Essential nelson 9th edition

SECTION 11

CHAPTER 64

Hypoxic-Ischemic Encephalopathy, Intracranial Hemorrhage, and Seizures

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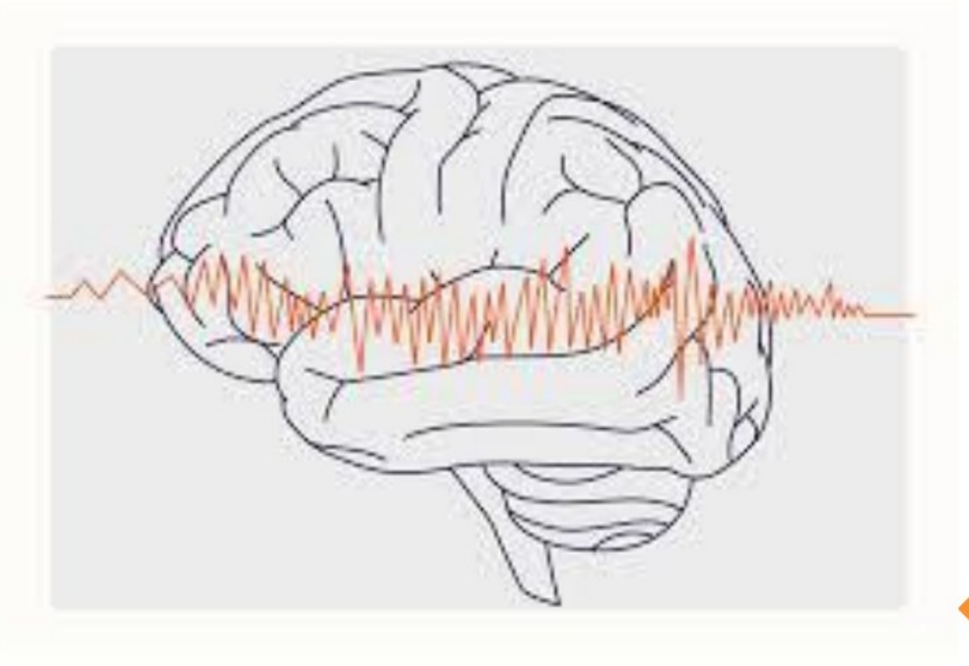
NEONATOLOGIST
SUMS

TITIES

- NEONATAL SEIZURES
- INTRACRANIAL HEMORRHAGE
- HYPOXIC-ISCHEMIC ENCEPHALOPATHY

NEONATAL SEIZURE

Symptomatic neonatal seizures may result from a wide range of **possible etiologies**



Inborn error of metabolism

Neonatal encephalopathy

Metabolic disturbances

Acquired structural brain lesions

Neonatal Epilepsy Syndromes

Drug withdrawal

Congenital brain malformation

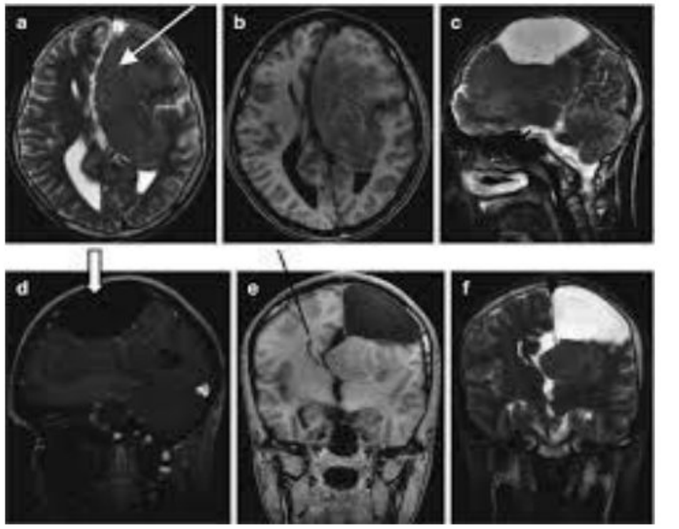
Local anesthetic agents

Infections

1- hypoxic-ischemic encephalopathy

- **A common cause of seizures** in the full-term infant
- Usually occur **12–24 hours** after a history of birth asphyxia
- Often are **refractory** to conventional doses of anticonvulsant medications
- Post-asphyxial seizures also may be caused by **metabolic disorders associated with neonatal asphyxia**, such as hypoglycemia and hypocalcemia

2- Congenital Structural brain lesions



- **Focal** cortical dysplasia: **Schizencephaly**
- **Diffuse** cortical dysplasia : **lissencephaly**

3- Acquired structural brain lesions

- **Ischemic and hemorrhagic stroke:**
- Local cerebral infarction: **Focal seizure**
- Intraventricular hemorrhage **(IVH)**
- Subarachnoid hemorrhage

