

Neonatology

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NEONATAL RESUSCITATION

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Introduction :

- Spontaneous breathing in : 85%.
- Initial steps required in : 10%.
- Bag and mask ventilation required in : 5%.
- Intubation required in : 2%.
- Chest compressions required in : 1 to 2%.
- Babies requiring only PPV : 3%.

Note : First step to be done in case of neonatal arrest is ventilation.

Events at birth

00:06:47

Pulmonary changes :

After the baby is born :

- Lungs get aerated.
- Placental circulation is terminated.
- Foramen ovale is closed.

These events initiate the pulmonary circulation in a neonate.

Changes in fetal circulation :

1. Ductus venosus :

- Closes immediately.
- Fibrosis starts at 3 days and completes by 3 months.

2. Ductus arteriosus :

- Starts closing by 72 hours and completes by 2 weeks.
- Can take upto 1 year in preterm babies.

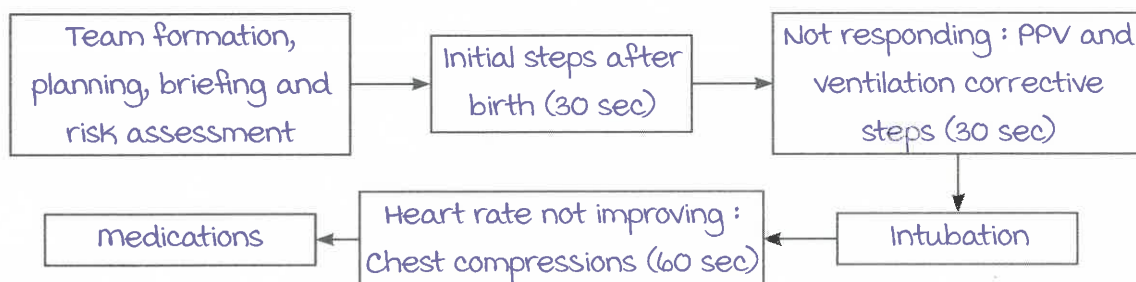
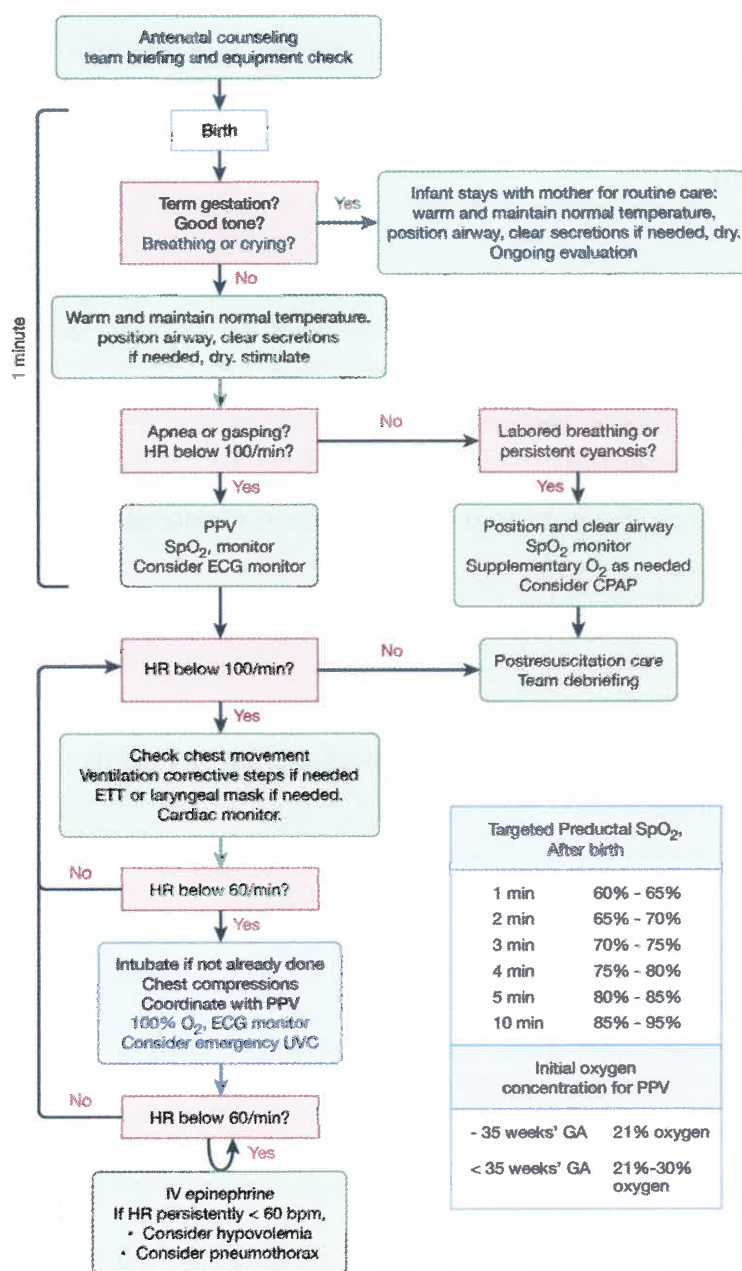
3. Foramen ovale :

- Immediate functional closure.
- Full closure might take from 3 months to 3 years.

