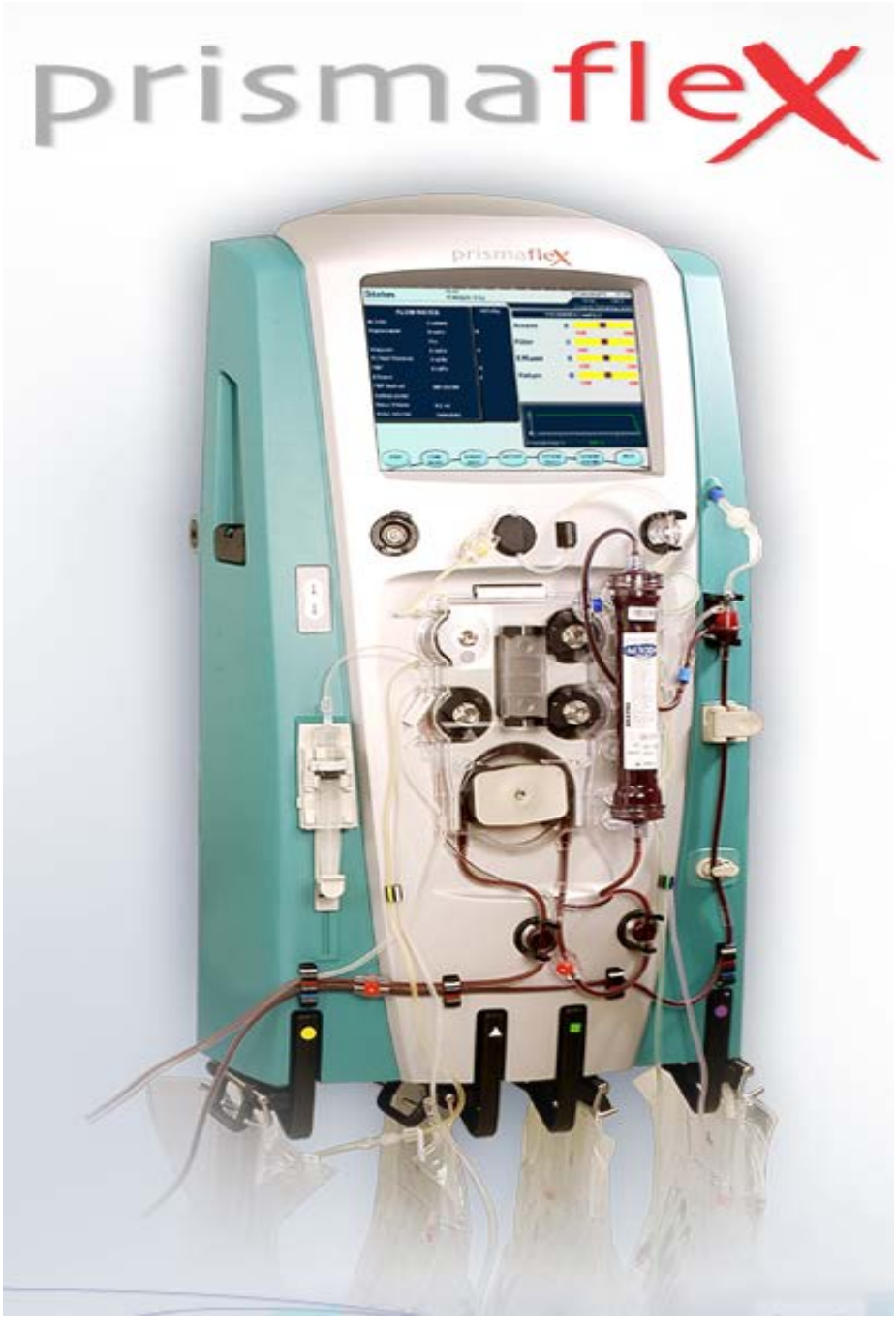
Less than 50kgs

PICU

Continuous Renal Replacement Therapy

Clinical Guideline



Update 08/18. BM/JF

WELCOME TO THE WORLD OF CONTINUOUS RENAL REPLACEMENT THERAPY (CRRT).

Background

In PICU we have been using continuous renal replacement therapy (CRRT) since 1993. Our total numbers of CRRT remain low when compared against the adult world. This is an average of 15 patients per year.

Our primary mode of filtration within PICU is Continuous Veno-Venous Haemofiltration (CVVH).

Anticoagulation prevents the blood clotting in the extracorporeal circuit.
Our standard method of anticoagulation is regional citrate anticoagulation. Citrate prolongs circuit life and causes less bleeding when compared with heparin. However, in some cases, the use of citrate is contraindicated and in this case, heparin or no anticoagulation will be used.

Rationale

The concept behind CRRT is to mimic the renal function of patients in a physiologic continuous way. Intensive care patients are particularly suited to this technique as when acutely unwell, they can be intolerant of the fluid swings associated with intermittent haemodialysis (IHD).
Common rationales for CRRT are:

- Renal Failure with
    - Fluid overload
    - Hyperkalaemia
    - Acidemia
- Removal of Toxins
    - Drug toxicity (non-plasma bound)
    - Inborn errors of metabolism

  Advantages:
    - Well tolerated cardiovascularly
    - Fine control over fluid and electrolyte shifts
    - Effective urea clearance and controlled fluid removal.
    - Creates room for essential fluids such as blood products and nutrition.

CONTENTS

These guidelines can be accessed on:

L:\Groups\STARSHIP\Utilisation\PICU\Renal\Staff Guides\Protocols and flow charts

CATHETERS		
Maximum blood flow rate achievable will vary with catheter size & machine. Approximate ranges for the different catheters are:		
7F	20-80mls/min	Use for up to 11kg
9F	50-120mls/min	Use for 11-29kg
11.5F	90-250mls/min	Use for 30kg+

VasCath counts as a CVL

A CLAB insertion form is required and the 'Daily Maintenance' form needs to be completed.

CIRCUITS

HF20:	< 11 KG	(60 MLS IN THE CIRCUIT)
ST60:	11 – 29.9 KG	(93 MLS IN THE CIRCUIT)
ST100:	> 30 KG	(152 MLS IN THE CIRCUIT)

FLUIDS

(All fluids have a **maximum hang time of 24 hours**)

1. Prismocitrate **Citrate 18mmol/litre**
   - 5 litres
   - **Citrate** based buffer replacement solution
   - ALWAYS infuse pre-filter/ pre blood pump (PBP) (predilution)
   - **NOTE : Potassium 0mmol/L**

2. Gambro **Hemosol**
   - 5 litres
   - **Bicarbonate** based buffer replacement solution
   - **NOTE : Potassium 0mmol/L**

CITRATE ANTICOAGULATION FOR CRRT

Citrate acts by chelating calcium ions that are essential in the clotting cascade.

Citrate fluid must be added Pre-Filter - pre blood pump (PBP), to ensure that the filter and circuit are anti-coagulated.

Calcium circulates primarily either in a free form or bound to protein. The free form, termed ionized calcium (iCa2+), is the calcium component which participates in the coagulation cascade.
Citrate binds and forms a complex (chelate) with iCa2+, resulting in a decreased concentration of iCa2+ in the extracorporeal circuit. ICa2+ (coagulation factor IV), therefore loses its influence in the clotting cascade and coagulation within the set is interrupted.

