SOUTHAMPTON Children's Hospital

Neonatal Formulary

Post responsible for updating the Neonatal Drug Formulary: Neonatal Pharmacy Team

Introduction

This formulary has been provided to aid the prescribing and administration of medicines to the local neonatal population within University Hospital Southampton NHS Foundation Trust. The A-Z of drug monographs provide the indication, dosage regimens and administration information in a clear concise format. This information has been gathered from multiple reference sources and aims to provide the most up-to-date and reliable data, relevant to our patient groups.

Important side effects and compatibility data have been provided where appropriate. Every drug has many documented side effects and the decision not to list all side effects here has been taken as they are freely available in the BNF for Children.

Unfortunately there is little data on the compatibility of intravenous medications with TPN, and what little there is cannot always be applied as we often use concentrated TPN. Where compatibility or incompatibility is known, we have provided this information. However if there is no comment, please assume it is incompatible and a separate line should be used, or if only one line available it should be flushed well between administrations. Where possible intravenous medicines should be given separately and never mixed within the same syringe.

For further information regarding administration and compatibility please refer to the paediatric Medusa monographs which can be accessed via any trust PC and via links on Metavision templates. If a paediatric monograph is not available, the adult monograph will sometimes contain information regarding paediatric administration. The paediatric pharmacy team are available to contact between 8:30am and 5pm (Monday-Friday) and Southampton Medicines Advice Service may be contacted on extension 6908 between the hrs of 9am-6pm. Out of hours, the emergency duty pharmacist may be contacted via switchboard.

Please note that whilst every effort has been made to ensure that the information contained within this formulary is correct at the time of publication, therapeutic guidelines may have been altered or errors occurred. If there is any doubt regarding any of the information within the monographs please contact the neonatal pharmacist, or the on-call pharmacist out of hours. For administration issues you may consult Medusa using the link on all trust desk tops. All antibiotic dosing may also be found on the PIER network,(https://www.piernetwork.org/guidelines.html), the guideline is named "First Line Antibiotic Therapy for Specific Childhood Infections."

Prescribing Etiquette:

- Take care with units, mg and micrograms.
- Appropriate rounding up/down of doses – please discuss with the nursing staff.
- The following times must be avoided: 00:00/24:00 (date confusion) and 08:00/20:00 (nursing handover).
- Abidec & Sytron to be prescribed as a 'morning' dose.
- Prescribe oral caffeine at 10:00. This allows the bottle to be shared as it cannot be kept after opening.

Reporting a drug reaction

All suspected adverse reactions to medicines should be reported to the Medicines and Healthcare products Regulatory Agency (MHRA) via the 'Yellow Card' System. Yellow cards can be found at the back of the BNF and BNF for Children or can be completed online at www.mhra.gov.uk/yellowcard.

Relevant Reference Sources:

British National Formulary for Children

Sean B. Ainsworth (2015) *Neonatal Formulary 7: Drug use in pregnancy and the first year of life*. 7th Ed. Chichester John Wiley & Sons Ltd

Guy's & St. Thomas', King's College and University Lewisham Hospitals *Paediatric Formulary.* Online Edition. London. Guy's St. Thomas NHS Foundation Trust. Accessed via: http://cms.ubqo.com/public/d2595446-ce3c-47ff-9dcc-63167d9f4b80

Taketomo C.K., Hodding J.H., Kraus D.M.(2012) *Pediatric and Neonatal dosage handbook* 19th Ed. Hudson, Ohio. Lexicomp

Summary of Product Characteristics (various) accessed via http://www.emc.medicines.org.uk

ADENOSINE

Indication	Route	Dose	Frequency	Notes
Termination of neonatal supraventricular tachycardia (SVT)	Rapid IV Bolus	150 micrograms/kg	Stat	If necessary, repeat every 1-2 minutes increasing dose by 50 micrograms/kg (max single dose of 300 micrograms/kg < 28 days old or 500 micrograms/kg if > 28 days old) until tachycardia terminated.

ADMINISTRATION

To dilute: Take 1ml from a 3mg/ml vial and dilute to 3ml with Sodium Chloride 0.9%. This will produce a 1mg/ml solution.

Rapid IV Bolus over less than 2 seconds preferably given centrally (or via large peripheral vein if central access unavailable)
This must be followed by a 5ml rapid sodium chloride 0.9% **flush**

The aim is to reduce transit time to the heart and reduce peripheral loss.

Adenosine should be administered by rapid IV bolus. Following parenteral administration, it is rapidly metabolised in the peripheral circulation. To be certain the solution reaches the systemic circulation administer either directly into a vein or into an IV line. If given into an IV line, it should be injected as proximally as possible, and followed by a rapid sodium chloride 0.9% flush.

Do not give this medicine via a line being used to infuse other medicines without stopping the current infusion and flushing the line prior to administration.

MONITORING

Continuous ECG, respiratory rate/ O2 saturation, apnoeas and seizure control

CONTRAINDICATIONS

- Sick sinus syndrome or 2nd or 3rd degree Atrio-ventricular block, unless a functioning pace-maker in place.
- Severe hypotension.
- Prolonged QT – risk of Torsades de pointes
- Bronchospasm (chronic obstructive lung disease)

FURTHER INFORMATION

- Patients who develop a high level of AV block should not be given further dose increments.
- The antiarrhythmic effects of adenosine are antagonised by caffeine, aminophylline and theophylline; therefore initial doses may not produce an effect. Escalate dose as described above until the desired effect as achieved.
- Very rarely, adenosine may accelerate some tachycardias especially in children with Wolff Parkinson White Syndrome; ensure resuscitation facilities are available before administration.
- No dosage adjustment is required in renal or hepatic impairment.
- **Do not** refrigerate adenosine
- The effect is enhanced by dipyridamole, give 25% of the usual dose.

References:
Intravenous adenosine for the treatment of children with supraventricular tachycardia and for diagnosis of supraventricular arrhythmias.*Southampton Children Hospital (2016)* accessed via http://staffnet/TrustDocsMedia/DeptDivSpecific/DivC/ChildHealth/ChildHealthGuidelines/ChildHealthdrugspecificguidelines/IV-adenosine/Intravenous-adenosine-for-treatment-of-child-with-supraventricular-tachycardia-guideline.pdf (27/04/20)
Summary of Product Characteristics (Adenosine 3mg/ml Solution for Injection) Accessed via https://www.medicines.org.uk/emc/product/4766/smpc (21/04/2020)
Guy's and St. Thomas', King's College and University Lewisham Hospitals. Paediatric Formulary. Online edition. Accessed via http://cms.ubqo.com/public/d2595446-ce3c-47ff-9dcc-63167d9f4b80/content/73e8effb-9475-4f11-96e2-2cc676ba3bb6 (21/04/2020)

Monograph last updated: 21/10/2020

ADRENALINE (Epinephrine)

Indication	Route	Preparation	Dose	Frequency
Cardiac Arrest	I.V./I.O.	1 in 10,000	20 micrograms/kg (0.2ml/kg of 1:10,000 injection)	Repeat when required every 3-5 minutes if heart rate remains <60bpm
Inotropic support	I.V. Bolus	Rescue adrenaline (See instructions below)	0.5-1ml boluses	Titrate to pulse volume/BP/heart rate/perfusion/cardiac output
	I.V. infusion	1 in 1000 (See table below)	0.1 – 1 micrograms/kg/min	Maximum rate 1.5micrograms/kg/min. (Discuss with cardiology)
Anaphylaxis	I.M./S.C	1 in 10,000	10 mcg/kg (0.1ml/kg of 1 in 10,000 solution	STAT. IM route preferred
Stridor	NEB	1 in 1000	0.4mg/kg (0.4ml of 1 in 1,000 solution)	STAT

Administration

Intravenous infusion for inotropic support (using 1 in 1000 (1mg /1ml) strength adrenaline)			
	Amount of drug	**Final total volume**	**Final concentration/rate**
For babies < 2.7kg	1.5mg/kg	Dilute to 25ml	0.1ml/hr = 0.1microgram/kg/min
For babies ≥ 2.7kg	1.5mg/kg	Dilute to 50ml	0.2ml/hr = 0.1microgramskg/min
For babies transferring to PICU	0.3mg/kg	Dilute to 50ml	1ml/hr = 0.1micrograms/kg/min

Maximum concentration: 160micrograms/ml

Continuous infusions must be given **centrally**. May be diluted using glucose 5%, 10% or sodium chloride 0.9%.

