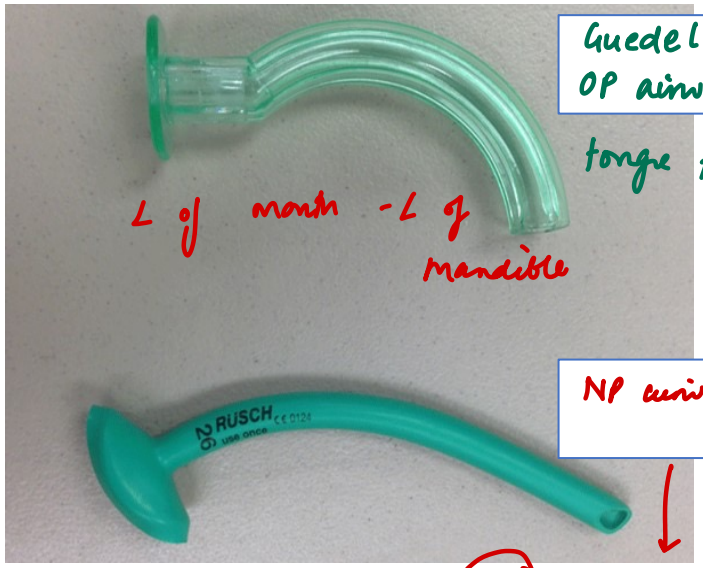
Anaesthesia

INSTRUMENTS

- unconscious



Guedel's OP airway

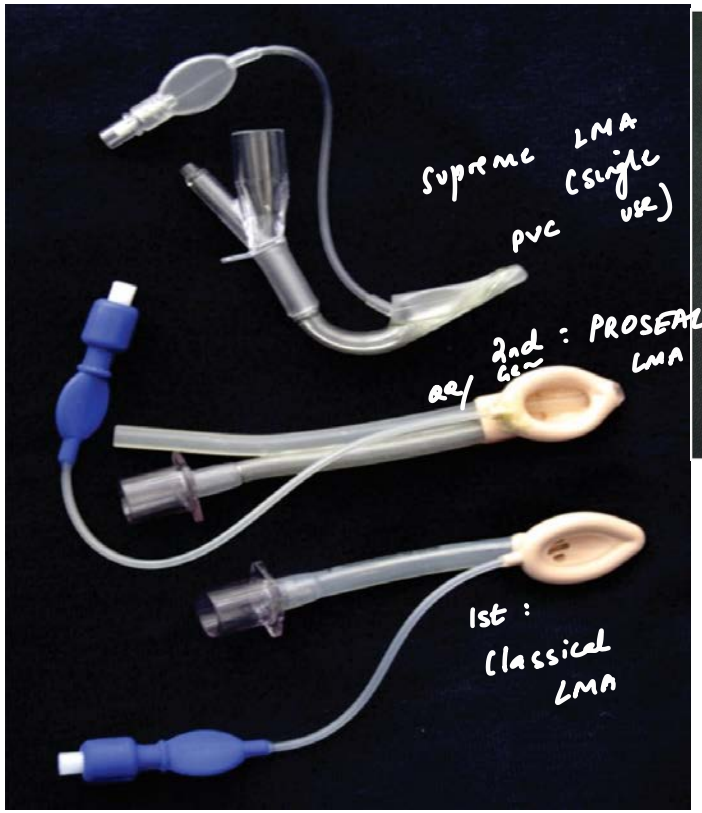
tongue fall

L of mouth - L of mandible

NP airway

tip of nose to ear lobule

CI: skull base # coagulopathy



Supreme LMA (single use) pvc

2nd gen : PROSEAL LMA

1st : Classical LMA

AMBU Aura LMA - 1st gen

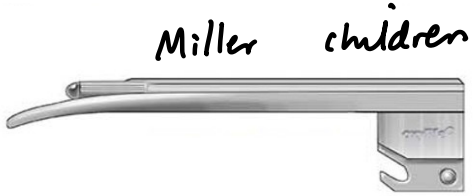
Streamlined Liner of the Pharynx Airway (SLIPA)

iGel

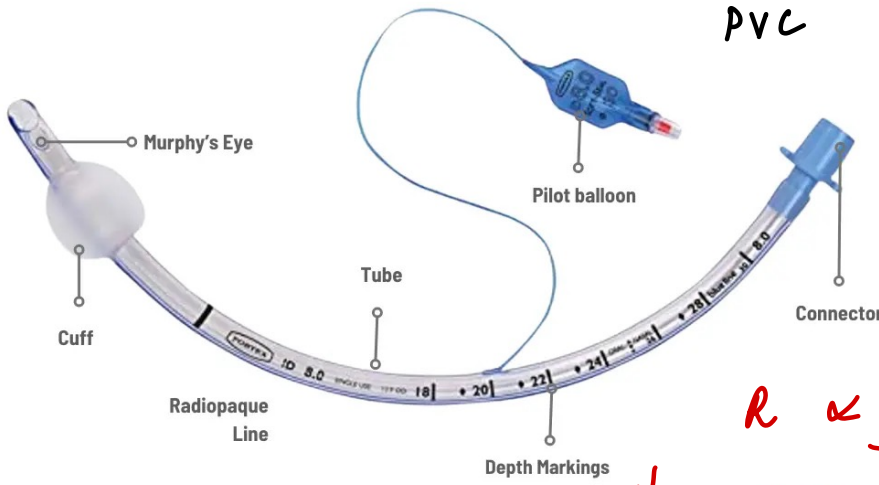
Fast track LMA

SIZE OF LMA = SAD
Child: 3
Female: 4
Male: 5

Intubation & Instruments Needed

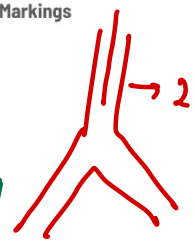


iMAC / Best Video laryngoscope → difficult intubⁿ



$R \propto \frac{1}{r^4}$

ET tube
- CXR
- Best: $ETCO_2$ 35-45 mm Hg



→ 2-5cm from carina

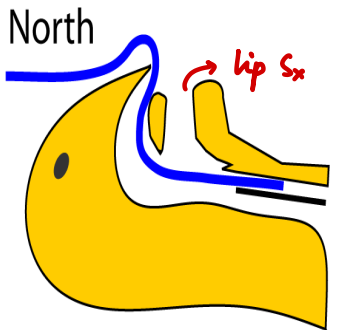
- Preterm- 0
- Term- 1
- Children- 2
- Female- 3
- Male- 4

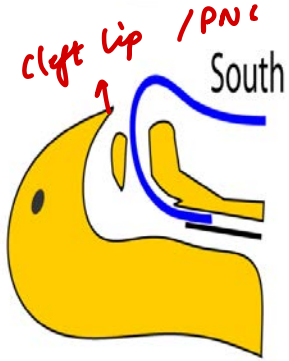
- Hand: Lt
- Insert: Rt ∠ of mouth
- Pressure: Forward & upwards
- MC injury: upper central incisors
- BURP: Backward upward Rtward

Internal diameter: Resistance
Cuff- Low pressure, High volume OR
Children: microcuffed > uncuffed
Size of ETT-
- <1200g (≤28wk): 2.5
- 1200-2200g (29-34wk): 3
- >2200g (>34wk): 3.5
- Child: 3-4
- Female:7
- Male: 8

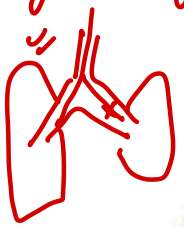
Instruments	Formula
ETT(mm) (Uncuffed)	~~4~~ 4 + (Age /4)
ETT depth (cm)	3 x ETT (gums-tip)
NG Tube/ Foley's (Fr)	2 x ETT
Chest Tube (Fr)	4 x ETT

RAE tubes





double lumen tube
↓
single lung ventln

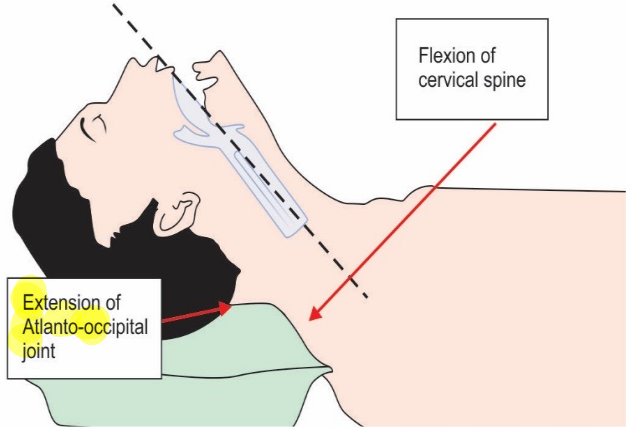


confirm:
fibreoptic bronchoscope

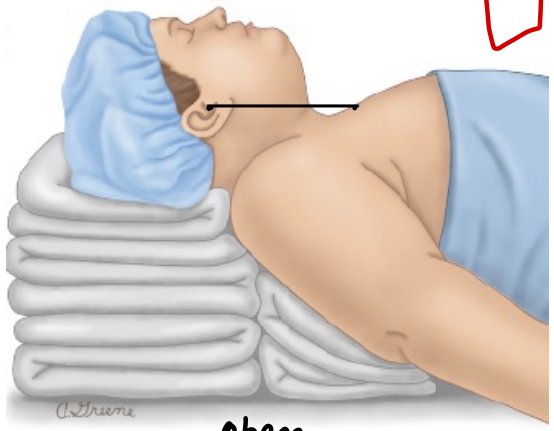
Combitube

Flexometallic tube
↓
PRONE Sx

Stylet Bougie
difficult airway



Sniffing position



Obese
RAMP /HELP

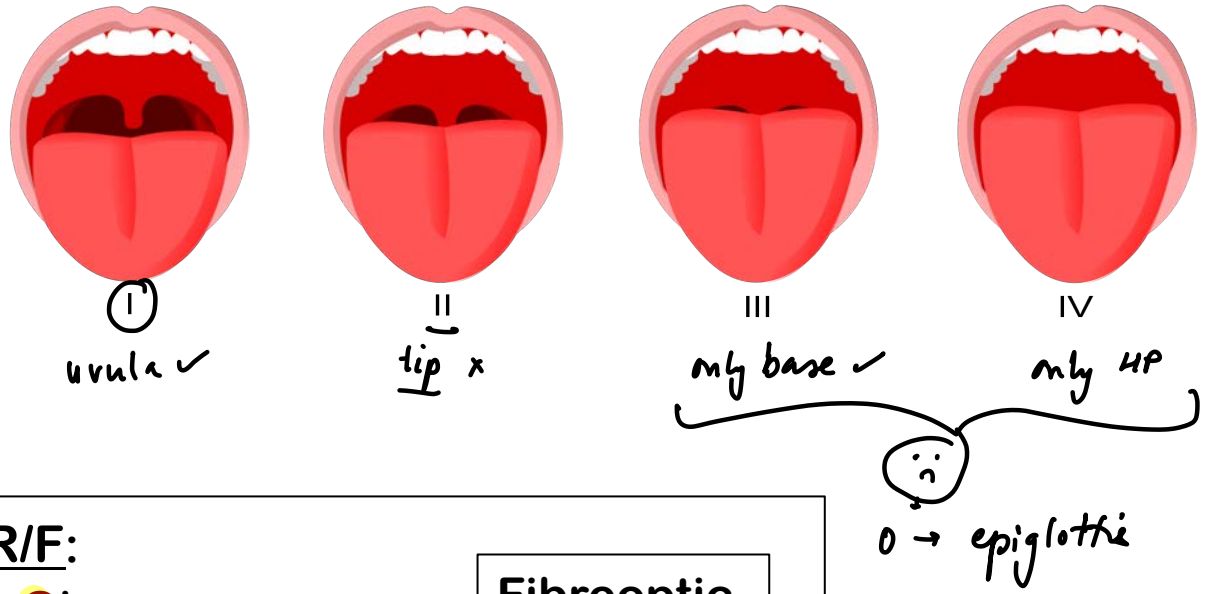
Head elevated laryngos position

RSI → Selick manouever
prevent aspiration

Larson manouever
= Laryngospasm ↓

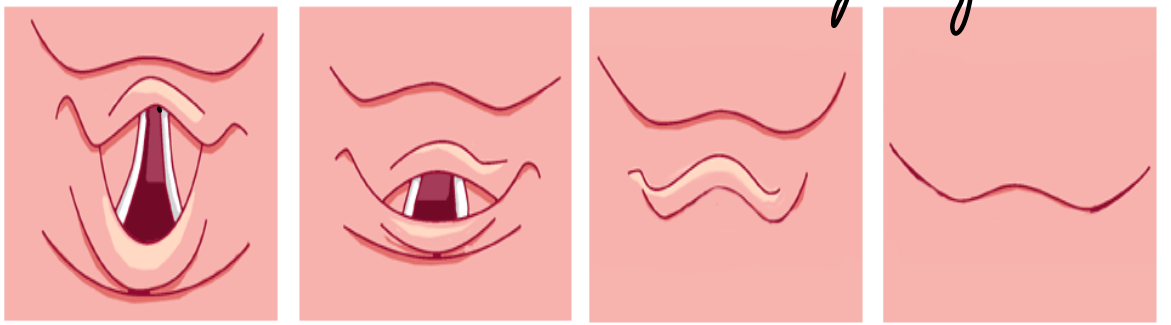
Difficult Intubation

Mallampatti classific



I → uvula ✓
II → tip ×
III → only base ✓
IV → only HP
0 → epiglottis

Cormack-Lehane grading → DL ✓



Grade 1 → vc, pc, e
Grade 2 → ≤ pc
Grade 3 → only epig
Grade 4 → ×

R/F:

- **O**bese
- **B**earded
- **E**dentulous
- **S**norer
- **E**lderly
- **N**eck circumference >40 cm
- Finger breadth:TMJ ≥ 3 fingers
- Thyro-mental distance- ≥ 6.5cm (N)
- Sterno-mental distance- ≥ 13cm (N)
- Lip bite test

Fibreoptic intubation

Plan A:
- Face-mask ventilation & Tracheal intubation
- Direct/ video Laryngoscopy (max. 3 + 1 attempts)

↓ ×

Plan B:
- 2nd generation SAD insertion
- Max- 3 attempts

↓ ×

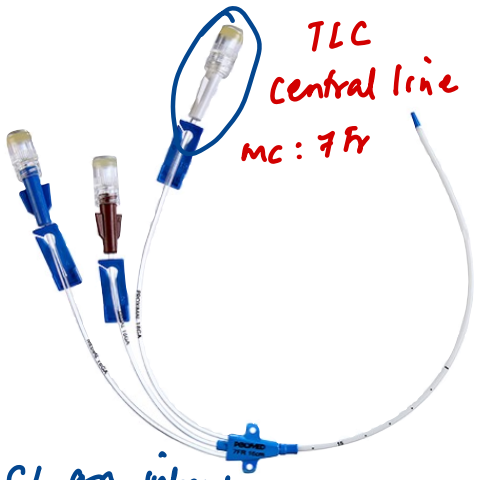
Plan C: Face-mask ventilation

↓ ×

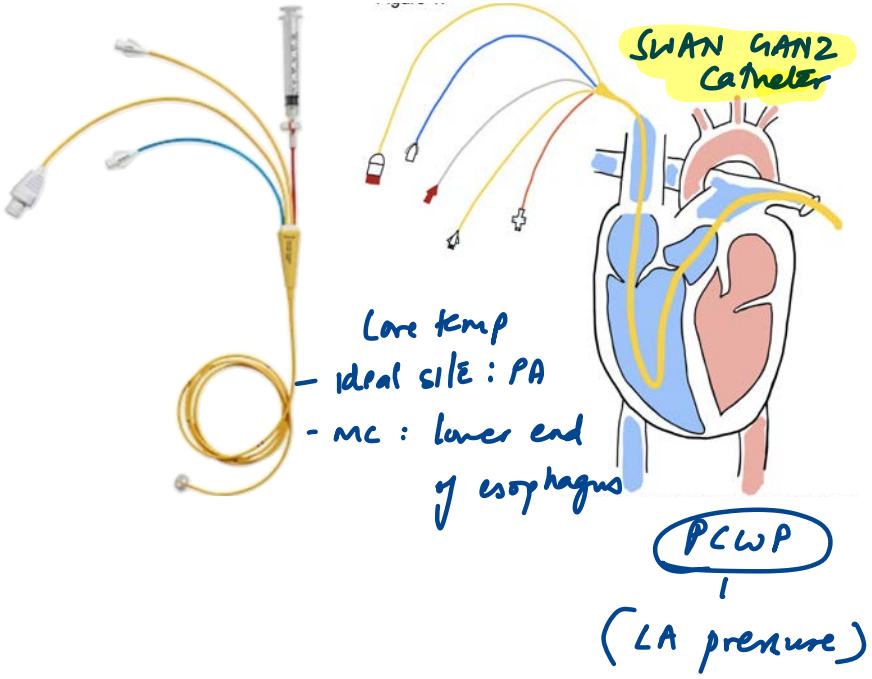
Plan D (CICO):
- Front Of Neck Access (FONA)
- Scalpel Cricothyrodotomy

← Restricted mouth opening

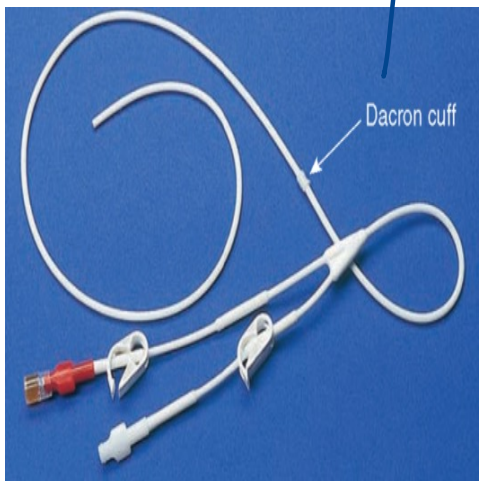
Instruments



CL ass infn :
S. epidermidis / CoNS



Chemoport

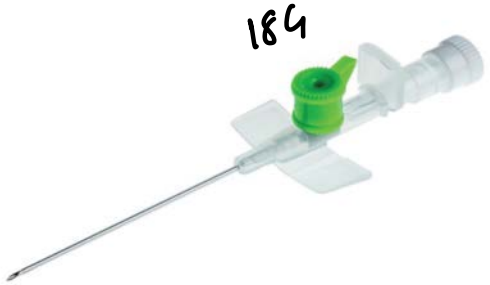


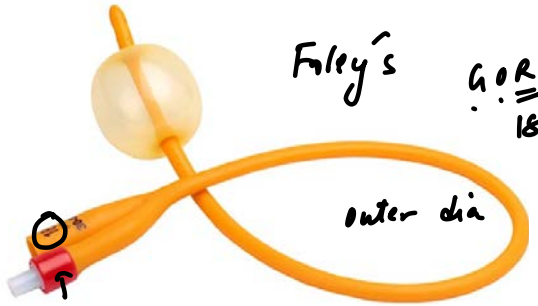
tunnelled catheter
↓
Permacath / Hickmann cather

- MC vein for central line: IJV
- MC vein for TPN: Subclavian vein
- Max risk of pneumothorax: "
- Max risk of infection: femoral vein
- Max risk of thrombosis: femoral vein

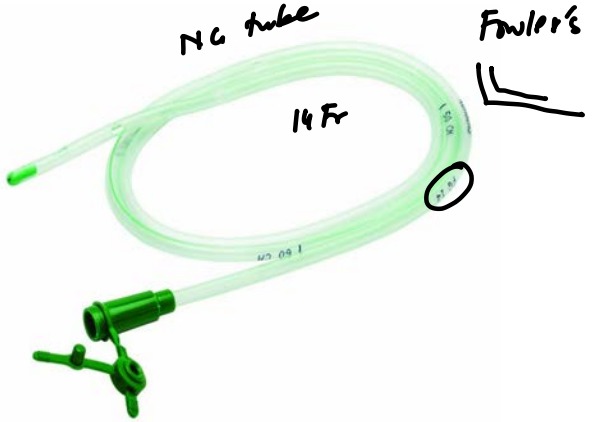
- Total Parenteral Nutrition (TPN):
- 20:30:50 - P : F : C
- >1kg/day weight gain: fluid overload
- Weight gain after: 6d
- ~~QR~~ Refeeding syndrome: ↓K ↓Mg ↓PO_4
- Zn, B12 deficiency
- ~~Q~~ MC metabolic complication: Insulin Resistance