Citrate also chelates magnesium. Therefore, a decrease in the magnesium concentration of the patient's serum is to be expected and will need supplementing.

A filter iCa2+ concentration of less than 0.5mmol/L is required for anticoagulation and is achieved by adding approximately 2-3 mmol/L of citrate.

To achieve optimal anticoagulation within the circuit using a citrate based PBP solution, a balance between circuit blood flow and PBP fluid flow rate is required. This ratio between citrate and blood flow remains reasonably fixed, allowing the prediction of what citrate dose (PBP flow rate) is needed for a particular blood flow rate.

A certain percentage (approx. 2-3mmol/kg/day) of the calcium-citrate complex in the blood is cleared by the filter and lost in the effulent. Most of the citrate returns to the patient and is metabolised rapidly by the liver, renal cortex and skeletal muscles producing bicarbonate and calcium.

Expect a continuously slightly elevated systemic plasma citrate level, which chelates calcium in the systemic circulation and leads to a low systemic ionised calcium level (despite normal total calcium). In order to avoid systemic ionised hypocalcaemia, a separate infusion of calcium is required and adjusted to maintain patient calcium levels at 0.9-1.2mmol/L. This ensures that only the circuit is anticoagulated.

Citrate is converted to bicarbonate: 1mmol of citrate will metabolise into 3mmol of bicarbonate and therefore influencing the patient's acid/base status and a degree of metabolic alkalosis.

If the complexes are not metabolised efficiently then the patient may develop an acidosis, due to lack of bicarbonate production and accumulation of citrate-calcium complexes which are acidic.

For more detailed citrate information please refer to the Gambro education pdf found at: L:\Groups\STARSHIP\Utilisation\PICU\Renal\StaffGuides\Citrate.pdf

Relative Contraindications

Absolute

Nil

Relative (Discuss with SMO/Fellow)

- Patients with severe hepatic failure and INR >3.5
- Patients with profound loss of hepatocyte mass
- Paracetamol hepatitis with gross elevation of AST, INR and with elevated lactate
- Hypoxic hepatitis with gross elevation of AST, INR and with elevated lactate
- Ethylene Glycol poisoning
- Clinical risk of bleeding considered too great for circuit anticoagulation
- Previous citrate accumulation ("Citrate Lock"), if organ dysfunction persists
- Additional citrate load e.g. on-going massive transfusion
- Patients with coagulopathy (ACT >200 sec, or APTT > twice normal) e.g. overwhelming sepsis.

Setting up the Circuit

Equipment

1 x Prismaflex
1 x weight appropriate circuit (see page 4)
2 x large bore 3-way taps
2 x smartsites (1x blue and 1x red)
2 x 1000ml 0.9% Sodium Chloride (priming and dialysis line)
1 x 5L bag Citrate fluid (PBP)
1 x 5L bag bicarbonate solution (Replacement line)
1 x posiflush and blind end cap (for priming syringe line)
1 x calcium gluconate infusion

Programming

- Filtration prescription by PICU Consultant/Fellow.
- Select mode "CVVHDF" and "no syringe" and run the calcium infusion on an external syringe driver.
- Enter the patient NHI as instructed.
- Enter the patients' weight as instructed.
- Enter the haematocrit as a % (i.e. 35%). Enter the latest reading from an ABG prior to initiation. **Update the patient haematocrit daily from the morning bloods**. To update while running press "system tools", then "modify settings", then "patient haematocrit".
- The pre-blood pump (PBP) or white line is the citrate administration line – this volume is dependent on the patients' weight.
- The replacement line or purple line runs the bicarbonate solution, Hemosol. Programme to **run post filter** (providing an air – blood barrier to reduce clotting in the deaeration chamber.). The volume is calculated depending on weight range.
- The dialysate line or green line is primed with 0.9% NaCl. It is always programmed as 0mls. This line is not currently used in any of our treatments.
- Under treatment settings, **increase the fluid/loss gain limit to maximum**. <u>This is highly sensitive alarm.</u> Knocking the machine may activate it and once activated, the machine will stop and it is not possible to re-start. These alarms cannot be changed once the Prismaflex is running.

Fluid Balance

Net fluid balance =

ALL ingoing fluid minus ALL outgoing fluid.

- The Prismaflex accounts for all machine fluids but not the patient IV and enteral fluids & drugs.
- Therefore, to achieve the fluid balance target:
    - Add up all fluids including infusions, feed, bolus medications, and flushes for 24hours.
    - This total **plus** the 'Target patient 24hr fluid balance' **divided** by 24 (hours in a day) =
    - Fluid removal rate (ml/h). This is the number you titrate to pull off more or less fluid each hour as required.

Electrolyte Additives

Additives can be added to both the Citrate and Hemosol 5L bags to achieve the required concentrations of potassium, phosphate and sodium.

Potassium is routinely added to maintain serum potassium of 4mmol/L.

Achieve this by adding either KCL or KH_2PO_4 to each 5 litre bag to achieve a concentration of 20mmol in a 5l bag (or as per patient's needs).

The PICU consultant/fellow will prescribe additives on the 'hemofiltration prescription and record form'.

Prior to connecting

Baseline bloods – ABG, FBC, U+E, LFT, Mg+, Phosphate, and Total Calcium.
Patient ionised calcium and magnesium levels normal?

