Children's Health Ireland

Crumlin | Temple Street | Tallaght | Connolly

CHILDRENS HEALTH IRELAND NURSING PRACTICE GUIDELINE ON HAEMODIALYSIS

Area of use:	All of organisation ☐	CHI at Connolly ☐	CHI at Crumlin ☐
		CHI at Tallaght ☐	CHI at Temple Street ☒
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Contents

1.0 Guideline Statement

The aim of this document is to provide guidelines for the management of children who require haemodialysis, to promote a safe and effective haemodialysis service and to assist staff in the provision of a service, which meets the individual physical and psychosocial needs of children and their families.

2.0 Introduction to Haemodialysis

Haemodialysis is a form of renal replacement therapy. Dialysis ensures homeostasis in people who are experiencing sudden or gradual loss of kidney function. The kidney's role of blood filtration and removal of fluid and waste products is supplemented by artificial equipment. Haemodialysis is performed using a patient's central line or fistula, through which blood is pumped through an external circuit and filter. Dialysis involves the removal of solutes across a semipermeable membrane down the concentration gradient (Murdeshwar & Anjum, 2022).

2.1 Introduction to Haemodiafiltration (HDF)

HDF combines diffusive and convective solute removal in a single treatment session (Blankestijn et al. 2018). HDF provides a greater removal of higher molecular weight uraemic retention solutes than conventional high-flux haemodialysis. It is also associated with better patient survival and clinical outcomes (Canaud et al. 2018). In this modality, the amount of ultrafiltration (UF) exceeds the desired fluid loss, and replacement fluid is administered to achieve the target fluid balance (Ronco, 2015).

Replacement fluid can be infused in either pre or post dilution mode, or both in different proportions. HDF requires a high-flux haemodialyser (Ronco, 2015).

Choice of pre or post dilution will be decided by patient's clinical need, anticoagulation, prescribed blood flows and characteristics of the dialyser. Post dilution HDF provides optimal clearance but pre dilution may be more suitable in patients with low blood flows, small dialysers or issues with haemoconcentration in the dialyser. The senior haemodialysis nurse and Nephrologist will choose the appropriate therapy (Tattersall & Ward, 2013)

3.0 Scope

This guideline applies to specialist areas that perform haemodialysis where children with central venous access devices are admitted. It is applicable to all nursing and medical staff who are involved in performing haemodialysis.

4.0 Glossary of Terms & Abbreviations

ACT	Activated Clotting Time
BSA	Body Surface Area
CVAD	Central Venous Access Device
CVC	Central Venous Catheter
ECV	Extra Corporeal Volume
ESKD	End Stage Kidney Disease
HD	Haemodialysis
HDF	Haemodiafiltration
HUS	Haemolytic Uremic Syndrome
OCM	Online Clearance Monitoring
PD	Peritoneal Dialysis

RBV	Relative Blood Volume
TBV	Total Blood Volume
URR	Urea Reduction Ratio
VBG	Venous Blood Gas

5.0 Procedure

NOTE: Where acute haemodialysis is required out of hours, the staff member must override the heat disinfection process. Instructions are located above the R.O. panel in haemodialysis.

5.1 Vascular Access

- Patient may need ultrasound examination to determine patency of vessels prior to surgery.
- Surgeon/ Interventional Radiologist to decide on line brand and size. Send two sizes of central venous catheters (CVC) and Quinton caps (x 2) to theatre. Ensure unused lines are returned to dialysis unit.
- CVC to be inserted in theatre. Refer to appendix 1 for CVC / Vascath sizes.
- Ensure CVC is x-rayed to confirm CVAD tip position. Confirmation of suitability for use to be documented in medical notes.
- Ensure CVC line is patent prior to Haemodialysis (HD). On return from theatre, line should be accessed and **unfractionated heparin 1000 international units / 1ml** should be instilled to each lumen and ensure caps are applied. Refer to CVC care bundle for instructions on accessing dialysis CVC's. Nurses to wear appropriate PPE including a face mask and eye protection.
- Document line size and priming volume of each lumen in nursing documentation and HD Kardex. Size and priming volumes are visible on lumens of Permcath and should be double-checked by nursing staff post insertion.
- Observe CVC site for signs of haemorrhage, haematoma and infection and document in the CVC record sheet in the patient notes.
- Dressing should remain intact for at least 5 days post insertion, unless loose or any visible signs of exudate/infection. For existing CVC's, change dressing weekly if using antimicrobial dressings. Otherwise, change two to three times weekly and document same in CVC record sheet.
- If a femoral line is sited, bed rest is essential. Observe neurovascular observations and document recordings in patient's chart hourly or as condition dictates.

