

Title:	Paediatric Arterial Ischaemic Stroke (AIS) Clinical Guideline
Version:	1
Supersedes:	n/a
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 & North Wales region.

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Date of Ratification:	<ol style="list-style-type: none"> 1. PCC Oversight 28.02.2024 2. PMMC 24.06.2024 3. P&G Committee 12.07.2024

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Minor Amendment (If applicable) Notified To:	
Date notified:	

EqIA Registration Number:	EQIA 2024-84
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1. Detail of Procedural Document

Paediatric Arterial Ischaemic Stroke (AIS) Clinical Guideline

2. Equality Impact Assessment

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			
Not relevant		Relevant	
Where the decision was NOT RELEVANT, please record the reason for the decision below...		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.	
EqIA registration Number for RMCH:		EQIA 2024-84	

3. Consultation, Approval and Ratification Process

This guideline was developed with input from:

- North West (England) and North Wales Paediatric Transport Service (NWTS).
- North West and North Wales Paediatric Critical Care Operational Delivery Network
- Representatives from the District General Hospitals within network above.

These guidelines were circulated amongst the North West and North Wales Paediatric Critical Care Operational Delivery Network for comments on the 16th October 2023.

All comments received have been reviewed and appropriate amendments incorporated.

These guidelines were signed off by the PCC ODN guidelines committee on

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 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 from NWTS on a case by case basis.

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

Face droop
Arm weakness
Speech difficulty
Time to call!

IDENTIFY SYMPTOMS
FAST positive?
Acute focal neurological deficit
Speech disturbance
Unexplained, persistent change in conscious level

Transfer immediately to **nearest** local paediatric unit/ED
Record time and onset of symptoms
Record time of presentation

EMERGENCY MANAGEMENT
Consider urgent intubation if GCS<8, AVPU=P or loss of airway reflexes or suspected/proven raised ICP
Target ETCO₂ 4-4.5 Target SpO₂ > 94%
Consider 3% sodium chloride 3-5mL/kg over 15 minutes **OR** 20% mannitol 1.25—2.5mL/kg over 30 minutes
If evidence of shock, give 10mL/kg IV isotonic fluid bolus (**target BP page 10**)
Check capillary glucose test within 15minutes of presentation
If ≤3 mmol/L deliver 3mL/kg IV 10% glucose and consider hypoglycaemia screen
Send ammonia level

PERFORM CT AND CTA WITHIN 1 HOUR OF PRESENTATION

YES

CONFIRMED STROKE?

NO

Calculate PedNIHSS score
(see Page 7 RCPCH Guideline Box 1)
Call NWTS for urgent conference call with
Paediatric Radiologist
Paediatric Neurologist
Neurosurgeon (if needed)
Interventional Neuro-Radiologist (Salford)
Is thrombectomy available?
(Page 8 Appendix 2 for RMCH pathway)

If thrombectomy service NOT available
Discuss with neurology and
Commence aspirin 5mg/kg (PO/NG)

Call NWTS for conference call with Paediatric Neurologist
Is Urgent MRI Indicated?
Transfer to tertiary paediatric unit if MR unavailable
locally and deemed urgent within 24 hours

Transfer for Paediatric Critical Care monitoring
1 hourly Neuro-observations
Raised ICP?: contact Neurosurgeon and follow emergency management
(as above)

1. RECOGNITION OF SYMPTOMS

All children who are FAST positive should be transferred to a local/nearest paediatric unit or emergency department for assessment without delay.

Stroke should be considered in all children who present with:

- Acute focal neurological deficit
- Speech disturbance
- Unexplained, persistent change in conscious level (GCS \leq 12 OR AVPU < V)

Also consider stroke in children with:

- New onset focal seizures
- New onset severe headache
- Ataxia
- Dizziness
- Resolved acute focal neurological deficit
- Sickle Cell Disease

If sickle cell disease is suspected or present, discuss with Paediatric Haematologist. Thrombolysis is not indicated in sickle cell disease and these patients warrant urgent red cell exchange.

Ongoing liaison with neurology is also important in managing these patients.

- Known cardiac condition

Initial management of suspected AIS

Oxygen to maintain SpO₂ > 94%

Obtain IV access X2

Send: venous/capillary blood gas (including lactate), FBC, PT, APTT, fibrinogen, U&E, Glucose, Group & Save, CRP, LFT, ammonia

If circulatory compromise give 10mL/kg isotonic fluid

Plasmalyte 148 or Hartmann's if Sodium \geq 135 mmol/L **OR** 0.9% Saline if Sodium \leq 134 mmol/L

DO NOT use hypotonic solutions at any point in management.

