed at being applied for 24 hours per day".
- See Appendix A for definitions of further CRRT terms.
- See CRRT Operator Manual for operation of PRISMAFLEX™ machine and troubleshooting guide.

Indications for CRRT include:

- Acute Kidney Injury (AKI)
- Renal failure (oliguria, anuria, ↑ serum creatinine and urea)
- Hyperkalemia
- Metabolic acidosis
- Uremia (encephalopathy)
- Rhabdomyolysis
- Sepsis
- Hemodynamically unstable patients unable to tolerate Intermittent Hemodialysis (IHD)
- Multi-organ System Failure (MOSF)
- Major surgery (cardiac or cardiopulmonary bypass)
- Contrast dye removal
- Fluid overload (CHF, pulmonary edema)
- Drug overdose

Treatment goals include:

- Maintaining fluid, electrolyte and acid/base balance.
- Preventing further damage to the kidney tissue.
- Promoting healing and total renal recovery; earlier treatment can reverse or prevent long term dialysis.
- Allowing other supportive measures such as optimal nutritional support (increased protein and fluids).

Quick Links to:

Equipment & Supplies

Set Up

Items	VGH	LGH	RH	SPH
1. Machine	Prismaflex			
2. Filter Set	ST 150 = 189 mL Warmer = 79 mL Extracorporeal circuit (ECC) = 268 mL			ST 150 = 189 mL Warmer = 79 mL Extracorporeal circuit (ECC) = 268 mL ST 100 = 152 mL Extracorporeal circuit (ECC) = 231 mL
3. Dialysate / Replacement Solutions	PrismaSOL 0 PrismaSOL 4	PrismaSOL 0 PrismaSOL 4	PrismaSOL 0	PrismaSOL 0 PrismaOCAL
4. KCL or additives for CRRT solutions as ordered			• 50 mL Luer lock syringe • 3 way Stopcock • Double male luer connector • Blunt fill needle • Accessory spike • Date change label • Medication added labels	• 50 mL Luer lock syringe • 3 way Stopcock • Double male luer connector • Blunt fill needle • Accessory spike • Date change label • Medication added labels
5. PRISMATHERM II™ heater tubing	1 x accessory extension line tubing			
6. Priming solutions	**ICU:** • ST 150 2 x 1000 mL bags Normal Saline (NS) (1 with 5000 Units Heparin, unless HIT) **CSICU:** • ST 150 2 x 1000 mL NS bags	• ST 150 2 x 1000 mL bags NS (1 with 5000 Units Heparin, unless HIT)	• ST 150 2 x 1000 mL bags NS (1 with 5000 Units Heparin, unless HIT)	• ST 150 2 x 1000 mL bags NS (1 with 5000 Units Heparin, unless HIT) • ST 100 2 x 1000 mL bags NS
7. Medication and syringe labels	Syringe labels (NS or Heparin)	Syringe labels (NS or Heparin)	Medication labels and syringe labels (NS or Heparin)	Green label to label dialysate bag
8. Anticoagulation and Returning blood	• 20 mL Syringe • NS or Heparin as per PPO • 500 mL NS • Spike adaptor	• 20 mL Syringe • NS or Heparin as per PPO • 500 mL NS • Spike adaptor	• 3 way Stopcock • Macro drip IV tubing • 500 mL NS	• 3 way Stopcock • Macro drip IV tubing • 500 mL NS

Connecting

Items	VGH	LGH	RH	SPH
To Connect	• 2 x 3 mL syringes • 4 x 10 mL Prefilled NS syringes • 2 x 2.5 mL Sodium Citrate 4% Prefilled syringes • 1 x sterile dressing tray • Sterile gloves and fluid shield mask • 2% Chlorhexidine / 70% Alcohol • 2 blue clamps • CRRT cart with extra supplies / fluids			

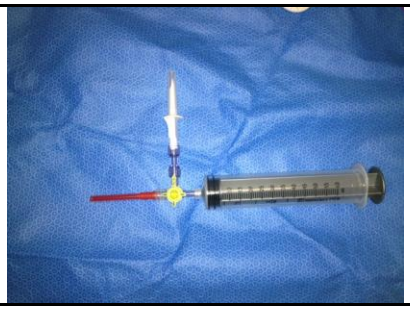
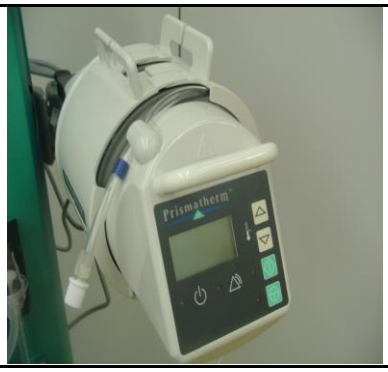
Capping

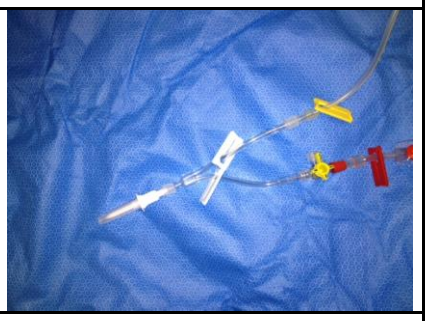
Items	VGH	LGH	RH	SPH
To Cap	• 2 x 10 mL Prefilled NS syringes • 2 x 2.5 mL Sodium Citrate 4% Prefilled syringes • 1 x Sterile dressing tray • Sterile gloves and fluid shield mask • 2% Chlorhexidine 70% Alcohol • 2 caps • Blue pad			

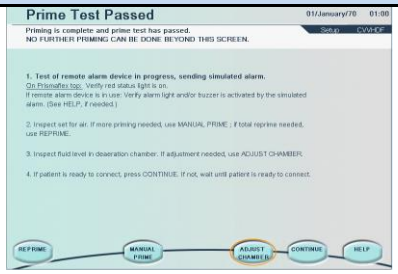
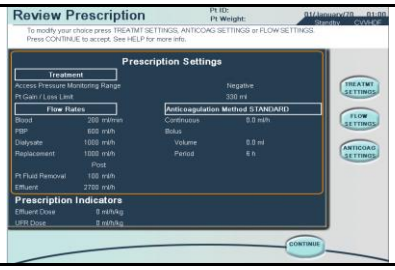
Procedure

Setting Up

- Ensure equipment and supplies available.
- Ensure Physician has written PPO for CRRT.
- Turn on PRISMAFLEX™ machine and allow to rest at ambient operating temperature for a minimum 20 minutes.
- Inspect system (i.e. all 4 scale hooks are in closed position, pressure pods are clean, pumps/knobs are tightened, clean blood lead detector)
  - Wipe pressure pods with alcohol swab
  - Floss alcohol swab through Blood Leak Detector (BLD)
  - Open filter set package and secure luer connections:
    - Red and yellow Y connections and spike
    - Top and bottom of filter membrane
    - Green reflux valve to syringe
    - Spikes on PBP, dialysate and replacement lines (prevent contamination if lines accidentally mishandled)

