PERFUSION PROTOCOLS

The Royal Children's Hospital Melbourne

Perfusion Department

Version: April 2020.

CONTENTS

All information supplied herein relates to current practice at the Royal Children's Hospital, Melbourne. No guarantee can be made with reference to flows, primes, and cannulae and all details should be considered and verified for suitability prior to use in any other institution.

PERFUSION UNIT PERSONNEL

Director of Unit

Stephen B. Horton PhD, CCP (Aust), CCP (USA), FANZCP

Cardiovascular perfusion

Haemodynamic monitoring

ECLS management

Computer systems management

Administration of Unit

Clarke A. Thuys B.App.Sc., GradDipAppSc., CCP (Aust), FANZCP

Cardiovascular perfusion

Haemodynamic monitoring

ECLS management

Equipment maintenance

Budget management

Martin Bennett B.App.Sc., CCP (Aust), FANZCP

Cardiovascular perfusion

Haemodynamic monitoring

ECLS management

Database management

ECLS Liaison

Simon Augustin B.App.Sc., CCP (Aust), FANZCP

Cardiovascular perfusion

Haemodynamic monitoring

ECLS management

VAD Liaison

Bradley Schultz CCP (Aust), FANZCP

Cardiovascular perfusion

Haemodynamic monitoring

ECLS management

Equipment maintenance

Stephen Bottrell CCP (Aust), FANZCP

Cardiovascular perfusion

Haemodynamic monitoring

ECLS management

Protocol management

Alison Horton CCP (Aust), FANZCP

Cardiovascular perfusion

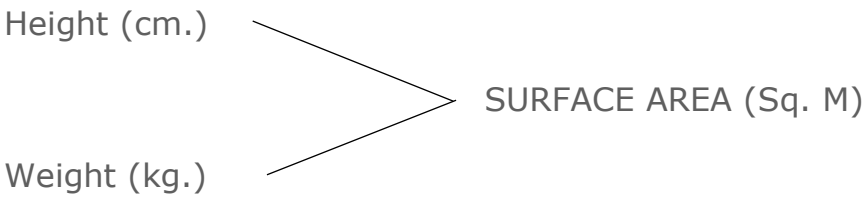
Haemodynamic monitoring

ECLS management

CARDIOPULMONARY BYPASS - BLOOD FLOW,

CIRCUIT & PRIME CHOICES

1. SURFACE AREA (uses the formula of DuBois)



2. FLOW

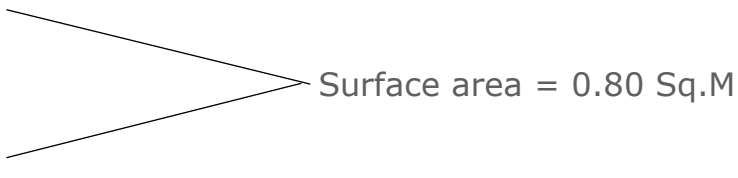
a) Patients < 10 kg: Flow = weight x 150ml/min/kg

Eg. 3.5 kg

Flow = 3.5 kg x 150 ml/min/kg = 525 ml/min

b) Patients > 10 kg: Flow = 2400 ml/Sq.M./min

Eg. 20 kg



Flow = 2400 ml/Sq.M./min x 0.8 Sq.M. = 1920 ml/min

3. PATIENT BLOOD VOLUME

This parameter is age dependent and is only approximate.

a)	0	-	6 months	=	100 ml/kg
b)	6 months	-	18 months	=	90 ml/kg
c)	18 months	-	and older	=	80 ml/kg

4. CHOICE OF CIRCUIT (at April 2020)

Once the patient flow has been calculated, the circuit is selected.

Blood Flow (ml/min)	Venous Line	Arterial Line	Pump Boot	Oxygenator	Prime Volume
< 1200	¼"	¼"	¼"	Terumo FX-05	~ 350 ml
1200-1500	3/8"	¼"	¼"	Terumo FX-05	~ 450 ml
1500 to 2000	3/8"	1/4"	3/8"	Terumo FX-15W30	~ 750 ml
2000 to 3000	3/8"	3/8"	3/8"	Terumo FX-15W30	~ 1000 ml
3000 to 4600	1/2"	3/8"	1/2"	Terumo FX-15W40	~ 1250 ml
> 4600	1/2"	3/8"	1/2"	Terumo FX-25	~ 1500 ml

These volumes do not include volume required to prime the cardioplegia or haemofilter circuits which add approximately 150 mls. The correct Spectrum flow/bubble and level sensors for the circuit being used must be placed appropriately.

5. PRIMES

The prime for cardiopulmonary bypass (CPB) is calculated such that the combined haemoglobin (ie. patient and bypass pump blood) is approximately 80-90 g/L as a minimum.

The prime volume is kept to an absolute minimum.

CPD packed cells are used for the prime. Ideally this blood is less than 5 days old. A donor blood unit is assumed to have a volume of 250ml. This blood contains citrate (CPD or ACD) as an anticoagulant. (The exception to this is the Hypoplastic Left Heart patient who receives a 1.5 unit prime. Refer HLHS Protocol)

Patients greater than 10 kg will be considered for a bloodless prime so long as the haemoglobin is > 120 g/L.

To calculate the total amount of diluent and volume of donor blood required, the following formula is used:

$$\left[\frac{\text{Patient Hb} - 90}{\text{Patient Hb}} \times \text{Patient Blood Volume}\right] + \left[\frac{\text{Volume of Donor Blood in Prime}}{4}\right]$$

= the volume of diluent, which should be added to the donor blood to achieve a combined Hb of approximately 90 g/L. The Hb of blood is estimated to be 120 g/L.

All the above calculations are done by a computer program designed by our unit, which has been programmed to calculate a prime based on the patient's Hb, age and weight.

6. DILUENT

Our aim is to have a biochemically and physiologically "balanced" CPB pump prime. The following primes are used, and some flexibility is advised with regard to the individual nature of patient presentation, patient pathology and the donor blood if used.

I. "CPD" BLOOD: PACKED CELLS

*	Blood	250 ml
*	Heparin	2500I/U- 3000I/U
*	Calcium Chloride	2-2.5 mmol.
*	Sodium Bicarbonate	30 mmol
*	20% Albumin	100 ml
*	PlasmaLyte 148	500ml
*	Sterile Water	100 ml

The circuit is primed and debubbled with the Plasmalyte and water. Then the albumin is added, followed by the blood and drugs. Excess volume is haemofiltered off to leave approximately 100 ml in the venous reservoir. This also reduces the sodium, potassium, glucose, calcium and free haemoglobin in the prime. Adjustments may need to be made to the prime blood gas and electrolyte levels to bring them to physiological levels with respect to the patient's blood gas and electrolyte levels even after the initial dosage and filtration. The sweep gas during priming is set at FiO2 21%, FiCO2 5% and sweep rate 3 lpm. Primes for hypoplastic left heart patients require more blood, as outlined later.

II. FFP and PACKED CELLS

In patients that are born premature (less than 37 weeks) or weigh less than 3 kg, Fresh Frozen Plasma (FFP) may be added to the bypass prime to offset the dilutional coagulopathy which may be more significant in this population. Additional electrolytes, heparin and water will be required to achieve a balanced prime. These should be adjusted after filtration and prime blood gas analysis. Correction of the prime should be confirmed with another blood gas.

IV. BLOODLESS PRIME

A clear prime is considered for all patients above 10 kg. assuming that the patients haemoglobin is > 120 - 140 g/L. Clear primes may be used in smaller patients with high starting haemoglobin. For low weight patients with high Hb, the FX-05 can be used up to 1.5 lpm flow. It should be primed as follows and the excess priming fluid removed from the circuit prior to bypass.

The FX15/25 prime is made up in the following ratio:

*	PlasmaLyte 148	800 - 1000 ml
*	20% albumin	200 ml
*	Heparin	5000 I/U
*	Calcium Chloride	2-2.5 mmol.
*	Sodium Bicarbonate	30 mmol
*	5 % Glucose	10 ml

The FX05 prime consists of:

*	PlasmaLyte 148	500 ml
*	20% albumin	100 ml
*	Heparin	3000 I/U
*	Calcium Chloride	2-2.5 mmol.
*	Sodium Bicarbonate	25 mmol
*	5 % Glucose	10 ml
*	Sterile water	50 ml

The biochemical and acid-base balance for the prime is tested by blood gas analysis and matched closely to the patient status prior to the initiation of bypass. Sterile water for injection should be used to dilute the prime if the Na+ level is too high. If the K+ is too high sterile water or 0.9% saline should be used to dilute the prime depending on the Na+ level and the type of prime (we do not add water to primes which already have blood in them due to the risk of haemolysis). If Na+ and K+ are high the prime may have to be haemofiltered to reduce these levels to match the patient. The sweep gas during priming is set at FiO2 21%, FiCO2 5% and sweep rate 3 lpm.

