University Hospitals of Leicester NHS
NHS Trust

Administration of Medicines and Intravenous Fluids via a Cardiopulmonary Bypass circuit within the Clinical Perfusion Department for Paediatric Cardiac Surgery

Approved By:	Policy & Guideline Committee
Date of Original Approval:	**16 April 2021**
Trust Reference:	**B22/2021**
Version:	2
Supersedes:	1 - April 2021
Trust Leads:	Dr Jaswant Sumal (Paediatric Consultant Anaethetist) & Gavin Majithia-Beet (Senior Perfusionist).
Board Director Lead:	Dr Andrew Furlong, Medical Director
Date of Latest Approval	19 April 2024 – Policy and Guideline Committee
Next Review Date:	**April 2027**

CONTENTS

REVIEW DATES AND DETAILS OF CHANGES MADE DURING THE REVIEW

Review of Policy after six months of implentation.

KEY WORDS

Cardiopulmonary Bypass (CPB)
Perfusion Department,
Administration of Medicines,
Paediatric Cardiac Surgery,
Accredited Clinical Perfusionist (ACP)
Patient Specific Directions (Akin to a prescription)

1 INTRODUCTION AND OVERVIEW

1.1 This document sets out the University Hospitals of Leicester (UHL) NHS Trusts Policy and Procedures for the safe administration of medicines and intravenous fluids by Accredited Clinical Perfusionists (ACP) during Paediatric Cardiopulmonary Bypass (CPB) for Paediatric cardiac surgery.

1.2 The department of Clinical Perfusion provides clinical perfusion services to patients requiring Paediatric cardiac surgery.

1.3 CPB requires a specialised circuit to be primed with fluids suitable for intravenous administration and medicines to be administered for the maintenance of a safe physiological environment for the patient. It is considered safe, practical and appropriate for the ACP to administer these medicines/fluids as they have expert knowledge of CPB and the circuits used.

1.4 The aim of this document is to design a framework for the safe administration of medicines and intravenous fluids by ACP during CPB for Paediatric Cardiac Surgery in accordance with recommendations made by the Department of Health, July 2009, within the "Guide to Good Practice in Clinical Perfusion" which can be found at https://www.actacc.org/sites/default/files/2019-06/DH-Guide-to-good-practice-199-30-07-2009.pdf

2 POLICY SCOPE –WHO THE POLICY APPLIES TO AND ANY SPECIFIC EXCLUSIONS

2.1 Clinical Perfusionists must be accredited by the Society of Clinical Perfusion Scientists of Great Britain & Ireland, and registered with the College of Clinical Perfusion Scientists of Great Britain & Ireland. All UHL Policies must clearly state the staff groups / professions that they apply to.

2.2 Only an accredited Clinical Perfusionist can undertake (or supervise a trainee) with the administration of medicines/fluids in the CPB circuit or prime of the circuit. The responsibility of medicine and fluid administration remains with the ACP when they are supervising a trainee Perfusionist.

2.3 This policy applies to all staff involved in the prescribing process & administration of medicines/fluids to patients by ACP via a cardiopulmonary bypass circuit whilst undergoing paediatric cardiac surgery.

3 DEFINITIONS AND ABBREVIATIONS

ACT = Activated Clotting Time

CPB = CardioPulmonary Bypass

ANTT = Aseptic Non-Touch Technique

4 ROLES – WHO DOES WHAT

4.1 The executive lead responsible for this policy is the Medical Director

4.2 **The Clinical Director and Head of Operations** are responsible for ensuring staff within the RRCV, ITAPS and W&C CMGS are aware of the policy and are adequetly trained

4.3 **The Principal Perfusionist** is responsible for:

- ensuring that the appropriate paperwork is completed with all signatories and that a record is maintained by W&C CMG office manager.

- Auditing the policy and reporting results highlighting concerns to the Medicines Optimisation Committee

4.4 **Consultant Paediatric Cardiothoracic Surgeons and Paediatric Cardiothoracic Anaesthetists** will support the implementation of this policy with the clinical perfusionists

4.5 **Clinical perfusionists** must be aware of and follow this policy. Perfusionists are trained and qualified to a Masters level in Perfusion run by Bristol University, where the pharmacology involving cardiac surgery forms part of the qualification gained. They are responsible for maintaining and updating their knowledge as appropriate. Agreement to use this policy confirms that the Clinical Perfusionist administering the drugs and fluids is adequately qualified and knowledgeable of drugs and fluids used in paediatric cardiac surgery, as well as the actions, indications, contra-indications, dosages, administration regimes/routes and side effects of those drugs and fluids.
All Clinical Perfusionists must attend and pass the "IV's – Administration of Intravenous Drugs – Paediatrics" course run by the University Hospitals of Leicester.