3- Acquired structural brain lesions

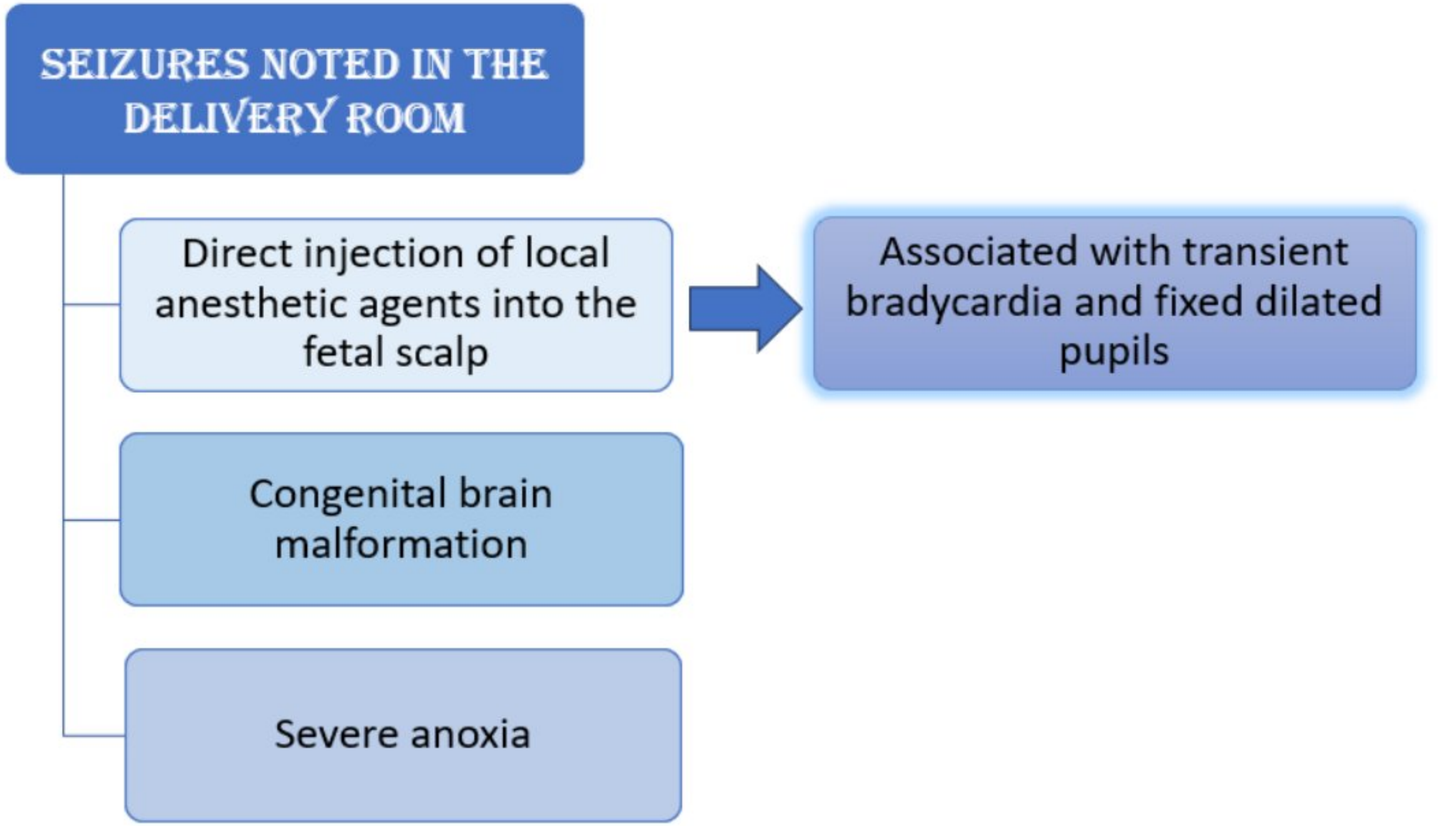
IVH

- A common cause of seizures in **premature infants**
- Often occurs between **1 and 3 days of age**
- Associated with a bulging fontanel, hemorrhagic spinal fluid, anemia, lethargy, and coma

Subarachnoid hemorrhage

- An infant who appears well
- A sudden onset on 1–3 days/o
- Short duration seizure

4- Seizures noted in the delivery room



5- Metabolic disturbances

- Hypocalcemia
- Hypomagnesemia
- Hypoglycemia
- Hypo- Hyper Natremia
- **Inborn errors of metabolism**

5- Metabolic disturbances

- Seizures caused by **hypoglycemia** often occur when blood glucose levels decline to the lowest postnatal value
  - **At 1–2 hours of age**
  - **After 24–48 hours of poor nutritional intake**
- Seizures caused by **hypocalcemia** and **hypomagnesemia** develop in high-risk infants and respond well to therapy with calcium, magnesium, or both.

6- infections

- **CNS Infection:**
  - Meningitis
  - Encephalitis
- **Systemic infection:**
  - Congenital TORCH infections
  - Sepsis

After the first 5 days of life

7- Drug withdrawal or intoxication

- **Neonates exposed to :**
  - Opioids
  - Alcohol
  - Selective serotonin reuptake inhibitors (SSRI)
  - Serotonin–norepinephrine reuptake inhibitors
  - Benzodiazepines
  - Barbiturates

After the first 5 days of life

8- NEONATAL EPILEPSY SYNDROMES

- An infant whose parent has a history of a neonatal seizure also is at risk for **benign familial neonatal seizures:**
- These seizures have **onset on days 3–7**
- **Resolve** by **1–4 months**
- Are due to mutations in KCNQ2 and KCNQ3 **potassium channel genes**