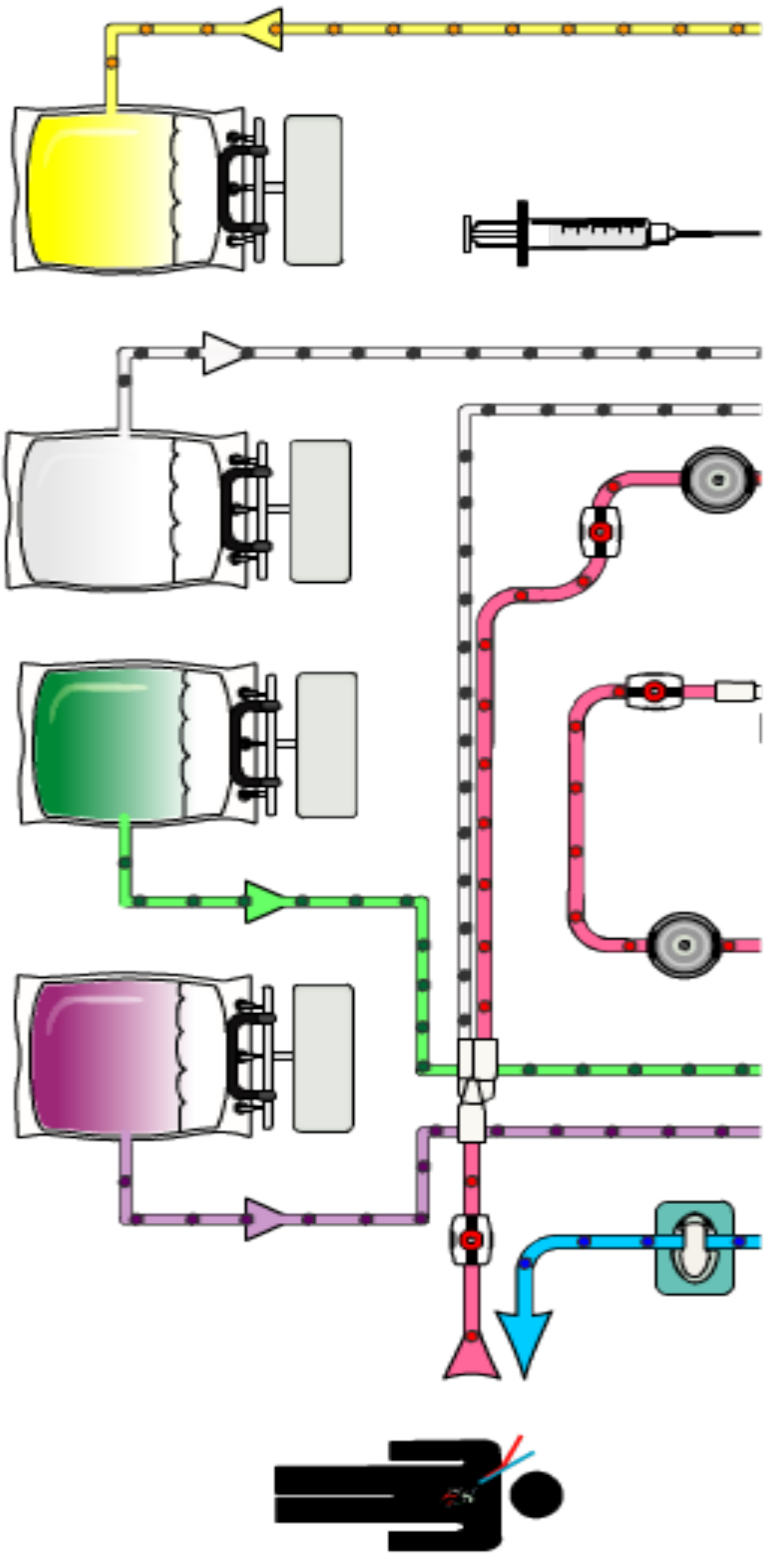
Citrate CVVHDF now delivering CVVH

EFFLUENT BAG

PRE BLOOD PUMP BAG
CITRATE

DIALYSATE BAG
0.9% SALINE

REPLACEMENT BAG
POST FILTER
HEMOSOL



PERFORMING CVVH with CITRATE ANTICOAGULATION

Less than 50kg

Step 1

Initial Blood and Fluid Flow rates

Use Table 1 to determine the initial blood, fluid and Calcium Gluconate infusion flow rates (as per prescription and weight). For citrate anticoagulation to be effective, the PBP flow rate matched to the blood flow rate.

Table 1:

PBP/citrate flow rate	27ml/kg/hr	37ml/kg/hr	44ml/kg/hr
Replacement/ bicarbonate flow rate	30% of PBP rate	30%of PBP rate	30% of PBP rate
Blood flow rate	4ml/kg/min	5ml/kg/min	6 ml/kg/min
10% Ca Gluconate infusion rate	0.3 ml/kg/hr	0.36 ml/kg/hr	0.42 ml/kg/hr
Approximate clearances of urea/creatinine	40ml/kg/hr	50ml/kg/hr	60ml/kg/hr

- For effective solute clearance to occur the minimum PBP fluid rate is 27ml/kg/hr.

- The lowest set rate for the blood flow rate (BFR) is 20ml/min and must be maintained to prevent stasis and clotting.

Step 2

Calcium Gluconate Infusion

- Infuse undiluted via a CVL with the initial rate set according to the table 1. Only if desperate for access is the infusion to run via the return lumen to the patient.
- **Correct a patient's serum ionised calcium of < 1mmol/**L prior to commencing hemofiltration – administer a bolus of 10% calcium gluconate 0.5mls/kg over 30 minutes.
- Calcium Gluconate 10% contains 0.22mmol Calcium/ml.
- For a child already on a Calcium Gluconate infusion you may utilise the existing infusion – increasing the rate to the calculated initial rate if needed.
- The Calcium Gluconate infusion is to be commenced at the appropriate rate **within 15 minutes** of commencing filtration.

Step 3

Monitoring and Adjusting the Circuit (Post-Filter) Ionised Calcium.

- Filter ionised calcium measures anticoagulation of the circuit to ensure the citrate dose is providing optimal regional anticoagulation.
- Samples are taken with an ABG syringe, from the **blue sample port** post-filter. This is a VENOUS sample.
- Note 'filter' sample when analysed through the gas machine.
- **Measured 1hour after starting treatment, or when changes made as per flowchart. Otherwise 6 hourly as per flowchart (page 13).**

Adequate circuit anticoagulation:

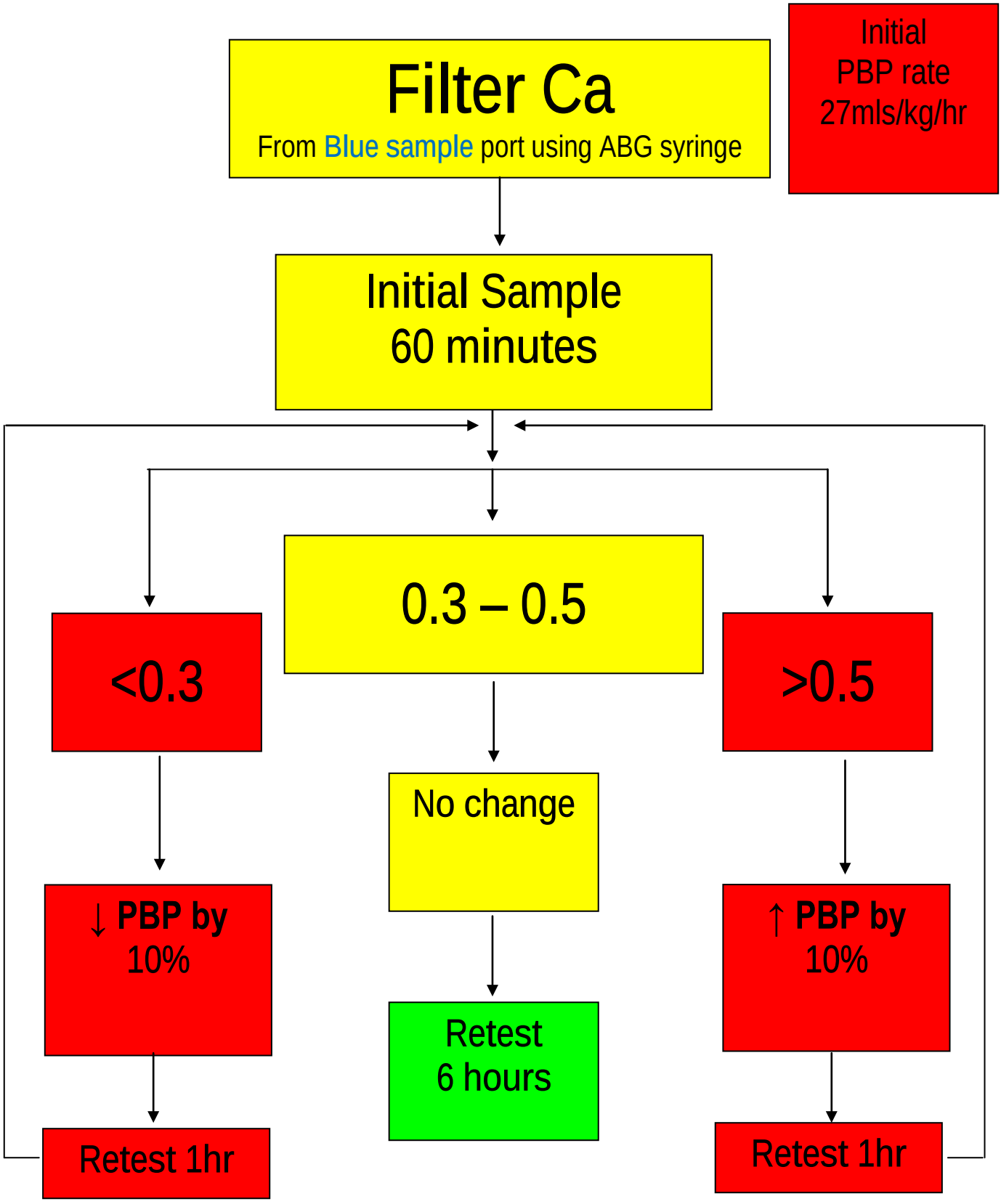
- Circuit ionised calcium level of 0.3 and 0.5mmol/L confirms adequate chelation.
- Adjust the citrate PBP flow rate, without adjusting the blood flow rate if the level is outside of range, refer to flowchart.
- A level < 0.3 mmol/L, may be an indication of excessive citrate administration. Check for signs of systemic citrate accumulation. Inform Consultant/Fellow.
- A level > 0.5 mmol/L indicates inadequate citrate administration. Increase citrate infusion rate as per flowchart. Inform Consultant/Fellow.

