

Before starting treatment:

- Check the blood results before the start of treatment to include:
- Total calcium (NOT the corrected calcium value), magnesium and potassium levels.
- Ensure a recent arterial blood gas includes documentation of the patient's ionised calcium.
- If ionised calcium (i.e. ABG) level is < 1.0mmol/L: administer 10mmol in 10ml of 10% calcium chloride via central venous access and as prescribed on the drug kardex. Then check ionised calcium level 1 hour after starting treatment as per protocol.
- If the bicarbonate level is low: correct with replacement e.g. 100mls of 8.4% sodium bicarbonate administered once only via central venous access and as prescribed on drug kardex. An alternative concentration of sodium bicarbonate may be prescribed as a continuous infusion at the discretion of the ICU Consultant.

Equipment needed:

- Prismaflex ST150
- CA250 calcium infusion administration set: no need to prime as machine does during priming procedure. The calcium administration set is changed every 72hrs.
- A 50ml BD Plastipak syringe is used for drawing up the calcium infusion. Prior to drawing up the calcium, **plunge the 50ml syringe several times** to release 'resistance pockets'.
- 50ml leur-lock syringe containing 30mmol in 30ml calcium chloride diluted to a total volume of 50ml using 0.9% sodium chloride providing a final concentration of 0.6mmol/ml.
- 5 litre bag Prismocitrate 18/0 on white scale(citrate is used as pre-dilution)
- 5 litre bag Prism0cal B22 on green scale (dialysate)
- 5 litre bag Phoxilium on purple scale (post dilution) – contains 1.25mmol/L of calcium
- 0.9% sodium chloride : a total of 2 litres is needed to prime the ST150 circuit.
- A blue or orange needle is used for obtaining blood samples from the ST150 sampling sites.

Setting up and priming the circuit:

- Choose CVVHDF.
- Choose citrate – calcium via prismaflex syringe pump.
- Follow the installation steps on the display screen.
- Install Prismocitrate 18/0 on the white scale i.e. pre-blood pump scale (PBP)
- Install Prism0cal B22 on the green scale i.e. dialysate scale.
- Install Phoxilium on the purple scale i.e. replacement scale.
- Prime the circuit with 2 litres of 0.9% sodium chloride – heparin is not required.
- Install the 50ml leur-lock syringe containing the diluted calcium chloride into the prismaflex syringe pump.

Vascular Access:

- A high flow venous catheter is used in either of the following sizes: 15cm, 20cm, 25cm.
- The appropriate size should be selected for the anatomical area and right/left side placement.
- Following insertion, and whilst sterility is maintained the vascath should be tested by withdrawing 20ml of blood from the red lumen over 6 seconds. If blood withdrawal takes longer than 6 seconds, the vascath should be manipulated or resited. This ensures adequate flow rates before connecting to the haemofiltration machine.

Connecting the treatment lines:

1. Clamp both ports on the priming y-connector. **Refer to the diagram on page 3.**
2. Ensure the access line is clamped before removing it from the y-connector.
3. Connect the access line (red) to the corresponding red vascath port.
4. Ensure the return line is clamped before removing it from the effluent drainage bag.
5. Connect the return line (blue) to one of the y-connector ports.
6. Connect effluent line to the effluent bag.
7. Next connect they-connector (already containing the blue return line and calcium CA250 line) to the corresponding blue vascath port.
8. Now connect the return line (blue) with its y-connector to the corresponding blue vascath port.
9. Tape both the y-connector ports together i.e. calcium and return. This ensures that the calcium and return line will always stay together in the event that treatment lines need to be swapped.
10. Press continue → Unclamp all lines.

Starting treatment:

- Start blood pump speed at 100ml/min: this will enable assessment of operating pressures.
- If operating pressures are not ideal at 100ml/min: stop treatment, clamp all lines & swap treatment lines. **Ensure that the calcium and the return lines are both taped together as per image on page 3.**
- As soon as blood flow at 100ml/min is achieved, refer to the flow rates on the table below and commence treatment as per patient's bodyweight.
- **Working example** for gentle increment of parameters for patient bodyweight of 70kg: start dialysate gently at 600mls and start replacement at 500mls. Assess at 20 to 30 seconds and then increase dialysate further to 1200mls. Finally increase blood pump speed to 120ml/min. Gentle increment should be done on all new patients and especially in patients that are haemodynamically unstable.
- Initiate patient fluid removal as required. The actual treatment dose is effluent minus 15% downtime.