4.6 **Principal pharmacists** for CMGs are responsible for supporting the annual review of the drug appendicies

5. POLICY STATEMENTS

5.1 Clinical Perfusionists are able to administer a limited list of Prescription Only Medicines (POMs) routinely used during CPB for paediatric patients under the direction of an appropriate prescriber.

The List includes:

a) Medicines added to the CPB circuit prime: GROUP A
b) Medicines administered routinely during CPB according to protocol: GROUP B
c) Medicines administered on the direction of the surgeon or anaesthetist in specific or emergency situations: GROUP C

Please refer to Appendix 1 for details of the POMS included.

5.2 The infusions and drug ampoules/containers will be checked for integrity and sterility to ensure there is no damage, debris or other contamination that could be detrimental to the patient. The preparation and administration of all drugs and fluids will be with aseptic non-touch technique (ANTT). All drugs and fluids used will be within their expiry date.

5.3 Drugs drawn up into syringes or added to infusions or fluids to be given, will be clearly identified by manufacturer's labelling or an approved drug additive label stating the name of the drug, dose added, volume of fluid to be added, date and time of constitution. All drugs/fluids must be second checked by a second ACP & documented as such on the perfusion chart.

5.4 All drugs to be administered to the patient via the CPB circuit must be documented on the Perfusionist record chart which will be filed in the patient's notes.

5.5 The Perfusionist will safely dispose of all sharps and waste in accordance with UHL Trust Waste Management policy.

5.6 Safe administration of medicines and intravenous fluids during CPB requires a high level of communication between surgeons, anaesthetists and ACP.

5.7 CPB Drug Administration Protocols suitable for the specific patient will be confirmed prior to starting CPB by the Consultant Cardiac Surgeon and Consultant Anaesthetist at the morning theatre team meeting.

5.8 The surgeon & anaesthetist will then prescribe the framework of drugs by signing the prescription box on the Patient's Perfusion Chart. Thereby giving the ACP permission to administer drugs/fluids to the patient within the parameters set out in the framework (see Appendix 1)

5.9 At the SIGN-IN session in theatre where the WHO checklist is carried out prior to skin incision for each patient, a check will be added to this list to ensure the perfusion medicines have been prescribed

6 EDUCATION AND TRAINING REQUIREMENTS

6.1 All Perfusionists must attend the Intravenous Study Day on Administration of Intravenous Drugs (Paediatrics) course run by UHL.

6.2 All ACPs will have undergone mandatory Trust training on ANTT before administering any drugs/fluids & maintain competence by renewal in line with Trust policy & adhere to the Trust policy on the safe administration of IV Medicines in their line of work.

6.3 All Perfusionists and interested parties must read this policy document along with the Appendices and most importantly Annex B of the protocol. The document with then be signed off by all parties involved on the signatory register.

7 PROCESS FOR MONITORING COMPLIANCE

7.1 The following table lists the monitoring arrangements for this policy:

Element to be monitored	Lead	Tool	Frequency	Reporting arrangements	Lead(s) for acting on recommendations	Change in practice and lessons to be shared
The Medicines framework (Annex B) is adhered to by the Perfusionists and Consultants	Principal Perfusionist	Inspect the Perfusion Charts to confirm they are being completed correctly with regards to prescribing and administration	6 months	Medicines Optimisation commitee (UHL) Quality and Safety Board Committee (W&C CMG and RRCV)	Principal Perfusionist	All Parties will be communicated of any changes needed along with a timeframe for implementation
Competence of ANTT training for perfusionists	Principal Perfusionist	Register of mandatory attendance for perfusionists	6 months	Quality and Safety Board Committee (W&C CMG and RRCV)	Principal Perfusionist	Mandatory training for staff
Incidents involving medicines and intravenous fluid via CPB circuits	Principal Perfusionist	Datix	6 months	Medicines Optimisation commitee (UHL) Quality and Safety Board Committee (W&C CMG and RRCV)	Principal Perfusionist & Lead Anaesthetist	All Parties will be communicated of any changes needed along with a timeframe for implementation

8 EQUALITY IMPACT ASSESSMENT

8.1 The Trust recognises the diversity of the local community it serves. Our aim therefore is to provide a safe environment free from discrimination and treat all individuals fairly with dignity and appropriately according to their needs.

