St George's University Hospitals NHS
NHS Foundation Trust

PICU at St George's

CRRT ON PICU

A quick 'how to guide' for PICU nurses & HCP

Zoom graphics and trouble-shooting guide on filter for detailed information

24/7 helpline: 07623945987

When you call, leave the name of the person they should contact, say it is PICU at St Georges Hospital calling, give them the number of the hands-free phone so you can take the call when they call you back for trouble-shooting, and a summary of the problem you are facing. The rep will call you back and work through problem-solving with you.

The most current number is displayed on all haemofilters.

Please note: For our very small patients, our first option is to administer a controlled blood transfusion rather than blood prime the circuit. Discuss this option with consultants. The blood prime protocol is at the end of this document.

WHAT I NEED

- The filter machine from GICU or CTICU
- Correct size aquamax filter & filter circuit (there are 3 sizes: 2 paediatric: *Aqualine S*, 1 adult: Aqualine)
- Replacement fluid (with or without potassium)
- Waste fluid bag
- 0.9% saline for priming (1 litre)
- Heparin for priming fluid (if not contraindicated) & making up infusion
- Saline for flushing lumens
- Sterile trolley and dressing pack
- Extra gauze if second nurse not available to assist as 'dirty nurse'
- 4X 10 ml syringes for aspirating lumens and flushing lumens
- Sterile gloves
- Blue clamps X 2 (to clamp lines in emergency when you attach child)
- 3 way tap and spike (for recirculation and disconnection)
- White bungs
- PPE
- Prescriptions
- Paperwork for calculating turnover, blood pump speed & fluid balance

EMERGENCY TRAY

Set up emergency tray later with: heparin for heplock, 4X 10 ml syringes and flushes for aspirating & flushing, 20 ml luer lock syringe for trouble-shooting, blue clamps X 2 if not already available, dressing pack, sterile gauze & sterile gloves, 500 mls normal saline with 3 way tap for returning blood or recirculating, 2 ml syringes X 2, white bungs.

CARE OF VASCATH and SITE

The femoral or right internal jugular site is the most common site for vascath insertion.

- Internal jugular lines must be X-rayed, position checked and documented by doctors prior to use.
- Perform a blood gas and check as an initial step to prevent unnecessary X-Rays.
- Transduce the vascath line to check waveform- **MUST NOT** be arterial waveform (more reliable than a blood gas).
- Check perfusion of limb distal to femoral lines and check pedal pulses minimum 4 hourly
- Dress the line with a clear occlusive dressing with the insertion site visible as per Trust policy.
- Clean the site as for any invasive line as per Trust policy.
- Always aspirate the line before flushing with normal saline (0.9%) using positive pressure flushing method.
- If the vascath is not in use within a few minutes of insertion, heplock with **1:1000** heparin according to the volumes stated in the vascath lumen and apply a label to indicate the line is heplocked. **ALWAYS** assume the vascath is heplocked and inform others (e.g. going to theatre/CT scan)
- Perform line and site surveillance checks and document on lines and tubes as per Trust protocol.
- Our standard: CRRT must be commenced within 2 hours once correct vascath position has been determined and the medical instruction to start CRRT is given.
- A sterile (surgical ANTT) is used when accessing the vascath.
- As a rule of thumb: you should be able to withdraw 10 mls of fluid in 3 seconds and 20 mls in 6 seconds from vascath for good flow from an adult vascath. This equates to a blood flow rate of 200ml/min.
- For the triple lumen vascath, anything infused into the third lumen will be filtered off
- Swapping lumens: Normally there is a 5% recirculation of blood between the lumens. If the lumen is swapped, this is increased by 20-40% (more for much smaller lines). Clearance will be affected. Swapping is not recommended and used as a last resort. A new vascath may be required.
- See Dr's protocol on vascath lines.

- ❖ The manual key located at the bottom of the filter is ONLY to be used in the case of power failure and you are aiming to return blood back to the patient.

Filters

There are three sizes of filter available on PICU

1. HF03
2. HF07. This can successfully filter up to 60Kg child.
3. HF12 60kg and over (adult size)

Patient size	**Filter size**	**Filter volume**	**Lines Volume**	**Blood flow rate/Blood pump speed (BFR/BPS). This is an overview. Check PICU flow rate/turnover chart for detailed information on management**
0-5kg	HF03	32 ml	61 ml	15-50mls/min up to 80ml/min if child tolerates
5-15kg	HF03	32 ml	61 ml	100mls/min
15 - 40kg	HF03 Consider HF07 (20Kg)	32 ml	61 ml	150mls/min (15-30kg child) or 200mls/min (>30 kg child)
> 40-60kg	HF07	49 ml	61 ml If using *Aqualine* (not *S*) then 100 ml	200mls/min (>30 kg child) see section on clotting and 'useful calculations' section to addendum to increase flow rates if filter clotting too much
> 60kg	HF12 HF19	73 109	100 ml	Up to 350mls/min (adult size). Choose **Aqualine** *NOT Aqualine S* on filter set up.