CARDIOPULMONARY BYPASS - CANNULA SIZES

Once the flow rate is calculated the choice of arterial and venous cannula size is made. In the case of venous cannulation, the choice as to single (right atrial) or double (SVC and IVC) cannulation is made. The overall choice of cannula size is done via the computer program, using the charts below.

1. AORTIC CANNULA SIZES

Based on the following article* and our own data

*ARTIFICIAL ORGANS VOLUME 40, ISSUE 1, PAGES 56–64, JANUARY 2016

FLOW	FR SIZE
<380	6*
380 - 560	8*
560 - 700	10
700 - 1000	12
1000 - 1400	14
1400 - 1800	16
1800 - 3000	18
3000 - 3500	20
>3500	22

2. FEMORAL CANNULA SIZES*

FLOW			SIZE FR Art	SIZE FR Ven
0	-	400	8	8-10
400	-	700	10	10-12
700	-	1000	12	12-14
1000	-	1500	14	14-18
1500	-	2000	16	18
2000	-	2700	18	20
2700	-	3500	20	24
3500	-	>	24	28

* Femoral cannulation is used on occasion, in re-operations.

- CURRENTLY USED:
- **6 FR** - STOCKERT PEDIATRIC AORTIC CANNULA;STOCKERT INSTRUMENTE, MUNICH, GERMANY, DLP ONE PIECE PEDIATRIC ARTERIAL CANNULA; MEDTRONIC INC, MINNEAPOLIS MN, USA
- **8 – 16 FR** DLP ONE PIECE PEDIATRIC ARTERIAL CANNULA; MEDTRONIC INC, MINNEAPOLIS MN, USA
- **18, 20, 22 FR** EOPA ELONGATED ONE PIECE ARTERIAL CANNULA; MEDTRONIC INC, MINNEAPOLIS MN, USA.
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* FOR FEMORAL CANNULATION

A "FEM-FLEX" OR MEDTRONIC BIOMEDICUS PERCUTANEOUS CANNULA IS USED.

3. VENOUS CANNULA SIZES

a) Bi-caval cannulation

FLOW	DOUBLE		VENOUS LINE
	SVC	IVC	
ml/min.	mm/FR	mm/FR	
0 - 350	3.3/10	3.3/10	¼"
350 - 450	3.3/10	3.9/12	¼"
450 - 600	3.9/12	3.9/12	¼"
600 - 800	3.9/12	4.7/14	¼"
800 -1000	4.7/14	5.3/16	¼"
1000 -1200	6.3/16	5.3/16	¼"
1200 -1500	5.3/16	6.0/18	3/8"
1500 -1800	6.0/18	6.0/18	3/8"
1800 -2000	6.0/18	6.5/20	3/8"
2000 -2250	6.5/20	6.5/20	3/8"
2250 -2650	6.5/20	7.3/22	3/8"
2650 -3000	7.3/22	8.7/24	3/8"
3000 -3500	8.7/24	8.7/24	½"
3500 -4000	8.7/24	9.5/28	½"
>4000 -	9.5/28	9.5/28	½"

CURRENTLY USED: Edwards "Thin Flex" Series and Custom made reusable metal tips based on "Pacifico" design.

b) Right atrial cannulation

FLOW (ml/min)			SINGLE (FR)	DUAL STAGE (FR)	VENOUS LINE
0	to	300	10		¼"
300	to	450	12		¼"
450	to	600	14		¼"
600	to	750	16		¼"
750	to	1000	18		¼"
1000	to	1200	20		¼"
1200	to	1500	22	20/20 Fr	3/8"
1500	to	2000	24	20/28 Fr, 28/32 Fr	3/8"
2000	to	3000	28	28/32 Fr, 29/37 Fr	3/8"
3000	->		28	29/37 Fr, 36/46 Fr 36/51 Fr	½"

Currently used dual stage cannulae:

EDWARDS THIN FLEX 20/20 Fr

MAQUET 28/32 Fr

MEDTRONIC MC2 29/37 Fr

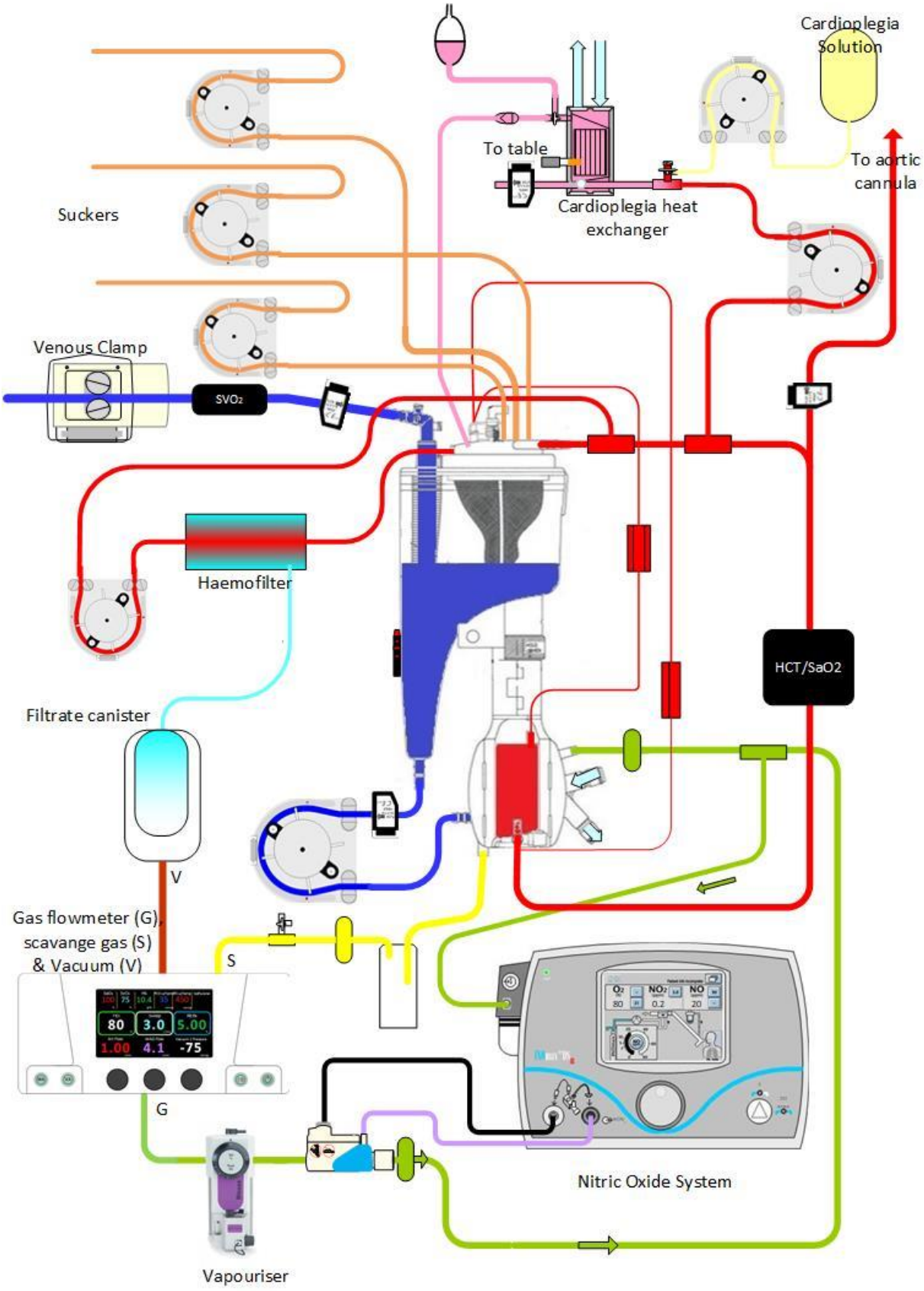
MEDTRONIC MC2 32/40 Fr

MEDTRONIC MC2 36/46 Fr,

EDWARDS 36/46 Fr

MEDTRONIC MC2 36/51 Fr

Cardiopulmonary Bypass Circuit Diagram



Perfusion Procedure

Anaesthetic
(anaesthetic protocol can vary between anaesthetists)

FENTANYL 15 – 150 MCG/KG +/- MORPHINE 0.2 – 0.5MG/KG (LOADING DOSE TO THE CPB CIRCUIT AS PER ANAESTHESIA)

Isoflurane (if required)

KETAMINE 2MG/KG/HR

Midazolam 0.04 mg/kg/hr

Pre bypass

Heparin 300-400 Units/kg

Prior to initiating CPB the cardiotomy suckers may be turned on at twice the Baseline ACT with Aortic cannulation occurring around this time. Once ACT reaches an acceptable level of 400s initiation of Bypass can occur. If there is significant patient cardiovascular instability at any time, then at the direction of the Surgeon and the Anaesthetist bypass may be initiated.