Instruments





GOR = 18Fr



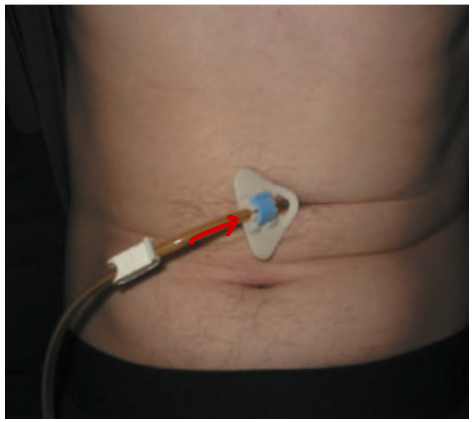
CI: Skull base #
Esophageal stricture

Length of NG tube:
NEX tip of nose - ear - xiphoid
NEMU children $\frac{x}{2}$ midpt

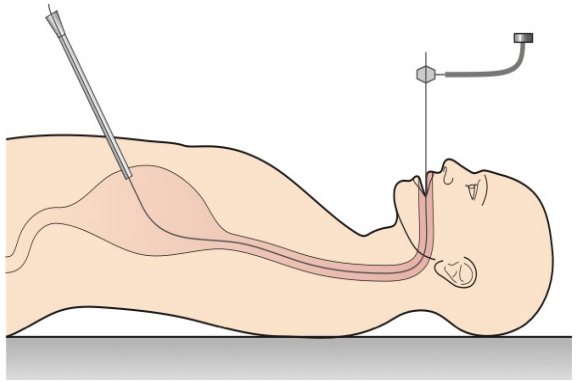
Colour Code	Size	Flow rate
Orange	14G	270
Gray	16G	210
White	17G	130
Green	18G	80
Pink	20G	50
Blue	22G	30
Yellow	24G	20
Violet	26G	10

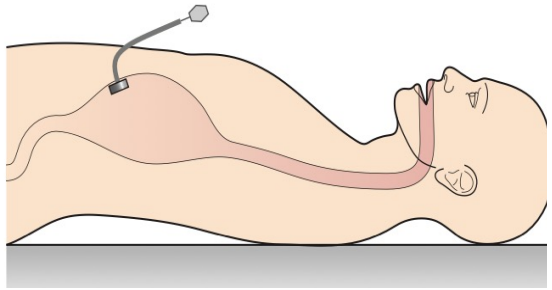
GORY PB

Color Code	French (1 Fr = 0.3mm)
Green	14
Orange	16
Red	18
Yellow	20
Purple	22
Blue	24



PEG tube
Percut endoscopic gastrostomy tube





Day Care Anesthesia

Criteria

- Surgery < 2hrs
- Low risk of significant immediate postoperative complications
- Patient able to eat, drink postoperatively
- Post-op pain managed by oral painkillers in conjunction with LA/ Peripheral block
- Patient able to mobilise postoperatively
- BMI (to avoid respiratory distress) <38

Contra-Indications

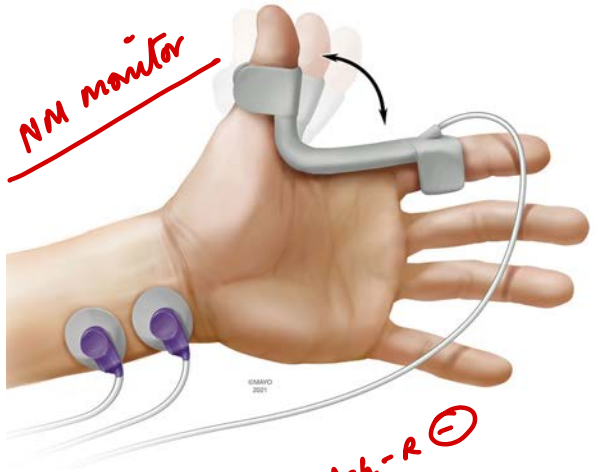
- Unstable ASA 3
- ASA 4, 5
- Any poorly controlled comorbidity

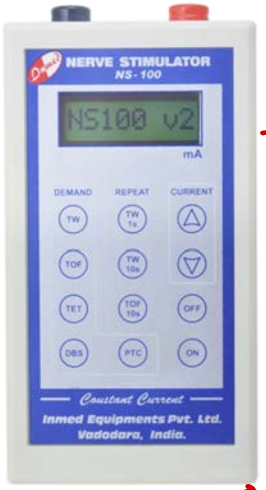
Preferred anesthesia: TIVA → Propofol
Preferred opioid: Remifentanyl (shortest acting) → pseudocholinE
Preferred MR: Sch / Rocuronium > Mivacurium
Leading cause of re-admission: PONV / Hge

→ discharge

Aldrete score: Activity/ BP/ Consciousness / Respiration/ o2 saturation

Monitoring during Anesthesia





MR.

Ach-R ⊖

Sch

No drug	Nondepolarizing block	Depolarizing block	
		Phase I	Phase II
Train-of-four	Fade	Constant but diminished	Fade
TOF–R = 1.0	TOF–R = 0.4	TOF–R = 1.0	TOF–R = 0.4

>5mg/kg

- MC nerve: ulnar N – adductor policis
- 2nd MC nerve: facial N – orbicularis oculi
- MC stimulus: TOF (2Hz)
- Tetanic stimulation: 50 Hz
- Extubation TOF: > 0.9 – clinical sign → lift head >5s

Bispectral index

Level of consciousness

0 – 100

Coma / awake

40-60

adequate anesthesia

Saturation Hb

Pulse oximeter

- Beer-Lambert law

IR : oxy Hb

Red : deoxy Hb

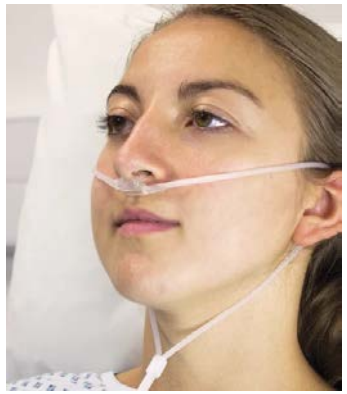
☹ · COHb ⓧ detected
↳ 100% satur°

· MetHb → fixed = 85%

↓

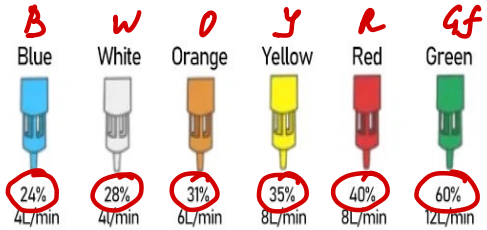
Co-oximeter =

Oxygen Delivery Devices






High flow



- fixed O_2 %.
- COPD ≤
- O_2 toxicity

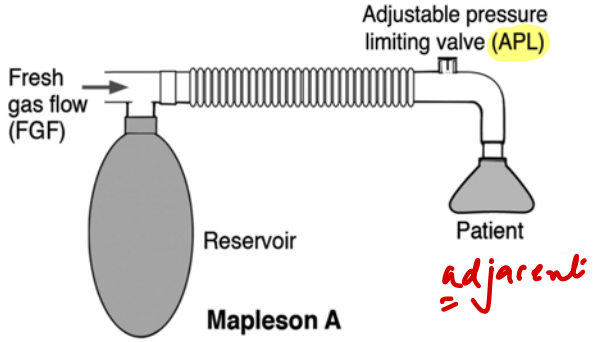
↓NP dead space

Humidification, PEEP+
May delay intubation

NIV pre-requisites – conscious, empty stomach

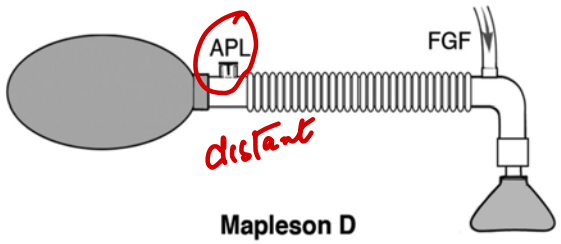
Device	Nasal prong/cannula	Hudson mask	Venturi device	NRBM	HFNC	NIV = CPAP
Max Flow Rate (L/min)	5	10	15	15	60	No limit
Max Saturation (%)	40	60	60	85-90	100	100

Mapleson circuits (semi-closed)



Mapleson A

adjacent



distant

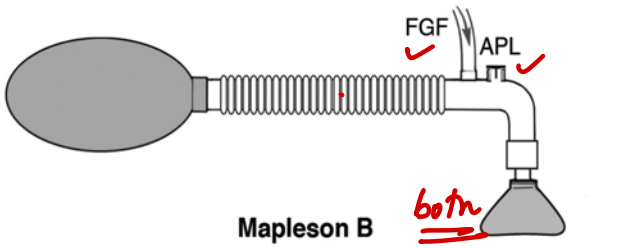
Mapleson D

MC circuit in spontaneous: Mapleson A (Magill's, Lack's - Coaxial)

(A) - FGF = MV

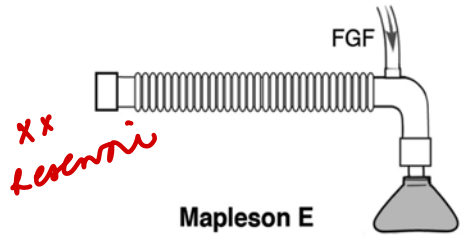
MC circuit in controlled: Mapleson D = BAIN's (Coaxial)

(D) - FGF = 1.6 X MV



Mapleson B

both

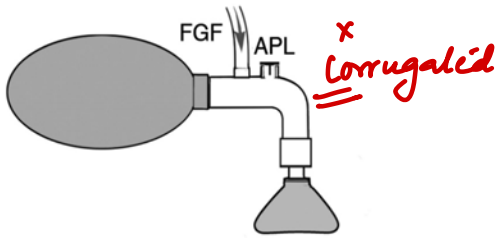


xx reservoir

Mapleson E

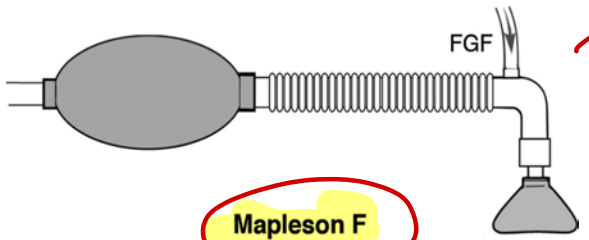
x APL

children



x corrugated

Mapleson C



Mapleson F

children

AMBU Bag.

Artificial Manual Breathing Unit


pop off valve : 30-40 cm H_2O

BAIN

Anesthesia Workstation (Boyle)

High-pressure system:

- Gas cylinders + Yokes

Size: A - H MC size: E Material: Mb. steel MR compatible: Aluminium, Titanium

Pressure: 2000 psi → O_2 / air / entonox N_2O → 760 psi

- Cylinder pressure regulators
- Cylinder pressure gauges

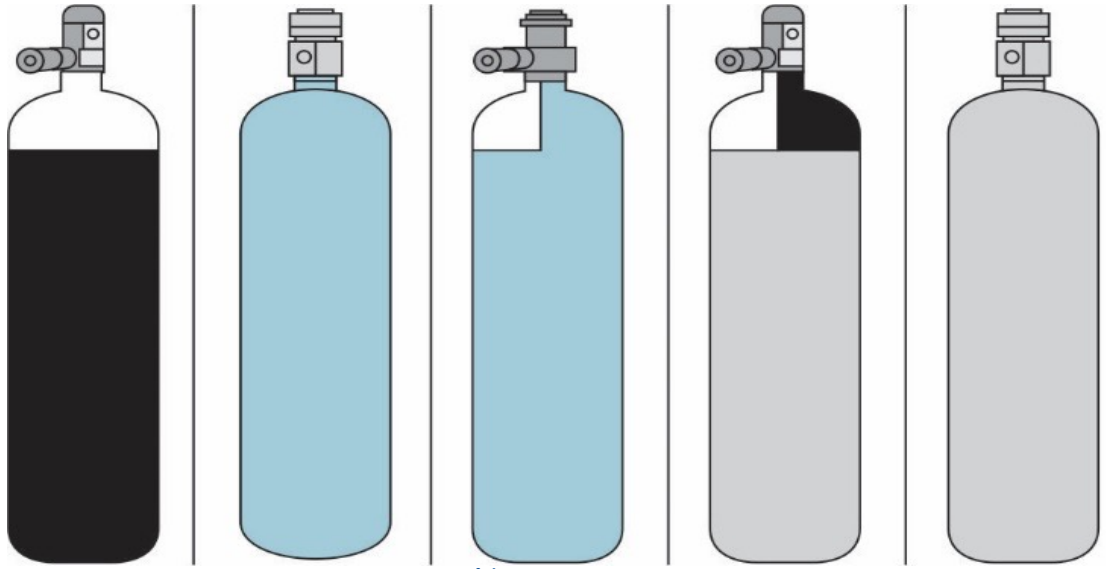
Intermediate-pressure system:

→ ~ 60 psi

- Pipeline gas inlets
- Pipeline pressure gauges
- Oxygen fail safe valve
- Flowmeter valves
- Oxygen flush valve

Low-pressure system:

- Flowmeters (rotameters)
- Vaporizers
- Common gas outlet



O_2 — 2,5

N_2O — 3,5

$N_2O + O_2$ (entonox) — 7

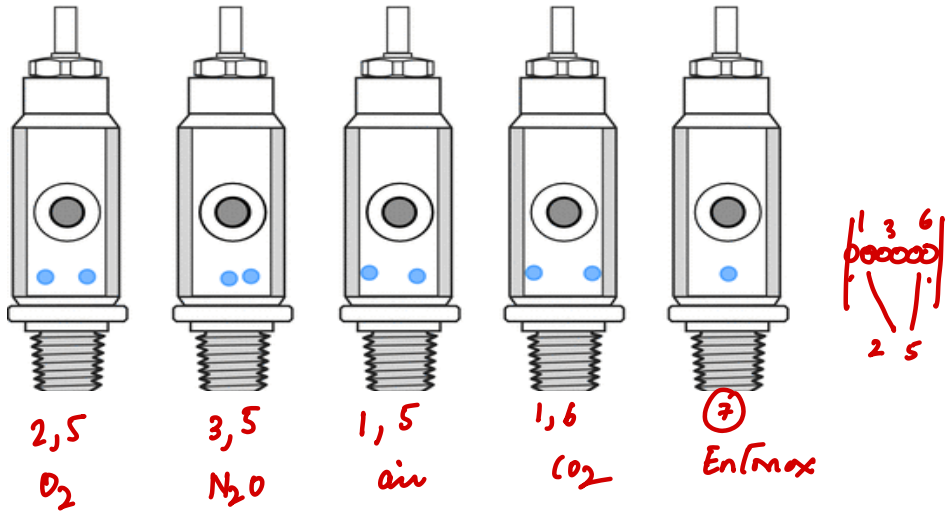
Air — 1,5

CO_2 — 1,6 / 2,6

PIN INDEX

1,6 — >7.5%.

2,6 — <7.5%.



2,5 O_2

3,5 N_2O

1,5 air

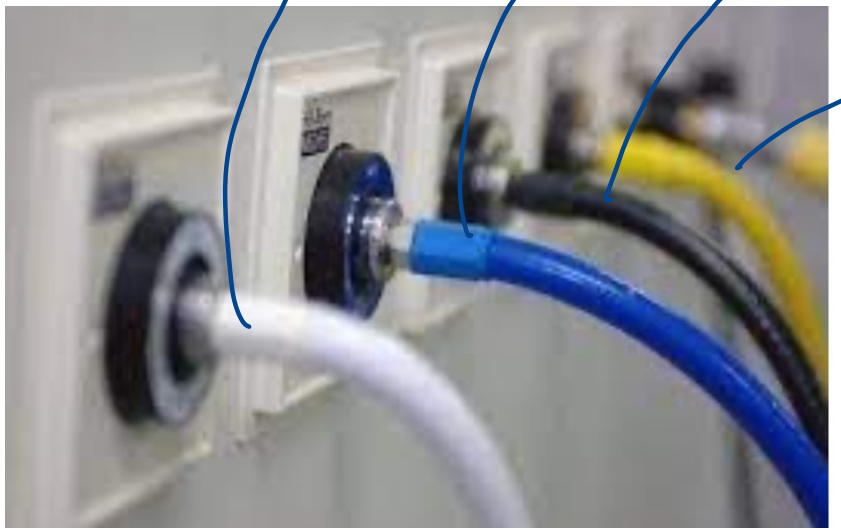
1,6 CO_2

7 Entonox

orange : cyclopropane : 3,6

Heliox : 79% He + 21% O_2

↳ brown → airway obstruc°



DISS diameter index safety system

pipelines : init pression

Inhalational anesthetics

← HISD →	MAC (α 1/potency)	BLOOD GAS SOLUBILITY (α 1/speed)
Methoxyflurane (→ nephrotoxic)	0.2	12
Halothane	0.75	2.5
Isoflurane	1	1
Sevoflurane	2	0.65
Desflurane	6	0.45 (Xenon min) (expensive)
N20	104	0.47

N_2O

- Concentration effect
- Second gas effect
- Diffusion hypoxia
- B12 deficiency

CI → int obstruc^/ middle ear Sx

- Compound A (nephrotoxic)
- Fruity odour
- Best for Asthma
- Day care Sx
- Liver D

Induction

Best for cardiac Sx

? Coronary steal

- Min MAC
- Max bronchdil
- AI hepatitis
- Max ICP rise
- Sensitises heart to epiN arrhythmias

Tec-6 vaporizer

- Irritant (x induction)
- CO with dessicated soda lime
- Maintenance agent of choice
- Best for Renal D, Obese

ALL Inhalational agents: (uncouplers)
- -Cerebral metabolic O2 ↓
- -CBF/ ICP ↑
- -CVS, HR ↓
- -Respiratory drive ↓

ALL IV agents:
- -Cerebral metabolic O2 ↓
- -CBF/ ICP ↓
- -CVS,HR ↓
- -Respiratory drive ↓

exc ketamine (ICP, IOP, BP ↑)

IV anesthetics

(TIVA)

DOC for Day care/ Liver/ Kidney/ NeuroSx/ TIVA/ Malignant Hyperthermia/ Porphyria/Antiemetic : PROPOFOL

Infusion syndrome (acidosis, green urine), Painful injection- Soyabean oil, Egg lecithin : PROPOFOL

(Phencyclidine)

NMDA antagonist, Dissociative anesthesia, DOC in Asthma/ COPD, Cyanotic HD, Shock : KETAMINE

(↑BP)

C/I in Hypertension / Epilepsy/ Glaucoma : KETAMINE

DOC in Cardiac surgery, S/E- Adrenal suppressant (11β-hydroxylase) : Etomidate

DOC in Hyperthyroidism, Seizures, Narcoanalysis, Redistribution S/E- Intra-arterial vasospasm: Thiopentone

(↓ICP)

↓

Rx- papaverine

- GABA (+) except Ketamine

Muscle relaxants

Depolarising MR: Sch
Best for **RSI**, **Shortest acting**
S/e: **Myalgia** (MC), **Hyperkalemia**, Bradycardia, **Intragastric pressure high**

(x) burns

Non-depolarising MR:
Aminosteroid compounds: Rocuronium, Vecuronium, Pancuronium
Longer duration, metabolized in liver & kidneys

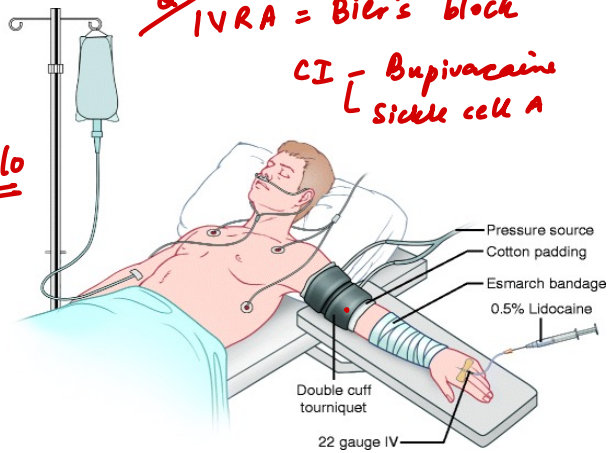
Benzylisoquinolinium compounds: Atracurium, Mivacurium
Shorter duration of action
Hofmann elimination & ester hydrolysis- safe in RF/ LF/ pediatrics (Atracurium)
May cause more histamine release
By-product of Atracurium: Laudanosine → seizure (Cis- atracurium)

- Most cardiostable, neuroSx (Biliary excretion) : Vecuronium
- Shortest acting NDMR: Gantacurium (CI Liver F) (XFDA approved) > Mivacurium (↓) → pseudocholinE
- •Dibucaine No. <30: atypical pseudocholinE ↑
Prolonged paralysis after giving **Succinylcholine** & **Mivacurium**
- Reversal : NDMR → Neostigmine (+ Atropine)
- ~~a~~Sugammadex : cyclodextrin → Ve / Ro curonium (CI in Liver D)

Local anesthetics

Amides	Esters
Bupivacaine, Lidocaine, Ropivacaine, Prilocaine	Cocaine, Procaine, Benzocaine
Liver – cytochrome P450	Plasma – pseudocholinesterases
Longer action	Shorter action
Less allergy	PABA metabolite- More allergy

Eutectic mixture
Ligno + Prilo
Surface anesthesia



IVRA = Bier's block
CI – Bupivacaine
└ Sickle cell A

- MOA- Unionised form → Na^+ (inactivated voltage gated) ⊖ ($NaHCO_3$ → ↑unionised) Action ↑
- Autonomic > Sensory > Motor
- Causing Hypertension: Cocaine
- S/E- MethHb: PRILOCAINE, Benzocaine
- Most cardiotoxic: Bupivacaine Dose: 2mg/kg
- Max dose of Lignocaine: 5mg/kg (± epi N) : 7mg/kg
- Proparacaine duration: topical A → 10-20min
- Safest in MH: Procaine
- LAST: CNS / CVS toxicity DOC: 20% intralipid
- Route: iv > intra-tracheal > intercostal > caudal / epidural > brachial

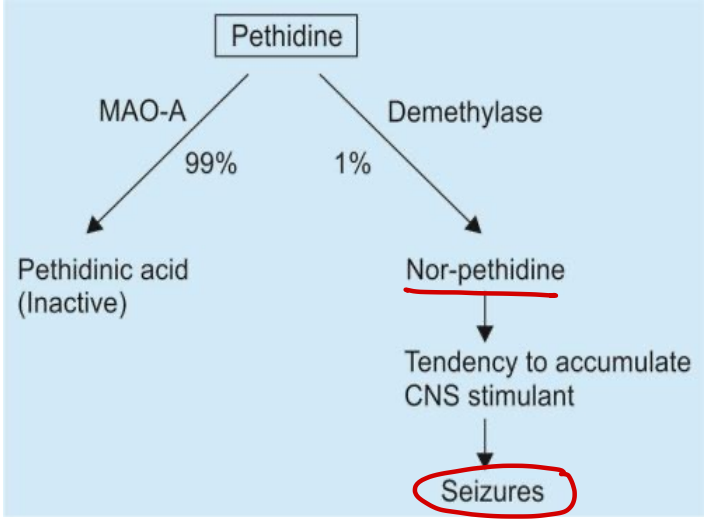
Opioids

- Full agonist: Morphine, Pethidine, Heroin, Meperidine, Methadone, Codeine, Fentanyl
- Partial agonist: Buprenorphine
- Mixed agonist/antagonist: Nalbuphine, Pentazocine, Butorphanol
- Antagonist: Naloxone / Naltrexone

Cough syp.

