Management of Paediatric Shock

Title:	**Management of paediatric shock**
Version:	**1**
Supersedes:	NEW: management of shock including escalation of inotropes separated from sepsis guideline
Application:	The guideline is intended for use by any hospital team caring for infants, children and young people under 16 years age across the Paediatric Critical Care Network in the North-West (England) & North Wales region.

Originated /Modified By: Designation:	**Originated By (working group) co-authors:** Kate Parkins, PICM/PCC transport consultant, NWTS Lisa Pritchard, PICM/PCC transport consultant, NWTS & UHNM Nicola Longden, Band 7 clinical nurse specialist, NWTS Gemma Burdis, consultant (Paediatric Anaesthesia/PCC Transport), NWTS & UHNM
Reviewed by:	1. North-West & North Wales Paediatric Critical Care Operational Delivery Network 2. Lewis Nicholls, Paediatric Pharmacist, PCC ODN & RMCH
Ratified by:	1. North-West & North Wales Paediatric Critical Care Operational Delivery Network 2. RMCH (Network Host Trust): - Paediatric Medicines Management Committee (PMMC) - Paediatric Policies & Guidelines Committee (P&G)
Date of Ratification:	1. PCC Oversight: 14.08.24 2. PMMC: December 25 3. P&G Committee: 12.12.25

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Circulated by:	PCC, SiC & LTV ODN
Dissemination and Implementation:	15.12.25
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Planned Review Date:	December 2028
Responsibility of:	Clinical lead North-West & North Wales Paediatric Critical Care Network & NWTS guideline lead consultant

Minor amendment (if applicable) notified to:	
Date notified:	

EqIA Registration Number:	EQIA 2025-351

1. Detail of Procedural Document

Management of paediatric shock guideline is for use by clinical teams managing infants, children and young people under 16 years age in the North-West (England) and North Wales region.

2. Equality Impact Assessment

<table>
<tr><td colspan="3">Equality Impact Assessment
Please record the decision whether the policy, service change or other key decision was assessed as relevant to the equality duty to:
Eliminate discrimination and eliminate harassment
Advance equality of opportunity
Advance good relations and attitudes between people</td></tr>
<tr><td>Relevant</td><td>YES</td><td rowspan="2">Guideline relevant for paediatric age group only
Intended for use across North-West (England) & North Wales region for those under 16 years of age.
Appropriate PEWS and observation target ranges included for all age groups.
Risk of occult hypoxaemia highlighted IE that it is more than 3 times greater in Black vs White pts AND may over-estimate SpO_2 between 1.5-5%.</td></tr>
<tr><td colspan="2">Where the decision was RELEVANT, please record details of the outcome of the full impact assessment and summarise the actions that will be taken to eliminate or mitigate adverse impact, advance equality or justification for the impact.</td></tr>
<tr><td colspan="2">EqIA registration Number for RMCH:</td><td>2025-351</td></tr>
</table>

3. Consultation, Approval and Ratification Process

This guideline was developed with input from:
- North-West (England) and North Wales Paediatric Transport Service (NWTS).
- Representatives from both Paediatric Intensive Care Units (Royal Manchester Children's Hospital and Alder Hey Children's Hospital) - medical, nursing and paediatric intensive care pharmacists
- Representatives from the North-West (England) and North Wales Paediatric Critical Care Network (PCCN) - medical, nursing and AHP (paediatrics, anaesthetics, and emergency medicine teams)

These guidelines were circulated amongst the North-West (England) and North Wales Paediatric Critical Care Operational Delivery Network for comments on the 01.08.24

All comments received have been reviewed and appropriate amendments incorporated.

These guidelines were signed off by the PCC ODN guidelines committee on 14.08.24
For ratification process for network guidelines see appendix 1.

4. Disclaimer

These clinical guidelines represent the views of the North-West (England) and North Wales Paediatric Transport Service (NWTS) and the North-West (England) and North Wales Paediatric Critical Care Operational Delivery Network (PCCN). They have been produced after careful consideration of available evidence in conjunction with clinical expertise and experience.

It is intended that trusts within the Network will adopt this guideline and educational resource after review and ratification (including equality impact assessment) through their own clinical governance structures.

The guidance does not override the individual responsibility of healthcare professionals to make decisions appropriate to the circumstances of the individual patient.

Clinical advice is always available 24/7 from NWTS on a case-by-case basis via referral line:

08000 84 83 82

Please contact NWTS (01925 853 550) regarding these documents if there are any queries.