Perfusion Procedure: On Pump.

Once the priming procedure has been completed, the checklist finalised (including cannula lot numbers where necessary) ,drugs countersigned, NIRS connected, recording started in EPIC and Spectrum Vision, and the patient heparinised, cardiopulmonary bypass can be commenced. The aortic cannulation is done first to allow rapid infusion, or bypass with cardiotomy sucker return if required.

NO may be blended into the CPB gas administration line upon initiation of CPB, via an Ikaria INOmax DS IR delivery system. Gas flow from the CPB electronic gas blender is set at a minimum of 3.0 L/min and NO delivered at 20 ppm. This minimum gas flow is necessary to ensure complete mixing and accurate sampling of the NO from a Luer lock port

just prior to the gas line in of the CPB oxygenator. Circuit blood gas management can be guided by a combination of a Terumo CDI Blood Parameter Monitoring System 500 and/or the Spectrum Quantum ventilator module/work station. In smaller patients, at times it is necessary to add CO_2 from the blender into the gas line to maintain $PaCO_2$ 35-45 mmHg with these higher gas sweep flows.

Bypass may be instituted with only one of the venous cannulae, nitric oxide should be started at this point with sweep gas set to a minimum of 3 lpm with CO2 being titrated to normalise pCO2. If this is the case flow is increased to the point where the blood level in the venous reservoir is steady even if it is not the calculated full flow. Once the second venous cannula is connected flow can be increased to the calculated full flow. There is usually a drop in perfusion pressure at the start of CBP. It is usually transient and the pressure will increase after 2-3 minutes. Flow should be increased to compensate for this pressure drop if possible. If the pressure has not increased after 3-4 minutes a dose (weight dependent) of metaraminol can be given. Cooling can commence, once full flow has been established, at the request of the surgeon. The surgeon will snare the caval tapes. If the perfusion pressure becomes too high during CPB Isoflurane (titrate) is used to manage the hypertension. Reducing flow should only be used as a last resort.

The flow remains at the calculated flow or greater unless specifically requested. If the aorta is to be cross-clamped the cardioplegia will be ready and the tubing flushed. The cardioplegia pump needs to be turned on very slowly as the line is connected to the cardioplegia cannula to ensure that there is no air in the line.

When the surgeon is ready to cross-clamp the aorta the flow is reduced to half and the clamp applied. Cardioplegia delivery is started at 110ml/m^2/min for 4 minutes and increased to give a cardioplegia pressure of 40 – 120 mmHg in the aortic root. This is a guide only as the root pressure may be increased at the request of the Surgeon (see myocardial preservation Protocol for greater detail). Once the heart has been arrested venting may be achieved by opening the atrium, ventricle or vessel opened to avoid distension and the flow is increased to normal.

When the cardioplegia has been delivered the blood gases, electrolytes and ACT (MaxACT) are measured. ACT must be kept at more than 480 seconds. Pressure, temperature, flow, sweep gas characteristics and venous saturation are constantly monitored, and recorded via the Spectrum Vision Data management system when a change is made. Cardioplegia is delivered for another 2 minutes at approximately 20-minute intervals or at the request of the surgeon. If delivered ostially the

delivery rate, time and pressure will be different compared to when delivered into the aortic root.

During the procedure the surgeon may require a dedicated vent sucker that needs to be managed appropriately.

If FFP is added to the circuit during bypass the equivalent volume should be removed by haemofiltration. Additional sodium bicarbonate, calcium and heparin may also be required. Sterile water can also be added to reduce the sodium load. These additions are in the following ranges:

Water	0 – 100 mls
Sodium Bicarbonate 8.4%	0 – 5 mls
Calcium Chloride 10%	3 mls
Heparin 1000IU/ml	0 – 1000 IU

and are dependent upon patient ACT, blood gas and electrolytes pre and post FFP administration.

If packed red cells are added to the circuit during bypass the equivalent volume may be removed by haemofiltration. Additional calcium (calcium chloride 10%) may be required at a dosage of up 0.5 mls per 60mls of red cells or 3ml per unit of red cells.

If the patient is very haemodiluted and there is a large volume in the cardiotomy reservoir a haemofilter is used to concentrate the circulating volume, Lasix may also be given. Blood may be given after discussion with Anaesthetic Team Blood gases (alpha stat) and electrolytes need to be checked more frequently (usually every 30 minutes) when haemofiltering or during ZBUF (zero balance ultrafiltration) because of the loss of electrolytes in the filtrate. Modified ultrafiltration (MUF) may be used post CPB to haemoconcentrate the patient if there is sufficient volume in the circuit.

Prior to removal of the cross-clamp warming the patient should commence. The blood temperature should be a reasonable gradient as determined by the primary PERFUSIONIST AND ANAESTHETIST relative to the nasopharyngeal temperature, and not exceed approximately 36.5° C. The flow is reduced to half when the clamp is removed and then slowly (over a period of about 1-minute) returned to full flow.

It is normal for the patient perfusion pressure to drop during warming. If possible increase flow to increase the pressure, otherwise a dose (weight

dependent) of metaraminol may be given. Hypotension may be due to arrhythmia and a combination of increased flow, pharmacological agents and defibrillation may be used if this is the case.

The FiO_2 should be increased to keep the venous saturation above 65% if possible. In infants this is not always possible, increasing the flow can help in this situation if there is sufficient reserve in aortic line pressure limits and perfusion pressure limits. This usually resolves once the patient is ventilated.

Prior to coming off CBP the patient should be: at the required temperature, the blood gases and electrolytes within acceptable parameters, ventilated, and in an acceptable cardiac rhythm (paced or unpaced).

The SVC cannula may be clamped first to allow ejection to occur. It may be necessary to reduce flow when the heart starts to eject to prevent emptying the venous reservoir. To separate the patient from CPB the venous clamp is slowly closed while the flow is reduced, transitioning to native cardiac output of the patient. Care must be taken not to overfill the heart and optimal filling pressures need to be set and all circuit shunts must be closed.

Once the venous clamp is closed and the flow reduced to zero, the blood in the venous line can then be flushed through to the venous reservoir for re-infusion or MUF. MUF can be started if required (see MUF guidelines), otherwise the IVC is clamped and the venous cannulae removed. Until the aortic cannula is removed blood can be re-infused through it.

When the Heparin is reversed with Protamine (5 mg/kg) the cardiotomy suckers must be turned off. Once the chest is closed the blood in the CPB circuit can be bagged for reinfusion (either haemoconcentrated or as is pump blood) labelled and given to anaesthesia team.

Post Bypass

Inotropes utilised post bypass determined by Anaesthetic and Surgical Staff and will depend on patient needs post procedure.

Possible Inotropes used:

Dobutamine

Adrenaline

Milrinone

Noradrenaline

AIR EMBOLISM

- ☐ ***Aetiology***

1) Oxygenator related

   a) Break in integrity of connections

   b) Detachment of oxygenator from holder

   c) Non venting of oxygenator e.g. occluded gas port

   d) Bumping of oxygenator during operation

   e) Rupture of hollowfibre with pressure in blood phase < pressure in gas phase

2) Pump related

   a) Runaway arterial pump

   b) Reversal of main pump

   c) Reversal of vent pump

   d) Cardioplegia pump flow rate exceeds arterial pump flow rate

   e) Pump boot rupture

   f) Inappropriate venting

      i) Aortic root venting with open left atrium/ventricles

      ii) Cardiac venting while aortic arch is opened (without aortic X-clamp)

3) Venous reservoir related

   a) Inattention to level

   b) Failure of level sensing devices/ air sensing devices

   c) Level sensing device set too low

4) Cardiotomy related

   a) Production of positive pressure at the input to the reservoir with air forced retrogradely up purge lines/ impair venous drainage

      i) High vent/cardiotomy flow rates

      ii) Plugging of filters due to clotting

5) Surgical

   a) Reversal of cannula

   b) Insertion of left ventricular vents

   c) Open heart procedures

   d) Unexpected resumption of heart beat

      (1) Eg: mitral valve surgery on fibrillating heart without X-clamp

- ☐ ***Prevention***

1) Adherence to checklist
2) Utilisation of Safety devices

2) Attention to venous level

3) Attention to pump flows

4) Adequate heparinisation

- ☐ ***Diagnosis***

1) Visual presence of bubbles in circuit

2) Air emboli detector activation

3) Raised S-T segments, poor cardiac output, dysrhythmias

- ☐ ***Management***

1) Management of massive systemic air embolism

a) Stop CPB

b) Place patient in steep Trendelenburg's position [*Head down*]

c) Clamp venous line & open recirculation line - allow bubbles in arterial line to passively retrogradely drain by gravity [several hundred mls max]

d) Reprime pump circuitry

i) Small quantity bubbles in arterial line

(1) Surgeon removes A-line/cannula, flush blood

ii) Large quantity bubbles in circuit

(1) Surgeon joins a-line to v-line, recirculate/prime circuit

e) Reestablish antegrade CPB

f) Hypothermia 20°C

i) Increased gas bubble solubility

ii) Minimise organ damage due to hypoperfusion while bubbles are being resorbed by increased gas solubility

g) Induce hypertension

i) Vasoconstrictors

ii) Hydrostatic pressure shrinks bubbles

h) Express coronary air by massage & needle venting

i) Drugs?