8.2 As part of its development, this policy and its impact on equality have been reviewed and no detriment was identified.

9 SUPPORTING REFERENCES, EVIDENCE BASE AND RELATED POLICIES

- Protocols and Guidelines for Perfusion Techniques, Perfusion Department Glenfield Hospital. January 2015
- Guide to Good Practice in Clinical Perfusion, Department of Health July 2009
- Leicestershire Medicines Code Policy (UHL Policy Number - B60/2011)
- IV Policy * (*excluding cytotoxic, epidural, PN and radiopharmaceuticals) Intravenous Policy (UHL Policy Number - B25/2010)
- Aseptic Non Touch Technique Guidelines (ANTT) (B20/2013)
- http://www.medicines.org.uk/emc/medicine/ Summary of Product Characteristics for the drugs included in this document

- BNF for Children 2018/2019 edition
- Royal College of Anaesthetists "*Planning the introduction & training for Physicians' Assistants (anaesthesia), Appendix E Executive summary*" April 2016 [accessed 4th December 2020] Available from: https://www.rcoa.ac.uk/sites/default/files/documents/2020-02/Planning-introduction-training-PAA-2016.pdf

10 PROCESS FOR VERSION CONTROL, DOCUMENT ARCHIVING AND REVIEW

This document will be uploaded onto SharePoint and available for access by Staff through INsite. It will be stored and archived through this system.

Review Record			
Date	**Issue No**	**Reviewed By**	**Description of change (if any)**
4/11/19	**1**	**Initial release**	**None**
19/4/24	2		

Appendix 1

Annex B

A Framework for the Administration of Named Medicines by Clinical Perfusion Scientists during Paediatric Cardiopulmonary Bypass

Framework version 1:

Valid from ……April 2021… ……

Expires ……April 2023……

Background

This document provides a framework for the administration of named medicines during cardiopulmonary bypass (CPB). Agreed medicines management protocols are outlined in the following pages to be used for individual named patients as a Patient Specific Directions. Prior to the operation it will be decided if it is safe for this framework to be followed for each specific patient & identify if any contra-indications. This framework only applies to paediatric patients.

This framework must be approved by the Trusts Medicines Optimisation Committee and Policy & Guideline Committee. It must also be read, signed and dated by all the Trusts Cardiac Anaesthetists, Cardiac Surgeons, Clinical Perfusionists within the unit as an integral part of their Standard Operating Procedures.

The medicines management protocols will be reviewed and updated as needed on an annual basis.

A signatories section with all parties responsible for the implementation of the Medicines Management policy for Perfusionists will be held by the Principal Perfusionist.

The signatories will be reviewed on a yearly basis by the Principal Perfusionist and updated where appropriate.

This framework applies to the following list of prescription-only medicines (POMS), routinely used during CPB at the direction of an appropriate prescriber.

This list includes:

GROUP A Medicines added to the CPB circuit <u>prime</u>;

GROUP B Medicines administered <u>routinely during</u> CPB according to protocol;

GROUP C Medicines administered on the <u>direction</u> of the Consultant surgeon/anaesthetist in <u>specific</u> or emergency situations.

The medicines on this list are subject to annual update.

Other medicines may be given on the direction of the anaesthetist/surgeon. When these directions need to be given orally, any medicine or fluid used by the ACP that is not detailed in this framework **must** be individually prescribed by an anaesthetist/surgeon & subsequently recorded in the patients notes and on the clinical perfusion chart.

Where this is occurring regularly, the medicine should be considered for adding to the list of drugs in this framework and therefore included in the annual update.