Management of Paediatric Shock

SHOCK PRESENT? **Persistent ↑HR, raised lactate > 2 mmol/L, ↓ urine output, altered mental state, poor peripheral perfusion, prolonged capillary refill time, new or worsening hepatomegaly.**

HYPOTENSION present (red/amber NPEWS) => pt is in extremis & peri-arrest: **ACT QUICKLY to avoid cardiac arrest**

Assess ABC & treat appropriately. Give 100% O_2, place PVL/IO & give fluid bolus

URGENT PAEDIATRIC CONSULTANT +/- ANAESTHETIC REVIEW

CHECK fluid responsiveness & for signs of cardiac failure BEFORE & AFTER each fluid bolus (page 5)

Fluid bolus 10 mL/kg MAX 500 mL: crystalloid (Plasmalyte 148 or Hartman's solution) & re-assess

Caution: give 5 mL/kg MAX 250 mL bolus if **CHD or cardiomyopathy** suspected

Persistent signs of shock despite 40-60 mL/kg OR any evidence of cardiac failure

Correct iCa aim >1.2

1ST LINE INOTROPE = ADRENALINE

Start at 0.2 microgram/kg/min & titrate to appropriate mean BP (pg 13)

Site 2nd PVL/IO

Don't delay inotropes. If no PVL/CVL after 3 attempts/5 mins insert an IO

2ND LINE = NORADRENALINE

Start when adrenaline ≥ 0.2-0.3 microgram/kg/min

Start at 0.1 microgram/kg/min & titrate to appropriate mean BP

Give IV hydrocortisone 1 mg/kg (max 100mg) Neonates 2.5mg/kg

When 2nd inotrope started OR patient presents with hypoglycaemia ie glucose < 3 mmol/L

Ideally check blood cortisol level first (may be added to previously sent biochemistry sample)

3rd line option = Vasopressin (argipressin)

Consider when both adrenaline & noradrenaline running at ≥ 0.3 micrograms

Start at 0.0006 units/kg/min OR 0.04 units/kg/hr (see page 11)

NB vials also labelled as argipressin or vasopressin USP or pitressin

Vasopressin may be added if hypotension persists despite noradrenaline and adrenaline

OR

Clinicians may opt not to use vasopressin, and titrate adrenaline/noradrenaline infusions to effect

Milrinone

May be considered for patients with cardiac failure due to CHD / cardiomyopathy

OR with evidence of persistent hypoperfusion +

cardiac dysfunction despite above vasoactive agents

Ideally only following POCUS ECHO to assess cardiac function and discussion with paediatric cardiologist

Cardiac dysfunction is defined as the difference in oxygen saturation between arterial and mixed venous blood (AVO_2) ≥ 30% or an increase in serum lactate more than 2 mmol/L

NEVER use a loading dose of milrinone in shock

START inotropes via dedicated IO or PVL. TITRATE INOTROPES TO RESPONSE. see page 12 for MEAN BP

Initial Management of Four Types of paediatric shock

Hypovolemia / Fluid loss

Haemorrhage

Give Blood +/- clotting products

See national paediatric **Massive Haemorrhage guideline**

Intestinal

Consider previous and ongoing losses.

Give Crystalloids

See **Acute abdomen guideline**

Burn ≥ 10% TBSA

Give Crystalloids ideally Plasmalyte 148 (or Hartmann's)

Use Lund & Bowder body chart or Mersey burns app to calculate TBSA

Parklands formula for fluid replacement IN ADDITION to 100% maintenance fluids (see **Mersey Burns App**)
= 3-4 mL/kg per TBSA
1st 50% in 1st 8 hrs since burn &
2nd 50% given over next 16 hrs
IE within 1st 24 hrs since burn

Cardiogenic

Congenital heart disease

Inotropes +/- Dinoprostone (duct dependent lesions)

Fluids in small aliquots ie max 5 mL/kg

D/W NWTS + Cardiology

See **page 3**

Cardiomyopathies / Myocarditis

Respiratory support i.e. High flow or NIV PLUS consider inotropes early

D/W NWTS + Cardiology

See **page 3**

Distributive

Sepsis

Give crystalloids fluids. Escalate to Inotropes.

Treat as per **Sepsis & Shock guidelines**

Anaphylaxis

Remove allergen.

Treat as per APLS/**Resus council anaphylaxis guidelines**.

High spinal cord injury

Discuss with TTL & prepare for time critical transfer.

Treat as per **Major Trauma** & time critical guidelines.

Obstructive

Pulmonary embolism, pneumothorax, critical aortic stenosis, coarctation or hypoplastic aortic arch, and cardiac tamponade

Treat underlying cause
D/W NWTS + appropriate specialist teams#

See **chest drain guideline** for management of tension pneumothorax
See **collapsed neonate/infant** for coarctation/hypoplastic arch

DEFINITION of Paediatric Shock = when circulatory system fails to adequately deliver oxygen and nutrients, and remove toxins, at tissue and cellular level, leading to (multi-) organ dysfunction due to inadequate tissue perfusion. Types of paediatric shock – page 3

Clinical recognition relies on surrogate markers ie tachycardia, altered mental status, poor peripheral perfusion, reduced volume peripheral pulses, prolonged capillary refill time, reduced urine output, and raised lactate.

Paediatric shock is NOT defined by hypotension. **Hypotension = LATE sign** and indicates the patient is in extremis and peri-arrest. It is essential to **act quickly to avoid cardiac arrest**.

Prompt recognition and treatment are crucial to prevent severe complications and mortality.