i) Steroids

ii) Mannitol

iii) Barbiturate coma (especially if embolism occurred while normothermic)

j) Perfuse for 45 min

k) Wean from CPB

l) Continue ventilating with 100% O_2 for at least 6 hours to displace N_2

m) Options:

i) Retrograde cerebral perfusion

(a) Options

(i) Connect arterial line to SVC cannula with tourniquet

1. Perfuse 20°C blood at 20% Calculated Cardiac Output into SVC

2. Measure cerebral pressure from IJ (< 25 mm Hg)

(ii) Coronary sinus cannula in SVC (preferable)

1. Perfuse 20°C blood at 20% Calculated Cardiac Output via coronary sinus

2. Measure cerebral pressure from IJ or coronary sinus (< 25 mm Hg)

(b) 100% O_2

(c) Air + blood drains from the aortic cannula hole in aortic root

(d) Carotid compression is performed intermittently to retrogradely purge vertebral arteries

(e) Continue for 1-2 minutes after air is seen exiting aorta (usually < 5 min total)

ii) Retrograde IVC perfusion

(1) Rarely done

(2) Performed after SVC perfusion

(3) To prevent re-embolisation of brain:

(a) Carotid arteries are clamped

(4) Continue for 1-2 minutes after air is seen exiting aorta (approximately < 5 min total)

iii) Hyperbaric chamber

(1) Good results

(2) Difficult to organise

2) Management of Localised myocardial air embolism

a) During X-clamping

i) Surgeon initiated cardiac deairing techniques (needle aspiration, ballottement etc.)

ii) Appropriate venting

iii) Retrograde cardioplegia

b) Post removal X-clamp

i) Dissipate bubbles

(1) Raised coronary perfusion pressures

(2) 100% oxygen

(3) Hypothermia usually not applicable

ii) Reduce ischaemia

(1) Raised coronary perfusion pressures

(2) Minimal ventricular distention

(3) Sinus rhythm

(4) Minimal inotropes (increases myocardial workload)

iii) Anticipate inotropes, pacing, ECLS to wean

OBSTRUCTION TO VENOUS RETURN

[Reduced blood flow draining into pump]

AIR LOCK -*PRESENCE OF LARGE AIR BUBBLES IN VENOUS LINE PRODUCING AN AIRLOCK*

- ☐ ***Aetiology***

1) Air enters venous line via cannula in right atrium

   a) Coronary sinus cannulae

   b) Venous cannula

2) Excessive exsanguination (e.g. during circulatory arrest)

- ☐ ***Prevention***

1) Maintain adequate right atrial filling during insertion right atrial cannula

- ☐ ***Diagnosis***

1) Rapidly falling venous reservoir level

- ☐ ***Management***

1) Source of air entry must be closed

2) 'Milk' air into reservoir (this may require removal of the venous line from the venous clamp)

3) Temporarily reduce pump flow rate, add fluid to reservoir

Mechanical

- ☐ ***Aetiology***

1) Lifting heart impairs venous drainage

2) Kinked venous cannulae

3) Malpositioned venous cannula

4) Too small venous cannula

5) Presence of thrombus or tumour

6) Caval snares still in place

- ☐ ***Prevention***

1) Observe for high regional venous pressures

2) Adequate heparinisation

- ☐ ***Diagnosis***

1) Rapidly falling venous reservoir level

2) Increased CVP (note if CVP monitored within RA may still remain low)

Note: Difficult to ascertain an IVC obstruction

- ☐ ***Management***

1) Reduce pump flow until cause identified

MALPOSITION OF ARTERIAL CANNULAE

Aortic dissection (or femoral dissection)

- ☐ ***Aetiology***

1. Cannula orifice is located within aortic wall not lumen

- ☐ ***Prevention***

1. Degree of damage ie extension of false lumen can be minimised by diagnosing problem before commencing CPB
2. Monitor for pulsatile waveform of a mean pressure correlating with radial line (after correcting for height difference between CPB & patient)

- ☐ ***Diagnosis***

1. Inappropriate high arterial line pressures
2. Inappropriate very low radial pressures
3. Loss of volume
4. TOE
5. Organ hypoperfusion (pupil dilation, anuria)
6. NIRS

- ☐ ***Management***

1. Discontinue CPB
2. Surgical reposition of cannulae
3. Surgical repair of aorta

- ☐ ***Complications of aortic dissection***

1. Global hypoperfusion

2. Occlusion origin of arteries from aorta
3. Occlusion of aorta
4. Aortic rupture
5. Aortic regurgitation

CAROTID OR INNOMINATE ARTERY HYPERPERFUSION

- ☐ ***Aetiology***

1. Preferential direction of perfusion into brachiocephalic artery

- ☐ ***Prevention***

1. Surgical vigilance
2. Use of short aortic cannula with flange

- ☐ ***Diagnosis***

1. Ipsilateral
    a) Blanching of face (not seen if blood in prime)
    b) Pupil dilation
    c) conjunctival oedema
2. Low left radial BP
3. Low femoral BP
4. High right radial BP (if innominate hyperperfused)
5. Change in NIRS

- ☐ ***Management***

1. Reposition aortic cannulae
2. Reduce cerebral oedema (mannitol; head up)

- ☐ ***Complications***

1. Cerebral oedema
2. Arterial rupture

REVERSED CANNULATION

- ☐ ***Aetiology***

1. Blood is drained from aorta
2. Blood is pumped into vena cava

- ☐ ***Prevention***

1. Visually confirm correct connection to cannula
2. Monitor for pulsatile waveform of a mean pressure correlating with radial line
3. Test aortic line pressure and patient pressure change with flow/volume immediately after cannulation

- ☐ ***Diagnosis***

1. Severe arterial hypotension
2. High CVP
3. Facial oedema
4. NIRS?

- ☐ ***Management***

1. Discontinue CPB
2. Place patient in steep Trendelenburg's
3. Disconnect cannulae & observe for air (if air is present follow gas embolism protocol)
4. Resume CPB
5. Consider mannitol, steroids, barbiturates to reduce cerebral oedema

- ☐ ***Complications***

1. High venous pressures may rupture veins
2. Bubble formation in aorta which may be reinfused when problem is corrected

HIGH AORTIC LINE PRESSURES

- ☐ ***Aetiology***

1. Cannulae lumen against wall of aorta
2. Long thin cannulae
3. Small lumen cannulae

- ☐ ***Prevention***

1. Monitor for pulsatile waveform of a mean pressure correlating with radial line
2. Use as large an orifice as possible
3. Avoid long narrow cannulae

- ☐ ***Diagnosis***

1. High aortic line pressures at less than calculated full flow

- ☐ ***Management***

1. Reposition cannula
2. Replace cannula

- ☐ ***Complications***

1. Hypoperfusion
2. Haemolysis
3. 'Sand blasting" effect of artery intima

OXYGEN SUPPLY FAILURE

- ☐ ***Aetiology***

1. Inadequate gas flow
2. Hypoxic gas mixture
3. Leaks in O_2 supply line

- ☐ ***Prevention***

1. Use of O_2 analyser on gas inflow line
2. Ensure tightness of fit in all fresh gas delivery components
3. Effluent gas (CO_2) monitoring

- ☐ ***Diagnosis***

1. Dark blood in arterial line (same colour as venous)
2. Dropping SvO_2
3. Blood gases
4. Severe vasodilation
5. NIRS
6. Ikaria Nitric Oxide alarm
7. Spectrum Ventilator alarm
8. Low PaO2
9. Dropping SaO_2

- ☐ ***Management***

1. Connect portable O_2 cylinder with flowmeter to oxygenator
2. Urgently contact maintenance engineers (dial 33) and medical gas fitters
4. Cool patient maximally

PUMP FAILURE

- ☐ ***Aetiology***

1. Electrical failure
2. Mechanical failure
3. Runaway pump

- ☐ ***Prevention***

1. Availability of backup equipment
2. Frequent servicing of equipment
3. Battery backup

- ☐ ***Diagnosis***

1. Pump unresponsive to RPM control

- ☐ ***Management***

1. 1. The patient should be maintained in one of the following states
   a) Normothermic with cardiac output and ventilation
   b) Enough volume in patient to enable internal cardiac massage and ventilation
   c) Deep hypothermic arrest
2. 2. If main pump stops — isolate source of stoppage:

   a) Hand crank main pump to maintain SvO_2 > 60%; ensure correct direction of rotation.

   b) Power down the effected pump by removing the cable, wait 10 seconds and reinsert the cable to the pump.

   c) Stop hand cranking and start the pump.

   d) If the pump does not reboot go through steps a) and b) again. If it still will not reboot replace the pump with a spare Spectrum pump or a Medos Deltastream diagonal pumphead connected into pumpboot. Deair and

recommence flow (see Medos DP3 Pump Addition) using Medos Deltastream DP3 Pump drive and battery.