5.2 Infection Control / Virology Screening

All new patients should be screened as follows:

- Blood samples should be taken for virology: HIV, Hep B, Hep C, antibodies and antigen. They should be sent urgently to National Virus Reference Laboratory (NVRL). Written consent to be obtained from parents / guardians.
- NVRL lab should be contacted to request urgent results. If out of hours, a call back service may be contacted.
- The dialysis machine should be isolated for that patient only until negative results are obtained. Ensure an isolation sign is placed on the dialysis machine until results are confirmed. All patients positive for blood borne viruses should be nursed in isolation on an isolated machine.
- Full screening for staph aureus (MRSA and MSSA), VRE, CRE and MRGNB should be completed pre-operatively as per Infection control guidelines PP-CLIN-IPC-001. See screening and IPC for MDRO guideline. Isolate the patient in a cubicle until results are available and confirmed.

- Patients should receive 5 days of prophylactic nasal mupirocin and Octenasin body wash. Hair should be washed with Octenasin at least once pre-operatively or on Day 2 and 4 if possible to complete prophylactic treatment prior to CVC insertion as per Staphylococcus aureus screening and decolonisation policy pre-dialysis catheter insertion
- Virology, MRSA, VRE, CRE and MRGNB screening should be repeated 3 monthly thereafter.

5.3 Prescription

- The dialysis prescription should be completed with the Consultant Nephrologist on-call and senior HD nurse. The prescription and consumables should be double-checked by two HD nurses before commencing the session. Refer to appendix 2 to facilitate the completion of the prescription.
- The patient's dry weight and height (when possible) should be obtained to calculate body surface area. Refer to appendix 4 for guide to estimated body surface area. The dialyser should be no more than 75% of body surface area of the child for an acute session and may increase to 100% of surface area once dialysis is established (BAPN, 2008).
- Calculate the patient's total blood volume (TBV). TBV is calculated by using the formula patient weight x 80mls. This is an estimate of the total circulating blood volume in the patient's body.
- Calculate the patient's safe extracorporeal volume (ECV) by calculating 8-10% of their TBV. This is the maximum amount of volume that can be safely tolerated out of circulation, in the lines and dialyser. Overestimating their ECV can cause the patient to experience unfavourable symptoms such as headaches, hypovolaemia, hypotension and shock.
- The dialyser selected should be high flux ensuring optimal dialysis and effective clearance. High flux dialysers can be used in the acute phase.
- Dialysis line size (neonatal, paediatric or adult) is also selected based on the patient's ECV, ensuring the priming volume of the filter and lines together do not exceed 8-10% of the patients TBV.
- For the patient's first session, ensure blood flows do not exceed 2-3ml/kg/min. Increase blood flows in consequent sessions by 1ml/kg/min, aiming for 5-7ml/kg/min once established.
- Higher initial blood flow speeds may be used in patients with acute-on-chronic presentations e.g. history of failed kidney transplant or previous peritoneal dialysis (PD) patients. This cohort of patients may tolerate increased urea clearances. Blood flow rates to be decided in conjunction with Consultant Nephrologist.
- An albumin or blood prime may be performed if clinically indicated, especially for small neonates and children with a reduced body surface area.
- The Consultant Nephrologist depending on the patient's clinical status, fluid overload and/or hyperkalaemia will decide the length of session. The first session usually consists of 1-1.5 hours of diffusion. An isolated UF can also be performed in in addition to diffusive time. Short sessions may be performed daily, with gradual increase in length of session until the patient is established on a minimum of 3 hours, three times weekly.
- Dialysate is chosen based on pre dialysis potassium. If K+ is >5.5 mmol/L in the **acute** patient, consider 1mmol dialysate concentration. Use same with extreme caution due to risk of hypokalaemia. Consider patient's length of session and blood flows achieved in order to ensure adequate clearance. Regular venous blood gases (VBG'S) are required every 15-30 minutes to assess safe potassium clearance. Consider dietary intake, nutritional status of the patient and potential medications that may exacerbate hyperkalaemia. Refer to appendix 3 for hyperkalaemia management in the **chronic** patient.

