Guidelines for Continuous Veno-Venous
Haemofiltration and Continuous Veno-Venous
Haemodiafiltration within Paediatric Intensive Care
Unit at LRI
## REQUIREMENT

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Who should be aware of the policy and where to access it.</td>
<td>All PICU nursing staff trained in extended role. All Consultants within PICU.</td>
</tr>
<tr>
<td>Who should understand the policy.</td>
<td>All PICU nursing staff trained in extended role. All PICU Consultants.</td>
</tr>
<tr>
<td>Who should have a good working knowledge of the policy.</td>
<td>All PICU nursing staff trained in extended role. All PICU Consultants.</td>
</tr>
<tr>
<td>Whether the policy should be included in the General Trust Induction Programme and/or departmental specific induction programme.</td>
<td>No extended role requiring specialist training and support.</td>
</tr>
<tr>
<td>Where is the Policy available:</td>
<td>Within PICU attached to each Prismaflex machine. Intranet.</td>
</tr>
<tr>
<td>Copy to be sent to personnel with a request for inclusion in induction documents</td>
<td>No</td>
</tr>
<tr>
<td>Copy to:</td>
<td>IT for Intranet site</td>
</tr>
<tr>
<td>Process for monitoring the effectiveness of this document</td>
<td>Will be audited internally.</td>
</tr>
<tr>
<td>Patient version.</td>
<td>No</td>
</tr>
<tr>
<td>Groups/persons consulted.</td>
<td>PICU Clinical Nurse Manager, PICU Educators, PICU Consultants, PICU Pharmacists, Nephrology Consultants</td>
</tr>
</tbody>
</table>

This Policy is subject to the Freedom of Information Act

## Contents

<table>
<thead>
<tr>
<th>Page</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Statement of Intent and Scope</td>
</tr>
<tr>
<td>4-7</td>
<td>Equipment required &amp; set up (inc. saline/4.5% HAS prime)</td>
</tr>
<tr>
<td>7-9</td>
<td>Priming: Blood</td>
</tr>
<tr>
<td>9-11</td>
<td>Connecting and Commencing Treatment</td>
</tr>
<tr>
<td>11</td>
<td>Standard Flow Rates</td>
</tr>
<tr>
<td>12-14</td>
<td>Anticoagulation: Heparinisation (inc. ACT measurement), Antithrombin III</td>
</tr>
<tr>
<td>15</td>
<td>Adding Electrolytes</td>
</tr>
<tr>
<td>16</td>
<td>Care &amp; Clinical Monitoring</td>
</tr>
<tr>
<td>17</td>
<td>Blood Sampling Frequency</td>
</tr>
<tr>
<td>18-21</td>
<td>Disconnection Procedure</td>
</tr>
<tr>
<td>22-23</td>
<td>Wash back/Return Blood Procedure</td>
</tr>
<tr>
<td>24-26</td>
<td>Recirculation Procedure</td>
</tr>
</tbody>
</table>

## SECTION 2

<table>
<thead>
<tr>
<th>Page</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>27</td>
<td>Principles of Continuous Veno-Venous Haemofiltration</td>
</tr>
</tbody>
</table>
Statement of Intent
The purpose of this guideline is to provide support and direction when caring for a child requiring haemofiltration and haemodiafiltration on the Prismaflex machine. It has been developed due to the introduction of an updated machine to PICU and in response to changes in therapy options. Clinical guidelines are ‘guidelines’ only. The interpretation and application of clinical guidelines will remain the responsibility of the individual. If in doubt consult a senior colleague or expert. Caution is advised when using the guidelines after the review date.

Scope
The following guidelines refer only to the use of the Prismaflex machine for children on the Paediatric Critical Care Unit (PICU) who are receiving Continuous Veno-Venous Haemofiltration (CVVH), Continuous Veno-Venous Haemodialysis (CVVHD) or Continuous Veno-Venous Haemodiafiltration (CVVHDF). This protocol is to be used solely within the Paediatric Critical Care Unit for all patients requiring CVVH, CVVHDF, CVVHD. Deviation from this protocol must be documented in the nursing notes with an explanation of the circumstances.

The authors are M. McLaughlin and J. Whitelaw. Further professional advice has been gained from C. Westrope, B. Harvey, S. Jepson, Dr A. Mayer, C. Jack, Professor A. Watson, Dr F. Hussain and Dr M. Mallik.

The Heparinisation protocol uses the Nottingham City hospital Acute Renal Failure and The Sheffield Children’s Hospital Heparinisation protocols as its basis.
The guidelines are in 2 parts:
Part 1 is a practical guide to setting up, starting, running and disconnecting treatment.
Part 2 is a more detailed description of the therapy, examples of calculations, problem solving and the full anticoagulation guidelines

EQUIPMENT REQUIRED FOR HAEMOFILTRATION WITH THE HOSPAL GAMBRO PRISMAFLEX MACHINE

- 2 or more units of packed cells available. This blood should be less than 2 weeks old, or 1 week old for a neonate if possible, to reduce potassium and acidity. Blood should be available even if not planning to blood prime.
- Circuit of appropriate size.

<table>
<thead>
<tr>
<th>Circuit</th>
<th>Patient Weight (kg)</th>
<th>Prime Volume (ml)</th>
<th>Max. Replacement Rate (ml/hr)</th>
<th>Max. Blood Pump Speed (ml/min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HF20</td>
<td>0-12</td>
<td>60</td>
<td>780</td>
<td>100</td>
</tr>
<tr>
<td>ST60</td>
<td>12-25</td>
<td>97</td>
<td>2250</td>
<td>180</td>
</tr>
<tr>
<td>ST100</td>
<td>25-100</td>
<td>150</td>
<td>9000</td>
<td>400</td>
</tr>
</tbody>
</table>

- 1 Litre of sodium chloride 0.9% with heparin 2000 units added for priming ST60 and ST100 circuits.
- 1 Litre of sodium chloride 0.9% with no heparin added for all circuits.
- 3 x 5 litre bags of Prismasol 4 replacement/dialysate fluid (*if patient's potassium is > 6mmol/l, use Hemosol BO see p.30 for information*).
- Once the CVVH/CVVHDF catheter is inserted obtain baseline bloods and a non heparinised ACT.
- Each lumen should then be locked with the exact volume as stated on the catheter with heparin 100 units/ml and labelled stating ‘heparin 100 units/ml insitu’.
- Heparin MUST be aspirated and the aspirate discarded, before connecting to patient.
SET UP OF PRISMAFLEX MACHINE

This information is a step-by-step guide to the preparation of the Prismaflex automated haemofiltration machine and should be used in conjunction with the manufacture's operating manual and instructions on the machine.

Always set up in CVVHDF mode on the Prismaflex, whichever mode is being used on the patient. Always use 3 bags of replacement/dialysate fluid.

The Prismaflex must be switched on before it is lined.