FLUID BOLUSES

(if shock NOT due to major haemorrhage)

- **ASSESS fluid responsiveness** and **LOOK for signs of fluid overload BEFORE & AFTER each bolus**
- **Check for fluid responsiveness:** assess the effect of sustained direct upwards (towards head) pressure on the liver (= hepato-jugular response)
  - ⇒ BP improves +/- pulse rate falls: patient still fluid responsive, therefore give more fluid
  - ⇒ BP does not improve or worsens (i.e. evidence myocardial impairment) start an inotrope
- **Check & re-assess for signs of volume overload/cardiac failure pre/post fluid boluses:**
  - Gallop rhythm
  - Hepatomegaly (new or worsening)
  - On examination of chest: evidence of pulmonary oedema (crepitations or crackles)
  - **All above may be present with or without hypotension**.
- **If ANY are present start inotropes/vasopressors ASAP & discuss with NWTS**
- **Aim** for a serial reduction of lactate by 10% every hour or normalisation of lactate
- **Fluid bolus 10 mL/kg MAX 500 mL** should be dosed **using ideal body weight (IBW).**
- **CAUTION:** anyone with **suspected CHD / cardiomyopathy use fluid bolus 5 mL/kg MAX 250 mL (IBW)**. Patient may be underfilled due to poor feeding/fluid intake and benefit from appropriate fluid resuscitation. Always re-assess after each fluid bolus, checking for cardiac failure as above.
- **ALWAYS use balanced crystalloid** e.g. Plasmalyte 148 or Hartmann's solution (if NOT available use 0.9% sodium chloride)
- **IDEALLY AVOID 0.9% sodium chloride** if feasible as it is associated with hyperchloraemic acidosis, AKI and higher mortality when compared to balanced crystalloids[5].
- **Albumin (4.5% or 5% human albumin solution)** has not been shown to be a superior initial resuscitation fluid, but there is no definite negative impact or difference in outcomes[3]. Balanced crystalloids are cheaper and more easily accessible than human albumin. HAS is usually only used in patients with septic shock.
- Total fluid bolus ≥ 60 mL/kg consider switching to 4.5% human albumin solution +/- appropriate blood products (page 6).
- **AVOID gelatin containing fluids** (causes coagulopathy). Do NOT use starches in acute resuscitation[16]. Both are associated with anaphylaxis.
- **High mixed venous oxygen saturation levels do not exclude fluid responsiveness** in critically ill septic patients[4], and should not be used to guide clinical decisions on fluid management.

BLOOD PRODUCTS[16]

Follow Massive Haemorrhage Guideline if shocked due to blood loss & received ≥ 30 mL/kg

For ALL other patients:

PACKED CELLS

- If patient **haemodynamically stable & SpO_2 > 92%** transfuse 10-20 mL/kg if **Hb < 70 g/L**
- If **haemodynamically unstable or severely hypoxic**[5] transfuse if **Hb < 100 g/L** (10-20 mL/kg)

COAGULOPATHY/THROMBOCYTOPENIA:

- Consider **Vitamin K IV** 0.3 mg/kg MAX 10 mg (dose in BNFc)
- Consider **Tranexamic Acid** bolus 15 mg/kg (MAX 1 gram) +/- infusion (2mg/kg/hr (MAX per dose 1 gram/hr) for 8 hours or until bleeding stops) if struggling to control bleeding due to coagulopathy or in trauma/surgical pts.
- Only consider treatment with **10-20 mL/kg Fresh Frozen Plasma (FFP) if actively bleeding**
- **Platelets:**
  - If not actively bleeding, only supplement platelets if count < 20 x 10^9/L
  - If bleeding or invasive procedures are planned, aim to keep platelets > 50 x 10^9/L
- **Cryoprecipitate:** low fibrinogen (< 0.75g/L) is suggestive of DIC – consider giving 5-10 mL/kg
- **Correct/avoid hypothermia** as this will worsen coagulopathy. Use active warming measures eg overhead heater, Transwarmer©, Bair hugger© device, hat, warmed blankets etc
- Don't forget to **correct / maintain ionized calcium (iCa) > 1.2 mmol/L**

CORRECT HYPOGLYCAEMIA & ELECTROLYTES

- **Hypoglycaemia = glucose ≤ 3 mmol/L:** give 10% glucose boluses (3 mL/kg bolus) **AND** start glucose-containing maintenance fluids early
- NB hypoglycaemia associated with shock may indicate poor stress response, give IV hydrocortisone 1 mg/kg (MAX 100 mg) 6 hrly; neonate 2.5 mg/kg/dose 6 hrly (ideally after blood sent to check cortisol level).
- Treat **Hypocalcaemia = iCa <1.2 mmol/L**: 10% calcium gluconate bolus +/- infusion (see NWTS emergency drugs guide). N.B. If giving via PVL 10% calcium gluconate must be diluted by 5 times (i.e. dilute each 1mL 10% solution with 4mL 0.9% sodium chloride to give a final concentration of 0.045 mmol/mL).
- **Aim** to maintain **ionised calcium > 1.2 mmol/L** (may need repeat doses +/- infusion—d/w NWTS)
- Treat **Hypomagnesaemia = Mg < 1 mmol/L**: to stabilise myocardium and/or treat cardiac arrhythmias; treat pulmonary hypertension. Use **cardiac arrest dose** and ALWAYS dilute Magnesium Sulfate 50% by 5 times as per NWTS emergency drug guide. **CAUTION: Magnesium causes vasodilation and may cause hypotension**. Give slowly over 20 minutes (MAX rate = 10 mg/kg/min) with an additional fluid bolus if needed.