HF03 and HF07: Aqualine *S* (paediatric sizes)

HF12: Aqualine (adult size)

Blood flow rate: maximum 6ml/kg/min. Less than 5kg may require blood prime/controlled blood transfusion. Less than 3 kg may need to go up to 7 ml/kg/min BFR.

Minimum BFR 3ml/kg/hr: more likely to clog and clot.

Consider HF07 for 10-30kg children.

You can change filters and BPS to meet the needs of the child, particularly if the filter is clotting frequently and/or if your ultrafiltrate is too large for your BPS. You need to consider child's circulating volume (so 8ml/kg can be safely extracorporeal) and Hb to determine which filter size to use. The main difference will be between HF03 and HF07 for our small children. Look at suggestions under clotting and TMP alarms and the 'useful tips' on how to calculate blood flow rate and filter size and reset these.

PRE-USE CHECKS: The filter is ready for lining when:

- There is a static green light
- There is a static orange light. DO NOT rush this stage as there will be a CPU heating alarm if the heater has not yet come on and the whole procedure will have to be re-commenced again from the start.
- If the yellow status light is still flashing after the system test is finished, the heater self-test is still running. Entering the priming process before the heater self-test is finished is not possible. The yellow light stops flashing when the heater self-test is finished. After that select the therapy (CVVH) and confirm.
- There is an audible alarm indicating the machine is ready
- The machine has passed the self-test

STEPS IN LINING THE HAEMOFILTER: use zoom graphics prompts. Below are some 'quick-fix' suggestions for successful set-up and prolong your set life. There is another folder with more extensive 'trouble-shooting' if needed.

Always plug the machine into an uninterrupted power switch. Switch the machine on. Machine performs System Test. This takes approximately 4 minutes. In the interim, you can prepare the priming fluid and infusions. All pump doors must be closed at this stage (the self-test will fail if any of the doors are not properly clicked shut.

The Aquarius™ system test must be performed before lining the device. The pump doors must be closed and no replacement / dialysate or waste bags must be placed on the relevant scales.

If the self-test fails:

- Try opening and re-shutting the door and see if this resolves the problem
- Wait a few minutes and for pump to reset and then retest. Maximum re-test: 3 times then take it out of circulation and inform company/technician.
- Check all doors are clicked shut and try again if you can for pump CPU1 failures.
- Suggestion: Unplug the Aquarius machine from the main power supply for 15 min. After that, switch the machine on and repeat the self-test.

1. Select therapy e.g. CVVH (the most common mode used on PICU)
2. Select the correct tubing. Paediatric circuits: Aquiline *S*. Adult circuits: AQUILINE
3. Use PPE/infection control as per policy
4. Two checks must be done once you have stalled the tubing:
    - Dry check: before priming check your set-up carefully
    - Wet check: after priming check degassing chamber, blood leak chamber and drip chamber are fluid-filled.

Install tubing (use zoom graphics which takes you through each stage)

- We use "Aqualine S" sets for all paediatric circuits (HF03 & HF07) and "Aqualine" for adult circuit (HF12). You will have to obtain this from adult ICU.
- Priming tubes and bags are colour-coded. Red-to-red, yellow to yellow, green to green. The blue line (return line) is attached to your priming fluid. So fluid is pulled through the return line. This is because priming occurs in an opposite direction to treatment mode. During priming, the blood pump will be spinning against the direction of the arrow.In treatment mode, the access line is red and pulls blood i.e. through negative pressure into the circuit and this is returned via the blue line on the filter. So, the blood pump will be spinning clockwise/in the direction of the arrow displayed on the red pump.

- Do NOT handle the blood leak chamber as it may trigger the blood leak alarm. If it alarms clean it with a paper towel and reinsert. If it still alarms then follow the trouble-shooting guide on the machine for this component.
- Sit the pressure transducer (Yellow pressure dome) next to the blood leak detection chamber in a '7 past 7' position. This will sit the blood leak chamber more securely so that it is less likely to pop out of its hold. If it does pop out the <blood leak >alarm will be activated. Pop it back in properly.
- Fix the degassing chamber into its functional position making sure the shortest line is towards the back closest to the machine. Ensure chamber cover is closed securely, around the tubing. Note: if fixation clip is not securely closed there will be a <degassing chamber missing or no fluid chamber detected> alarm at the end of priming. You must hear a CLICK as you attach it and make sure the chamber is sitting on the switch.
- So, Place degassing chamber in the ADU and: Ensure the fixation plate is in horizontal position and closed around the short tubing with the green clamp at the top of the ADU. Ensure the magnet on the underside of the fixation plate is not missing. Ensure this magnet is not dirty. Ensure the ADU chamber is sitting on the pressure switch (black and red switch at the bottom of the ADU unit).
- Connect degassing line (it has a clamp) to pressure dome (sensor). **Connect the luer-lock hydrophobic filter from the ADU longer degassing line to the ADU silver pressure monitor. If this is not securely attached, it will entrain/suck in a lot of air into the heater circuit if it becomes loose during therapy. DO NOT PANIC. Use a 50ml syringe to aspirate the air AND THE CHAMBER WILL FILL UP AGAIN but make sure you clamp the line before and after aspirating and unclamp it only after fixing it back or it will entrain air again.**
- The ADU is automatic and it will be removing the small amount of air (CO2) in the steps. However, if the heater coil is filled with air due to the