Steps	Rationale/Site Specific Information	Image
1. Prepare priming solution. Check orders to see which Priming solution is ordered, NS or NS with 5000 units of heparin.	If patient has a **history of HIT**, then priming solution will be NS (if already primed with heparin, a new set up is required).	
2. Prepare Dialysate and Replacement fluids as indicated on the PPO.	**SPH/RH:** • Add additives to CRRT Dialysate and Replacement solutions as per PPO, date and time administration setup and change every 24 hours.	
3. Prepare anticoagulant as per PPO.	• Prepare either heparin syringe or saline syringe for set up. • Prepare systemic heparin for anticoagulation run. **SPH** • Prepare citrate and calcium chloride for citrate run. **RH** • Prepare heparin bag for PBP if not using systemic nomogram.	
4. Follow the on-screen instructions given on the PRISMAFLEX™ control unit for set up.	Follow screen steps: • Enter MRN • Enter patient weight (dry weight) • Set up always in CVVHDF • **VGH/LGH:** utilize Standard Syringe setup • **SPH/RH:** utilize Standard No Syringe setup	
5. Remove the thermal containment sleeve of the PRISMATHERM II™ by grasping the two white side handles and gently pulling apart.		
6. Position the green marker on the Prismatherm tubing in the tubing holder (front). Starting from the front, press the tubing clockwise into the groove. Position the tubing through the tubing holder (rear) and then onto the safety seat at the back of the PRISMATHERM II™.	Leave enough line between the filter and heater. A slight stretching of the tubing down and up makes fitting easier. Ensure that there are no kinks in the Prismatherm tubing prior to replacing the thermal containment sleeve.	

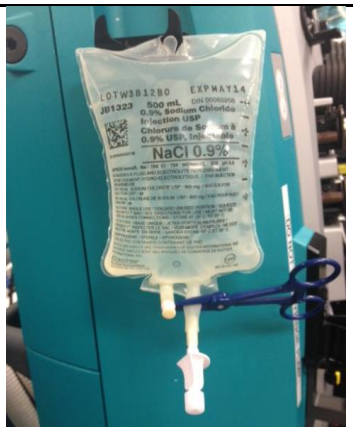
Steps	Rationale/Site Specific Information	Image
7. Connect the female connector of the Prismatherm tubing to the male connection of the **Return** line, immediately distal to the filter. Connect the female connector of the return line proximal to the deaeration chamber to the male end of the Prismatherm tubing.	**Note:** the Prismatherm tubing must be connected to set prior to priming. Do not replace warming sleeve until PRISMAFLEX™ is primed to ensure tubing is free of kinks and primed fully. Do not turn warmer on until blood is cycling through to avoid CO_2 bubbles forming in the solution.	
8. **SPH/RH ONLY** Install the 3 way stopcock at the end of the PRISMAFLEX™ set Access line.	Installation of the stopcock system facilitates an easier transition from run mode to temporary disconnect, or for emergency return.	
9. **VGH/LGH ONLY** Follow steps on PRISMAFLEX™ screen for inserting syringe during the set up process.	If heparin is not being administered, then install a 20 mL luer lock syringe with NS into the syringe pump.	
10. Complete the first 1000 mL prime of the PRISMAFLEX™ machine. The second 1000 mL prime will be completed immediately prior to attaching the patient. Leave the PRISMAFLEX™ on this screen. **ALWAYS USE A NEW FULL 1000 mL BAG OF PRIMING SOLUTION WHEN PRIMING TO PREVENT AIR ENTERING THE CIRCUIT.** **Additional priming:** If the set has been sitting **for more than one hour** **'reprime'** with priming solution. (This requires a new bag of priming solution).	All filters must be primed with 2000 mL of priming solution; if there is a delay in connecting the patient, leave the system between the first prime and the second prime to allow for the system to be reprimed. **ST150** – reprime function will require a full 2000 mL of priming solution. **ST100** reprime function will require only 1000 mL of priming solution. Ethylene Oxide (EtO) can produce an allergic reaction if it gets into the blood stream; therefore, the second prime of NS should be completed just prior to the patient being connected. If both primes have been completed and connection to the patient is greater than one hour, a reprime must be performed.	

Steps	Rationale/Site Specific Information	Image
11. After priming is complete, continue through prime test. Once prime test is passed, adjust deaeration chamber to desired level indicated on the PRISMAFLEX™ screen. **Do NOT press "CONTINUE" until ready to connect.**	**The last option to reprime is only available on this screen.** **Note:** If you continue past the "**Reprime**" screen, you cannot go back to it again. You will not be able to 'reprime' the set unless you dismantle the set and start over again.	
12. Enter Treatment Settings • Fluid Loss/Gain Limit • Pressure monitoring range Negative or Positive	• Excess Patient Fluid Loss or Gain limit is a safety tool for patient care management. The alarm limit ranges from 100 to 400 mL within a 3 hour period. The PRISMAFLEX™ will default to a set value according to the type of filter. Set as per PPO. • **Negative range should always be selected for standard set up** with the PRISMAFLEX™. Range selection should be chosen in discussion with perfusionist if CRRT is being connected into an ECMO circuit (can be either negative or positive depending where connected).	
13. Enter initial flow rates on PRISMAFLEX™ according to PPO. This allows for patient assessment for response to therapy.	• **VGH/LGH:** Initiate blood flow rate at 150 mL/min. • **SPH/RH:** Initiate blood flow rate at 100 mL/min.	
14. Verify setting in "Review Prescription" and adjust according to PPO.	• **LGH/RH:** 2 RNs to verify settings and sign PPO. • **SPH:** If using **high flow order set** check that the replacement line has been changed to post filter.	
15. At the **CONNECT PATIENT** screen, clamp the white connections on the priming Y and the **Red** and **Blue** clamps on the **Access** and **Return** lines respectively. Disconnect the **Return** line from the effluent bag and connect to the priming Y where the **Effluent** line is, then connect the **Effluent** line to the effluent bag. The priming 'Y' is now ready for connection.		