K⊕ μ⊖

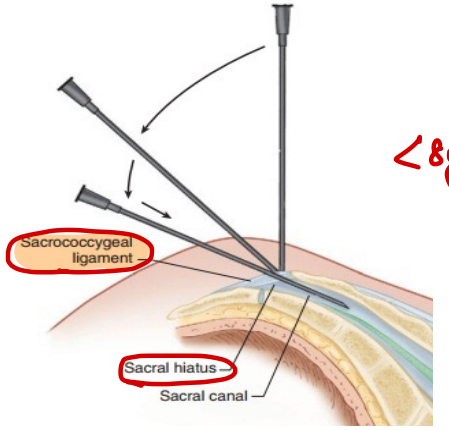
- Avoid Opioids in- biliary colic (SOD spasm), Head traeema (GCS↓), asthma
- Mydriasis: Meperidine
- Pruritus: MC c/e → Histamine release (↓BP)
- No tolerance to: miosis / constipation
- Serotonin syndrome: tramadol / agonist + SSRI / SNRI
- ~~Q~~ Wooden chest syndrome: FENTANYL
- ~~Q~~ Prolonged QTc: Methadone
- Shortest acting (Day care): Remifentanyl



Regional Anesthesia

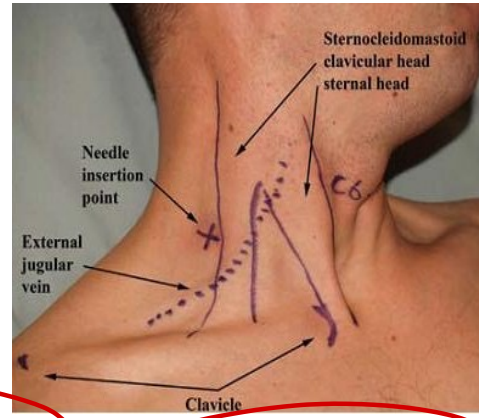
Ant ethmoidal N

Nasociliary N



<8yrs

Caudal anesthesia

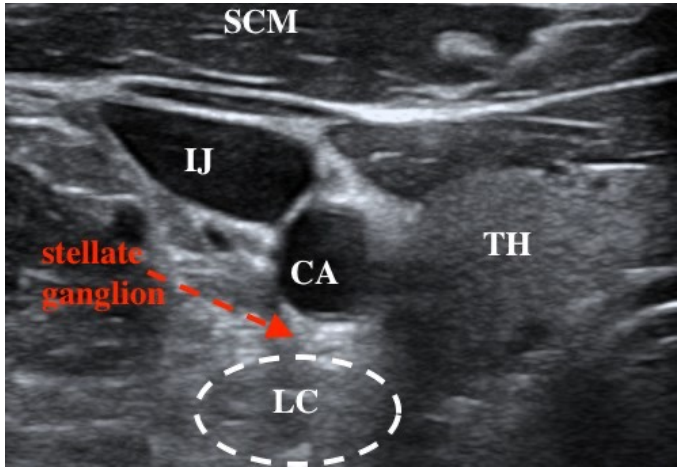


Supraclavicular

S/e → Ptx / Phrenic N injury

Interscalene

- ulnar N spared



C6

Stellate ganglion block

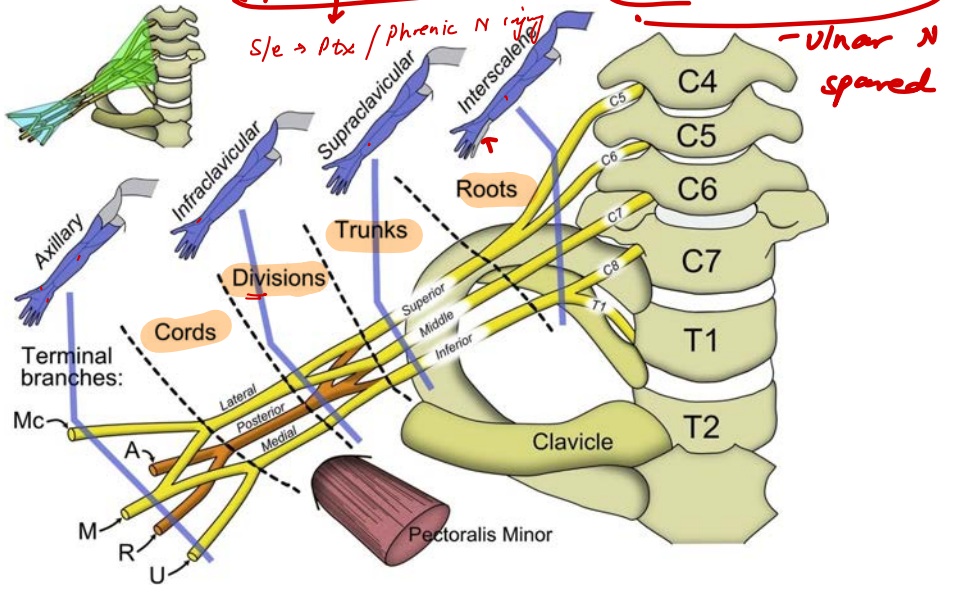
Indics → PTSD

→ Raynaud's

→ Vasospasm

Signs → Horner's → Ptosis 1st

→ Guttman sign → nasal mucosal congest'



Neuraxial block

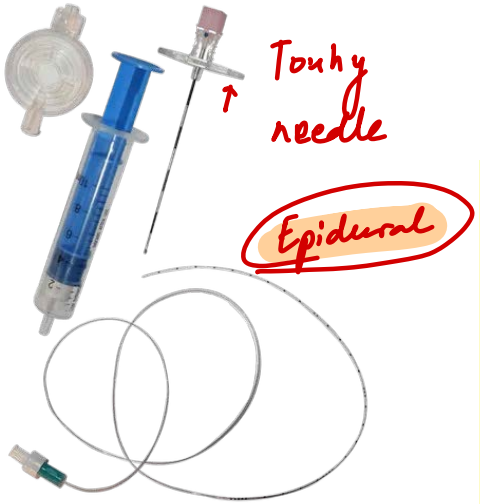
→ autonomic / sens / motor

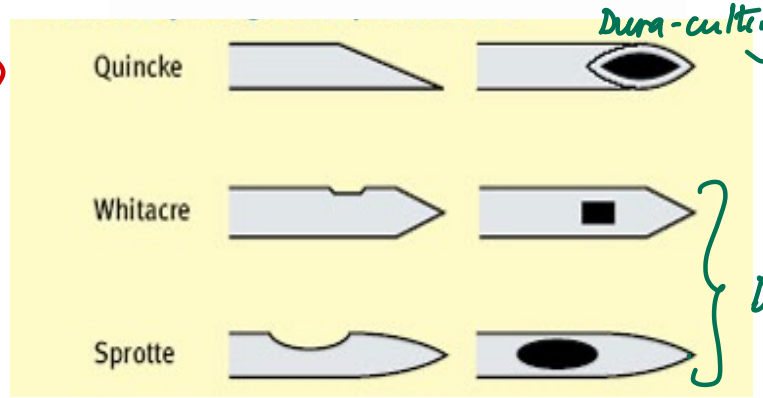
Epidural Anesthesia (EA)	Spinal Anesthesia (SA)
Larger dose of drug	Smaller dose of drug
Anywhere	L3-L4 MC (Tuffier's line ≈ L4-L5 iliac crest)
Not as good as SA	Better quality of anesthesia
Adjustable, prolonged action via a catheter	Single-shot injection; action for ~3hrs ← Umbilicus

CI: ↑ICP papilledema, local infx, Coagulopathy, Shock

Layers punctured for LP:

skin - subcut fat - Supraspinous lig - Interspinous lig ⋮ ARACHNOID ← DURA ← Epidural ← LIG FLAVUM "LOR"





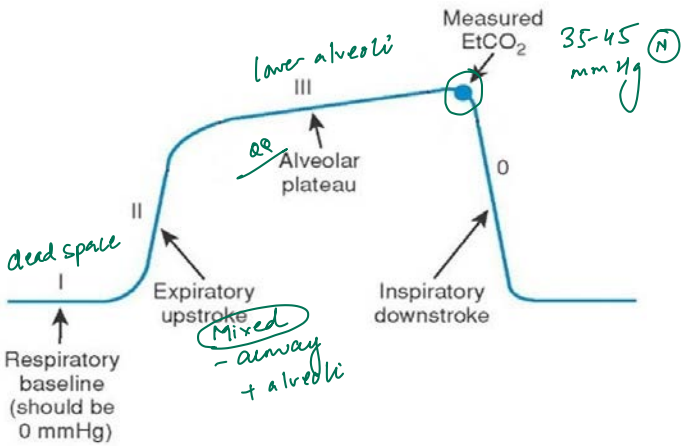
↑ risk Dura-cutting

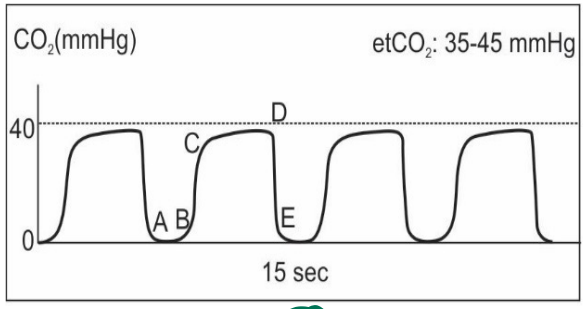
Post-dural puncture headache: ↑ on ambulation, ↓ on supine, ↑ preg, dull, frontal/occi
- TOC: IV fluids, bed rest → autologous blood patch
- MC Intra-op complication: Hypotension
- DOC: Phenylephrine (α⊕)
- MC post-op complication: Urinary retention

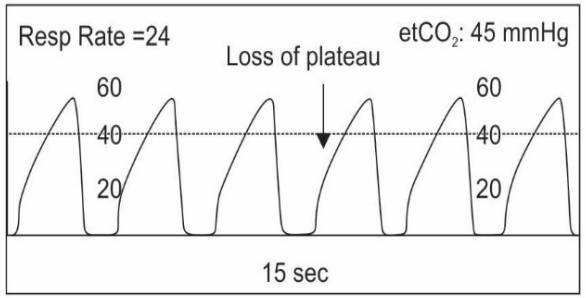
1. Adult spinal cord-Lower border of L1
2. Spinal cords in infants-Upper border of L3
3. A/D/Subarachnoid space-Lower border of S2

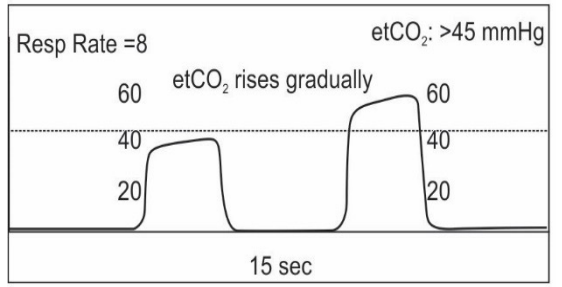
PIH, Heart ds in pregnancy: Epidural / GA
Except CoA/ Eisenmenger/ Uncorrected TOF: GA

Capnography

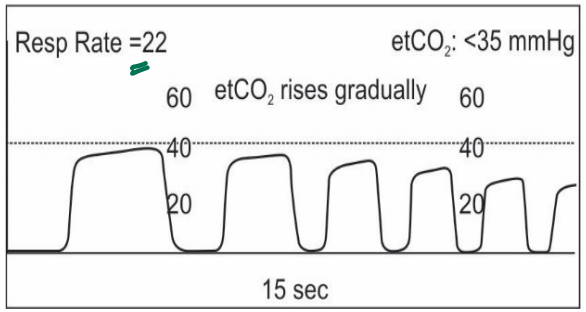


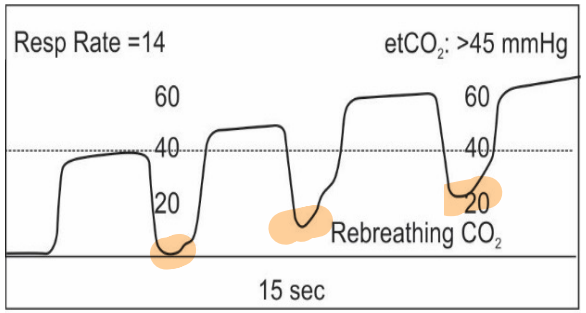


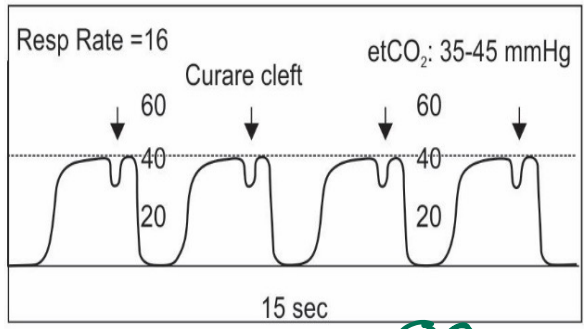




Infrared spectroscopy



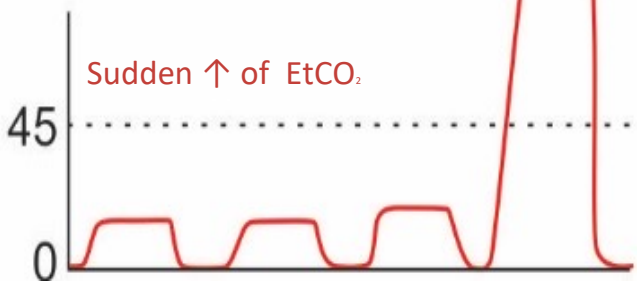




80% Ca(OH)2 + NaOH + KOH +15% H20 → Soda lime
Ca(OH)2 + NaOH + CaCl2 → Amsorb
Ba(OH)2 + CaSO4 → Baryline

STEPLADDER

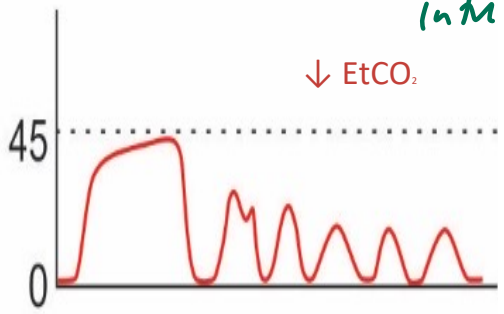
OR

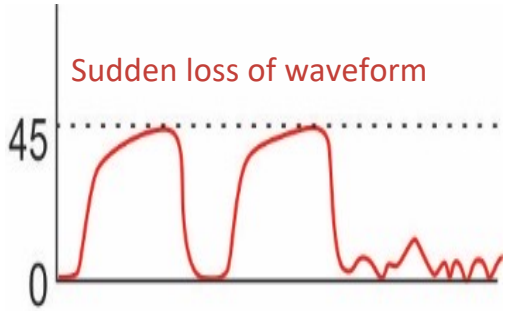


Malignant hyperthermia

- Sch, Lignocaine, Inhalational agents
- Tachycardia + Rigidity
- Earliest sign- ↑↑ $ETCO_2$
- Late sign- Hypermemia
- RyR/DHPR (Chr 19)-AD
- DOC- Dantrolene sodium.