Review Record			
Date	**Issue No**	**Reviewed By**	**Description of change (if any)**
16/4/2021	**1**	**Initial release**	**None**
19/4/24	2		

Medicines for Children

Group A: Medicines added To the CPB circuit prime

Calcium Chloride
Gelatin Solution (eg. Gelofusine)
Hartmann's Solution
Heparin
Mannitol
Plasmalyte 148 Solution
Ringer's Solution
Sodium Bicarbonate 8.4%

Group B: Medicines administered during CPB according to protocol

Calcium Chloride
Gelatin Solution (eg. Gelofusine)
Hartmann's Solution
Heparin
Metaraminol
Phentolamine
Phenylephrine
Plasmalyte 148 Solution
Potassium Chloride
Ringer's Solution
Sodium Bicarbonate 8.4%
Sodium Chloride 0.9%

Group C: Medicines administered on the direction of surgeon or anaesthetist

Dexamethasone
Cardioplegia
Furosemide
Isoflurane
Magnesium Sulphate
Methylprednisolone
Milrinone
Sevoflurane
Tranexamic Acid

Prescribing:

These Patient Specific Directions, if appropriate for the patient, will be prescribed by the Anaesthetist/Surgeon prior to the case, on the Clinical Perfusion Chart by signing against Group A/B/C in the prescription box.

This thereby authorises the Clinical Perfusionist to follow this framework within the parameters set out.

Detailing, if appropriate, any medicines that are contra-indicated for that patient within the framework, or any drug allergies.

The anaesthetist/surgeon is signing in line with their prescribing role within the Trust and is in no way accountable for the ACP standard of care.

In line with other non-statutory regulated groups of staff, the supervising consultant must prescribe the medication for the specific patient in order to allow the perfusionist to check and administer the drugs within the agreed framework.

(Please refer to https://www.rcoa.ac.uk/sites/default/files/documents/2020-02/Planning-introduction-training-PAA-2016.pdf "planning the introduction and training for physician assistants (anaesthesia), Appendix E executive summary : number 9)

Administration:

Any medicine administered by the ACP under this framework must be recorded on the clinical perfusion chart in accordance with unit protocols.

Any medicines administered by ACP must be done following Trust protocol on the safe IV administration of drugs/fluids; ensuring second checks of drugs/fluids are carried out and documented prior to administration.

Details of the Prescription Only Medicines allowed within this framework are outlined in the following pages:

Childrens Group A: Medicines added to the CPB circuit prime

In the following descriptions, the dose range and maximum dose information pertain only to use of the medicine during priming of the circuit. Refer to SOP for priming of CPB circuit.

Medicine	**CALCIUM CHLORIDE**
Legal Status	POM
Form and Strength	Injection 10% 100 mg/ml (Ca^{2+} 0.68 mmol/ml).
Indications	Acute hypocalcaemia; blood based CPB circuit prime.
Contra-Indications	Conditions associated with hypercalcaemia and hypercalciuria (e.g. some forms of malignant disease).
Dose Range	Blood prime: 2.5 mmol per unit of blood.
Maximum Dose	Ionised Ca^{2+} level 1.1–1.4 mmol/L.
Acute Side-Effects	Peripheral vasodilatation, hypotension.

Medicine	**GELATIN SOLUTION (eg. Gelofusine or Volplex)**
Legal Status	POM
Form and Strength	Intravenous infusion 4% in 500 ml. Also contains Na^{+} 154 mmol and Cl^{-} 120 to 125 mmol per L (depending on brand).
Indications	CPB prime.
Contra-Indications	Susceptibility to circulatory overload. Hypersensitivity
Dose Range	10–30 ml/kg. (10 to 1000ml for prime)
Maximum Dose	Administered according to clinical need and size of patient.
Acute Side-Effects	Hypersensitivity reactions may occur including, rarely, severe anaphylactoid reactions.

Medicine	**COMPOUND SODIUM LACTATE SOLUTION (Hartmann's Solution)**
Legal Status	POM
Form and Strength	Compound Sodium Lactate intravenous infusion 500ml and 1000 ml bags. Each litre contains: Na^+ 131 mmol, K^+ 5 mmol, Ca^{2+} 2 mmol, Cl^- 111 mmol, lactate 29 mmol.
Indications	Component CPB circuit prime; Circulatory volume replacement.
Contra-Indications	Severe hepatic damage, respiratory/metabolic alkalosis, severe renal insufficiency (with oliguria/anuria) or any condition where lactate level is elevated.
Dose Range	10-50 ml/kg. Up to 2 Litres of Hartmann's solution may be used in the CPB circuit prime depending on body weight.
Maximum Dose	Administered repeatedly according to clinical need, with a usual maximum of 3 Litres.
Acute Side-Effects	Rare. Anaphylactic/anaphylactoid reactions, urticaria, skin rashes and pruritus. Chest tightness, chest pain with tachycardia or bradycardia. Nasal congestion, coughing, sneezing, bronchospasm and difficulty in breathing have been reported.