Rescue Adrenaline (Previously called adrenaline light/dilute adrenaline): Take 0.1ml/kg of 1:10,000 (100microgram/ml) adrenaline and dilute to a total of 10ml using 0.9% sodium chloride. Final concentration is 1microgram/kg/ml

For **nebulised** Adrenaline dilute the dose to 2.5ml with 0.9% sodium chloride.

Further Information

Caution: Adrenaline is available in a range of concentrations. Some packaging refers to adrenaline 1:10,000 as “dilute” adrenaline- this usually requires further dilution for bolus titration.

Monitor heart rate and blood pressure.

Correct acidosis before administration (where possible) to enhance the effectiveness of adrenaline.

The effect of nebulised adrenaline rapidly wears off.

Compatible	**NOT** compatible
TPN (Aqueous) Dobutamine Dopamine Heparin Midazolam Milrinone Morphine	**Lipid** Sodium Bicarbonate Alkaline solutions

For further information regarding administration and compatibility - see Medusa.

References:
Joint Formulary Committee. British National Formulary (04/2020). London: British Medical Association and Royal Pharmaceutical Society. Electronic edition. Accessed via https://www.new.medicinescomplete.com/#/browse/bnfc (21/04/2020*)*
Sean B. Ainsworth (2015) *Neonatal Formulary 7: Drug use in pregnancy and the first year of life*. 7th Ed. Chichester John Wiley & Sons Ltd
Summary of Product Characteristics (Adrenaline (Epinephrine) 1mg/ml (1:1000) solution for injection) Accessed via https://www.medicines.org.uk/emc/product/3673 (21/04/2020)
Guy's and St. Thomas', King's College and University Lewisham Hospitals. Paediatric Formulary. Online edition. Accessed via http://cms.ubqo.com/public/d2595446-ce3c-47ff-9dcc-63167d9f4b80/content/6f632caf-57ac-45ed-b5e3-e732b351ca44 (21/04/2020)
Newborn resuscitation and support of transition of infants at birth Guidelines https://www.resus.org.uk/library/2021-resuscitation-guidelines/newborn-resuscitation-and-support-transition-infants-birth (21/5/2021)

Monograph last updated: 17/2/2023

ALBUMIN 5% (5g/100ml)

Please ensure to prescribe correct strength to match indication.
See Albumin 20% (next monograph) for use in hypoalbuminaemia

Indication	Route	Dose
Volume replacement	I.V.infusion	10-20ml/kg

Administration Details

Infuse solution over 30 minutes, although rate is dependent on clinical circumstances. For further administration instructions refer to the Medusa monograph.

Record the name and batch number of the product on Metavision in order to maintain a link between the patient and the batch of the product.

Do not infuse with any other medicines. Glucose 5% or Sodium Chloride 0.9% infusions can be 'Y-sited' if needed.

Albumin solutions **must not** be diluted with water for injections as this may cause haemolysis in recipient.

Do not use solutions which are cloudy or have deposits.

Monitoring

- Cardiovascular and Respiratory function (Blood pressures, heart rate)
- Urine Output
- Electrolytes and haemoglobin

Further Information

The effects may be short lived.

Allergic or anaphylactic-type reactions - stop the infusion immediately.

Mild reactions including flushing, urticaria, fever, nausea, vomiting, increased salivation, hypotension, febrile reactions and tachycardia are rare and normally disappear rapidly when the infusion is slowed or stopped.

Hypervolaemia may occur if the dose and rate of infusion are too high. Stop the infusion at the first clinical signs of cardiovascular overload (e.g. headache, dyspnoea, jugular vein congestion) or increased blood pressure, raised central venous pressure and pulmonary oedema.

References:
Albumin solution, human, isotonic. Accessed via https://medusa.wales.nhs.uk (21/04/2020)
West of Scotland Neonatal pharmacy group (2020). *Neonatal parenteral drug monographs- Albumin. Accessed via* http://www.knowledge.scot.nhs.uk/child-services/communities-of-practice/neonatal-managed-clinical-networks/west-of-scotland/neonatal-drug-formulary-(wos).aspx *(11/05/2020)*
Sean B. Ainsworth (2015) *Neonatal Formulary 7: Drug use in pregnancy and the first year of life*. 7th Ed. Chichester John Wiley & Sons Ltd
Summary of Product Characteristics (Albunorm 5%, 50 g/l, solution for infusion) Accessed via https://www.medicines.org.uk/emc/product/420/smpc (21/04/2020)

Monograph last updated: 11/05/2020

ATROPINE

Indication	Route	Dose	Frequency	Notes
Pre-medication for intubation	I.V.	See dose banding table	STAT	Use with fentanyl and suxamethonium
Bradycardia	I.V.	20microgram/kg		
Hypersalivation	I.V./Oral	10microgram/kg	8 hourly	Not first line for secretion management. For short term use. Monitor the thickness of secretions prior to giving the dose.

Dose Banding:

Atropine (40microgram in 1ml) pre-filled syringe

Weight (grams)	Calculated dose (microgram)	Volume required (ml)
< 500	8	0.2
500 – 749	12	0.3
750 – 999	16	0.4
1000 - 1249	24	0.6
1250 – 1499	28	0.7
1500 – 1999	36	0.9
2000 – 2499	44	1.1
2500 – 2999	56	1.4
3000 – 3499	64	1.6
3500 – 3999	76	1.9
4000 – 5000	92	2.3

IV Administration

Pre-filled syringes are stored in the CD fridge in Nursery 3 as part of the CIVAS prepared intubation drug kits. The intubation kits have a 7 day expiry, remember to check expiry date and time before use.

If no intubation drug kits are available:

Follow the instructions in the table below to make up the correct concentration to use with the dose banded prescription on metavision.

	Volume of Atropine	Volume of 0.9% Sodium Chloride	Final Volume	Concentration of solution
Atropine 600microgram/ml Injection	1ml (600microgram)	14ml	15ml	40microgram/ml

IMPORTANT: Check volume of dose very carefully as overdose can cause respiratory depression and convulsions.

Give as a rapid IV bolus, slow IV administration may cause paradoxical slowing of the heart.

Oral Administration

The injection can be given orally

Available to order from Pharmacy CIVAS as a 100microgram/ml oral solution

Monitoring

Monitor heart rate, rhythm and respiratory markers.

Adverse Effects

Atropine is an antimuscarinic and therefore may delay gastric emptying, decrease gastric motility and relax the oesophageal sphincter. Atropine may also cause urinary retention, constipation, flushing, tachycardia and arrhythmias and in some cases anaphylaxis.

Further Information:

See the Staffnet for the current neonatal intubation guideline:

http://staffnet/TrustDocsMedia/DeptDivSpecific/DivC/WomenNewborn/NeonatalUnit/NeonatalGuidelines/Intubation/Intubation-guideline.pdf

References:
Summary of Product Characteristics (*Atropine Sulfate Injection 600mcg in 1ml (hameln)*) Accessed via https://www.medicines.org.uk/emc/product/6282/smpc (07/05/21)
Joint Formulary Committee. British National Formulary (03/2021). London: British Medical Association and Royal Pharmaceutical Society. Electronic edition. Accessed via http://www.medicinescomplete.com/mc/bnf/current/ (25/3/2021)
Guy's and St. Thomas', King's College and University Lewisham Hospitals. Paediatric Formulary. Online edition. Accessed via http://cms.ubqo.com/public/d2595446-ce3c-47ff-9dcc-63167d9f4b80 (09/04/2021)
UptoDate. Primary drugs in pediatric resuscitation. Atropine. Accessed via CHARTS (25/03/21)

Monograph last updated: 07/05/2021

DINOPROSTONE (Prostaglandin E_2)

Indication	Route	Dose	Notes
Maintenance of PDA	I.V. infusion	5-50 nanograms/kg/min	Start at 5 nanograms/kg/min and increase by 5 nanograms/kg/min according to response.

Administration Details

Take 50 microgram from the dinoprostone ampoule (1mg/mL). Dilute to 50ml with either sodium chloride 0.9% or glucose 5%. This gives a 1microgram/ml solution.

This dilution means 0.3ml/**kg**/hr = 5 nanogram/kg/min.

Do NOT infuse with other drugs.

Further Information

Be prepared to intubate and resuscitate if necessary.

Apnoea and respiratory depression may occur.

Monitor heart rate, respiratory rate, blood gases, temperature, and arterial pressure.

Doses up to 100nanogram/kg/min have been used but this should be under consultation with neonatal consultant or cardiology consultant. Higher doses have been associated with more side effects and is rarely recommended.