user error, you might need to help the ADU and use 50ml syringe to aspirate the air from the heater coil via the short tubing to prevent its escape to pre and post dilution line. Do not panic, if it escapes, the air would accumulate in the drip chamber. It could escape from there to the air detector but the safety mechanism of the machine would clamp the circuit. You could troubleshoot or call the clinical pager.

- Locate return line which has the drip chamber/bubble trap connected to it, ensure that this is inserted under the air detector.
- Push and lock the priming line against the air detector dome (sensor) groove.
- Attach pressure domes. Clamps on the pressure dome must be nicely tight and clicked into place. The PRE-FILTER TUBING has the highest pressure and slows flow of the blood pump speed. Check that the pressure clamp (gate) is securely closed
- Alcohol wipes should NOT be used to clean the gates/clamps or any other part as the residue makes it sticky. Use a water and paper towel.
- Place pre-filter tubing (RED DOME) around pre-filter pressure dome in a 'take dog for walk' position. See the illustration on zoom graphics.
- Place haemofilter (kidney) in holder – REMEMBER: RED to the TOP and BLUE to the BOTTOM.
- Top green pump is the post-dilution pump.
- Bottom green pump is pre-dilution. We do 100% pre-dilution on PICU. If you need post-dilution see adult protocol or do 50/50.
- Do not hang more than one waste bag (yellow line) and one substitution bag (green line) on the hanging poles at the bottom of the filter to prevent moving and handling injuries. A moving and handling risk assessment must be performed and documented if you use more than one bag at any time. In this case, you will need the multi-spike (borrowed from the adult units)
- Do not re-use substitution bags for ultra-filtrate waste bag

- Bung off and clamp the anti-coagulation line if you are not using it with a PICU white bung. If you hear a whistling noise, this may be because the line is drawing air in. You can flush the line with normal saline but clamp the line and change the bung.

5. **PRIME CIRCUIT: Heparin 5000 units in 1 (one) litre 0.9% normal saline for priming OR prime with heparin then reprime with normal saline OR prime with normal saline only (consultant choice)**
6. **CLAMP & PRESSURE test** using the guide on the machine. If a CPU alarm occurs, then reprime the blood-side. Ensure the return and access pressure gates at the bottom end of the machine are properly closed. Sometimes there is an air-lock in the pressure dome, give this a couple of flicks and ensure everything is tightened.
7. Recirculate at a **BFR of 50ml/hr for at least 20 minutes** prior to connection. This will help to fully 'wet' the filter fibres. (the default is 10mls so increase the rate)
8. Turn the machine **OFF** until you are ready to start treatment (not for blood prime). Blood prime: start the treatment as soon as the circuit has been primed with blood. Only blood prime when you are ready to commence treatment.
9. Calculate your fluids and set treatment parameters.
10. Ensure the treatment and all infusions, priming fluid and other parameters are prescribed and signed for prior to commencing treatment.
11. When instructed to start treatment, observe patient tolerance and their haemodynamics which may become unstable. Have a bolus of fluid available or inotropes if required. Poor intravascular circulation or blood pressure will cause filtration problems.
12. Prepare your emergency access tray with saline ampoules, 10 ml syringes, gauze, blue clamps, alcowipes, sterile spike and 3-way tap, goggles/visor and sterile gloves. Accessing your vascath is a STERILE procedure (surgical ANTT).

13. Heparin infusion must be prescribed (this is the infusion- **not priming**).

- **Standard infusion: 100 units/kg in 50 mls normal (0.9%) saline**
- **Normal rate is 5ml/hr (10 units/kg/hr)**
- **See protocol for heparin management on DR's protocol attached to this document.**

Prostacycline (PGI 2) (FLOLAN/EPOPROSTENOL)
NB : CANNOT BE USED IN SYRINGE DRIVER BUILT INTO AQUARIUS
Prime the giving set and attach it to filter anticoagulant line.
Only used when there is evidence of abnormal platelet activity and when specifically requested by consultant.
This is a Prostanoid, which is a potent inhibitor of platelet activation and works by reducing platelet aggregation. It has no other effect on the clotting process.
One limiting side effect is systemic vasodilation. Do not bolus the drug. If the line has been clamped, reduce the rate first before unclamping. Increase rate to normal once stable. Systemic vasodilation can cause unstable hypotension. Have a bolus of fluid available and/or inotropes.
Approximately 40% will be filtered out during CVVH treatment
Before increasing the infusion above 15ng/kg/min consider adding Heparin (unless contraindicated), whilst accepting that the child's condition may necessitate more frequent circuit changes

Prostacycline (PGI 2)
Standard infusion:
100,000 nanograms : i.e. 10ml of the prepared solution made up to 50ml with 0.9% normal saline = 2000 nanograms/ml and run at 5-10 nanograms/kg/min.