Esophageal intubn





circuit disconnect

↓ arrest

VENOUS AIR EMBOLISM

R/F: Neuro Sx / Laparoscopy / sitting

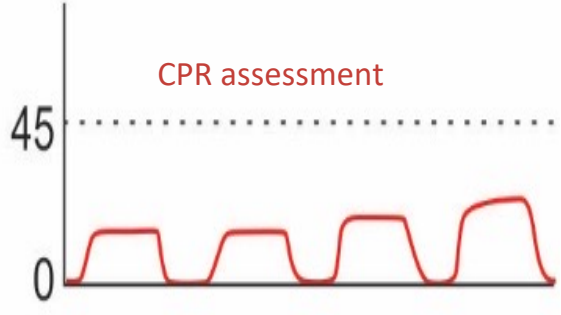
Fowler's / neck Sx

- Mill-wheel murmur

Next: - DURANT POSITION

lt lat decubitus + Trendelenburg

- aspirate



$ETCO_2$ >10 -20mm

↓

adequate CC

↑

Intra-arterial DBP >20mm

Pre-Op Assessment

Pre-op drug DOC to reduce anxiety: Midazolam
Pre-op drug DOC to reduce secretions: Glycopyrollate
Pre-op Antibiotic time: 30min - 1hr prior to incision → Cefazolin
MC nerve injured intra-op- ulnar N
MC intra-ophthalmic complication- Corneal abrasions
PONV DOC: Ondansetron
POVL MCC: ischemic optic N (↑-prone)
MCC of intra-op anaphylaxis: Antibiotics > NMB
Min acceptable Hb: 8 mg/dl (elective)
Min acceptable platelet: 1 lakh

Mendelson syndrome aspiration + pregnancy
NPO heavy meal: 8hr
Light/semi-solid meal/ Formula: 6hr
Breastmilk: 4hr
Clear liquids: 2hr

Goldman Grading system :
♡ risk assessment

Stop Drugs before surgery

Clopidogrel: 7d Warfarin: 5d LMWH: 24h UFH: 4-6h Li: 48hr SGLT2-: 24hr → r/o euglycemic ketoacidosis

ACEi/ ARB/ OHG/ Insulin/ Diuretic (except thiazide): Omit morning dose

OCP: ↑ r/o DVT (immobilised/ obese) - 4-6wks

Smoking: 4-6wks

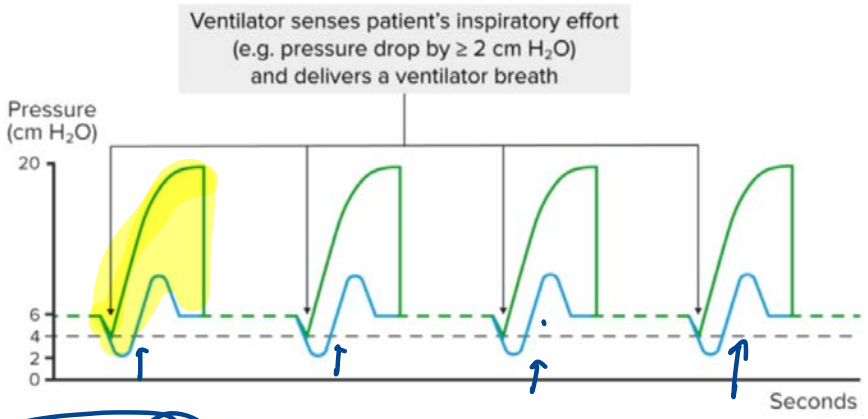
ASA classification

ASA PS	Definition	Examples (including, but not limited to):
ASA I	A normal healthy patient	Healthy, non-smoking, no or minimal alcohol use
ASA II	A patient with mild systemic disease	Current smoker, social alcohol drinker, pregnancy, obesity (BMI 30–40), well-controlled DM/HTN, mild lung disease
ASA III	A patient with severe systemic disease	Poorly controlled DM or HTN, COPD, morbid obesity (BMI ≥40), active hepatitis, alcohol dependence or abuse, implanted pacemaker, moderate reduction of ejection fraction, ESRD undergoing regularly scheduled dialysis, premature infant PCA < 60 weeks History (>3 months) of MI, CVA, TIA, or CAD/stents
ASA IV	A patient with severe systemic disease that is a constant threat to life	Recent (<3 months) MI, CVA, TIA, or CAD/stents, ongoing cardiac ischemia or severe valve dysfunction, severe reduction of ejection fraction, sepsis, DIC, ARD, or ESRD **not** undergoing regularly scheduled dialysis
ASA V	A moribund patient who is not expected to survive without the operation	Ruptured abdominal/thoracic aneurysm, massive trauma, intracranial bleed with mass effect, ischemic bowel in the face of significant cardiac pathology, or multiple organ/system dysfunction
ASA VI	A declared brain-dead patient whose organs are being removed for donor purposes	Organ donor (brain-dead patient)

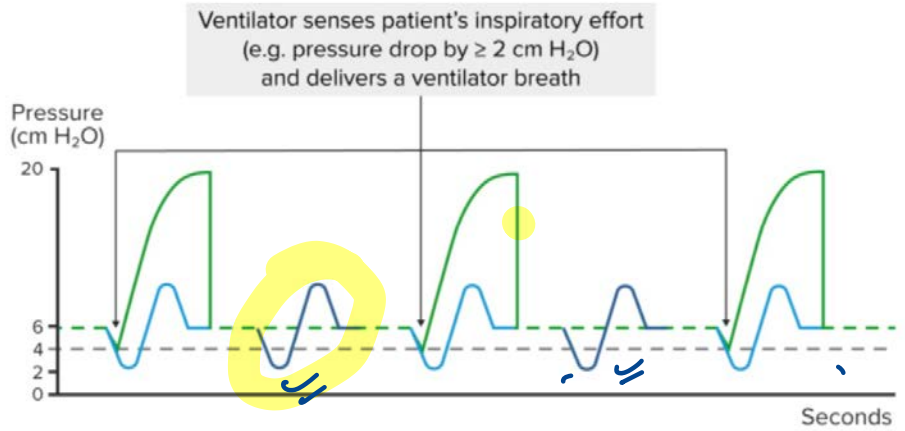
Mechanical ventilation modes

Volume-controlled	• Controlled mechanical ventilation (CMV): Breaths all triggered by ventilator, predefined rate and volume set • Assist-controlled ventilation (ACV): Breath triggered by patient's effort, if no patient breath per unit time, ventilator triggered; predefined tidal volume set • Synchronized intermittent mandatory ventilation (SIMV): Spontaneous breathing permitted with no ventilator assist; predefined tidal volume set.
Pressure-controlled	• Pressure support ventilation (PSV): Triggered by patients inspiration only; assist with pressure limitation provided.
Mixed	• PS/SIMV: Ensures spontaneous breaths permitted in SIMV receive pressure assist

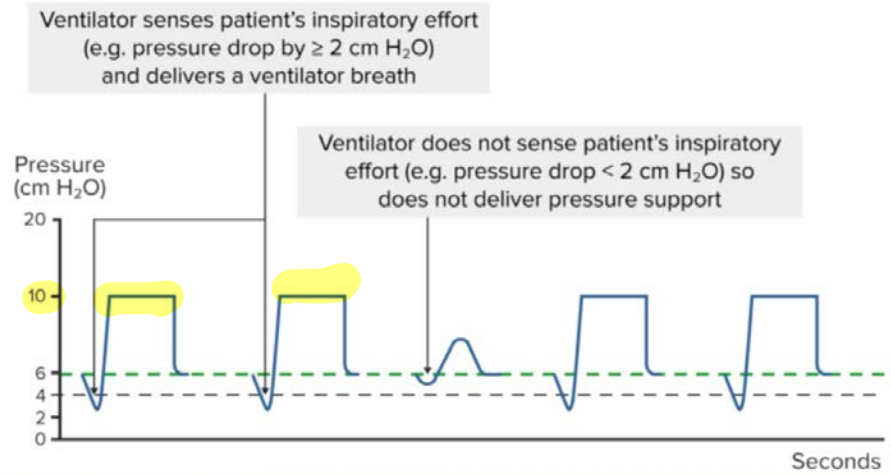
Modes of Mechanical Ventilation



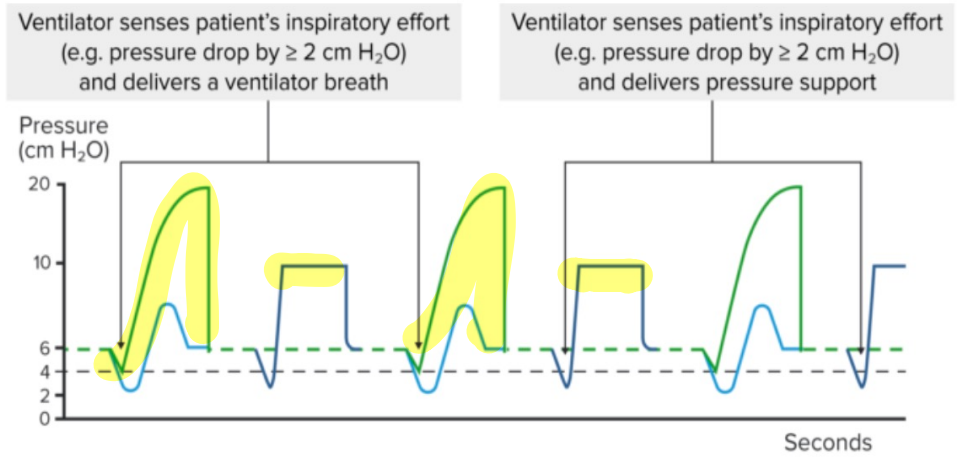
Assist control ventilation (ACV)	Ventilator breaths do not occur at regular intervals and are triggered by patient breaths (all patient breaths are assisted)



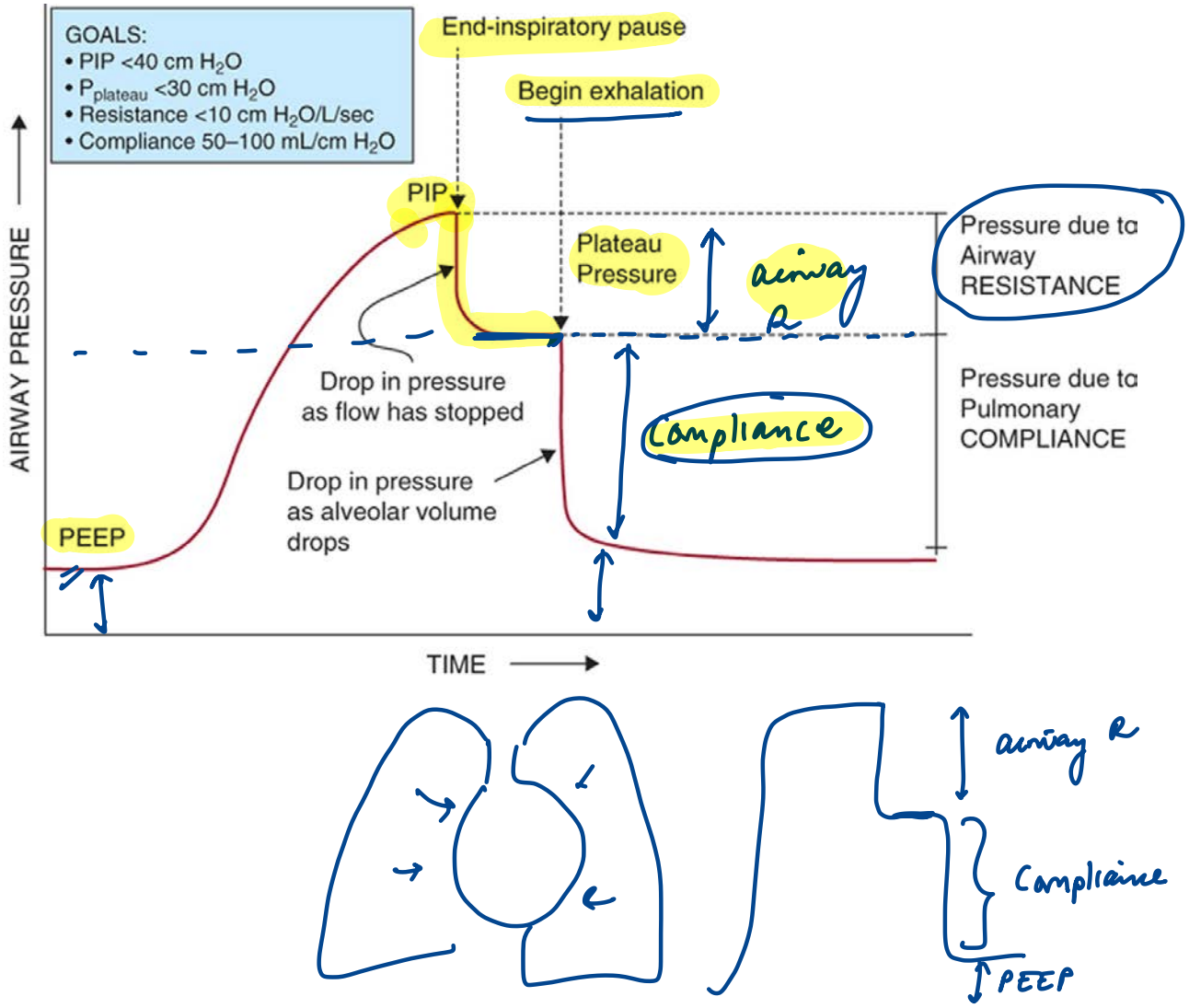
Synchronized intermittent mandatory ventilation (SIMV)	Ventilator breaths occur at regular intervals but are triggered by patient breaths (only some patient breaths are assisted)



Pressure support (PS)	All sensed patient breaths are supported by pressure



Synchronized intermittent mandatory ventilation (SIMV) + pressure support (PS)	Ventilator breaths occur at regular intervals but are triggered by patient breaths (only some patient breaths are assisted) + unassisted breaths are supported by pressure



Not for weaning: CMV
Best for weaning: SIMV / PS
Rapid shallow breathing index: product weaning RR/TV
<105: weaning ✓

PEEP: positive end-expiratory pressure
-Prevents collapse, Increase recruitment
-Reduce work of breathing
-Barotrauma, Low CO, Raised ICP GFR↓ CPP↓

GOALS of mechanical ventilation:
Tidal volume: 6-8ml/kg ARDS: 4-6ml/kg
RR: 12-18 bpm
FiO2: 21-100% → ABG paO_2 / $paCO_2$
PEEP: >5cm H_2O (5-8cm) ARDS: >8cm H_2O
Plateau pressure: <30cm H_2O

Basics of CPR

PUSH HARD-PUSH FAST

Adequate CPR

- 1/3 AP dia : 5-6cm (2-2.5in)
- allow complete recoil

100-120/min

Rate of breathing in CPR
Adults: 10 b/min
Children: 20-30 b/min
Neonates: 30-60 b/min (NRP '25)

POST CARDIAC ARREST CARE

1. Optimization of circulation (MAP > 65 mmHg)
2. Optimization of ventilation (SpO_2 > 94%)
3. Targeted temperature management
   32–36°C for 24 hours for comatose patients
4. Moderate glycemic control
   (Blood sugar 144–180 mg/dL)
5. Coronary intervention (PCI)
   If cause is MI (preferably within 90 minutes)
6. Early prognostication of neurologic outcome
   (To be assessed after 72 hours)

Adrenaline Doses

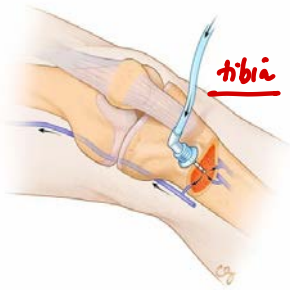
- Anaphylactic shock / Status Asthmaticus: 1mg 1:1000 im/sc
- Cardiac Arrest: 1:10000 iv > intraosseous > intra-tracheal
- Vasoconstriction: 1: 1 lakh
- With LA for VC: 1 : 2 lakh
- Labour Epidural: 1 : 4 lakh

Amiodarone Dose: 300mg → 150mg

Lignocaine Dose: 1-1.5 mg/kg → 1/2

Shock energy for defibrillator:

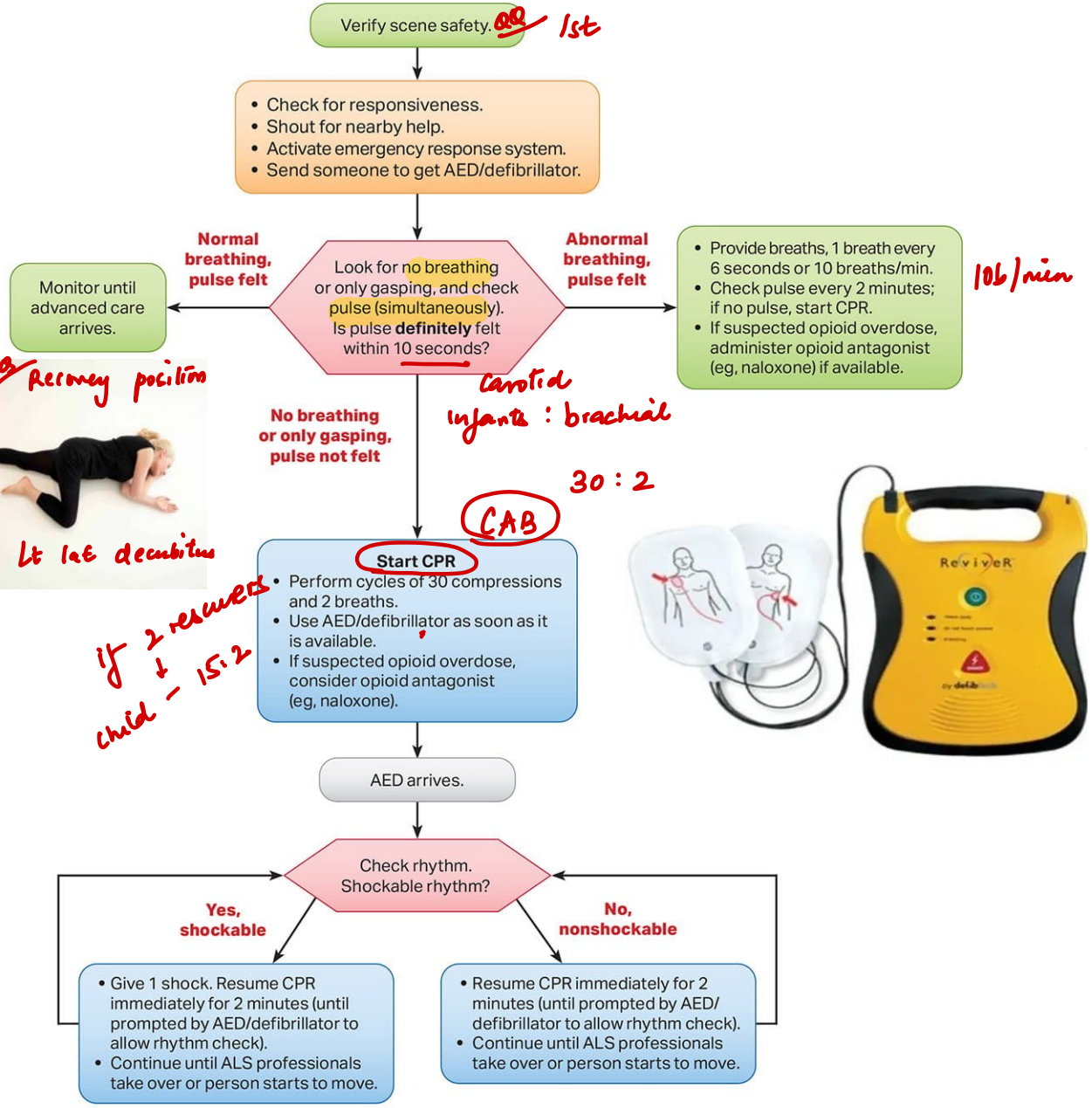
- Monophasic: 360 J
- Biphasic: 120-200 J



Reversible causes:

5H	5T
Hypovolemia	tension PTx
O_2	thrombus - PA
thermia	" coronary - MI
H^+ - acidosis	TOXINS
↑/↓ K^+	TAMPONADE

BLS

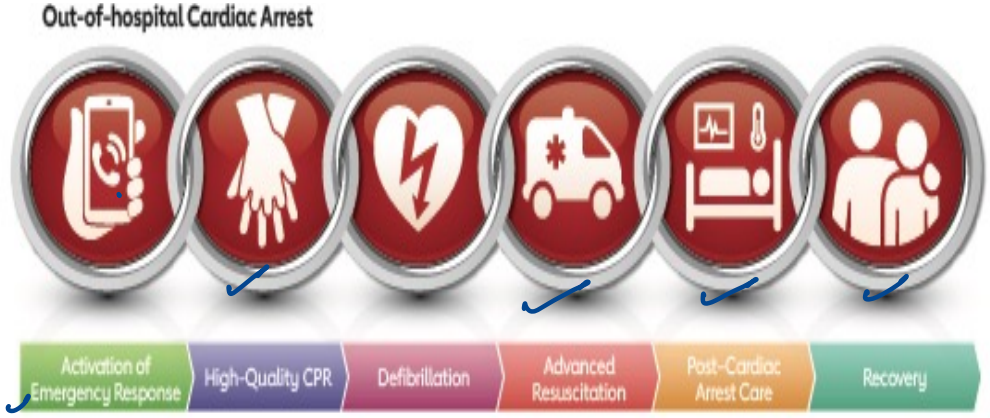


BLS/Universal Termination of Resuscitation Rules

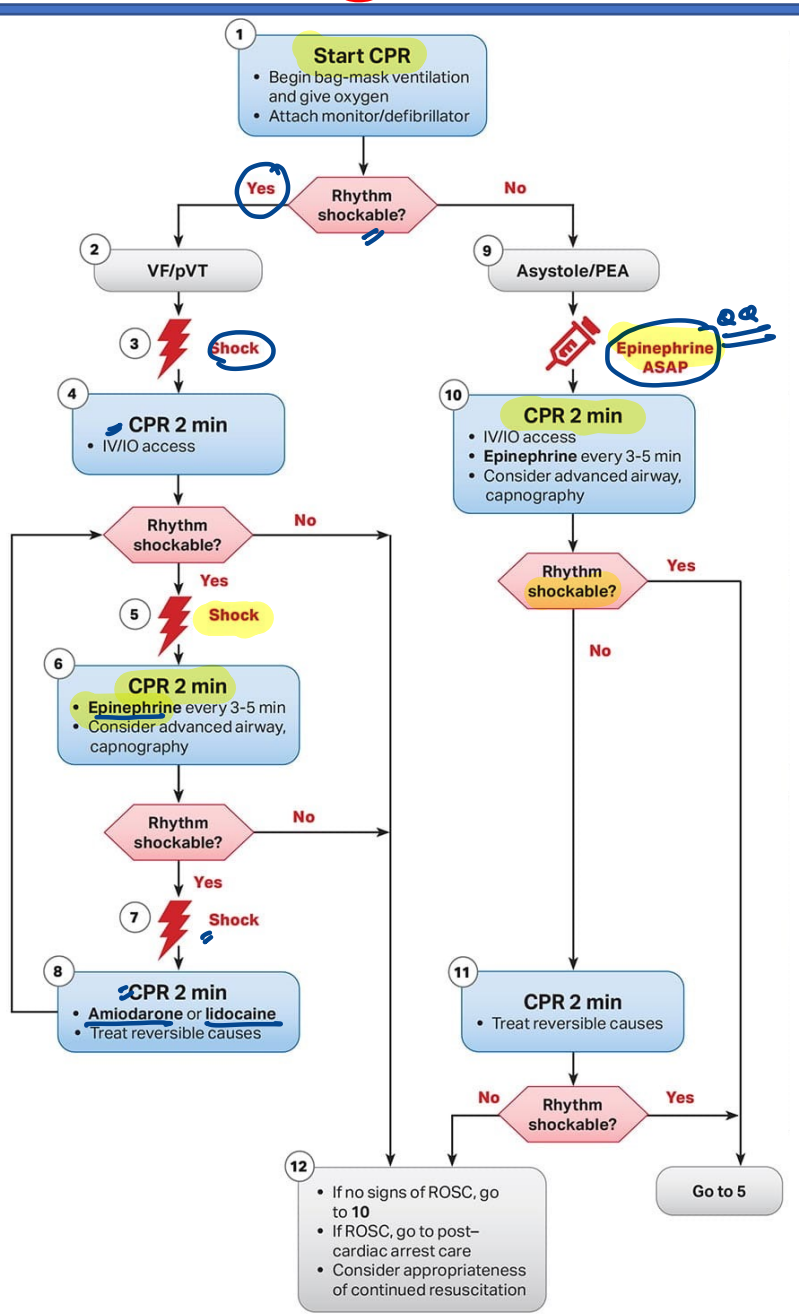
Arrest not witnessed by emergency medical services personnel
No return of spontaneous circulation (before transport)
No AED shock was delivered (before transport)

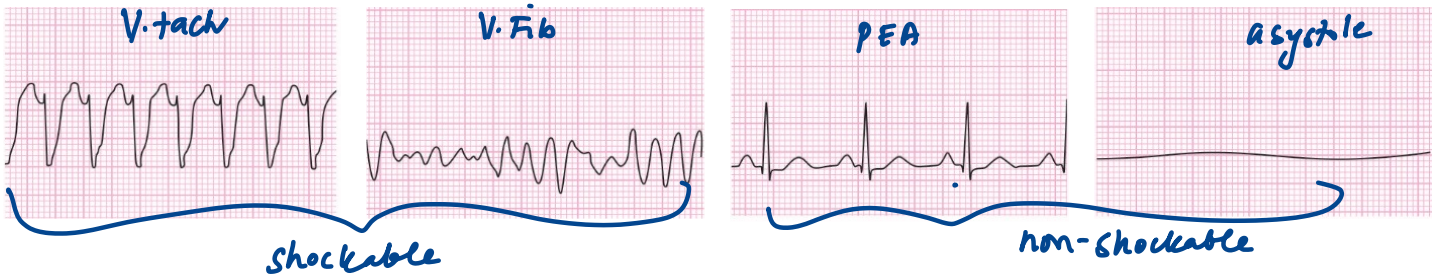
If ***all*** criteria are present, consider termination of resuscitation.

