University Hospitals of Leicester NHS
NHS Trust

Administration of Medicines and Intravenous Fluids via a Cardiopulmonary Bypass Circuit within the Clinical Perfusion Department for Adult Cardiac Surgery.

Approved By:	Policy and Guideline Committee
Date Approved:	20 May 2016
Trust Reference:	**B16/2016**
Version:	4
Supersedes:	3 (March 2021)
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Latest Review Date	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 implementation.
No Changes.

KEY WORDS

Cardiopulmonary Bypass (CPB)

Perfusion Department,

Administration of Medicines,

Adult 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 Adult Cardiopulmonary Bypass (CPB) for adult cardiac surgery.

1.2 The department of Clinical Perfusion provides clinical perfusion services to patients requiring adult 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 Adult 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.scps.org.uk/resources/useful-downloads**

2 POLICY SCOPE

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.

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 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 adult cardiac surgery.

3 ROLES AND RESPONSIBILITIES

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

3.2 **The Clinical Director and Head of Operations** are responsible for ensuring staff within the RRCV and ITAPS CMG's are aware of the policy and are adequately trained.

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

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

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

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

3.5 **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 involved 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 adult 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 – Adult run by the University Hospitals of Leicester.

3.6 **Principal pharmacists** for CMGs are responsible for supporting the annual review of the drug appendices.

4 POLICY STATEMENTS

4.1 Clinical Perfusionists are able to prescribe a limited list of Prescription Only Medicines (POMS) routinely used during CPB for adult patients under the direction of an appropriate prescriber.

The List includes:

1) Medicines Added to the CPB circuit prime: GROUP A
2) Medicines Administered routinely during CPB according to protocol: GROUP B
3) 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.

4.2 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.

4.3 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.

4.4 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.

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

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

4.7 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.

4.8 The surgeon & anaesthetist will then prescribe the framework of drugs by signing the prescription box on the Patients 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)

4.9 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.

5 EDUCATION AND TRAINING REQUIREMENTS

5.1 All Perfusionists must complete the Intravenous Study course on Administration of Intravenous Drugs (Adult) course available on HELM.

5.2 All ACP 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.

5.3 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.

6 PROCESS FOR MONITORING COMPLIANCE

6.1 The pertinent IV study day is available on HELM.

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 (RRCV CMG)	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 (RRCV CMG)	Principal Perfusionist	Mandatory training for staff

7 EQUALITY IMPACT ASSESSMENT

7.1 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.

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

8 SUPPORTING REFERENCES, EVIDENCE BASE AND RELATED POLICIES

Guide to Good Practice in Clinical Perfusion, Department of Health July 2009

Leicestershire medicines code

Intravenous Policy (B25/2010)

Aseptic Non Touch Technique Guidelines (ANTT) B20/2013

BNF (British National Formulary) | NICE Summary of Product Characteristics for the drugs included in this document
BNF edition 70
Royal College of Anaesthetists "*Planning the introduction & training for Physician Assistants (anaesthesia), Appendix E Executive summary*" April 2016 [accessed May 3rd 2016]
Available from: https://www.anaesthesiaassociates.org/wp-content/uploads/2018/03/Planning-introduction-training-PAA-2016.pdf

9 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.

Appendix 1

Annex B

A Framework for the Administration of Named Medicines by Accredited Clinical Perfusion Scientists (ACP) during Adult Cardiopulmonary Bypass.

Framework Version 1

Valid From ..... April 2021

Expires..... April 2024

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 Adult 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 prime;

GROUP B Medicines administered routinely during CPB according to protocol;

GROUP C Medicines administered on the direction of the Consultant surgeon/anaesthetist in specific 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.

Medicines for adults:

Group A: Medicines added to the CPB circuit prime
Compound Sodium Lactate (Hartmann's solution)
Gelatin solution (e.g. Volplex)
Heparin Sodium
Mannitol
Plasma-lyte 148 solution
Sodium Bicarbonate

Group B: Medicines administered during CPB according to protocol
Compound Sodium Lactate (Hartmann's solution)
Gelatin solution (e.g. Volplex)
Heparin Sodium
Isoflurane
Mannitol
Phenylephrine
Plasma-lyte 148 solution
Potassium Chloride
Ringer's Solution
Sodium Bicarbonate

Group C: Medicines administered on the specific direction of surgeon/anaesthetist
Amiodarone
Atropine
Cardioplegia
Magnesium sulphate
Milrinone
Noradrenaline

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.anaesthesiaassociates.org/wp-content/uploads/2018/03/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:

Adults 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.