3. Pump module failure:

   a) Clamp patient off CPB

4. Total AC mains failure (pump should revert to battery operation).

   a) Use torch to monitor venous reservoir level.

   b) If total mains AC failure, air compressor will be off.

   c) Automatic takeover of emergency generator should be within 5s.

   d) Disconnect the gas line from the Quantum ventilator and reconnect it to an O2 cylinder with flowmeter.

   E) Urgently contact maintenance engineers.

RUNAWAY PUMP

- ☐ ***Aetiology***

1. Pump/workstation module circuitry failure

- ☐ ***Prevention***

1. Availability of backup equipment
2. Frequent servicing of equipment

- ☐ ***Diagnosis***

1. Unable to manipulate rpm of pump

- ☐ ***Management***

1. Switch off pump
2. Hand crank main pump to maintain SvO_2 > 60%
3. The patient should be maintained in one of the following states while replacing module:
    a) Normothermic with cardiac output and ventilation
    b) Enough volume in patient to enable internal cardiac massage and ventilation
    c) Deep hypothermic arrest
4. Replace pump
5. The pumps can be operated separately from the workstation if the workstation is faulty.

WATER LEAK FROM HCU INTO OXYGENATOR

- ☐ ***Aetiology***

1. Heat exchange loss of integrity within oxygenator

2. Note: small leaks may be difficult to diagnose

- ☐ ***Prevention***

1. Test heat exchanger by subjecting to very cold water prior to priming, observing for a raising fluid level within oxygenator

- ☐ ***Diagnosis***

1. Rising venous reservoir level

2. haemoglobinuria

- ☐ ***Management***

1. Exchange oxygenator [see oxygenator exchange protocol]
2. If possible wean from bypass.

3. Drugs:

    a) Diuretics; mannitol

    b) Antibiotics

OXYGENATOR FAILURE

- ☐ ***Aetiology***

1. Manufacturing defect
2. Clogging due to clot
3. Disruption of shell (trauma, spill of Isoflurane)

- ☐ ***Prevention***

1. Availability of backup equipment
2. Monitoring and maintenance of anticoagulation

- ☐ ***Diagnosis***

1. Dark blood in arterial line (same colour as venous)
2. Dropping SvO_2
3. Blood gases

- ☐ ***Management***

1. If failure is partial but deteriorating, cooling (or rewarming?) may be instituted to render the patient in one of the following states:
   a) Normothermic with cardiac output and ventilation
   b) Enough volume in patient to enable internal cardiac massage and ventilation
   c) Deep hypothermic arrest
2. Remove from failing oxygenator:
   a) Water lines
   b) Gas outlet line
   c) Temperature probe
3. Turn off pump
4. Clamp patient 'off CPB'; clamp arterial and venous lines

5. Double clamp (leaving 1 inch between clamps) adjacent to connectors at oxygenator:

    a) Arterial outlet

    b) Venous inlet

    c) Cardioplegia outlet

6. Cut [close to clamp nearest oxygenator]

    a) Arterial outlet

    b) Venous inlet

    c) Cardioplegia outlet

    d) Gas line

7. Remove defective oxygenator (and keep)

8. Install new oxygenator into holder: ensure is tilted with recirculation port on top

9. Attach cut tubing to

    a) Arterial outlet

    b) Venous inlet

    c) Cardioplegia outlet

    d) Gas port

10. Remove all 4 clamps

11. Add additional prime to venous reservoir

12. Prime oxygenator via recirculation line

13. Reestablish CPB with shunt line from arterial filter open

SPLIT MAIN PUMP BOOT TUBING

- ☐ ***Aetiology***

1. Worn tubing due to over occlusion
2. Foreign object in pump head
3. Faulty tubing or connector

Prevention

1. Correct occlusion
2. Assess pump boot:
    a) Visually
    b) Observe for leaks when priming
3. Keep pump head covered

- ☐ ***Diagnosis***

1. Leakage of blood/priming fluid from pump boot

- ☐ ***Management***

If in priming phase just change the pump boot and adjust prime volume accordingly. Otherwise:

1. The patient should be maintained in one of the following states while replacing pump boot:
    a) Normothermic with cardiac output and ventilation
    b) Enough volume in patient to enable internal cardiac massage and ventilation
    c) Deep hypothermic arrest
2. Collect and assemble the correct spare pump boot
3. Clamp patient 'off CPB'
4. Double clamp (leaving 1 inch between clamps) adjacent to connectors at oxygenator:

a) Arterial outlet

b) Venous reservoir outlet

5. Cut [close to clamp nearest oxygenator]

a) Arterial outlet

b) Venous reservoir outlet

6. Attach new pump boot to venous outlet

7. Prime new pump boot antegrade by removing venous reservoir outlet clamp and clamping distal end when primed

8. Attach distal end of pump boot to arterial inlet

9. Install pump boot into pump head

10. Remove remaining clamp

11. Debubble via recirculation line

12. Reestablish CPB with bleed line from arterial filter open

CLOTTED OXYGENATOR OR CIRCUIT

- ☐ ***Aetiology***

1. Inadequate heparinisation
2. Direct administration of FFP to reservoir during CPB

- ☐ ***Prevention***

1. Appropriate and frequent assessment of ACT:
    a) Prior to commencement of CPB
    b) $^1/_2$ hourly interval whilst on CPB (May be more frequent)
    c) Whilst rewarming
    d) More vigilance when heparin resistant
    e) Before and after administering FFP while on CPB
2. ☐ ***Diagnosis***

1. Elevated pre oxygenator pressures [indicating clotting within oxygenator]

- ☐ ***Management***

1. Stop CPB
2. Replace oxygenator & circuit
3. The patient should be maintained in one of the following states while replacing circuit & oxygenator:
    a) Normothermic with cardiac output and ventilation
    b) Enough volume in patient to enable internal cardiac massage and ventilation
    c) Deep hypothermic arrest
4. Re-heparinise patient & circuit using a different batch of heparin

5. Recommence CPB

6. If clots appear in oxygenator

    a) Give heparin equal to initial dose from a different batch

Medos DP3 Pump Addition.

Can be used in the case of a) pump boot rupture

b) arterial pump failure

Management

1. The patient should be maintained in one of the following states while replacing pump boot:

    a) Normothermic with cardiac output and ventilation

    b) Enough volume in patient to enable internal cardiac massage and ventilation

    c) Deep hypothermic arrest

2. Collect and assemble pump boot change out kit

3. Clamp arterial and venous lines (patient 'off CPB')

4. Clamp adjacent to connectors at reservoir and oxygenator

5. Remove boot from raceway

6. a: If rupture, cut out damaged section.

    b: If no rupture, cut in middle of boot

7. Join inlet of appropriate DP3 head* (1/4" or 3/8") to line from reservoir.

* If ½” pump boot is used, 3/8” DP3 head will need to be placed into PVC section adjacent to oxygenator. If rupture has occurred within the ½” tubing, place DP3 into PVC reservoir outlet tubing and PVC oxygenator tubing.