Perform CT and CTA within 1 hour of presentation

2. Perform CT and CTA within 1 hour of presentation to hospital and call NWTS for conference call with:

Local anaesthetic team if concerns for low GCS/clinical instability

PLUS: Paediatric Neurologist

Paediatric Neuroradiologist

Paediatric Neurosurgeon (if needed)

Interventional Neuroradiologist (Salford)

IF ANY OF THE FOLLOWING PRESENT

- *GCS <8
- *AVPU = P
- *Loss of airway protection reflexes eg cough & gag
- *Proven raised ICP or clinical evidence raised ICP

Call local anaesthetic team to intubate & ventilate to protect the airway

Management of raised ICP:

- Tight control of end tidal CO₂ (target 4—4.5 kPa)
- Aim SpO₂ > 94%
- Manage hypotension with isotonic fluid bolus +/- inotropes (target BP—see page 10)
- Consider 3% sodium chloride 3-5mL/kg over 15 minutes **OR** 20% mannitol 1.25—2.5mL/kg over 30 minutes
- Nurse with head up at 30 degrees if possible
- Aggressive avoidance of pyrexia—aim for temperature 36°- 37° C
- Maintain normal blood glucose ie ≥ 3 mmol/L
- Aim High-Normal Sodium (140-145 mmol/L)
- If seizures suspected have a low threshold for loading with 40mg/kg Levetiracetam or 20mg/kg phenytoin

D/W Neurologist, Neurosurgeons and NWTS for guidance
on time critical transfer to the nearest Neurosurgical centre
(see Page 9 Appendix 3 “Time Critical Transfers”)

3. If stroke is confirmed via CT and CTA following discussion with above specialties:

- Calculate PedNIHSS score (see page 7 = RCPCH Stroke in Childhood guideline Box 1)¹
- Call NWTS for conference call with Paediatric Neurologist, Neurosurgeon, Neuroradiologist (if available), Interventional Radiologist (Salford). **DO NOT DELAY.**
- Thrombectomy should be discussed as an option, dependent on availability of interventional radiologist and paediatric anaesthetist (see appendix 2 Page 8 for RMCH thrombectomy pathway).
- If thrombectomy cannot be facilitated then liaise with Paediatric Neurologist to commence aspirin.
- **Thrombolysis is not readily available in units currently, but may be more widely used in the future**
- **ASPIRIN 5mg/kg (PO/NG):** only start after discussion with a neurologist AND no evidence of haemorrhage on CT scan AND not amenable to thrombectomy.
- Check for evidence of malignant middle cerebral artery (MCA) infarction (rapid neurological deterioration due to the effects of space occupying cerebral oedema following middle cerebral artery territory stroke²) and/or evidence of raised intracranial pressure. **Time critical transfer** to a Neurosurgical centre is required as these children may benefit from decompressive hemicraniectomy. (see page 9, Appendix 3 “Time Critical Transfers”)

4. ALL CHILDREN SHOULD BE ESCALATED FOR PAEDIATRIC CRITICAL CARE MONITORING.

- Even if patient is deemed well at presentation, they are at risk of deterioration.
- Include minimum **one hourly** neurological observations as part of their management.
- This may mean transfer to a tertiary centre. Therefore, discuss with NWTS who will organise a conference call with Paediatric Neurologist/Neurosurgeon/Paediatric Critical Care to facilitate.
- If any concerns of raised intracranial pressure during observation period, contact NWTS and paediatric neurosurgical team ASAP and consider time critical transfer.

5. HYPERACUTE THERAPY (WITHIN 6 HOURS)

- Hyperacute therapy works best if delivered within 6 hours of presentation.
- All therapy should be discussed urgently and treatment decisions made on a case by case basis.
- Thrombolysis is not currently readily available.
- Contact interventional radiologist (Salford) for consideration of thrombectomy.
- Start aspirin 5mg/kg (PO/NG) **AFTER** a discussion with neurologist unless alternate anticoagulation is recommended for any specific reason.

6. TRANSFER TO PICU / TERTIARY HOSPITAL VIA NWTS

- **All** patients should be discussed with paediatric neurologist/neurosurgical team accepting the patient and a decision made whether the transfer is “Time Critical”.
- **Call an anaesthetist** to aid stabilisation and assist with airway management if required and they may be needed for transfer if deemed time critical.
- **All** patients should be taken to the nearest available tertiary paediatric critical care unit.
- If transfer is not required, justification for this should be documented in notes.
- If not transferred, continue close neurological observation as highlighted above.