Please note that values just outside this range may not necessitate a change in Citrate flow.

Consider the patient's ionised serum levels, blood flow and that clearance is adequate.

Please do not chase the filter calcium if the patient and circuit are stable but do discuss with the Consultant/Fellow.

< 50kg


Filter Ca
From Blue sample port using ABG syringe
Initial
PBP rate
27mls/kg/hr
Initial Sample
60 minutes
<0.3
0.3 – 0.5
>0.5
No change
↓ PBP by
10%
↑ PBP by
10%
Retest
6 hours
Retest 1hr
Retest 1hr

Step 4

Monitoring and Adjusting the Systemic (Patient) Ionised Calcium

Arterial or Venous blood gas.

Perform hourly until stable.

Ionised calcium must be kept in the range 1.0-1.2mmol/L.

Adjust the Calcium Gluconate infusion according to flowchart (page 15). Sequential adjustments may be needed.

Do **not** make adjustments for magnesium levels.

Total Serum Calcium - check 12 hourly

- (more frequently if > two sequential increases in calcium/magnesium infusion rate have been required, or if a metabolic acidosis with rising anion gap occurs).

Record both the circuit ionised calcium and the patient's ionised calcium on the haemofiltration prescription and record sheet.

If calcium gluconate infusion is >20ml/hr to maintain serum levels, converting to a Mixed Protocol may need to be considered. **This is consultant/fellow lead.**

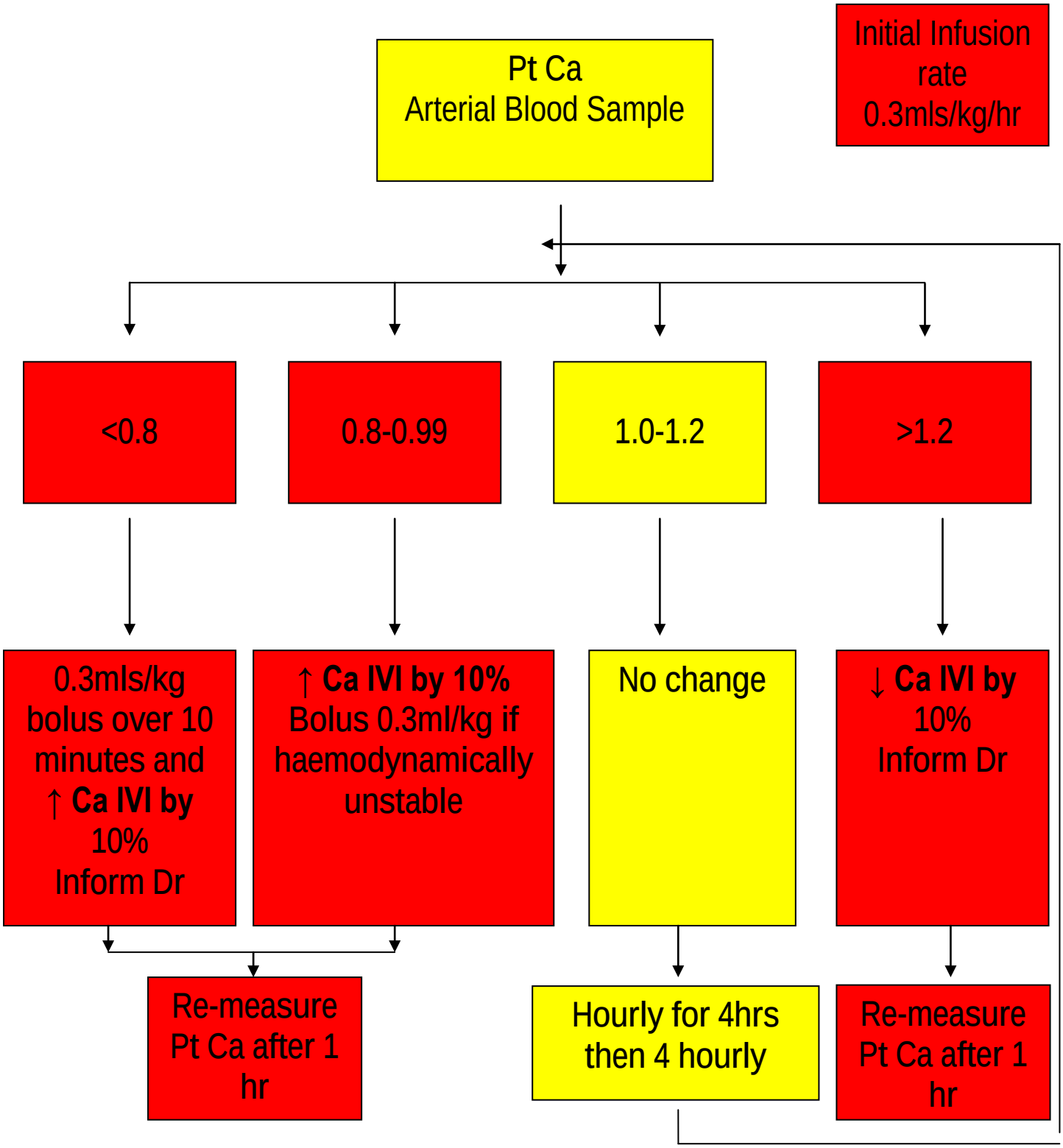
Clinical features of hypocalcaemia:

- Confusion, arrhythmia, tetany, hypotension and paraesthesia.