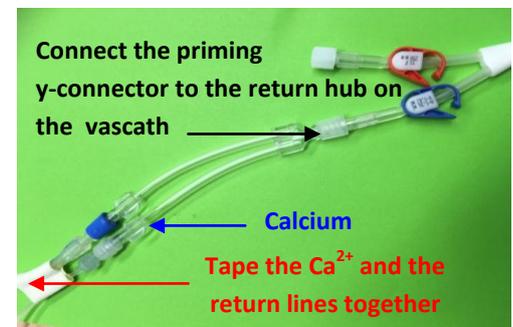
Mode: CVVHDF - Starting citrate dose is 3.0mmol/L blood - Starting calcium compensation is 100%				
Weight (kg)	Blood pump speed (ml/min)	Dialysate (ml/hr)	Replacement post-filter (ml/hr)	Actual treatment dose obtained
50	100	1000	200	37ml/kg/hr
60	110	1100	400	37ml/kg/hr
70	120	1200	500	35ml/kg/hr
80	130	1300	500	33ml/kg/hr
90	140	1400	500	31ml/kg/hr
100	150	1500	600	31ml/kg/hr
110	160	1600	700	30ml/kg/hr
120	170	1700	800	30ml/kg/hr
130	180	1800	1000	30ml/kg/hr

Troubleshooting treatment:

1. The **fluid on the dialysate (green) scale must never** be changed or discontinued: this scale should **always have PrismOcal** on it. The rate of infusion can be changed as per guidelines.
2. If **hyperkalaemia or increasing acidosis** is a concern, then this may be managed by **increasing to a higher weight** range e.g. if 80kg – pump speed 130ml, dialysate 1300ml and replacement 500ml, suggest increasing parameters to at least **2 or 3 weight ranges up** to increase clearance. So parameters for 100kg would apply i.e. pump speed 150ml, dialysate 1500ml and replacement rate 600ml/hr.
3. If **increasing alkalosis** is a concern, then this may be managed by **decreasing to a lower weight** range e.g. if 80kg – pump speed 130ml, dialysate 1300ml and replacement 500ml, suggest decreasing parameters to at least 2 or 3 weight ranges down to reduce clearance. So parameters for 60kg would apply i.e. pump speed 110, dialysate 1100 and replacement 400ml.
4. Alternative treatment should be considered if (i) citrate accumulation cannot be resolved as per page 5 instructions or (ii) the patient develops a metabolic acidosis as a result of changes made to resolve an accumulation and the acidosis cannot be resolved.
5. Remember: **any** changes to **any** of the parameters means that hourly measurement of both total and ionised calcium will need to be recommenced until stable for 2 hours i.e. the results are in the normal ideal values range for at least 2 hours.

Treatment monitoring is made up of four components:

1. Ionised calcium: post filter and patient.
2. Total calcium/ionised calcium patient ratio.
3. pH, acid-base balance.
4. U+E's and other daily blood checks obtained at 0600hrs.



Ionised calcium – post filter and patient:

- Once treatment is initiated and blood flow has been established, at **60 minutes** obtain two separate blood samples so that the ionised calcium can be checked. The first sample is taken from the patient's arterial line and the second sample is taken from the blue port on the filter.
- Using a blood gas syringe obtain the first sample from the patient's arterial line – apply **red ART sticker** to identify syringe.
- Using a blood gas syringe and either a **blue or orange** needle, obtain the second sample from the blue sampling port (positioned anteriorly) on the ST150 and clean the sample site with an **alcohol wipe**.
- Check results for each and alter according to the Adjustment table on page 4.
- The above needs to be repeated at **1 hour and also** whenever the following are carried out:
 - After starting CRRT.
 - When the **citrate infusion rate** or **calcium infusion rate** has been changed.
 - When the blood pump speed and/or rate of any of the replacement bags has been changed
 - Or after recirculation.



Compare the results from each sample and refer to the adjustment table to guide treatment.

Continue to **measure hourly** until stable for **2 consecutive hours** – then check **every 6 hours**. Press **System Tools** to increase the interval period to 6 hours.

Treatment Adjustment Table

If there are any changes in citrate dose or calcium compensation % hourly checks need to be carried out

Compare results ↘	Filter Ca ²⁺ > 0.50	Filter Ca ²⁺ > 0.25 to 0.5	Filter Ca ²⁺ < 0.25
Patient (arterial) Ca ²⁺ < 1.0	Citrate dose increased by 0.5mmol/L blood. Calcium compensation is increased by 10%.	Calcium compensation increased by 10%	Citrate dose decreased by 0.5mmol/L blood
Patient (arterial) Ca ²⁺ 1.0 to 1.3	Citrate dose increased by 0.5mmol/L blood	Normal ideal values	Citrate dose decreased by 0.5mmol/L blood
Patient (arterial) Ca ²⁺ > 1.3	Calcium compensation decreased by 10%	Calcium compensation decreased by 10%	Calcium compensation decreased by 10% Citrate dose decreased by 0.5mmol/L blood

Consider the potential for citrate accumulation:

- **Increasing requirements for calcium compensation** could indicate citrate accumulation and in this context **the calcium ratio should be checked.**

Approximately half of the citrate calcium complexes are removed by dialysis from the blood. The remaining citrate is metabolised to form bicarbonate in the liver and in the muscles.