Once a satisfactory response has been achieved, the infusion should be reduced to the lowest dose possible.

References:
Medusa Injectable Medicines Guide. *Dinoprostone*. Accessed via http://medusa.wales.nhs.uk/ (17/08/22)
Guy's and St. Thomas', King's College and University Lewisham Hospitals. Paediatric Formulary. Mobile App. Accessed on 17/08/22
Joint Formulary Committee. British National Formulary (04/2020). London: British Medical Association and Royal Pharmaceutical Society. Electronic edition. Accessed via http://www.medicinescomplete.com/mc/bnf/current/ (17/08/2022)

Monograph last updated: 17/08/22

DOBUTAMINE

Indication	Route	Dose	Notes
Inotropic support	I.V. infusion	5-10 micrograms/kg/min	Initial rate
		2-20 micrograms/kg/min	Maintenance rate

Administration Details

Give via a central line if possible, never administer intra-arterial. Dilute in Sodium Chloride 0.9% or Glucose 5%

For dobutamine prescribed at 5-20micrograms/kg/min and **< 1.5kg:**

Prepare infusion by taking 60mg PER KILO and DILUTE to 20ml. A rate of 0.1ml/hr = 5micrograms/kg/min.

For dobutamine prescribed at 5-20micrograms/kg/min and **1.5kg – 3kg:**

Prepare infusion by taking 30mg PER KILO and DILUTE to 50ml. A rate of 1ml/hr = 10micrograms/kg/min.

For dobutamine prescribed at 5-20micrograms/kg/min and **> 3kg:**

Prepare infusion by taking 15mg PER KILO and DILUTE to 50ml. A rate of 1ml/hr = 5micrograms/kg/min.

For dobutamine prescribed at a rate of 2-6micrograms/kg/min:

A more dilute solution may be required. Prepare infusion by taking 60mg PER KILO and DILUTE to 50ml. A rate of 0.1ml/hr = 2micrograms/kg/min.

In fluid restricted patients, a fixed concentration of 250mg in 50ml may be used. A rate of 0.12ml/**kg**/hr = 10micrograms/kg/min.

Maximum concentration 5mg/ml

Further Information

Monitor blood pressure and heart rate. Rate may be increased to a maximum of 20microgram/kg/min under the authorisation of a consultant.

Solutions of dobutamine may turn pink due to a slight oxidation of the drug. Such solutions are safe to use as there is no significant loss of potency.

Compatibility

Compatible	**NOT** compatible
Noradrenaline, Parenteral Nutrition Fentanyl Lidocaine Midazolam Milrinone Morphine	Sodium Bicarbonate Alkaline solutions

References:
Dobutamine. Accessed via https://medusa.wales.nhs.uk (10/08/2022)
Paediatric Formulary Committee. *British National Formulary for Children App*. London: British Medical Association, the Royal Pharmaceutical Society of Great Britain, the Royal College of Paediatrics and Child Health, and the Neonatal and Paediatric Pharmacists Group. Accessed on 10/08/2022.
Guy's and St. Thomas', King's College and University Lewisham Hospitals. Paediatric Formulary. Online edition. Accessed via http://cms.ubqo.com/public/d2595446-ce3c-47ff-9dcc-63167d9f4b80 (10/08/2022)

Monograph last updated: 14/12/2023

FENTANYL

Indication	Route	Dose	Notes
Intubation pre-medication	I.V. bolus	See dose banding chat below	Stat dose. (Give with atropine and suxamethonium).
Less invasive surfactant administration (LISA)	I.V. bolus	0.7 – 1 micrograms/kg	Stat dose. (Give with atropine)
Opiate analgesia/ Respiratory depressant for children with assisted ventilation	I.V. bolus	1 – 5 micrograms/kg	Loading dose
	I.V.infusion	1 – 3 micrograms/kg/hour	Adjust according to response. Maximum dose 8 micrograms/kg/hour

Administration Details

Dilute in either 5% glucose or 0.9% sodium chloride.

For **bolus administration** - Take 50microgram (1ml) and DILUTE to 5ml to give a 10micrograms/ml solution, give the required dose as a slow bolus.

For **intravenous infusion** - Take 100micrograms of fentanyl PER KILO and DILUTE to 20ml to give a rate of 0.2ml/hr = 1microgram/kg/hr.

See Medusa monograph for further reconstitution, administration, and compatibility details.

Dose banding for intubation pre-medication

Assuming a concentration of 10 micrograms in 1ml

Weight (grams)	Calculated dose (micrograms)	Volume required (ml)
< 500	2	0.2
500 – 749	3	0.3
750 – 999	4	0.4
1000 - 1249	6	0.6
1250 – 1499	7	0.7
1500 – 1999	9	0.9
2000 – 2499	11	1.1
2500 – 2999	14	1.4
3000 – 3499	16	1.6
3500 – 3999	19	1.9
4000 – 5000	23	2.3

When CIVAs syringes are unavailable, ward stock will need to be prepared. The following preparation instructions may be used to prepare the correct concentration of each intubation drug so that the dose banding can still be used.

	Volume of medication	Volume of sodium chloride 0.9%	Final volume	Concentration of solution
Fentanyl 100microgram/2ml injection	1ml = 50microgram	4ml	5ml	10microgram/ml

Further Information

Fentanyl IV 1microgram/kg is approximately equivalent to morphine IV 25microgram/kg when used as a respiratory depressant for ventilated patients. A different conversion may be required when used for pain- consult the neonatal pharmacist team for further advice.

Monitor heart rate and respiration rate. Bradycardia may respond to atropine.

Naloxone is a direct opiate antagonist- please see naloxone monograph.

Tolerance may develop and withdrawal symptoms are not uncommon after prolonged infusion (>3days), wean slowly.

References:
Joint Formulary Committee. British National Formulary (28/09/2022). London: British Medical Association and Royal Pharmaceutical Society. Electronic edition. Accessed via http://www.medicinescomplete.com/mc/bnf/current/ (28/09/2022)
Guy's and St. Thomas', King's College and University Lewisham Hospitals. Paediatric Formulary. Online edition. Accessed via http://cms.ubqo.com/public/d2595446-ce3c-47ff-9dcc-63167d9f4b80 (28/09/2022)
PICU Monitoring and management of withdrawal symptoms. 2021. Leicester Children's Hospital. Accessed via: https://secure.library.leicestershospitals.nhs.uk/PAGL/Shared%20Documents/Medication%20Withdrawal%20Symptoms%20-%20Monitoring%20and%20Management%20UHL%20Paediatric%20Intensive%20Care%20Guideline.pdf (28/09/2022)
Medusa Injectable Medicines Guide. *Fentanyl*. Accessed via http://medusa.wales.nhs.uk/ (28/09/2022)

Monograph last updated: 28/09/2022

GLUCAGON

Indication	Route	Dose	Frequency	Notes
Treatment of Hypoglycaemia	I.V./S.C./I.M.	20 micrograms/kg	Stat	If not effective within 15minutes, give IV glucose
Treatment of Hyperinsulinaemia	I.V. infusion	5 – 20 micrograms/kg/hr		Adjust to response Max dose 50 microgram/kg/hr

Administration Details

Discuss with Endocrine team before starting.

Reconstitute the 1mg vial with 1.1ml of water for injection (do not use the diluent provided due to the phenol content). This gives a 1mg in 1ml solution.

Take 250microgram PER KILO and dilute to 10ml with glucose 5%.
A rate of 0.2ml/hr = 5microgram/kg/hr.

If any precipitation or particles occur in the solution, discard immediately.

See Medusa monograph for further reconstitution, administration, and compatibility details.

Further Information

Monitor blood glucose and electrolytes, especially potassium.

Incompatible with calcium containing solutions.

GlucaGen Hypokit® can be stored up to 25°C for 18 months provided the kit is still within its expiry.