NEVER BOLUS prostacycline infusion as it can cause unstable hypotension. Monitor patients' BP very closely when first commencing this drug.

Never release any clamps suddenly without first reducing the rate as this will cause a bolus of drug and life-threatening hypotension

Prepared flolan can be kept in the fridge with patients name and details

Argatroban: short-acting, synthetic, direct thrombin inhibitor with anti-coagulant and antiplatelet activity. Seek adult ITU guidelines/advice if used for CRRT.

RECIRCULATION

14. Attach patients name and date/time the filter. The recirculated fluid is valid up to 24 hours. After 24 hours, re-prime the circuit again, and recirculate the set for two minutes before starting treatment.
15. If the set is being recirculated following treatment, and the blood has been washed back, this is valid for only one hour. You can recirculate multiple times but only for a **maximum of one hour** at a time.
16. To end treatment, go to end treatment section and follow the prompts. Make very sure you really **want to end treatment** as you cannot undo this once it has been initiated.

RETURNING BLOOD: It may not be appropriate to return patient's blood in all cases (e.g. in case of overload) when ending treatment. Remember that once the child is established onto the filter, you are essentially giving a rapid fluid bolus when you return blood to the patient. Those particularly at risk are cardiovascularly unstable patients and small babies. **ALWAYS** risk assess and discuss with consultant/doctors first.

PRE AND POST-DILUTION

Sometimes we use post-dilution**. If this is the case use ½ pre-dilution and ½ post-dilution**. Post dilution is Accusol that we give after the filter and before the drip chamber. It helps to prevent clotting in the DRIP CHAMBER. But it also means the blood in the filter is less dilute as we pull off more waste products from the blood resulting in better solute clearance.

For adult formula: ratio of pre to post is: 1/3rd Accusol as pre-dilution and 2/3rd post-dilution. So for 3000ml exchange: 1000ml pre and 2000ml post-dilution. This ratio is changed if there are signs of the filter clotting or clogging so: decrease post-dilution and increase pre-dilution to make the blood more dilute as it moves through the filter and so less likely to clot or clog.

This is the default protocol on PICU BFR which includes also turnover volumes. Spare copies are in this folder. Please replace if you have used the last copy.

You can increase the BFR if higher volumes are required. See section on 'clotting' and information on 'useful calculations for how this is done. Consider the child's circulating volumes and Hb when choosing the higher volume/larger filter when changing this protocol.

ST. GEORGE'S HEALTHCARE TRUST PICU
GUIDELINES FOR SELECTING BLOOD PUMP SPEEDS & TURNOVER RATES

WEIGHT	BLOOD PUMP	TURNOVER (%)			
(in kgs.)	SPEED (ml / min)	10% in l/hr	15% in l/hr	20% in l/hr	2 5% l/hr
3 - 10	80	0.48	0.72	0.96	1.20
	90	0.54	0.81	1.08	1.35
10 – 20	100	0.60	0.90	1.20	1.50
	110	0.66	0.99	1.32	1.65
	120	0.72	1.08	1.44	1.80
20 – 30	130	0.78	1.17	1.56	1.95
	140	0.84	1.26	1.68	2.10
30 – 40	150	0.90	1.35	1.80	2.25
	160	0.96	1.44	1.92	2.40
	170	1.02	1.53	2.04	2.55
	180	1.08	1.62	2.16	2.70
	190	1.14	1.71	2.28	2.85
> 40	200	1.20	1.80	2.40	3.00

NB: **For older patient's only:**
Attempts to place an adult sized cannulae (from AICU) can be made. This will allow higher Blood Flow Rates than 150 ml / min to be used e.g. up to 300 ml / min (but only if the venous pressures remain reasonable and the patient tolerates it).

The higher Blood Flow Rates will enable maximum Turnover rates of 25%.

Up to 30% Turnover Rates can even be achieved, but only if Pre-dilution replacement is being used.

Remember though that 30 mmol / l / hr of Sodium Bicarbonate is filtered off during CVVH.

D20/Blood Pump Speeds/Turnover
N. Wardine / AJKinder 209.Aug

Common alarms

Additional trouble shooting available on: www.gicu.sgul.ac.uk/resources-for-current-staff

Tips for trouble shooting are also in the folder 'CRRT Trouble-shooting' at each bedside.

BLOOD LEAK ALARM: The blood leak detector alarm is a safety mechanism. It detects molecules 2 ml of blood in 1000 mls. If there is a true BLOOD LEAK, there will be blood in the filtrate (yellow line). Waste may appear rose-coloured. Causes of blood leak alarm:

- Filtrate / plasma contain blood.
- Filter membrane is damaged / ruptured.
- During treatment the BLD chamber has been removed from its housing.
- BLD chamber not filled with fluid.