Clinical features of hypercalcaemia:

- Hallucinations and arrhythmia.

< 50kg


Pt Ca
Arterial Blood Sample
Initial Infusion rate 0.3mls/kg/hr
<0.8
0.8-0.99
1.0-1.2
>1.2
0.3mls/kg bolus over 10 minutes and ↑ Ca IVI by 10% Inform Dr
↑ Ca IVI by 10% Bolus 0.3ml/kg if haemodynamically unstable
No change
↓ Ca IVI by 10% Inform Dr
Re-measure Pt Ca after 1 hr
Hourly for 4hrs then 4 hourly
Re-measure Pt Ca after 1 hr

Step 5

Magnesium Replacement

- **Normalise prior to starting this treatment (>0.7mmol/L).**
  Give a undiluted bolus if necessary (0.2mmol/kg $MgSO_4$ IV over 60 min)
- Ensure plasma magnesium level is checked 12 hourly and kept over 0.7mmol/L.
- Magnesium may require 0.2mmol/kg, BD/TDS top-ups and should be prescribed on medication chart.
- If necessary, top-up via a CVC or into the venous return limb of the circuit.

Step 6

Changing the clearance (filtrate rate) – Consultant decision.

To improve clearance, the replacement (bicarbonate) flow rate is increased. By increasing just the replacement rate (rather than the citrate and blood flow rates together), means that calcium monitoring and replacement will be unchanged. .

Step 7

Other monitoring

Citrate is completely metabolised in most patients with normal liver function.

The following Biochemistry requires immediate attention - Inform medical team.

- Ca^{++} < 0.8mmol/L or >1.5mmol/L
- Total serum Ca > 3mmol/L
- Na^+ < 130mmol/L or Na^+ > 150mmol/L
- HCO_3^- > 35mmol/L
- pH < 7.25 or pH > 7.5
- Base Excess < - 5
- Patient Anion Gap > 8mmol/L [$Na-(HCO_3 + Cl)$]
- Plasma magnesium > 0.7mmol/L

Citrate Lock

Citrate accumulation (citrate lock) is evidenced by a **rising anion gap**, and an **increasing calcium ratio** (**rising total calcium but falling ionised calcium)** despite increasing the calcium infusion.

Patients most at risk are those who have poor liver function, those receiving large amounts of blood products (as they can contain citrate) and shock (possible decreased metabolism via muscles).

Acidosis may develop as the calcium-citrate complexes are not metabolised (due to falling bicarbonate, an increasing anion gap, and a decreasing base excess). Usually expect citrate to cause a circuit anion gap of +5-7mmol/L than the patient's anion gap.

Citrate delivery needs to be decreased.

- But maintain not less than 27ml/kg/hr of PBP rate.

- Consider a mixed protocol – see pages 17/18 – a proportion of citrate will be replaced with Hemosol.

Total Calcium: Ionised calcium ratio
Detects citrate accumulation and potential toxicity.
Ratio calculates the total vs. ionised ratio.
If ratio is >2.5 it implies accumulation of citrate with risk of the associated toxicity.

If the ratio remains >2.5

1. Change to a mixed protocol
2. Stop citrate and use alternative anticoagulant/no anticoagulant.

Ratio Total Calcium ÷ Ionised Calcium	Action
< 2.5	No change
>2.5	Risk of citrate accumulation CONSIDER decreasing dose of citrate as per flowchart Seek Consultant / Fellow / CCN support

After reducing the citrate dose, check post-filter calcium after 30minutes.

Acid Base: The pH is the first parameter to detect acidosis or alkalosis and the use of citrate can cause changes in the pH in either direction. Monitor at least 4 hourly.

Alkalosis: Some patients with normal liver function may become alkalotic due to overproduction of bicarbonate from the citrate load.

Electrolyte and other bloods:

Magnesium Q12h
Sodium Q6-12h
Total Calcium 12 hourly (more frequent if > two sequential increases in calcium gluconate infusion rate have been required or a concern with citrate lock).
ABG/VBG Q4-6h
FBC, U+E, LFT, Coags Q12-24h

Mixed Protocol

Consultant lead

1. Calculate 65% of the PBP rate currently running
2. Give this calculated rate on **both** the PBP and Replacement pumps as the flow rate
3. This equates to a 50/50 mix
4. Patient calcium as per flowchart page 15.

If completely stopping Citrate

Cease the Calcium Gluconate infusion immediately after ceasing ALL citrate fluid. Recheck total and ionised Calcium and Magnesium at 1 hour and 6 hours post cessation.

Change Hemosol to the PBP pump and change to heparin anticoagulation and guideline (page 20).

HEPARIN ANTICOAGULATION FOR CRRT

Setting up the Circuit

1 x Prismaflex
1 x weight appropriate circuit
2 x large bore 3-way taps
2 x smartsites (1x blue and 1x red)
2 x 1000ml 0.9% Sodium Chloride (priming and dialysate line)
2 x 5L bags Hemosol bicarbonate fluid (PBP and replacement line)
1 x 10ml posiflush and blind end cap (for priming syringe line)

Heparin infusion in 50ml BD Precise syringe

- <30kg = 500u X weight (1ml = 10u/kg/hr)
- >30kg = 200u X weight (1ml = 4u/kg/hr)

ACT machine & LR cartridges

Programming

- Filtration prescription by PICU Consultant/Fellow.
- Select mode "CVVHDF" and "no syringe" and run heparin infusion on an external syringe driver.
- Enter the patient NHI as instructed.
- Enter the patient weight as instructed.
- Enter the haematocrit as a percentage (i.e. 35%). Enter the latest reading from an ABG prior to initiation. **Update the patient haematocrit daily from the morning bloods.** To update while running press "system tools", then "modify settings", then "patient haematocrit".
- The pre-blood pump (PBP) or white line is bicarbonate Hemosol solution – this volume is dependent on the patients' weight.
- The replacement line or purple line also runs bicarbonate solution (Hemosol). Programme to **run post filter** (providing an air-blood barrier to reduce clotting in the deaeration chamber). The volume is calculated depending on weight range.
- The dialysate line or green line is primed with 0.9% NaCL. It is always programmed as 0mls. This line is not currently used in any of our treatments.

- Under treatment settings**, increase the fluid/loss gain limit to maximum**. This is highly sensitive alarm. Knocking the machine may activate it and once activated, the machine will stop and it is not possible to re-start. These alarms cannot be changed once the Prismaflex is running.
- Once connected the BFR is increased to run as fast as is tolerated by the patient up to 5ml/kg. This is determined by the patient's haemodynamic status and the circuit pressures.

Fluid Balance & Electrolyte Additives – Refer to Page 8

Prior to connecting

Baseline bloods – ABG, FBC, U+E, and Coags.