References:
Glucagon. Accessed via https://medusa.wales.nhs.uk (17/03/2023)
GlucaGen® Hypokit. Accessed via https://medusa.wales.nhs.uk (17/03/2023)
Paediatric Formulary Committee. *British National Formulary for Children App*. London: British Medical Association, the Royal Pharmaceutical Society of Great Britain, the Royal College of Paediatrics and Child Health, and the Neonatal and Paediatric Pharmacists Group. Accessed on 17/03/2023.
Guy's and St. Thomas', King's College and University Lewisham Hospitals. Paediatric Formulary. Online edition. Accessed via http://cms.ubqo.com/public/d2595446-ce3c-47ff-9dcc-63167d9f4b80 (17/03/2023)

Monograph last updated: 17/03/2023

HYDROCORTISONE (as sodium succinate)

Indication	Route	Dose	Frequency	Notes
Prophylactic hydrocortisone for all premature babies born < 28 weeks	I.V.	0.5mg/kg	12 hourly for 7 days then ONCE a day for 3 days	• To be started within 24 hours of birth • Total 10 day course • Sometimes referred to as "PREMILOC protocol"
Hypotension	I.V.	1 - 2.5mg/kg	The first 2 doses can be 4 hours apart then 6 hourly thereafter	• Once blood pressure normalised for 24 hours wean by halving the dose every 48 hours • If hypertension recurs restart treatment at the previous dose
Congenital adrenal hyperplasia	Oral	2.5 - 3.75mg/m^2	6 hourly	Discuss with Endocrinology Adjust to response
Replacement therapy	Oral	2.7 - 3.4mg/m^2	8 hourly	Discuss with Endocrinology Total daily dose can be given in 4 divided doses if required
Acute hypersensitivity reactions/ angioedema	I.V.	2.5mg/kg	STAT	
		2mg/kg	Four times a day	To be used if further doses required 6 hours after the STAT dose

IV Administration

- Peripheral: Administer the prepared dose as a bolus over 1-3minutes.
- Via Longline: Further dilute the prepared dose to an appropriate volume using the same diluent and infuse over 10 minutes.

Reconstitution of the vial:

Reconstitute the 100mg vial with 1.9ml water for injection to give a 50mg in 1ml concentration. This can be used undiluted if the dose prescribed is ≥ 5mg.

Preparing doses ≥ 1mg – 5mg:

1. Reconstitute the 100mg vial with 1.9ml water for injection to give a 50mg in 1ml concentration
2. Take **1ml** from the 50mg/ml solution and make up to a total volume of **5ml** using either 5% glucose or 0.45% sodium chloride. This results in a 10mg/ml solution that is used to prepare the dose required.

Preparing doses under 1mg:

1. Reconstitute the 100mg vial with 1.9ml water for injection to give a 50mg in 1ml concentration
2. Take **1ml** from the 50mg/ml solution and make up to a total volume of **5ml** using either 5% glucose or 0.45% sodium chloride. This results in a 10mg/ml solution.
3. Take **1ml** form the 10mg/ml solution and make up to a total volume of **10ml** using the same diluent in step number two. This results in a 1mg/ml solution that is used to prepare the dose required.

Oral Administration

A hydrocortisone 5mg/5ml suspension is available from pharmacy.

Hydrocortisone muco-adhesive buccal tablets **must not be used** for treating adrenal insufficiency as they can result in insufficient cortisol absorption. https://www.gov.uk/drug-safety-update/hydrocortisone-muco-adhesive-buccal-tablets-should-not-be-used-off-label-for-adrenal-insufficiency-in-children-due-to-serious-risks?UNLID=68434094920215712563 1)

Monitoring

Monitor blood pressure and blood glucose.

Adverse Effects

Prolonged courses of steroids can cause adrenal suppression, increased risk of infections and growth retardation. Abrupt withdrawal after prolonged periods can lead to acute adrenal insufficiency, hypotension or death.

The PREMILOC study found an increase in sepsis rates in babies < 25 weeks receiving prophylactic hydrocortisone; however the cohort still showed improved neurodevelopmental outcomes and all-cause mortality was reduced.

Use with caution when considering the use of ibuprofen in conjunction with the 10 day course of prophylactic hydrocortisone Previous studies with early hydrocortisone treatment found an increased risk of intestinal perforation. However this was not observed in the PREMILOC study. This difference may be explained by the historic use of indomethacin for treatment of PDA in previous study groups.

Further Information

Hydrocortisone should be given peripherally, however if this is not possible due to access issues, there is evidence that hydrocortisone is compatible with parenteral nutrition.

For further information regarding Y-site compatibility see the Medusa monograph which can be accessed via UHS Trust computers.

If whilst on prophylactic hydrocortisone the baby requires management of hypotension using higher doses of hydrocortisone, the prophylactic course should be suspended. All days of higher dose treatment will be considered as counting towards the 10-day prophylactic course and the prophylactic dosing may resume to complete the total 10 day hydrocortisone course.

Fludrocortisone may be needed with replacement therapy and serum sodium should be closely monitored and supplements prescribed if necessary. There is no need to measure cortisol levels before starting hydrocortisone.

If requiring dosing of hydrocortisone for adrenal crisis please refer to the PIER guideline: https://www.piernetwork.org/adrenal-crisis.html

IV hydrocortisone is available as a number of different salts such as hydrocortisone sodium phosphate, check you are using information for the correct product.

References:
Baud O, Maury L, Lebail F, Ramful D, El Moussawi F, Nicaise C, et al. Effect of early low-dose hydrocortisone on survival without bronchopulmonary dysplasia in extremely preterm infants (PREMILOC): a doubleblind, placebo-controlled, multicentre, randomised trial. Lancet 2016;387:1827-36.
Guy's and St. Thomas', King's College and University Lewisham Hospitals. Paediatric Formulary. Online edition. Accessed via http://cms.ubqo.com/public/d2595446-ce3c-47ff-9dcc-63167d9f4b80 (07/05/2021)
British Medical Association, Royal Pharmaceutical Society of Great Britain and Royal College of Paediatrics and Child Health. BNF for Children [April 2021]. Electronic edition. London: BMJ Publishing Group Ltd, RPS Publishing and RCPCH Publications Ltd.
Vancouver Coastal Health Parenteral Drug Therapy IV compatibility charts . Y-SITE INJECTION DRUG COMPATIBILITY CHART with Parenteral Nutrition Solutions (TPN) Accessed via https://drive.google.com/file/d/1N3VIlpXNRNHatbfmt2fOujE2nQTJ8r4B/view (14/5/2021)

Monograph last updated: 21/05/2021

MIDAZOLAM

Indication	Route	Dose	Notes
Premedication	I.V. slow bolus	50 micrograms/kg as a single dose (over 2-3 mins)*	5-10 mins prior to procedure. If after 2 minutes sedation is not adequate, further incremental doses can be given. Max 6mg per course.
	Oral	500microgram/kg as a single dose	30-60 minutes prior to procedure
	Buccal	200 – 300 micrograms/kg as single dose	
Continuous Sedation	I.V. infusion	60 micrograms/kg/hr (reduced after 24 hours to 30 micrograms/kg/hr if patient is under 32 weeks)	Adjust according to response. Maximum 4 days treatment
Seizures	I.V. slow bolus	100 – 200 micrograms/kg (over 2-3 mins)*	
	I.V. infusion	60 micrograms/kg/hr increased by 60 micrograms/kg/hr every 15 minutes until seizure controlled.	Max. 300 micrograms/kg/hr
	Buccal	300micrograms/kg (max 2.5mg)	The dose may be repeated after 10 mins

Administration Details

Take 9mg PER KILO from a 10mg/2ml ampoule dilute to 30ml with sodium chloride 0.9%, glucose 5% or glucose 10%, so that a rate of 0.1ml/hr = 30micrograms/kg/hr.

*Administer IV injection over 2 – 3 minutes as rapid injection may cause seizure-like myoclonus in preterm neonates potentially leading to respiratory depression, hypotension and a fall in cerebral blood flow.

Loading doses must not be used in pre-term babies.

For further information regarding administration and compatibility please refer to the paediatric monographs on Medusa.

Further Information

IV midazolam can cause respiratory depression and severe hypotension at high doses and there is a risk of respiratory and cardiovascular depression when used in combination with opiates.

The half-life (metabolism) of midazolam is likely to be longer in cooled infants.

Antidote: Flumazenil reverses midazolam induced respiratory depression.

IV midazolam can be given orally/sublingually but it has a very bitter taste maybe irritant to mucosa.

Erythromycin and clarithromycin inhibits the metabolism of midazolam resulting in profound sedation. This effect can also possibly be seen with fluconazole.

NOT compatible with intravenous lipid.