Clinical Characteristics of Neonatal Seizures

DESIGNATION	CHARACTERIZATION
Focal clonic	Repetitive, rhythmic contractions of muscle groups of the limbs, face, or trunk
	May be unilateral or multifocal
	May appear synchronously or asynchronously in various body regions
	Cannot be suppressed by restraint
Focal tonic	Sustained posturing of single limbs
	Sustained asymmetric posturing of the trunk
	Sustained eye deviation
	Cannot be provoked by stimulation or suppressed by restraint
Myoclonic	Arrhythmic contractions of muscle groups of the limbs, face, or trunk
	Typically not repetitive or may recur at a slow rate
	May be generalized, focal, or fragmentary
	May be provoked by stimulation
Generalized tonic	Sustained symmetric posturing of limbs, trunk, and neck
	May be flexor, extensor, or mixed extensor/flexor
	May be provoked by stimulation
	May be suppressed by restraint or repositioning
Ocular signs	Random and roving eye movements or nystagmus
	Distinct from tonic eye deviation
Orobuccolingual movements	Sucking, chewing, tongue protrusions
	May be provoked by stimulation
Progression movements	Rowing or swimming movements of the arms
	Pedaling or bicycling movements of the legs
	May be provoked by stimulation
	May be suppressed by restraint or repositioning

Jitteriness

- Jitteriness is characterized by movements with qualities primarily of **tremulousness** but occasionally of **clonus.**

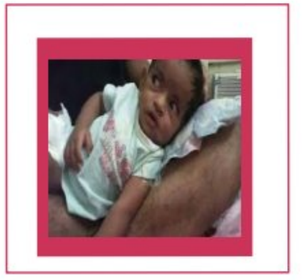
- The most consistently defined ***causes of jitteriness*** are:
  - **Hypoxicischemic encephalopathy (HIE)**
  - **Hypocalcemia**
  - **Hypoglycemia**
  - **Drug withdrawal.**

Seizures Vs benign jitteriness

Jitteriness is exquisitely stimulus sensitive; seizures generally are not stimulus sensitive.

In contrast to seizures, **jitteriness interrupted by holding** the extremity or with passive flexion

Jitteriness is rhythmic(equal rate and amplitude, typically high-frequency and low amplitude movements) but seizure is clonic jerking.



Seizures may be associated with **abnormal eye movements**, such as tonic deviation to one side(gaze)

Jitteriness is not accompanied by autonomic changes but seizure may be accompanied by one or more of these autonomic changes

Subtle seizures

- Subtle seizures are a **common manifestation** in newborns.
- The subtle signs of seizure activity include:
  - **Apnea**
  - **Eye deviation**
  - **Tongue thrusting**
  - **Eye blinking**
  - **Staring**
  - **Fluctuation of vital signs**

- Continuous bedside electroencephalographic monitoring can help identify subtle seizures.

Diagnostic evaluation

- Immediate determination of **capillary blood glucose** levels
- Blood concentrations of **sodium**, **calcium**, **glucose**, and **bilirubin** should be determined.
- When infection is suspected, **cerebrospinal fluid**(CSF) and **blood specimens** should be obtained for **culture**.

Diagnostic evaluation

- After the seizure has stopped, a **careful examination** should be done to identify signs of increased intracranial pressure, congenital malformations, and systemic illness.

- If signs of elevated intracranial pressure are absent, a **lumbar puncture** should be performed.

- If the diagnosis is not apparent at this point, further evaluation should involve **MRI, CT, or cerebral ultrasound** and **tests** to determine the presence of an **inborn error of metabolism**.

Determinations of **inborn errors of metabolism** are especially important in infants with **unexplained lethargy**, **coma**, **acidosis**, **ketonuria**, or **respiratory alkalosis**

Treatment

- The **treatment of neonatal seizures** may be specific, such as;
- **Treatment of meningitis**
- The correction of **hypoglycemia**, **hypocalcemia, hypomagnesemia, hyponatremia**
- **Treatment** of **vitamin B6 deficiency** or **dependency**

Treatment

- In the absence of an identifiable cause, therapy should involve an anticonvulsant agent, such as:
- **20–40 mg/kg** of **Phenobarbital**
- **10–20 mg/kg** of **Phenytoin**
- **0.1–0.3 mg/kg** of **Diazepam**

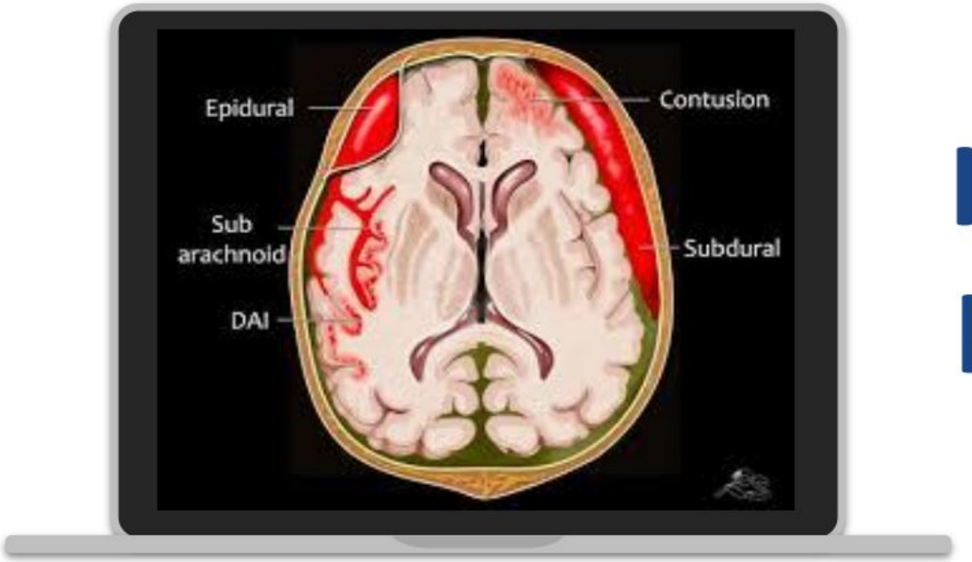
- **Levetiracetam** (Keppra) is an alternative anticonvulsant drug.