If ***any*** criteria are not present, continue resuscitation and consider transport.



ACLS Algorithm for Cardiac Arrest in Adults





PREGNANCY

Start BLS/ALS
- Provide **high-quality CPR.**
- Provide continuous **left lateral uterine displacement** when the fundal height is at or above the umbilicus.
- Use **AED/defibrillator** when indicated.

Activate cardiac arrest in pregnancy team
- Address etiology of arrest.

Optimize resuscitation in pregnancy
- Prioritize early airway management.
- Place IV above diaphragm.
- If receiving IV magnesium, stop magnesium and give calcium.
- Detach fetal monitors.
- Activate massive blood transfusion protocol if amniotic fluid embolism suspected.

Prepare for resuscitative delivery
When fundal height is at or above the umbilicus

Goal is delivery by 5 minutes if no ROSC

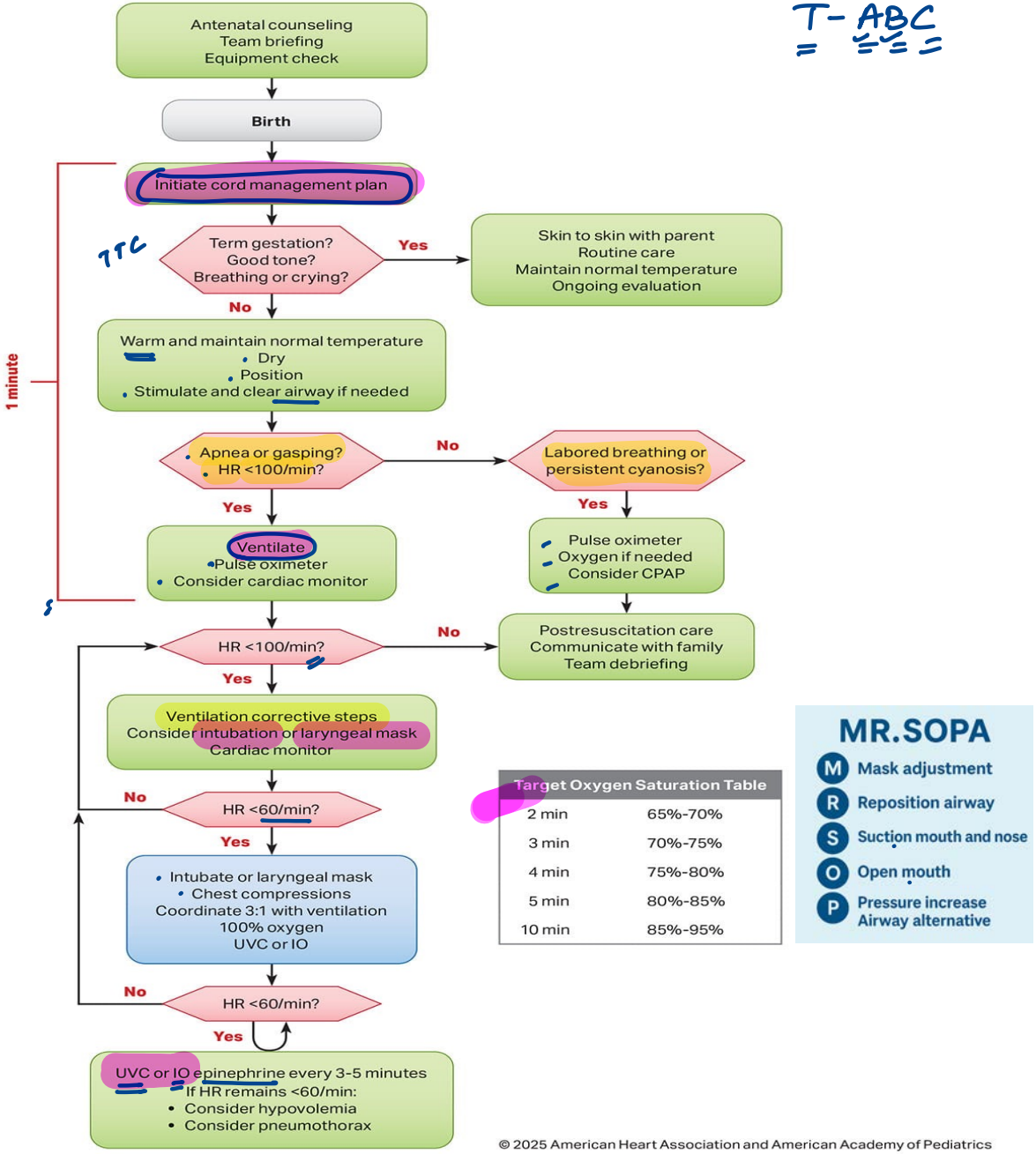
Continue ALS.

Resuscitate newborn infant using the Neonatal Resuscitation Algorithm.

OT? No
Pffanelstein? No
LSCS? No

Neonatal Resuscitation Protocol 2025 (9th edn)

T-ABC



Target Oxygen Saturation Table	
2 min	65%-70%
3 min	70%-75%
4 min	75%-80%
5 min	80%-85%
10 min	85%-95%

MR.SOPA

- M — Mask adjustment
- R — Reposition airway
- S — Suction mouth and nose
- O — Open mouth
- P — Pressure increase Airway alternative

Order of suction: M → N

Temperature of room: 25°C

Delayed cord clamping: stable term/preterm at least 60s

Cord milking: Non vigorous 35-42 wks PDA

Bag & Mask Ventilation (BMV)

-Start within: 1min

-Saturation

>35weeks: 21%

32-34 weeks: 21-30%

<32 weeks: ≥ 30%

-RR: 30-60 /min

-C/I: CDH / TEF

Saturation monitoring done at: Preductal Rt UL

Chest Compressions(CC)

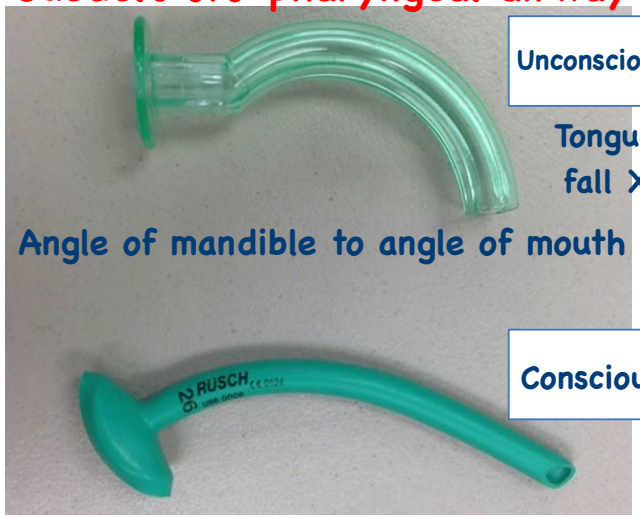
- 2 thumb
- Lower 1/3 body sternum
- 1/3rd depth of AP

CC:PPV- 3:1

Anaesthesia

INSTRUMENTS

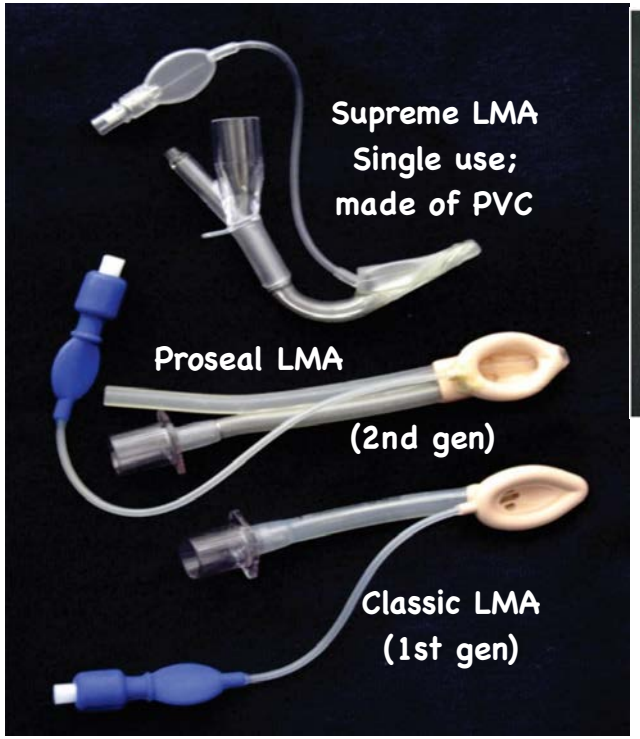
Guedel's oro-pharyngeal airway



Nasopharyngeal airway

Tip of nose to ear lobule

C/I in base of skull injuries & coagulopathies



AMBU AURA LMA - 1st generation LMA

Streamlined Liner of the Pharynx Airway (SLIPA)

Fastrack LMA

iGel LMA (3rd gen LMA)

SIZE OF LMA
Child: 3
Female: 4
Male: 5

Intubation & Instruments Needed

Macintosh-Adults

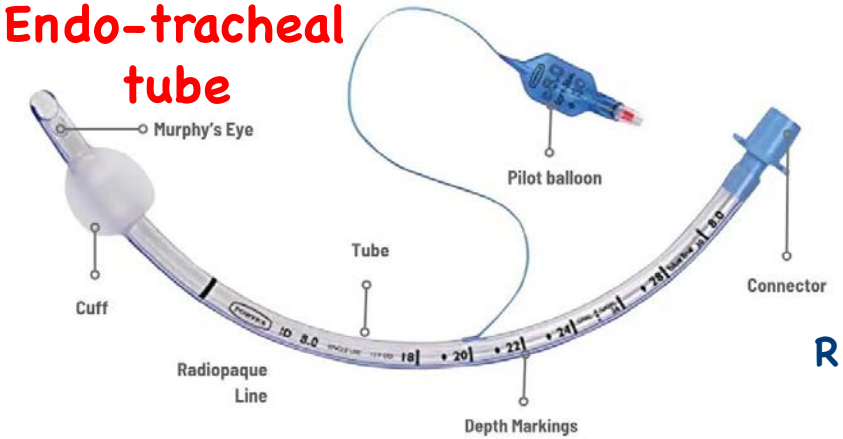
McCoy- Levered blade

Intubation Blades

Miller's- Child

C-Mac Video laryngoscope

Endo-tracheal tube



$R \propto \frac{1}{r^4}$

ET tube placement:

- CXR
- Best: EtCO2 = 35-45mmHg

- Preterm- 0
- Term- 1
- Children- 2
- Female- 3
- Male- 4

- Hand: Left sided
- Insert: Right side of mouth
- Pressure: Forwards & upwards
- MC injury: Upper central incisions
- BURP: Backward-Upward-Rightward

Internal diameter: Resistance

Cuff- Low pressure, High volume

Children: Microcuffed > Uncuffed

Size of ETT-

- <1200g (<28wk): 2.5
- 1200-2200g (29-34wk): 3
- >2200g (>34wk): 3.5
- Child: 3-4
- Female:7
- Male: 8

Instruments	Formula
ETT(mm) (Uncuffed)	4 + (Age /4)
ETT depth (cm)	3 x ETT
NG Tube/ Foley's (Fr)	2 x ETT
Chest Tube (Fr)	4 x ETT

RAE tubes

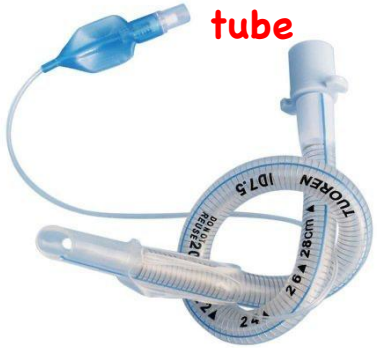
Double lumen ET tube

Single lung ventilation

Confirm: Fibreoptic bronchoscope

Combitube

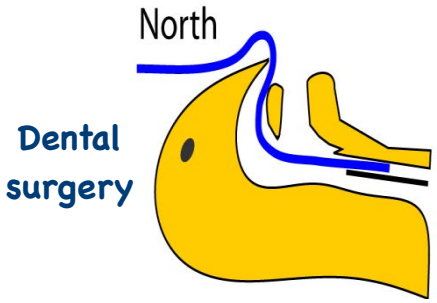
Flexometallic tube



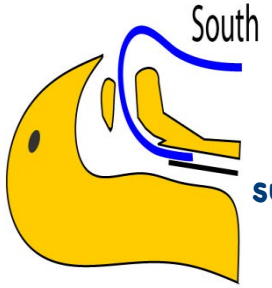
Prone surgery

Stylet Bougie

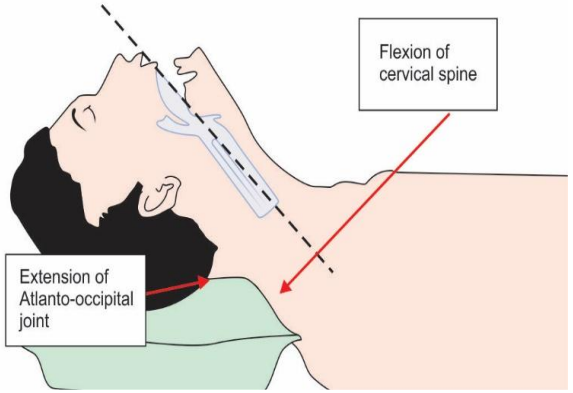
Difficult airway



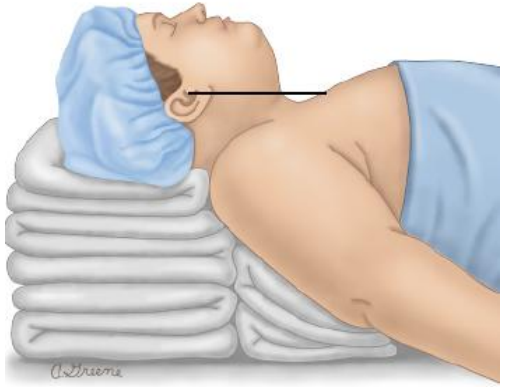
Dental surgery



PNS surgery



Sniffing position



RAMP/HELP position

Obese patients

RSI - Selick manoeuver

Larson manoeuver

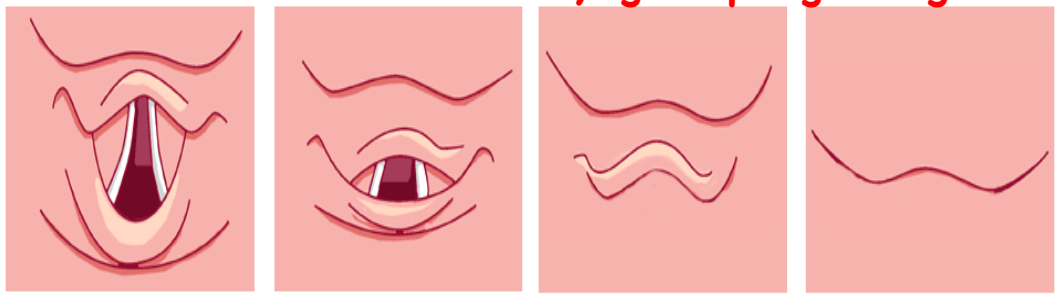
Reduces r/o Laryngospasm

Difficult Intubation

I Complete uvula +
II X tip of uvula
III Only base of uvula
IV X soft palate

Mallampati score

Cormack-Lehanne Laryngoscopic grading



Grade 1 VC, PC, E +
Grade 2 PC, E +
Grade 3 E +
Grade 4 XX

R/F:

- **O**bese
- **B**earded
- **E**dentulous
- **S**norer
- **E**lderly
- **N**eck circumference >40 cm
- Finger breadth:TMJ >3 fingers
- Thyro-mental distance- >6.5cm
- Sterno-mental distance- >13cm
- Lip bite test

Fibreoptic intubation

Difficult Intubation

Plan A:
- Face-mask ventilation & Tracheal intubation
- Direct/ video Laryngoscopy (max. 3 + 1 attempts)

Pre-oxygenation - 3min 100%

Plan B:
- 2nd generation SAD insertion
- Max- 3 attempts

Plan C: Face-mask ventilation

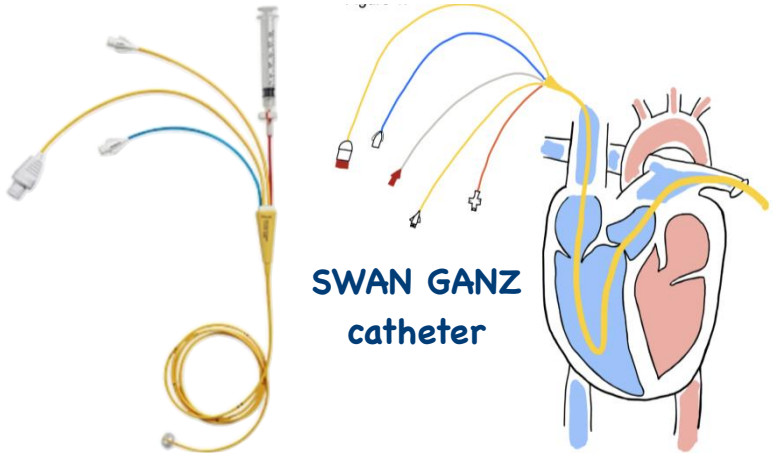
Plan D (CICO): Restricted mouth opening
- Front Of Neck Access (FONA)
- Scalpel Cricothyrodotomy

Instruments

Central-line/TLC
Best IX - CXR
SVC @RA junction

MC: 7Fr

CLAI: S.epidermidis/CoNS



SWAN GANZ catheter

Core temperature
- ideal site: PA
- MC: lower end of esophagus

Chemoport/Portcath
For chemotherapy

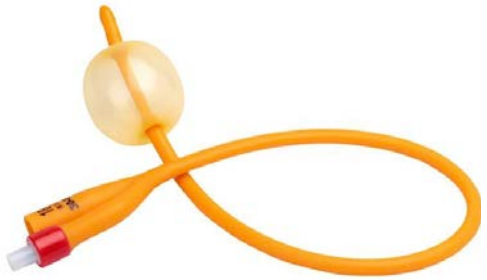
Tunnelled catheter
-Permacath
-Hickmann's catheter
Dialysis, TPN, Chemotherapy

- MC vein for central line: Internal Jugular Vein
- MC vein for TPN: Subclavian vein
- Max risk of pneumothorax: Subclavian vein
- Max risk of infection: Femoral vein
- Max risk of thrombosis: Femoral vein