Resuscitation algorithm

00:13:16

The recent algorithm is based on NRP 2020.



NRP algorithm for neonatal resuscitation

Anticipation and planning :

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Based on four factors :

- Expected gestational age.
- Amniotic fluid.
- Additional risk factors.
- Umbilical cord management plan.

The resuscitation team :

- Number of personnels required :
 - Low risk pregnancy : 1 personnel.
 - High risk pregnancy : 2 personnel (1 should be able to do extensive resuscitation.)
 - Chest compression : 4 people.
 - Complete resuscitation should be available.
- Team briefing.
- Team leader.
- Closed loop communication.
- Documentation.

Components of resuscitation

00:17:45

The steps involved are :

1. T : Temperature.
2. A : Airway.
3. B : Breathing.
4. C : Circulation.
5. D : Drugs.
6. E : Everything else.

Temperature :

- Room temperature : $>25^{\circ}\text{C}$.
- Preheated warmer.
- Preheated towels.
- Caps.
- Plastic wraps and thermal warmers for <32 weeks of gestation.

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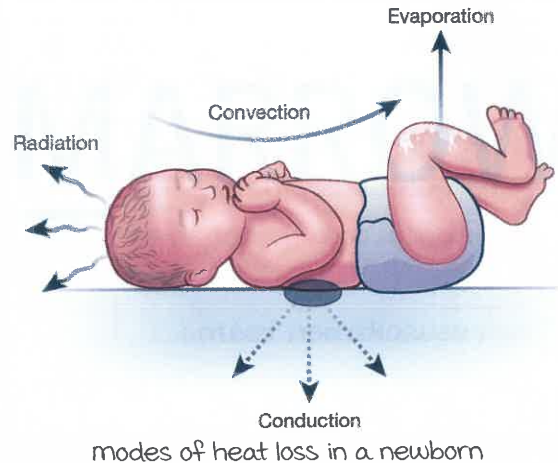
modes of heat loss in a newborn :

- Evaporation (most important).
- Convection.
- Radiation.
- Conduction.

Rate of heat loss in a newborn :

0.1 to 0.3°C/minute.

In first 20 min, babies' temperature can fall by 2 to 4°C.



Airway :

- Suction catheter size : 10 and 12 F catheter.
- Pressure : 80 to 100 mm Hg.
- Shoulder roll.

Breathing :

- Flow meter : 10 L/min.
- Blender :
 - For term : 21% FiO₂.
 - For preterm : 30% FiO₂.
- Oxygen tubes, compressed oxygen source.
- PPV device : T piece resuscitator/self inflating bag and flow inflating bag.
- 8 F orogastric tube.
- Pulse oximeter.
- Appropriate size mask.
- Laryngoscope.
- ET tubes.

Circulation :

- Stethoscope.
- Cardiac monitors.

Drugs :

- Adrenaline :
 - 1 in 10,000.
 - 0.2 mL/kg IV.
 - 1 mL/kg for intra tracheal dose.

- UVC catheters : 3.5 or 5 size.
- Syringes.
- Normal saline.

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Everything else :

- Tapes.
- Ties.
- Name tags.
- Cord clamp.
- Gloves.

Resuscitation steps

00:33:24

Initial steps :

- Provide warmth.
- Dry.
- Stimulate.
- Position.
- Suction : mouth before nose.
- Drying is not required in less than 32 weeks.
- Plastic bags are used in <32 weeks and in <1.5 kg babies.

Respiratory support :

- No breathing : Start PPV.
- Breathing but distressed : CPAP.
- Breathing, no distress but cyanosed : Free flow oxygen → Not improving → CPAP.