Treatment

- Treatment of **status epilepticus** requires **repeated doses of phenobarbital** and may **require diazepam or midazolam**, titrated to clinical signs.

PROGNOSIS

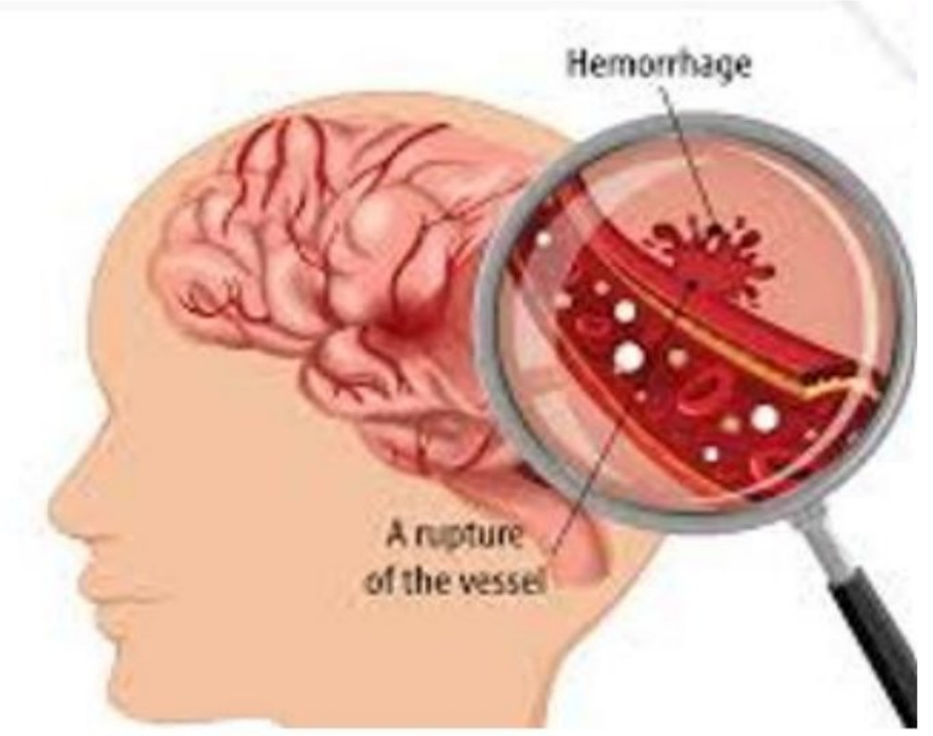
- The **long-term outcome** for neonatal seizures usually is related to the **underlying cause** and to the **primary pathology**, such as hypoxic-ischemic encephalopathy, meningitis, drug withdrawal, stroke, or hemorrhage



INTRACRANIAL HEMORRHAGE

Intracranial hemorrhage

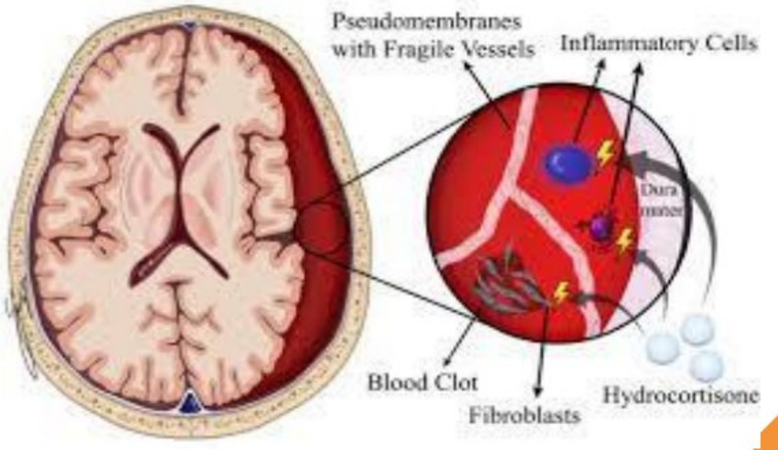
- Intracranial hemorrhage may be confined to **one anatomic area of the brain**, such as:
  - Subdural
  - Subarachnoid
  - Periventricular
  - Intraventricular
  - Intraparenchymal
  - Cerebellar region



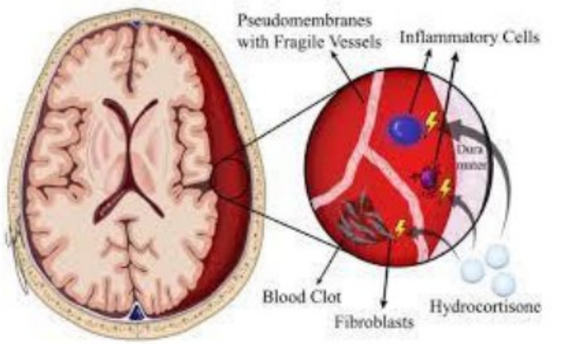
Subdural hemorrhages

Subdural hemorrhages

- Subdural hemorrhages are seen in association with:
  - Birth trauma
  - Cephalopelvic disproportion
  - Forceps delivery
  - Large for gestational age infants
  - Skull fractures
  - Head trauma.