Medicine	**HEPARIN SODIUM**
Legal Status	POM
Form and Strength	Injection 1000 units/ml strength. Available in 5ml (5,000 units) ampoules,
Indications	Anticoagulation of circuit
Contra-Indications	Haemophilia and other haemorrhagic disorders, existing or previous thrombocytopenia, recent cerebral haemorrhage. Previous skin necrosis secondary to heparin. Severe liver disease, including oesophageal varices
Dose Range	100 to 3000 units in CPB circuit prime - see reference: protocols and guidelines for perfusion techniques
Maximum Dose	3000 units.
Acute Side-Effects	Haemorrhage, thrombocytopenia, hypersensitivity, hyperkalaemia

Medicine	**MANNITOL**
Legal Status	POM
Form and Strength	Intravenous infusion 10% and 20% in 500 ml bags. (10% solution = 1g in 10ml) or (20% solution – 2g in 10ml)
Indications	Osmotic diuretic.
Contra-Indications	Severe dehydration, pulmonary oedema. Do not use if mannitol crystals present
Dose Range	0.5 g/kg (single dose to CPB prime)
Acute Side-Effects	Chills, fever, hypotension

Medicine	**PLASMALYTE 148 SOLUTION**
Legal Status	POM
Form and Strength	1000 ml bags. Each Litre contains Na^+140 mmol, K^+ 5 mmol, Mg^{2+}3 mmol, Cl^- 98 mmol, acetate 27 mmol, and gluconate 23 mmol.
Indications	CPB prime.
Contra-Indications	None; caution in renal failure, hyperkalaemia, hypernatraemia, hyperchloraemia
Dose Range	Up to 1000 ml depending on weight and volume status (10–50 ml/kg)
Acute Side-Effects	Haemorrhage, thrombocytopaenia, fever, phlebitis, thrombosis.

Medicine	**RINGER'S SOLUTION**
Legal Status	POM
Form and Strength	Ringer's Solution intravenous injection 500 ml or 1 Litre bags. Each litre contains: Na^+ 147 mmol, K^+ 4 mmol, Ca^{2+} 2.2 mmol, Cl^- 156 mmol.
Indications	Prime, Crystalloid component of the cardioplegia solution.
Contra-Indications	Hyperkalaemia, hypernatraemia, hypercalacaemia, hyperchloraemia. Severe renal insufficiency (with oliguria/anuria)
Dose Range	10–50 ml/kg. Up to 2 Litres of Ringer's Solution may be used depending on patient size.
Maximum Dose	Administered according to clinical need, with a usual maximum of 3 Litre.
Acute Side-Effects	Rare. Anaphylactic/anaphylactoid reactions, urticaria, skin rash and pruritus. Chest tightness, chest pain with tachycardia or bradycardia. Nasal congestion, coughing, sneezing, bronchospasm and difficulty in breathing have been reported.

Medicine	**SODIUM BICARBONATE 8.4%**
Legal Status	POM
Form and Strength	Injection BP 8.4% (1 mmol/ml) in 50 ml glass syringe.
Indications	Control of metabolic acidosis. May be added to the bypass circuit prime to adjust pH. Blood based CPB prime.
Contra-Indications	Metabolic or respiratory alkalosis, hypocalcaemia, or hypochlorhydria.
Dose Range	Blood Prime: 10 ml 8.4% for every unit of blood. For priming the circuit the following formula is used: Circuit volume (ml) x 0.025 Note: The circuit volumes used at UHL are 450 or 650 or 950ml
Acute Side-Effects	Sodium bicarbonate injection 8.4% is hypertonic. Tissue necrosis may follow extravasation at the site of injection. Excessive administration of bicarbonate may lead to metabolic alkalosis, especially in patients with impaired renal function, and sodium overload.

Childrens Group B: Medicines administered during CPB according to protocol

Medicine	CALCIUM CHLORIDE
Legal Status	POM
Form and Strength	Injection 10% 100 mg/ml (Ca^{2+} 0.68 mmol/ml).
Indications	Acute hypocalcaemia.
Contra-Indications	Conditions associated with hypercalcaemia and hypercalciuria (e.g. some forms of malignant disease).
Dose Range	0.1–0.14 mmol/kg.
Maximum Dose	Ionised Ca^{2+} level 1.1-1.4 mmol/L.
Acute Side-Effects	Peripheral vasodilatation, hypotension.