References:
Sean B. Ainsworth (2015) *Neonatal Formulary 7: Drug use in pregnancy and the first year of life*. 7th Ed. Chichester John Wiley & Sons Ltd
Paediatric Formulary Committee. *British National Formulary for Children App*. London: British Medical Association, the Royal Pharmaceutical Society of Great Britain, the Royal College of Paediatrics and Child Health, and the Neonatal and Paediatric Pharmacists Group. Accessed on 2/4/020.
Guy's and St. Thomas', King's College and University Lewisham Hospitals. Paediatric Formulary. Online edition. Accessed via http://cms.ubqo.com/public/d2595446-ce3c-47ff-9dcc-63167d9f4b80 (09/04/20)
West Scotland Neonatal Pharmacy Group - Parental Monographs*. Midazolam. Accessed via: http://www.knowledge.scot.nhs.uk/child-services/communities-of-practice/neonatal-managed-clinical-networks/west-of-scotland/neonatal-drug-formulary-(wos).aspx (9/04/20)*

Monograph last updated: 9/04/20

MILRINONE

Indication	Route	Dose	Frequency	Notes
Low cardiac output/ Cardiac failure	I.V. infusion	0.375 – 0.75 micrograms/kg/min	Continuous	Adjust to response

Administration Details

A fixed concentration of 10mg in 50ml is used.

Dilute 10mg of milrinone to a total volume of 50ml using either Glucose 5% or Sodium Chloride 0.9%. A rate of 0.15ml/**kg/hr** = 0.5micrograms**/kg/min**

Milrinone must be diluted if given via peripheral access, may cause venous irritation and tissue damage in cases of extravasation.

On the advice of the cardiac consultant a loading dose maybe given at a dose of 50 – 75micrograms/kg over 30 – 60minutes. This may be given undiluted if volume restricted and central access is available. Omit loading dose if risk of hypotension. Loading doses are not used on PICU but are used by some anaesthetists in theatre.

If hypotension occurs, volume expansion or the use of low dose dopamine should counteract this.

See Medusa monograph for further reconstitution, administration, and compatibility details.

Further Information

In severe renal failure the dose should be reduced by 25-50% and the infusion adjusted to haemodynamic and clinical response.

Monitor blood pressure, heart rate, ECG, central venous pressure, fluid and electrolyte status, renal function, platelet counts and hepatic enzymes.

Mild thrombocytopenia is common if infusion continues over 24 hours.

May delay closure of patent ductus arteriosus.

Compatible	**NOT** compatible
Adrenaline Atracurium Dobutamine Fentanyl Heparin Insulin Isoprenaline Midazolam Morphine Noradrenaline	Furosemide Sodium bicarbonate

References:
Milrinone. Accessed via https://medusa.wales.nhs.uk (31/08/2023)
Paediatric Formulary Committee. *British National Formulary for Children App*. London: British Medical Association, the Royal Pharmaceutical Society of Great Britain, the Royal College of Paediatrics and Child Health, and the Neonatal and Paediatric Pharmacists Group. Accessed on 31/08/2023.
Guy's and St. Thomas', King's College and University Lewisham Hospitals. Paediatric Formulary. Online edition. Accessed via http://cms.ubgo.com/public/d2595446-ce3c-47ff-9dcc-63167d9f4b80 (31/08/2023)

Monograph last updated: 31/08/2023

MORPHINE SULPHATE

Indication	Route	Dose	Notes
Analgesia and Sedation (with respiratory support)	Loading dose I.V. injection	25-100 micrograms/kg	Give over 5 minutes
	I.V. infusion	5 – 20 micrograms/kg/hr	Adjust to response
Therapeutic hypothermia	Loading dose I.V. injection	50 micrograms/kg	Give over 5 minutes. Further I.V. bolus doses of 25 micrograms/kg can be given for acute agitation or shivering
	I.V. infusion	5 - 10 micrograms/kg/hr	Adjust to response. Titration should be in increments of no more than 2.5micrograms/kg/hr Weaning of morphine should be considered due to risk of accumulation and toxicity.
Neonatal opioid withdrawal	Oral	Initially 40 micrograms/kg every 4 hours. Increase after each dose by 20 micrograms/kg until symptoms settling	Once symptoms are stable for 48hrs, wean the dose by 20% of the **original dose** every 48 hours as tolerated. Withdrawal scoring is required, if score increases, then go back to the higher dose and wean at a slower rate. May take 3 – 4 weeks to fully wean.
Weaning of prolonged treatment courses	Oral	Wean the dose by 20% of the **original dose** every 48 hours as tolerated	Please see further information on how to convert I.V. morphine to oral. Pain and withdrawal scoring is required, if score increases, then go back to the higher dose and wean at a slower rate.

Administration Details

For *BOLUS* administration take 0.1ml from a morphine sulphate 10mg/ml ampoule and dilute to 10ml with sodium chloride 0.9%. This gives a 0.1mg/ml solution (100 micrograms/ml).

For an *INFUSION* take 1ml from a 10mg/ml ampoule dilute to 10ml with sodium chloride 0.9%, this makes a 1mg/ml solution (1000 micrograms/ml).
THEN using the 1mg/ml solution (1000 micrograms/ml):

Take 1mg PER KILO and DILUTE to 20ml with a suitable diluent, for example glucose 10%.
A rate of 0.1ml/hr = 5 micrograms/kg/hour.

See Medusa monograph for further reconstitution, administration, and compatibility details.

Further Information

Monitor heart rate and respiration rate.

Naloxone is a direct opiate antagonist- please see naloxone monograph.

Adjust dose if evidence of renal impairment (see below table):

Creatinine clearance (ml/minute/1.73m^2)	Dosage
10-50	75%
< 10	50%

IV Infusion dose and frequency adjustment in renal failure (adapted from Paediatric Formulary, Guys and St Thomas' -28/10/22)

Side effects associated with prolonged use include paralytic ileus, delayed gastric emptying, urinary retention, and tolerance.

Tolerance may develop and withdrawal symptoms are not uncommon after prolonged treatment course, in these patients wean slowly.

To convert an intravenous dose to an equivalent oral dose, multiply the **total daily dose** by 2 and administer in 6 divided doses, this is the original dose when weaning. See weaning examples below. Do not prescribe oral doses as weight-based doses, this can result in unintentional dose increases whilst weaning if the working weight changes.

Please prescribe as Morphine Sulphate oral solution NOT Oramorph.

Morphine weaning example

A baby weighing 1.5kg is on 10 micrograms/kg/hr of IV morphine and requires conversion to oral dosing.

1. Calculate the total daily IV dose: 10 x 1.5 x 24 = 360 micrograms/day
2. Convert the total daily IV dose to the total daily oral dose: 360 x 2 = 720 micrograms/day
3. Divide the total daily oral dose into 6 divided doses: 720/6 = 120 micrograms every 4hours

The baby has been stable on the oral dose for 48 hours, with a stable withdrawal score. The baby is ready for weaning by 20% of the original dose, every 48hours.

1. Calculate 20% of the original oral dose, which in this case is 120 micrograms:

   120/100 x 20 = 24 micrograms
2. Decrease the dose by 24 micrograms every 48 hours or as tolerated and guided by the withdrawal scoring:
   - Day 1: 120 micrograms 4 hourly
   - Day 3: 96 micrograms 4 hourly
   - Day 5: 72 micrograms 4 hourly
   - Day 7: 48 micrograms 4 hourly
   - Day 9: 24 micrograms 4 hourly. The baby can now stop the morphine at this dose and frequency. If the baby starts to score on the withdrawal score or becomes unsettled after stopping morphine, restart the day 9 regimen. Once the baby is resettled, consider decreasing the frequency of the dose whilst keeping the dose the same e.g. to 6 hourly, 8 hourly, then 12 hourly before stopping.

References:
British Medical Association, Royal Pharmaceutical Society of Great Britain and Royal College of Paediatrics and Child Health. BNF for Children [November *2022*]. Electronic edition. London: BMJ Publishing Group Ltd, RPS Publishing and RCPCH Publications Ltd. Accessed via https://www.medicinescomplete.com/#/browse/bnfc (17/11/22)
Guy's & St. Thomas', King's College and University Lewisham Hospitals *Paediatric Formulary.* Online Edition. London. Guy's St. Thomas NHS Foundation Trust. Accessed on 17/11/2022
Morphine sulphate. Accessed via https://medusa.wales.nhs.uk (17/11/2022)

Monograph last updated: 23/11/2022

NALOXONE

Indication	Route	Dose	Frequency	Notes
Reversal of opioid induced respiratory depression	I.V. injection	10 micrograms/kg	Repeat every 2 - 3 minutes as necessary.	If multiple doses are required, consider switching to a continuous infusion
	Continuous infusion	5-20 micrograms/kg/hr	-	-
	I.M. injection	200 micrograms	Stat	Useful for babies exposed to maternal opioids as provides prolonged effect within 4 hours of delivery. Do NOT use in babies with acute opioid overdoses

Administration Details

See Medusa for further administration details.