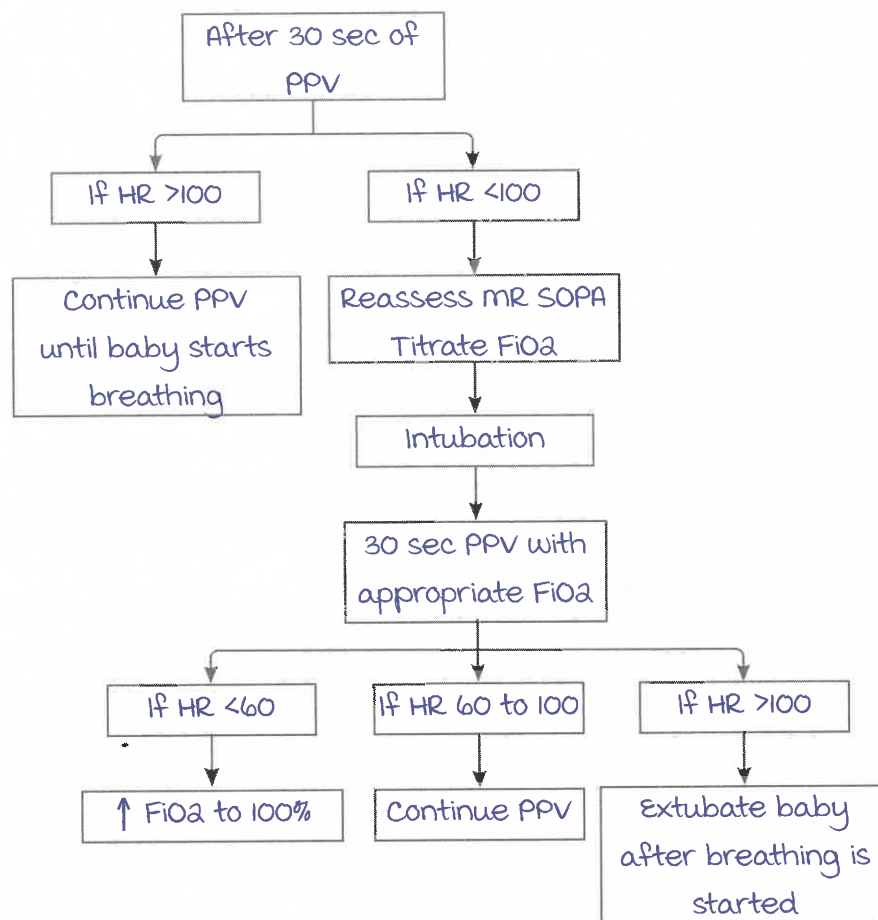
PPV :

- Indications :
 - Apnea.
 - HR <100 : Quickest and accurate method is auscultation.
- Initial pressure of 20 to 25 cm H₂O.
- Rate is 40 to 60 breaths/minute.
- The initial PEEP is 5 cm H₂O.

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After PPV is started :

- Tie pulse oximeter probe, check heart rate.
- FiO_2 is 21% for term and 30% for preterm neonate (<35 weeks).
- After 15 seconds, recheck heart rate.
- No increase in heart rate $\rightarrow$ MR SOPA $\rightarrow$ maximum pressure is 40 cm for term and 30 cm for preterm baby.
- After chest rise $\rightarrow$ Continue PPV for 30 sec.

**Intubation :**

- Done always before chest compression.
- Alternate airway.
- Prolonged ventilation.
- Congenital diaphragmatic hernia : Intubation is started immediately.
- Best measure for ET tube insertion : Nasotragal length + 1 cm.
- One attempt should be over with 30 seconds.

Signs of correct intubation :

- mist in the tube.
- Chest rise.
- Increase in heart rate.
- ETCO₂.

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Chest compressions :

One third of the anteroposterior diameter.

Rhythm : One and two and three and breathe.

Numbers :

- PPV alone : 40 to 60 breaths per minute.
- PPV with chest compressions :
 - 3 : 1 ratio.
 - 90 chest compressions, 30 breaths : Total 120 events per minute.

Adrenaline :

- Dose : 0.2 mL/kg as iv push.
- First dose can be given ET : 1 mL/kg.
- Followed by 3 mL flush.
- Normal saline bolus 10 mL/kg if there is evidence of volume loss.

If no response to resuscitation :

Look for **CARDIO**.

- Chest raise.
- Airway secured.
- Rote : Rhythm.
- Depth of compression.
- Inspired oxygen.
- Stopping resuscitation : 20 minutes.

Naloxone :

If mother has received opiates during delivery and the baby suffers from respiratory depression → CPAP and respiratory support preferred over naloxone.

Cord clamping :

- Timing of cord clamping : 30 to 60 seconds.
- Benefits :
 - Decreased need of vasopressor for preterm neonates.
 - Fewer blood transfusions.
 - Improved hematological status.
 - Improved survival and neurological outcomes.
- Increases risk of jaundice requiring phototherapy.

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Indications for early cord clamping :

- Fetal blood loss : Abruption placenta, placenta previa, vasa previa, cord avulsion.
- Fetal growth restriction.
- Twins.
- Rh negative pregnancy.

Note : Prematurity is not a contraindication for delayed cord clamping.

Uncomplicated delivery :

- Baby placed on skin to skin with mother : Golden one hour.
- Couplet care : For babies >35 weeks and >2 Kg.
- Vitamin K1 dose : 1 mg (For <1 Kg : 0.5 mg).
- Hepatitis B before 12 hours.
- BCG and OPV before discharge.
- TcB : Done between 24 to 48 hours or atleast before discharge.
- Newborn screening.
- Hearing screening.
- Pulse ox screening within 24 hours of discharge.

PERINATAL ASPHYXIA

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Causes of perinatal asphyxia

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Perinatal asphyxia has 3 components :

- maternal.
- Peripartum.
- Neonatal.