- Ensure that **nothing** is attached to the Prismaflex, also ensure the heater lines are not fouling the scales.
- Press the “ON” button on the right side of machine. The machine will bleep a few times and self test.
- You will have the option to select a new patient or same patient. Options will have to be confirmed several times.
- Enter patient details and weight and follow on-screen instructions.
- Select CVVHDF option for all therapies (the Prismaflex will always display which therapy is currently being delivered on the ‘Status Screen’).
- Even if not planning to use CVVHDF it is imperative to prime with 3 bags of replacement solution on the pre blood pump (PBP), dialysate and replacement solution scales.
- The machine will then confirm again the set loaded and the limits of the filter. Follow the on-screen instructions.
- Follow the lining and priming instructions as displayed on the screen.
- If you get a ‘set up error’ or ‘wrong set loaded’ alarm, follow the instructions on screen.
- If you get a ‘barcode reading failure’ message, double check that the correct set has been loaded, if it has, select the type of set used from the options displayed on screen.
- **For HF20 sets**
  Carry out prime using a litre of sodium chloride 0.9% with nothing added.
- **For ST60 and ST100 sets**.
Carry out a first prime using a litre of heparinised sodium chloride 0.9%. Then select the ‘re-prime’ option for the second prime using a litre of sodium chloride 0.9%.

- Go into prime test after priming finished.
- In the HF20 set it is not uncommon to see air present on the outside of the filters hollow fibres at the top and bottom. Do NOT attempt to clear this air as is unnecessary and may damage the haemofilter.
- Once prime test has passed, adjust the level in the deaeration chamber as required, following on screen instructions. Then STOP!
- If not connecting to patient straight away, or setting up machine away from the patient’s beside, ensure ‘Prime Test Passed’ but do not go beyond ‘Prime Test Passed’ screen.
- Having successfully passed the prime test it is now safe to unplug the machine (do not switch off first) and move to the patient’s bedside, as it will allow continuation with the same circuit when plugged back in.
- Only move away from the ‘prime test passed’ screen when the CVVH/CVVHDF catheter is inserted, the correct patient priming solution is available, and the patient is ready to commence.
- If the machine has been stood for >30mins you will need to perform a further sodium chloride 0.9% prime using the re-prime option.
- The next actions depend on whether carrying out a sodium chloride 0.9%, a HAS 4.5%, or a blood prime. Each procedure is described below.
- At ’Prime Test Passed’ screen
  - If doing a HAS 4.5% prime
    - Clamp Y line, effluent and access line
    - Replace empty bag of sodium chloride 0.9% with 500ml bottle of HAS 4.5% (remembering to insert an air inlet into the bottle).
    - Unclamp all of the above.
    - Press and hold down ‘manual prime’ button until HAS primed through the circuit.
    - Press ‘continue’.
  - If not doing HAS 4.5% prime just press ‘continue’ at this screen.
- At ‘Enter Treatment Settings’ screen –
  - The ‘patient fluid loss/gain limit’ is automatically calculated on patient’s weight (approx 10ml/kg over 3 hours). This may be adjusted as per prescription. Once set, it cannot be changed during treatment.
• ‘Enter Flow Settings’ screen;
  enter half blood flow rate and ensure all other settings are programmed to 0ml/hr at this point.
• ‘Enter Anticoagulation Settings’ screen – set the continuous heparin infusion rate. Starting rate of 1ml/hr. Do not set a bolus dose.
• ‘Review Prescription’ screen – review and confirm/change settings at this point.
• ‘Connect Patient’ screen follow onscreen instructions unless blood priming. If blood priming see p.8-9

PRIMING

0-20kg - 4.5% HAS prime
> 20kg   - 0.9% Sodium Chloride prime

The decision to blood prime, in very small neonates, needs to be assessed on an individual basis and this decision must be made by the PICU Consultant.

Blood Prime

Blood priming should only ever be required if using a HF20 set

Equipment required:
  • Blood giving set
  • Burette
  • 50ml syringe
  • 3 way tap

  • Ensure the blood used for priming is less than 2 weeks old (or less than 1 week old for a neonate).
  • Ensure you are ready to connect to the patient before commencing blood prime.
  • Ensure you have programmed the information onto the 'Treatment Settings', 'Flow Settings', and 'Anticoagulation Settings' screens (These come after the Prime Test Past screen) as per prescription and guidelines (see p. 6-7) prior to mixing blood.
  • Prepare blood for priming by mixing packed cells with sodium chloride 0.9% in a buretted giving set to a ratio of 70/30 (blood/sodium chloride 0.9%). The required volume for priming is documented on the prescription chart.
• Use one paediatric unit of packed cells for priming.
• Prime through the blood giving set and 3 way tap.
• Clamp Access, Effluent and Return line.
• Clamp Y connector.
• Disconnect the Access line from the Y set and connect to blood giving set with a 3 way tap. Unclamp Access line.

• Disconnect Return line from Effluent bag and connect to Y set, unclamp Return line and Y set connector above Return line.
• Connect Effluent line to Effluent bag, unclamp bag and line.
• At the ‘Connect Patient’ screen press the ‘blood prime’ button, and then press and hold down ‘manual prime’ button.
• A ‘blood in flowpath’ alarm will sound – mute and continue.
• If giving one, inject Heparin bolus into red pre-filter port before blood reaches the filter.
• When circuit has filled with blood ‘stop’ the blood pump.
• Clamp Access, Return lines, Y connector and blood giving set.
• Disconnect Access line from three way tap and attach to the Y connector.
• You are now ready to connect to your patient (see Connecting and Commencing Treatment section for further instructions p.11).

CONNECTING & COMMENCING TREATMENT

Before connection, ensure emergency drugs and fluid boluses are readily available and that suitable medical staff are available. If the patient is particularly unstable consider increasing inotropes and oxygen concentration.

Commencing CVVH/CVVHDF treatment on a patient.
For all types of connection the following equipment is needed. Use the trusts aseptic non touch technique (ANTT) for accessing central line.

Equipment
Non-sterile gloves
Apron
Sani-cloth
Sterile field
2 x large sterile gauze
4 x 10ml luer lock syringes
1-2 x 10ml ampoules sodium chloride 0.9%
2 x needles
Procedure for patient connection

1. Obtain baseline vital signs and haemodynamic assessment.
2. Pre ACT, coagulation screen, platelet count and any active bleeding must be taken into account.
3. If not already done so, switch on and attach the heater wires to the Return line, leaving a 15cm gap at the patient end.
4. Set the blood pump at half the required rate for the weight of the child.
5. Wash hands, put on gloves & prepare tray.
6. Prepare 2 empty 10ml syringes, 2 filled with sodium chloride 0.9% and sterile gauze maintaining non-touch.
7. Clean access catheter with sani-cloth.
8. Connect a 10 ml syringe to the Access lumen of the CVVH/CVVHDF catheter. Release the clamp on the Access lumen and aspirate the lock volume of blood (will be on the lumen of the catheter).
9. Clamp the Access lumen, remove the 10ml syringe and expel the aspirated 3ml blood onto a piece of gauze to ensure that clots are not present. If they are present re-aspirate until no more clots appear. (Keeping in mind the volume of blood circulating in the patient).
10. If no clots are found, then attach on to the Access lumen a 10ml syringe containing 5ml of sodium chloride 0.9% and flush up to 5mls. Clamp and leave the syringe in place until ready to attach the CVVH/CVVHDF circuit line.
11. Repeat the same procedure with the Return lumen of the CVVH/CVVHDF catheter.
12. Connect Access line to Access lumen, and connect Return line to Return lumen, (unless assessed line to work better with lines switched round).
13. Unclamp patient lines, Access and Return lines and press ‘continue’, then ‘start’ or ‘resume’ if you’ve blood primed.
14. Run blood pump at half prescribed rate.
15. Standby with clamps on the Return lumen initially to ensure that no air travels back to the patient. If air is seen then clamp line immediately, stop pump and remove air from circuit. Then recommence.
16. Observe patient for anaphylaxis, cardiovascular instability and desaturation.
17. If a heparin bolus is required (and has not already been given during a blood prime), ensure it is given into pre-filter port before the blood comes into contact.
with the filter.