If CT and CTA do not confirm stroke

MRI head is required if CT and CTA do not suggest changes consistent with stroke.

This requires discussion with a Paediatric Neurologist and Radiologist.

If NOT available in your local hospital, then an urgent transfer out to a tertiary centre may be needed to expedite this.

Appendix 1

Stroke in Childhood

Clinical guideline for diagnosis, management and rehabilitation



Identify children with suspected stroke

1

Identify potential stroke

- Acute focal neurological deficit
- Speech disturbance
- Unexplained, persistent change in conscious level (GCS \leq 12 OR AVPU $<$ V)

Also consider stroke in children with:

- New onset focal seizures
- New onset severe headache
- Ataxia
- Dizziness
- Resolved acute focal neurological deficit
- Sickle Cell Disease



Neurological assessment

PedNIHSS definitions	Scale definition
1a. Level of Consciousness:	0 = Alert; keenly responsive 1 = Not alert, but arousable by minor stimulation 2 = Not alert, requires repeated stimulation to attend, or is obtunded and requires strong or painful stimulation to make non-stereotyped movements 3 = Responds only with reflex motor or autonomic effects or totally unresponsive
1b. LOC Questions: <i>Tested by asking age and 'where is XX', XX referring to the name of the parent or other familiar family member present (> 2 years)</i>	0 = Answers both questions correctly 1 = Answers one question correctly 2 = Answers neither question correctly
1c. LOC Commands: <i>Tested by asking to open / close the eyes and to 'show me your nose' or 'touch your nose' (> 2 years)</i>	0 = Performs both tasks correctly 1 = Performs one task correctly 2 = Performs neither task correctly
2. Best Gaze: <i>Horizontal eye movements tested</i>	0 = Normal 1 = Partial gaze palsy 2 = Forced deviation / complete gaze palsy
3. Visual: <i>Tested by visual threat (2-6 years); confrontation, finger counting (> 6 years)</i>	0 = No visual loss 1 = Partial hemianopia 2 = Complete hemianopia 3 = Bilateral hemianopia (including cortical blindness)
4. Facial Palsy: <i>Tested by patient showing teeth or raising eyebrows / close eyes</i>	0 = Normal symmetrical movement 1 = Minor paralysis (flattened nasolabial fold, asymmetry on smiling) 2 = Partial paralysis (total or near total paralysis of lower face) 3 = Complete paralysis of one or both sides
5 & 6. Motor Arm and Leg: <i>Tested by patient extending arms 90 degrees (if sitting) or 45 degrees (if supine), and the leg 30 degrees</i>	5a. Left Arm, 5b. Right Arm 0 = No drift for full 10 seconds 1 = Drift \leq 10 seconds 2 = Some effort against gravity 3 = No effort against gravity 4 = No movement 5 = Amputation 6a. Left Leg, 6b. Right Leg 0 = No drift for full 5 seconds 1 = Drift 5 seconds 2 = Some effort against gravity 3 = No effort against gravity 4 = No movement 5 = Amputation
7. Limb Ataxia: <i>Tested for by reaching for a toy / kicking a toy (< 5 years); finger-nose-finger / heel-shin tests (> 5 years)</i>	0 = Absent 1 = Present in one limb 2 = Present in two limbs
8. Sensory: <i>Observe behavioural response to pin prick</i>	0 = Normal, no sensory loss 1 = Mild to moderate sensory loss 2 = Severe to total sensory loss
9. Best Language: <i>Tested by observing speech and comprehension (2-6 years); describe picture (> 6 years)</i>	0 = Normal 1 = Mild to moderate aphasia 2 = Severe aphasia 3 = Mute, global aphasia

2

Pre-hospital care: Ring 999 / 111

- Manage Airway
- Administer high flow O₂ if clinically indicated
- Perform a capillary glucose test within 15 minutes of presentation
- Treat HYPOGLYCAEMIA (if capillary blood glucose 3 mmol/L give 2 ml/kg of 10% dextrose)
- Assess using **FAST**
- Transport to nearest ED with acute paediatric services
- Priority call / pre-alert ED of impending arrival of child with suspected stroke
- Activate (locally defined) acute paediatric stroke pathway
- If Sickle Cell Disease is suspected, discuss with paediatric haematologist who should be present in pre-hospital care / ED