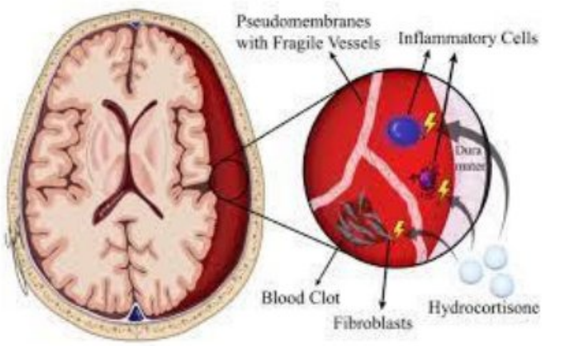
subdural hematoma



- The subdural hematoma **does not** always cause symptoms **immediately after birth**

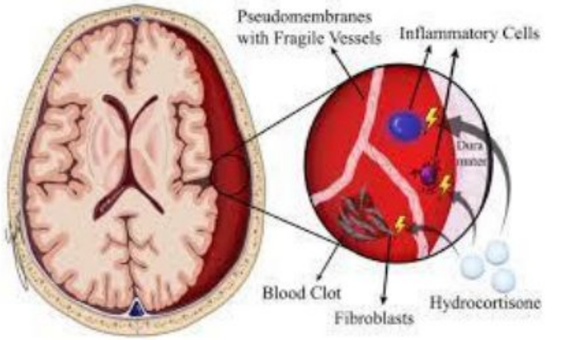
- **Anemia, vomiting, seizures**, and **macrocephaly** may occur in an infant who is **1–2 months** of age and has a subdural hematoma

subdural hematoma



- with time, however, the **red blood cells** (RBCs) **undergo hemolysis** and <u>water is drawn into the hemorrhage</u> because of the **high oncotic pressure** of protein, resulting in an **expanding symptomatic lesion.**

subdural hematoma



- **Child abuse** should be suspected in this situation.
- Appropriate diagnostic evaluation undertaken to identify other possible signs of **skeletal**, **ocular**, or **soft tissue injury**.

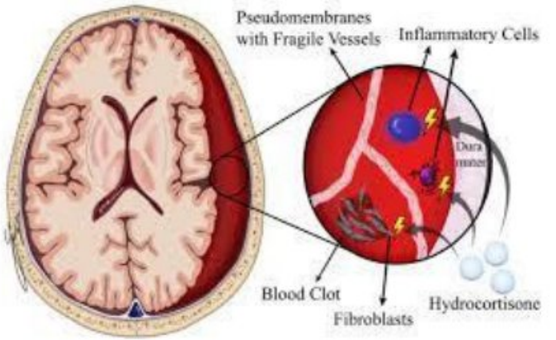
subdural hematoma

- Occasionally, a **massive subdural hemorrhage** in the neonatal period is caused by **rupture of the vein of Galen** or by an **inherited coagulation disorder**, such as **hemophilia**.

- Infants with these conditions exhibit **shock**, **seizures,** and **coma**.

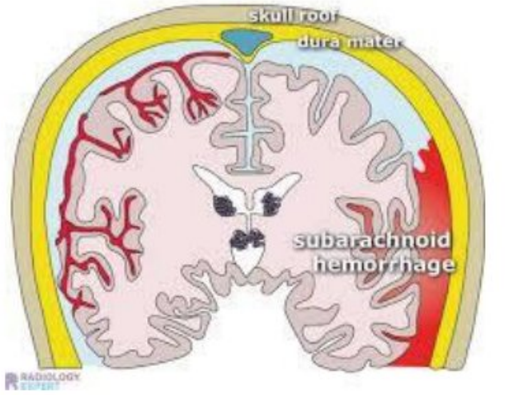
subdural hematoma

- The treatment of all symptomatic subdural hematomas is **surgical evacuation**.



Subarachnoid hemorrhages

Subarachnoid hemorrhages



- Subarachnoid hemorrhages may be spontaneous, associated with **hypoxia**, or caused by bleeding from a **cerebral arteriovenous malformation**.
- **Seizures are a common presenting manifestation.**
- **The prognosis** depends on the **underlying injury**.
- **Treatment** is directed at the **seizure** and the rare occurrence of **posthemorrhagic hydrocephalus**.

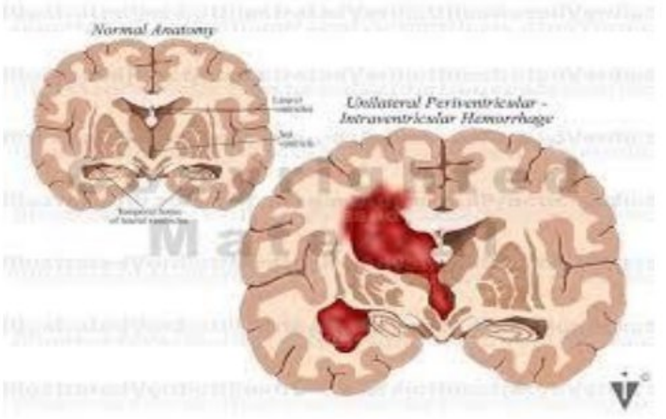
Periventricular hemorrhage and IVH

Periventricular hemorrhage and IVH

- Periventricular hemorrhage and IVH are common in **very low birthweight infants**
- The risk decreases with increasing gestational age.
- 50% of infants weighing less than 1,500 g have evidence of intracranial bleeding.