18. Increase the blood flow rate slowly to that prescribed for the patient (blood flow should be 6 to 9ml/kg/min).

19. You will need to programme in the flow settings (i.e. replacement rate, pre blood pump rate and dialysate rate if using).

20. Observe Prismaflex for circuit pressures.

21. Ensure Prismaflex observations are charted hourly.

22. Patient fluid removal rate should be calculated, set and documented once the prescribed blood flow rate has been reached and the patient is haemodynamically stable.

23. Prismaflex hourly patient fluid removal must also be documented on the PICU chart every hour.

24. Regularly observe circuit for air and clots.

25. When Prismaflex alarms are activated help is available on screen to define and resolve the problem. More information is available in Hospal GAMBRO’s written information attached to the machine and from the helpline. Document all advice from the helpline on the patient log sheets.

### Standard flow rates

<table>
<thead>
<tr>
<th>Weight (kg)</th>
<th>Total Replacement (mls/hr)</th>
<th>Dialysate flow rate (mls/hr)</th>
<th>Min. Blood Flow Rate (mls/min)</th>
<th>Max. Blood Flow Rate (mls/min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.5</td>
<td>75</td>
<td>50</td>
<td>20</td>
<td>30</td>
</tr>
<tr>
<td>5</td>
<td>150</td>
<td>100</td>
<td>30</td>
<td>45</td>
</tr>
<tr>
<td>10</td>
<td>300</td>
<td>200</td>
<td>60</td>
<td>90</td>
</tr>
<tr>
<td>15</td>
<td>450</td>
<td>300</td>
<td>90</td>
<td>120</td>
</tr>
<tr>
<td>20</td>
<td>600</td>
<td>400</td>
<td>120</td>
<td>150</td>
</tr>
<tr>
<td>25</td>
<td>750</td>
<td>500</td>
<td>150</td>
<td>180</td>
</tr>
<tr>
<td>30</td>
<td>900</td>
<td>600</td>
<td>180</td>
<td>240</td>
</tr>
<tr>
<td>35</td>
<td>1050</td>
<td>700</td>
<td>180</td>
<td>240</td>
</tr>
<tr>
<td>40</td>
<td>1200</td>
<td>800</td>
<td>180</td>
<td>240</td>
</tr>
<tr>
<td>45</td>
<td>1350</td>
<td>900</td>
<td>180</td>
<td>240</td>
</tr>
<tr>
<td>50</td>
<td>1500</td>
<td>1000</td>
<td>180</td>
<td>240</td>
</tr>
</tbody>
</table>

*In patients >30kg aim for a blood pump speed of 180-240mls/min. The machine will allow speeds up to maximum of 400mls/min, but this is often not achievable or necessary.*
High volume treatment

Treatment parameters are a starting point for therapy and can be increased. In some circumstances the starting rates should be higher.

Heparinisation

- **Heparin is administered to anti-coagulate the CVVH/CVVHDF circuit, not the patient.**
- Heparin is set on the anticoagulation screen.
- There will be the option for ‘Continuous Rate’ or ‘Bolus Delivery’, **do not set ‘Bolus Delivery’**.
- Heparin bolus at start of treatment (0-50 units/kg) should be drawn up separately and injected into the **Access** side of the circuit before blood hits the filter.
- Select ‘Continuous Rate’. The heparin infusion normally runs at 2.5-25 units/kg/hr.
- ACT is usually maintained at 140-160 on Actalyke machine with Max ACT (grey top) tubes, depending on the patient’s coagulation status.

Equipment for measurement of Activated Clotting Time (ACT)

- ACT machine (Actalyke MINI II)
- ACT tubes (MAX ACT bottles grey top)
- 23G needles (blue)
- 1 ml syringes
- Sani-cloth
- Gloves, apron and goggles/face shield

- Ensure the ACT machine has passed its electronic QC prior to use (see Actalyke MINI II Standard Operation Procedure for further information).
- Obtain a baseline ACT from the CVVH/CVVHDF catheter rather than arterial line if possible, prior to heparinisation. This should be normal i.e. 100-130 seconds in a patient without a coagulopathy. If you have to use an arterial sample ensure adequate drawback to remove heparin from sample.
- Heparinise the filter (if necessary). Give the prescribed bolus dose of heparin into the red injection port just before the blood reaches it.
Start the heparin infusion at the commencement of CVVH/CVVHDF. Aim to keep infusion at least 1ml/hr (unless infusion turned off) you may need to dilute the concentration/prescription to achieve this.

Perform an ACT after connection to ensure adequate heparinisation after the bolus dose. Samples should be taken from the CVVH/CVVHDF circuit from the return injection port – 0.5ml blood should be taken for each sample.

Press the START button on ACT machine at the same time as dispensing the blood into the ACT bottle.

Gently agitate the sample or flick the bottom of the tube 5-7 times.

Insert the ACT bottle into the machine and rotate clockwise 720 degrees.

Perform an ACT at least hourly for the next 4 hours until a stable state has been reached. **Consistency in taking blood samples is very important.**

Once a stable state has been reached ACT monitoring can be reduced to 2 hourly.

Adjustment of dose/infusion rate should be based on ACT results and if unsure ask the medical team for advice. The patients APTT and PT must also be monitored to ensure optimum coagulation of the circuit without impacting dramatically on the patients coagulation. It is usually better to further dilute the infusion rather than stop it altogether. **If the patients clotting becomes deranged, yet ACTs remain low the ACT target range needs to be reviewed and possibly reduced (see p.40-44).**

<table>
<thead>
<tr>
<th>ACT LEVEL</th>
<th>HEPARIN RATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 160</td>
<td>Decrease Heparin by 0.5ml/hr</td>
</tr>
<tr>
<td>140-160</td>
<td>No change in Heparin</td>
</tr>
<tr>
<td>&lt;140</td>
<td>Increase Heparin by 0.5ml/hr</td>
</tr>
</tbody>
</table>
A further bolus dose may be needed if the ACT is too low. The dose for this will be dependent on the patients coagulation status, the circuit coagulation status and the current dose of heparin being administered. If in doubt consult with medical staff.

- **An ACT above 200 seconds should be acted upon immediately** by reducing the heparin infusion rate and reassessing the ACT level within 30 minutes. (This is due to the bleeding risk posed to the patient) If ACT has not reduced then the heparin infusion should be stopped. **ACT should be monitored at least 30 minutes to ensure the level is dropping.**

- If the patient has abnormal clotting this will affect the amount of heparin needed, as it is the patient's blood flowing through the circuit.

- The administration of blood products especially platelets (and FFP to a lesser degree) can also decrease the ACT.

**Special Considerations**

- If ATIII or Protein C are given in conjunction with heparin the advice of a Consultant Intensivist or Haematologist should always be sought.