3

ED: Activate acute stroke pathway

- !** This algorithm is not wholly applicable to children with Sickle Cell Disease. If Sickle Cell Disease is suspected:
- Discuss with paediatric haematologist
 - Exchange transfusion even if initial imaging is normal
- Intubate if GCS $<$ 8, AVPU = U, if there is a loss of airway reflexes or there is suspected / proven raised intracranial pressure
 - Administer high flow O₂ and target SpO₂ \geq 92%
 - If the circulation is compromised give a 10 ml/kg isotonic fluid bolus
 - Perform a capillary glucose test within 15 minutes of presentation. If capillary blood glucose 3 mmol/L give 2 ml/kg of 10% dextrose and consider a hypoglycaemia screen

4

Investigations

- Venous or capillary blood gas
- FBC, PT, APTT
- Fibrinogen
- Urea and electrolytes
- Blood glucose
- Group and save
- C-reactive protein
- Liver function tests
- Blood cultures as appropriate

Monitoring

- BP
- Temperature
- SpO₂
- HR
- RR
- GCS
- Assess PedNIHSS score

See 'Neurological assessment'

5

Urgent brain imaging

Perform CT / CTA < 1 Hour of ED admission

Record time of symptom onset
Window for tPA = 4.5 hours

Record time of admission
Window for imaging = 1 hour

6

Stroke mimic

MRI with stroke-specific sequences should be performed in patients with suspected stroke when there is diagnostic uncertainty.

Haemorrhagic stroke

Urgent discussion with neurosurgical team regarding need for transfer.

Arterial ischaemic stroke

Consider suitability for other emergency interventions, such as; Thrombectomy or Decompressive craniectomy.

7

Treatment for Arterial ischaemic stroke (AIS)

Aspirin

- 5mg/kg \leq 1 hour (Unless CI, e.g. parenchymal haemorrhage)
- Delay for 24 hours in context of thrombolysis

In children presenting with AIS Thrombolysis, the use of tPA... may be considered if 2-8 years and could be considered if \geq 8 years

IF ALL OF THE FOLLOWING ARE TRUE:

- PedNIHSS \geq 4 and \leq 24
- tPA can be administered \leq 4.5 hours of symptom onset
- CT has excluded intracranial haemorrhage
- CTA demonstrates normal brain parenchyma or minimal early ischaemic change
- CTA demonstrates partial / complete occlusion of the intracranial artery corresponding to clinical / radiological deficit

OR

- MRI and MRA showing evidence of acute ischaemia on diffusion weighted imaging + partial / complete occlusion of the intracranial artery corresponding to clinical / radiological deficit