5.4 Ultrafiltration

- Fluid removal should be prescribed at the rate 10-12ml/kg/min. An isolated UF may also be performed at this rate, where fluid removal is indicated but patient has had adequate diffusion. Isolated ultrafiltration

should always be used with caution in patients who are hyperkaliaemic. Always ensure isolated phase is completed and haemodialysis has recommenced.

- It is not advisable to aim for more than a 5-6% reduction in body weight during any session. Discuss the ultrafiltration regimen with the Consultant Nephrologist. Utilise RBV monitoring on Fresenius machine to aid assessment of hourly fluid removal. This will aid as supplementary insight in conjunction with the patient's vital signs, general appearance and the colour of their blood circuit to determine whether the patient has reached their dry weight safely. Each patient must be individually assessed as per condition. Additional sessions should be considered to achieve target weight.

5.5 Anticoagulation

- Discuss with the Consultant Nephrologist which anticoagulation agents will be administered to the patient. Heparin is routinely used in the acute phase of HD and Tinzaparin™ is used once patients are established. For patients requiring haemodialysis before or after surgery, anticoagulation should be held. Anticoagulation free dialysis may also need to be considered in patients who are severely uraemic or have other clotting risk factors.
- Unfractionated heparin 1000 international units/1 ml is routinely used as anticoagulation during the acute phase of HD, as ACTs can be monitored and the infusion can be adjusted accordingly to prevent circuit-clotting issue. The loading dose and infusion should be held for the patient's first session. Subsequent sessions should include a loading dose of 10units/kg up to but not exceeding 20units/kg once established on haemodialysis.
- The unfractionated heparin infusion should be prescribed as 20units/kg/hr and titrated according to ACTs. The heparin infusion should never exceed 50 units/kg/hr.
- See appendix 5 for further information on the preparation of heparin for dialysis.
- Check activated clotting times (ACT) 15 minutes into session and every 15-30 minutes thereafter in an acute session. Patients established on haemodialysis with heparin as anticoagulation require monthly ACTs or if there are circuit issues.
- ACTs should be in the range of 180-220 seconds (Carter & Benador, 2014). However, in patients with coagulopathy or where uraemia > 35mmol/L, aim for ACTs 160-200. Refer to appendix 6 for titration instructions.
- If using Tinzaparin™, this is given directly into the circuit via the red port five minutes after starting the session.
- Refer to Tinzaparin™ guideline for dosages PP-CLIN-NEPH-10 (See Tinzaparin in HD guideline.) No activated clotting times (ACT) are required when using Tinzaparin™. Routine factor Xa levels are also not required.
- In patients with clotting in the circuit, poor flows or high TMP, plasma anti-factor Xa can be measured at the end of dialysis (or mid dialysis if there are severe problems). The target anti-Xa level at the end of dialysis is less than 0.3 units/ml and dosing can be guided by these results on discussion with the team.
- In the event of over administration of Tinzaparin or heparin or active bleeding, consider use of protamine.

5.6 Patient Monitoring

- Ensure a nurse to patient ratio of 1:1 for acute HD and children <2 years. Children who are established on HD require a 1:2 nurse to patient ratio.
- Continuous cardiac monitoring with ECG leads and O2 Saturation monitoring are required during the initial phase or in patients who are acutely unwell.