- The use of Antithrombin 3 (ATIII) will potentiate the effect of heparin without changing the ACT.

- **Protein C** will also increase anticoagulation.

- When using ATIII it may be appropriate to stop the heparin infusion, and restart at half the original rate after 1 hour, and when using Protein C it may be necessary to stop the heparin infusion completely and use Epoprostenol instead.

For further information on the use Epoprostenol and anticoagulation see section two p.41-45.
Adding electrolytes to replacement and dialysate fluid

- With the exception of sodium whenever possible the correction of electrolyte imbalance should be administered directly to the patient.
- Additives are always prescribed to be added per litre of fluid and as a total dose, as bag sizes vary. Care needs to be taken when making up the fluid as a result.

Management of hypernatraemia on CRRT

In cases of hypernatraemia in patients requiring CRRT it may be necessary to add sodium to replacement/dialysis fluids to ensure sodium correction does not occur too rapidly. The sodium content of both Prismasol 4 and Hemosol BO is 140mmol/L, so without the addition there is a significant risk the patient’s serum sodium could drop too quickly.

If the patient’s plasma sodium is greater than 160mmol/L it will be necessary to add 30% sodium chloride to bags of Prismasol 4 or Hemosol BO to prevent a rapid fall in plasma sodium. It should never fall >10mmol/L in 24 hours. Sodium chloride 30% contains 5mmol/ml of sodium.

<table>
<thead>
<tr>
<th>Target Na⁺ (mmol/L)</th>
<th>Addition to 5 litre bag (either Prismasol 4/Hemosol BO)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>150</td>
<td>10mls of sodium chloride 30%</td>
<td>Remove same volume from replacement/dialysate bag before addition (i.e. for target 150mmol/L remove 10mls from Prismasol 4/Hemosol BO, then add 10mls sodium chloride 30%)</td>
</tr>
<tr>
<td>160</td>
<td>20mls of sodium chloride 30%</td>
<td></td>
</tr>
<tr>
<td>170</td>
<td>30mls of sodium chloride 30%</td>
<td></td>
</tr>
<tr>
<td>180</td>
<td>40mls of sodium chloride 30%</td>
<td></td>
</tr>
<tr>
<td>190</td>
<td>50mls of sodium chloride 30%</td>
<td></td>
</tr>
</tbody>
</table>

If an addition is required this must be clearly documented on the patients CVVH/CVVHDF Daily Prescription and Record Chart and the patient’s serum sodium must be closely monitored.
Care and clinical monitoring of patient

- Continuous monitoring of cardiovascular and respiratory parameters should be undertaken.
- Ensure cardiovascular observations are recorded on PCCU chart hourly or half hourly depending on stability of patient.
- All patients who are receiving CVVH/CVVHD must have central/peripheral temperature*, heart rate, arterial blood pressure and preferably CVP monitoring (*central temperature does not have to be a rectal temperature).
- Fluid balance needs careful monitoring because of the large volumes of fluid being removed/infused.
- There are inherent errors in all the measures of fluid balance therefore it is prudent to assess the following factors before deciding upon the hydration status of the patient in relation to CVVH:
  - Fluid balance
  - Clinical examination (HR, ABP, CVP, etc.)
  - Biochemistry
  - Haematocrit
  - Weight (if possible)
- Treat the patient NOT the machine.
Blood sampling guidelines

This specifies the minimum frequency, but will be dictated by patient’s clinical condition.

<table>
<thead>
<tr>
<th>Test</th>
<th>Frequency</th>
<th>Special notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arterial blood gas</td>
<td>4 hourly</td>
<td>Carry out initial gas 1 hr after treatment commenced. Particular attention to; pH, lactate, bicarbonate, sodium, potassium &amp; blood sugar.</td>
</tr>
<tr>
<td>FBC</td>
<td>Daily</td>
<td>Consider wash back/blood prime.</td>
</tr>
<tr>
<td>U&amp;E’s</td>
<td>4 hourly on ABG 12 hourly in labs</td>
<td>If using Prismasol 4 fluid remember to gradually discontinue potassium in maintenance, infusions &amp; supplements.</td>
</tr>
<tr>
<td>Clotting</td>
<td>Every 12hrs</td>
<td>Increase frequency if on Protein C or Antithrombin III.</td>
</tr>
<tr>
<td>Other electrolytes</td>
<td>Calcium, Magnesium &amp; Phosphate 12 hourly</td>
<td>These are slowly filtered out.</td>
</tr>
</tbody>
</table>

Sleeve Heater

- The sleeve heater should be set at 1-2°C above the desired patient body temperature.
- Beware of the heater masking pyrexia especially in neonatal patients.
- As the heater sleeve covers the Return line it is essential that a 15cm portion of the line be left exposed next to the patient’s catheter so air would be visible.
- Additional warming devices may be required.
DISCONNECTION PROCEDURE

When treatment is finished or electively discontinued, the blood in the circuit can be re-infused back into the patient (see wash back procedure).
If this is not an option then disconnection occurs in accordance with the disconnection procedure below.

**Equipment**

- Non-Sterile gloves
- Apron
- Goggles or Face Shield
- Sani-cloths
- Sterile field
- 2 x large sterile gauze
- 6 x 10ml luer lock syringes
- 1-2 x 10ml ampoules sodium chloride 0.9%
- 2 x 5ml ampoules Heparin (100units/ml)
- 2 x filter needles
- 2 x needles
- 2 x white caps

**Procedure for patient disconnection**

1. Obtain baseline vital signs and haemodynamic assessment.
2. Wash hands, put on gloves and prepare tray.
3. Maintaining asepsis prepare white caps and 6 x 10ml syringes; 2 empty, 2 x filled with sodium chloride 0.9%, 2 x filled with correct volume of heparin (based on vascular access insitu).
4. Get your assistant to press ‘stop’ on the Prismaflex at the same time as you clamp both **Access** and **Return** lumens.
5. Select ‘end treatment’ button, then ‘disconnect’.
6. When you get to the ‘Disconnect Patient’ screen follow the instructions below:
   - Clean and disconnect the **Access** line from the **Access** lumen with chlorhexidine soaked gauze.
   - Connect a 10 ml syringe to the **Access** lumen of the CVVH/CVVHDF catheter. Release the clamp on the **Access** lumen and aspirate volume of blood in line.
- Clamp the Access lumen, remove the 10ml syringe and expel the aspirated 3ml of blood onto a piece of gauze to ensure that clots are not present. If they are present re-aspirate until no more clots appear (Keeping in mind the volume of blood circulating in the patient).
- If no clots are found, then attach on to the Access lumen a 10ml syringe containing 5ml of sodium chloride 0.9% and flush up to 5mls.
- Replace the sodium chloride 0.9% syringe with heparin syringe and flush the correct volume to lock off the line (volume of line printed on them).
- Ensure the line is then clearly labelled with the volume and strength of heparin in situ.
- Replace the heparin syringe with a white cap.
- Repeat the same procedure with the Return lumen of the CVVH/CVVHDF catheter.
- Once you have disconnected from the patient you are now ready to unload the set.

8. At the ‘Disconnect Patient’ screen press ‘unload’. The machine will then ask you confirm all lines and bags are clamped and that the patient is disconnected before proceeding at this point.