Medicine	**COMPOUND SODIUM LACTATE SOLUTION (HARTMANN'S SOLUTION)**
Legal Status	POM
Form & strength	Compound Sodium Lactate intravenous infusion 500ml, 1000ml bags. Each litre contains Na^{+} 131mmol, K^{+} 5mmol, Ca^{++} 2mmol, Cl^{-} 111mmol, Lactate 29mmol
Indications	CPB prime
Contra-indications	Severe hepatic damage, respiratory/metabolic alkalosis, severe renal insufficiency (with oliguria/anuria) or any condition where plasma lactate is elevated
Dose range	Up to 1000ml of Hartmann's solution is used in the priming solution of the bypass circuit
Acute side-effects	Rare, anaphylactoid/anaphylactic reactions, urticaria, skin rashes and pruritis. Chest tightness, chest pain with tachycardia or bradycardia. Bronchospasm and difficulty in breathing have been reported.

Medicine	**GELATIN 4% SOLUTION (e.g. VOLPLEX)**
Legal Status	POM
Form & strength	Intravenous infusion 4% in 500ml bags. Also contains Na 154mmol and Cl^{-} 125mmol per litre
Indications	CPB prime
Contra-indications	Susceptibility to circulatory overload, hypersensitivity
Dose range	500ml of a 4% solution
Acute side-effects	Hypersensitivity reactions may occur including, rarely severe anaphylactoid reactions.

Medicine	**HEPARIN SODIUM**
Legal Status	POM
Form & strength	Injection 1000units/ml in 5ml, 10ml 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	5000-10,000units bolus
Acute side-effects	Haemorrhage, thrombocytopenia, hypersensitivity, priapism, hyperkalaemia

Medicine	**MANNITOL**
Legal Status	POM
Form & strength	Intravenous infusion 10% and 20% in 500ml bags
Indications	CPB prime
Contra-indications	Severe dehydration, pulmonary oedema. Check bags for mannitol crystals before use
Dose	0.5g/kg, (10% solution = 1g in 10ml) E.g. typical dose range of a 10% solution is 250-500ml (25-50g)
Maximum Dose	0.5g/kg (=5ml/kg of 10% solution)
Acute side-effects	Chills, fever, hypotension

Medicine	PLASMALYTE 148 SOLUTION
Legal Status	POM
Form & strength	1000ml bags. Each litre contains Na^+ 140mmol, K^+ 5mmol, Mg^{++} 3mmol, Cl^- 98mmol, acetate 27mmol, gluconate 23 mmol
Indications	CPB prime
Contra-indications	Electrolyte disturbances including hyperkalaemia, hypernatraemia, hyperchloraemia; caution in renal failure,
Dose	1000ml in circuit prime
Acute side-effects	Hypersensitivity reactions, thromboembolism, electrolyte disturbances. Fever, phlebitis, seizures

Medicine	SODIUM BICARBONATE 8.4%
Legal Status	POM
Form & strength	Injection BP 8.4% (1mmol/ml drawn up in to a 50ml syringe)
Indications	May be added to the CPB prime to adjust the pH
Contra-indications	Metabolic or respiratory alkalosis, hypocalcaemia or hypochlorhydria
Dose range	Up to 40mmol added to the prime according to the base deficit
Maximum Dose	None in this context
Acute side-effects	Sodium bicarbonate 8.4% injection 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.

Adults Group B: Medicines administered during CPB according to protocol

Medicine	COMPOUND SODIUM LACTATE (HARTMANN'S SOLUTION)
Legal Status	POM
Form & strength	Compound Sodium Lactate Intravenous Infusion 500ml, 1000ml bags. Each litre contains Na^+ 131mmol, K^+ 5mmol, Ca^{++} 2mmol, Cl^- 111mmol, Lactate 29mmol
Indications	Low circulating volume
Contra-indications	Severe hepatic damage, respiratory/metabolic alkalosis, severe renal insufficiency (with oliguria/anuria) or any condition where plasma lactate is elevated
Dose range	Repeated bolus doses of 200ml
Maximum Dose	Administered repeatedly according to clinical need, with a usual maximum of 3000ml
Acute side-effects	Rare, anaphylactoid/anaphylactic reactions, urticarial, skin rashes and pruritis. Chest tightness, chest pain with tachycardia or bradycardia. Bronchospasm and difficulty in breathing have been reported.

Medicine	GELATIN 4% SOLUTION (e.g. VOLPLEX)
Legal Status	POM
Form & strength	Intravenous infusion 4% in 500ml bags. Also contains Na^+ 154mmol and Cl^- 125mmol per litre
Indications	Low circulating volume

Contra-indications	Susceptibility to circulatory overload
Dose range	Initially 200ml of a 4% solution
Maximum Dose	Administered according to clinical need. The usual maximum volume added during adult bypass is 2000ml although much larger volumes may be required in some procedures (e.g. dissecting aneurysm).
Acute side-effects	Hypersensitivity reactions may occur including, rarely severe anaphylactoid reactions.