For a continuous infusion take 500microgram PER KILO and DILUTE to 10ml with sodium chloride 0.9% or glucose 5%, so that 0.2ml/hr = 10microgram/kg/hr.

Further Information

Use in an infant of an opiate-dependent mother can precipitate withdrawal symptoms, therefore ensure withdrawal scoring is completed.

Monitor blood pressure, heart rate and respiratory rate.

The onset of action is approximately 2 minutes when given via the IV route, with a duration of action of 3-4hours.

The onset of action is approximately 3-4 minutes when given via the IM route (which makes it less suitable in acute opioid overdoses), the duration of action is 18hours.

The half-life of an opioid may be longer than naloxone and therefore repeat doses of naloxone maybe required to prevent respiratory depression reoccurring.

References:
Naloxone hydrochloride. Accessed via https://medusa.wales.nhs.uk (10/08/2022)
Paediatric Formulary Committee. *British National Formulary for Children App*. London: British Medical Association, the Royal Pharmaceutical Society of Great Britain, the Royal College of Paediatrics and Child Health, and the Neonatal and Paediatric Pharmacists Group. Accessed on 10/08/2022.
Guy's and St. Thomas', King's College and University Lewisham Hospitals. Paediatric Formulary. Online edition. Accessed via http://cms.ubqo.com/public/d2595446-ce3c-47ff-9dcc-63167d9f4b80 (10/08/2022)

Monograph last updated: 12/08/2022

NORADRENALINE

Indication	Route	Initial Dose	Notes
Hypotension	I.V. infusion	0.1 micrograms/kg/min	Increase according to response. Maximum dose 1 micrograms/kg/min.

Administration Details

In neonatal patients- administer via **central** access. The drug causes vasoconstriction and has a low pH and therefore extravasation can cause necrosis. Monitor insertion site closely.

Babies ≤ 2.6kg
Take 1.5mg PER KILO from a 1mg/ml ampoule DILUTE to 25ml with 5% glucose, 10% glucose or 0.9% sodium chloride. A rate of 0.1ml/hr = 0.1micrograms/kg/min.

Babies > 2.6kg – 5.3kg
Take 1.5mg PER KILO from a 1mg/ml ampoule DILUTE to 50ml with 5% glucose, 10% glucose or 0.9% sodium chloride. A rate of 0.2ml/hr = 0.1micrograms/kg/min.

Term infants (If fluid restricted see dosing above if patient 5.3kg or below)
Take 0.3mg PER KILO from a 1mg/ml ampoule DILUTE to 50ml with 5% glucose, 10% glucose or 0.9% sodium chloride. A rate of 1ml/hr = 0.1micrograms/kg/min.
For more information regarding the use of this concentration please see the PICU guidelines at www.sort.nhs.uk (Guidelines > Guidelines: drugs > Drug infusion guide 2018)

Maximum recommended concentration: 160micrograms/ml

Incompatible with bicarbonate and alkaline solutions. Discard any discoloured solution (e.g., pink, dark yellow or brown) or contains a precipitate.

See Medusa monograph for further administration and compatibility details.

Monitoring
Monitor ECG (as can cause arrhythmias), heart rate and blood pressure during infusion as it can cause peripheral vasoconstriction.

Check the infusion site closely and frequently.

Further Information
Do not let the infusion run out, ensure that a new infusion is prepared before the previous syringe finishes.

When stopping the infusion, monitor the blood pressure closely whilst reducing the rate of infusion gradually. When the infusion is discontinued, disconnect the administration set and aspirate the contents of the access device before flushing to avoid unintentional administration of a 'bolus' dose or flush the line at the same rate the medicine was administered.

References:
British Medical Association, Royal Pharmaceutical Society of Great Britain and Royal College of Paediatrics and Child Health. BNF for Children [January *2023*]. Electronic edition. London: BMJ Publishing Group Ltd, RPS Publishing and RCPCH Publications Ltd. Accessed via https://www.medicinescomplete.com/#/browse/bnfc (06/01/2023)
Guy's & St. Thomas', King's College and University Lewisham Hospitals *Paediatric Formulary.* Online Edition. London. Guy's St. Thomas NHS Foundation Trust. Accessed on 06/01/2023
Noradrenaline (norepinephrine). Accessed via https://medusa.wales.nhs.uk (06/01/2023)

Monograph last updated: 10/03/2023

PANCURONIUM

Indication	Route	Dose	Frequency
Neuromuscular blockade in patients with assisted ventilation	I.V.	100 micrograms/kg	Initial dose
		50 micrograms/kg	Subsequent doses as required

Administration Details

Can be given neat or diluted in sodium chloride 0.9% or glucose 5% to aid administration.

Pancuronium has a low pH, give via central venous access, if this is unavailable administer via a large peripheral vein monitoring insertion site closely.

Monitoring

Monitor blood pressure, heart rate and CO_2 accumulation.

Further Information

Duration can be prolonged in renal or liver impairment.

Vagolytic and sympathomimetic effects can cause hypertension and tachycardia.

Activity is prolonged in hypothermia.

Allergic cross-sensitivity between neuromuscular blocking drugs, caution is advised in cases of hypersensitivity to these drugs (polarising and non-polarising).

This is a fridge item.

References:
Medusa Injectable Medicines Guide. *Pancuronium Bromide*. Accessed via http://medusa.wales.nhs.uk/ (06/09/2023)
Guy's & St. Thomas', King's College and University Lewisham Hospitals *Paediatric Formulary.* Online Edition. London. Guy's St. Thomas NHS Foundation Trust. Accessed on 06/09/2023
British Medical Association, Royal Pharmaceutical Society of Great Britain and Royal College of Paediatrics and Child Health. BNF for Children [September *2023*]. Electronic edition. London: BMJ Publishing Group Ltd, Pharmaceutical Press and RCPCH Publications Ltd. Accessed via https://www.medicinescomplete.com/#/browse/bnfc (06/09/2023)
Medicines and Health Products Regulatory Agency (MHRA) – Pancuronium Bromide Summary of Product Characteristics, Accessed via: https://mhraproducts4853.blob.core.windows.net/docs/628a4fd7a37882f7ac343a1e03a91015aa0f6fe8 on 06/09/2023

Monograph last updated 06/09/2023

PHENOBARBITAL

Indication	Route	Dose	Frequency	Notes
Seizures	I.V.	20mg/kg	Loading dose over 20 – 30 minutes	
		2.5mg/kg	Twice daily	Alternatively give 5mg/kg ONCE daily
	Oral	2.5mg/kg	Twice daily	
Pre HIDA scan	Oral	2.5mg/kg	Twice daily for 3-5 days pre-scan	

Administration Details

Give as a slow infusion at a maximum rate of 1mg/kg/minute. Dilute with water for injection to 15mg/ml.

Preferably to be given via central venous access, if this is unavailable administer via a large peripheral vein monitoring insertion site closely.

Due to high pH, and phenobarbital injection containing 90% propylene glycol, extravasation can cause severe tissue damage.

Further Information

The maximum anti-convulsant effect may take up to 20 minutes following completion of the phenobarbital infusion. Further loading doses at 10mg/kg (half-loading doses) up to total of 40mg/kg, may be given if control is not achieved.

Maintenance dose usually starts 12 hours after loading if using 2.5mg/kg BD or 24 hours after loading if giving 5mg/kg OD.

May consider checking the level 2 hours post the administration of the final loading dose.

Monitor for abnormal movements and respiratory depression.

A trough plasma level should be taken after one week of therapy, trough level 15-40mg/l

Metabolised by the liver and excreted via the kidney, therefore toxicity may occur if patient has liver or renal impairment.

The sedative effects of phenobarbital may last longer in babies with asphyxia.

Therapeutic hypothermia can double the half-life and therefore cause prolonged sedation.

Higher loading doses may cause respiratory depression in the preterm baby.

Approximate time to steady state is 10-14 days but this is prolonged in neonates.

Due to metabolic pathway, interacts with many medicines (including phenytoin), always perform interaction check or confirm with pharmacy if ongoing treatment required.