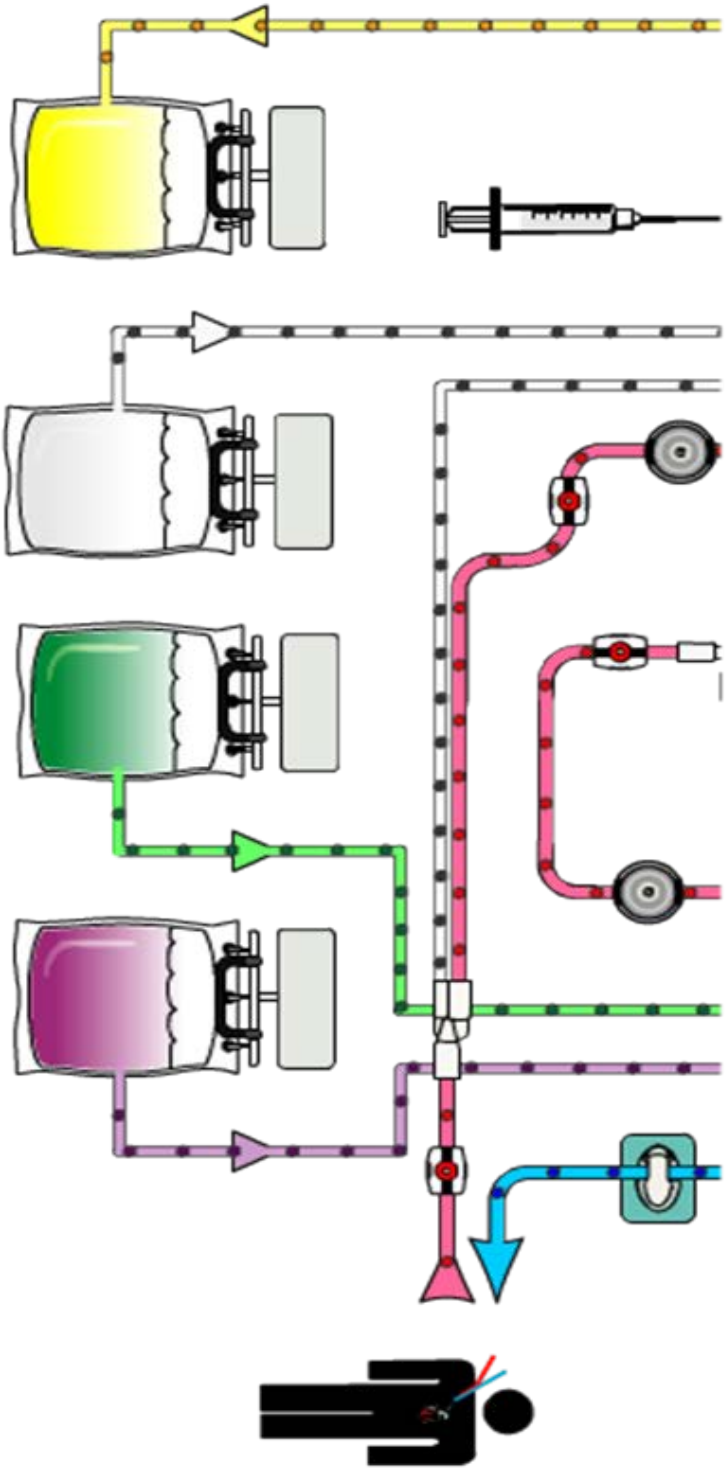
Heparin CVVH now delivering CVVHDH

EFFLUENT BAG

PRE BLOOD PUMP BAG
HEMOSOL

DIALYSATE BAG
0.9% SALINE

REPLACEMENT BAG
POST FILTER
HEMOSOL



PERFORMING CVVH with HEPARIN

ANTICOAGULATION

Less than 50kg

Step 1

Initial Blood and Fluid Flow rates

Use Table 2 and prescription to determine initial blood, fluid and Heparin infusion rate.

Table 2:

Blood flow rate (BFR)	Pre-blood pump (PBP) (Hemosol)	Replacement (Hemosol)	Heparin infusion
5mls/kg/min	27-80 ml/kg/hr	30% of PBP	10unit/kg/hr

Step 2

Heparin infusion protocol

Make up a Heparin infusion to 50mls total volume in a 50ml syringe.

- **< 30kgs 1ml = 10u / kg / hr**

  Add Heparin 500 IU x patient weight to 5% dextrose. Thus 1 ml/hr = 10iu/kg/hr

- **>30kgs 1ml = 4u / kg / hr**

  Add Heparin 200 IU x patient weight to 5% dextrose. Thus 1 ml/hr = 4iu/kg/hr

Use the guardrails profile “heparin treatment”.

Connect to the syringe line on the Prismaflex.

Start the heparin infusion at 10u/kg/hr as per Table 2.

Step 3

ACT monitoring

- Check ACT from **blue sample port** (post filter) at 30 minutes post commencement of the circuit.
- Make any changes necessary, as per table below.
- Recheck ACT 2 hourly after any change and until stable, then 4 hourly (as per table below)

ACT Range (sec)	Bolus (iu/kg)	Stop Infusion (min)	% Rate Change	Repeat Act
< 100	50	0	+ 15%	2 hours
100-120	30	0	+ 10%	2 hours
120-140	10	0	+ 10%	2 hours
140-160	0	0	0	4 hours
160-180	0	0	- 10%	2 hours
180-200	0	30	- 10%	2 hours
> 200	0	60	- 10%	2 hours

Consider limiting Heparin administration and boluses for patients with severe coagulopathies such as fulminant liver failure and severe sepsis.

Consider anti-coagulant free circuit.

For those patients with an absolute contraindication to Heparin in whom citrate cannot be used, an anticoagulant free circuit with the blood flow rate as high as is tolerated (by the circuit and patient) is an acceptable means of managing the filter.

Step 4

Anticoagulation monitoring

Monitor routine bloods - FBC and Coags. Report abnormal results.

Monitor for HITT - Large, isolated, falls in the platelet count. Inform Consultant/Fellow.

Blood products (e.g. FFP, Cryoprecipitate), can have variable effects on the ACT - recheck the ACT after they have been given.

CONNECTING

Required:

- Sterile gloves
- Dressing pack with sterile gauze and sterile guard/drape
- 2 x 10ml syringes
- 2 x 10ml posiflush
- 2% Chlorhexidine solution

If doing the bypass manoeuvre:

- 1 x adult unit red blood cells (RBC's)
- 2 - 4x 60 ml syringes
- 1x in-line blood-filter for drawing up blood.

Before attaching the circuit to the patient ensure that:

- Baseline bloods have been obtained: FBC, Coags, U&E's + ABG
- A PICU Consultant/Fellow is present
- Appropriate volume is present e.g. Red Blood Cells, 4% albumin
- Resuscitation sheet and drugs are available
- Continuous ECG, SaO_2, BP and core temperature monitoring are in place.
- The filtration order is prescribed.

GOING ON

- Use a sterile technique throughout.
- Clean the catheter hubs with the 2% Chlorhexidine solution and allow drying.
- Draw back Citralock volume locking lines.
- Check that both the access (red) and return (blue) lumens aspirate and flush freely. Use separate 10ml syringes and posiflush.
- Check that large bore 3-way taps are in situ on each lumen.
- READ THE SCREEN and follow the clear instructions on the Prismaflex.