BICARBONATE USE

- Not recommended for treatment of hypoperfusion-induced lactic acidaemia, especially if pH ≥ 7.15
- Appropriate fluid resuscitation is treatment of choice and usually results in resolution of lactic acidaemia without the need for sodium bicarbonate in majority of patients.
- Bicarbonate may be considered if pH < 7 despite fluid resuscitation and inotropes OR if known renal failure
- **Dose**: 1 mmol/kg/dose OR formula: sodium bicarbonate (mmol) = F X base deficit (mmol/L) X Wt (kg) X 0.5
  F = extracellular fluid:ratio. F = 0.5-0.6 in premature neonates (up to 37 weeks CGA); 0.4 in neonates (37 to 44 weeks CGA) & 0.3 in infants & children.
- NB ALWAYS dilute further (MIN = with equal volume of water for injection) & usually given over 20-30 mins
- Watch for evidence of extravasation as can cause burn/necrotic injury
- NB do NOT use same lumen / line for bicarbonate and inotropes – inotropes will stop working.
- Use large flush between calcium bolus & bicarbonate to avoid production calcium carbonate & blocking line.

INOTROPES

INOTROPES	VASOPRESSORS	INODILATORS	LUSITROPES	CHRONOTROPES
Alter strength of contraction	Cause vasoconstriction	Inotropes that also cause both vasodilation & improved myocardial contractility	Improve ventricular relaxation	Alter heart rate
Examples: Positive / Increases Adrenaline Negative / Reduces Amiodarone	Examples: Noradrenaline Vasopressin	Example: Milrinone	Example: Milrinone	Examples: Positive / Faster Adrenaline Isoprenaline Dopamine Negative / Slows Propranolol

- **START inotropes after 40-60 mL/kg** total fluid bolus if there is evidence shock has not reversed i.e. persistent ↑HR, raised lactate (≥ 2 mmol/L), reduced urine output, poor peripheral perfusion (core: peripheral temperature difference; poor peripheral pulses; prolonged CRT), OR wide pulse pressure (especially low diastolic) and vasodilation. OR new hepatomegaly.
- **START inotrope earlier** if ↓BP OR any evidence of cardiac dysfunction/failure i.e. hepatomegaly, gallop rhythm, or pulmonary oedema (crepitations or crackles) on examination.
- **HYPOTENSION** = late sign and is not required for diagnosis of shock.
- **HYPOTENSION** confirms severe shock and child is **PERI-ARREST**—**ACT QUICKLY to avoid cardiac arrest.**
- See algorithm on page 3 for escalation of inotropes/vasopressors pathway
- Do NOT delay starting inotropes for central access – use either intra-osseous (IO) OR peripheral venous line (see **intra-osseous insertion guideline** on NWTS website: www.nwts.nhs.uk)
- See appendix for peripheral concentration inotropes, information on administration and rate calculations.
- Watch carefully for signs of extravasation if using PVL or IO to administer inotropes.
- NB NWTS emergency drug guide includes both CENTRAL & PERIPHERAL concentrations – take care when using the guide to select the right concentration AND right rate of infusion for line used and intended dose.

ADRENALINE infusion for PERIPHERAL administration

Amount ADRenaline to add to 500 mL bag 0.9% sodium chloride / 5% glucose = 0.3 mg x weight (kg)
MAXIMUM concentration = 16 mg in 500 mL (Patients >80kg, dose at 80kg)
Dose: 0.05-1.5 micrograms/kg/min via peripheral line (for rate mL/hr see table below)

IF STARTING AN ADRENALINE INFUSION ALWAYS DISCUSS WITH NWTS TEAM.

OBTAIN FURTHER NWTS ADVICE IF > 0.5 MCG/KG/MIN REQUIRED.

LARGE VOLUMES REQUIRE NWTS REVIEW WITHIN 1 HOUR OF COMMENCING.

WEIGHT (kg)	Amount (mg) to add to 500 mL bag	RATE (ml/hr) = 0.05 microgram/kg/min	RATE (ml/hr) = 0.1 microgram/kg/min	RATE (ml/hr) = 0.2 microgram/kg/min	RATE (ml/hr) = 0.5 microgram/kg/min	RATE (ml/hr) = 1 microgram/kg/min	RATE (ml/hr) = 1.5 microgram/kg/min
2	0.6 mg	5 mL/hr	10 mL/hr	20 mL/hr	50 mL/hr	100 mL/hr	150 mL/hr
2.6	0.78 mg	5	10	20	50	100	150
3	0.9 mg	5	10	20	50	100	150
3.6	1.08 mg	5	10	20	50	100	150
4	1.2 mg	5	10	20	50	100	150
4.5	1.35 mg	5	10	20	50	100	150
5	1.5 mg	5	10	20	50	100	150
6	1.8 mg	5	10	20	50	100	150
7	2.1 mg	5	10	20	50	100	150
8	2.4 mg	5	10	20	50	100	150
9	2.7 mg	5	10	20	50	100	150
10	3 mg	5	10	20	50	100	150
12	3.6 mg	5	10	20	50	100	150
16	4.8 mg	5	10	20	50	100	150
20	6 mg	5	10	20	50	100	150
22	6.6 mg	5	10	20	50	100	150
26	7.8 mg	5	10	20	50	100	150
30	9 mg	5	10	20	50	100	150
35	10.5 mg	5	10	20	50	100	150
40	12 mg	5	10	20	50	100	150
45	13.5 mg	5	10	20	50	100	150
50	15 mg	5	10	20	50	100	150
55	16 mg	5.2	10.3	20.6	52	103	155
60	16 mg	5.6	11.3	22.5	56	113	169
65	16 mg	6.1	12.2	24.4	61	122	183
70	16 mg	6.6	13.1	26.3	66	131	197
75	16 mg	7	14.1	28.1	70	141	211
80	16 mg	7.5	15	30	75	150	225