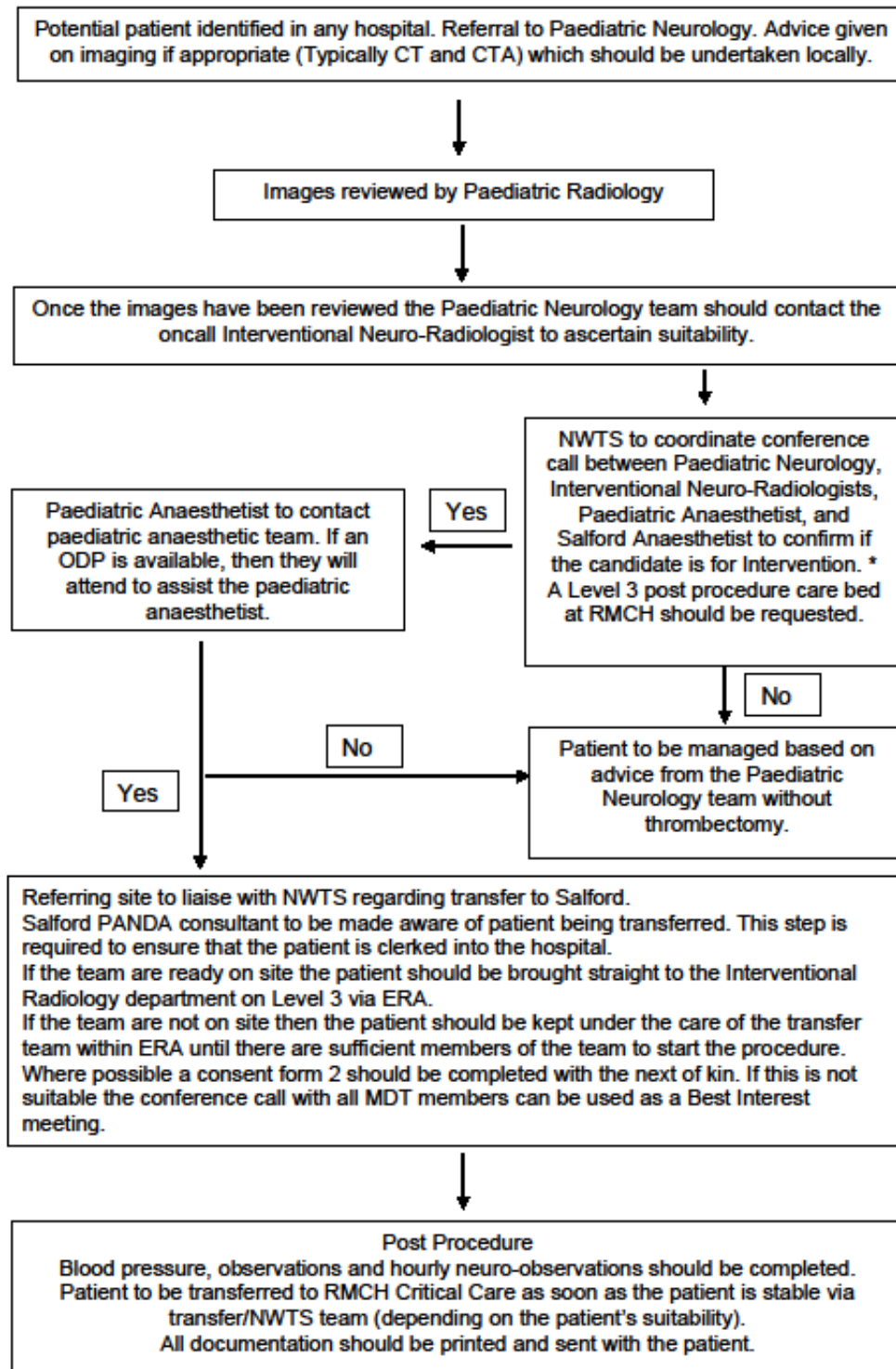
PROVIDING THAT THERE ARE NO CONTRAINDICATIONS

aPTT=Activated partial thromboplastin time; AVPA=Alert, Voice, Pain, Unresponsive; CI=Contra-indication; CT=Computerised tomography; CTA=Computerised tomography angiography; ED=Emergency Department; FAST=Face, Arms, Speech Time; FBC=Full blood count; GCS=Glasgow Coma Scale; HR=Heart rate; LOC=Level of consciousness; MRA=Magnetic resonance angiogram; MRI=Magnetic resonance imaging; AIS=Arterial ischaemic stroke; O₂=Oxygen; PedNIHSS=Paediatric National Institute of Health Stroke Scale; PT=Prothrombin time; RR=Respiratory rate; SpO₂=Oxygen saturation; tPA=Tissue plasminogen activator.



Produced in line with the full RCPCH clinical guideline.
For further details on all recommendations, visit: www.rcpch.ac.uk/stroke-guideline

RMCH Thrombectomy Pathway



*All communication and discussion should be completed at a Consultant-to-Consultant level.

Appendix 3: Time critical transfers

RESPONSIBILITIES OF LOCAL TEAM: TIME CRITICAL TRANSFERS

Stabilise child (discuss with NWTS for advice on stabilisation and transfer)

Intubate and ventilate if required

Conference call via NWTS to Neurologist, Neurosurgeon, Neuroradiologist, Interventional Radiology

Identify appropriate transfer team (eg experienced anaesthetist + appropriate nurse/ODP) using STOPP risk assessment (see below)

Contact NWS via 0345 140 0144 and ask for “**Category 2**” ambulance

<https://www.nwas.nhs.uk/services/professionals/emergency-ambulance/>

OR contact Welsh Ambulance Service via healthcare professional line (or 999)

& request a time critical transfer following local policy

Arrange urgent transfer of all images via PACS

Refer to safeguarding team if appropriate

AMBULANCE REQUEST FOR TIME CRITICAL TRANSFER VIA NORTH WEST AMBULANCE SERVICE (NWS) = CATEGORY 2

- **Category 2 response time = 18-minute** mean response time and should be used if child or young person is due to have intervention, ie surgery, or thrombectomy on arrival at tertiary centre.
- **Category 3:** for any urgent transfers via emergency department for further assessment/review

<https://www.nwas.nhs.uk/services/professionals/emergency-ambulance/>

For further information on organising inter-hospital transfers with NWS. The code assigned is based on clinical presentation and not location of patient. All requests must be placed on the basis of clinical need.