- Relevant blood samples should be obtained prior to connection and disconnection. Pre dialysis samples should be taken before injecting any diluents. Post dialysis adequacy samples should be taken strictly as per policy to ensure precise measurement of clearance. Post samples should be taken on completion of HD. Dialysis flow, UF should be turned off, and blood flows reduced to 100ml/min for 15 seconds before disconnecting patient from the circuit and taking relevant samples (KDOQI, 2015). Be mindful of methods of stopping dialysate flow if patient on HD or HDF and depending on use of Fresenius or Baxter machines.
- Ensure urea reduction ratio (URR) is calculated each session until established. Monitor URR and Kt/V once monthly thereafter. Aim for Kt/V of 1.2-1.4. Use Kt/V to guide prescription changes (KDOQI, 2015)
- Online Clearance Monitoring (OCM) can be utilised on the Fresenius machine throughout the session as an indicator of clearance and Kt/V. OCM should be utilised for suitable patients only, as some patients can become symptomatic of shifts in sodium required to assess clearance.
- In the acute phase, monitor patient observations every 15-30 minutes. Once established record observations hourly at a minimum or as condition dictates.
- Consider six core PEWS parameters:
    - Clinician / Family Concern
    - Respiratory Rate
    - Respiratory Effort
    - Oxygen Therapy
    - Heart Rate
    - AVPU
- Complete patient assessment and document on an age appropriate PEWS chart. Follow escalation pathway if any clinical concerns.
- Use RBV monitoring on Fresenius machines to determine blood volume status and amount of fluid removal required.
- Obtain and review VBG at the start of each session to check pH, K+ level, bicarbonate, and Hb.
- For patients with urea >35mmol/L and in patients with Haemolytic uremic syndrome, assess neurological status and document neurological observations on Glasgow Coma Scale.
- Some patients, in particular neonates /small infants, may require a warming device e.g. Bair Hugger™ to maintain normal body temperature.
- Complete online documentation of dialysis session on eMed and/or TMON (Therapeutic Monitoring).

5.7 Special Considerations in Acute Dialysis

- If patient is uremic (urea > 35mmol/L), there is a risk of disequilibrium syndrome if urea is cleared too rapidly. Urea clearance should be gradually increased from 2-3ml/kg/min as the patient is established on haemodialysis. Consider blood flows, dialyser size and length of session to ensure safe URR.
- With urea > 40 mmol/L and hyponatremia < 133 mmol/L consider giving Mannitol in the first hour to prevent disequilibrium. Mannitol 20% is stored in unit medication cupboard at all times. Inspect solution for crystallisation prior to use. A filter must be used with Mannitol 20%. Mannitol must be flushed with 5% Glucose. Please refer to drug formulary (Clinibee™) for dosing guidance and liaise with Consultant Nephrologist re the prescription.
- There should be no more than 30% URR for the first 1 to 2 sessions, then increased to 50% with an eventual goal of 65% and above. A pre and post U&E must be taken with each session until established on full prescription to calculate URR. It may take up to 1-2 weeks to establish a patient on adequate flows for a URR aim of 65-70%.
- If patient is polyuric, IV fluids/ online fluid boluses may be required to avoid symptoms of hypovolaemia.

- Patients being dialysed in the acute phase should receive HD not HDF. HDF may be commenced in increments when patient is established on HD. HDF post dilution is advised for optimal clearance but HDF pre dilution may be preferential in some patients.
- In consultation with Departments of Anaesthesia and Nephrology, it may be necessary to consider administration of sedation to infants or small children during initial dialysis sessions to achieve adequate blood flows. If the child is requiring a significant amount of sedation, admission to ICU should be considered. Ensure sedation used is not cleared by the HD process by consulting Renal Drug Handbook.

5.8 Troubleshooting

- Management of a hypovolemic episode during Haemodialysis:
    - Assessment of tolerance of fluid removal using RBV monitoring, frequent vital signs recording and regular assessment of dry weight are essential to avoid hypovolemic episodes. Rescue fluids should be attached via connection to circuit or via programmed online bolus in the event of the need to provide rescue of fluid bolus. See Hypovolaemia Management Algorithm in appendix 7.

Air Detect Alarm:

<u>Fresenius Machine</u>

- If air is detected, the machine will alert with the message "Microbubbles detected below the venous bubble catcher" or "Air detected below the venous bubble catcher". Follow machine prompts to resolve same.
- Air Detect Emergency Kit containing items necessary to manage the alarm, is always available and stored in visible area in the dialysis unit.
- Using Aseptic Non Touch Technique, disconnect patient lines and attach 10ml syringes to each lumen. Spike a 100ml bag of 0.9% NaCl and connect to Y connector. Attach patient lines to Y connector and following machine prompts to expel air from circuit into saline bag. When air has been expelled, patient can be reconnected to circuit. Check all ports and connections to ensure they are tightly closed.