- **Total Parenteral Nutrition (TPN):**
- 20:30:50 Protein:Fat:Carbs
- >1kg/day weight gain: Fluid overload
- Weight gain after: >6days
- Refeeding syndrome: Hypo-K/Mg/P
- Zn, B12 deficiency
- MC metabolic complication: Insulin resistance

Instruments

18G needle
Minimum G in ATLS(Trauma)



18Fr Foley's catheter

14Fr NG tube

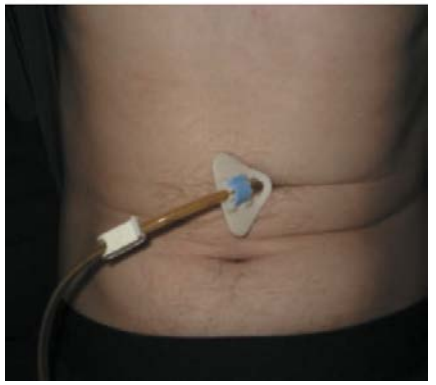
CI: Skull base #
Esophageal stricture

Length of NG tube:
NEX (Nose-Ear-Xiphoid) - Adults
NEMU (Nose-Ear-Midpt. b/w Xiphoid & Umbilicus) - children

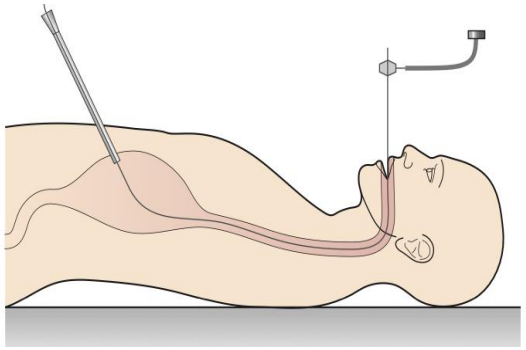
Colour Code	Size	Flow rate
Orange	14G	270
Gray	16G	210
White	17G	130
Green	18G	80
Pink	20G	50
Blue	22G	30
Yellow	24G	20
Violet	26G	10

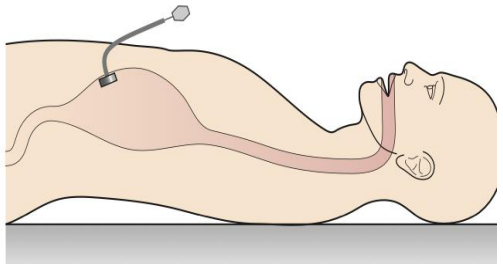
GORY from PunjaB

Color Code	French 1Fr = 0.3mm
Green	14
Orange	16
Red	18
Yellow	20
Purple	22
Blue	24



PEG tube (Percutaneous Endoscopic Gastrotomy)





Day Care Anesthesia

Criteria

- Surgery < 2hrs
- Low risk of significant immediate postoperative complications
- Patient able to eat, drink postoperatively
- Post-op pain managed by oral painkillers in conjunction with LA/ Peripheral block
- Patient able to mobilise postoperatively
- BMI (to avoid respiratory distress) <38

Contra-Indications

- Unstable ASA 3
- ASA 4, 5
- Any poorly controlled comorbidity

Preferred anesthesia: TIVA –> Propofol

Preferred opioid: Remifentanyl [shortest acting] –> Pseudocholinestrase

Preferred MR: SCh/Rocuronium > Mivacurium

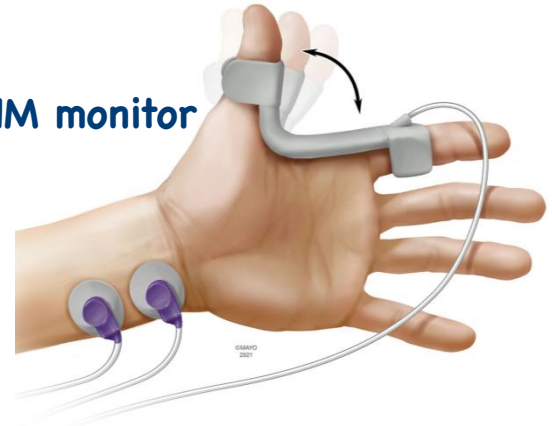
Leading cause of re-admission: PONV; Hemorrhage

discharge

Aldrete score: Activity/ BP/ Consciousness / Respiration/ o2 saturation

Monitoring during Anesthesia

NM monitor



MR

No drug	Nondepolarizing block	Depolarizing block	
		Phase I	Phase II
Train-of-four	Fade	Constant but diminished	Fade
TOF-R = 1.0	TOF-R = 0.4	TOF-R = 1.0	TOF-R = 0.4

>5mg/kg

- MC nerve: Ulnar nerve - adductor pollicis
- 2nd MC nerve: Facial nerve - orbicularis oculi
- MC stimulus: ToF[2Hz]
- Tetanic stimulation: 50Hz
- Extubation TOF: >0.9 - clinical sign —> lifts head > 5s

Bispectral index

Level of consciousness

- frontal processed EEG
- Depth of anaesthesia

0 - 40-60 - 100 → Fully awake

Coma — Anaesthesia

Pulse oximetry

Beer lambert law

OxyHb: IR light

DeOxyHb: Red light

False low(~85%) = Meth-Hb

False high(~100%) = CO-Hb

Detect via Co-oximetry

Oxygen Delivery Devices






High flow

B	W	O	Y	R	Gf
Blue	White	Orange	Yellow	Red	Green
24% 4L/min	28% 4l/min	31% 6L/min	35% 8L/min	40% 8L/min	60% 12L/min

- fixed O2 %
- COPD
- O2 toxicity

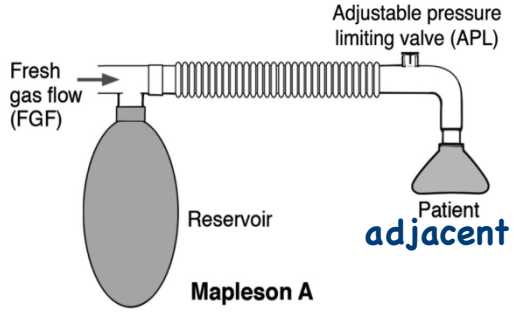
NP dead space

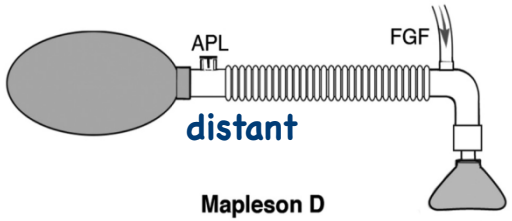
Humidification, PEEP+
May delay intubation

Prerequisites for NIV:
- Conscious
- Empty stomach

Device	Nasal Cannula	Hudson mask	Venturi device	NRBM	HFNC	NIV[CPAP]
Max Flow Rate (L/min)	5	10	15	15	60	No limit
Max Saturation (%)	40	60	60	85-90	100	100

Mapleson circuits (Semi-closed)



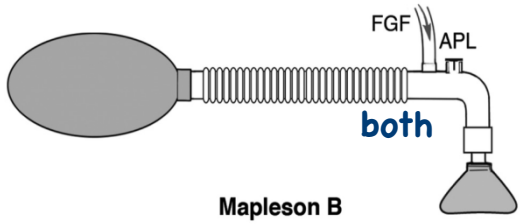


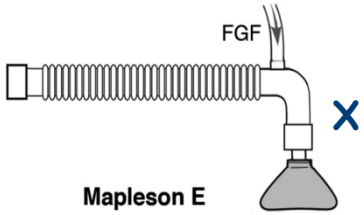
MC circuit in spontaneous: FGF = MV

Mapleson A - Magill's circuit; Lack's Coaxial circuit

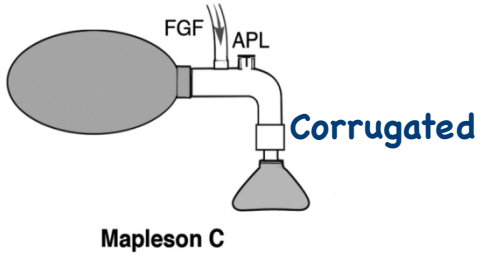
MC circuit in controlled: FGF = 1.6 x MV

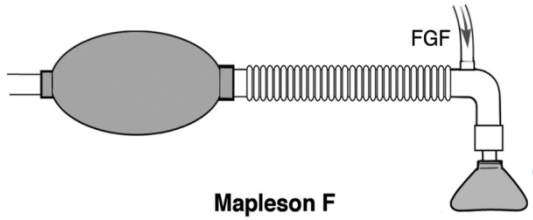
Mapleson D - Bain's coaxial circuit





X reservoir; children





BAIN's circuit

AMBU bag (Artificial Manual Breathing Unit)

Pop-off valve: 30-40 cm H2O

Anesthesia Workstation (Boyle)

High-pressure system:

N2O —> 760psi

- Gas cylinders + Yokes

Size: A – H MC size: E Material: Mb-steel MR compatible:
- Aluminium
- Titanium

Pressure: 2000psi – O2/air/entonox

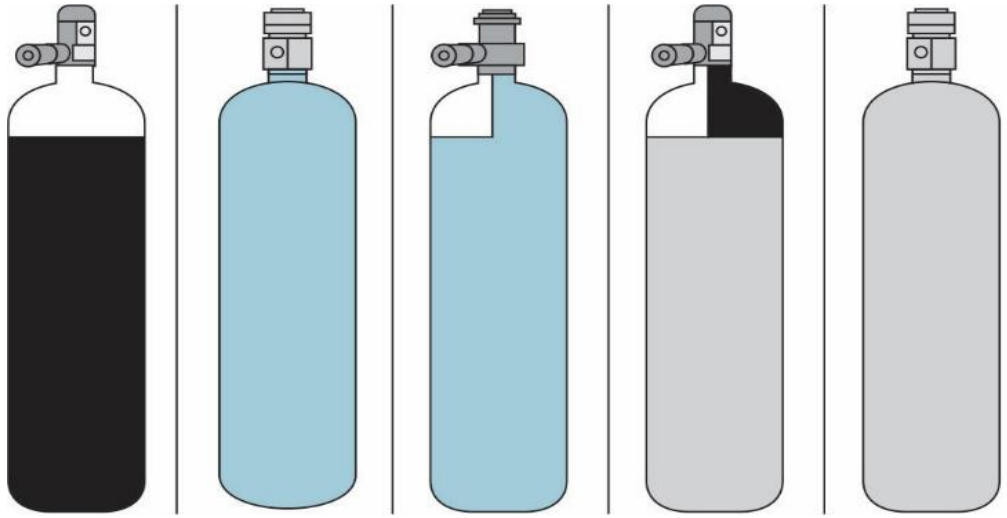
- Cylinder pressure regulators
- Cylinder pressure gauges

Intermediate-pressure system: 60psi

- Pipeline gas inlets
- Pipeline pressure gauges
- Oxygen fail safe valve
- Flowmeter valves
- Oxygen flush valve

Low-pressure system:

- Flowmeters (rotameters)
- Vaporizers
- Common gas outlet



O2
2,5

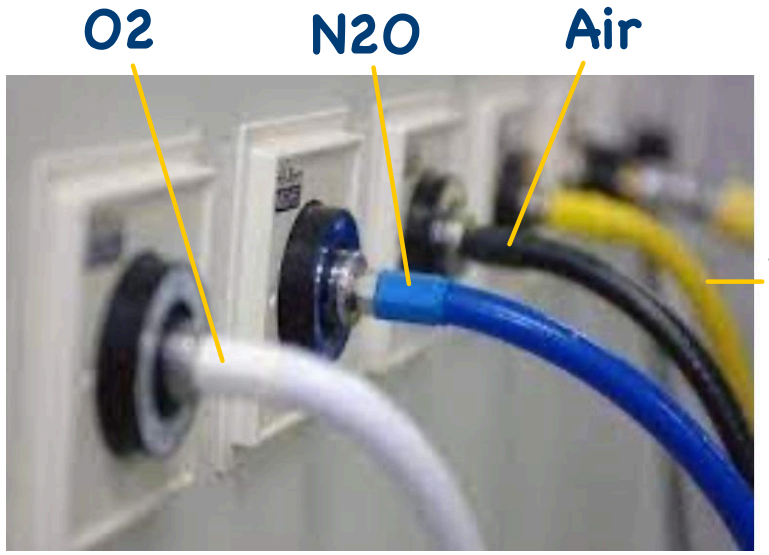
N2O
3,5

N2O+O2
(entonox)
7

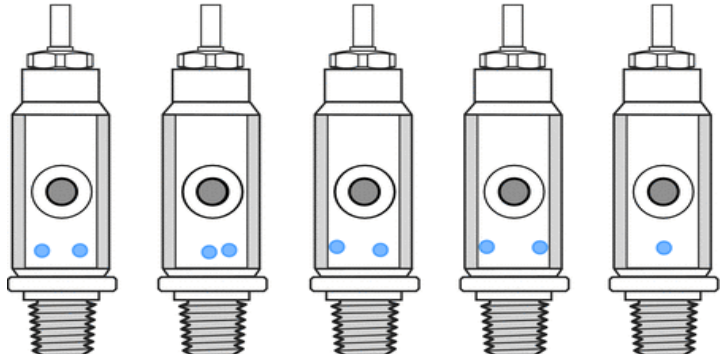
Air
1,5

CO2
1,6 - >7.5%
2,6 - <7.5%

PISS [Pin Index Safety System]



DISS [Diameter index Safety system]
pipelines : int. pressure



2,5
O2

3,5
N2O

1,5
Air

1,6
CO2

7
entonox

Orange: Cyclopropane [3,6]
Brown: Heliox(79% Helium + 21% Oxygen) - airway obstruction

Inhalational anesthetics

	MAC α 1/potency	BLOOD GAS SOLUBILITY α 1/speed
Methoxyflurane	0.2	12
Halothane	0.75	2.5
Isoflurane	1	1
Sevoflurane	2	0.65
Desflurane	6	0.45 (Xenon min)
N20	104	0.47

Sevoflurane

Compound A
Fruity odour
Best for
Asthma
Day care Sx
Liver D

Isoflurane

Best for
cardiac Sx

Halothane

Min MAC
Max bronchdil
AI hepatitis
Max ICP rise
Sensitises heart
to epiN

arrhythmia

Desflurane

Tec-6 vaporizer
Irritant X induction
CO with dessicated
soda lime
Maintenance agent of
choice
Best for Renal D,
Obese

Compound A: Nephrotoxic

N2O

Concentration effect
Second gas effect
Diffusion hypoxia
B12 deficiency

C/I: Intestinal obstructn;
Middle ear sx

ALL Inhalational agents:
-Cerebral metabolic O2↓
-CBF/ ICP ↑
-CVS, HR ↓
-Respiratory drive ↓

ALL IV agents:
-Cerebral metabolic O2↓
-CBF/ ICP ↓ Except KETAMINE
-CVS,HR ↓
-Respiratory drive ↓

IV anesthetics

(TIVA)

DOC for Day care/ Liver/ Kidney/ NeuroSx/ TIVA/ Malignant Hyperthermia/ Porphyria/Antiemetic : PROPOFOL

Infusion syndrome (acidosis, green urine), Painful injection- Soyabean oil, Egg lecithin : PROPOFOL

NMDA antagonist, Dissociative anesthesia, DOC in Asthma/ COPD, Cyanotic HD, Shock : KETAMINE

C/I in Hypertension / Epilepsy/ Glaucoma : KETAMINE

DOC in Cardiac surgery, S/E- Adrenal suppressant (11β-hydroxylase) : ETOMIDATE

DOC in Hyperthyroidism, Seizures, Narcoanalysis, Redistribution S/E- Intra-arterial vasospasm: THIOPENTONE

Rx: Paperverine injection

Muscle relaxants

Depolarising MR: Sch
Best for RSI, Shortest acting
S/e: Myalgia (MC), Hyperkalemia, Bradycardia, Intragastric pressure high

Non-depolarising MR:
Aminosteroid compounds: Rocuronium, Vecuronium, Pancuronium
Longer duration, metabolized in liver & kidneys

Benzylisoquinolinium compounds: Atracurium, Mivacurium
Shorter duration of action
Hofmann elimination & ester hydrolysis- safe in RF/ LF/ pediatrics Atracurium
May cause more histamine release
By-product of Atracurium: Laudonosine- seizure (cis-atracurium preferred)

- Most cardiostable, neuroSx (Biliary excretion) : Vecuronium
- Shortest acting NDMR: Gantacurium(X FDA approved) > Mivacurium

•Dibucaine No. <30: Atypical psuedocholinesterase
Prolonged paralysis after giving Succinylcholine & Mivacurium

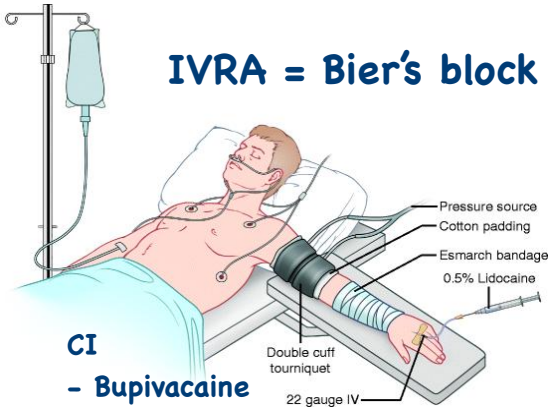
- Reversal : NDMR —> Neostigmine + Atropine
- Sugammadex : Cyclodextrin —> for Ve/Rocuronium [C/I in Liver ds.]

Local anesthetics

Amides	Esters
Bupivacaine, Lidocaine, Ropivacaine, Prilocaine	Cocaine, Procaine, Benzocaine
Liver – cytochrome P450	Plasma – pseudocholinesterases
Longer action	Shorter action
Less allergy	PABA metabolite- More allergy

Eutectic Mixture of Lignocaine + Prilocaine

IVRA = Bier's block



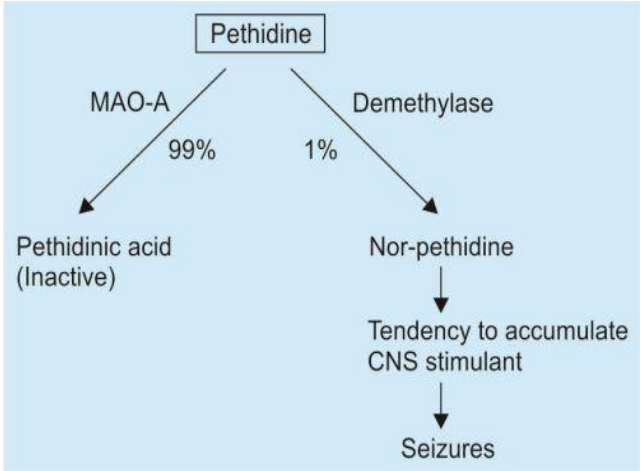
CI
- Bupivacaine
- Sickle cell A

- MOA- unionised form –> Na+ (inactivated voltage gated) inhibition
- Autonomic > Sensory > Motor
- Causing Hypertension: Cocaine
- S/E- MethHb: PRILOCAINE, BENZOCAINE
- Most cardiotoxic: Bupivacaine Dose: 2mg/kg
- Max dose of Lignocaine: 5mg/kg [w/ epinephrine: 7mg/kg]
- Proparacaine duration: topical - 10-20 min
- Safest in MH: Procaine
- LAST: CNS/CVS toxicity DOC: 20% intralipid
- Route: iv > intra-tracheal > intercostal > caudal/epidural > brachial

Opioids

- Full agonist: Morphine, Pethidine, Heroin, Meperidine, Methadone, Codeine, Fentanyl
- Partial agonist: Buprenorphine
- Mixed agonist/antagonist: Nalbuphine, Pentazocine, Butorphanol
- Antagonist: Naloxone, Naltrexone

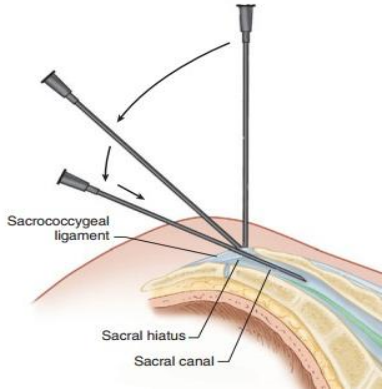
- Avoid Opioids in- Head injury, Biliary obstruction - SOD dysfunction, asthma
- Mydriasis: Meperidine
- Pruritus: Histamine release- vasodilation, hypotension
- No tolerance to: Constipation, Miosis
- Serotonin syndrome: TRAMADOL(μ Rc action + Serotonin Rc)
- Wooden chest syndrome: Fentanyl
- Prolonged QTc: Methadone
- Shortest acting (Day care): Remifentanyl