Troubleshoot:

Clean and reposition the BLD chamber.

Go to "reprime" and choose ultrafiltrate line.

Remove mirror and clean and replace as found

After priming make sure the blood leak chamber is filled with fluid. If the chamber is not **FULL** attach a new bag of saline to return line and reprime the filtrate line using the reprime option.

If the blood leak alarm is triggered, perform a dipstick test for blood from fluid in the waste bag to check for blood leak. The blood leak alarm may be activated by contaminants outside the chamber. Clean the chamber with warm water and paper towel. NO alcohol wipes as it can leave a residue and this can trigger the alarm. If the alarm is still active, pop the mirror out of its socket in the holding chamber without touching the actual mirror (taking note of which way the mirror was actually situated as this is the way the machine would have been calibrated by the company) clean it and replace it in the **SAME** way as it was taken out.

If the mirror is cracked, the machine is out of use. Call the rep (number on filter machine). An engineer will attend to change the mirror and recalibrate the filter machine for future use.

***INSERT* DEGASSING CHAMBER:** Use zoom graphics for positioning the degassing chamber. An analogy 'elephant trunk to front, ears on side and tail at the back' position -this position allows the magnet to see the chamber.

The gating mechanism must be properly closed and you must hear it CLICK into place (the elephant's bottom needs to click to sit otherwise you will get an '***INSERT* DEGASSING CHAMBER'** alarm.

NO FLUID CHAMBER DETECTED (the ADU chamber is not inserted correctly).

Place degassing chamber in the ADU and:

Ensure the fixation plate is in horizontal position and closed around the short tubing with the green clamp at the top of the ADU.

Ensure the magnet on the underside of the fixation plate is not missing.

Ensure this magnet is not dirty.

Ensure the ADU chamber is sitting on the pressure switch (black and red switch at the bottom of the ADU unit)

***CHECK* DEGASSING CHAMBER**: **DO NOT** press the mute key.

The ADU has not detected any fluid in the chamber or fluid in the chamber is down=> look DOWN.

Check all clamps on the substitution/dialysate line are unclamped.

Check the substitution/dialysate line is not kinked.

If using a manifold ensure lines are not clamped or kinked. NOTE: If there is a counted balance alarm present and multiple bags are on each scale, consider reverting back to one bag per scale without the manifold.

Ensure both seals on the Accusol bag/s are broken.

Ensure lines are not trapped under the heater door. (Ensure heater coil is positioned with the smooth side against the heater plate and the lines are in a horizontal position.).

Ensure there is no air lock in the heater coil.

Check if the Clampex on the Accusol bag/s has been opened to fluid flow

The level of the fluid is up => look at UP - at ADU

The hydrophobic filter on the ADU sensor/ degassing line (the long tubing at the front with green clamp) are wet

Troubleshoot:

1. Clamp the long tubing line at the front of the ADU.
2. Disconnect line from the sensor and hold the line up, so it is vertical.
3. Attach a 10ml syringe to the end of the line, unclamp the green clamp and push air into the line until the line is clear of any water.
4. Clamp the line again, remove the syringe and re-attach the line to the sensor.
5. Lift the chamber up from the pressure switch and push the chamber down again. Ensure the fixation plate is pushed down around the short tubing.
6. Unclamp the green clamp.
7. Press the mute key to reset the alarm and restart the treatment.

If the elephant trunk is rotated, the trunk may fill with fluid and the hydrophobic filter becomes damp. If this occurs, clamp this line, flush the fluid back into the chamber, position the elephant trunk carefully with no kinks, etc and reset the degassing chamber, unclamp the trunk once you have restarted treatment.

If you need to detach the hydrophobic filter for any reason, always, CLAMP IT FIRST OR air will go into the heater coil and substitution line. So, UNCLAMP the line, PRESS MUTE KEY only after the problem is resolved and the degassing chamber will then fill with fluid. The fluid adjusts itself so you need not manipulate this. If there is air in the substitution line, **balance alarms** will be triggered. Do not mute the balance alarms as you need to resolve this problem first.

The more common problem: Check the level of fluid in the chamber, look **DOWN** to check **SUBSTITUTION** fluid as this is where the gas is coming from and if the substitution fluid seal is not completely broken. Common problem: substitution seals not completely broken for the gas to escape. If the bag is not spiked or the substitution fluid seal is not

completely broken, the machine is unable to pull the fluid from the bag into the chamber. (The gas cannot escape if the sensor /degassing line and hydrophobic filter are wet)

There may be an air-lock in the heater circuit especially if you have high exchange (turnover) on low blood pump speed (BPS). For air lock, open heater door, give a couple of flicks to dislodge and release the air. This should resolve the problem.

When the substitution fluid arrives at the heater coil, it releases carbon dioxide gases. The degassing chamber stops this gas from moving to the blood part of the line. Otherwise call the rep who will talk you through the problem.