Periventricular hemorrhage and IVH

- The initial site of bleeding may be the **weak blood vessels** in the **periventricular germinal matrix**



Periventricular hemorrhage and IVH

- The vessels in **periventricular germinal matrix** have poor structural support and increase the risk of IVH.

Periventricular hemorrhage and IVH

- These vessels may **rupture** and **hemorrhage** because of**:**
  - **Passive changes in cerebral blood flow** occurring with:
    - The **variations of blood pressure** (failure of autoregulation)
    - The disorders that **interfere with venous return from the head** (venous stasis)

Passive changes in cerebral blood flow

- Asphyxia
- Pneumothorax
- Mechanical ventilation
- Hypercapnia
- Hypoxemia
- Prolonge labor
- Breech delivery
- Patent ductus arteriosus
- Heart failure
- Therapy with hypertonic solutions

periventricular hemorrhages and IVH

- Most periventricular hemorrhages and IVHs occur in the **first 3 days of life**.
- It is **unusual** for IVH to occur **after day 5 of life**.
- Many infants with small hemorrhages (**grade 1 or 2**) are **asymptomatic.**
- Infants with larger hemorrhages (**grade 4**) often have a **catastrophic event** that rapidly progresses to shock and coma

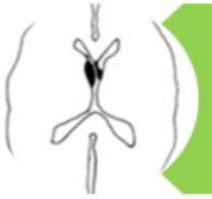
The clinical manifestations of IVH include:

1- Seizures
2- Apnea
3- Bradycardia
4- Lethargy
5- Anemia not corrected by blood transfusion
6- Hypotension
7- Metabolic acidosis
8- Bulging fontanel
9- Cutaneous mottling
10- Coma

IVH

- The diagnosis of IVH is confirmed and the severity graded by **ultrasound** through the anterior fontanel or **CT examination**

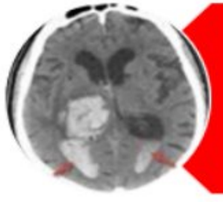
IVH



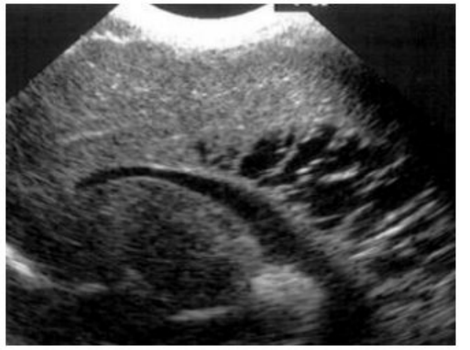
Grade 1 : is confined to the germinal matrix

Grade 2 is an extension of grade 1, with blood noted in the ventricle without ventricular enlargement

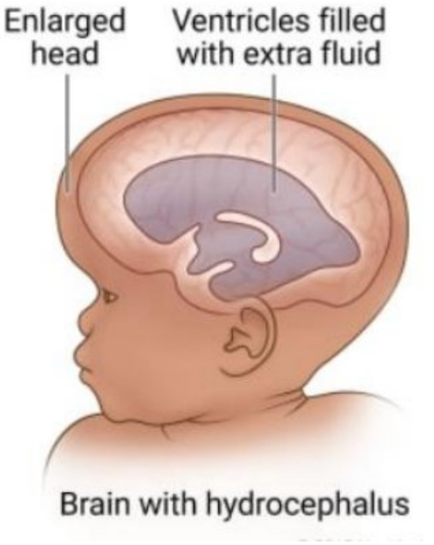
Grade 3 is an extension of grade 2 with ventricular dilation.



Grade 4 has blood in dilated ventricles and in the cerebral cortex, either contiguous with or distant from the ventricle



- **Grade 4 hemorrhage** has a *poor prognosis*, as does the development of periventricular, **small, echolucent cystic lesions**, with or without porencephalic cysts and posthemorrhagic hydrocephalus.



The cystic lesions

↓

periventricular leukomalacia

↓

cerebral palsy

- **Extensive intraparenchymal echodensities** represent **hemorrhagic necrosis**.
  - **hemorrhagic necrosis** is associated with a high mortality rate and have a poor neurodevelopmental prognosis for survivors

Treatment

Treatment of an **acute hemorrhage** involves standard supportive care, including :