9. Select ‘unload’ once you have checked all of the above.
CLEANING OF PRISMAFLEX AND DISPOSAL OF CIRCUITS

Once the circuit is unloaded the nurse carrying out CVVH/CVVHDF is responsible for the correct disposal of the circuit and cleaning of the Prismaflex. The following procedure should be followed:

✓ Plastic aprons and gloves should be worn.
✓ Filtration waste and unused replacement fluid should be emptied down the sluice.
✓ Spikes should be removed.
✓ Any open connectors should be attached onto the circuit to make a closed circuit.
✓ Prismaflex circuit and bags should be disposed of in a yellow plastic clinical waste bin.
✓ The Prismaflex should be cleaned with detergent and warm water or wipes. If any blood spills are found, they should be cleaned according to the unit’s policy on blood spillage.
✓ Any patients undergoing cytotoxic chemotherapy must have lines and filtrate waste handled in accordance with local policy.
**Emergency Disconnection**

In some circumstances emergency disconnection is appropriate e.g. lines have clotted, technical failure or evacuation of the unit. In these circumstances wash back is not usually appropriate. If time allows lines should be disconnected and CVVH/CVVHDF catheter flushed and locked in accordance with disconnection procedure described above or at least with sodium chloride 0.9%.

**Cardiac Arrest**

In the event of cardiac arrest while the patient is undergoing CVVH/CVVHDF treatment should be stopped and the line aspirated, flushed and locked as time allows. It may be an option to wash back the blood in the circuit, if deemed necessary to the patient. In some circumstances continuing filtration may be appropriate (e.g. if being used for life threatening electrolyte disturbance). Haemofiltration catheters are central venous access and can be used instead of standard central lines in an emergency.

**Air Embolism**

In the event of the patient having an air embolism, attempt to aspirate air using the central line. To do so, put the patient on their left side with their head down. Summon emergency assistance.
WASH BACK/RETURN BLOOD PROCEDURE

Do not attempt wash back if the lines are sludgy and clotted or if the patient is on ECMO.
If the patient has been blood primed they should not require wash back of blood.

Rationale for wash back
The Haemofiltration circuit is washed back to conserve red blood cells without giving the child unnecessary fluid.

Equipment
Non-sterile gloves
Apron
Goggles or Face Shield
3 x Sani-cloths
Sterile field
2 x large sterile gauze
6 x 10ml luer lock syringes
1-2 x 10ml ampoules sodium chloride 0.9%
2 x 5ml ampoules Heparin (100 units/ml)
2 x filter needles
2 x needles
2 x white caps
500mls sodium chloride 0.9%

Procedure for patient wash back/return blood
1. Obtain baseline vital signs and haemodynamic assessment.
2. Wash hands, open the sterile dressing pack, and put on sterile gloves.
3. Maintaining asepsis prepare white caps and 6 x 10ml syringes; 2 empty, 2 x filled with sodium chloride 0.9%, 2 x filled with correct volume of heparin (based on CVVH/CVVHDF catheter insitu).
4. Get your assistant to press ‘stop’ on the Prismaflex at the same time as you clamp both Access and Return lumens.
5. Select ‘end treatment’, then ‘return blood’
6. At the ‘Enter Blood Return Rate’ screen there is the option to run it at 10-100ml/min.
   - HF20 sets recommended rate = 10-30mls/min.
   - ST60 sets recommended rate = 30-50mls/min.
   - ST100 sets recommended rate = 50-80mls/min.
7. At the ‘Return Blood’ screen follow the on-screen instructions, remembering to unclamp the Return lumen.
8. You will need to hold down the ‘start’ button until the fluid going back to the patient is light pink in colour (i.e. more sodium chloride than blood).
9. Whilst carrying out procedure observe patient for hypertension and cardiovascular instability.
10. If child becomes hypertensive reduce blood return rate by pressing the ‘flow rate’ button. If no immediate improvement, stop wash back, aspirate, flush and lock lumens. Inform medical staff.
11. Closely observe lines for air and blood clots while wash-back is taking place.
12. Once you have returned the blood to the patient clamp the Access and Return lumens.
13. Press ‘continue’ which will bring you to the ‘Disconnect Patient’ screen.
14. Follow the disconnection procedure from page 20, point 7.
Recirculation Procedure

Either a sodium chloride 0.9% or blood recirculation may be performed through the Prismaflex.

The sodium chloride recirculation will ask you to wash back the blood to the patient, which you may not wish to do depending on clinical status. This should not be attempted if the lines are sludgy and clotted and may not be required if the patient has had a blood prime. It is possible to perform a sodium chloride prime without performing a wash back, further information provided below.

Rationale
Recirculation may be necessary when you are encountering access problems or need to disconnect a patient for scan.
Blood recirculation can be performed for 1 hour.
Sodium Chloride 0.9% recirculation can be performed for 2 hours.

Equipment
Non-sterile gloves
Apron
Goggles or Face Shield
3 x sani-cloth
Sterile field
2 x large sterile gauze
6 x 10ml luer lock syringes
1-2 x 10ml ampoules sodium chloride 0.9%
2 x 5ml ampoules Heparin (100 units/ml)
2 x filter needles
2 x bare cannula needles
2 x white caps
100ml sodium chloride 0.9% for blood recirculation
500ml sodium chloride 0.9% for saline recirculation
Bag spike
3-way tap
Spare effluent bag (if performing saline recirculation and not wanting to return blood)
Procedure

1. Obtain baseline vital signs and haemodynamic assessment.
2. Get your assistant to press ‘stop’ on the Prismaflex at the same time as you clamp both Access and Return lumens. Then get them to select ‘recirc’.
3. In the ‘Choose Recirculation Mode’ screen you then have the option for saline or blood recirculation.

**NB: blood recirculation is for 1 hour useful for when having access issues or in an arrest situation. Saline recirculation is for 2 hours useful for when a patient is being disconnected for a planned reason (e.g. CT/MRI scan).**

For a blood recirculation

- Follow on-screen instructions at ‘Prepare Blood Recirculation’ screen, disconnecting, aspirating, flushing and locking the Access and Return lumens if possible.
- Press ‘continue’.
- Continue to the ‘Initiate Blood Recirculation’ screen and select ‘start recirc’.
- The ‘Recirculation in Progress’ screen will now display. There will be a countdown timer showing how long you have left before needing to either discard the set or reconnect to patient.
- There is also the option to adjust the recirculation rate or deaeration chamber level.
- Once you have selected ‘stop’ at the ‘Blood Recirculation Stopped’ screen you will have the option to ‘resume recirc’, ‘end treatmt’ or ‘connect to patient’.
- If wanting to reconnect to patient you will be asked to verify patient connection.
- At ‘Reconnect Patient' screen ‘review prescr’ to check all the treatment, flow and anticoagulation settings are correct. Commencing the blood flow rate at half the prescribed rate, as per patient connection guidelines.
- Follow on-screen instructions to recommence treatment.