8. Slowly release clamp on reservoir outlet, priming DP3 head

9. Once primed, join to line entering oxygenator

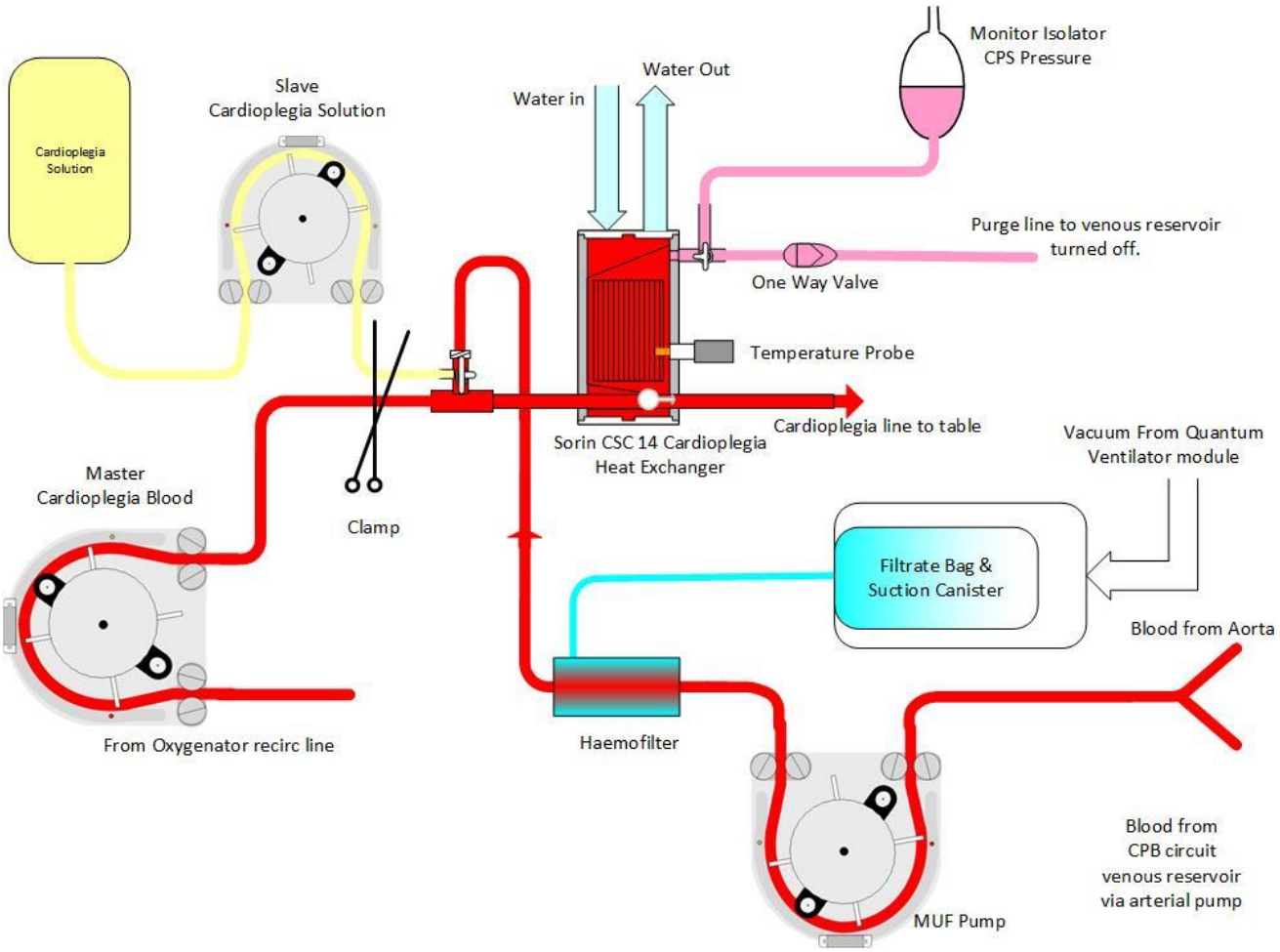
10. Place DP3 head into drive unit

11. Turn drive on and up to 3000 RPM,

12. De-bubble via recirculation line

13. Re-establish CPB with bleed line from arterial filter open

MODIFIED ULTRAFILTRATION - PROTOCOL & CIRCUIT



The modification to conventional ultrafiltration in use at RCH is based on the technique described by Elliott et al, Great Ormond Street, London.

Why Filter?

The increase in extravascular fluid which tends to accompany cardiopulmonary bypass (CPB), is in part due to increased capillary permeability, as a result of the inflammatory response initiated by CPB.

The effects of oedema have been described by various authors in relation to lungs, heart, brain, kidneys and abdomen.

Perioperative ultrafiltration and more specifically post CPB modified ultrafiltration (MUF), can be used to decrease total body water thereby minimising these deleterious effects.

We have found that A-V MUF can be implemented effectively and easily immediately post CPB, and generally result in notable improvements in patient haemodynamic and pulmonary status.

Our aim is to remove 50 - 100ml/kg of filtrate and this usually requires a period of 7 to 15 minutes in the neonatal population. Time taken and amount of filtrate removed will vary in larger children.

MUF the RCH way:

Equipment: Haemofilter – Terumo HC05

Circuit – 3/16" tubing.

Return line – cardioplegia circuit.

Suction - > - -70--100mmHg

Pump – Spectrum Roller pump

Method: (A-V MUF)

The inlet to the haemofilter is attached via a Luer connector to the re-circulation line. The filter outlet is connected to the venous reservoir for initial priming, zero balance ultrafiltration (ZBUF) during bypass or haemofiltration should this be necessary.

The temperature of the water circulating through the cardioplegia heat exchanger should be set at 37.9C . The MUF circuit is primed if possible using the contents of the venous reservoir / oxygenator during bypass, returning the blood to the venous reservoir, and used as a conventional haemofilter.

To prepare the CPS circuit for MUF during CPB move the haemofilter outlet line from the venous reservoir to the Base Solution 3 way tap on the CPS circuit. Clamp the cardioplegia delivery line to the table closed, open the purge line to the reservoir and turn the 3 way tap to open the haemofilter to the CPS circuit. Slowly flush the contents of the CPS heat exchanger into the reservoir. In this configuration you can continue to haemofilter or ZBUF. To convert to MUF close the purge line and open the CPS delivery line.

Otherwise, at completion of CPB the arterial line is clamped off to the patient and the MUF circuit is primed using the contents of the venous reservoir / oxygenator. It may be necessary in small patients to drain the venous line to facilitate this. When adequately deaired the filter inlet line is placed in the raceway of the MUF pump. The filter outlet line is connected to the three way tap at the crystalloid component inlet of the cardioplegia circuit. The tap is turned off to the cardioplegia solution, the cardioplegia blood line is clamped. Flush the return line

to remove the 30 ml of cardioplegia that remain in it, and attach to the silicon tubing on the venous cannula, which remains in the RA. During MUF priming and prior to commencing MUF itself adequate patient filling must be maintained via the arterial line.

Removal all claps from the MUF circuit and commenced MUF slowly ensuring that a positive pressure is maintain in the arterial line at all times. We find no problem with this providing the aortic cannula remains will positioned, the MUF pump flow does not exceed **10% of calculated full flow** and that suction is not applied to the filter unless the MUF pump is running.

Once flow from the patient arterial line to the MUF circuit is established, turn the suction on to maximise the transmembrane pressure differential across the filter. Maintain adequate patient filling by adding volume from the oxygenator / venous reservoir but ensure that this is done at a rate that always ensures the top up flow rate is less than the MUF flow rate. This will ensure that flow is directed via the filter rather than back up the arterial line.

Continue to MUF until the desired amount of filtrate has been removed and an adequate haemoglobin has been achieved.

It may be necessary to "chase" the oxygenator contents through with crystalloid to provide adequate patient filling. Bear in mind that this could be a problem if a return to bypass is required, and in any case the "chaser" volume must stop short of the haemofilter itself or dilution will negate the progress achieved. If necessary, blood rather than crystalloid can be used as the top up volume.

On completion of MUF, once the venous cannula has been removed, the MUF circuit can be emptied by attaching a 60 ml syringe to the 3 way tap in place of the base solution tubing and aspirating the blood

through the circuit into the syringe. This is then labelled and handed to the anaesthetist for transfusion.

MYOCARDIAL & PULMONARY PRESERVATION -

SOLUTIONS, PROTOCOL & CIRCUIT

1. CARDIOPLEGIA SOLUTION

The blood cardioplegia is based upon that used at the Royal Melbourne Hospital.

Blood Cardioplegia Base Solution (500 ml) (Baxter Healthcare Pty Ltd. Toongabbie NSW Australia)

Sodium – 77 mmol

Potassium – 40 mmol

Magnesium – 15 mmol

Chloride – 149 mmol

Glucose – 11 mmol

Lidocaine – 1 mmol

Water for injections BP QS

Approximate pH 3.5 – 4.0, approximate osmolality 586 mOsm.

To this is added 30 ml of 8.4% Sodium Bicarbonate and 28 mmol of Monosodium L-Aspartate. The induction dose is mixed in a ratio of 1:4 utilising the master/slave operation of the HLM cardioplegia pumps, Base solution:blood. Small neonates may need 1:3. The maintenance dose may be delivered at 1:6, Base solution:blood. Stage 1 Norwood operations have approximately 300 micrograms of GTN added to the Base Solution.

Blood Cardioplegia Maintenance Solution (500ml) (Baxter HealthCare Pty Ltd. Toongabbie NSW Australia)

Sodium – 77 mmol

Potassium – 17 mmol

Magnesium – 5 mmol

Chloride – 104 mmol

Glucose – 11 mmol

Water for injections BP QS

Approximate pH 3.5 – 4.0, approximate osmolality 408 mOsm.

To this is added 30 ml of 8.4% Sodium Bicarbonate and 28 mmol of Monosodium L-Aspartate. The dose is mixed in a ratio of 1:6

Patients below 10 kg:

This is usually delivered at a pressure of 40 - 70 mmHg.

Patients above 10 kg:

This is usually delivered at a pressure of 60 - 90 mmHg in adult patients.