- The circuit access (red) line connects to the 3-way tap (no smartsite) on the red lumen of the catheter. The circuits return (blue) line connects to the 3-way tap (no smartsite) of the blue lumen of the catheter. Ensure secure, bubble-free connections.
- Recheck the circuit for air bubbles, loose connections, cracks or deformities.
- Open **all** clamps on the blood path of the Prismaflex circuit.
- Start the blood pump slowly, watching for any sign of catheter obstruction or flow impedance.
- Increase the blood pump speed until the circuit is thoroughly filled with the patient's blood. Ensure all rates are up to the prescribed rate and that that the patient remains haemodynamically stable.
- The circuit should be fully running within 15 minutes of connection.
- Commence calcium gluconate or heparin infusion (within 15 min).
- Start monitoring as per protocols.

Bypass Manoeuvre

This is done when connecting any circuit onto a patient who weighs less than 11kg or is haemodynamically unstable. **Ensure the consultant is present**

- Draw up 2 - 4x 60 ml syringes of RBC's via a blood filter.
- Attach the blood syringe
    - to the side port of the 3-way tap smartsite on the return (blue) lumen of the vascath.
- Attach the access (red) line
    - To the 3-way tap end (no smartsite) on the access (red) lumen of the vascath. Open the tap.
- Attach the return (blue) line
    - To the saline prime bag.
- Start the Prismaflex. You should see blood sucking through the access (red) line.
- Simultaneously push RBC's into the patient as per the blood pressure **(this is a good job for the Consultant/Fellow).**
- Gradually increase the blood pump speed.
- When the patients' blood is just leaving the filter, disconnect the return (blue) line from the saline bag and attach to the 3-way tap end (no smartsite) on the blue lumen of the vas-cath.
- The RBC's administered need to be documented.
- Commence calcium infusion (within 15 min) or heparin infusion
- Start monitoring as per protocols

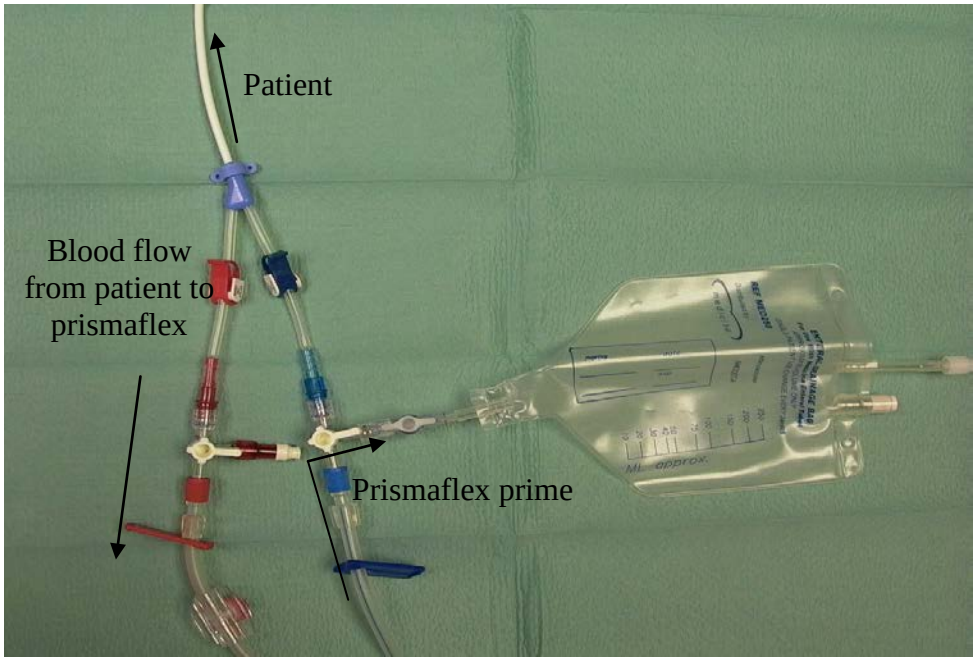
Bypass Manoeuvre using an enteral bag

(Some consultants may prefer this but we routinely use technique described previously).

Additional equipment:

Enteral drainage bag (250ml)

- Draw up 2-4x 60 ml syringes of RBC's via a blood filter.
- Attach the blood syringe to additional vascular access, not the 3-way tap on the vas-cath.
- Attach the enteral bag onto the side port of the 3-way tap (no smartsite) connected to the return (blue) lumen of the vas-cath. Turn tap off to patient
- Attach the return (blue) line to the 3-way tap end (no smartsite) on the blue lumen of the vas-cath.
- Attach the access line to the 3-way tap end (no smartsite) on the red lumen of the vascath and open the tap.



- Start the Prismaflex. You should see blood sucking through the access (red) line and saline prime entering the enteral bag.

- Push RBC's into the patient as per the blood pressure **(this is a good job for the Consultant/Fellow).**
- Gradually increase the blood pump speed.
- When the patients' blood is nearing the vascath turn the 3-way tap on the return line, off to the enteral bag and open to the patient. Remove and discard enteral bag, place blue smartsite on open port.
- The RBC's administered need to be documented.
- Commence calcium infusion (within 15 min) or heparin infusion
- Start monitoring as per protocols

Under no circumstances should two three-way taps be placed on the return line.

DISCONNECTING CRRT CIRCUIT

This procedure reflects a planned disconnection from the patient and circuit.

1. Inform medical staff.
2. If patient **to go back on filter press CHANGE SET -** this will keep all the stored history. If treatment being **discontinued press END TREATMENT**. Then select 'Disconnect'.
3. READ THE SCREEN and follow the clear instructions on Prismaflex.
4. Clamp all lines.
5. Turn the 3-way taps on vascath OFF to the patient.
6. Using an *aseptic non-touch technique*, swab the access and return ends of the circuit with 2% Chlorhexidine. Disconnect, including the 3-way taps.
7. Flush each lumen with 0.9% Sodium Chloride.
8. Citralock each lumen with the volume stipulated on the individual catheters. Clearly document each lumen with the drug, volume, date and time with a red medication label.
9. Cap each lumen with a sterile 'blind end luer lock' (Combi lock).
10. Ensure the Citralock used for the locking is prescribed in the medication chart.
11. Stop any circuit related infusions e.g. Calcium, Heparin.

RETURNING CIRCUIT VOLUME

The circuit volume is not routinely returned to the patient.

This is a Consultant/Fellow decision and only possible if the circuit **has not clotted**. DO NOT return blood if clotting is seen in filter or lines.

- If patient **to go back on filter press CHANGE SET -** this will keep all the stored history. If treatment being **discontinued press END TREATMENT**. Then select 'Return Blood'.
- Hang a bag of 0.9% sterile saline on the priming hook.
- Clamp access (red) line and disconnect from patient.
- Connect access line to saline, unclamp access line and press continue.
- Press manual return (not auto) and hold finger on button.
    - The screen will show how many mls the set contains.
    - An indicator of blood mls returned will count up on screen.
    - The rate of return is pre-programmed.
- You will not be able to return all the patients' blood. Aim to return approx. 2/3 of circuit volume.
- This volume must be documented on flowchart as it is additional.
- Once desired amount is returned, press continue and then disconnect.
- Disconnect as per page 31.

POTENTIAL COMPLICATIONS OF CRRT

Hypovolaemia

- Have volume readily available for emergencies.
- Monitor haemodynamic's continuously.

Fluid Overload

- Ensure rates are running as prescribed.
- Observe for signs of pulmonary oedema.