ACOG guidelines :

Criteria for perinatal asphyxia	
<ul style="list-style-type: none"> • APGAR score ≤ 5 at 5 min, 10 min • Fetal umbilical artery acidosis : pH ≤ 7.2 & base excess ≥ 12. Some definitions include lactate >10 mmol/L • Neuroimaging evidence of acute brain injury seen on brain MRI or MR spectroscopy • Presence of multisystem organ failure consistent with HIE : Renal injury, hepatic injury, hematological abnormalities, cardiac and GI disturbances. 	<p>Negative associations :</p> <ul style="list-style-type: none"> • If APGAR score is ≥ 7 at 5 minutes : Less risk of cerebral palsy • If cord pH >7.2, unlikely to be a peripartum event • If MRI between 24–96 h is normal : No evidence of HIE

APGAR Score

00:11:18

Indicator		0 Points	1 Point	2 Points
A	Appearance (Skin colour)	Blue/pale	Pink body, blue extremities	Pink
P	Pulse	Absent	<100 bpm	>100 bpm
G	Grimace (Reflex irritability)	No response	minimal response to stimulation	Cough/sneeze when stimulated
A	Activity (muscle tone)	Floppy	Some flexion	Well flexed
R	Respiratory efforts	Absent	Slow and irregular	Strong cry

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Features of APGAR score :

- Provides information about the newborn overall status & **response to resuscitation.**
- Resuscitation must be initiated before the 1-minute score is assigned.
- Not used to determine the need for initial resuscitation, resuscitation steps are necessary, or when to use them.
- Scoring in APGAR score :
 - 0-3 : Severe asphyxia.
 - 4-6 : moderate asphyxia.
 - 7-10 : mild asphyxia.

Sign	0	1	2	1 minute	5 minute	10 minute	15 minute	20 minute
Color	Blue or Pale	Acrocyanotic	Completely Pink					
Heart rate	Absent	<100 minute	>100 minute					
Reflex irritability	No Response	Grimace	Cry or Active Withdrawal					
Muscle tone	Limp	Some Flexion	Active Motion					
Respiration	Absent	Weak Cry; Hypoventilation	Good, Crying					
Total								

Comments:	Resuscitation					
	Minutes	1	5	10	15	20
	Oxygen					
	PPV/NCPAP					
	ETT					
	Chest Compressions					
	Epinephrine					

APGAR chart by American academy of paediatrics

False positive APGARs :

Falsely low APGARs/low APGAR in asphyxia.

- maternal sedation or anaesthesia.
- Birth trauma.
- Congenital heart blocks.
- Infection.
- Pulmonary disorders.
- Neuromuscular and central nervous system disorders.
- Gestational age.

Peripartum causes

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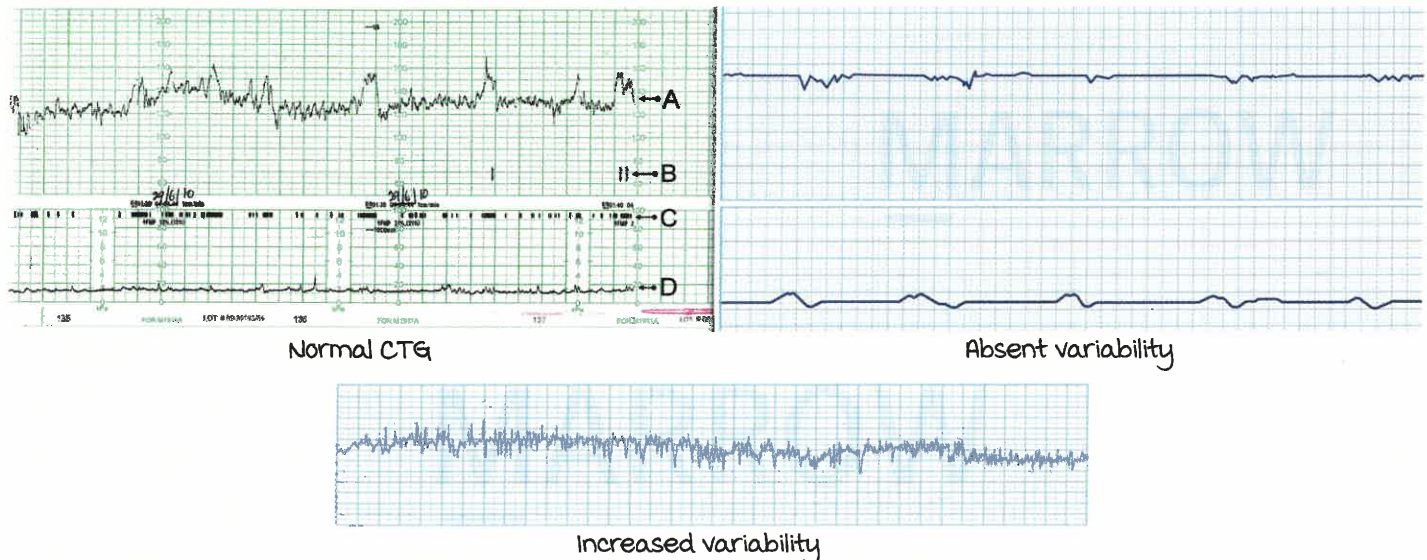
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Sentinel events	Delivery events
<ul style="list-style-type: none"> Ruptured uterus Severe abruptio placenta Amniotic fluid embolism Cord prolapse maternal cardiovascular collapse Fetal exsanguination These events → Abrupt obstruction in blood flow & oxygen supply to fetus 	<ul style="list-style-type: none"> CPD (Cephalo-Pelvic Disproportion) Shoulder dystocia Breech delivery/malpresentations Obstructed labor midforceps delivery Precipitate delivery malpresentation Prolonged labor

