

Prescription and observation record for use during the trial of the Nikkiso Aquarius Plus using regional citrate anticoagulation CVVHF on GICU / CTICU

1. Patient eligibility:

- The decision to use the **Nikkiso Aquarius Plus** with regional citrate anticoagulation must be made by the Consultant of the week in daylight hours.
- For the purposes of the trial, contraindications to using citrate are:
 - Sustained / refractory to replacement, systemic hypocalcaemia PRIOR to cRRT initiation - defined as a blood ionised calcium (blood gas) $\leq 1.00\text{mmol/l}$ (despite attempted IV replacement) AND the presence of any of: long QT, problematic cardiac dysrhythmia; refractory / unstable cardiogenic and/or vasoplegic shock
 - Patients who require systemic anticoagulation for any reason
 - Patients with fulminant liver failure - defined as a recognised liver insult AND a high lactate + low glucose + elevated INR
 - Patients with a metabolic alkalosis (defined as an arterial pH > 7.45)
 - Patients with a serum sodium < 135 or $> 145\text{mmol/l}$ (trisodium citrate is the circuit anticoagulant thus a rapid rise in serum sodium AND / OR hypernatraemia can be induced)
- General contraindications to using the **Nikkiso Aquarius Plus** in the context of the trial are any Patient who needs emergency / time critical cRRT (defined as life threatening hyperkalaemia / acidosis / fluid overload / other) AND / OR is considered to be physiologically or biochemically unstable (in the opinion of the consultant).

2. Please define the goals of cRRT and amend these AT LEAST every 24 hours (or more often - as indicated by the patient's clinical condition / biochemistry)

Date and time	Goals - e.g. normalisation of pH within 6-12 hours urea clearance of 12-18mmol/l in 24 hours fluid balance of MINUS1,500mls in 24 hours starting at MINUS 100ml / hour)	Print & sign

3. Treatment initiation, escalation / de-escalation strategy

PLEASE DO NOT DEVIATE FROM THE RATES / RATIOS BELOW UNLESS DISCUSSED WITH A CONSULTANT AND THE NIKKISO CLINICAL EXPERT TEAM

- This protocol is based upon the Royal London's Guideline, Version 8 - September 2018
- Start all patients on the height based CVVHF protocol in Table 1 - which is based upon an approximate dose of 25ml/kg/hour ideal body weight.
- Each row has a fixed ratio of post dilution : blood flow : citrate. The formulae are shown in Table 1.
- If normalisation of potassium / pH AND / OR clearance of urea is inadequate INCREASE the post dilution AND blood flow AND citrate by 2 rows [e.g. if starting in row 5 change settings to row 7].
- If normalisation of potassium / pH AND / OR clearance of urea is still inadequate, INCREASE the post dilution AND blood flow AND Citrate by another 2 rows [e.g. go from row 7 settings to row 9 settings].
- To de-escalate, if clearance is in excess of targets, DECREASE the post dilution AND blood flow AND citrate by 2 rows [e.g. go from row 6 settings to row 4 settings]. Repeat this decremental step if clearances remain in excess of targets.
- Anticoagulation is provided by a continuous infusion of Acid Citrate formula A in place of heparin.
- Most patients DO NOT require calcium chloride infusion as the post dilution fluid contains calcium. Start with a 1000ml bag of 0.9% sodium chloride attached to the "calcium" pump and set the flow to ZERO. If the patient's ionised calcium is <1.0mmol/l make up a calcium chloride solution (see over) and start at the rate specified in Table 2.
- The maximum rate of fluid removal (ultrafiltration) should not exceed 15% of blood flow unless authorised by a consultant and discussed with the Nikkiso clinical expert team
- Alkalosis (blood gas pH ≥ 7.45) can occur as both citrate and bicarbonate are used in this protocol. If this occurs DECREASE the post dilution AND blood flow AND citrate by 2 rows [e.g. go from row 6 settings to row 4 settings]. If this fails to resolve the situation SWITCH to our standard cRRT prescription of heparin anticoagulation + 1/3 pre dilution + 2/3 post dilution.
- Set the fluid warmer to 38°C and titrate to the desired patient core temperature as appropriate.

Table 1

	A MEASURE	B eIBW based on A	C Starting Dose ~25ml/kg/hour based on B	D = C / 11.78	E = D x 60 / 40	F = D x 60 x 0.15
Row No.	Patient height range (cm) [feet & inches]	Gender neutral estimated ideal body weight (kg)	Post dilution flow (ml / hour)	Blood flow (ml / min)	Acid Citrate formula A (ml / hour)	Max fluid removal rate (ml / hour)
1			1000	80	120	720
2	<150 <4' 11"	<48	1100	100	150	900
3	150-159 4' 11"- 5' 2"	48-55	1300	110	170	990
4	160-169 5' 3"- 5' 6"	56-65	1500	130	200	1170
5	170-179 5' 7"- 5' 10"	66--77	1700	140	210	1260
6	180-189 5' 11"- 6' 2"	78-89	1900	160	240	1440
7	≥ 190 $\geq 6' 3"$	≥ 90	2100	180	270	1620
8			2400	200	300	1800
9			2700	230	350	2070
10			3000	260	390	2340

