STROKE

- Defined as a group of heterogenous conditions with focal disruption of cerebral flow secondary to arterial or venous thrombosis, embolisation or haemorrhagic events between 20 weeks' gestation and 28th postnatal day, and confirmed by neuroimaging studies. Includes:
  - perinatal arterial ischaemic stroke (PAIS): disruption of cerebral artery blood flow due to thrombosis, embolism, vasospasm or hypoxic-ischemic encephalopathy
  - cerebral sinovenous thrombosis (CSVT): clots within venous sinuses results in congestion, oedema and eventually venous infarction with/without haemorrhage
  - haemorrhagic infarct: results from focal accumulation of blood within brain parenchyma
  - periventricular haemorrhagic infarction: venous congestion following germinal matrix haemorrhage
- Prevalence in term and near term babies estimated 6–17 per 100,000; in preterm, estimated prevalence 1:1600–1:8000. Approximately 80% ischemic stroke and 20% CVST and haemorrhagic stroke

RISK FACTORS

Exact cause of neonatal stroke unknown but risk factors include:

Neonatal	Maternal	Prothrombotic disorders
Cardiac lesions or fetal heart rate abnormalities	Primiparity or history of infertility	Methyltetrahydrofolate reductase (MTHFR) mutation
Intrauterine growth restriction	Chorioamnionitis	Protein C deficiency
Coagulation disorder	Oligohydramnios	Protein S deficiency
Hypoxic ischaemic encephalopathy	Premature rupture of membranes	Antiphospholipid antibody
Infection	Vacuum extraction	Homocysteine defect
Trauma	Pre-eclampsia	
Metabolic conditions	Gestational diabetes	
Male sex	Coagulation disorders	
	Substance misuse (cocaine)	
	Toxins	
	Emergency section or vacuum extraction	

ACUTE PRESENTATION

- Most common presentation is seizure (typically focal) involving 1 extremity
  - occurs in 70–90% of cases
  - typically presents within first 3 days of life
- Approximately 80% of cases involve left hemisphere
- May manifest with:
  - features of encephalopathy (irritability, lethargy, increased or decreased muscle tone)
  - feeding difficulties
  - apnoeic episode
  - intraventricular haemorrhage (IVH) – CVST to be excluded in term babies with unexplained IVH

LONG-TERM PRESENTATION

- Subtle signs may not be obvious in newborn period
- As child grows, most common sign is weakness or decreased movement on one side of body
  - one-handedness or hand preference in children aged <1 yr
- Delayed/missed developmental milestones

INVESTIGATIONS

Initial investigations

- As majority of babies with stroke will present with seizure, initial investigations for stroke is similar to first line investigations for seizures (see **Seizure** guideline)
- Placental histology
- Cranial ultrasound scan (USS)
  - PAIS – typical triangular or wedge-shaped echo-density in region of middle cerebral artery may be seen but may take up to end of first week to evolve on USS
  - difficult to diagnose CVST on USS due to high false negatives
- MRI
  - diffusion-weighted imaging with apparent diffusion co-efficient considered gold standard for identifying infarct in neonatal brain
  - location and extent of lesions best assessed 2–4 days after onset of stroke when apparent co-efficient of diffusion reaches its nadir
- MR arteriogram or venogram
  - perform acutely where thrombosis suspected

Second line investigations where stroke diagnosis strongly suspected

- Echocardiography to assess for cardiac problems, especially if:
  - abnormal cardiac examination
  - multifocal infarcts on USS
- Thrombophilia screen
  - discuss with tertiary paediatric haematologist before conducting this
  - limited utility in neonatal period due to decreased levels of proteins C and S, antithrombin, and Factor XI (30% of adult levels)
  - if carried out too early in neonatal period repeat testing after 3–6 months may be required
  - no longer routinely indicated in neonates except:
    - positive family history of venous thromboembolic disease – perform factor V Leiden
    - maternal history of antiphospholipid syndrome – antiphospholipid antibodies test

MANAGEMENT

- Mainstay of management is support and neuroprotection
- Admit to NNU
- Ensure ABC of resuscitation; avoid hyperventilation
- Seizure control
  - see **Seizures** guideline and liaise with neurology team if necessary
  - once seizures stopped aim to discontinue treatment if possible, due to long-term effects on the developing brain
  - seizures rarely persist beyond neonatal period in babies with stroke
- Treat underlying infection if suspected – avoid hyperthermia
- If too unstable to feed start IV fluids
- Correct electrolyte/glycaemic derangement or dehydration (common in CSVT)
- Discuss antithrombotic agents for CSVT with tertiary paediatric haematologist (not shown to be useful in PAIS treatment)
- Referral to allied health professionals (AHP) team for neurodevelopmental assessment/screening
- If feeding and/or swallowing difficulties identified, refer to speech and language therapy for dysphagia assessment

Haemorrhagic stroke

- Correct platelet or clotting factor deficiencies if present; extra dose of vitamin K may be required
- Urgent neurosurgical discussion if confirmed on scan

LONG-TERM OUTCOMES

- Dependent on type of stroke, extent and location of infarction
- MRI has important role in predicting motor outcome especially in PAIS

- involvement of basal ganglia, cerebral hemisphere and posterior limb of internal capsule is highly predictive of contralateral spastic hemiplegic cerebral palsy
- Approximately two-thirds of children with PAIS have poor long-term outcomes, ranging from mild to severe neurologic disability. Deficits can be variable and recognised early in infancy (i.e. delayed motor milestone or early handedness, speech, language and communication difficulties), or later into childhood and adolescence. Hence these babies require long-term follow-up in neonatal clinic or with a neurologist (where available)
- Neuro-rehabilitation improves outcome – early referral to neurodevelopmental rehabilitation services (inpatient where available) and community occupational therapy, physiotherapy and speech and language therapy on discharge