Air Detect Alarm: AK98™

- If air is detected by machine, it will alert "air in venous drip chamber". If level is low in bubble trap, the level can be increased with adjustment knob whilst pump is running. If there is considerable air in circuit that cannot be resolved and it is unsafe to continue therapy, patient will need to be disconnected from circuit.

Blood Leak Detect Alarm

- A blood leak alarm may be caused by rupture of dialyser membrane or blood or air in the system. If a blood leak alarm occurs, the dialyser and inlet/outlet tubing should be assessed for visible signs of blood. If blood is visible, lines should be clamped and therapy discontinued immediately. No washback should be given and U&E should be obtained to ensure safety of patient's electrolytes.
- A dialysate sample can be obtained from the sampling valve on outlet tubing and can be tested on a urinalysis strip.
- Fresenius machine: sample can be taken with a syringe directly from the port.
- AK98™: Sample must be taken with a needle and a syringe from the port.
- The senior nurse may override the blood leak alarm on his/her discretion, if it is not considered to be a true blood leak alarm, for example in the case of air in tubing or possible technical fault.
- Blood leak detect alarm should only be overridden once and if it occurs again, therapy should be discontinued immediately and no washback given.

If machine has had a confirmed blood leak

- **Fresenius machine:** Diasafe should be changed and machine should be put into heat disinfect and then run a T1 test to out rule further detection of blood. If there is any concern that blood has entered any part of hydraulics, machine should be pulled from use and reviewed by a technician.

- **AK98:** Machine to be pulled from treatment and patient use. Baxter should keep dialyser and lines for analysis. Inform Clinical Engineering of the event so that Baxter technicians can review. Machine disinfection with both Clean Cart A and C should be performed prior to next patient treatment.

Circulation of Circuit

If during therapy, it is necessary to access patient's CVC to assess flows or troubleshoot an issue, the nurse can connect the red and blue patient's line together with a blue recirculation connector. This will allow blood to circulate while managing the CVC issue. Circulation should be carried out for as short a time as possible, but never longer than 10 minutes. This is a function on the Fresenius machine but should only be performed in urgent situations on the AK98™ when the nurse must ensure ultrafiltration is off and blood flows are reduced.

6.0 Monitoring, Audit & Evaluation

- This policy and procedure shall be reviewed and updated at least every two years by the Haemodialysis Clinical Nurse specialist team in order to determine its effectiveness and appropriateness. It shall be assessed and amended as necessary during this period to reflect any changes in best practice, law, substantial organisational change and professional or academic change.
- In order to ensure the effectiveness of this policy and procedure the Haemodialysis team shall review and monitor compliance with this policy and procedure. The Haemodialysis team must further provide a systematic process for the reporting and investigation of compliance breaches, to enable proactive prevention in the future.

7.0 Key Stakeholders

The following stakeholders were consulted in the review of this document:

Name	Grade	Location
Jennifer Caverly	Senior Pharmacist	Temple Street
Dr Clodagh Sweeney	Consultant Nephrologist	Temple Street
Dr Melanie Cotter	Consultant Nephrologist	Temple Street
Reviewed and approved at the CHI NPC Oct 2023		

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Appendix 1 – Child Weights for Single and Double Lumens

Weight of child (kg)	Catheter gauge (Fr)	Catheter length (cm)
Double-lumen		
3 - 10	7 - 8	7 - 15
>10 - 20	9 - 10	10 - 20
>20 - 30	10 - 11.5	12 - 24
>30 - 40	11.5 - 12.5	20 - 30
>40 - 50	12.5 - 14	30 - 40
>50	14 - 16	40
Single-lumen		
<5	6.5	29 or 32
>10	10	36 or 40

(Rees, 2020).