Vascular Access Preparation: Connecting to Patient

Steps	Rationale/Site Specific Information	Image
1. Prepare sterile dressing tray with Chlorhexidine, syringes and flushes. **SPH/RH:** Place blue pad under catheter.		
2. Move priming Y with **Access** and **Return** lines connected to patient bedside.	By moving return line to the Y connector and the **Effluent** line to the effluent bag, allows for easier connection.	
3. Don sterile gloves and fluid shield mask.	As per **VCH/PHC:** CVC Non-Tunnelled CVC (NT-CVC) – Basic Care and Maintenance (Adult).	
4. Using sterile forceps pick up hemodialysis catheter lumens and place on a sterile field (4x4, drape, etc.). Repeat same process with connections at priming Y.		
5. **SPH/RH:** Take 2 4x4 gauze soaked in Chlorhexidine solution (2% CHG & 70% alcohol) and clean catheter lumens using friction for 15 seconds. Allow to dry completely for minimum 30 seconds. **VGH/LGH:** Take 2 – Chlorhexidine Pads (2% CHG & 70% alcohol), and clean catheter lumens using friction for 15 seconds and allow to dry completely for minimum 30 seconds.		
6. Remove caps from each lumen and discard appropriately.		
7. Aspirate 3 mL gently from each lumen with an empty syringe, assessing for clots in the blood. Close the clamp, remove the syringe, and empty syringe contents into gauze. If clots present, aspirate a further 3 mL of blood.	Aspirating 3 mL also prevents inadvertent systemic injection of Citrate. Empty syringe contents into gauze allows for checking if clots present.	

Steps	Rationale/Site Specific Information	Image
8. **For new catheters**: attach a 10 mL Prefilled NS syringe and flush line; attempt to aspirate 10 mL of blood in 3 seconds. Attach Prefilled NS syringes and flush each lumen with NS and close clamp	If you are able to achieve this, the PRISMAFLEX™ will be able to acheive a blood flow rate of 200 mL/min. If there are any issues with the line at this point, consideration can be given to reversing the lines (i.e. if the **Red** port is difficult to aspirate, but the **Blue** port is fine you will connect the **Access** line to the **Blue** port and the **Return** line to the **Red** port). If there are problems with both lumens **DO NOT START THERAPY**. Notify the Physician there is a line issue. NS flushes prevent line from clotting.	
9. When catheter patency is verified • attach the patient's **Red** port to the **Red Access** line • attach the patient's **Blue** port to the **Blue Return** line	Always verify the flow rates with the physician's orders before attaching PRISMAFLEX™ to the patient.	
10. Unclamp any clamped lines; only lines that should have been clamped are: • Patient catheter clamps x 2 • **Access** line • **Return** line	PRISMAFLEX™ has not asked you to clamp any lines other than the **Access** and **Return** lines for connection. **SPH/RH:** The syringe line will be clamped and remain clamped throughout the treatment.	
11. Press **START** on the PRISMAFLEX™ screen and monitor patient during priming solution/blood exchange. Assess patient response to commencement of CRRT; monitor vital signs, and pressure changes on the PRISMAFLEX™ and assess for signs of filter reaction.	**VGH/LGH:** Initiate blood flow rate at 150 mL/min. **SPH/RH:** Initiate blood flow rate at 100 mL/min.	
12. Replace the thermal containment sleeve on the Prismatherm II once blood flow is established through the tubing.		
13. Turn PRISMATHERM II™ on. Adjust to maintain normothermic state.	Ensure that the sleeve fits closely to maximize heat transfer.	

Steps	Rationale/Site Specific Information	Image
14. Increase the blood flow to goal rate within the first 2 to 3 mins.	Goal rate is as patient condition or catheter permits.	
15. **SPH/RH:** Connect 500 mL NS bag using a macro drip to the 3 way stopcock in the **Access** line. **SPH:** When running Citrate start systemic Calcium Chloride infusion **VGH/LGH:** Spike 500 mL NS bag with accessory spike, cross clamp with extra blue clamp and hang on side of PRISMAFLEX™. Date and time the NS bag and change every 24 hours.	**SPH/RH:** 3 way stopcock and NS used for return of blood. **VGH/LGH:** Spike NS bag is used for returning of blood.	
16. Document start date and time as per organizational requirements see Documentation section.		

Care of the Patient

Blood work

	VGH	LGH	RH	SPH
Pre-Treatment Check/Draw	• Cross Match • CBC • Coagulation screen • Lytes, BUN, CR, • Magnesium • Phosphorus • Lactate • Ionized Calcium	• Cross Match • CBC • Coagulation screen • Chem 7 • Magnesium • Phosphorus • Lactate • Ionized Calcium	• Cross Match • CBC • Coagulation screen • Lytes, BUN, CR, • Magnesium • Phosphorus • Lactate • Ionized Calcium	• Cross Match • CBC • Coagulation screen • Renal Profile • Magnesium • Phosphorus • Lactate • Ionized Calcium
During Treatment				
• Q12H for first 24 hr	• Lytes, BUN, CR		• Lytes, BUN, CR • Magnesium • Phosphorus	• Renal Profile • Magnesium • Phosphorus
• Q24H	• CBC • Lytes, BUN, CR • Magnesium • Phosphorus	• CBC • Chem 7 • Magnesium • Phosphorus	• CBC • Lytes, BUN, CR • Magnesium • Phosphorus • Lactate • INR, PTT	• CBC • Renal Profile • Magnesium • Phosphorus • Coagulation screen • Total Calcium • Ionized Calcium
NOTE: When running CRRT with No potassium, monitor potassium levels Q2H				

	VGH	LGH	RH	SPH
If patient is on systemic Heparin	• Systemic PTT as per Heparin nomograms	• Systemic PTT as per Heparin nomograms	• Systemic PTT as per Heparin nomograms (from post filter/blue **Return** site as per PPO)	• Systemic PTT as per Heparin nomograms
Citrate Run • Q1H **after initiation or any change in rate** until within target range (2 or 3 measurements) **THEN** Q4H x 24 hours **THEN** Q6H				• Ionized calcium from post filter/blue (**Return**) **and** Ionized calcium from the patient's arterial line

Troubleshooting

The PRISMAFLEX™ machine provides trouble shooting information on the screen during alarm situations. Read the screen.

Blood leak detected alarm:

- Draw sample from Effluent pod.
- Label sample as "Effluent fluid" and request test for Whole RBC Count.
- DO NOT use dipstick (false positive with myoglobin or conjugated bili).
- If result is negative go to **SYSTEMS TOOLS**, press **NORMALIZE BLD** and continue treatment.
- If result is positive press **END TREATMENT** and follow process to return blood to patient and start a new set-up.