Fetal hypoxia on uterus contraction during labor → **Partial prolonged asphyxia**.

Peripartum monitoring (CTG):

- Baseline heart rate.
- Variability (Slight variability in FHR at rest of 5 - 25bpm).
- Accelerations.
- Decelerations.
- Absent variability is very dangerous for fetus.



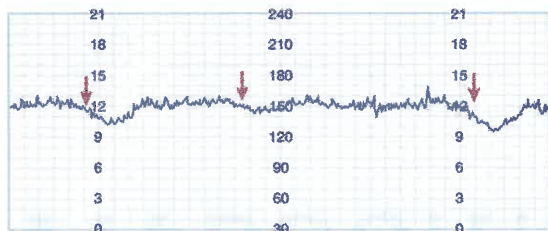
FHR variabilities:

- FHR >25 bpm : marked variability.
- FHR <5 bpm : minimal variability.
- FHR 5-25 bpm : moderate variability.

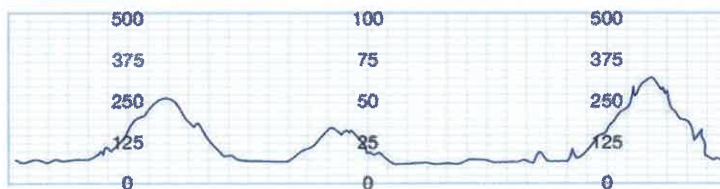
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Early deceleration :

- As the uterus starts contracting the fetal heart rate starts decreasing.
- Peak of fetal heart rate dip corresponds to peak of uterine contraction.
- Shallow curve in CTG.



Fetal heart rate



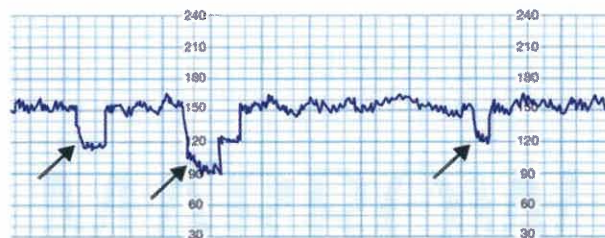
Uterine contractions

Early deceleration

- Due to compression of fetal during uterine contraction and a vagal response.
- It is not dangerous to the fetus.

Variable deceleration :

- There is no link between uterine contraction and fetal head compression.
- It is either 'u' or 'v' shaped.
- Seen in cord compression.



Variable deceleration

Late deceleration :

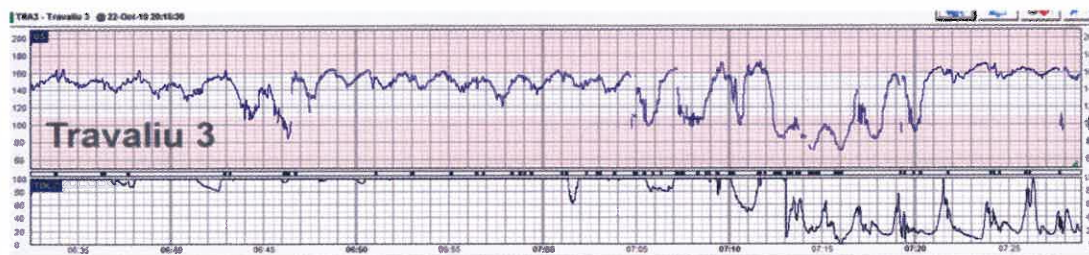
- Beginning of deceleration happens at the peak of uterine contraction.
- It is pathological.
- Usually in last 10 minutes of delivery, late deceleration is acceptable.



Late deceleration

Prolonged deceleration :

Lasts for more than 20 seconds.



Prolonged deceleration

Classification of CTG :

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Category I	Baseline rate : 110-160 bpm
	Baseline variability : moderate
	Late or variable decelerations : Absent
	Accelerations : Present or absent
Category II	Includes all tracings not categorised as I or III
Category III	Absent baseline FHR variability & any of the following : <ul style="list-style-type: none"> • Recurrent late decelerations • Recurrent variable decelerations • Bradycardia
	Sinusoidal pattern

Category I : Reassurance.