NORADRENALINE infusion for PERIPHERAL administration

Amount NORadrenaline to add to 500 mL bag 0.9% sodium chloride / 5% glucose = 0.3 mg x weight (kg)
MAXIMUM concentration = 8 mg in 500 mL. (Patients >80kg dose at 80kg)
Dose: 0.05-1.5 micrograms/kg/min via peripheral line (for rate ml/hr see table below)

DISCUSS WITH NWTS TEAM IF STARTING NORADRENALINE INFUSION.

OBTAIN FURTHER NWTS ADVICE IF > 0.5MCG/KG/MIN REQUIRED.

LARGE VOLUMES REQUIRE NWTS REVIEW WITHIN 1 HOUR OF COMMENCING.

Weight (kg)	Amount (mg) to add to 500 ml bag	RATE (ml/hr) = 0.05 microgram/kg/min	RATE (ml/hr) = 0.1 microgram/kg/min	RATE (ml/hr) = 0.2 microgram/kg/min	RATE (ml/hr) = 0.5 microgram/kg/min	RATE (ml/hr) = 1 microgram/kg/min	RATE (ml/hr) = 1.5 microgram/kg/min
2 kg	0.6 mg	5 mL/hr	10 mL/hr	20 mL/hr	50 mL/hr	100 mL/hr	150 mL/hr
2.6	0.78 mg	5	10	20	50	100	150
3	0.9 mg	5	10	20	50	100	150
3.6	1.08 mg	5	10	20	50	100	150
4	1.2 mg	5	10	20	50	100	150
4.5	1.35 mg	5	10	20	50	100	150
5	1.5 mg	5	10	20	50	100	150
6	1.8 mg	5	10	20	50	100	150
7	2.1 mg	5	10	20	50	100	150
8	2.4 mg	5	10	20	50	100	150
9	2.7 mg	5	10	20	50	100	150
10	3 mg	5	10	20	50	100	150
12	3.6 mg	5	10	20	50	100	150
16	4.8 mg	5	10	20	50	100	150
20	6 mg	5	10	20	50	100	150
22	6.6 mg	5	10	20	50	100	150
26	7.8 mg	5.1	10.1	20.3	51	101	152
30	8mg	5.6	11.3	22.5	56	113	169
35	8mg	6.6	13.1	26.3	66	131	197
40	8mg	7.5	15	30	75	150	225
45	8mg	8.4	16.9	33.8	84	169	253
50	8mg	9.4	18.8	37.5	94	188	281
55	8mg	10.3	20.6	41.3	103	206	309
60	8mg	11.3	22.5	45	113	225	338
65	8mg	12.2	24.4	48.8	122	244	366
70	8mg	13.1	26.3	53	131	263	394
75	8mg	14.1	28.1	56	141	281	422
80	8mg	15	30	60	150	300	450

MILRINONE infusion for PERIPHERAL administration:

Weight (kg)	Amount mg in 50 mL	Rate (mL/hr) = 0.5 microgram/kg/min
< 5 kg	5 mg	Wt (kg) x 0.3
> 5 kg	10 mg	Wt (kg) x 0.15

Weight (kg)	Amount (mg) made up to 50 mL	RATE (mL/hr) = 0.25 microgram/kg/min	RATE (mL/hr) = 0.5 microgram/kg/min	RATE (mL/hr) = 0.75 microgram/kg/min
2 kg	5 mg	0.3 mL/hr	0.6 mL/hr	0.9 mL/hr
2.6	5mg	0.4	0.8	1.2
3	5mg	0.5	0.9	1.4
3.6	5mg	0.5	1.1	1.6
4	5mg	0.6	1.2	1.8
4.5	5mg	0.7	1.4	2
5	10mg	0.4	0.8	1.1
6	10mg	0.5	0.9	1.4
7	10mg	0.5	1.1	1.6
8	10mg	0.6	1.2	1.8
9	10mg	0.7	1.4	2
10	10mg	0.8	1.5	2.3
12	10mg	0.9	1.8	2.7
16	10mg	1.2	2.4	3.6
20	10mg	1.5	3	4.5
22	10mg	1.7	3.3	5
26	10mg	2	3.9	5.9
30	10mg	2.3	4.5	6.8
35	10mg	2.6	5.3	7.9
40	10mg	3	6	9
45	10mg	3.4	6.8	10.1
50	10mg	3.8	7.5	11.3
55	10mg	4.1	8.3	12.4
60	10mg	4.5	9	13.5
65	10mg	4.9	9.8	14.6
70	10mg	5.3	10.5	15.8
75	10mg	5.6	11.3	16.9
80	10mg	6	12	18