References:

Medusa Injectable Medicines Guide. *Phenobarbital*. Accessed via http://medusa.wales.nhs.uk/ (01/09/2023)

Summary of Product Characteristics Phenobarbital Sodium 200mg/mL injection Accessed via https://www.medicines.org.uk/emc/product/3607/smpc (01/09/2023)

Guy's & St. Thomas', King's College and University Lewisham Hospitals *Paediatric Formulary.* Online Edition. London. Guy's St. Thomas NHS Foundation Trust. Accessed on 01/09/2023

Ainsworth, S. (2020). *Neonatal Formulary* (8th ed.). Oxford University Press. https://doi.org/10.1093/med/9780198840787.001.0001

British Medical Association, Royal Pharmaceutical Society of Great Britain and Royal College of Paediatrics and Child Health. BNF for Children [August *2023*]. Electronic edition. London: BMJ Publishing Group Ltd, Pharmaceutical Press and RCPCH Publications Ltd. Accessed via https://www.medicinescomplete.com/#/browse/bnfc (01/09/2023)

Scottish Perinatal Network, NHS Scotland. *West of Scotland Neonatal Drug Monographs*. Online Edition. Accessed via https://www.perinatalnetwork.scot/guidance/neonatal-guidance/local-regional-drug-monographs/ (01/09/2023)

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Mohamadien, N. R. A., Makboul, R., Galal, S. M., & Mostafa, N. M. (2021). Role of hepatobiliary scintigraphy with different semi-quantitative parameters along with histopathological scoring in differentiating biliary atresia from neonatal hepatitis. *Egyptian Journal of Radiology and Nuclear Medicine*, *52*(1), 111. https://doi.org/10.1186/s43055-021-00482-5

Malik, D., Khan, S. H., Ali, S. W., Rather, T. A., Pakala, R., Hassan, M. U., Yadav, N., & Pasupula, M. (2015). Comparison of phenobarbitone and ursodeoxycholic acid in drug-augmented hepatobiliary scintigraphy for excluding the diagnosis of obstructive cholestasis in neonatal cholestasis syndrome. *Nuclear Medicine Communications*, *36*(8), 827–832. https://doi.org/10.1097/MNM.0000000000000322

Kelly, D. (2012). Pediatric Cholestatic Syndromes. In *Zakim and Boyer's Hepatology* (pp. 1223–1256). Elsevier. https://doi.org/10.1016/B978-1-4377-0881-3.00068-1

Cowles, R. A. (2012). The Jaundiced Infant. In *Pediatric Surgery* (pp. 1321–1330). Elsevier. https://doi.org/10.1016/B978-0-323-07255-7.00105-7

Monograph last updated: 01/09/2023

PHENYTOIN

Indication	Route	Dose	Frequency	Notes
Seizures	I.V.	20mg/kg	Loading dose	Infuse over 30 minutes
		2.5mg/kg	Twice a day	Maintenance dose starts 12 hours after loading dose. Adjust to response and serum levels. (Usual maximum 7.5mg/kg twice a day)

Administration Details

Incompatible with Glucose, do NOT mix with glucose and use sodium chloride 0.9% or 0.45% to flush the line before administering phenytoin. Once the phenytoin infusion has finished flush the line with sodium chloride at the same rate as the phenytoin administration.

Infuse phenytoin over 30minutes. (Maximum rate: 1mg/kg/min) into a large vein, this is to avoid cardiac dysrhythmia, CNS depression and severe hypotension.

Dilute 1ml (50mg) of the injection to 10ml with sodium chloride 0.9% to give a 5mg/ml solution, withdraw the required amount and further dilute with sodium chloride 0.9% if required, use within one hour of dilution. Use an in-line filter. (0.22 - 0.5 micron).

Due to high pH, extravasation can cause severe tissue damage.

Monitoring

Monitor ECG, BP and signs of respiratory depression when giving intravenously. Monitor every 15 minutes for 2 hours post infusion if continuous monitoring not possible.

Monitor trough levels either 2 hours after loading, to direct further loading doses, or after 7 days of therapy. However, it can take approximately 1-2 weeks to reach steady state (this is highly variable).

Trough sample should be taken IMMEDIATELY prior to next dose.

Therapeutic range for Neonates – 3 months: 6-15mg/L.

Further Information

Therapeutic cooling prolongs the half-life of phenytoin.

Oral route is unsuitable for neonates as it interacts with feeds, please consult a pharmacist prior to switching from IV to oral.

Beware of cardiotoxicity, particularly in premature and asphyxiated neonates.

Phenytoin exhibits dose dependent kinetics so small dose changes may bring about large changes in steady state plasma levels. Phenytoin causes enzyme induction so interacts with many other drugs.

Phenytoin often increases the plasma concentration of phenobarbital as well as many hepatically metabolised drugs due to enzyme induction, phenytoin itself may be increased or decreased by drugs which alter its absorption or metabolism.

Administration to patients receiving thyroid hormone may induce supraventricular tachycardia.

Highly protein bound, with 90% bound to serum albumin.

Presence of HLA-B*1502 allele, particularly in individuals of Han Chinese or Thai origin, may be associated with an increased risk of Steven-Johnson Syndrome.

References:
Medusa Injectable Medicines Guide. *Phenytoin Sodium*. Accessed via http://medusa.wales.nhs.uk/ (06/09/2023)
Summary of Product Characteristics (*Phenytoin Hospira 50mg/mL injection BP*) Accessed via https://www.medicines.org.uk/emc/product/3794/smpc (06/09/2023)
Guy's & St. Thomas', King's College and University Lewisham Hospitals *Paediatric Formulary.* Online Edition. London. Guy's St. Thomas NHS Foundation Trust. Accessed on 06/09/2023
British Medical Association, Royal Pharmaceutical Society of Great Britain and Royal College of Paediatrics and Child Health. BNF for Children [September *2023*]. Electronic edition. London: BMJ Publishing Group Ltd, Pharmaceutical Press and RCPCH Publications Ltd. Accessed via https://www.medicinescomplete.com/#/browse/bnfc (06/09/2023)
Scottish Perinatal Network, NHS Scotland. *West of Scotland Neonatal Drug Monographs*. Online Edition. Accessed via https://www.perinatalnetwork.scot/guidance/neonatal-guidance/local-regional-drug-monographs/ (06/09/2023)

Monograph last updated: 07/09/2023

ROCURONIUM

Indication	Route	Dose		Frequency	Notes
Short term muscle relaxation	I.V. injection	Initial dose	0.6mg/kg	Stat	
		Further doses (if required)	0.15mg/kg	Stat	Repeat dose as required
Sustained muscle relaxation	I.V. infusion	0.3-0.6 mg/kg/hr		Continuous	Adjust rate according to response

Rocuronium should only be given to babies receiving respiratory support and who are adequately sedated.

Administration Details

For *BOLUS* administration the solution may be given undiluted or diluted to aid administration with sodium chloride 0.9% or glucose 5% to a convenient volume. Dilution is advised for neonates. Administer by rapid injection (over 10 to 15 seconds).

For an INFUSION take 40mg PER KILO from a 10mg/ml vial DILUTE to 20ml with sodium chloride 0.9% or glucose 5%. A rate of 0.15ml/hr = 0.3mg/kg/hr.

Preferably administer via central access, the low pH of the drug can result in venous irritation and tissue damage in cases of extravasation. If central access is not available, administer via a large peripheral cannula and monitor insertion site closely.

See Medusa monograph for further administration and compatibility details.

Monitoring

Monitor heart rate, blood pressure, ventilation.

Reversal agents

An acetylcholinesterase inhibitor e.g., neostigmine (in conjunction with atropine) can be used once spontaneous recovery starts.

Further Information

Excreted in urine and bile. Use in caution in patients with severe renal failure as prolonged duration of action may occur (consider dose reducing).

Prolonged duration of action when given with ketamine, fentanyl, other muscle relaxants, aminoglycosides, metronidazole and diuretics. Titrate dose to response.

A reduction in duration of action may occur when given with chronic steroid use, phenytoin, carbamazepine, noradrenaline, calcium chloride and potassium chloride. Titrate dose to response.

Prescribe Hypromellose 0.3% eye drops for patients on continuous infusion.

References:
British Medical Association, Royal Pharmaceutical Society of Great Britain and Royal College of Paediatrics and Child Health. BNF for Children [November *2022*]. Electronic edition. London: BMJ Publishing Group Ltd, RPS Publishing and RCPCH Publications Ltd. Accessed via https://www.medicinescomplete.com/#/browse/bnfc (29/11/2022)
Guy's & St. Thomas', King's College and University Lewisham Hospitals *Paediatric Formulary.* Online Edition. London. Guy's & St. Thomas NHS Foundation Trust. Accessed on 29/11/2022
Rocuronium bromide. Accessed via https://medusa.wales.nhs.uk (29/11/2022)

Monograph last updated: 17/02/2023

SODIUM BICARBONATE

Indication	Route	Dose	Frequency
Resuscitation	Slow I.V.	1-2 mmol/kg	Stat dose
Renal/Gut losses	Oral	1-2 mmol/kg	Daily in divided doses
To correct acidosis	I.V.	**Base deficit x weight (kg) x 0.4** (divide by 2 for half correction) Only half the base deficit should be corrected initially	
Exchange transfusion	I.V	Add 4 mmol for 1st unit and 2 mmol to any 2nd unit of CPD blood used	

Administration Details

Intravenous:
Administer via a dedicated line if possible. Maximum rate 0.5 mmol/kg/min.