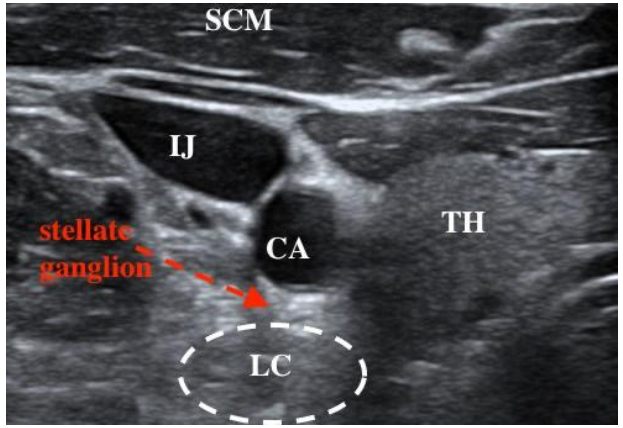
Regional Anesthesia

Anterior ethmoidal nerve

Nasociliary n. block



Caudal anasthesia (<8yrs)
Sacral hiatus open
S3-S4 lvl



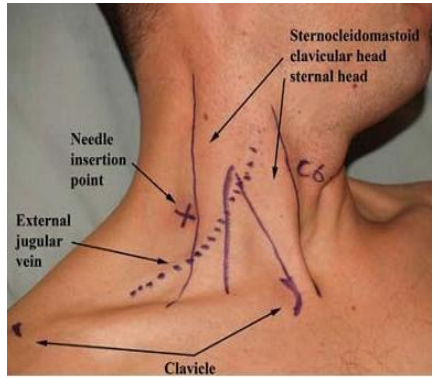
C6 - Stellate ganglion block
Done for: Raynaud's; Vasospasm; PTSD
Signs:

- Horner's - Ptosis[1st]
- Guttman sign - nasal mucosal congestion

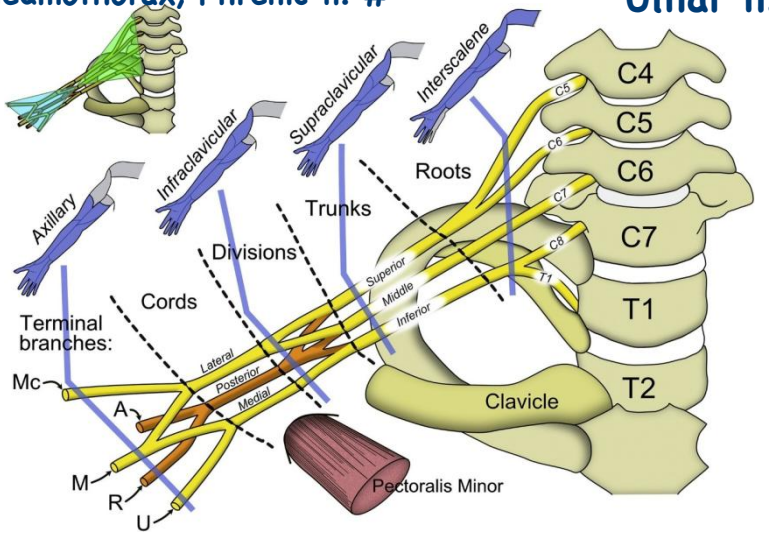
Supraclavicular block

Upper arm surgery; R/o Pneumothorax, Phrenic n. #

Interscalene block



Shoulder & upper arm
Ulnar n. spared



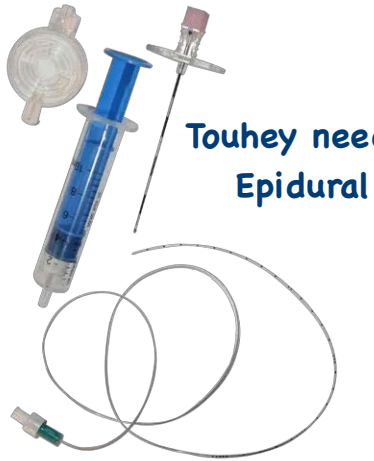
Neuraxial block autonomic/motor/sensory

Epidural Anesthesia (EA)	Spinal Anesthesia (SA)
Larger dose of drug	Smaller dose of drug
Anywhere	L3-L4 MC Tuffier's line ~ iliac crest[L4-5]
Not as good as SA	Better quality of anesthesia
Adjustable, prolonged action via a catheter	Single-shot injection; action for ~3hrs Umbilicus

CI: Raised ICP; Papilledema; Coagulopathy; Shock; Local infection

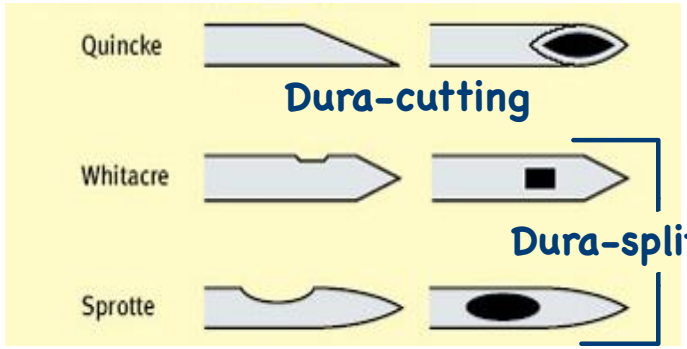
Layers punctured for LP:

Skin → subcutaneous fat → supraspinous lig → interspinous lig → Ligamentum flavum → Dura → Arachnoid



Touhey needle
Epidural

Spinal/LP needle



Post-dural puncture headache:
- TOC: iv fluids + bed rest -x-> Autologous blood patch

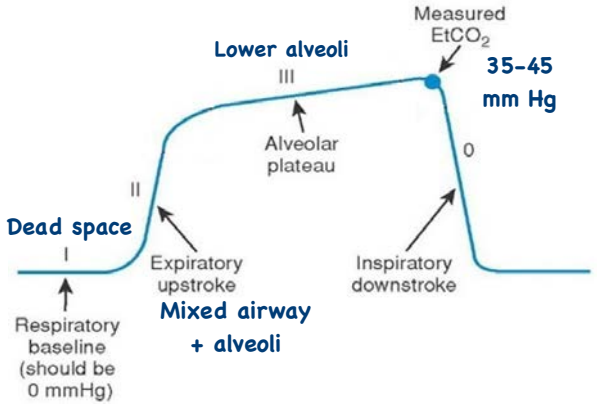
MC Intra-op complication: Hypotension
DOC: Phenylephrine
MC post-op complication: Urinary retention

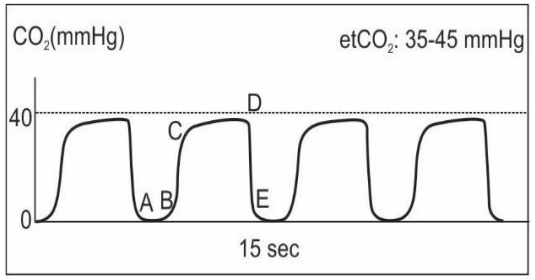
PDPH: increases in pregnancy & on ambulation; reduces on supine position

1. Adult spinal cord-Lower border of L1
2. Spinal cords in infants-Upper border of L3
3. A/D/Subarachnoid space-Lower border of S2

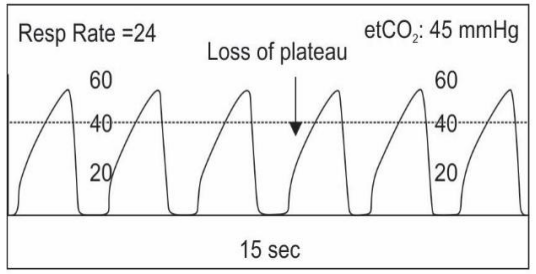
PIH, Heart ds in pregnancy: Epidural / GA
Except CoA/ Eisenmenger/ Uncorrected TOF: GA

Capnography

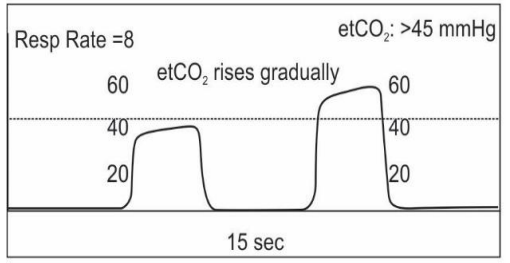




Normal

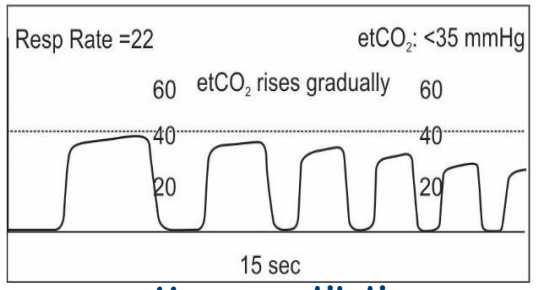


Shark Finn - COPD
airway obstruction

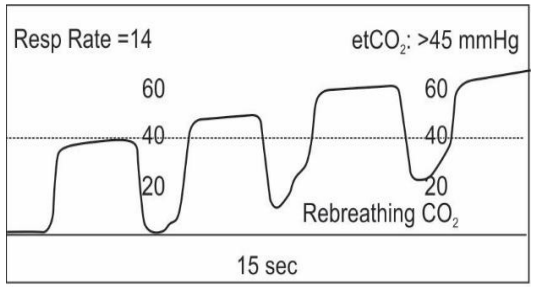


Hypoventilation

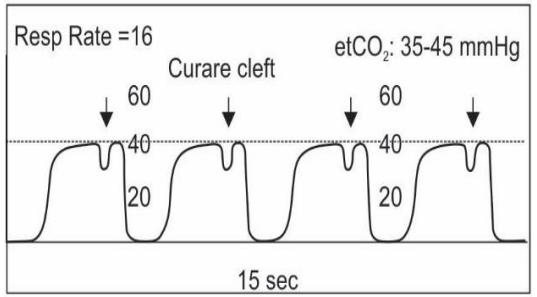
Infrared spectroscopy



Hyperventilation



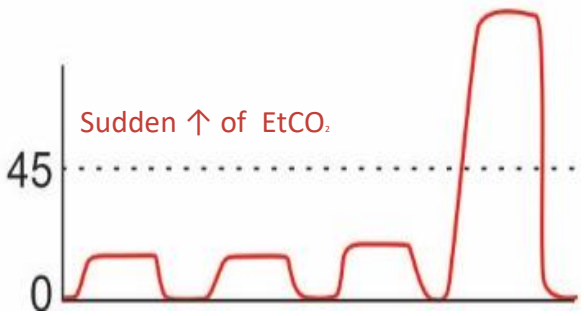
Extinguished soda lime



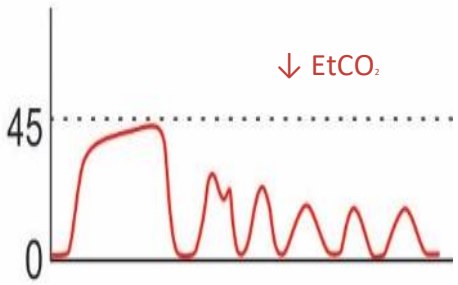
Resp. effort ++

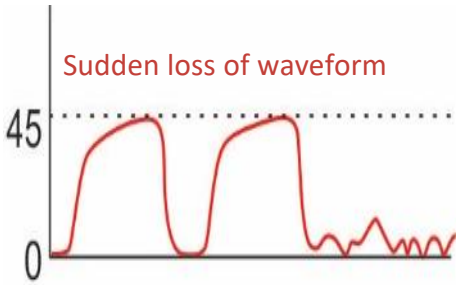
80% Ca(OH)2 + NaOH + KOH +15% H20 Soda lime
Ca(OH)2 + NaOH + CaCl2 Amsorb
Ba(OH)2 + CaSO4 Barylime

Stepladder



Esophageal intubation

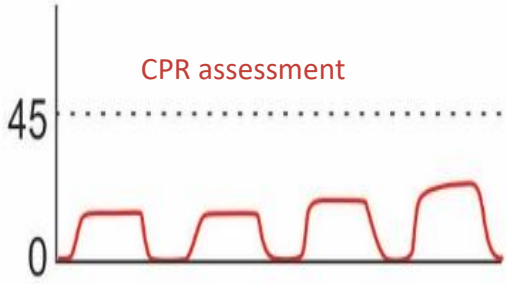




- Circuit disconnect
- Cardiac arrest
- Venous air embolism

R/F: Neurosurgery/ Laparoscopy/ Sitting posture/ Fowler's position/ Neck surgery

Next: DURANT position [Lt.lateral decubitus + Trendelenberg] —> Aspirate



EtCO2 > 10-20mm

↓

Adequate Chest compression

↑

Intra-arterial DBP >20mm

Malignant hyperthermia

- Sch, Lignocaine, Inhalational agents
- Tachycardia + Rigidity
- Earliest sign- EtCO2 ↑
- Late sign- Hyperthermia
- RyR/DHPR (Chr 19)-AD
- DOC- Dantrolene sodium

Pre-Op Assessment

Pre-op drug DOC to reduce anxiety: Midazolam
Pre-op drug DOC to reduce secretions: Glycopyrollate
Pre-op Antibiotic time: 30min - 1hr prior to incision - Cefazolin
MC nerve injured intra-op- Ulnar nerve
MC intra-ophthalmic complication- Corneal abrasions
PONV DOC: Ondansetron
POVL MCC: Ischemic optic N
MCC of intra-op anaphylaxis: Antibiotics > MR
Min acceptable Hb: 8mg/dL(elective)
Min acceptable platelet: 1 lakh

Mendelson syndrome Aspirin + pregnancy
NPO heavy meal: 8hr
Light/semi-solid meal/ Formula: 6hr
Breastmilk: 4hr
Clear liquids: 2hr

Goldman Grading system
❤️ risk assessment

Stop Drugs before surgery

Clopidogrel: 7d Warfarin: 5d LMWH: 24h UFH: 4-6h Li: 48hr SGLT2-: 24hr (r/o Euglycaemic ketoacidosis)

ACEi/ ARB/ OHG/ Insulin/ Diuretic (except thiazide): omit morning dose

OCP: r/o DVT (immobilisation/obese) - 4-6wks

Smoking: 4-6wks

ASA classification

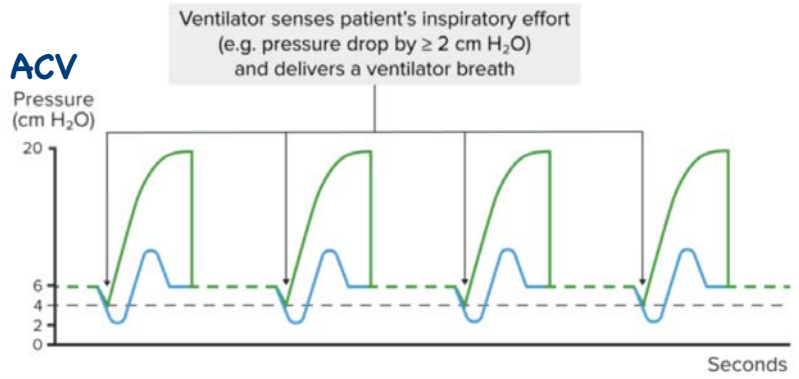
ASA PS	Definition	Examples (including, but not limited to):
ASA I	A normal healthy patient	Healthy, non-smoking, no or minimal alcohol use
ASA II	A patient with mild systemic disease	Current smoker, social alcohol drinker, pregnancy, obesity (BMI 30–40), well-controlled DM/HTN, mild lung disease
ASA III	A patient with severe systemic disease	Poorly controlled DM or HTN, COPD, morbid obesity (BMI ≥40), active hepatitis, alcohol dependence or abuse, implanted pacemaker, moderate reduction of ejection fraction, ESRD undergoing regularly scheduled dialysis, premature infant PCA < 60 weeks History (>3 months) of MI, CVA, TIA, or CAD/stents
ASA IV	A patient with severe systemic disease that is a constant threat to life	Recent (<3 months) MI, CVA, TIA, or CAD/stents, ongoing cardiac ischemia or severe valve dysfunction, severe reduction of ejection fraction, sepsis, DIC, ARD, or ESRD **not** undergoing regularly scheduled dialysis
ASA V	A moribund patient who is not expected to survive without the operation	Ruptured abdominal/thoracic aneurysm, massive trauma, intracranial bleed with mass effect, ischemic bowel in the face of significant cardiac pathology, or multiple organ/system dysfunction
ASA VI	A declared brain-dead patient whose organs are being removed for donor purposes	Organ donor (brain-dead patient)

Mechanical ventilation modes

Volume-controlled	• Controlled mechanical ventilation (CMV): Breaths all triggered by ventilator, predefined rate and volume set • Assist-controlled ventilation (ACV): Breath triggered by patient's effort, if no patient breath per unit time, ventilator triggered; predefined tidal volume set • Synchronized intermittent mandatory ventilation (SIMV): Spontaneous breathing permitted with no ventilator assist; predefined tidal volume set.
Pressure-controlled	• Pressure support ventilation (PSV): Triggered by patients inspiration only; assist with pressure limitation provided.
Mixed	• PS/SIMV: Ensures spontaneous breaths permitted in SIMV receive pressure assist

Modes of Mechanical Ventilation

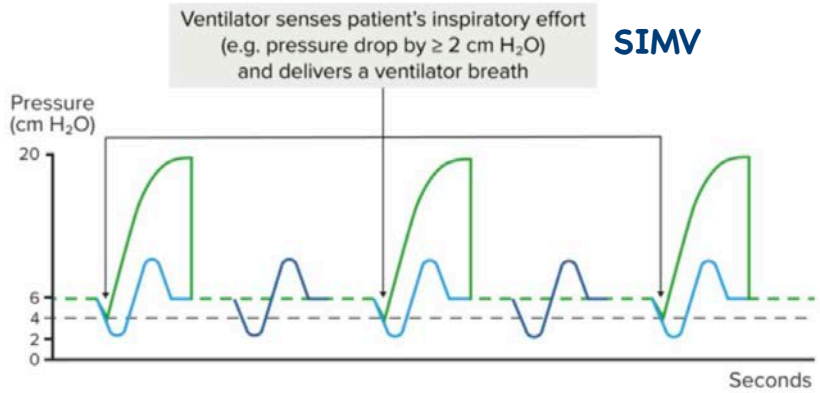
ACV



Assist control ventilation (ACV)	Ventilator breaths do not occur at regular intervals and are triggered by patient breaths (all patient breaths are assisted)

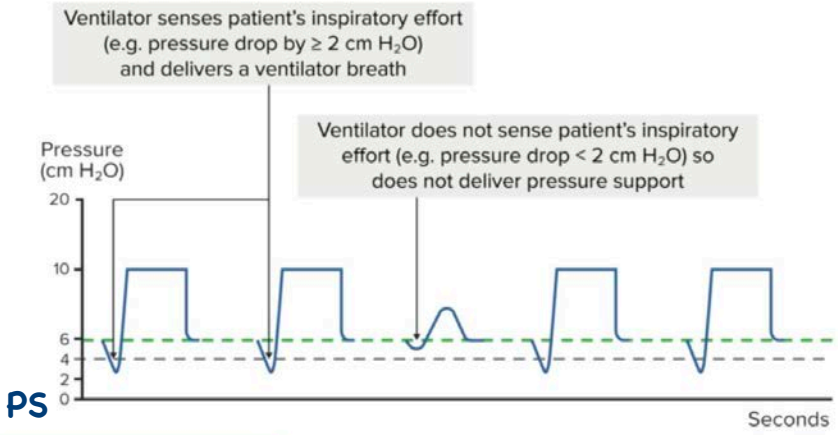
r/o Hyperventilation

SIMV



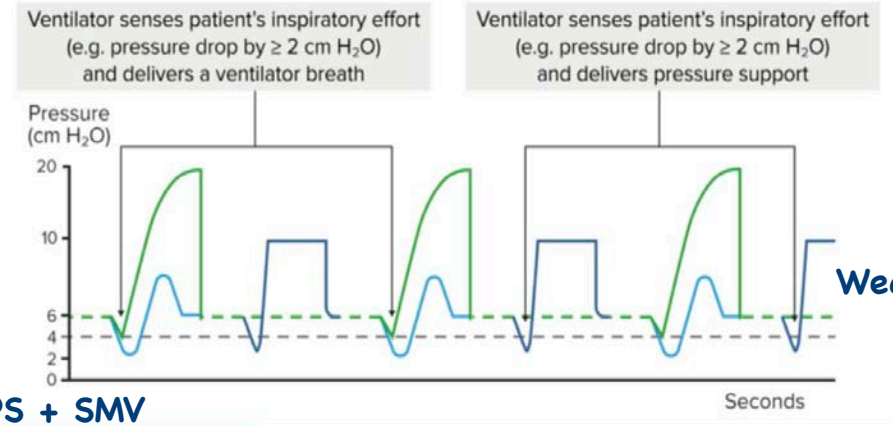
Synchronized intermittent mandatory ventilation (SIMV)	Ventilator breaths occur at regular intervals but are triggered by patient breaths (only some patient breaths are assisted)