Medicine	**HEPARIN SODIUM**
Legal Status	POM
Form & strength	Injection 1000units/ml in 5ml, 10ml ampoules
Indications	Anticoagulation
Contra-indications	Haemophilia and other haemorrhagic disorders, thrombocytopenia, recent cerebral haemorrhage, previous skin necrosis secondary to heparin. Severe liver disease (including oesophageal varices).
Dose range	5000unit bolus if ACT <480 seconds
Target Range	Maintain ACT above 480 seconds
Maximum Dose	Seek medical advice
Acute side-effects	Haemorrhage, thrombocytopenia, hypersensitivity, priapism, hyperkalaemia.

Medicine	**ISOFLURANE**
Legal Status	POM
Form & strength	Glass bottles containing 250ml liquid isoflurane
Indications	Control of hypertension, myocardial protection, anaesthesia
Contra-indications	Malignant hyperthermia, hypersensitivity
Dose range	Between 0.5- 3%, administered via dedicated vapouriser into sweep gas flow. Usual dose 1-2%
Target Dose	Adjusted according to blood pressure & depth of anaesthesia. Aim to keep MAP between 60-70mmHg or as specified by the Consultant Anaesthetist
Other	Isoflurane can dissolve the plastic components of the CPB circuit if spilled onto them directly. Scavenge exhaust gas and measure isoflurane concentrations.
Acute side-effects	Hypotension due to vasodilation, cardio respiratory depression

Medicine	**MANNITOL**
Legal Status	POM
Form & strength	Intravenous infusion 10% and 20% in 500ml bags
Indications	Osmotic diuretic for cerebral oedema
Contra-indications	Severe dehydration, pulmonary oedema. Check bags for mannitol crystals before use
Dose range	0.5g/kg, (=5ml/kg of 10% solution) E.g. typical dose range of a 10% solution is 250-500ml (25-50g)
Maximum Dose	500ml
Acute side-effects	Chills, fever, hypotension

Medicine	**PHENYLEPHRINE 10mg in 1ml**
Legal Status	POM
Form & strength	10mg/ml in 1ml ampoule

Indications	Acute hypotension
Contra-indications	Hypertension, pregnancy, care with patients on MAOIs (or within 14 days of ceasing MAOIs), severe hypertension, hyperthyroidism.
Dose range	Dilute 10mg to 10ml with sodium chloride 0.9% (1mg/ml solution). Titrate the dose incrementally as required to maintain an average MAP of between 60-70mmHg or as specified by the Consultant Anaesthetist
Maximum dose	Cumulative 10mg then seek medical advice
Acute side-effects	Tachycardia, reflex bradycardia.

Medicine	**PLASMALYTE 148 SOLUTION**
Legal Status	POM
Form & strength	1000ml bags. Each litre contains Na 140mmol, K 5mmol, Mg 3mmol, Cl^- 98mmol, acetate 27mmol, gluconate 23 mmol
Indications	Volume replacement
Contra-indications	Electrolyte disturbances e.g. hyperkalaemia, hypernatraemia, hyperchloraemia; caution in renal failure
Dose range	200ml bolus as required
Maximum dose	Usual maximum 2000ml
Acute side-effects	Hypersensitivity reactions, thromboembolism, electrolyte disturbances. Fever, phlebitis, seizures

Medicine	**POTASSIUM CHLORIDE**
Legal Status	CD POM
Form & strength	Injection 1.5g (20mmol K^+) in 10ml ampoule or a Pre-filled syringe of Potassium Chloride (20mmol in 10ml. **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	10-20mmol potassium chloride given via <u>slow bolus</u> in 2mmol aliquots
Maximum dose	Total dose administered during CPB should not exceed **20mmol** –seek medical advice
Target Range	To maintain the K^+ 4.5-5.5mmol/L level, monitored continuously via the CDI500 monitor on CPB machine.
Acute side-effects	Hyperkalaemia, with paraesthesia, muscle weakness, hypotension, cardiac arrhythmias, and cardiac arrest.

Medicine	**RINGER'S SOLUTION**
Legal Status	POM
Form & strength	Intravenous solution 500ml or 1000ml bags. Each litre contains Na^+ 147mmol, K^+ 4mmol, Ca^{2+} 2.2mmol, Cl^- 156mmol.
Indications	Volume replacement in the CPB circuit
Contra-indications	Hyperkalaemia, Hypernatraemia, Hypercalcaemia, Hyperchloraemia. Severe renal insufficiency (with oliguria/anuria).
Dose range	200ml bolus doses to maintain circulating volume.
Maximum dose	Administered according to clinical need, with a usual maximum of up to 3000ml
Acute side-effects	Electrolyte disturbances

Medicine	**SODIUM BICARBONATE 8.4%**

Legal Status	POM
Form & strength	Injection BP 8.4% (1mmol/ml drawn into a 50ml syringe)
Indications	Control of metabolic acidosis
Contra-indications	Metabolic or respiratory alkalosis, hypocalcaemia or hypochlorhydria
Dose range	10mmol dose according to arterial blood gases
Maximum Dose	100mmol cumulatively then seek medical advice
Acute side-effects	Sodium bicarbonate 8.4% injection 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.