Ending Treatment and Disconnecting

Temporarily or permanently end treatment if:

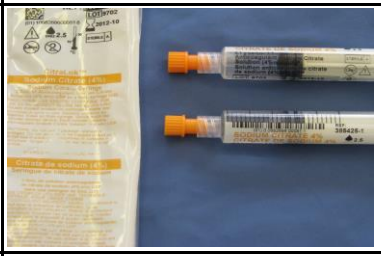
- Patient is away for a test or surgery
- Filter is clotted
- Filter change is due (Advisory alarm occurs when 780 litres blood processed or 72 hours)
- Positive blood leak in the effluent drainage
- Patient is in cardiac arrest
- Filter reaction on new start up (rare) due to EtO used in processing. DO NOT return blood to patient
- Power failure
- Ordered by the Physician

Steps	Rationale/Site Specific Information	Image
1. Press **STOP**. Not returning blood to patient: • Follow steps on screen to disconnect patient	DO NOT RETURN BLOOD IF SUSPECTED FILTER REACTION (i.e. ethylene oxide). If not returning blood to patient then blood loss must be accounted for as output (ST 150 = 268 mL ST 100 = 231 mL).	
2. Select **END TREATMENT** to change filter set or end CRRT.	End Treatment : • *Ends treatment with that specific filter set*. • Allows view/download of history. • Clears existence of any illuminated yellow alarm light with next filter set. **DO NOT** select **CHANGE SET** as it does not allow data download, access of last treatment history and does not clear yellow alarm status (if override used) with new set. **SPH:** If running Citrate, stop systemic Calcium Chloride infusion.	
3. Press **DISCONNECT.** Press **RETURN BLOOD** to return blood to patient if desired. **SPH/RH:** **Returning blood to patient:** • turn stopcock on **Access** line off to patient and open to NS 500 mL bag. • Return blood until desired volume. • Follow steps on screen to disconnect patient. **VGH/LGH:** **Returning blood to patient:** • Follow steps on screen to clamp **Access** line, disconnect from patient and and connect to 500 mL NS bag with spike. • Unclamp **Access** line and press **RETURN BLOOD.**	**SPH/RH:** NS infusion attached to the stopcock facilitates return of blood to patient using (ST 150 = 268 mL ST 100 = 231 mL).	

Steps	Rationale/Site Specific Information	Image
4. Increase rate of blood return to 100 mL/min. Press and hold **MANUAL RETURN** key until desired volume of blood is returned and **Return** line appears clear. When complete press **CONTINUE**.	The blood pump runs at the operator-selected Blood Return Rate when the **START RETURN** key is pressed and held. The PRISMAFLEX™ indicates the volume to be returned. This will need to be accounted for in the fluid balance.	
5. Press **DISCONNECT Patient** and follow steps on screen to disconnect patient and unload set. Discard filter as per hospital policy.		
6. Press **HISTORY** and then **DOWNLOAD DATA** to download data.	PRISMAFLEX™ holds 5000 events or 90 hours of data. If data is not downloaded after each filter change or at beginning/ end of each therapy, overwriting of data will occur.	
7. If continuing with therapy, select **NEW TREATMENT**.		

Capping

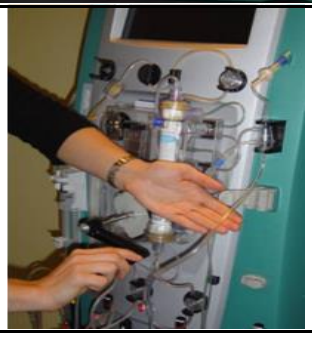
Steps	Rationale/Site Specific Information	Image
1. Prepare sterile dressing tray with Chlorhexidine, 2 x 10 mL prefilled NS syringes, 2 x 4% Sodium Citrate syringes and 2 caps. **SPH/RH:** Place blue pad under catheter.		
2. Don sterile gloves and fluid shield mask.		
3. Using sterile forceps, pick up hemodialysis catheter lumens and place on a sterile field (4x4, drape, etc.).		

Steps	Rationale/Site Specific Information	Image
4. **SPH/RH:** Take 2 4x4 gauze soaked in Chlorhexidine solution, (2% CHG & 70% alcohol), and clean catheter lumens using friction for 15 seconds. Allow to dry completely for minimum 30 seconds. **VGH/LGH** Take 2 – Chlorhexidine Pads (2% CHG & 70% alcohol), and clean catheter lumens using friction for 15 seconds and allow to dry completely for minimum 30 seconds.	As per unit policy **VCH/PHC:** Non-Tunnelled CVC (NT-CVC) – Basic Care and Maintenance (Adult).	
5. Attach 10 mL NS Prefilled syringe to each lumen. Open clamp. Turbulent flush each lumen with 10 mL NS and close clamp.	Use a separate syringe for each lumen to ensure sterility is maintained.	
6. Remove syringe and attach a prefilled 4% Sodium Citrate syringe to each lumen. Open clamp and fill each lumen to volume of catheter. Close clamp.	Discard excess volume of Citrate prior to connection to ensure accuracy. Use a separate syringe for each lumen to ensure sterility is maintained.	
7. Remove syringe and apply cap. **LGH/RH:** Wrap catheter lumens with 4x4 gauze and label outside with date and time of Citrate and initials.		
8. Document Citrate used for capping onto MAR.		

Manual Blood Return

Manual blood return is required when there are no other options to return the blood to the patient (i.e. power failure). The PRISMAFLEX™ machine **MUST BE TURNED OFF** for this procedure.

PLEASE NOTE: If there is any suspicion of clotted blood or air **DO NOT RETURN BLOOD**.

Steps	Rationale/Site Specific Information	Image
1. Turn Power OFF.		
2. **SPH/RH:** Turn stopcock on **Access** line off to patient and open to NS bag. **VGH/LGH:** • Clamp **Access** catheter and **Access** line. • Disconnect **Access** line from catheter and spike into a sterile 500 mL NS bag. • Unclamp **Access** line.	**SPH** use 1000 mL NS bag **RH** use 500 mL NS bag	
3. Inspect **Return** line for air or clots.	If air or clots present DO NOT return blood.	
4. Remove **Return** line from **Return** line clamp.	Slide **Return** line out of clamp.	
5. Remove the hand crank located at the back of the PRISMAFLEX™.		
6. Manually turn the blood pump clockwise using the hand crank until sufficient blood is returned to the patient and the **Return** line appears clear.	**NOTE:** Return blood slowly Normal return rate = 100 mL/min. **WARNING:** During this procedure the alarm system is off. Stop the manual blood return if air/clot is seen in the **Return** line tubing.	

Steps	Rationale/Site Specific Information	Image
7. Clamp the **Return** line and disconnect from the patient. **LGH/RH:** Place PRISMAFLEX™ aside for Biomed to remove filter.	**NOTE:** Deal with disconnecting and capping the catheter lumens as per policy in steps under "Disconnecting and Capping". (see Step 5 on pg 13 and then the Capping on pg 13).	
8. Follow capping procedure prior to dealing with machine unload.		
9. Clamp all lines to bags and syringe.		
10. **SPH/VGH:** Insert pump crank into the rotor of each pump and turn counterclockwise to free pump segments from raceways.		
11. When pump segments are free use the crank to set the pinch valves in neutral position.		
12. Pull out gently on filter set to disengage lines from pinch valves. Discard filter set.		