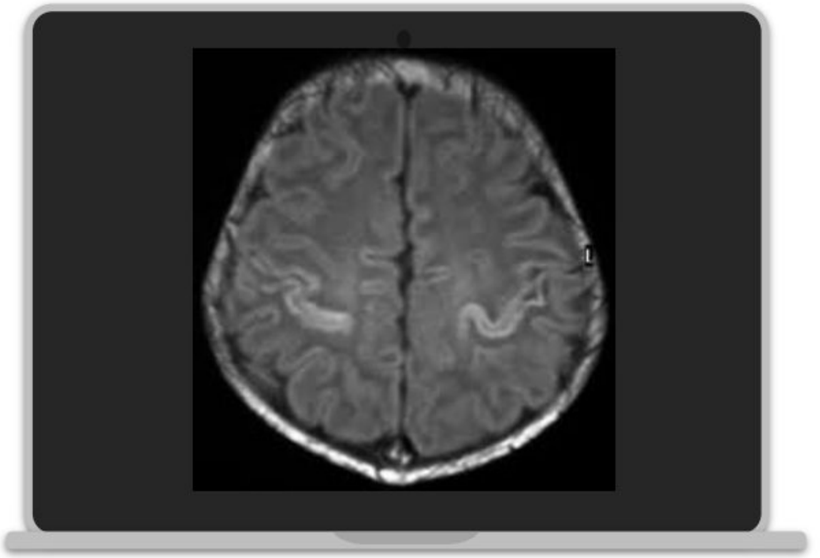
a. Ventilation for apnea
b. Blood transfusion for hemorrhagic shock
c. Holding the infant's head in a straight, upright position for the first 96 hours of life
d. Minimizing stimulation

c and d some benefit in the prevention of severity of IVH

Treatment

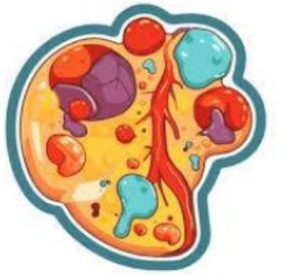
- **Posthemorrhagic hydrocephalus** may be managed with:
  - Serial daily lumbar punctures
  - An external ventriculostomy tube
  - A permanent ventricular-peritoneal shunt

- Implementation of the shunt **often is delayed** because of the **high protein content** of the hemorrhagic ventricular fluid



HYPOXIC-ISCHEMIC ENCEPHALOPATHY

HYPOXIC-ISCHEMIC ENCEPHALOPATHY

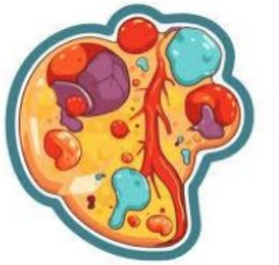


Reduce uteroplacental blood flow

Fetal spontaneous respiration

→ Perinatal hypoxia , Lactic acidosis → Reduce cardiac output or cause cardiac arrest → Brain Ischemia

HYPOXIC-ISCHEMIC ENCEPHALOPATHY



Diminished or **absent** blood flow to the brain(**Ischemia**)