Always clamp the degassing chamber line before disconnecting from the sensor to stop air being sucked into the heater coil. Release the clamp before starting treatment or soon after. If the heater coil has sucked in air then use a 50 ml syringe, to suck it out but remember to clamp the line first and to reattach it securely afterwards so it does not suck air back in.

Heater coil is full of air and degassing chamber alarm is triggered: Use 50ml syringe to help degassing chamber empty the air. If air is in red line it will go into the bubble trap so attach a syringe and let air push the plunger outwards.

RESET DEGASSING CHAMBER: If you press the mute button first, the degassing chamber will assume you have sorted the problem out, so only press it after you have sorted it to reset this alarm.

Do **NOT** change the bung on the bubble trap of the return (blue) line unless you have handled it then change to sterile bung.

Do **NOT** clamp the degassing chamber line unless you are trouble-shooting

Prefilter pressure alarm

Low pre-filter alarm

Check the prefilter sensor (dome) during priming. This dome may have drawn in air and the air can stick to the sensor. Check all your connections everywhere whilst priming in case there is a loose connection that is drawing air in. Tap the tubing a couple of times to dislodge any air that may have lodged in the sensor during priming.

High pre-filter alarm

Return line may be kinked and the pressure has travelled all the way up.

High TMP alarm

This is a late indicator of clogging. Septic mediators, TPN, lipid-based drug, tumour lysis can cause this problem. The filter is struggling to pull dirty filtrate off. **May require faster blood pump speed (BPS)** as usually pre-dilution is already 100% on PICU, otherwise can increase pre-dilution. Check coagulation status also.

Check if child will tolerate increased BPS, even an extra 10-20 mls higher BPS will help. It may be necessary to change filter size.

Low TMP alarm

Filtrate pressure dome (YELLOW DOME) may be unable to read pressure correctly. Press down on gate clamp securing filtrate pressure dome. DO NOT remove gate clamp-pressure as it could rupture.

Check that the filtrate line is not closed between the filter & the bag

There may be an airlock in the filtrate line. Make sure at the end of priming that the whole filtrate line is primed with fluid and the blood leak detector chamber is also full. If not reprime the filtrate circuit to make sure it is.

Clamp off & disconnect the effluent bag and reconnect and unclamp to make sure the connection is allowing free flow of fluid.

Filtrate pump may be running **SLOWER** than the pre-dilution pump. Consider modifying the blood flow rate and/or exchange rate. This will impact the blood-flow-to-fluid removal OR blood-flow-to-turnover ratio. It may not be clinically indicated to increase the filtration fraction and BPS due to patient condition, but as the filter is licensed for use in 20kg and over patients, **a smaller child may alarm low TMP and so a higher BPS may be required.**

The machine may have been switched off before filtrate pressure (dome) sensor is removed. Switch off and do the self-test up to 3 times then call technician.

High Pressure Drop

If the filter is beginning to clot, there may be a dark ring at the top of the red side of the filter and/or the drip chamber.

STOP THE BLOOD PUMP

UNCLAMP DRIP CHAMBER LINE. The drip chamber should start to fill itself.

The drip chamber should be at least 2/3rd full and not less than this.

On rare occasions you may have to use a 20ml syringe to help the drip chamber to fill.

CLOTTING

Low BPS and larger filter (surface area) increases clotting risk

Increase blood pump speed/may need larger filter (see section on filter sizes and 'useful calculations' if not using default protocol)

Manage anticoagulation

Usually already on 100% pre-dilution, otherwise increase pre-dilution rate

BALANCE ALARMS: call rep immediately if you have got 3 balance alarms in succession

This is a safety mechanism. The alarm is activated when there is a 20ml discrepancy in scales for paediatric circuit and 50ml discrepancy if you use the adult circuit.

If the clamp is on: what you told the filter to remove and give is unbalanced and there will be a discrepancy, so alarm will be activated.

If substitution line is kinked/occluded, balance alarms are triggered.

Check the clamps especially after bag change

Check that the long and short seals are properly broken in the substitution bag

If the counter balance alarm box comes up, there is a variation in the ultra-filtrate. This is to do with the bags swinging or moving. Here, only the filtrate pump spins and the problem will be clear on the screen as to which side the problem is.

Total Fluid Loss (TFL) management

Treatment pumps run to achieve the programmed ultrafiltration volume (or fluid loss volume).
The balance scales measure the difference between the substitution volume and the filtration volume, which is the ultrafiltration volume.
A **balance alarm** occurs in an adult case when a 20 g for pediatric (50g for adult) difference is detected between the programmed ultrafiltration volume and the actual ultrafiltration volume. When the pumps are reactivated by pressing the ***Balance Start/Stop*** key, the volume discrepancies are automatically compensated for by the system. This function is Total Fluid Loss (TFL) management.

When a balance alarm occurs, a yellow box will indicate the number of counted balance alarms detected during a 20 minute period. If within 20 minutes 5 counted balance alarms are detected, a red box will be displayed to inform the operator that the treatment has stopped. Only the blood pump continues. At this time press the ***Next*** button, to go to disconnection mode.