Patient/Client/Resident Education

Explain procedure to the patient/family to provide information and decrease anxiety.

Site Specific Practices

Cleaning of Prismaflex™

- Use only alcohol wipes to clean screen.
- Use only Oxivir or Caviwipes as per hospital policy to clean Prismaflex™ machine.

Anticoagulation (VGH/LGH)

Standard is to run CRRT without anticoagulation. If heparin is not being administered prepare a 20 mL luer lock syringe with Normal Saline and install into the syringe pump (prevents having to change filter if anticoagulation decided upon at a later time). **ALWAYS** install a syringe on setup.
Note: Systemic infusions of Heparin are documented on the MAR.

Recirculation (SPH/RH)

Recirculation procedure is indicated when the filter does not need to be changed but the patient needs CRRT temporarily stopped for Diagnostics or the Operating Room for a procedure that is done in less than 2 hours. CRRT Filter patency and sterility are to be maintained by continuously running normal saline through the extracorporeal circuit (ECMO).

Equipment & Supplies

For Disconnecting CRRT from the patient:

- 1 x sterile dressing tray
- Sterile gloves and dressing mask
- Blue Pad
- Chlorhexidine 2% with Alcohol 70%
- 4x4 gauzes
- Tape
- 2 x 10 mL Normal Saline syringes
- 2 x 2.5 mL Sodium Citrate 4.% Prefilled syringes (to volume of catheter for capping)
- 2 caps

For Recirculation

- 1 x 100 mL Normal Saline (NS)
- 1 x Y-connector
- 1 x accessory spike

Re-priming the filter set:

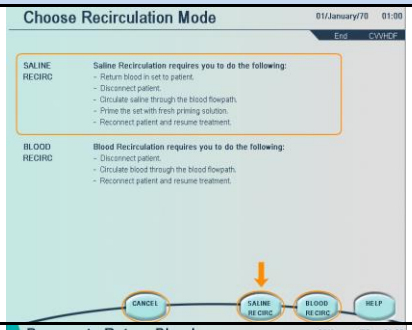
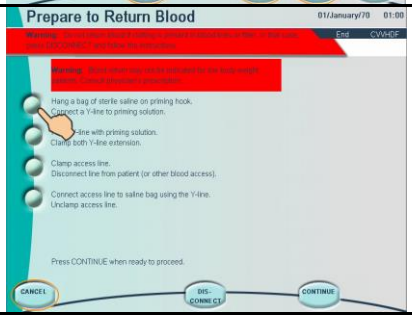
- 1 x new effluent bag
- 1 x 1000 mL NS

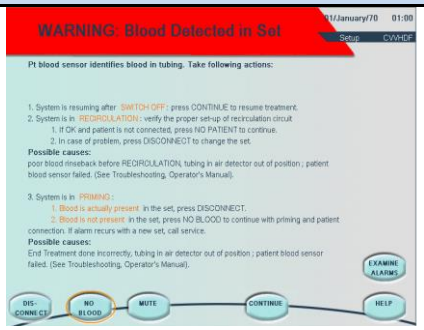
For Re-connecting to CRRT:

- 2x 3 mL syringes
- 4 x 10 mL Prefilled NS syringes
- 1 blue pad
- 1 x sterile dressing tray
- Sterile gloves and dressing mask
- 2% Chlorhexidine/70% Alcohol

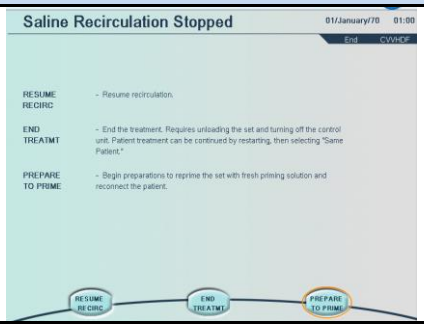
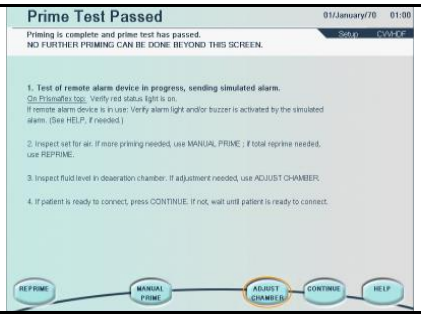
Recirculation Procedure (SPH/RH ONLY)

Steps	Rationale/Site Specfic Information	Image
1. Wash hands Place blue pad under catheter. Wear non-sterile gloves and fluid shield mask.		
2. Prepare sterile dressing tray with Chlorhexidine, syringes and NS flushes.		
3. Attach accessory spike to Y-connector and spike 100 mL bag NS. Prime lumens and hang on side hook of PRISMAFLEX™ machine.		

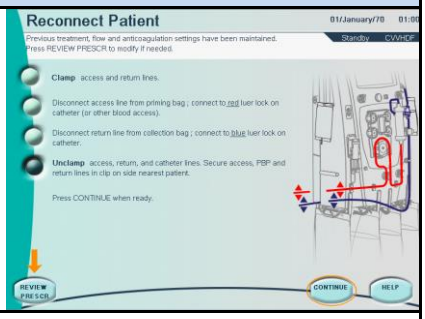
Steps	Rationale/Site Specfic Information	Image
4. Select STOP on PRISMAFLEX™ machine and then select RECIRC. **SPH:** **If Citrate run, STOP Calcium Chloride infusion.**	**NOTE: Always select SALINE RECIRCULATION.** Blood Recirculation is only used with the paediatric population when a blood prime has been used.	
5. Open 3 way stopcock so that the NS bag is open to the machine.	By utilizing the 3 way stopcock you can skip all the steps associated with this screen and select **CONTINUE**.	
6. Follow steps on PRISMAFLEX™ to return blood.	Verify blood return rate and set at 100 mL/min. The PRISMAFLEX™ indicates the volume to be returned. This will need to be accounted for in the fluid balance.	
7. Once the patient's blood has been returned, clamp catheter lines as well as the blue clamp on the **Return** line and red clamp on the **Access** line.		
8. Don sterile gloves. Take 2 4x4 gauze soaked in 2% Chlorhexidine & 70% Alcohol solution. Wrap catheter lumens for 1 minute. Remove gauze and air dry for 1 minute.		
9. Disconnect the **Access** line from the hemodialysis catheter and attach to Y-connector. Flush the **Access** lumen of the hemodialysis catheter as per policy. Repeat the same procedure for the **Return** line. Complete capping process for the hemodialysis catheter outlined in the policy.		