PS



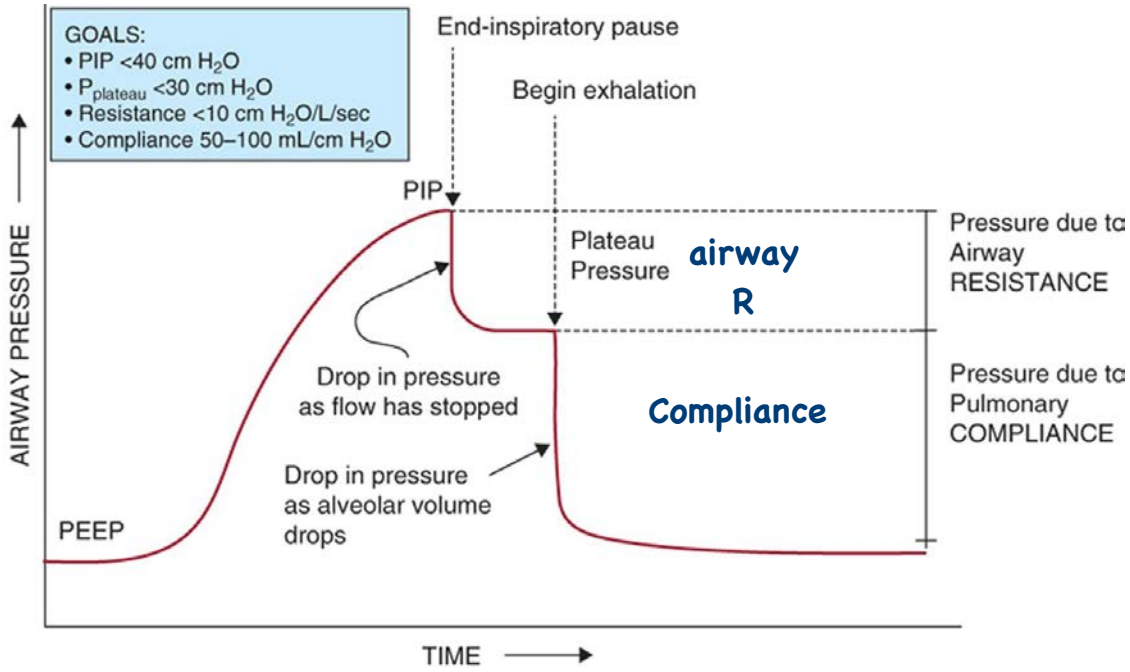
Pressure support (PS)	All sensed patient breaths are supported by pressure

PS + SMV



Weaning

Synchronized intermittent mandatory ventilation (SIMV) + pressure support (PS)	Ventilator breaths occur at regular intervals but are triggered by patient breaths (only some patient breaths are assisted) + unassisted breaths are supported by pressure



Not for weaning: CMV
Best for weaning: SIMV/PS
Rapid shallow breathing index: Predict weaning[RR/TV]
<105: Weaning

PEEP: Positive end-expiratory pressure
-Prevents collapse, Increase recruitment
-Reduce work of breathing
-Barotrauma, Low CO, Raised ICP

GOALS of mechanical ventilation:
Tidal volume: 6-8ml/kg ARDS : 4-6ml/kg
RR: 12-18bpm
FiO2: 21-100% — ABG paO2/paCO2
PEEP: >5cm H2O (5-8cm) ARDS : >8cm H2O
Plateau pressure: <30cm H2O

Basics of CPR

PUSH HARD-PUSH FAST

1/3 AP dia: 5-6cm (2-2.5in) 100-120/min

allow complete recoil

Adequate CPR

Rate of breathing in CPR
Adults: 10 bpm
Children: 20-30 bpm
Neonates: 30-60 bpm[NRP Update]

POST CARDIAC ARREST CARE

1. **Optimization of circulation** (MAP > 65 mmHg)
2. **Optimization of ventilation** (SpO_2 > 94%)
3. **Targeted temperature management**
   32–36°C for 24 hours for comatose patients
4. **Moderate glycemic control**
   (Blood sugar 144–180 mg/dL)
5. **Coronary intervention (PCI)**
   If cause is MI (preferably within 90 minutes)
6. **Early prognostication of neurologic outcome**
   (To be assessed after 72 hours)

Adrenaline Doses

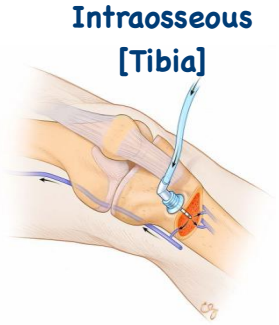
- Anaphylactic shock / Status Asthmaticus: 1mg 1:1000 im/sc
- Cardiac Arrest: 1:10000 IV > Intraosseous > Intratracheal
- Vasoconstriction: 1 : 1 lakh
- With LA for VC: 1 : 2 lakh
- Labour Epidural: 1 : 4 lakh

Amiodarone Dose: 300mg –> 150mg

Lignocaine Dose: 1-1.5mg/kg –> 1/2

Shock energy for defibrillator:

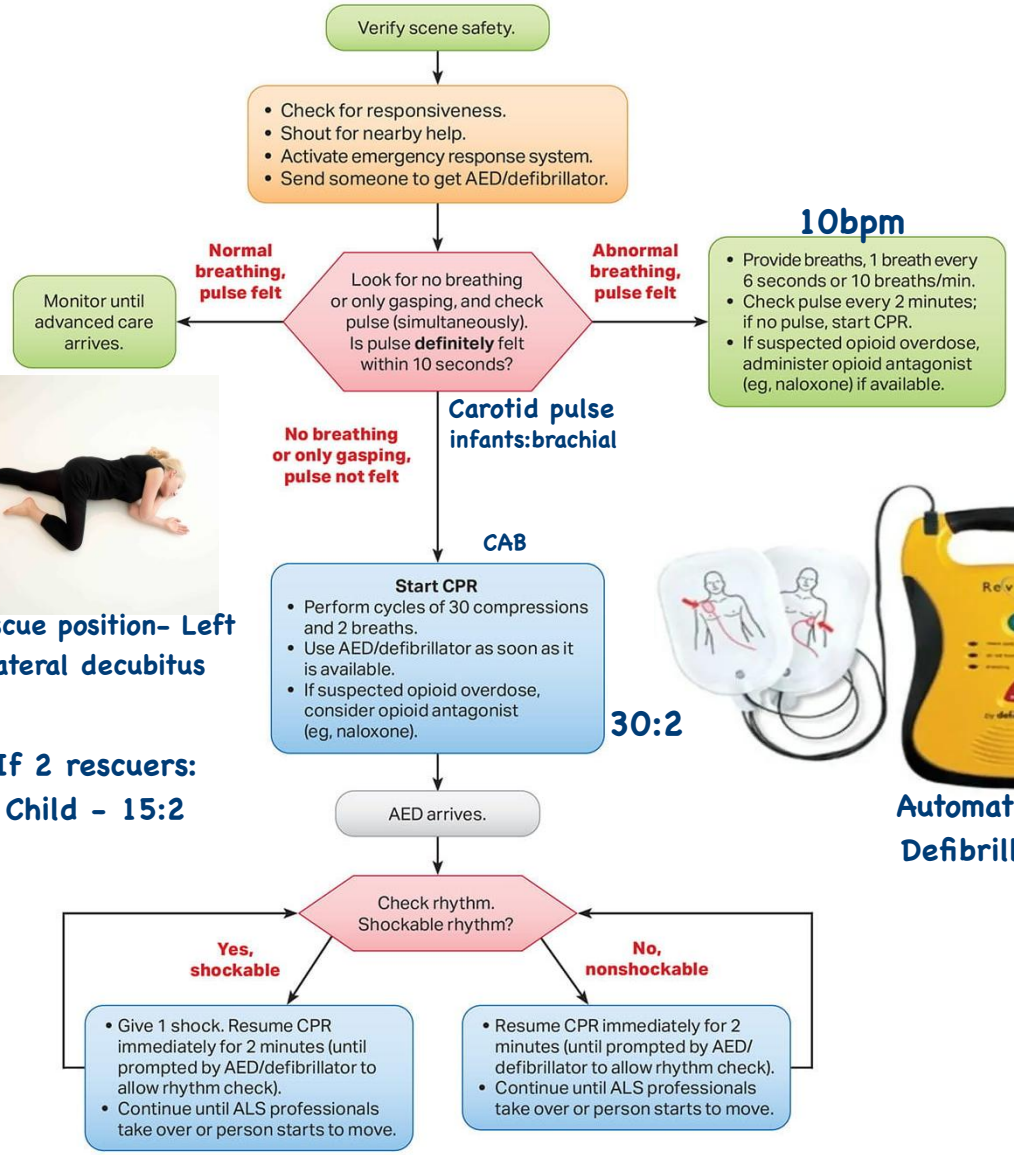
- Monophasic: 360J
- Biphasic: 120-200J



Reversible causes:

5H	5T
Hypovolemia	- Tension ptx
Hypoxaemia	- Thrombus –> PA
Hypothermia	- Thrombus –> Coronary A
H+ - acids	- Toxins
Hyper/Hypo-K	- Tamponade

BLS



10bpm

Carotid pulse
infants:brachial

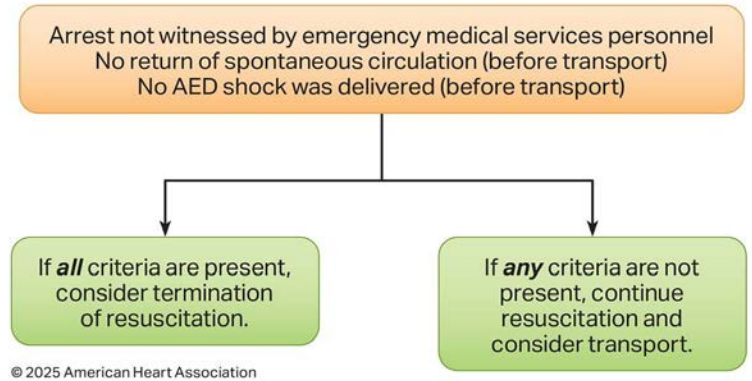
CAB

30:2

Rescue position- Left lateral decubitus

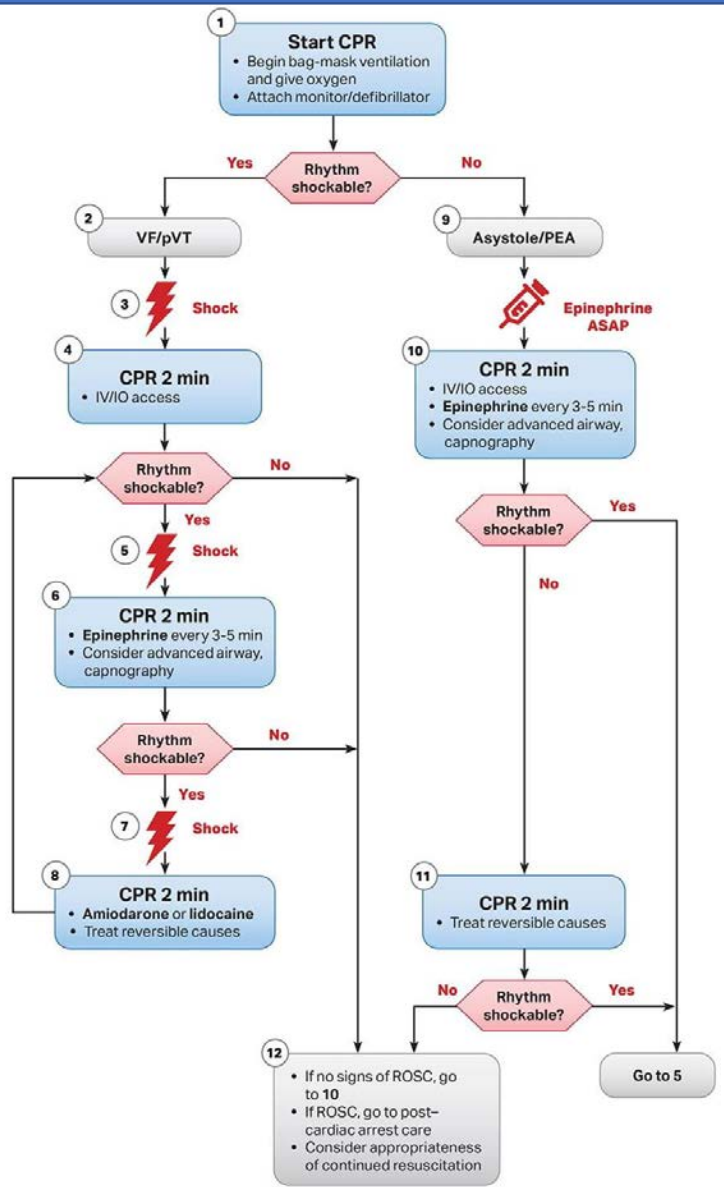
If 2 rescuers:
Child - 15:2

Automatic External Defibrillator (AED)



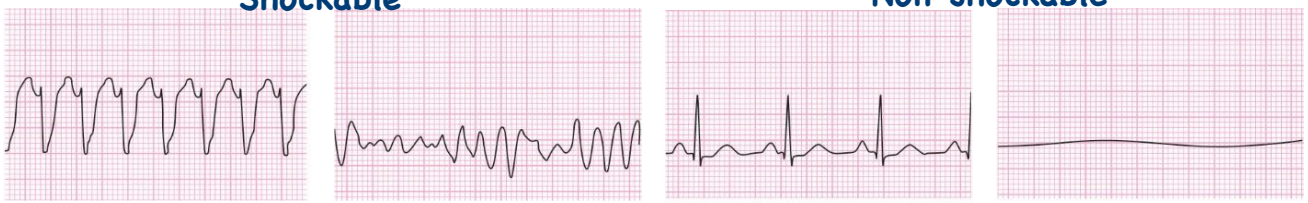
Chain of Survival

ACLS Algorithm for Cardiac Arrest in Adults



Shockable

Non-shockable



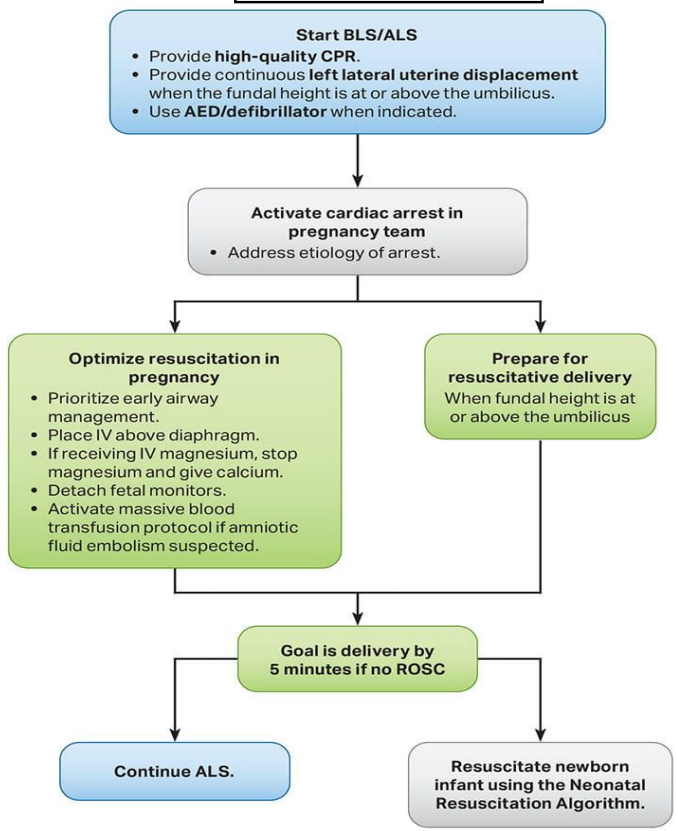
V. Tachycardia

V. Fibrillation

Pulseless Electrical Activity

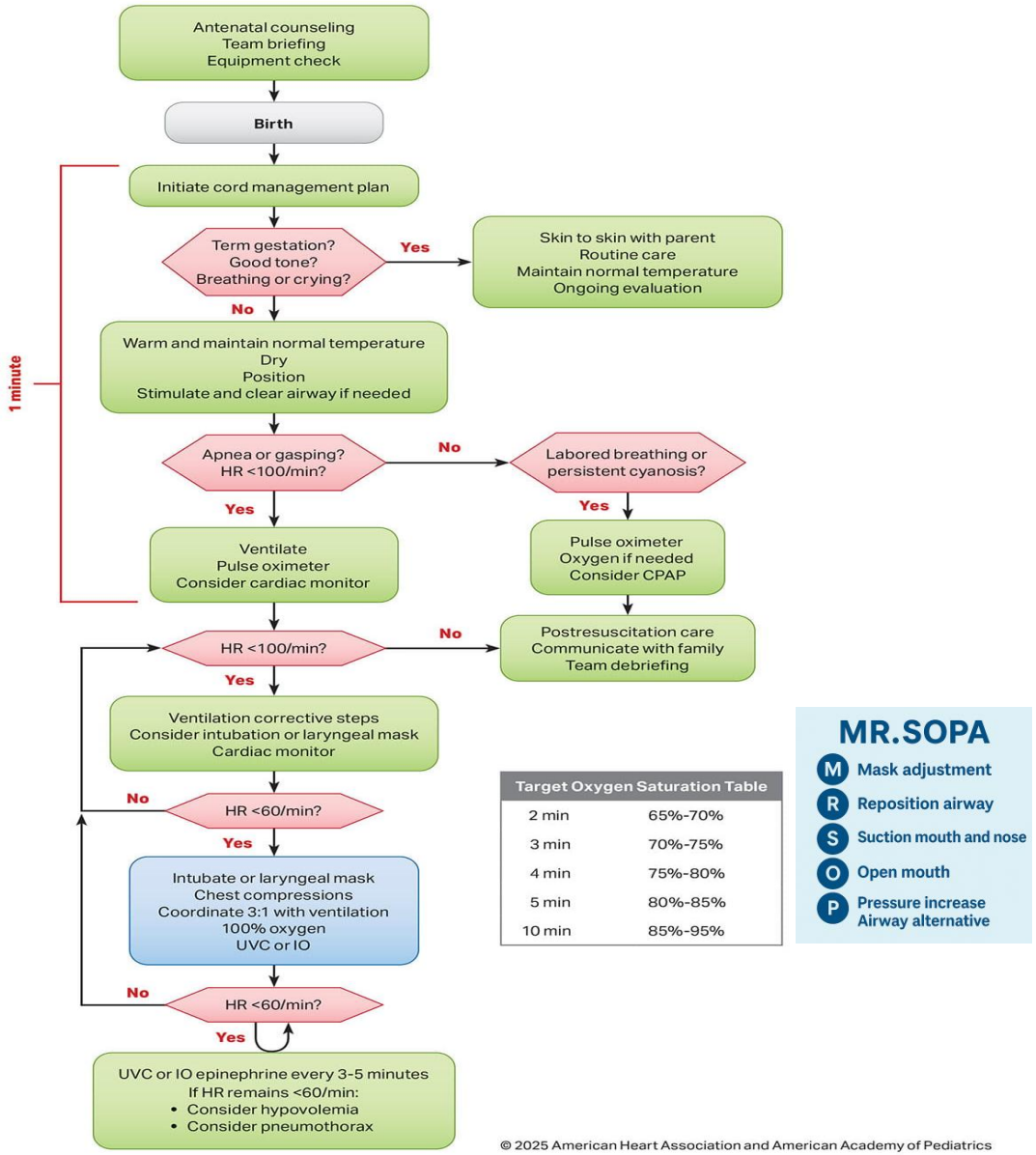
Asystole

PREGNANCY



OT? X
Pffanelstein? X
LSCS? X

Neonatal Resuscitation Protocol 2025



Order of suction: Mouth f/b Nose
Temperature of room: 25°C
Delayed cord clamping: stable term/preterm at least 60s
Cord milking: Non-vigorous 35-42wks POG

Bag & Mask Ventilation (BMV)

-Start within: 1 min
-Saturation
>35weeks: 21%
32-24 weeks: 21-30%
<32 weeks: ≥30%
-RR: 30-60bpm
-C/I: CDH, TEF

Saturation monitoring done at: Rt. UL(pre-ductal)

Chest Compressions(CC)

- 2 thumb
- Lower 1/3 body sternum
- 1/3rd depth of AP

CC:PPV- 3:1