Dilute 4.2% 1 in 4 for peripheral administration. Dilute in glucose 5% or glucose 10% as there is a risk of hypernatraemia if diluted in Sodium Chloride.

4.2% may be given neat but requires close monitoring of the line as extravasation can cause severe tissue necrosis.

Dilute 8.4% 1 in 10 for peripheral administration and 1 in 5 for central administration.

Umbilical arterial line:

- **Dilute** solution: take 3mmol of 4.2% sodium bicarbonate and 40units of heparin sodium and make up to 40ml with water for injection. This solution gives 0.9mmol of sodium bicarbonate over 24 hours, the syringe must be changed every 24hours.
- **Concentrated** Solution: take 6mmol of 4.2% sodium bicarbonate and 40units of heparin sodium and make up to 40ml with water for injection. This gives 1.8mmol of sodium bicarbonate over 24 hours.

Oral:
8.4% oral solution available from pharmacy. Allow 1 – 2 hours before administering other drugs as sodium bicarbonate can affect the stability of other drugs if administered at the same time.

Further Information

Monitor pH and electrolytes after half correction before a full correction.

Sodium bicarbonate may increase blood pressure or cause fluid retention and pulmonary oedema in those at risk.

Hypokalaemia may be exacerbated.

Monograph last updated 2016

SODIUM CHLORIDE

Indication	Route	Dose	Frequency	Notes
Sodium Supplement	Oral/I.V.	3-5 mmol/kg	Daily in divided doses	Adjust according to response
Patency of lines	UVC	0.5ml/hr	Continuous infusion	Use either 0.45% or 0.9%
	Central venous catheter	1ml/hr	Continuous infusion	

Administration Details

Oral solution available containing 5 mmol/ml.

30% I.V. solution can be given orally if required.

Further Information

Check the bottle for expiry date on opening.

Monograph last updated 2016

SUXAMETHONIUM

Indication	Route	Dose	Frequency
Premedication for intubation	I.V.	See dose banding table below	Stat dose

Suxamethonium (4mg in 1mL)

Weight (grams)	Calculated dose (mg)	Volume required (ml)
< 500	0.8	0.2
500 – 749	1.2	0.3
750 – 999	1.6	0.4
1000 – 1249	2.4	0.6
1250 – 1499	2.8	0.7
1500 – 1999	3.6	0.9
2000 – 2499	4.4	1.1
2500 – 2999	5.6	1.4
3000 – 3499	6.4	1.6
3500 – 3999	7.6	1.9
4000 – 5000	9.2	2.3

Administration Details

Give after Fentanyl and Atropine.

Use pre-filled syringes found in the CD fridge in Nursery 3.

If pre-filled syringes unavailable follow the instructions below:
Using **Suxamethonium 100mg/2ml Injection:**

> Dilute 50mg (1ml) to a total of 12.5ml with sodium chloride 0.9%. This gives a 4mg/ml solution. Withdraw the required dose and discard the remainder.

Further Information

Onset of action: 30 – 60 seconds. The dose will provide 5 – 10 minutes of muscle paralysis.

Paralysis can cause painful muscle fasciculations.

Atropine reduces bradycardia and excessive salivation associated with Suxamethonium use.

Can cause hyperkalaemia, especially in burns, trauma, and renal failure patients – causes a 0.5mmol rise in plasma potassium.

Suxamethonium is contraindicated in the presence of hyperkalaemia and family history of malignant hyperthermia, severe liver disease, burns patients, muscular dystrophy (relative in undiagnosed muscular disorders), known allergy and family history of plasma cholinesterase deficiency.

Can cause prolonged paralysis due to low levels of pseudocholinesterase (for example, liver disease or genetically determined variants of pseudocholinesterase.

Caution when used with anaesthetic gases as can cause malignant hyperthermia.

Remember to complete the Intubation Drug Register if using the pre-filled syringes.

There is a risk of cross-sensitivity reactions with other neuromuscular blocking (both depolarising and non-depolarising) drugs, caution is advised where there is a patient or family history of sensitivity to neuromuscular blocking drugs.

References
University Hospitals Southampton NHS Foundation Trust – Neonatal Intubation Guideline version 1.1(April 2023), available from: http://staffnet/TrustDocsMedia/DeptDivSpecific/DivC/WomenNewborn/NeonatalUnit/NeonatalGuidelines/Intubation/Intubation-guideline.pdf (accessed 06/09/2023)
Medusa Injectable Medicines Guide. *Suxamethonium Chloride*. Accessed via http://medusa.wales.nhs.uk/ (06/09/2023)
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British Medical Association, Royal Pharmaceutical Society of Great Britain and Royal College of Paediatrics and Child Health. BNF for Children [September *2023*]. Electronic edition. London: BMJ Publishing Group Ltd, Pharmaceutical Press and RCPCH Publications Ltd. Accessed via https://www.medicinescomplete.com/#/browse/bnfc (06/09/2023)
Summary of Product Characteristics (*Suxamethonium chloride 50mg/mL solution for injection*) Accessed via https://www.medicines.org.uk/emc/product/5189/smpc (06/09/2023)

Monograph last updated 06/09/2023

VECURONIUM

Indication	Route	Dose		Frequency	Notes
Short term muscle relaxation	I.V. injection	Initial dose	80mcg/kg	Stat	
		Further doses (if required)	30-50mcg/kg	Stat	Repeat dose as required
Sustained muscle relaxation	Continuous infusion	30-120mcg/kg/hr		Continuous	Adjust rate according to response

Vecuronium should only be given to babies receiving respiratory support and who are adequately sedated.

Administration

Reconstitute a 10mg vial with 5ml water for injection. This gives a concentration of 2mg/ml.

I.V. bolus – Further dilute reconstituted vial to 25ml using either Glucose 5% or 0.9% Sodium Chloride. This provides a 400microgram/ml solution.

Continuous infusion - Take 6mg PER KILO from the 2mg/ml vial dilute to 20ml with fluid e.g. glucose 5% so that a rate of 0.1ml/hr = 30microgram/kg/hr.

Onset of Action is approximately 3 minutes; the duration of action is 30-40 minutes for an IV bolus.

Monitoring

Monitor heart rate, blood pressure, ventilation.

Reversal agents

1. Sugammadex for reversal of intense and deep block.
2. An acetylcholinesterase inhibitor e.g. neostigmine (in conjunction with atropine) can be used once spontaneous recovery starts.

Compatibility

Compatible	**NOT** compatible
Glucose 5%	Furosemide
Sodium Chloride 0.9%	Omeprazole
Dobutamine	Isosorbide dinitrate
Dopamine	
Gentamicin	
Midazolam	
Milrinone	
Morphine	
Noradrenaline	

This table is a guide only and gives information for two combinations only, it cannot be extrapolated to multiple drug concentrations.

For further information regarding administration and compatibility see the Medusa monograph.

Additional Information

Prolonged recovery time has been seen in patients with renal failure and premature babies. Use with caution in severe renal failure as 25% of the drug is renally excreted – atracurium could be used in these cases.

Duration of action may be increased by aminoglycosides, magnesium sulphate, metronidazole and suxamethonium.

Therapeutic hypothermia decreases plasma clearance therefore duration of action is prolonged.

Use of continuous infusions carries the risk of drug accumulation.

Prescribe Hypromellose 0.3% eye drops for patients on continuous infusions.

References:
Summary of Product Characteristics (Vecuronium SUN 10 mg powder for solution for injection/infusion) Accessed via https://www.medicines.org.uk/emc/product/2619 (08/04/21)
Sean B. Ainsworth (2015) *Neonatal Formulary 7: Drug use in pregnancy and the first year of life*. 7th Ed. Chichester John Wiley & Sons Ltd
Guy's and St. Thomas', King's College and University Lewisham Hospitals. Paediatric Formulary. Online edition. Accessed via http://cms.ubqo.com/public/d2595446-ce3c-47ff-9dcc-63167d9f4b80 (08/04/21)

Monograph last updated: 8/04/2021