Appendix 2 - Haemodialysis Prescription

Patient Details

Diagnosis	
Date of 1st Dialysis	
Access Type	
Serology Results *screen 3monthly	**HIV:** **HEP B:** **HEP C:**

Patient Parameters

Dry Weight	
Height	
Body Surface Area	
Total Blood Volume (80mls/kg)	
Extracorporeal Volume (8-10% of Total Blood Volume	

Haemodialysis Prescription – Fresenius Machine

Modality	
Treatment Time	
Schedule	
Circuit:	
Dialyser	
Dialysis Lines	
Total Circuit Volume	
Machine Segment	
Circuit Washback Volume *Account for this volume in ultrafiltration goal	
Circuit Washback Rate	
Dialysate Concentrates	
Buffer - Bicarbonate	
Acid *Select / Adjust acid concentrate based on patients serum potassium on VBG	
Dialysate Sodium	
Dialysate Bicarbonate	
Dialysate Flow	
Ultrafiltration	

Ultrafiltration Rate per Hour *10-12mls/kg/hour (Max. 5% of Dry Weight – consult HD CNS/Consultant if further UF required)	
Anti-Coagulation Therapy	
Tinzaparin (*to arterial port of circuit within 5minutes of treatment start)	
Blood Flows	
Blood Flow Rate *(Calculate at 5-7mls/kg/minute)	

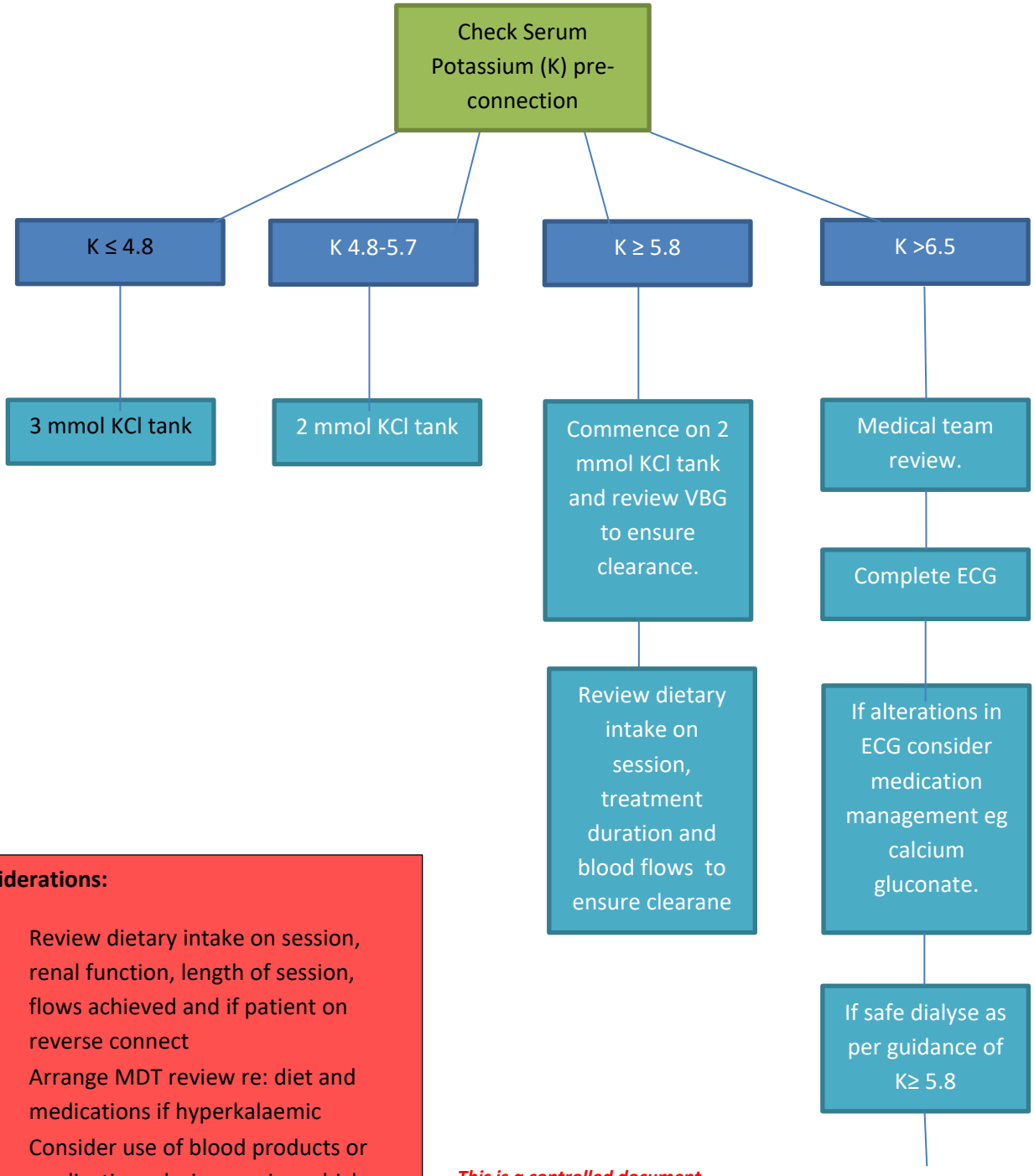
Nurses Signature (*Handwrite): _____ Date: _____