⇩

Reduced availability of oxygen for the brain

⇩

Hypoxia

⇩

Reduced glucose for brain metabolism

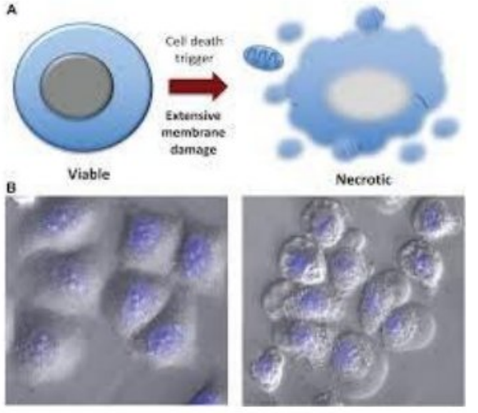
⇩

An accumulation of lactate

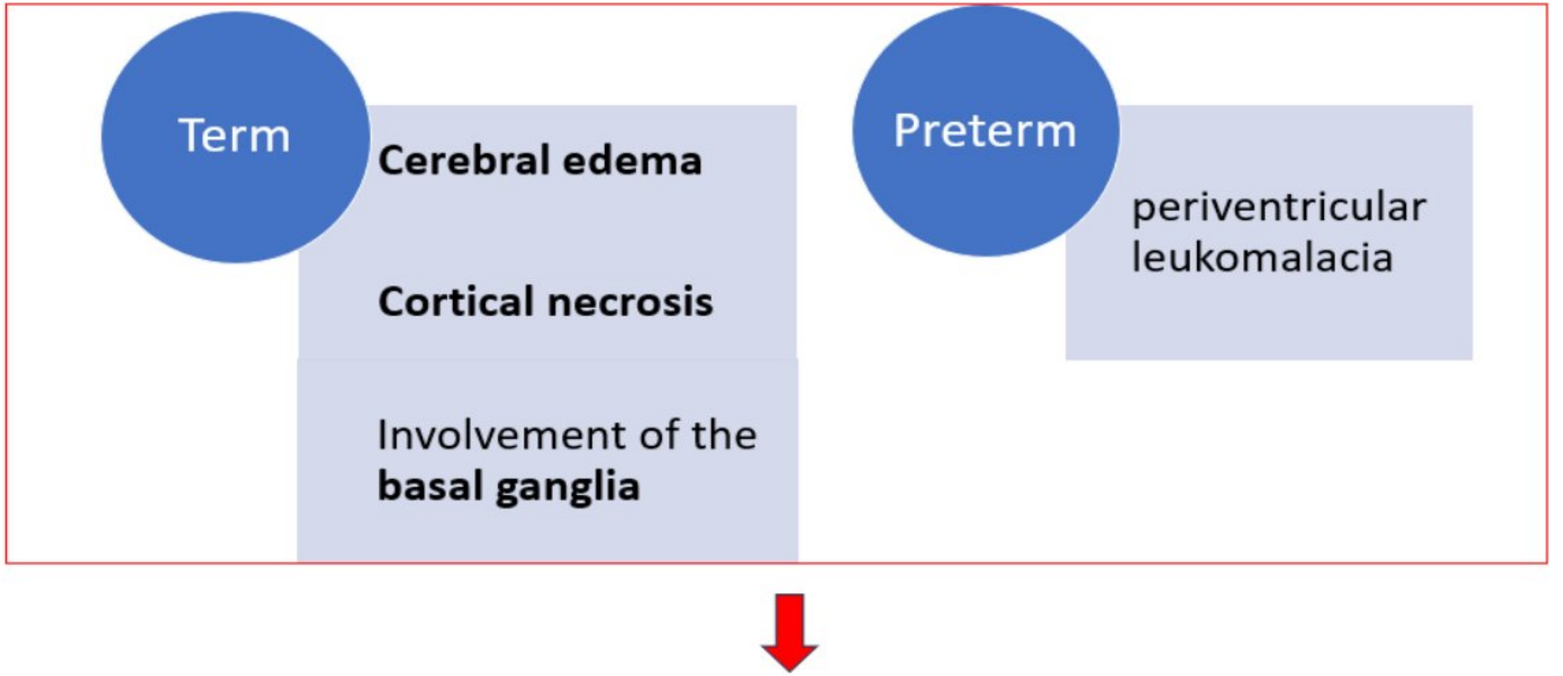
⇩

Local tissue acidosis

- **After reperfusion**, hypoxic-ischemic injury also may be complicated by **cell necrosis** and **vascular endothelial edema**, **reducing blood flow** distal to the involved vessel.



Hypoxic-ischemic encephalopathy



Cortical atrophy, **Mental retardation**, and **Spastic quadriplegia or diplegia**.

Clinical manifestations

TABLE 64.2 Hypoxic-Ischemic Encephalopathy in Term Infants

SIGNS	STAGE 1	STAGE 2	STAGE 3
Level of consciousness	Hyperalert	Lethargic	Stuporous
Muscle tone	Normal	Hypotonic	Flaccid
Tendon reflexes/clonus	Hyperactive	Hyperactive	Absent
Moro reflex	Strong	Weak	Absent
Pupils	Mydriasis	Miosis	Unequal, poor light reflex
Seizures	None	Common	Decerebration
Electroencephalography	Normal	Low voltage changing to seizure activity	Burst suppression to isoelectric
Duration	>24 hr if progresses, otherwise may remain normal	24 hr to 14 days	Days to weeks

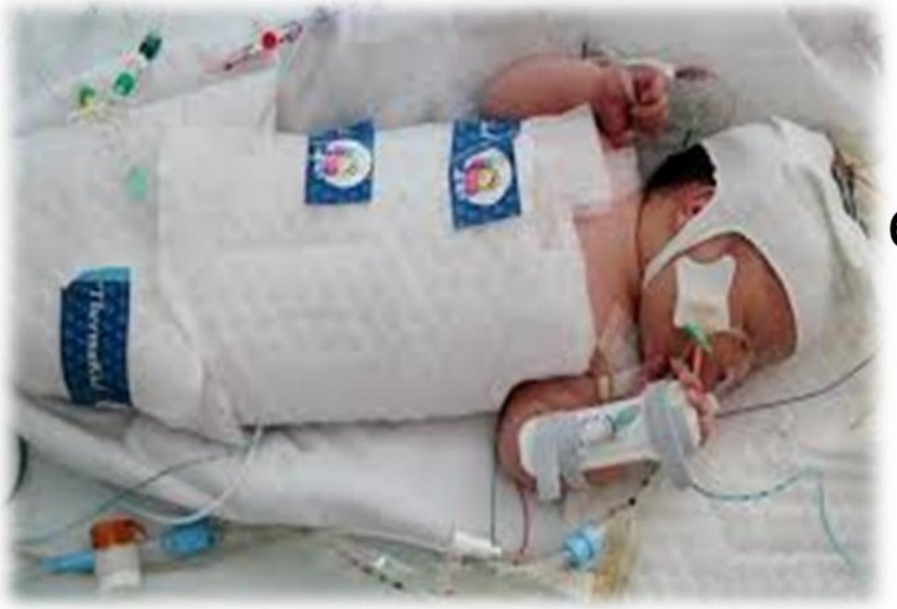
- **As cerebral edema develops**, brain functions are affected.
- As **cerebral edema** progresses, **refractory seizures** *begin 12–24 hours after birth.*
- **Cortical depression** produces **coma.**
- **Brainstem depression** results in **apnea**.

Survivors of stage 3 hypoxic-ischemic encephalopathy have a high incidence of **seizures** and serious **neurodevelopmental handicaps.**

- One indicator of poor prognosis is **time of onset of spontaneous respiration** as estimated by **Apgar score**.

- Infants with **Apgar scores of 0–3 at 10 minutes** have a **20%** mortality and a **5%** incidence of cerebral palsy.

- **If the score remains this low by 20 minutes**, the mortality increases to **60%**, and the incidence of cerebral palsy increases to **57%**



Hypoxic-ischemic encephalopathy in term infants is often managed with induced hypothermia.

THANK YOU!