For a sodium chloride 0.9% recirculation

- Follow the on-screen instructions on 'Prepare to Return Blood' screen, attaching an empty 10ml luer lock syringe to the lumen on the patients vascath.
- You will need a bag spike & 3-way tap (this is used in place of a Y connector) to spike your bag of fluid.
- **If not wanting to return the blood to the patient:**
• Hang an empty effluent bag on the priming hook (right of machine).
• Disconnect the Return line from the patient, connecting an empty 10ml luer lock syringe to the lumen on the patient’s vascath and attach Return line to the empty effluent bag.
• Follow on-screen instructions at ‘Return Blood’ screen. Recommendations for return rates are: HF20 sets = 10-30mls/min. ST60 sets = 30-50mls/min. ST100 sets = 50-80mls/min
• Remember to unclamp the Return lumen before attempting return.
• You will need to hold down the ‘manual return’ button until the fluid going back to the patient (or bag) is light pink in colour.
• Whilst carrying out procedure observe patient for hypertension and cardiovascular instability.
• If child becomes hypertensive reduce blood return rate by pressing the ‘return rate’ button. If no immediate improvement, stop wash back, aspirate, flush and lock lumens. Inform medical staff.
• Closely observe lines for air and blood clots while wash-back is taking place.
• Once you have returned the blood to the patient clamp the Access and Return lumens.
• Continue to the ‘Initiate Saline Recirculation’ screen and select ‘start recirc’.
• The ‘Recirculation in Progress’ screen will now display. There will be a countdown timer showing how long you have left before needing to either discard the set or reconnect to patient.
• You can now aspirate, flush and lock both lumens of the patients vascath if possible.
• There is also the option to adjust the recirculation rate or deaeration chamber level.
• Once you have selected ‘stop’ at the ‘Saline Recirculation Stopped’ screen you will have the option to ‘resume recirc’, ‘end treatment’ or ‘prepare to prime’.
• If wanting to reconnect to the patient you will firstly need to reprime the circuit by selecting ‘prepare to prime’ and following on-screen instructions.
• At ‘Reconnect Patient’ screen ‘review prescr’ to check all the treatment, flow and anticoagulation settings are correct. Commencing the blood flow rate at half the prescribed rate, as per patient connection guidelines.
• Follow on-screen instructions to recommence treatment.
PART 2

Principles of Haemofiltration

- Haemofiltration is the removal of plasma water by the filtration of blood.
- The concentration of solutes (electrolytes and other low molecular weight solutes) in the filtrate is the same as in the plasma (e.g. plasma water).
- Biochemistry is controlled by removing large volumes of filtrate and replacing it with electrolyte containing fluid (replacement fluid). The more filtrate you remove and replace, the more efficient haemofiltration is in controlling biochemical disturbance.
- Because most solutes are distributed within the extracellular and intracellular fluid compartments (total body water), the volume of filtration (replacement) necessary to control biochemistry relates to total body water. Clinical experience has shown that a replacement of approximately 50% of bodyweight (1kg = 1litre) is usually adequate for solute and electrolyte removal.
- The extracorporeal circuit requires good central venous access to allow the high blood flows necessary to prevent clotting in the circuit/filter.
- A low blood flow rate, high haematocrit and high plasma protein concentration will limit the rate at which filtration can occur and solutes (particularly of higher molecular weight) can be removed.
- Any formula for the prescription of haemofiltration is at best an approximation or starting point as the needs will be determined by many unmeasured variables such as the rate of solute production, nutritional intake and the actual volumes of the extracellular fluid and intracellular fluid compartments.
Aims of Haemofiltration

- **Fluid removal;**
  - If this is all that is required then relatively low rates of filtration are needed.
  - There will be negligible solute removal under these circumstances.
- **Correction of "uraemia" and electrolyte disturbance;**
  - This requires the replacement of large volumes of fluid typically of the order of 50% of bodyweight (assuming bodyweight in Kg ~ volume in litres) per day.
  - The blood urea level will be determined not only by the efficiency of filtration but also by the amount of nutrition, the muscle bulk, and the presence of catabolism.
- **Allow the safe administration of blood products and nutrition.**
- **Treatment of inborn errors of metabolism;**
  - In this instance “high volume” haemofiltration may be necessary with daily filtration volumes (replacement) equal to body weight.
- **Septicaemia;**
  - There is evidence that haemofiltration may be beneficial.
  - It is not clear whether this is because of better fluid control or the removal of undesirable inflammatory mediators.
Principles of Continuous Haemodiafiltration

- The addition of dialysate flow will improve the efficiency of acid base, waste and control of electrolyte balance.
- In many Paediatric units in the UK CVVHDF is seen as the standard therapy for all PICU patients, but others suggest that CVVH may be more appropriate in some circumstances.
- The set up of the machine will not involve any change to current practice.
- The dialysate flow is programmed into the machine the same way the pre blood pump or replacement flow rates would be.
- 20ml/kg/hr is the usual starting point for dialysate flow. As with CVVH this is only an approximation.

Principles

- Dialysate flow runs counter current to blood flow
- Dialysate flow generates a diffusion gradient with the patient blood.
- Waste and electrolytes diffuse from the patient’s blood into the dialysate fluid surrounding the fibres. The “saturated” dialysate fluid (effluent) is removed from the filter and discarded.
- Diffusion is a two way process, molecules that are at a low concentration in the blood and high in the dialysate fluid will diffuse into the blood and vice versa (e.g. bicarbonate).
- Convective transport systems utilised in CVVH are limited by the blood flow achieved.
- If higher replacement rates are indicated, but are not achievable adding in dialysate flow will optimise clearance. Reasons for not achieving desired replacement rates could be due to patient stability, or issues with access limiting the blood flow rates.
- This is practically important when treating children with inborn errors in metabolism, for overdose of drug of therapeutic agent and for patients with a high lactate.
**Aims of Haemodiafiltration**

- Dialysate flow is added to haemofiltration circuits to generate a diffusion gradient across the filter. This increases the efficiency of solute clearance.
- Using both convective and diffusive transport systems will optimise the clearance of molecules of varying molecular weights.
- Dialysis will be more efficient at removing urea, creatinine and drugs than filtration. It may also be more efficient in metabolic conditions.
- Dialysate flow will optimise the clearance of molecules of a small to medium molecular weight.
- Increasing dialysate flow will at least theoretically improve clearance, however this is limited by the relatively low dialysate flow rates generated by continuous therapy equipment.
REPLACEMENT FLUID AND ELECTROLYTES

Hemosol BO/Prismasol 4 Replacement/Dialysate Fluid

Prismasol 4 should be used as the standard replacement fluid unless the patient’s serum potassium is over 6.0mmol/l. If the patient is receiving a potassium infusion, has potassium chloride in the intravenous maintenance, or as a supplement this should be reviewed and usually stopped at the commencement of therapy.

Prismasol 4 and Hemosol BO (HBO) are bicarbonate based replacement/dialysate fluids and must be mixed before use. If the patients U&E’s/ blood sugars drop after starting treatment ensure fluid has been mixed properly.

Prismasol 4 has added potassium at a dose of 4mmol/L and glucose of 6.1mmol/L. HBO and Prismasol 4 also contain a low magnesium concentration (0.5mmol/l). When considering electrolyte balance remember the patients electrolyte levels will became similar to the concentration in the replacement/dialysate fluid and the higher the replacement/dialysate flow rate the faster this will happen.