Steps	Rationale/Site Specfic Information	Image
10. Unclamp Y-connector, **Access** and **Return** line. When ready, select **START RECIRCULATION.**	The SALINE recirculates within a closed loop at minimum rate of 50 mL/min. Maximum recirculation time is 120 minutes or to the maximum 780 litres through the filter. **Note:** If the PRISMAFLEX™ alarms Blood Detected in Set Alarm, select **NO BLOOD** so that the machine knows it is disconnected from the patient. All alarms are temporarily inactive.	

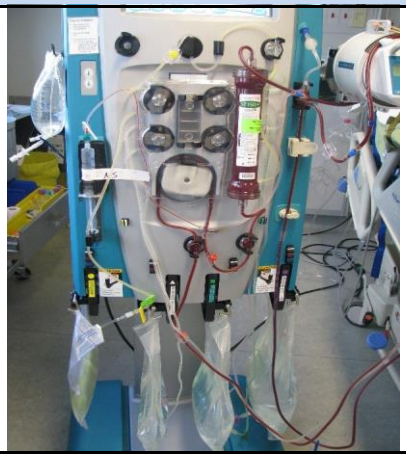
Priming – Post Recirculation

Steps	Rationale/Site Specfic Information	Image
1. When ready to restart CRRT press **STOP.** Select **PREPARE TO PRIME** and follow the instructions.		
2. Hang a new effluent bag on the hook at the side of PRISMAFLEX™. Connect 1 x1000 mL NS to Y-connector. Clamp the return side of Y-connector and **Return** line. Disconnect **Return** line from Y-connector and connect to a new effluent bag. Then unclamp **Return** line. **ALWAYS USE a new 1000 mL PRIMING SOLUTION**	During recirculation all filters must be reprimed with 1000 mL of priming solution. EtO build up can produce an allergic reaction if bolused into the blood stream; therefore, the reprime flushes the filter to decrease the risk.	
3. After repriming the filter set, select **PRIME TEST**. Once Prime Test is completed, adjust the deaeration chamber and follow the steps for reconnection.		

Reconnect to Patient

Steps	Rationale/Site Specfic Information	Image
1. Clamp Y-connector, **Access** and **Return** lines. Disconnect the **Return** line from the effluent bag and connect to the Y-connector. Move priming Y with **Access** and **Return** lines to patient bedside. Follow Hospital Policy to prepare Dialysis Catheter.	By moving **Return** line to the Y connector and the **Effluent** line to the effluent bag, allows for easier connection.	
2. Follow procedure on **Vascular Access Preparation Connecting to Patient**		
3. Unclamp dialysis, catheter, and **Access** and **Return** lines. Press **CONTINUE** when ready to start. Monitor patient during priming solution/blood exchange. **SPH: If using Citrate run, restart Calcium Chloride infusion.**	Start blood flow rate at 100 mL/min. Adjust the blood flow rate up based on patient and dialysis catheter status.	

Cytotoxic Precautions with CRRT

Steps	Rationale/Site Specfic Information	Image
1. Label filter and **Effluent** line with cytotoxic stickers.	Heighten awareness of cytotoxic precautions when changing set and to reduce risk of staff exposure.	
2. Each time the effluent bag is emptied, the RN must don a gown, gloves, mask and face shield.	Use of appropriate PPE • **VCH:** Cytotoxic Agents – Administration and Handling • **PHC:** Cytotoxic Handling Policy) Effluent bags are considered	

	cytotoxic.	
Steps	**Rationale/Site Specfic Information**	**Image**
3. The filter and effluent bags **MUST** be discarded in the cytotoxic bucket as per hospital policy. **SPH:** The effluent bag will be drained over the hopper/drain and then discarded into a cytotoxic bucket as per hospital policy.	Maximum 2 x 5 Litre effluent bags per bucket due to weight restrictions (25 lbs for large red bucket). Prevent repeated lifting and potential strains/injury to staff.	
4. **VGH/LGH:** Wheel bucket to dirty utility room using cart. Slide bucket off cart and obtain a new bucket. **SPH/RH:** Take cytotoxic bucket to dirty utility room.	No lifting for staff.	

CRRT and ECMO

The integration of CRRT onto the ECMO circuit will be highly dependant upon the patient's clinical presentation. The decision to integrate CRRT onto the ECMO circuit will be made between the perfusionists and attending physician.

The perfusionist will assess the safety and potential complications of attaching such a device on a case by case basis due to the variability in clinical management of these patients. For example: If there are difficulties maintaining ECMO flow rates/ oxygenation or if the integrity of the ECMO circuit is compromised by the presence of clot or coaguolopathic disorders such as Heparin Induced Thrombocytopenia, it is preferred for the CRRT to use different access port.

If alternative access ports are not available then as a last resort the CRRT will be attached to the ECMO circuit with the potential to terminate CRRT immediately if any complications arise. Maintaining ECMO flow rates and oxygenation will always remain the priority for these patients. There are many clinical scenarios that will determine the benefits and potential safety issues of attaching CRRT to the ECMO circuit. Some are listed below.

Preferred Scenarios:

- If the patient on ECMO already has CRRT access then this port will be used in preference to attaching it to the ECMO circuit.
- If the patient requiring CRRT has no vascular access ports already in situ and ECMO flow rates and oxygenation are stable then CRRT will be attached to the ECMO circuit.

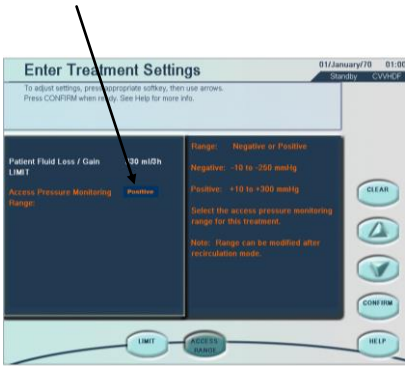
Emergent Scenarios:

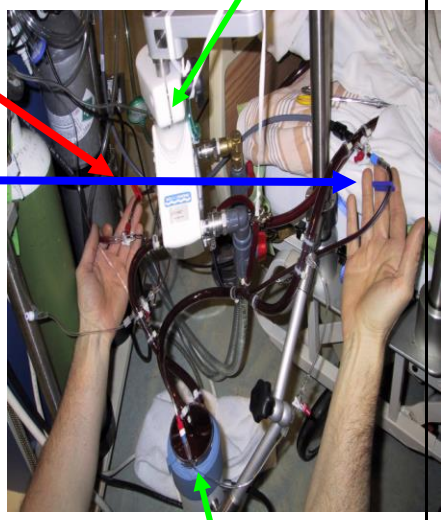
- If the patient is severely edematous or requires CRRT to normalize electrolyte levels and no access can be found then CRRT will be attached to the ECMO circuit.