In **severe liver dysfunction** the metabolism of citrate may be compromised and **accumulation of citrate** can occur. Most of these patients also present with high lactate concentrations due to liver failure or poor perfusion.

The impaired citrate metabolism can result in **low systemic ionised calcium and increased total calcium** with an **increase in the total to ionised calcium ratio.**

Citrate accumulation should be considered in patients with persistent hypocalcaemia despite increase in calcium compensation. Signs that are indicative of accumulation are:

- Calcium compensation is > 150% (although calcium compensation may be increased to maximum of 200%)
- Total calcium < 3mmol/L in relation to high or increasing calcium ratio.
- Unexplained/unresolving metabolic acidosis in conjunction with a high lactate.

Diagnosis of citrate accumulation:

A calcium ratio greater than 2.5 is diagnostic of citrate accumulation.

The calcium ratio should be measured:

1. Initially **6 hours after starting** RRT.
2. Subsequently **once every 24** hours.
3. Every **12 hours** in liver failure.
4. One hour after making any changes to resolve an outstanding citrate accumulation.

How to measure the calcium ratio:

- A fresh sample needs to be sent to biochemistry → request total calcium level.
- At the same time as obtaining the blood sample for total calcium level, obtain an ABG sample and enter the ionised calcium level into the following formula.
- Once the total calcium level result is obtained from the lab, divide the patient's total calcium (or uncorrected calcium level) by the patient's ionised calcium.

$$\frac{\text{Total uncorrected calcium (lab)}}{\text{Patient's ionised calcium (ABG value)}} = \text{calcium ratio}$$

Calcium ratio value	Action
< 2.5 is normal	<ul style="list-style-type: none">- Check once daily- Liver failure patients: check twice daily.
> 2.5 For every change made, a new blood sample for total calcium will need to be sent to the lab.	<ul style="list-style-type: none">- Seek medical support.- Aim post filter calcium of 0.4 to 0.5mmol/L by reducing citrate dose in 0.2mmol/L increments until this range is achieved.- Repeat ionised calcium check and new total calcium sample at 1 hour. If ratio remains above 2.5 despite post filter calcium of 0.4 to 0.5mmol/L then consider:<ol style="list-style-type: none">1. Reducing blood pump speed by 20: this will reduce total administered citrate dose. Repeat calcium ratio at 1 hour i.e. ionised calcium check and new total calcium check.2. If the calcium ratio at 1 hour remains above 2.5, consider doubling the base line dialysate flow: this will increase citrate clearance.3. Repeat calcium ratio at 1 hour i.e. ionised calcium check and new total calcium check. If at 1 hour the calcium ratio remains above 2.5, consider stopping citrate and use an alternative anticoagulant or no anticoagulant.

Timing of calcium monitoring		
Calcium monitoring timing summary	Initially	And then
Post filter ionised calcium (blood sample in ABG syringe obtained from ST150 circuit) Target 0.25mmol to 0.50 mmol/L	Hourly for 2 consecutive hours until stable	6 hourly
Patient systemic ionised blood calcium (ABG sample from patient's arterial line) Target 1.0 to 1.3 mmol/L	Hourly for 2 consecutive hours until stable	6 hourly
Patient total calcium (NOT corrected calcium) Target 2.20 to 2.50 mmol/L	After 6 hours	Daily and twice daily in liver failure. Within an hour if changes made.
Calcium ratio Total calcium/patient systemic ionised calcium Target ratio < 2.5	After 6 hours	Daily and twice daily in liver failure. Within an hour if changes made.

Prescribing and monitoring chart:

- Ensure that all the replacement fluids and the calcium infusion is prescribed on the drug kardex.
- Ensure hypocalcaemia is treated prior to starting treatment – refer to page 1.
- Complete monitoring chart each hour.
- Record total calcium levels on patient's blood results sheet.
- Record post filter ionised calcium and patient ionised calcium on monitoring chart.
- Update haematocrit value on the prismaflex machine once daily at 0600hrs – ideally refer to the lab result as this is more accurate – however haematocrit from ABG may be used.
- Update total calcium level on the observation chart when 0600hrs blood results are obtained.

Problems with Calcium administration sets:

- The Prismaflex machine may alarm and indicate that the calcium infusion set needs changed. This is normal for when the volume to be infused is almost complete.
- However, the machine may still alarm and indicate that the calcium infusion set needs changed even when sufficient volume remains in the syringe.
- Do **NOT** change the infusion set – instead clamp the calcium infusion line – remove the 50ml syringe and 'plunge' it backwards and forwards to remove 'resistance pockets'.
- Reinstall the 50ml syringe – unclamp the calcium infusion line and restart the calcium infusion.

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