Medicine	GELATIN SOLUTION (eg. Gelofusine or Volplex)
Legal Status	POM
Form and Strength	Intravenous infusion 4% in 500 ml. Also contains Na^{+} 154 mmol and Cl^{-} 120 to 125 mmol per Litre (depending on brand).
Indications	Low blood volume.
Contra-Indications	Susceptibility to circulatory overload.
Dose Range	Initially 10–40ml
Maximum Dose	Administered according to clinical need and size of patient. The usual maximum volume added during bypass is 500ml although larger volumes may be required in more complicated procedures.
Acute Side-Effects	Hypersensitivity reactions may occur including, rarely, severe anaphylactoid reactions.

Medicine	**COMPOUND SODIUM LACTATE SOLUTION (Hartmann's Solution)**
Legal Status	POM
Form and Strength	Compound Sodium Lactate intravenous infusion 1000 ml. Each litre contains: Na^+ 131 mmol, K^+ 5 mmol, Ca^{2+} 2 mmol, Cl^- 111 mmol, lactate 29 mmol.
Indications	Circulatory volume replacement.
Contra-Indications	Severe hepatic damage, respiratory/metabolic alkalosis, severe renal insufficiency (with oliguria/anuria) or any condition where lactate level is elevated.
Dose Range	Up to 2 Litres of Hartmann's solution is used according to patient size. 10 to 40ml bolus when required
Maximum Dose	Administered repeatedly according to clinical need, with a l maximum of 2 Litres.
Acute Side-Effects	Rare. Anaphylactic/anaphylactoid reactions, urticaria, skin rashes and pruritus. Chest tightness, chest pain with tachycardia or bradycardia. Nasal congestion, coughing, sneezing, bronchospasm and difficulty in breathing have been reported.

Medicine	**HEPARIN SODIUM**
Legal Status	POM
Form and Strength	Injection 1000 units/ml strength. Available in 5ml (5,000 units), 10ml (10,000 units) or 20ml (20,000 unit) ampoules.
Indications	Anticoagulation.
Contra-Indications	Haemophilia and other haemorrhagic disorders, existing or previous thrombocytopenia, recent cerebral haemorrhage. Previous skin necrosis secondary to heparin. Severe liver disease, including oesophageal varices.
Dose Range	Additional bolus of 100 to 5000 units if Activated Clotting Time (ACT) < 480s. Target ranges. Maintain ACT above 480 seconds
Maximum Dose	Seek medical advice.
Acute Side-Effects	Haemorrhage, thrombocytopenia, hypersensitivity, hyperkalaemia

Medicine	**METARAMINOL**
Legal Status	POM
Form and Strength	Injection 10 mg/ml in 1 ml ampoule.
Indications	Acute hypotension.
Contra-Indications	Hypertension, pregnancy.
Dose Range	0.01 mg/kg, repeated as required, if not achieving response seek advice from anaesthetist / surgeon.
Acute Side-Effects	Tachycardia.

Medicine	**PHENTOLAMINE**
Legal Status	POM
Form and Strength	Injection 10 mg/ml in 1 ml ampoule.
Indications	Acute hypertension.
Contra-Indications	Hypotension.
Dose Range	5–20 micrograms/kg repeated as required, if not achieving response seek advice from anaesthetist/surgeon.
Acute Side-Effects	Tachycardia, dizziness, nausea vomiting, prolonged hypotension

Medicine	**PHENYLEPHRINE**
Legal Status	POM
Form and Strength	Injection 10 mg/ml in 1 ml ampoule.
Indications	Acute hypotension.
Contra-Indications	Severe hyperthyroidism, pregnancy, care with patients on MAOI's (or within 14 days of ceasing MAOI's), severe hypertension
Dose Range	2–10 micrograms/kg, repeated as required, if not achieving response seek advice from anaesthetist / surgeon.
Acute Side-Effects	Tachycardia or reflex bradycardia.