4. PRESCRIPTION

DATE	TIME	Patient's Name			
Height		Date of birth		Gender (circle)	M / F
IDEAL BODY WEIGHT (as per Table 1)		St George's Hospital No.			
INITIAL GOALS SET IN 2.	(tick)	NHS number			
PLEASE complete this form for EVERY cRRT CIRCUIT used. Keep completed forms with the ICU charts for the audit team.				PLEASE affix a patient's sticker if available	

Fluid	Volume	Rate	Print & sign
Accusol 35 with NO potassium	5000ml	As per protocol (Table 1)	
Accusol 35 with 20mmol/l potassium	5000ml	As per protocol (Table 1)	
Acid Citrate formula A	2000ml	As per protocol (Table 1)	
0.9% sodium chloride	1000ml	As per protocol (Table 2)	
0.9% sodium chloride + 10mmol/l calcium chloride	990ml + 10ml	As per protocol (Table 2)	

Please ensure the following are prescribed in Cerner

- "10mmol of Ca²⁺" (either 50mls of 10% calcium gluconate = 11.25mmol Ca²⁺ OR 10mls of calcium chloride = 10mmol Ca²⁺ - given as per our IV prep guide). Rate of administration may need to be increased to treat citrate induced hypocalcaemia. THIS IS URGENT / EMERGENCY treatment for hypocalcaemia.
- Unfractionated heparin 5,000units s/c 12 hourly as thromboprophylaxis (unless contra-indicated OR alternative strategy e.g. therapeutic systemic anticoagulation)
- Antibiotic doses are as for NORMAL RENAL FUNCTION (i.e. eGFR>60ml/min)
- Magnesium, potassium and phosphate replacement as per standard protocols.

5. Monitoring ionised calcium in the patient. Note this regional anticoagulation DOES NOT require any monitoring of ionised calcium in the cRRT circuit.

- Circuit anticoagulation if achieved by continuous infusion of Acid Citrate formula A with reversal achieved by the calcium in the post dilution fluid +/- a continuous infusion of additional calcium chloride (10mmol/l).
- Prior to starting cRRT, ensure an arterial or central venous blood gas has been performed within 2 hours to ensure iCa²⁺ is between 1.0 and 1.3mmol/l. If outside this range seek consultant advice.
- At start or change of calcium rate, check blood gas after 1 hour & adjust as per Table 2. Otherwise check blood gas every 3 hours.

Table 2

Calcium Adjustment		
ABG [iCa]	CaCl infusion adjustment - (MAXIMUM RATE = 175 mL/h)	Repeat
< 0.8	<ul style="list-style-type: none"> • Doctor to give 5ml, 10% CaCl (3.4 mmol) 'minijet' by slow IV bolus via a central line immediately • Increase CaCl infusion rate by 50 mL/h • If patient not on CaCl, change the bag and start at 100 mL/h • If CaCl infusion already at 175 mL/h stop RCA & inform ACCU Consultant immediately 	1 h
0.8 - 0.89	<ul style="list-style-type: none"> • Increase CaCl infusion by 25ml/h • If patient not on CaCl, change the bag and start at 75 mL/h • If CaCl infusion already at 175 ml/h cease citrate & inform ICU Consultant immediately 	1 h
0.9-0.99	<ul style="list-style-type: none"> • Increase by 25mL.h 	1 h
1 - 1.2	No change	3 h
> 1.2	<ul style="list-style-type: none"> • i. Decrease CaCl infusion by 25ml/h • ii. If CaCl infusion off then check systemic [iCa] in 3 hours • Inform Doctor if [iCa] rises to >1.5 	1 h

Patient name and MRN

Observation chart - Day of therapy ONE	DAILY: ratio of total (unadjusted) serum Ca to ionised Ca ²⁺ [target <2.25]
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Hour	Blood flow rate ml/min	Acid Citrate rate ml/hr	Post dilution		Calcium Infusion mmol/l	Patient iCa ²⁺ mmol/l	Access pressure	TMP	Return pressure	Fluid removal ml/hr	Balance ml	Filtration dose ml/kg/hr
			ml/hr	Bag change								
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Patient name and MRN

Observation chart - Day of therapy TWO	DAILY: ratio of total (unadjusted) serum Ca to ionised Ca ²⁺ [target <2.25]
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Hour	Blood flow rate ml/min	Acid Citrate rate ml/hr	Post dilution		Calcium Infusion mmol/l	Patient iCa ²⁺ mmol/l	Access pressure	TMP	Return pressure	Fluid removal ml/hr	Balance ml	Filtration dose ml/kg/hr
			ml/hr	Bag change								
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Patient name and MRN

Observation chart - Day of therapy THREE	DAILY: ratio of total (unadjusted) serum Ca to ionised Ca ²⁺ [target <2.25]
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Hour	Blood flow rate ml/min	Acid Citrate rate ml/hr	Post dilution		Calcium Infusion mmol/l	Patient iCa ²⁺ mmol/l	Access pressure	TMP	Return pressure	Fluid removal ml/hr	Balance ml	Filtration dose ml/kg/hr
			ml/hr	Bag change								
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