Hypothermia

As the CRRT circuits are extra-corporeal, a fall in temperature is expected.

- Continuously monitor core temperature.
- Use the 'hot dog' warmer, this can be used up to its max setting of 43^{o}C.
- Use the Bair Hugger to warm the patient if core temperature is less than 36.C.

Infection

- Avoid contamination of the exposed ends of the circuit when setting up and priming.
- Avoid breaking the circuit wherever possible.
- Manage and redress vascath as per CVL RBP with CLAB dressings. Record on the equipment chart. Maintain CLAB maintenance cares.
- Observe cannulation site for inflammation.
- Inform medical staff if patient becomes febrile.

DOCUMENTATION

- Haemofiltration Prescription and Record form run for 24hrs from 0800-0700.
- All orders and modifications are to be **prescribed daily by Fellow or Consultant**.
- Safety checks to be completed and singed off at beginning of shift.
- Fluid bag changes to be documented and co-signed.
- Document hourly
  - The delivered blood flow, PBP, replacement fluid, fluid removal rate and hourly/total fluid removal.
  - The access, return, filter and TMP pressures.
  - The heparin or calcium / magnesium infusion rate in mls/hr hourly
- Only the hourly/total fluid removal (ml/hr) is transcribed to the PICU 24hr Flowchart.
- Document relevant monitoring bloods (serum Ca++, ACT, Filter Ca++, Total Ca+).
- Remember to complete a CLAB form every shift for the vas-cath.
- Enter the haematocrit every day with morning bloods (see page 7).
- Include a 'CVVH' shift summary in the clinical notes.

ECMO AND CVVH

Placement of the renal circuit is imperative to the success of maintaining both circuits to reduce recirculation of blood, lysis and promote adequate flow.

Post pump head
Access and return lines are all placed post pump head to eliminate air being sucked into the ECMO circuit at any point. NOTE there are no smartsite ports, these will impede blood flow

Pre oxygenator
Ideally access and venous lines are placed pre oxygenator to ensure all blood flow passes across the oxygenator and that there is not a shunt fraction around the oxygenator (i.e. if blood is removed pre oxygenator and returned post oxygenator this blood will not be oxygenated).

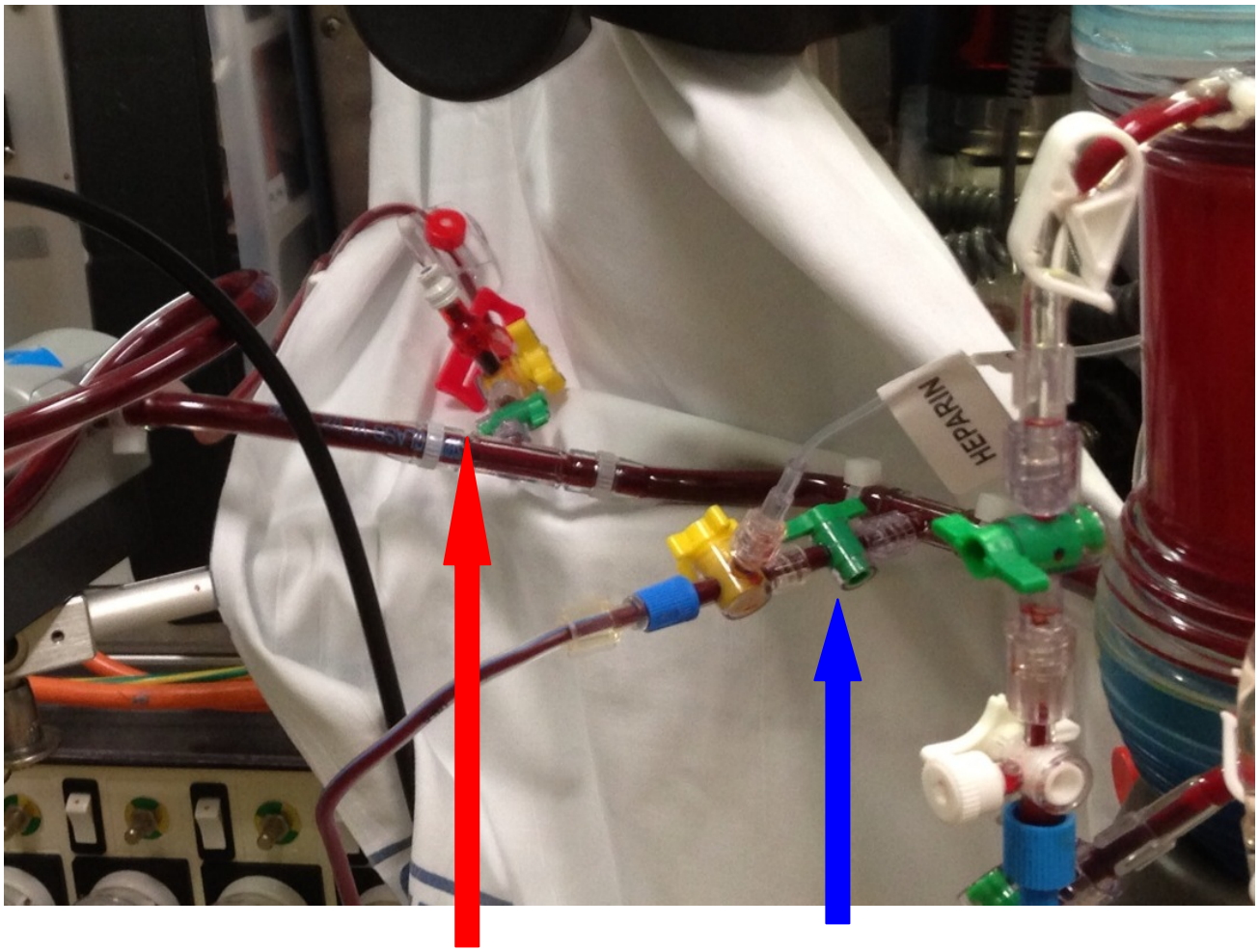
Sampling port
This is where the haemofilter is connected via a wide bore tap to remove blood from the ECMO circuit – RED line. This is a positive pressure tap. The port is located between the pump head and oxygenator. This is a standard port.

Heparin administration port
This is where the blood is returned to the ECMO circuit – BLUE line. This is a positive pressure tap.
The placement of the heparin administration port may vary between circuits and oxygenators.
There may be a second port pre oxygenator – if so use this port.
Each oxygenator has at least one pre oxygenator port on the inflow.

The CRRT circuit will be running as BICARBONATE ONLY – Hemosol on both PBP and Replacement lines.

The CRRT circuit is heparinised as part of the ECMO circuit.

The ECMO nurse specialist manages the heparin.



Red / Access line Blue / Return line

The heparin infusion runs on the side port of the wide bore tap connected to the return line POST HAEMOFILTER.

RESOURCES

On the L drive you can access:

L:\Groups\STARSHIP\Utilisation\PICU\Renal\StaffGuides

This folder has lots of good Gambro tutorials such as:
Acid base
Anticoagulation
ARF
CRRT
Citrate

Check out the **Baxter Education Portal – this is an online simulator training website.**

https://portal.baxter.semcon.com/content/education-evaluation-4555.html
Login and Password: Starship-Auckland-01.