If the patient has serum potassium over 6.0.mmol/L the potassium free HBO solution should be used as the initial replacement/dialysate fluid. Caution should be taken when using HBO as this fluid does not contain any glucose therefore very close monitoring of patients blood glucose is essential. As the serum potassium falls below 6.0mmol/L, the replacement/dialysate fluid should be exchanged for the Prismasol 4 solution.

If the patient has serum potassium less than 6.0mmol/L at the commencement of therapy Prismasol 4 solution should be used at the outset. The use of Prismasol 4 solution negates the use of extra potassium infusions. The patient’s serum potassium will settle out at about 4.0mmol/L if Prismasol 4 is used.

With the exception of sodium and glucose if the patient requires other electrolytes the first line would be to administer this directly to the patient. If access is a major problem you may need to consider adding electrolytes to the replacement/dialysis
solution and where possible advice should be sought from pharmacy to ensure there are no compatibility problems.

**POTENTIAL PROBLEMS WHILST UNDERGOING TREATMENT**

*Septicaemia* – CVS instability during haemofiltration.
*Action*: use of inotropes +/- colloid may help.

*Hypernatraemia* - often occurs as a result of fluid restriction and excessive sodium intake e.g. in fluids and drugs. Haemofiltration replacement fluid itself contains approximately 140mmol/l.
*Action*: Minimise sodium intake in drugs, infusions and TPN.
  - Increase free water intake (water which does not contain electrolytes).

*Hyponatraemia* - may be present as part of water overload. When haemofiltration removes large amounts of fluid, the hyponatraemia may be worsened, as the fluid removed is plasma water (therefore has a high sodium content).
*Action*: Increase sodium intake and decrease free water intake.

*Coagulation of circuit in a patient with Haemolytic Uraemic Syndrome. (H.U.S)*
Despite a low platelet count and high dose heparin it may be very difficult to keep continuous therapies running.
*Action*: A combination of heparin and Epoprostenol may be a more effective form of anticoagulation. NB Epoprostenol will not affect ACT.

*Unable to get enough blood flow to perform total body water exchange in 8 hours in a metabolic patient.*
*Action*: Run CVVHDF
CALCULATING TREATMENT PARAMETERS

This prescription is based on CVVH (24hr/day). Shorter sessions of haemofiltration will require adjustment of the flow rates and filters to achieve the same daily amount of filtration.

The prescription needs to account for the patient’s current situation and the desired management over the next 24 hours. In general it is difficult to achieve a negative balance of more than 5-10% of patients body weight over 24 hours.

All fluid handling rates on the Prismaflex are set in ml

‘Unintended Pt Fluid Loss or Gain Limit’ screen.
This is the difference between the fluid removal measured on the machine and the set fluid removal rate over the last 3 hours. Once this limit has been reached the machine will stop and no longer run. Therefore if a clamp has been left on a bag the alarm cannot be continuously over ridden. The default limit is 60-400mls, but should be set based on patient’s weight, clinical condition and haemodynamic stability. This should be assessed and prescribed on the prescription chart.

Blood Flow Rate
6-9ml/kg/min
This is at least ~ 10X filtration rate and prevents excessive haemoconcentration in the filter. Volume of blood passing through filter in a given time relative to body weight.
Minimum rate = 20ml/min.
Clotting in the filter or lines is most likely to occur when blood is travelling slowly along the lines and takes a long time to cross the filter, therefore use the smallest filter and lines possible to achieve the desired filtration rate. Blood flow rates should be run at the higher end of the range if at all possible.

Replacement rate
Total replacement rate is the volume of fluid taken out of the patient and replaced with replacement fluid every hour in ml/hr. It is also known as the volume of exchange.
Total replacement rate on the Prismaflex is the same as turnover on the BM25. Total replacement is calculated on 30ml/kg/hr this is the starting point to provide effective solute waste control. However replacement can be increased for enhanced clearance. For example septic/metabolic patients may have higher replacement rates, up to 80ml/kg/hr have been used. If a higher replacement is used a proportional higher blood pump speed is needed to stop the filter clotting. This is only possible if the patient's cardiovascular status and vascular access will tolerate it.

The Prismaflex allows for a mix of pre and post dilution replacement rates. As a usual starting rate 10mls/kg/hr pre dilution and 20mls/kg/hr post dilution is recommended. This may be altered dependent on the patients clinical status and the condition of the circuit (e.g. if the circuit pressures are rising indicating that the filter is clogging up increasing the amount of pre-dilution may prolong the life of the filter).

**High Volume Treatment**

In patients with metabolic diseases ideally total body water should be exchanged in 8 hours, however this is usually not possible to achieve as enough blood flow cannot be achieved to avoid the filter clotting. In the case of metabolic patients the highest practical replacement rate should be used and dialysate flow used from the start. The normalisation of ammonia and metabolic acidosis being the point at which to consider a reduction in flow rates.

**Effects of high volume treatment**

High volume replacement or dialysate flow rates have a dramatic effect on electrolyte balance, regular review of potassium, phosphate, calcium, sodium and pH balance are essential. All flow rates should be reviewed every 24 hours and reduced when patient improves or when desired outcome has been achieved. **Medical staff must prescribe any changes in flow rates.** The danger of haemoconcentration of blood in filter can be a problem with high volume replacement.

**Dialysate flow rate**

Initial dialysate flow rate should be 20ml/kg/hr. As with replacement, increasing the rate will increase efficiency of therapy. Dialysate will rapidly change electrolyte and waste balance. Dialysate flow should not start at high volume rates because of the potential to change patient’s osmotic pressure. Dialysate flow show only be...
increased if treatment is not being effective. Dialysate flow is not affected by blood flow and increasing it does not cause haemo-concentration in the filter. If more efficiency of treatment is needed, but replacement rate cannot be increased dialysate flow can be added (e.g. in a neonatal patient with metabolic disease where more efficient ammonia removal is necessary).

**Pharmacokinetics**

Drug removal by haemofiltration depends on molecular weight, albumin binding, water solubility and volume of distribution, therefore some drugs handling properties are changed by the therapy. Filtration will remove non-protein bound, water soluble drugs, which are available in the circulation. Adding dialysate flow will cause more efficient drug removal by diffusion. Drug dose changes should be checked with literature (in drug information folder) and a pharmacist.

**Patient Fluid Loss**

This is calculated on an hourly basis depending on actual patient fluid balance, desired fluid balance and condition and stability of the patient. Individual prescription depends on input (i.e. nutrition, IV fluids, drugs) and output (i.e. urine, gastric, drain losses).

If a negative balance is required this may be calculated on a 12 hourly basis or over a specified period of time. This should be prescribed on the patients prescription chart. Desired negative balance and hourly actual fluid balance both need to be added together to work out fluid loss total to be programmed. Do not remove fluid bolus given to support blood pressure or intravascular loss. Blood products which have not been administered for volume should be added to the fluid loss to be programmed.

The Prismaflex will continue to run at the set hourly rate until changed by staff. The rate must be reviewed every hour. Beware of removing fluid too quickly. If the fluid removal rate needs to be reduced after a number of hours it must be marked on the Prismaflex calculation chart when that should take place. The form must be signed every hour by two nurses to show it has been reviewed. Adding up replacement solution input, dialysate total and then subtracting the effluent total will confirm the total fluid removal.
If the machine shows a minus number that means that it has gained that amount of fluid. This may occur when you first commence treatment, but will readjust itself after a few minutes.