VASOPRESSIN (argipressin)

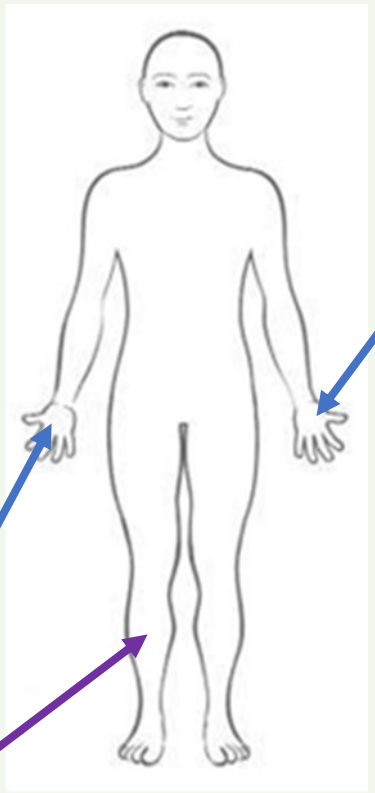
VASOPRESSIN should only be administered CENTRALLY: via a central line or Intraosseous
Amount of Vasopressin to be made up to 50 mL with 0.9% sodium chloride / 5% glucose = (1 unit x weight (kg))
MAXIMUM concentration = 50 units in 50 mL. (Patients >80kg dose at 80kg)
The dose is 0.0003 – 0.002units/kg/min (for rates in mL per hour please see table below)
Discuss with NWTS if planning to start Vasopressin.

WEIGHT (kg)	AMOUNT (units) made up to 50 mL	RATE (mL/hr) = 0.0003units/kg/min	RATE (mL/hr) = 0.0006units/kg/min	RATE (mL/hr) = 0.0009units/kg/min	RATE (mL/hr) = 0.002units/kg/min
2 kg	2 units	0.9 mL/hr	1.8 mL/hr	2.7 mL/hr	6 mL/hr
2.6	2.6 units	0.9	1.8	2.7	6
3	3 units	0.9	1.8	2.7	6
3.6	3.6 units	0.9	1.8	2.7	6
4	4 units	0.9	1.8	2.7	6
4.5	4.5 units	0.9	1.8	2.7	6
5	5 units	0.9	1.8	2.7	6
6	6 units	0.9	1.8	2.7	6
7	7 units	0.9	1.8	2.7	6
8	8 units	0.9	1.8	2.7	6
9	9 units	0.9	1.8	2.7	6
10	10 units	0.9	1.8	2.7	6
12	12 units	0.9	1.8	2.7	6
16	16 units	0.9	1.8	2.7	6
20	20 units	0.9	1.8	2.7	6
22	22 units	0.9	1.8	2.7	6
26	26 units	0.9	1.8	2.7	6
30	30 units	0.9	1.8	2.7	6
35	35 units	0.9	1.8	2.7	6
40	40 units	0.9	1.8	2.7	6
45	45 units	0.9	1.8	2.7	6
50	50 units	0.9	1.8	2.7	6
55	50 units	0.9	2	3	6.6
60	50 units	1.1	2.2	3.2	7.2
65	50 units	1.2	2.3	3.5	7.8
70	50 units	1.3	2.5	3.8	8.4
75	50 units	1.4	2.7	4.1	9
80	50 units	1.4	2.9	4.3	9.6

APPENDIX 2

INTRAVENOUS INFUSIONS: PRACTICAL TIPS

- **IDEALLY** aim for 2 good peripheral venous lines (PVL) or one PVL plus one intra-osseous line.
- Using the 2 intravenous / intra-osseous lines it is possible to give all infusions and bolus drugs required safely, see example below.



PERIPHERAL VENOUS LINE:

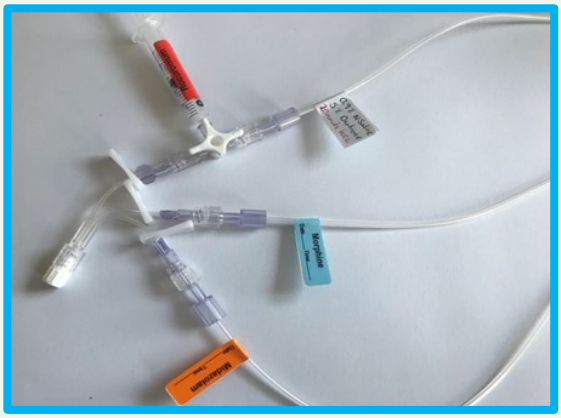
SEDATION + MAINTENANCE + BOLUS

Attach triple tail extension

Lumen 1: morphine or fentanyl infusion

Lumen 2: midazolam

Lumen 3 (with 3-way tap): maintenance fluids plus bolus drugs e.g. rocuronium



INTRAOSSEOUS LINE OR 2ND PERIPHERAL VENOUS LINE (IF NO ALTERNATIVE)

INOTROPE SET-UP

Attach a triple tail extension with 3-way tap on each lumen

Lumen 1: Adrenaline (central, IO or peripheral)

Lumen 2: Noradrenaline (central, IO or peripheral)

Lumen 3: Vasopressin (central or IO ONLY)

OR Milrinone (central, IO or peripheral line)

OR Dinoprostone (central, IO or peripheral line) if suspect duct dependent congenital heart disease

This enables inotrope infusions to be changed safely using the piggyback technique ie avoiding any interruption in infusions.