- For heparin induced thrombocytopenia the increased potential for clot formation will require that the CRRT not be connected to the ECMO circuit. If no access can be found then additional anticoagulant (argatroban, bivalurudin, citrate) will have to be administered.

CRRT connections to the ECMO circuit.
Supplies
Prismaflex
ECMO Circuit

- When a catheter cannot be inserted into the patient, the Prismaflex is attached to the ECMO circuit.

Steps	Rationale/Site Specific Information	Image
1. **Follow the steps in SET UP Steps 1 – 14** (pg 5) then continue on from here.		
15. Enter Treatment Settings • Fluid Loss/Gain Limit • Pressure monitoring range Negative or Positive	Excess Patient Fluid Loss or Gain limit is a safety tool for patient care management. The alarm limit ranges from 100 to 400 mL within a 3 hour period. The PRISMAFLEX™ will default to a set value according to the type of filter. Set as per PPO. **SPH:** Access pressure monitoring range to "**POSITIVE**" to accommodate the high positive pressures –inlet and outlet - generated by the PRISMAFLEX™. This is a guide and the range selection should be chosen in discussion with perfusionist when CRRT is being connected into an ECMO circuit (can be either negative or positive depending where connected). **VGH:** Access pressure monitoring range to "**NEGATIVE**".	POSITIVE  PRISMAFLEX™ Positive Access Range: +10 to 300mmHg
16. Enter initial flow rates on PRISMAFLEX™ according to PPO. This allows for patient assessment for response to therapy.	**VGH:** Initiate blood flow rate at 150 mL/min. **SPH:** Initiate blood flow rate at 100 mL/min.	
17. Verify setting in Review Prescription and adjust according to PPO.	**SPH:** **Note** - if using high flow order set check that the replacement line has been changed to post filter.	

Steps	Rationale/Site Specific Information	Image
18. At the **Connect Patient** screen, clamp the white connections on the priming Y and the **Red** and **Blue** clamps on the **Access** and **Return** lines respectively. Disconnect the **Return** line from the effluent bag and connect to the priming Y where the **Effluent** line is, then connect the **Effluent** line to the effluent bag. The priming 'Y' is now ready for connection.	Double check all lines to ensure there is no air in the lines.	
19. **VGH Connection:** Once the circuit is primed the nurse will hand both the **Access** and **Return** lines to the perfusionist for connection to the ECMO at the same time. The circuit is then started. **SPH Connection:** The nurse will pass the **Access** connector of the PRISMAFLEX™ circuit to the perfusionist. The perfusionist attaches it to the appropriate post-membrane connector and ensures that the connection is air free.	**VGH Connection:** Prismaflex **Access** to ECMO venous line Post Centrifugal Pump BUT Pre Oxygenator. Prismaflex **Return** line to ECMO venous line Pre-Centrifugal Pump and Pre Oxygenator.	ECMO Oxygenator  ECMO Centrifugal Pump (Blood Pump)
20. The PRISMAFLEX™ is then primed using patient blood and the priming solution is collected in a bag.		
21. Once this is completed, press stop on the PRISMAFLEX™. The Nurse will then pass the perfusionist the **Return** to connect to the ECMO circuit, again via an air free connection.		

Steps	Rationale/Site Specific Information	Image
22. Press **START** on the PRISMAFLEX™ screen and monitor patient during priming solution/blood exchange. Assess ECMO response to commencement of CRRT; monitor patient vital signs, and pressure changes on the PRISMAFLEX™ and ECMO, assess patient for signs of filter reaction	**VGH:** Initiate blood flow rate at 150 mL/min. **SPH:** Initiate blood flow rate at 100 mL/min.	
23. Replace the thermal containment sleeve on the Prismatherm II once blood flow is established through the tubing.		
24. Turn PRISMATHERM II™ on. Adjust to maintain normothermic state.	Ensure that the sleeve fits closely to maximize heat transfer.	
25. Increase the blood flow to goal rate within the first 2 to 3 minutes.	Goal rate is as patient condition or ECMO CRRT circuit pressure limits allow.	

Removal of Patient from ECMO

Steps	Rationale/Site Specfic Information	Image
1. RN will press **STOP** on the machine and then press **END TREATMENT** and **DISCONNECT**.		
2. Press **RETURN BLOOD** to return blood to patient if desired. Increase rate of blood return to 100 mL/min.		
3. Perfusionist will clamp **Access** line and pass to the nurse. The nurse will hook up the **Access** line to a 500 mL bag of NS.	To allow for returning the patient's blood.	
4. Press and hold **MANUAL RETURN** key until desired volume of blood is returned and **Return** Line appears clear.		
5. Perfusionist clamps **Return** line and hands to RN.		
6. Press **DISCONNECT PATIENT** and follow steps to disconnect patient and unload set. Discard filter as per hospital policy.		
7. Press **HISTORY** and then **DOWNLOAD DATA**.		

Documentation

Each hour the nurse will review and document the following:

Flows

- Blood Flow Rate
- PBP Flow Rate
- Dialysate Flow Rate
- Replacement Flow Rate
  - **SPH only**: indicate Pre/Post (done at start of shift)
- Fluid Removal
- **SPH/RH only:** Effluent Dose
- Temperature
- Anticoagulant

VGH: above Flows will be documented on the Critical Care Nursing Assessment Record (CCNAR) **each shift**. Blood flow rate and Fluid Removal will be documented **each hour** on the Critical Care Flowsheet (CCFS).

Pressures

- Access
- Filter
- Effluent
- Return
- Pressure Drop
- TMP

History

- Fluid Removal
- **SPH/RH only:** Actual Run Time (hourly)

Deaeration Chamber

- Check level and adjust accordingly

Every 12 hours: at 0700 & 1900 the nurse will review and document the 12 hour accumulative for:

- Dose Delivered in mL/H/kg
- **VGH/LGH:** run time for 12 hour period
- **VGH:** Solutions, Flow Rates and Fluid Removal, Anticoagulant will be documented on CCNAR

Documentation Records:

- **VGH:** Kardex, CCNAR, CCFS, Nurses Notes
- **LGH:** CCFS, Nurses Notes
- **RH:** CCFS, Nurses Notes
- **SPH:** Nurses Notes, ICU Flowsheet, CSICU CRRT Documentation Log

Related Documents

VCH/PHC:

- Non-Tunnelled CVC (NT-CVC) – Basic Care and Maintenance (Adult).

VCH: Cytotoxic Agents – Administration and Handling

PHC

- OH&S Cytotoxic Handling Policy

References

Gambro Lundia, AB, Sweden (2009). *Prismaflex™ Tutorial SW4.XX Trainer Guide* DVD

Gambro Lundia, AB, Sweden (2009). *Prismaflex™ Operator's Manual*.