AMBULANCE REQUEST FOR TIME CRITICAL TRANSFER VIA WELSH AMBULANCE SERVICE: follow local policy

IF ANY DELAY IS ANTICIPATED eg ambulance NOT arrived within 20 minutes: **escalate** the call to the senior clinician on duty for either North West Ambulance Service (NWS) or Welsh Ambulance Service

TEAM COMPOSITION:

- Always use **STOPP** tool (<https://nwts.nhs.uk/guidelines>) for all paediatric transfers
- Complete a risk assessment prior to any transfer; if any delay repeat just prior to transfer
- Joint decision should be made by paediatric & anaesthetic consultants on team composition

NWTS: 08000 84 83 82 NWTS will....

Contact the Neurologist/Neurosurgeon/Neuroradiologist via conference call

Advise local team on stabilisation & transfer if required

Inform PCC team of transfer and potential need for PCC bed

For drug calculations use: <https://www.nwts.nhs.uk/documentation/crashcall>

Resources

Oxygenation targets: SpO₂ ≥ 94%

Glucose target: ≥ 3 mmol/L

BNFc: please use to check all drug doses

CRASHCALL: doses / concentration of infusions for sedation / analgesia (if intubated and ventilated) and central inotrope infusions <https://www.nwts.nhs.uk/documentation/crashcall>. If inotropes given via peripheral line ALWAYS use lower peripheral concentration found in the regional sepsis guideline (www.nwts.nhs.uk/clinicalguidelines)

SYSTOLIC BP ¹⁸	NORMAL	MODERATE	SEVERE	DIASTOLIC BP	TARGET mean BP
37–44 weeks (neonate)	60-80	50-59	< 50	35-53	40-45
< 4 months	60-80	50-59	< 50	37-56	45-50
4 m–2 yr	70-90	60-69	< 60	42-63	50-55
2–5 yr	90-129	80-89	< 80	46-72	55-60
5-12 yr	90-129	80-89	< 80	57-76	60
> 12 yr	110-130	91-100	≤ 90	64-83	65

RESP RATE	NORMAL	MODERATE	SEVERE	HEART RATE	NORMAL	MODERATE	SEVERE
Neonate 37– 44 weeks	30-59	60-79	≥ 80	Neonate	91-149	150-179	≤ 70 or ≥ 180
<1yr	30-39	40-54	> 54	<1yr	110-149	150-159	<80 or >160
1-2	25-34	35-49	> 50	1-2	100-139	140-149	<80 or >150
3-4	25-29	30-39	> 40	3-4	95-129	130-139	<60 or >140
5-7	20-23	24-28	> 29	5-7	80-109	110-119	<60 or >120
8-11	15-21	22-24	> 25	8-11	60-104	105-114	<60 or >115
> 12 yr	15-21	22-24	> 25	> 12 yr	65-90	91-130	<55 or >130

CRASHCALL via: <https://www.nwts.nhs.uk/documentation/crashcall>

GUIDELINES: www.nwts.nhs.uk/clinicalguidelines

For regional and relevant national guidelines including, Intubation and difficult airway guideline, Sepsis guideline Safe Transfer of Paediatric Patients (STOPP) tool which includes risk assessment prior to transfer, and checklists

EDUCATION: via education website tab on NWTS website

www.nwts.nhs.uk/education-website

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

RECORDED SESSIONS ON A WIDE VARIETY OF PAEDIATRIC CRITICAL CARE TOPICS WHICH INCLUDES:

Intubation of infants and children , Management of neurological emergencies, Time critical transfers, Septic shock, Collapsed neonate etc

References

1. https://www.rcpch.ac.uk/sites/default/files/2018-04/2017_stroke_in_childhood_-_pathway_poster.pdf
2. 'Malignant Middle Cerebral Artery (MCA) infarction: Pathophysiology, diagnosis and management.' *Postgraduate Medical Journal* 2010; **86** 235-242 Published Online First: 30 Mar 2010. doi: 10.1136/pgmj.2009.094292

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North West & North Wales Paediatric Transport Service (NWTS)

North West and North Wales Paediatric Critical Care Operational Delivery Network

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Date of Review: July 2027

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For the most up to date version of this guideline please visit PCC / SiC / LTV ODN

<https://northwestchildrensodnhub.nhs.uk/> or

NWTS website <https://www.nwts.nhs.uk/clinicalguidelines/regionalguidelines-a-z>

RATIFICATION PROCESS