As a guide, note the end diastolic pressure of each individual patient prior to cardiopulmonary bypass. This will indicate the normal filling pressure of the coronary arteries. When aortic incompetence is present, the CPS flow may be increased if directed by Surgeon. Alternately a direct ostial approach may be utilized.

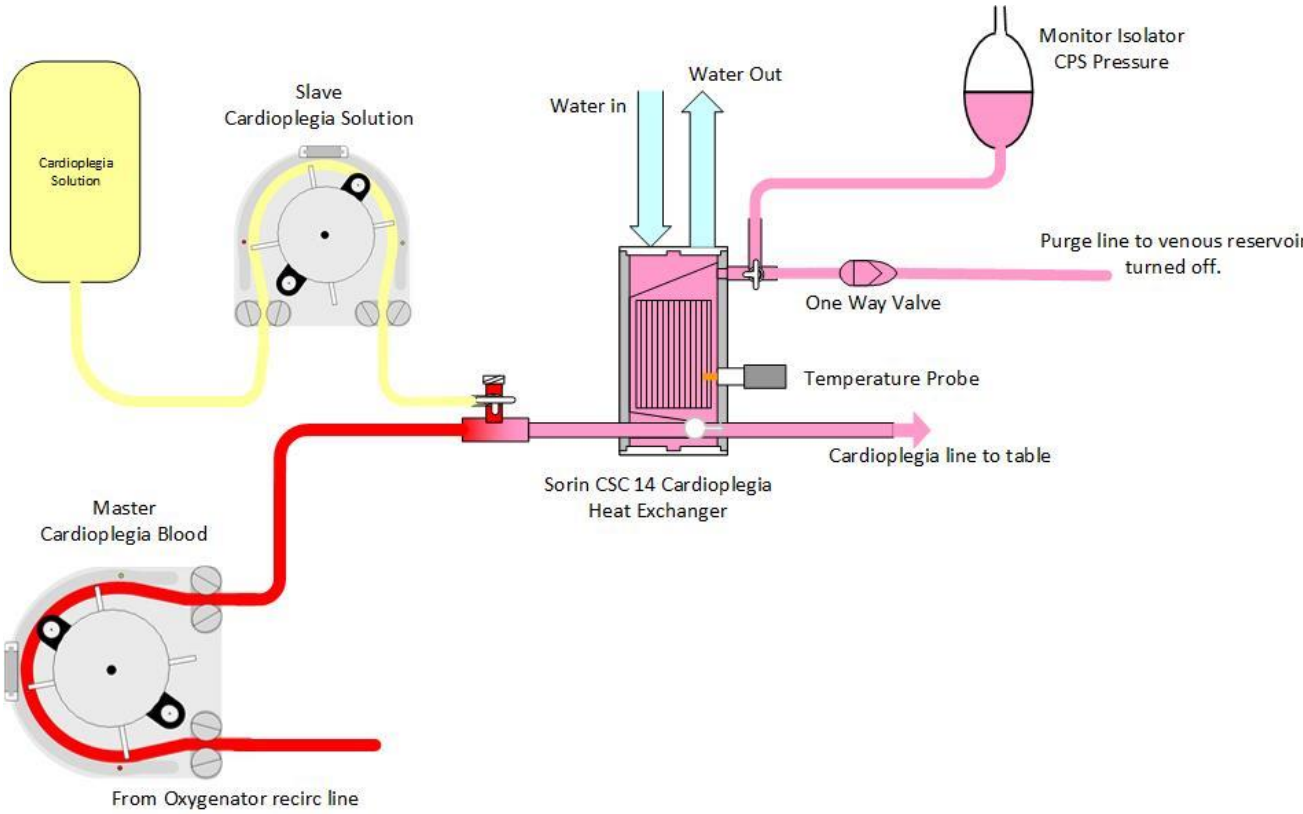
Administration

For ALL Patients: Temperature: 32°C Induction, reduced to 25°C for subsequent dose.

Initial Delivery Rate:	110 ml/m²/min for 4 minutes
Subsequent Delivery Rate:	110 ml/m²/min for 2 minutes

Continuous cardioplegia can be given at a rate of 1/4 – 1/3 of calculated flow using a syringe pump rather than the HLM pump to deliver the base solution. Approximately 12ml/hr Base solution for every rpm of the cardioplegia blood pump will give a final K+ concentration of about 9 mmol/L.

Cardioplegia Circuit



2. DONOR HEART CARDIOPLEGIA

Donor Heart Protocol

Donor Heart Cardioplegia

Base Solution - Cardioplegia Solution A - Baxter AHB7832 1000ml

Add to this:	GTN	100mg
	Monosodium L-Aspartate	28 mmol
	(2 x 10ml Ampules)	
	Sodium Bicarbonate	10 mmol
	(10 ml 8.4%)	
	(Erythropoietin – if available)	5000 units

Oxygenate solution through a five micron filter prior to leaving.

This mixture is also used as the storage solution.

Depending on the size of the heart retrieved, make up 2 -3 bags of the above mixture.

Place all bags in an esky with ice.

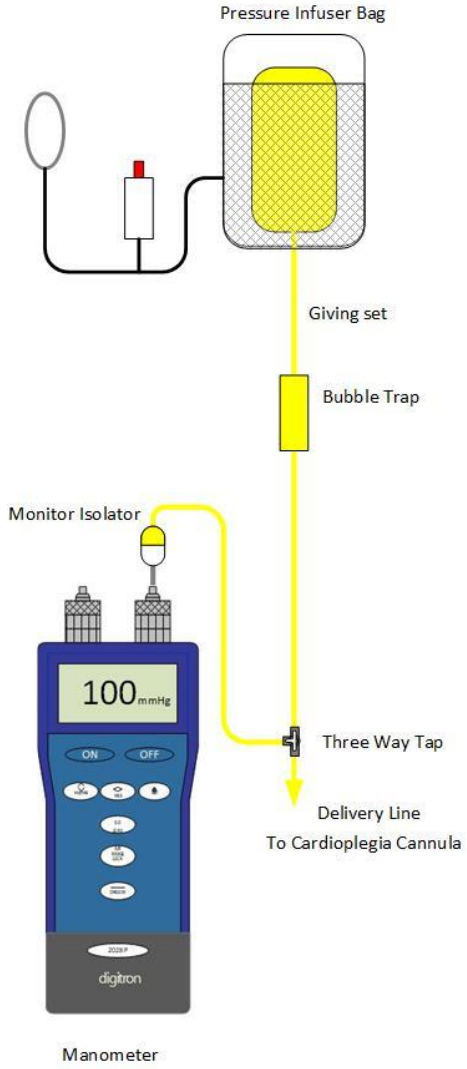
Administration Protocol

Calculate predicted cardioplegia flow for donor based on weight, from perfusion database. This will give you a guide to volume of cardioplegia required to give, and the possible need for two bags. Run cardioplegia at a line pressure of ~100 mmHg (as measured by digital manometer) for 4 minutes.

Once heart is removed, place into 1st sterile bag filled with 1 -2 litres of donor heart cardioplegia formula. (Depending on heart size).

This bag is then tied and placed into a 2nd sterile bag filled with cold saline. This is then placed into a third sterile bag also filled with cold saline.

The 3rd bag is then placed into an esky filled with ice.



Donor Cardiac Death

Donor heart cardioplegia given at 4C (from fridge) at standard dose then transported to theatre submerged in cardioplegia for administration of tepid Buckberg blood cardioplegia (21C).

EXAMPLE ONLY

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ROYAL CHILDREN'S HOSPITAL

PERFUSION DATA CASE NUMBER 206. DATE - TUSEDAY 6 JULY 2016
****
****

NAME - FX-05, PC PRIME *HEIGHT- 50 CM.*
U.R. - 9999999 BLD.GRP - B NEGATIVE WEIGHT- 3.50 KG.
DOB - 04/07/2016 AGE - 2 DAYS SURFACE AREA- 0.208 SQ.M
HAEMOGLOBIN- 11.2 GM/DL.
BLOOD VOL. - 350 MLS.
PREVIOUS SURGERY :
DIAGNOSIS : TRANSPOSITION

HEPARIN - 2500 IU. *HCT. ON BYPASS - 34.7*
BICARBONATE- 30 ML 8.4% MM. *HB ON BYPASS - 11.4*
CALCIUM - 2 MMOL *FEMORAL SIZE - 2.5*
PLASMALYTE 148- 500 MLS.
ALBUMIN 20%- 100MLS *DILUENT VOLUME – 735.5 MLS.*
STERILE WATER - 100 MLS *VOLUME OF BLOOD - 250 MLS.*

TOTAL PRIME >>>>> 985.5 MLS. AFTER FILTRATION – 450MLS

OXYGENATOR : TERUMO FX 05 OPTIMUM FLOW : 520 MLS/MIN.
ARTERIAL CANNULA : 8 FR. *C.P.S. FLOW : 23 MLS/MIN.*
92.86 % OF MAX. FLOW *C.P.S. SPEED : 6 RPM*
136.84 % > MAX. FLOW
BLOOD PLEGE *1:4, 1:6*
FOR DOWNSIZED CANNULA *RPM BLOOD 4 5*

VENOUS CANNULAE : *COOLING : 32 DEGREES N/P*
3.9 MM TIP 12 FR
3.9 MM TIP 12 FR *86.67% OF MAX. FLOW – INDICATED CANNULAE*
130.0% > MAX. FLOW – DOWNSIZED

PERFUSIONIST - MR.C.THUYS

SURGEON - MR.D'UDEKEM

ANAESTHETIST - DR.N.MARTIN

INSTRUMENT NURSE - SR.