REMEMBER that the **PREFERRED** route for **INOTROPES** is **CENTRAL** ie **INTRAOSSEOUS or CENTRAL line**

ONLY DELIVER INOTROPES VIA PERIPHERAL VENOUS LINES IF THERE ARE NO OTHER OPTIONS

NEVER DELAY STARTING INOTROPES WHEN INDICATED

RESOURCES: Quick reference guide for National PEWS

TARGETS for managing any critically sick child

ALL AGES	SpO_2 ≥ 94%	Lactate ≤ 2 mmol/L	Glucose: ≥ 3 mmol/L

CAUTION inaccurate pulse oximetry (SpO_2) readings can occur in severe anaemia, high carbon monoxide levels and hypoperfusion. IN ADDITION, SpO_2 may inaccurately over-read in all races, especially those with darker skin pigmentation, masking occult or unrecognised hypoxaemia, i.e. ARTERIAL oxygen < 88% vs SpO_2 ≥ 92%. Occult hypoxaemia was >3xs greater in Black vs White patients and may over-estimate SpO_2 between 1.5-5%.

AGE	TARGET MEAN BP	AGE	TARGET MEAN BP
0-11 Months	45-55	5-12 Years	60
1-4 Years	55-60	>13 Years	60-65

Respiratory Rate (Score up to 4)							
Score	**4**	**2**	**1**	**0**	**1**	**2**	**4**
0-11 months	0-10	11-20	21-20	31-49	50-59	60-69	≥70
1-4 years	0-10	11-20		21-39	40-49	50-59	≥ 60
5-12 years	0-10	11-15	16-20	21-24	25-39	40-49	≥ 50
>13 years	0-10		11-15	16-24	25-29	30-39	≥ 40

All Ages Score	Respiratory Distress (Score up to 4) - ALL AGES
0 = none	None
1 = mild	Nasal flaring, subcostal recession
2 = moderate	Tracheal tug, intercostal recession, inspiratory or expiratory noises
4 = severe	Supraclavicular recession, grunting, exhaustion, impending respiratory arrest

All Ages Score	Oxygen Saturations (Score up to 4) - ALL AGES
0	95-100%
2	92-94%
4	≤ 91%

All Ages Score	Oxygen Requirement (Score up to 4) - ALL AGES
0	Room Air
2	0.01 up to 4 litres/min
4	4 or more litres/min **NB** High flow humidified NC oxygen, NIV CPAP or BiPAP score 4 (irrespective of O_2 requirement)

Heart Rate (Score up to 4)							
Score	**4**	**2**	**1**	**0**	**1**	**2**	**4**
0-11 Months	0-80	81-90	91-110	111-149	150-169	170-179	≥ 180
1-4 Years	0-60	61-70	71-90	91-139	140-149	150-169	≥ 170
5-12 Years	0-60	61-70	71-80	80-119	120-139	140-159	≥ 160
>13 Years	0-50	51-60	61-70	71-99	100-119	120-129	≥ 130

Blood Pressure Systolic (Score up to 4)							
Score	**4**	**2**	**1**	**0**	**1**	**2**	**4**
0-11 Months	0-50	51-60	61-70	71-89	90-99	100-109	≥ 110
1-4 Years	0-50	51-60	61-80	81-99	100-119	120-129	≥ 130
5-12 Years	0-70	71-80	81-90	91-109	110-119	120-129	≥ 130
>13 Years	0-80	81-90	91-100	101-119	120-129	130-139	≥ 140

Capillary Refill Time (CRT) (Score up to 2) - ALL AGES							
Score	**4**	**2**	**1**	**0**	**1**	**2**	**4**
All Ages		≥ 3 secs		<3 secs		≥ 3	

Check if your patient has any additional Risk Factors (NPEWS)

Risk Factors	Tick	Think!	
Baseline vital signs outside normal reference ranges		Always score relevant PEWS value even if this is normal for the patient eg cyanotic heart disease	Vital Sign: Patients normal value:
Tracheostomy / Airway Risk / Difficult Intubation		Do you need additional help in an airway emergency? Needs review by local anaesthetics & ENT teams. Consider d/w NWTS early	
Invasive/Non-invasive ventilation/high flow		Check oxygen requirement on additional respiratory support. Remember High Flow/BiPAP & CPAP score max 4 on oxygen delivery	
Neutropenic/immunocompromised		Sepsis recognition & escalation has a lower threshold	
<40 weeks corrected gestational age		Sepsis recognition & escalation has a lower threshold (beware hypothermia)	
Neurological condition (ie meningitis, seizures)		Remember: check pupil response if anything other than ALERT on AVPU	
Neurodiversity or Learning Disability		Be aware of the range of responses to pain & physiological changes	