Bellomo, R., Cass, A., Cole, L., Finfer, S., Gallagher, M., Lo, S., McArthur, C., McGuinness, S., Myburghm J., Norton, R., Scheinkestel, C., & Su, S. for the RENAL Study Investigators (2009). Intensity of continuous renal-replacement therapy in critically ill patients. *The New England Journal of Medicine*, 361(17), 1627-1638.

Bouchard, J., Soroko, S.B., Chertow, G.M., Himmelfarb, J., Ikizler, T.A., Paganini, E.P., Mehta, and R.L., & Program to Improve Care in Acute Renal Disease (PICARD) (2009). Fluid accumulation, survival and recovery of kidney function in critically ill patients with acute kidney injury. *Kidney International,* 76(4), 422-427

Kidney Disease: Improving Global Outcomes (KDIGO) Acute Kidney Injury Work Group. KDIGO Clinical Practice Guideline for Acute Kidney Injury. Kidney inter., Suppl. 2012; 2: 1–138.

The VA/NIH Acute Renal Failure Trial Network (2008). Intensity of renal support in critically ill patients with acute kidney injury. New England Journal of Medicine, 359(1), 7-20. doi: 10.1056/NEJMoa0802639

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VCH: *(Regional SharePoint 2nd Reading)*
Health Authority Profession Specific Advisory Council Chairs (HAPSAC)
Health Authority & Area Specific Interprofessional Advisory Council Chairs (HAIAC)
Operations Directors
Professional Practice Directors

PHC: Professional Practice Standards Committee

Final Sign-off & Approval for Posting by

Chief Nursing Officer & Executive Lead Professional Practice – VCH

Professional Practice Standards Committee – PHC

Date of Approval/Review/Revision

Approved: April 28, 2014

Posted: May 2, 2014

Appendix A: CRRT Definitions

Actual Run Time: of the Prismaflex is the time accrued only when all pumps required for the therapy are running. This takes into account all stop times for alarms, changing bags, changing filters etc. It can be obtained by changing the In and Out period on the screen to view, for instance, the actual run time in a 12 hour period. The actual run time affects the dose delivered to the patient.

Adsorption: the ability of larger solutes to adhere to the surface of the dialysis membrane (i.e. septic mediators, inflammatory mediators. The greatest benefit appears to occur in the first few hours. Once the filter becomes saturated with these proteins, the removal from the serum is limited. Adsorption (i.e. in a septic patient) plays a role in how quickly the TMP or Filter Pressure Drop will rise during treatment.

CRRT Dose:

$$\text{Prescribed Effluent Dose (mL/H/kg)} = \frac{\text{prescribed dialysate, replacement, PBP \& Fld Removal Rates (mL/H)}}{\text{Patient weight (Kg)}}$$

Delivered Effluent Dose = If there were no interruptions, the pumps would never stop delivering the prescribed amount of solution (the programmed flow settings, so the delivered dose would equal the prescribed dose (i.e. prescribed 25 mL/H/kg = delivered 25 mL/H/kg).

CVVH (Continuous Venous-venous Hemofiltration) facilitates the removal of small and middle (myoglobin, septic and inflammatory mediators, cytokines) molecular weight solutes with a water flow "solvent drag". This is achieved through the principles of ultrafiltration and convection. Convection utilizes a pressure gradient, from high to low pressure. The volume of replacement fluid infused prefilter (PBP pump) +/or post filter (Replacement pump) drives the convective clearance by increasing the ultrafiltration rate (effluent pump). Replacement fluid replaces the wanted solutes ((K+, HCO3) and replaces the water removed during hemofiltration so the patient's fluid status is not affected.

CVVHD (Continuous Venous-venous Hemodialysis) is the removal of small solutes (electrolytes, BUN, CR, Glucose) based on a concentration gradient (higher concentration to lower concentration). It achieves this through the principle of diffusion until there is equilibrium.
Solute removal is dependent on solute size, blood flow rate, dialysate flow rate and the concentration gradient between the blood and dialysate solution. Dialysate runs counter current to the blood and remains separated from the blood by the semipermeable membrane.

CVVHDF (Continuous Venous-venous HemoDiaFiltration) utilizes the principles of Ultrafiltration, Diffusion and Convection. It is most effective method for removing excess fluids and solutes. When setting up the Prismaflex™ CVVHDF is the mode chosen in order to gain accessibility to the other modes should therapy be changed.

Deaeration Chamber is a semi-automatic air removal system located on the return line above the air/blood detector. The level of fluid within the deaeration chamber can be adjusted as necessary by using the "Adjust Chamber" button on the bottom of the screen.

ECMO is Extracorporeal membrane oxygenation, a treatment that uses a pump to circulate blood through an artificial lung back into the bloodstream of the patient. This system provides heart-lung bypass support outside of the patient's body and can be veno-venous or veno-arterial. It can be used for cardiac (cardiogenic shock/arrest, end stage heart disease) and/or respiratory failure (hypoxemic for ARDS or hypercapneic failure as in reactive airways disease).

Complications of using CRRT while on ECMO.

- Air entrainment
- Blood loss due to damaged connector/stopcock/ luer port.
- Hypovolemia leading to reduction/interruption in ECMO flow rates resulting in hemodynamic instability and delivery of oxygenated blood.
- Infection
- Blood clot formation potentially compromising the ECMO circuit.

Ethylene Oxide (EtO) is a gas used to sterilize the Filter Sets. EtO can produce an allergic reaction if it gets into the blood stream; therefore, the second litre of Normal Saline for priming should be completed just prior to the patient being connected. If both litres have been completed and connection to the patient is greater than one hour, a second prime of 2 litres must be performed.

Filter Pressure Drop(△P) is an indicator of clotting. It represents the pressures in the hollow fibers of the filter and the pressure reduction that occurs as blood flows through the filter. Microclotting can occur in the hollow fibers, creating resistance to blood flow, thus pressure drop increases over time. A △P greater than 100mmHg = filter is clotting and a △P greater than 300mmHg = filter is clotted. Filter pressure – Return pressure = Filter Pressure Drop

SCUF (Slow Continuous Ultrafiltration) is the removal of plasma water (0 to 2 L/hr) from the patient's blood as it travels through the filter. This is achieved by the principle of ultrafiltration, the movement of fluid through a semipermeable membrane, caused by a pressure gradient (from high pressure to low pressure).

TMP is the pressure exerted on the dialysis membrane during operation and reflects the difference between blood and fluid compartments (i.e. across the membrane). During treatment, permeability of the membrane decreases due to protein coating or clotting on blood side, causing the TMP to increase. A TMP above +350 mmHg will produce an advisory alarm. A TMP above +450 mmHg will produce a "filter is clotted alarm".

TMP = (Filter pressure + Return Pressure)/2- Effluent Pressure