The balance alarm count will reset to zero only after the Aquarius system operates for 20 minutes continuously without stopping the pumps. An alarm that stops the balancing system or the user manually stopping the balancing system,
will re-start the 20 minute period.

Weight deviations greater than ± 120 g may be caused if, during treatment, the user does not stop the balance system when adding or removing a bag from the scale, or if there is a large fluid leak, or if the Aquarius system is moved while the balance system is active. Although this will generate a balance alarm, the balance alarm count will not increase, the UF variation will be reset to the value displayed before the deviation occurred, and the weight deviation will not be compensated when treatment is restarted because it is not related to patient fluid deviation.

Please, look for more info on the Balance Alarm in IFU guide (p 117-118)

Blood Prime: If not using blood transfusion as the first option

- Blood prime is sometimes used if patient is **<10kg**, but must be discussed with the consultant on duty. At times, blood prime will be necessary for older children whose haemoglobin is low. Our default is to do controlled blood transfusion rather than blood prime especially if the need to start CVVH may override the need for a blood prime e.g. in severe hyperkalaemia, or metabolic emergencies, GVHD. Blood transfusion can also be administered shortly after. Some patient will require washed red cells. Check with consultants.
- Oncology patients may require many transfusions of blood products during their illness so to prevent antibodies forming consider withholding blood products if not absolutely necessary.
- Blood bank must be informed if you are likely to do perform a blood prime. This is because **all children under this section of the protocol should have a group and save and those under 10kg (and those with very low haemoglobin) should have a unit of blood available prior to starting treatment.**
- **Ensure blood is prescribed and available. Inform blood bank.** A **blood giving set** must be used at all times when infusing blood into the circuit.
- **Sometimes, you will need to do prime with Human Albumin Solution (HAS) before hand-** discuss with consultants. You can use a connection so can run both into the circuit (see below)
- **Do not i**nfuse blood into the circuit until CVVH is ready to commence. The circuit is primed with heparinised saline and flushed with normal saline prior to blood prime. The aim is to prevent frothing in the line.
- Once the circuit is primed do not delay commencing CVVH because a few minutes delay may result in the circuit clotting.
- Use < double connection > then step by step prompts on zoom graphics.
- Take blood for FBC, Clotting, U&E's and ABG as a baseline before commencing CVVH, as therapy is dependent on these results

Blood prime (adapted from 2003 SGH PICU protocol)

1. You may need to add heparin directly to cross-matched whole blood and mix well. Check this step with doctors especially if heparin is contra-indicated.

2. For the volume of blood to order- calculate the total priming volumes needed for the circuit and filter being used. You can check this on the Nikkiso website.

3. Use a BLOOD GIVING SET

4. Prime the circuit with heparinised saline as usual

5. Then fully prime the circuit with HAS

6. AT THE LAST MINUTE put the blood prime through

7. Run the blood prime through until it reaches the end of the arterial side and most of the air bubbles have gone.

8. Choose double connection and follow the steps

THIS IS A CUMBERSOME PROCESS- USE CONTROLLED BLOOD TRANSFUSION AS OUR DEFAULT PROTOCOL.

The PICU standard default charts are shown below.

ST. GEORGE'S HEALTHCARE TRUST
PICU CVVH CHART

PATIENT NAME:		HOSP. NO.:	
DATE:			

MEDICAL CVVH PRESCRIPTION
Net Target fluid loss .....
Zero or negative balance .....

Target Turnover % .....
Pump Speed .....

Cycle Number (record cycle start & finish time		Fluid Turnover for the next cycle		Fluid loss for the next Cycle (mls per hour).								
Cycle No.	Cycle time start & finish 2 hourly cycles If lots of blood products etc to ensure accurate fluids	Pre dilution ml/hr Prescribed rate by medical staff	Post dilution (must be prescribed by consultant)	Total IV / Enteral over previous cycle	+	Total deficit required over the next cycle	-	Total non-CVVH losses over previous cycle.	=	Fluid loss total	Fluid loss rate ml/hr (ml/total ÷ no. hrs In cycle) If no fluid loss must put in 4 hour time (for predilution)
					+		-		=		
					+		-		=		
					+		-		=		
					+		-		=		
					+		-		=		
					+		-		=		
					+		-		=		
					+		-		=		
					+		-		=		
					+		-		=		
					+		-		=		
					+		-		=		

NAME: **D.O.B:** **Hosp. No:**

Circuit running each hr:	00:00	01:00	02:00	03:00	04:00	05:00	06:00	07:00	08:00	09:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00
yes √ no x filter change (I)																								
Chamber degassed (tick) √																								
Access pressure (0-100)																								
Return pressure (50-100)																								
TMP																								
Pressure drop (0-100)																								
Blood flow rate (ml/min)																								
Filtration rate ml/hr																								
TURNOVER %																								
Filtration fraction % (0-25%)																								
Set Temperature on circuit*																								
Central Temp (patient)																								
Heparin (u/kg/hr)																								
INR/PTT																								

* default 39C. Lowest 35C. To actively cool switch off and monitor core temp every 20 minute

Taking the filter down

a. The machine must be 'naked' before switching it off
b. Reduce high pressures before taking down the set. Pressures must be less than 100mmHg otherwise there is a risk of (blood filled) pressure transducers 'popping'.
c. All components of the set are taken 'down' so place an orange (waste) bag on the floor. Move everything against the arrow.