Category III : Immediate delivery.

Antenatal causes

00:39:03

Antepartum fetal monitoring :

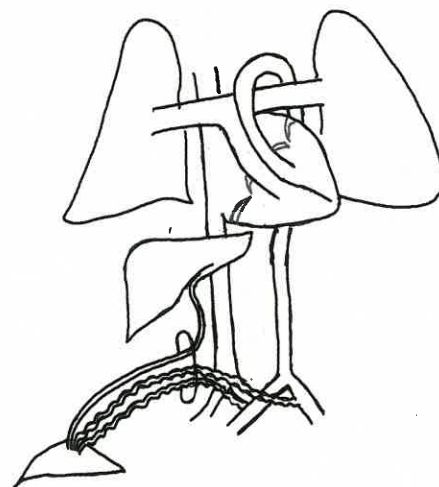
- Fetal growth status.
- Dopplers.
- NST (Non Stress Test).
- BPP (Biophysical profile).

Antenatal fetal dopplers :

- m/c fetal doppler done is **umbilical artery doppler**.

It has 3 forms :

- Normal form.
- Absent end diastolic flow.
- Reverse end diastolic flow.
- Aortic isthmus doppler.
- MCA doppler : To determine the resistance index.
- Ductus venosus doppler : Fetal acid base status.



Fetal circulation

NST :

- Reactive : 2 accelerations lasting for 15 seconds and rising 15 bpm in 20 min.
- Can be done from 26 weeks gestation.
- Reactive NST is seen only from 32 weeks gestation.

----- Active space -----

BPP :

Fetal heart rate	2 or more accelerations of 15 bpm lasting more than 15 seconds in a 30 minute record	1 or no acceleration in a thirty minute period
Fetal muscle tone	1 or more episodes of active extension and return to flexion in 30 min	Slow extension and return to partial or no flexion, no movement in 30 min
Fetal body movements	3 or more in 30 minutes	2 or less in 30 minutes
Fetal breathing movements	One or more episodes of FBM of >30 seconds in 30 minutes	Absent or no episodes of FBM in a 30 minute period
Amniotic fluid volume	1 or more pockets of fluid measuring >2 cm in vertical axis	No or largest pocket <2 cm

BPP scoring :

- Score of 8 - 10 : Reassurance.
- Score of 1 - 4 : Abnormal.
- Score of 5 - 7 : Grey zone.

BIRTH INJURIES

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Incidence & risk factors

00:00:21

Incidence :

- 0.2% (2 per thousand deliveries).
- more common in normal vaginal deliveries.

Risk factors :

- Breech delivery :
 - Biggest risk factor.
 - Can cause fractures in humerus, clavicle and mandible, gluteal hematomas, genital lacerations, spinal injuries and intracranial injuries.
- Other risk factors are :
 - Forceps.
 - vacuum delivery.
 - macrosomia.
 - Abnormal presentation.
 - Precipitous delivery.
 - maternal factors : Primigravida, CPD and short stature.

Note :

Gestational diabetes mellitus (GDM) is not a risk factor.

Common injury sites :

- Cranium : most common.
- Nerves, bones and soft tissues around cranium.

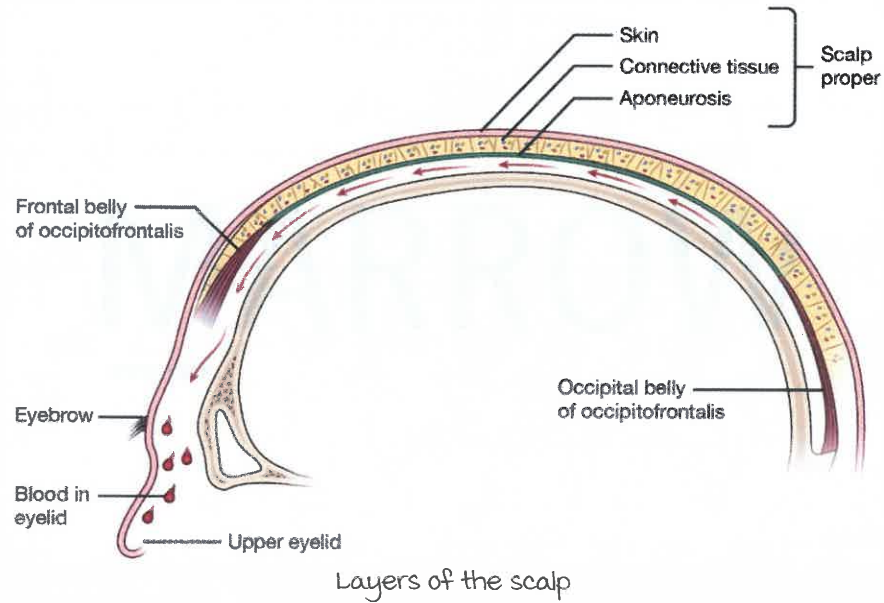
Extracranial bleeding

00:03:32

Layers of the scalp :

- | | |
|----------------------|-------------------------|
| • Skin. | • Loose areolar tissue. |
| • Connective tissue. | • Periosteum. |
| • Aponeurosis. | • Bone. |

----- Active space -----



Injuries :

- Between skin and connective tissue : Caput (Less severe).
- Between aponeurosis and loose areolar tissue : Subgaleal bleed (most severe).
- Between periosteum and bone : Cephalhematoma (more severe).