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

Medicine	**AMIODARONE**
Legal Status	POM
Form & strength	50mg/ml in 3ml ampoules, neat
Indications	Control of atrial and ventricular dysrhythmias
Contra-indications	Sinus bradycardia, sino atrial block, thyroid dysfunction, iodine sensitivity, severe respiratory failure, circulatory collapse, severe arterial hypotension, pregnancy and breast feeding.
Dose range	300mg bolus as a slow injection over 3 minutes
Maximum Dose	300mg then Consultant may consider possible infusion if necessary
Acute side-effects	Hypotension, raised serum transaminases, bradycardia, cardiac depression, tremors, sleep disorders, photosensitivity, thyroid disorders.

Medicine	**ATROPINE**
Legal Status	POM
Form & strength	600 micrograms in 1ml injection
Indications	Bradycardia
Contra-indications	Hypersensitivity, closed-angle glaucoma, prostatic enlargement, myasthenia gravis (unless given in conjunction with anticholinesterase), paralytic ileus or pyloric stenosis and severe ulcerative colitis
Dose range	300-1200micrograms
Maximum Dose	1200micrograms
Acute side-effects	Anaphylaxis, tachycardia, arrhythmias, difficulty with micturition.

Medicine	**CARDIOPLEGIA SOLUTION intermittent boluses**
Legal Status	POM
Form & strength	500 or 1000ml bags containing Mg^{++} 20mmol/L, K^{+} 20mmol/L and procaine
Indications	Myocardial protection on CPB during aortic clamping, mixed in a 1:4 ratio with blood
Contra-indications	None in this context
Dose range	Induction use 1-2000ml of the mixture (200ml-400ml of cardioplegia)

Maximum Dose	Subsequent doses of mixture can be between 300-600ml (60-120ml of cardioplegia) when directed by the Consultant Surgeon. Maximum dose determined by the Consultant Surgeon.
Acute side-effects	hyperkalaemia

Medicine	**CARDIOPLEGIA SOLUTION continuous infusion**
Legal Status	POM
Form & strength	20ml ampoules containing Mg^{++} 20mmol/L, K^+ 20mmol/L and procaine. NEAT in 60ml syringe.
Indications	Myocardial protection on CPB during aortic clamping,
Contra-indications	None in this context
Dose range	Continuous infusion adjusted to maintain blood K^+ at 5mmol/L monitored continuously via the CDI500 monitor on CPB machine
Maximum Dose	Maximum dose determined by the Consultant Surgeon.
Acute side-effects	hyperkalaemia

Medicine	**MAGNESIUM SULPHATE**
Legal Status	POM
Form & strength	Injection 50% 0.5g/ml in 10ml ampoules (2mmol/ml)
Indications	Treatment of arrhythmias, especially in the presence of hypokalaemia
Contra-indications	Hepatic impairment, renal impairment, hypersensitivity, renal impairment
Dose range	1-5g/4-20mmol dose (2-10ml)
Maximum Dose	5g/20mmol then seek further medical advice
Acute side-effects	Nausea, vomiting, thirst, flushing of skin, hypotension, arrhythmias, coma, muscle weakness, respiratory depression.

Medicine	**MILRINONE**
Legal Status	POM
Form & strength	Injection 1mg/ml in 10ml ampoule
Indications	Acute heart failure including low output states following heart surgery
Contra-indications	Hypertrophic cardiomyopathy, obstructive cardiac valvular disease
Dose range	0.25 – 0.75micrograms/kg/min as per ITU protocol
Maximum Dose	As above, according to Trust Protocol.
Acute side-effects	Chest pain, tremor, bronchospasm, anaphylaxis, rash, hypotension, arrhythmias.

Medicine	**NORADRENALINE**
Legal Status	POM
Form & strength	Injection 1mg/ml in 2ml, 4ml ampoules
Indications	Acute hypotension, cardiac arrest
Contra-indications	hypertension
Dose range	Dilute 1mg to 20ml in sodium chloride 0.9% (50micrograms/ml) Give 1-2ml, repeated as required.
Maximum Dose	1mg (20ml) then seek further medical advice
Acute side-effects	Hypertension, headache, bradycardia, arrhythmias, peripheral ischaemia.

References:

Department of Health "*The Guide to Good Practice in Clinical Perfusion";* July 2009. Available from: **https://www.scps.org.uk/resources/useful-downloads**

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