Safe Removal of the Aqualine Tubing Set

a. Ensure that the Access and Return lines are connected to the saline bag and all clamps are open.
b. Place the saline bag in a disposal container in front of the machine.
c. Ensure that the filtrate and the substitution or dialysate lines are still connected to the corresponding filtrate and substitution or dialysate bags and that both lines are unclamped.
d. Remove the return line from the air detector and clamp.
e. Remove the pump tubing segments from the pumps in the following order:
    i. Filtrate pump (yellow) – in direction of arrow.
    ii. Pre-dilution or dialysate pump (green) – in opposite direction of arrow.
    iii. Post-dilution pump (green) – in opposite direction of arrow.
    iv. Blood pump (red) – in opposite direction of arrow.
f. Check if pressures are below 400 mmHg (100 mmHg if circuit clotted).
g. If not all pressures are below 400 mmHg (100 mmHg if circuit clotted), refer to the instructions to decrease pressure level. Otherwise continue as follows:
h. Disconnect the bags as follows:
i. Clamp the access and return line and disconnect the saline solution bag.
j. Clamp the filtrate line and disconnect the filtrate bag(s).
k. Clamp the substitution or dialysate line and disconnect the substitution or dialysate bag(s).
    i. Disconnect the hydrophobic connector line of the degassing chamber from the ADU unit.
    ii. Remove the heater coil line spiral from the heating unit.
    iii. Remove the blood leak detector pot.
    iv. Remove all the pressure domes from the transducers.
    v. Remove the filter from the holder and discard complete Aqualine set into disposal container.
l. When the Aqualine tubing set is completely removed from the Aquarius™ System, "Aquarius off" can be confirmed by pressing the Main selector button to switch the Aquarius off. Select and confirm "Aquarius off" or press the ON / OFF key located on the right side of the display screen.

Useful calculations and tips

1.	Total blood volume for any weight is calculated using **80ml/kg.** So if child is 6 kg, their total circulating volume is: 80 X 6 = 480 mls.
2.	The maximum BFR (blood flow rate) is **8% of the patient's total circulating volume/min (5-10ml/kg/min). So for a 6 kg child, 8% of 480 mls is 38.4 mls rounded off to 38mls.**
3.	**Fluid substitution speed** in ml/hr: first change the (BPS) from ml/min to ml/hr. So times by 60 to get ml/hr. BPS in ml/hr times filtration fraction/100 = substitution fluid rate in ml/hr. Example: 15% FF in 6 kg child is: 38 X 60 x15/100 = 342ml/hr substitution fluid speed. We got the 38ml/min by taking 8% of total circulating volume. So circulating volume in 6kg child is 480 times 8% = 38ml (rounded off).
4.	**Fluid Turnover:** This is the amount of fluid that is removed from the blood arriving in the filter per hour. 25% turnover means you remove 25% of the total amount of fluid arriving at the filter/hour. Higher the turnover, better the clearance. Maximum turnover is 25% of BFR. So **blood pump speed is set at 100ml/min, then the total amount of blood arriving at the filter every hour is 100 X 60 minutes = 6000mls. At 25% turnover this is 25% of 6L = 1500mls.**
5.	Turnover is calculated as: **Pump speed X 60 X required filtration fraction**
6.	Look for the correct blood pump speed (BPS) and correct turnover rate on the pre-set chart in the CVVH folder when choosing this treatment parameter. Start at the lowest for a 2 hour cycle and then build up. Use the pre-set parameters on the chart.
7.	**Filtration fraction** % (FF) A 5-15% filtration fraction is used. FF% = filtered volume divided by volume of fluid entering the filter. If your ultrafiltrate is increased but not blood pump rate (speed), the FF% will increase and more likely to clot the filter.
8.	**FF% is calculated as predilution flow rate + post-dilution flow rate + fluid loss rate divided by predilution flow rate + blood flow rate. The pre-dilution pump rate programmed affects this value (FF %).**
9.	**Filtration ratio** (FR) %: post-dilution flow rate (ml/hr) + fluid loss (ml/hr) divided by BFR (ml/min) X 100: So, FR% = UFR (ml/hr) divided by BFR (ml/hr) X 100. If FR is above 25%, haematocrit increases, there is a higher risk of filter thrombosis and clot. The FR% (keep under 25%) gives an indication of haematocrit increases in the filter before the post-dilution solution replaces the filtrate removed. This calculation is not affected by the rates programmed on the dialysate pump.