AK98 Machine – Specific Considerations

(*please refer to main prescription – outlined below are specific requirements for AK98)

Modality	
Circuit:	
Dialyser	
Dialysis Lines	
Total Circuit Volume	
Machine Segment *3.70 – Neonatal Lines 6.35 – Paediatric Lines 7.90 – Adult Lines	
Dialysate Concentrates	
Buffer - Bicarbonate	
Acid *Select / Adjust acid concentrate based on patients serum potassium on VBG	
Dialysate Sodium	
Dialysate Bicarbonate	
Dialysate Flow *(Minimum dialysate flow on AK98 is 300ml/min)	**Manually Programme Dialysate Flow** Calculate @ 1.5times the achieved blood flow rate

Appendix 3 – Chronic Haemodialysis Hyperkalaemia Algorithm



Considerations:

- Review dietary intake on session, renal function, length of session, flows achieved and if patient on reverse connect
- Arrange MDT review re: diet and medications if hyperkalaemic
- Consider use of blood products or medications during session which may alter serum K.
- Use caution with isolated

Consider use of 1mmol KCL tank in exceptional circumstances on discussion with senior staff for part of session

Appendix 4 - Estimated Surface Area

Body Weight (kg)	2	2.5	3	3.5	4	4.5	5	5.5	6	6.5	7	7.5	8	8.5	9	9.5	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28-29	30-34	35-43	44-48	49-53	54-58	59-64	65-69	70-75	76-81	82-87	88-90
Surface Area (m2)	0.16	0.19	0.21	0.24	0.26	0.28	0.3	0.32	0.34	0.36	0.38	0.4	0.42	0.44	0.46	0.47	0.49	0.53	0.56	0.59	0.62	0.65	0.68	0.71	0.74	0.77	0.79	0.82	0.85	0.87	0.9	0.92	0.95	0.97	1	1.1	1.2	1.4	1.5	1.6	1.7	1.8	1.9	2	2.1	2.2

Acknowledgement: Surface area of the Human body. Boyd e. The University of Minnesota press 1935

Appendix 5 – Guidance on preparation of Heparin for Haemodialysis

Heparin Bolus

- 10units/kg of unfractionated heparin 1000 international units / 1ml to be administered into the access lumen of the CVC, ordinarily the arterial lumen, on commencement of haemodialysis

Heparin Infusion

- A 30ml leur-lock syringe is required for heparin infusion.
- Heparin dose is calculated at 20-50units per kg per hour. The correct dose of unfractionated heparin 1000international units/1ml is then diluted in NaCl 0.9% to a total volume of 20ml.
- Heparin infusion is attached to heparin syringe driver in the dialysis machine. Heparin functionality must be switched on on the Fresenius machine using the UserCard. If unable to do this, a syringe driver pump can be used alternatively.
- Commence infusion at 20units/kg/hr (5units/kg/ml) and titrate according to ACT results and for consequent sessions on discussion with Consultant Nephrologist.

Appendix 6 - Procedure for Heparin titration based on ACT Monitoring

Normal ACT range= 180 - 220 seconds
With Uraemia >35mmol/L consider lower ACTs 160 - 180 seconds

ACT level:	Indication:
Greater than 220:	Decrease heparin infusion by 5iu/kg/hr
180-220:	No change to Heparin Infusion
<180:	Increase heparin infusion by 5iu/kg/hr

Appendix 7 - Management of Hypovolaemic Episode on Haemodialysis