Medicine	**PLASMALYTE 148 SOLUTION**
Legal Status	POM
Form and Strength	1000 ml plastic container. Each 1000 ml contains Na^+140 mmol, K^+ 5 mmol, Mg^{2+} 3 mmol, Cl^- 98 mmol, acetate 27 mmol, and gluconate 23 mmol.
Indications	Volume replacement.
Contra-Indications	None; caution in renal failure, hyperkalaemia.
Dose Range	10–40 ml/kg bolus regardless of the size of the patient.Usual maximum 1000ml
Acute Side-Effects	Fever, phlebitis, thrombosis. Hypersensitivity reactions electrolyte disturbance thromboembolism

Medicine	**POTASSIUM CHLORIDE**
Legal Status	CD POM
Form and Strength	1st line product Potassium Chloride Injection Prefilled Syringes 10mmol in 20ml 2nd Line product Potassium Chloride Injection 1.5 g (20 mmol K^+) in 10 ml ampoule. **Neat into circuit**
Indications	To maintain serum potassium concentration during CPB.
Contra-Indications	Caution in patients with renal or adrenal insufficiency, cardiac disease, or extensive tissue destruction as in severe burns.
Dose Range	0.2–0.5 mmol/kg Administered slowly into the CPB circuit, such that dilution occurs before reaching the patient. Eg in slow bolus in 0.5 mmol aliquots (every 5 minutes)
Target Range	To maintain the blood K^+ level 4.5–5.5 mmol/L, (monitored continuously via the CD1500 monitor on CPB machine)
Maximum Dose	Single dose should not exceed 10 mmol This excludes the potassium delivered in the cardioplegia solutions.
Acute Side-Effects	Hyperkalaemia, with paraesthesia, muscle weakness, hypotension, cardiac arrhythmias and cardiac arrest.

Medicine	**RINGER'S SOLUTION**
Legal Status	POM
Form and Strength	Ringer's Solution intravenous injection 500 ml or 1000 mL bags. Each litre contains: Na^+ 147 mmol, K^+ 4mmol, Ca^{2+} 2.2 mmol, Cl^- 156 mmol.
Indications	Crystalloid component of the cardioplegia solution; circulatory volume replacement.
Contra-Indications	Hyperkalaemia, hypernatraemia, hypercalacaemia, hyperchloraemia. Severe renal insufficiency (with oliguria/anuria)
Dose Range	10 to 40ml bolus doses to maintain circulating volume.
Maximum Dose	Administered according to clinical need, with a usual maximum of 3 Litres.
Acute Side-Effects	Electrolyte disturbances. Rare. Anaphylactic/anaphylactoid reactions, urticaria, skin rash and pruritus. Chest tightness, chest pain with tachycardia or bradycardia. Nasal congestion, coughing, sneezing, bronchospasm and difficulty in breathing have been reported.

Medicine	**SODIUM BICARBONATE 8.4%**
Legal Status	POM
Form and Strength	Injection 8.4% (1 mmol/ml) in 50 ml glass syringe.
Indications	Control of metabolic acidosis.
Contra-Indications	Metabolic or respiratory alkalosis, hypocalcaemia, or hypochlorhydria.
Dose Range	0.5–5 mmol/kg to correct acid base balance based on the following formula or equivalent: • <5 kg weight: dose (mmol)=base excess x weight/4 • Adolescent: dose (mmol)=base excess x weight/10 • Child: dose (mmol)=base excess x weight/6
Acute Side-Effects	Sodium bicarbonate injection 8.4% is hypertonic. Tissue necrosis may follow extravasation at the site of injection. Excessive administration of bicarbonate may lead to metabolic alkalosis, especially in patients with impaired renal function, and sodium overload.

Medicine	**SODIUM CHLORIDE 0.9%**
Legal Status	POM
Form and Strength	Intravenous Infusion 0.9% in 500 ml or 1 Litre bags.
Indications	Used as a flush and washer in the cell saver and as the crystalloid component of cardioplegia.
Contra-Indications	None.
Dose Range	Not applicable.
Maximum Dose	Not applicable.
Acute Side-Effects	Not applicable.

Children Group C: Medicines administered on the direction of surgeon or anaesthetist

Medicine	**CARDIOPLEGIA SOLUTION (HAREFIELDS FORMULA)**
Legal Status	POM
Form and Strength	500 or 1000 ml bags containing Mg^{2+} 20 mmol/L, K^{+} 20 mmol/L and procaine.
Indications	Myocardial protection on CPB during aortic clamping.
Contra-Indications	None in this context.
Dose Range	See reference: Protocols and guidelines for perfusion techniques
Acute Side-Effects	Hyperkalaemia.

Medicine	**DEXAMETHASONE**
Legal Status	POM
Form and Strength	Dexamethasone sodium phosphate 3.3 mg/ml in 1 ml ampoule.
Indications	Cerebral protection on CPB and during DHCA.
Contra-Indications	None in this context.
Dose Range	0.5-1 mg/kg.
Acute Side-Effects	Hyperglycaemia.