Cephalhematoma :

- m/c site : Parietal region.
- U/L > B/L. usually in an enclosed space.
- Complications :
 - Jaundice (m/c).
 - Abscess.
 - underlying depressed fracture of skull.
 - Anaemia.
 - Fractures (5 to 10%) : CT to be done if suspected.
- Resolution : Starts calcifying by 2 weeks & disappears completely by 8 weeks.

Subgaleal hemorrhage :

Risk factors :

- vacuum/forceps delivery.
- Hemophilia A.
- Acquired early vitamin K deficiency disorders.
- Occurs in cephalic presentation.

Types :

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- Acute onset :
 - Immediately after delivery.
 - Baby taken to NICU for fluid resuscitation.
- Gradual onset :
 - Baby slowly becomes dull, anaemic and develops respiratory failure.
 - HC monitoring : Every hourly for first three hours; every 6 hourly for 24 hours, then every 24 hours for 3 days.
 - monitor Hb values.

Complications :

- DIC due to consumptive coagulopathy.
- Tight cap can cause scalp necrosis.

Note :

- Around 240 mL of blood can collect in subgaleal space.
- The volume of blood loss to be assumed with every cm increase in HC subgaleal hemorrhage is 40 mL.

Skull and facial fractures

00:11:51

Linear fractures	Depressed fracture
<ul style="list-style-type: none"> • m/c than depressed fractures. • Asymptomatic. • Occurs in parietal region. • Can be associated with subdural/subarachnoid bleeding. 	<ul style="list-style-type: none"> • Occurs in parietal region with circumferential fractures. • Can have seizures.

Note :

- m/c intracranial bleeding in a term neonate : SDH (Subdural hemorrhage).
- m/c intracranial bleeding in a preterm neonate : Intraventricular hemorrhage.

Nerve injuries

00:13:55

The common nerve injuries are :

- Facial nerve injury (m/c).
- Brachial plexus injury.
- Phrenic nerve injury.

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- Recurrent laryngeal nerve injury.

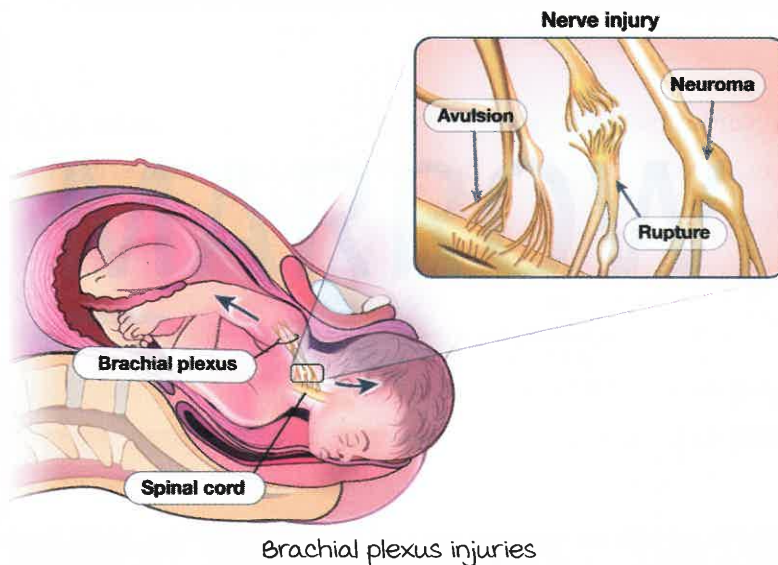
Extent of nerve injuries	Features
Neuropraxia	<ul style="list-style-type: none"> • myelin sheath is damaged. Axons are intact
Axonotmesis	<ul style="list-style-type: none"> • Axons are cut. myelin sheath is intact
Neurotmesis	<ul style="list-style-type: none"> • Both axons and myelin sheath are damaged • Could be due to rupture or avulsion • Rupture : At the cord/bundle level • Avulsion : At the level of cyton → Cell death → Less chance of nerve regeneration

Brachial plexus :

- Located at supraclavicular region.
- Extends below the clavicle into axilla.
- Nerve supply to the arm.

Nerves and their functions :

- C5 root : Shoulder abduction (Deltoid).
- C6 root :
 - muscles supplied : Biceps, supinator and brachioradialis.
 - Functions : Flexion, supination, biceps reflex, radial reflex.
- C7 root : Wrist flexion.
- C8 root : Finger flexion.