Deciding exactly how much fluid to remove from the patient is difficult to quantify as it depends on many clinical factors including urine output, insensible loss, hypervolaemia/hypovolaemia and clinical observations. Once fluid removal is started, close observation of the patient’s cardiovascular and fluid balance status needs to be undertaken. Continuous evaluation of heart rate, core/peripheral temperature gap, capillary refill, CVP, blood pressure and blood biochemistry are essential.

**EXTREME CAUTION** should be used when setting the patient fluid loss rate, as the haemofiltration machine will try to remove that fluid; it has no way of assessing the effect on the patient. It will continue to remove fluid even when the patient is HYPOVOLAEMIC.

**Always treat the patient NOT the machine.**
ANTICOAGULATION

Unfractionated heparin should be used as an anticoagulant unless:

- The patient is extremely thrombocytopaenic
- Heparin is not effective
- The patient has liver failure or is sensitive to heparin (in which case Epoprostenol (Flolan) should be considered).

Heparin bolus/infusion should be worked out according to prescription information, heparinisation policy and regime.

Heparin

Introduction
During haemofiltration, platelets react with foreign surfaces such as blood tubing and haemofilters; leading to clotting via the intrinsic clotting cascade, this can be reduced by heparinisation. Factors that influence the heparin consumption are:

1. Platelet count
2. Liver function
3. Kidney function
4. Metabolic rate

The level of anticoagulation is monitored by measuring the Activated Clotting Time (ACT). This is measured using a Actalyke MINI machine.

If the ACT is low, thrombosis and clotting may occur – in filter and patient.
If the ACT is too high, bleeding may occur – in patient.

ACT’s should be maintained within the prescribed range, usually between 140-160 seconds however this may change depending on the patient situation (patient with liver damage may have a high baseline ACT, or a bleeding patient may require lower ACT’s).
This prescribed range should be prescribed by the medical staff on the CVVH/CVVHDF prescription chart.

Properties of Heparin
- The effects are immediate
- The effective is short lived once discontinued
- The action of heparin can be reversed with Protamine Sulphate 1mg per 100U of Sodium Heparin. However Protamine is difficult to titrate because its use can cause anti-coagulation problems if overused and it’s dose calculation is difficult. Protamine is also associated with serve anaphylactic reactions.

Heparin is administered to prolong the clotting time because of the risk of clot formation due to the use of an extra corporeal circuit. It inhibits coagulation by preventing the conversion of prothrombin to thrombin and fibrinogen to fibrin. Heparin displays almost immediate action following intravenous administration. The clotting time then returns to normal within 2-6 hours after the infusion is discontinued. It binds extensively to plasma proteins and is activated in the liver and excreted in the urine.

Administration of Heparin
Heparin is administered into the dedicated heparin infusion line on the access side of the Prismaflex circuit.

The initial bolus (if appropriate) should be given as blood reaches pre filter port, this is then followed by a continuous infusion. The aim is to raise the patients clotting time sufficiently to prevent clotting in the filter and lines, while not increasing the risk of bleeding to the patient.

Dosage of Heparin
In order to gauge the amount of heparin to be given, the following guidelines should be followed. Activated clotting time (ACT) should be measured using bedside monitoring with a Actalyke MINI machine. The patients clotting must also be monitored closely via laboratory bloods, should the patients clotting become deranged the ACT target range may need to be reviewed and reduced.

A clotting time that is taken pre-filtration and is not heparinised, such as at initial insertion of haemofiltration catheter must always be taken. This is essential because
each individual will respond differently to the same dose of heparin; therefore, their reaction to it (the increase in the clotting time following heparin) will be different. The initial ACT should be 100-130 seconds. Once commenced on treatment you will need to check an ACT. Further ACT’s should be taken hourly and more frequently if indicated by the patient’s condition. The aim is to maintain the patient’s clotting time within the pre-determined limits on the prescription chart. Once stable this may be reduced to 2 hourly. **The maximum concentration of heparin should be 100 units/ml with a maximum rate of 5mls/hr (25 units/kg/hr).** Should the ACTs remain low on this maximum rate the target range needs to be reviewed, amended and documented on the prescription chart.

**Contraindications**

Heparin should be used with caution and/or withheld according to medical advice in the following:

- Active bleeding
- Imminent or recent surgery
- Coagulopathies such as thrombocytopenia, especially in septic and oncology patients.
- Heparin Induced Thrombocytopenia (H.I.T.)
- Disseminated Intravascular Coagulation (D.I.C.)
- Liver disease
- Haemophilia
- Diabetes
- Pericarditis

CVVH/CVVHDF may be carried out in the above circumstances with minimal or no heparin or with an alternative agent such as Epoprostenol/Prostacyclin (see below).

**NB.** It is possible to use less heparin if a faster blood flow is obtained, if the circuit is pre-diluted, or if the patient is on warfarin, aspirin or another anti platelet agent.

**Side effects of Heparin**

Short-term use of heparin has been associated with the following:

- Bleeding
- Thrombocytopenia
- Hypersensitivity reactions
Longer-term use of heparin has been associated with the following;
- Demineralisation of bone
- Disturbances of fat metabolism
- Alopecia

Hypersensitivity reactions include;
- Tingling on the lips
- Pruritus
- Rashes

Heparin is incompatible with;
- Ciprofloxacin
- Clarithromycin
- Phenytoin

Antithrombin 3 and Protein C have been used to treat septic patients with DIC, and both have the side effect of increasing the effectiveness of heparin without changing the ACT. In these circumstances it may be appropriate to stop the heparin and restart it after 1 hour at a reduced rate. Take advise from a haematologist regarding its use with heparin.

**Epoprostenol/Flolan**
Epoprostenol is a prostaglandin and a potent inhibitor of platelet aggregation. This inhibition is dose related. Epoprostenol will not affect the ACT. It may however be of use to check the overall coagulation status regularly, but should not be used to titrate the Epoprostenol rate.

If patient is already on 6-10 nanogram/kg/min or more of Epoprostenol then Heparin is not required. If there are problems with Heparin use Epoprostenol at 6 -10 nanogram/kg/min. Infusion should be started at 1 nanogram/kg/min and only increased by increments of 1 nanogram/kg/min up to 6-10nanogram/kg/min, provided the blood pressure does not fall severely.

**NB.** A bolus of Epoprostenol should not be given because of its systemic effects.
When administering Epoprostenol it must be delivered directly to the patient, not through the machine.

**Side effects and contraindications:**

- Epoprostenol is a very potent pulmonary and systemic vasodilator; the cardiovascular effects will disappear within a few minutes of stopping infusion. It therefore must not be withdrawn suddenly.
- Bradycardia and a fall in BP - If hypotension occurs the infusion must be stopped.
- Risk of haemorrhage.
- Severe hypotension.
- Tachycardia.
- Blood sugar may increase.
- Facial flushing.

Headache and gastrointestinal symptoms including nausea, vomiting and colic. Nausea is particularly a problem with conscious patients.

- Epoprostenol is incompatible with any other drugs.
Education and Training

Initial training session followed by on-going training.

References


Gambro www.gambro.com


Pediatric Continuous Renal Replacement Therapy. [www.pcrf.com](http://www.pcrf.com)