Medicine	**FUROSEMIDE (FRUSEMIDE)**
Legal Status	POM
Form and Strength	Injection 10 mg/ml in 2 ml ampoule.
Indications	Oedema, chronic heart failure.
Contra-Indications	Precomatose states associated with liver cirrhosis, renal failure with anuria.
Dose Range	0.5–1 mg/kg.
Maximum Dose	2 mg/kg.
Acute Side-Effects	Hyponatraemia, hypokalaemia, hypomagnesaemia, hypochloraemic alkalosis.

Medicine	ISOFLURANE
Legal Status	POM
Form and Strength	Bottles containing 100 or 250 ml liquid isoflurane.
Indications	Control of hypertension, myocardial protection, anaesthesia
Contra-Indications	Hypersensitivity. Susceptibility to malignant hyperthermia
Dose Range	0.5 – 5% administered via dedicated vaporizer into sweep gas flow.
Maximum Dose	5%.
Target Dose	Adjust according to blood pressure and depth of anaesthesia. Aim to keep MAP as specified by the Consultant Anaesthetist
Specific Caution	Waste gases must be scavenged and isoflurane concentration measured. Isoflurane can dissolve the plastic components of the CPB circuit, if spilled directly on them
Acute Side-Effects	Hypotension due to vasodilation, cardio respiratory depression.

Medicine	MAGNESIUM SULPHATE
Legal Status	POM
Form and Strength	Injection 50% (500 mg/ml; 2mmol/ml) in 10 ml ampoule.
Indications	Treatment of arrhythmias, especially in the presence of hypokalaemia.
Contra-Indications	Hepatic impairment, renal impairment, hypersensitivity, renal impairment.
Dose Range	25–50 mg/kg.
Maximum Dose	100 mg/kg.
Acute Side-Effects	Nausea, vomiting, thirst, flushing of skin, hypotension, arrhythmia, coma, muscle weakness, respiratory depression.

Medicine	METHYL PREDNISOLONE
Legal Status	POM
Form and Strength	Methyl prednisolone sodium succinate dry powder in glass vials of 40 mg, 125 mg, 500 mg, 1 g or 2 g for reconstitution with water.
Indications	Raised intracranial pressure, cerebral oedema, steroid replacement therapy, anti-inflammatory.
Contra-Indications	Hypertension; systemic infection.
Dose Range	20–30 mg/kg.
Maximum Dose	30 mg/kg.
Acute Side-Effects	Hypersensitivity reactions, thromboembolism, electrolyte disturbance.

Medicine	MILRINONE
Legal Status	POM
Form and Strength	Injection 1mg/ml in 10 ml ampoule.
Indications	Acute heart failure including low output states following heart surgery.
Contra-Indications	Hypertrophic cardiomyopathy, obstructive cardiac valvular disease.
Dose Range	0.25-0.75 micrograms/kg/min as per PICU protocol
Maximum Dose	As above, according to Trust Protocol.
Acute Side-Effects	Chest pain, tremor, bronchospasm, anaphylaxis, rash,

Medicine	SEVOFLURANE
Legal Status	POM
Form and Strength	Bottles containing 250 ml liquid sevoflurane.
Indications	Control of hypertension, myocardial protection.
Contra-Indications	Susceptibility to malignant hyperpyrexia.
Dose Range	0.5-5% administered via dedicated vaporizer into sweep gas flow.
Maximum Dose	8%.
Caution	Waste gases must be scavenged and sevoflurane concentration measured. Potential damage to CPB components if direct contact with liquid.
Acute Side-Effects	Agitation, cardio respiratory depression, hypotension.

Medicine	**TRANEXAMIC ACID**
Legal Status	POM
Form and Strength	100 mg/ml in 5 ml glass ampoules.
Indications	To prevent and treat bleeding post surgery.
Contra-Indications	Hypersensitivity reactions; Pro thrombotic conditions.
Dose Range	As per local guide for Cardiac surgery: *Loading dose:* 30mg/kg at induction over *30 minutes* *Maintenance infusion*: 5mg/kg/hour for a total of 10hours (including time on CPB)
Acute Side-Effects	Vomiting, diarrhoea, thromboembolism, allergic skin reactions, hypotension.

Reference

Adapted from DoH guidance (2009) Guide to Good Practice in Clinical Perfusion July 2009