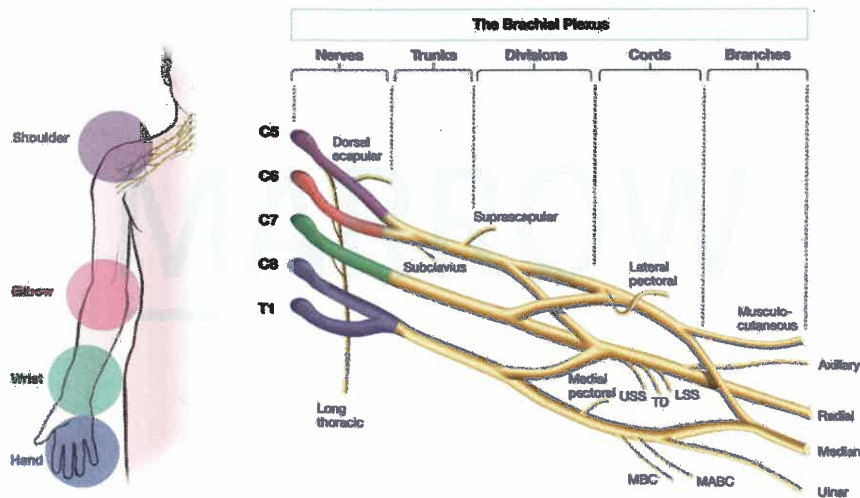
Injuries :

- C5 and C6 : **Erb's palsy** (90%).
- C8 and T1 : **Klumpke's paralysis** (1%).
- C5 to T1 : **Total paralysis** (10%).
- Police man's tip hand : Arm is adducted, extended and pronated but wrist action is present.



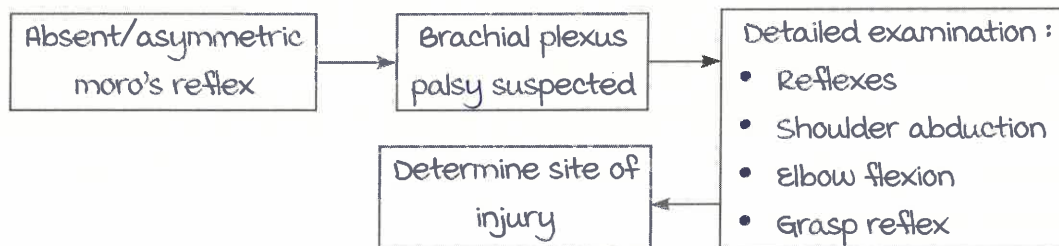
Police man's tip hand

----- Active space -----



Sites of brachial plexus injuries

Assessment :



Naraka's classification :

1. C5-C6 : Wrist flexion is present (80% recovery).
2. C5, C6, C7 : Wrist flexion absent (60% recovery).
3. C5-T1 with no Horner's syndrome (40 to 50% recovery).
4. C5-T1 + Horner's syndrome (Due to avulsion of root of T1) : Worst prognosis.

Investigations :

Chest X-ray :

- To r/o clavicular fracture.
- Look for diaphragmatic palsy (Associated with 10% cases of Erb's palsy).

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management :

- **Early mobilisation** : 7 to 10 days.
- mother should perform abduction, supination and flexion of elbow during every direct breast feeding session.
- Proper **physiotherapy** assessment based on **Toronto score**.
- If no elbow flexion after 1 month → Specialist referral → MRI/NCV/EMG → Primary neural repair/tendon transfer for 3 to 9 month old babies.
- Statue of liberty splint : Abduction of arm, flexion of forearm and wrist is turned inwards.

Phrenic nerve palsy :

- Loss of C5 root.
- Right > Left.
- U/L > B/L.
- Sign : Respiratory distress.
- Chest X-ray : Elevated hemidiaphragm.

Note :

- Erb's palsy → 10% associated with diaphragmatic palsy.
- Diaphragmatic palsy → 75% associated with Erb's palsy.

Diagnosis :

- Bedside USG.
- Fluoroscopy.

Treatment :

- Respiratory support.
- Recovery takes 1 to 3 months.
- If not improving : Diaphragmatic plication.

Facial nerve palsy :

- m/c neural injury.
- LMN type of palsy.
- m/c risk factor : Forceps delivery.
- Features : Branched facial nerve palsy.

Treatment :

- Supportive management.
- Eye lubricants and feeding support.
- Usual recovery by 3 weeks of age.

Other injuries

00:28:59

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Fractures :

Clavicular fracture :

- most important risk factor : Shoulder dystocia.
- Features :
 - Crepitus.
 - Swelling.
 - Callus (Greenstick fracture).
- Diagnosis : X-ray.
- Treatment :
 - Starts healing by 1 week.
 - No splinting.
- Humerus and femur fractures : Starts healing by 7 to 10 days.

Soft tissue injuries :

- Seen in breech deliveries.
- Liver injury (m/c).
- Adrenal hemorrhage :
 - 75% are u/L.
 - Right > Left.