NPEWS Escalation	Actions	Medical Review	Observation / Plan
E0 – no concerns **Score = 0**	None	Not required	Continue current observations
E1 – Increased monitoring **Score = 1- 4**	Inform Nurse-in-Charge Consider medical review (ST3+ or equivalent) Ensure feedback to parents	As required Discuss with Nurse-in-Charge whether medical review required	Reassess within 60 mins & document ongoing plan
E2 – Needs clinical review (within 30 mins) **Score = 5-8**	Review by Nurse-in-Charge Ensure feedback to parents	Within 30 mins Review by ST3+ or equivalent Discuss stabilisation plan with consultant	Reassess within 30 mins & document ongoing plan Continuous SpO_2 monitoring
E3 – Needs rapid review (within 15 mins) **Score = 9-12**	Immediate review by Nurse-in-charge Discuss medical plan with consultant Senior feedback to parents	Within 15 mins Alert to ST3+ or equivalent Stabilisation plan to be agreed after review by consultant Consider NWTS referral after consultant review	Reassess every 30 mins Continuous monitoring SpO_2, RR, & ECG Record full GCS if change in AVPU
E4 – Needs emergency review (immediate) **Score > 12**	Immediate review by Nurse-in-Charge Consider immediate 2222 call for immediate emergency medical response Inform paeds consultant Senior feedback to parents	Immediate Alert to ST3+ or equivalent Consultant review ASAP Anaesthetic review Consider NWTS referral after appropriate initial interventions	Reassess every 15 mins Continuous SpO_2, ECG, & RR Record full GCS if change in AVPU

NB Escalation levels can also be selected and triggered if parent or carer expresses concern that their child needs increased monitoring +/- clinical review despite PEWS, OR parent or nursing gut instinct irrespective of score.

Medical Plan for Stabilisation:

Structured plan must be documented including:

1. Specific actions to be taken
2. Expected outcome
3. Outcome deadline / in timeframe
4. Escalation if outcome not met by deadline / in timeframe

Resources

For Drug Doses:

British National Formulary for Children

NWTS Emergency Drugs Guide (wt based) via NWTS website - for intubation drugs / sedation regime / inotropes
https://www.nwts.nhs.uk/emergency-drug-guides

Guidelines for <16 years: www.nwts.nhs.uk/clinicalguidelines

STOPP tool: Safe Transfer of Pediatric Patients which includes risk assessment prior to transfer, and checklists
NWTS LocSIPPS: includes sizes of ETT, suction, NGT, CVL & arterial lines and checklist for paediatric intubation
Guidelines including: intubation and difficult airway, sepsis, insertion of intraosseous needle, collapsed neonate or infant, acute asthma, acute abdomen, management of under 16 years outside PCC level 3 unit
National Guidelines including: paediatric massive haemorrhage, anaphylaxis & refractory anaphylaxis

Education: www.nwts.nhs.uk/education-website

Includes recordings of NWTS education eg time critical transfers, sepsis, airway management etc
Login details for NWTS education site are available from your nursing, AHP and medical paediatric critical care operational delivery network links
OR via email: info@nwts.nhs.uk

CONTACT NUMBERS:

NWTS (North-West (England) & North Wales Paediatric Transport Service): **Referrals 08000 84 83 82**
General enquiries: 01925 853 550
Regional Paediatric Intensive Care Units:
Alder Hey Children's Hospital: 0151 252 5241
Royal Manchester Children's Hospital: 0161 701 8000

Guideline authors:

Kate Parkins, PICM/PCC transport consultant, NWTS
Lisa Pritchard, PICM/PCC transport consultant, NWTS & UHNM
Nicola Longden, Band 7 clinical nurse specialist, NWTS
Gemma Burdis, consultant (Paediatric Anaesthesia/PCC Transport), NWTS & UHNM

Consulted parties:

North-West (England) & North Wales Paediatric Transport Service (NWTS)
North-West (England) and North Wales Paediatric Critical Care Operational Delivery Network
North-West Children's Major Trauma Operational Delivery Network
North-West (England) & North Wales Surgery in Children Operational Delivery Network
PICU, Royal Manchester Children's Hospital
PICU, Alder Hey Children's Hospital

Date of Review: December 2028

Guideline team at NWTS: Kate.parkins@nwts.nhs.uk or Constantinos.kanaris@mft.nhs.uk or Nicola.longden@mft.nhs.uk
For the most up to date version of this guideline please visit PCC / SiC / LTV https://northwestchildrensodnhub.nhs.uk
Or NWTS website: https://www,nwts.nhs.uk/clinicalguidelines/regionalguidelines-a-z

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6. Hibbard O, Karageorgos S, Round J, Kanaris C. Beginner's Guide to Vasoactive Drug Use in Children with Septic Shock; June 2024 Don't Forget the Bubbles

7. Masarwa R, Paret G, Perlman A, Reif, S ,Raccah BH, Matok I. Role of vasopressin and terlipressin in refractory shock compared to conventional therapy in the neonatal and pediatric population: a systematic review, meta-analysis, and trial sequential analysis. Crit Care. 2017; 21: 1.

8. National Paediatric Early Warning Score NHS England, November 2023

9. NWTS emergency drug guides: https://www.nwts.nhs.uk/emergency-drug-guides

Ratification process: