CLINICAL GUIDELINE

MANAGEMENT OF ARTERIAL ISCHAEMIC STROKE IN CHILDREN

Document details	
Summary	This clinical guideline outlines the standards for the early assessment and management of paediatric arterial ischaemic stroke. It is intended to support clinical decision-making in line with Royal College of Paediatrics and Child Health and NICE recommendations, and to promote the safe, timely, and consistent care of children with suspected or confirmed paediatric arterial ischaemic stroke.
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Related documents	Acute ischaemic stroke in childhood: information for clinicians to share with family (02/09/2025, version 1.0, Oxford University Hospitals NHS Foundation Trust)
Document replaces	N/A
Version updates	N/A

Arterial Ischaemic Stroke Pathway

Identify symptoms of potential stroke[1]

Record time of symptom onset
Time - hh:mm
4.5 hours thrombolysis window
6 to 24 hours thrombectomy window

Transfer to nearest ED
Pre-alert department with senior paediatrician in attendance

Record time of presentation
Time - hh:mm
1 hour imaging window

Emergency management[2], diagnostics[3] and **CT and CTA within 1 hour of presentation** to department[4]
(No CTA if bleed or space occupying lesion identified on plain CT)

Haemorrhagic stroke (bleed) or space occupying lesion
Call SORT (who contact Neurosurgery)
Time critical transfer to OUH/UHS (ED or PICU, discuss with SORT)

Call **SORT*** on **023 8077 5502** to inform of suspected stroke

1 - see Appendix 1
2 - see Appendix 2
3 - see Appendix 3
4 - see Appendix 4
5 - see Appendix 5
6 - see Appendix 6
7 - see Appendix 7
8 - see Appendix 8

Confirmed arterial occlusion on CTA?
Confirmed by Radiologist (local or tertiary)

NO

YES

TIME CRITICAL

Update SORT who will organise conference call between:
– Paediatric Critical Care
– Paediatric Neurology
– Diagnostic Neuroradiology
Is further imaging (e.g. MRI)[6] indicated? Should the patient transferred for further imaging?

Senior paediatrician to calculate PedNIHSS score[5]
Update SORT who will organise conference call between:
– Consultant Paediatrician (DGH) (consider DGH Adult Stroke Team)
– Radiologist (DGH)
– Paediatric Neurology (OUH/UHS)
– Diagnostic Neuroradiology (OUH/UHS)
If MCA infarct, include Neurosurgery (OUH/UHS)

NO

YES

OUTCOME OF DISCUSSION

If no stroke and no CVS instability, then alternative management

Does MRI[5] confirm AIS?

YES

NO

Is thrombolysis indicated?
Give within 4.5 hours of symptom onset
See inclusion/exclusion criteria[7]
Contact adult stroke CNS urgently to support

NO

CONSENT DISCUSSION

Consent by local (DGH) paediatrician AFTER conference call with paediatric neurology

Is thrombectomy indicated?
Urgent conference call with SORT
Give aspirin 5 mg/kg (max 300 mg)

IF CONSENT GIVEN

NO

YES

Thrombolyse locally on advice of paediatric neurology with **alteplase[8]**
Hold aspirin for 24 hours

Discussion with SORT for consideration of transfer to tertiary neurology

Time critical transfer[9] to OUH/UHS for possible thrombectomy (OUH has out-of-hours service)

Time critical transfer to OUH/UHS (ED or PICU, discuss with SORT)[9]

[9]Time critical transfer by local team for neurological emergency
*Or other regional retrieval team if applicable

APPENDIX 1

Symptoms of potential stroke in children

- Acute focal neurological deficit/hemiparesis
- Speech disturbance
- Unexplained, persistent change in conscious level (GCS ≤12 OR AVPU<V)
- Headache
- Seizures
- Aphasia
- Altered mental status
- Ataxia, vertigo, dizziness
- Resolved acute focal neurological deficit (including before arrival to the hospital)

Sickle cell disease

This guideline excludes children with stroke associated with sickle cell disease. This has a different pathology to that of acute arterial ischaemic stroke, and different treatment. For children with stroke secondary to sickle cell disease, the regional guideline, *Stroke and other CNS manifestations in children with sickle cell disease (SCD)*, should be followed in conjunction with advice from the regional haematology centre.

APPENDIX 2

Emergency management of suspected acute ischaemic stroke in children

- Intubate if GCS <8, AVPU=U, if there is loss of airway reflexes or there is suspected/proven raised intracranial pressure
- Administer high flow oxygen and target $SpO_2 \geq 92\%$
- If circulation is compromised, administer a 10ml/kg isotonic fluid bolus
- Perform capillary glucose test within 15 minutes of presentation, if capillary blood glucose ≤3 mmol/L, give 2ml/kg of 10% dextrose and consider a hypoglycaemia screen

APPENDIX 3

Investigations for possible acute ischaemic stroke in children

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

Monitoring for possible acute ischaemic stroke in children

- BP
- Temperature
- SpO_2
- HR
- RR
- GCS
- Assess PedNIHSS score (see Appendix 4)

APPENDIX 4: CT protocols

Standardised CT protocols have been developed to comply with current best clinical practice in the investigation of patients who present with acute stroke within the time window where thrombolysis is appropriate.

Patients (including children) presenting to the OUH/UHS acute stroke service or hospitals within the Thames Valley and Operational Delivery Network should be assessed within the local Emergency Department to assess whether intravenous thrombolysis should be administered and consideration given to whether mechanical thrombectomy is appropriate.

These patients require immediate a CT Head within 1 hour of presentation to the department.

Requests

The clinical team will need to request the examinations: CT Head, CT Angio Aortic Arch and Carotid Both and CT Intracranial Angiogram (or as locally described). A good cannula should have been sited during emergency triage, and can be used for contrast.

CT protocols

The CTA protocol requires imaging from aortic arch to skull vertex. Implementation of this guideline, *Management of Arterial Ischaemic Stroke in Children*, will require the development of specific protocols including dosing at each site. The tertiary neurology centres will collaboratively support this as requested.

APPENDIX 5

PedNIHSS score - https://www.mdcalc.com/calc/10270/pediatric-nih-stroke-scale-nihss

Use MDCalc, image or full scoring system in to calculate score and record below:

PedNIHSS Definition	Score
1a. Level of Consciousness (LOC)	
1b. LOC Questions	
1c. LOC Commands	
2. Best Gaze	
3. Visual	
4. Facial Palsy	
5a. Left Arm	
5b. Right Arm	
6a. Left Leg	
6b. Right Leg	
7. Limb Ataxia	
8. Sensory	
9. Best Language	
Total Score	

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: *Tested by asking age and 'where is XX', XX referring to the name of the parent or other familiar family member present (> 2 years)*	**0** = Answers both questions correctly **1** = Answers one question correctly **2** = Answers neither question correctly
1c. LOC Commands: *Tested by asking to open / close the eyes and to 'show me your nose' or 'touch your nose' (> 2 years)*	**0** = Performs both tasks correctly **1** = Performs one task correctly **2** = Performs neither task correctly
2. Best Gaze: *Horizontal eye movements tested*	**0** = Normal **1** = Partial gaze palsy **2** = Forced deviation / complete gaze palsy
3. Visual: *Tested by visual threat (2–6 years); confrontation, finger counting (> 6 years)*	**0** = No visual loss **1** = Partial hemianopia **2** = Complete hemianopia **3** = Bilateral hemianopia (including cortical blindness)
4. Facial Palsy: *Tested by patient showing teeth or raising eyebrows / close eyes*	**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: *Tested by patient extending arms 90 degrees (if sitting) or 45 degrees (if supine), and the leg 30 degrees*	**5a. Left Arm, 5b. Right Arm** **0** = No drift for full 10 seconds **1** = Drift ≤ 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: *Tested for by reaching for a toy / kicking a toy (< 5 years); finger-nose-finger / heel-shin tests (> 5 years)*	**0** = Absent **1** = Present in one limb **2** = Present in two limbs
8. Sensory: *Observe behavioural response to pin prick*	**0** = Normal; no sensory loss **1** = Mild to moderate sensory loss **2** = Severe to total sensory loss
9. Best Language: *Tested by observing speech and comprehension (2–6 years); describe picture (> 6 years)*	**0** = Normal **1** = Mild to moderate aphasia **2** = Severe aphasia **3** = Mute, global aphasia

APPENDIX 6

Approach to rapid MR imaging for possible acute ischaemic stroke

Do full MRI if possible

Minimum MR sequences:

- DWI
- Axial T2
- Flair
- MRA head and neck

APPENDIX 7

Inclusion and exclusion criteria for thrombolysis in acute ischaemic stroke

Inclusion criteria:

Inclusion criteria	Yes	No	Comment
Clinical treating team to assess prior to conference call:			
Presence of an acute focal neurological deficit consistent with arterial ischaemia			
Paediatric National Institute of Health Stroke Scale (PedNIHSS) more than or equal to 4 and less than or equal to 24			*Score:*
Treatment can be administered within 4.5 hours of known onset of symptoms			*Time of onset:*
Tertiary (OUH/UHS) team to assess:			
Intracranial haemorrhage has been excluded			
CT demonstrates normal brain parenchyma or minimal early ischaemic change *OR* MRI shows acute ischaemic on diffusion weighted imaging			
CTA *OR* MRA demonstrates partial/complete occlusion of the intracranial artery corresponding to clinical/radiological deficit			

Exclusion Criteria:

Exclusion criteria	Yes	No	Comment
Relative exclusion criteria:			
Age <2 years – discuss with OUH/UHS neurology team			
Known sickle cell disease (see separate guidelines referenced above)			
Clinical treating team to assess prior to conference call:			
Unknown time of symptoms onset			
Pregnancy			*Test:*
Age <2 years of age			
Clinical presentation suggestive of subarachnoid haemorrhage (SAH), even if brain imaging is negative for blood			
Patient who would decline blood transfusion if indicated			
History of prior intracranial haemorrhage			
Known cerebral arterial venous malformation, aneurysm or neoplasm			
Persistent systolic blood pressure more than 15% above the 95th percentile for age while sitting or supine			
Glucose less than 2.8 mmol/L or more than 22 mmol/L			
Bleeding diathesis including platelets less than 100 000, prothrombin time (PT) more than 15s (international normalised ratio (INR) more than 1.4), or elevated activated partial thromboplastin time (aPTT) more than upper limits of the normal range			
Clinical presentation consistent with acute myocardial infarction (MI) or post-MI pericarditis that requires evaluation by cardiology before treatment			
Prior stroke, major head trauma, or intracranial surgery within the past three months			
Major surgery or major organ biopsy within 10 days (relative contraindication)			
Gastrointestinal or urinary bleeding within 21 days (relative contraindication)			
Arterial puncture at non-compressible site or LP within seven days (relative contraindication). Patients who have had a cardiac catheterization via a compressible artery are not excluded			
Patient with malignancy or within one month of completion of treatment for cancer			
Patients with an underlying significant bleeding disorder. Patients with a mild platelet dysfunction, mild von Willebrand disease, or other mild bleeding disorders are not excluded			
Mild deficit (Paediatric National Institute of Health Stroke Scale (PedNIHSS) less than 4) at start of tPA infusion or at time of sedation for neuroimaging, if applicable			
Severe deficit suggesting large territory stroke, with pre-tPA PedNIHSS more than 24, regardless of the infarct volume seen on neuroimaging			
Previously diagnosed primary angiitis of the central nervous system (PACNS) or secondary central nervous system (CNS) vasculitis. Focal cerebral arteriopathy of childhood is not a contraindication			
Known allergy to recombinant tissue plasminogen activator			
Patient who received heparin within four hours must have activated partial thromboplastin time (aPTT) in normal range			
Low molecular-weight heparin (LMWH) within past 24 hours (aPTT and INR will not reflect LMWH effect)			
OUH/UHS team to assess:			
Intracranial haemorrhage on pre-treatment head CT or MRI			
Intracranial dissection (defined as at or distal to the ophthalmic artery)			
Large infarct volume, defined by the finding of acute infarct on MRI involving one-third or more of the complete middle cerebral artery (MCA) territory involvement			

APPENDIX 8

Use alteplase for thrombolysis in paediatric stroke.

- Start infusion as early as possible within 4.5 hours of onset of stroke symptoms
- Please see inclusion and exclusion criteria
- Ensure consent given from parents/guardians – consent will be obtained by DGH consultant paediatrician (after conference MDT).
- To be administered by local consultant paediatrician + adult stroke/CNS team

Risk vs Benefit of thrombolysis using alteplase:

What is the role of alteplase?
The aim of thrombolysis with alteplase is to restore blood flow and limit tissue damage.

What are the benefits of thrombolysis?
There are limited studies in children and the benefits can't be quantified, however a panel of experts have recommended it be considered in the certain cases (RCPCH stroke guideline).
There is good evidence for use in adults within 4.5 hours of presentation and as soon as possible. 3 in 10 adult patients make a good recovery without thrombolysis; an additional 1 in 5 have good recovery if given within 90 minutes vs additional 1 in 15 have good recovery if treated between 3 and 4.5 hours.

What are the risks of thrombolysis?
- The major adverse effect is the risk of symptomatic intracranial haemorrhage.
Limited studies are available to quantify the risk in children, however the available studies indicate a risk of around 2% for symptomatic intracranial haemorrhage (1,2). This is considered a low risk.
- Other risks include bleeding from injection sites or nose bleeds.
- Very rarely allergic reactions can occur.

How can the risks be minimized?
- The risks can be minimized by careful selection of patients who meet the criteria for thrombolysis and based on MDT discussions of risk vs benefit for each individual case.
- Close post alteplase monitoring to pick up any early signs of side effects.

ALTEPLASE:

- Alteplase is a recombinant tissue plasminogen activator (rt-PA). It binds to fibrin in a thrombus and converts plasminogen to plasmin which then causes local fibrinolysis with minimal systemic effects.
- Alteplase has been licensed since 2002 for the treatment of acute ischaemic stroke in adults. It is not licensed in children under 16 years but has been used under guidance from paediatric neurology, paediatric neuroradiology and with parents' consent.

Available as 10mg vial, 20mg vial or 50mg vial
(each vial comes with water for injections filled into either 10 ml, 20 ml or 50 ml vials, depending on the size of the powder vials.)

	Under 2 years (including neonates)	**Above 2 years**
Dose	**0.2mg/kg IV over 60 minutes**	**0.9mg/kg IV in total (maximum 90 mg)** -First 10% (0.09 mg/kg) given as an IV bolus over 1 to 2 minutes - 90% (0.81 mg/kg to be given) given as an infusion over 60 minutes
Preparation	- Reconstitute the appropriate strength of vial(s) to 1 mg/mL concentration with water for injection provided with the vial - Calculate the dose based on patient's weight - Draw up the required dose volume from the reconstituted syringe - further dilution of each 1ml of the reconstituted solution with 4ml 0.9% sodium chloride to have a 0.2mg/ml final dilution. - 0.2micrograms/kg/hr = 1ml/kg/hr - Set the infusion to run over 60minutes	- Reconstitute the appropriate strength of vial(s) to 1 mg/mL concentration with water for injection provided with the vial - Prepare 2 syringes at the same time - Administer contents of the first syringe with 10% of the dose for IV push (0.09 mg/kg) over 1 minute - Administer contents of the second syringe with 90% of the dose for infusion (0.81 mg/kg) over 60 minutes <u>Where the IV infusion dose is > 50 mg:</u> - the reconstituted dose should be split equally into 2 equal volumes in 50ml syringes (to avoid having to prepare more than 2 syringes for volumes over 50mls) - Administer 10% of the dose as bolus over 1 minute, followed by 90% of the dose as infusion over 60 minutes
Compatibility	• Compatible fluids: sodium chloride 0.9% • Incompatible fluids**: glucose solutions**, precipitation will occur	

***** Aim to transfer patient immediately after starting infusion *****

Managing significant bleeding complications after thrombolysis[9,10]:

Although alteplase has a short half-life, the resultant bleeding diathesis can last up to 24 hours, and intracranial haemorrhage attributed to alteplase can occur within 48 hours of infusion.

If there is clinically or radiologically significant bleeding, then consider the following after careful MDT discussion:

- Stop all thrombolytic, antithrombotic antiplatelet drugs
- Request full blood count, PT, APTT, fibrinogen (repeat 2-hourly until bleeding controlled)
- Reverse fibrinolysis: cryoprecipitate (5-10 ml/ kg; aiming for fibrinogen >2 g/ L); fresh frozen plasma (10-20 ml/kg, aiming to keep INR and APTR < 1.5; or normalise PT and APTT)
- Platelet transfusion (aiming for platelets >100 x 10^9/l)
- Other supportive management to include red cell transfusion and tranexamic acid (15-20 mg/kg)

APPENDIX 9: Itepla

Arterial ischaemic stroke in childhood: information for clinicians to share with family (02/09/2025, version 1.0)

Introduction

This leaflet is for paediatricians and other treating clinicians of children who have been diagnosed with acute ischaemic stroke (AIS) in childhood. It is designed to guide conversation and consent for treatment of acute ischaemic stroke in childhood using thrombolysis or mechanical thrombectomy.

This leaflet is not a patient/parent information leaflet. A detailed patient/parent information leaflet on *Stroke in Childhood* from the RCPCH is available. National guidelines for *Stroke in Childhood: Diagnosis, Management and Rehabilitation* are also available.

Information for parents and carers of children with AIS

This information is for parents and carers of children with a clinically and radiologically confirmed AIS.

Thrombolysis

The use of thrombolysis (clot-busting treatment) is well established in adults with stroke. In children, we haven't been able to do large clinical trials due to the much smaller numbers of children who have stroke. This means the evidence for using clot-busting treatment in children is much weaker, and the treatment is used "off-label". In other words, this is not a tried and tested treatment, but child neurologists think it can help in some cases.

In adults:

- Without thrombolysis approximately three in ten patients will recover with little or no disability
- The sooner a patient is treated with clot-busting treatment, the more likely recovery with little or no disability is to happen:
- If treated within 90 minutes, an additional one in five patients will recover
- If treated within 3 hours, an additional one in ten patients will recover
- If treated within 4.5 hours, an additional one in fifteen patients will recover
- There is an increased risk of bleed into the brain with thrombolysis: approximately on in 20 patients will have a bleed into the brain (with the risk higher in the elderly, with high blood pressure, and with more severe strokes).

We can't quantify these benefits risks in children because not enough studies have been done. The adult data suggest that we can give thrombolysis up to 4.5 hours following onset of AIS symptoms. There is an important checklist of inclusion and exclusion criteria to minimise the risks (and maximise the benefit) of thrombolysis for AIS.

Mechanical thrombectomy

Mechanical thrombectomy is a clot retrieval procedure that uses a catheter inserted into an artery that is carefully guided into the affected artery in the brain with a treatable clot. This must be done by an expert interventional radiologist. This is discussed on a case-by-case basis with experts involved and can be done up to 24–48 hours following the onset of stroke symptoms. We cannot quantify the risks and benefits of thrombectomy for AIS in children, but child neurologists think that it can help in some cases.

Other treatments for AIS in children

Very rarely, a major clot in the middle cerebral artery may be treated with neurosurgery. This will be discussed as an emergency between the treating paediatricians and the paediatric neurosurgical team on-call.

AIS in children with Sickle Cell Disease (SCD) is treated differently than AIS due to a large clot. This is because, in SCD, there are numerous tiny clots made up of red cells clumping together. In SCD, an exchange transfusion to give normal red blood cells and remove the sickle-shaped red cells is a treatment priority.

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