MIN. PULM.VALVE RING DIAM.>>

MIN.RING SIZES.	*AREA (MM^2)*	*HALF*	*DIAMETER (MM)*
7	*39*		*5.0*

MEAN NORMAL VALVE DIAM.>>	*MITRAL*	*TRICUSPID*	*AORTIC*	*PULM.*
	11.2	13.4	7.2	8.4

EXAMPLE ONLY

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ROYAL CHILDREN'S HOSPITAL

PERFUSION DATA
CASE NUMBER 206
DATE - TUSEDAY 6 JULY 2014
****
****

NAME - FX-05, CLEAR PRIME *HEIGHT - 88 CM.*
U.R. - 9999999 BLD.GRP - A NEGATIVE WEIGHT - 11.75 KG.
DOB - 04/07/2012 AGE - 24 MONTHS SURFACE AREA - 0.523 SQ.M
HAEMOGLOBIN - 15.5 GM/DL.
BLOOD VOL. - 940 MLS.
PREVIOUS SURGERY :
DIAGNOSIS : VSD

HEPARIN - 15 MG. *HCT. ON BYPASS - 33.8*
BICARBONATE - 12 MM. *HB ON BYPASS - 11.2*
CALCIUM - 2.0 MM. *FEMORAL SIZE - 2.5*
PLASMALYTE 148 - 350 MLS.
5% DEXTROSE - 10 MLS. *DILUENT VOLUME - 475 MLS.*
ALBUMIN 20% - 100 MLS. *VOLUME OF BLOOD - 0 MLS.*

TOTAL PRIME >>>>> 475 MLS.

OXYGENATOR : TERUMO FX 05 *OPTIMUM FLOW : 1250 MLS/MIN.*
ARTERIAL CANNULA : 14 FR. *C.P.S. FLOW : 58 MLS/MIN.*
89.29 % OF MAX. FLOW *C.P.S. SPEED : 15 RPM*
125.00 % > MAX. FLOW *BLOOD PLEGE 1:4, 1:6*
FOR DOWNSIZED CANNULA *RPM BLOOD 11 13*

VENOUS CANNULAE : *COOLING : 32 DEGREES N/P*
3.9 MM TIP 16 FR
3.9 MM TIP 16 FR *89.29% OF MAX. FLOW – INDICATED CANNULAE*
125.0% > MAX. FLOW – DOWNSIZED CANNULAE

PERFUSIONIST - *MR.C.THUYS*

SURGEON - *MR.D'UDEKEM*

ANAESTHETIST - *DR.I. SMITH*

INSTRUMENT NURSE - *SR.*

MIN. PULM.VALVE RING DIAM.>>	*MIN.RING DIAMETER (MM)*	*SIZE*	*AREA (MM^2)*	*HALF SIZES.*
	12		*113*	*8.5*

MEAN NORMAL VALVE DIAM.>>	*MITRAL*	*TRICUSPID*	*AORTIC*	*PULM.*
	15.8	19	11	12

EXAMPLE ONLY

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ROYAL CHILDREN'S HOSPITAL

PERFUSION DATA
CASE NUMBER 206
DATE - TUSEDAY 6 JULY 2014
****
****

NAME - FX15W30, CLEAR PRIME HEIGHT - 142 CM.
U.R. - 9999999 BLD.GRP - A NEGATIVE WEIGHT - 28.60 KG.
DOB - 02/11/2005 AGE - 8.7 YEARS SURFACE AREA - 1.080 SQ.M
HAEMOGLOBIN - 15.0 GM/DL.
BLOOD VOL. - 2288 MLS.
PREVIOUS SURGERY :
DIAGNOSIS : ASD

HEPARIN - 38 MG. HCT. ON BYPASS - 34.8
BICARBONATE - 35 MM. HB ON BYPASS - 10.4
CALCIUM - 3.0 MM. FEMORAL SIZE - 4.0
PLASMALYTE 148 - 750 MLS.
5% DEXTROSE - 10 MLS. DILUENT VOLUME - 902 MLS.
ALBUMIN 20% - 100 MLS. VOLUME OF BLOOD - 0 MLS.

TOTAL PRIME >>>>> 902 MLS.

OXYGENATOR : TERUMO FX15W30 OPTIMUM FLOW : 2590 MLS/MIN.
ARTERIAL CANNULA : 18 FR. C.P.S. FLOW : 121 MLS/MIN.
86.33 % OF MAX. FLOW C.P.S. SPEED : 32 RPM
143.89 % > MAX. FLOW BLOOD PLEGE 1:4, 1:6
FOR DOWNSIZED CANNULA RPM BLOOD 24 28

VENOUS CANNULAE : COOLING : 34 DEGREES N/P
3.9 MM TIP 22 FR

3.9 MM TIP 20 FR *94.18 % OF MAX. FLOW – INDICATED CANNULAE*

103.6 % > MAX. FLOW – DOWNSIZED CANNULAE

PERFUSIONIST - *MR.C.THUYS*

SURGEON - *MR.D'UDEKEM*

ANAESTHETIST - *DR.I.SMITH*

INSTRUMENT NURSE - *SR.*

MIN. PULM.VALVE RING DIAM.>>	*MIN.RING DIAMETER (MM)*	*SIZE*	*AREA (MM^2)*	*HALF SIZES.*
	18.5		*270*	*13*

MEAN NORMAL VALVE DIAM.>>	*MITRAL*	*TRICUSPID*	*AORTIC*	*PULM.*
	20.2	24.9	14.0	15.3

EXAMPLE ONLY

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ROYAL CHILDREN'S HOSPITAL

PERFUSION DATA
CASE NUMBER 206
DATE - TUSEDAY 6 JULY 2014
****
****

NAME - FX15W40/FX25, CLEAR PRIME HEIGHT - 176 CM.
U.R. - 9999999 BLD.GRP - A NEGATIVE WEIGHT - 65.40 KG.
DOB - 25/04/1999 AGE - 15.2 YEARS SURFACE AREA - 1.794 SQ.M
HAEMOGLOBIN - 13.6 GM/DL.
BLOOD VOL. - 5232 MLS.
PREVIOUS SURGERY :
DIAGNOSIS : ASD

HEPARIN - 38 MG. HCT. ON BYPASS - 36.2
BICARBONATE - 45 MM. HB ON BYPASS - 11.0
CALCIUM - 4.0 MM. FEMORAL SIZE - 5.0
PLASMALYTE 148 - 1000 MLS.
5% DEXTROSE - 10 MLS. DILUENT VOLUME - 1259 MLS.
ALBUMIN 20% - 200 MLS. VOLUME OF BLOOD - 0 MLS.

TOTAL PRIME >>>>> 1259 MLS.

OXYGENATOR : TERUMO FX15W40/FX25 OPTIMUM FLOW : 4300 MLS/MIN.
ARTERIAL CANNULA : 20 FR. C.P.S. FLOW : 201 MLS/MIN.
61.43 % OF MAX. FLOW C.P.S. SPEED : 54 RPM
143.33 % > MAX. FLOW BLOOD PLEGE 1:4, 1:6
FOR DOWNSIZED CANNULA RPM BLOOD 41 47

VENOUS CANNULAE : COOLING : 34 DEGREES N/P
3.9 MM TIP 28 FR

3.9 MM TIP 28 FR *86.00 % OF MAX. FLOW – INDICATED CANNULAE*

110.3 % > MAX. FLOW – DOWNSIZED CANNULAE

PERFUSIONIST - *MR.C.THUYS*

SURGEON - *MR.D'UDEKEM*

ANAESTHETIST - *DR.M.CLIFFORD*

INSTRUMENT NURSE - *SR.*

MIN. PULM.VALVE RING DIAM.>>	*MIN.RING DIAMETER (MM)*	*SIZE*	*AREA (MM^2)*	*HALF SIZES.*
	20.0		*314*	*14*

MEAN NORMAL VALVE DIAM.>>	*MITRAL*	*TRICUSPID*	*AORTIC*	*PULM.*
	23.8	29.1	16.5	18.2

CBP RECORDS

Records are kept in both EPIC and the Spectrum Vision data management systems. EPIC contains patient data while Spectrum Vision contains pump related data.