Contents

ANAESTHESIA REVISION - 1

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

PAC : Past Medical & Personal History

00:03:28

Pre Anaesthesia check-up (PAC).

Past Medical History :

Co-morbid conditions	Treatment plan prior to surgery
Hypertension	Continue antihypertensives till day of Sx. • Exceptions : ACE-I & ARBs (Cause severe hypotension). • Minor surgeries (Minimal blood loss) : Continue ACEI & ARBs.
Diabetes mellitus	• Discontinued : – OHA & Insulin : On surgery day (Risk of hypoglycemia). – SGLT-2 inhibitors : 24 hrs prior (Risk of euglycemic ketoacidosis). • Intra-op ⟶ Start regular short acting insulin.
Epilepsy	• Continue antiepileptics till day of Sx. (Triggers : hypoxia, hypercarbia, acidosis, can precipitate seizures). • Obtain baseline LFT.
Thyroid disorder	Continue medications till day of Sx. • Hypothyroidism : May cause delayed recovery d/t ↓BMR. • Hyperthyroidism : To prevent thyroid storm (Tachycardia, SVT).
Psychiatric problems	Continue antipsychotics. Exceptions : • MAO inhibitors : Stopped 3 weeks prior. Interacts with Synthetic opioids (Meperidine) ⟶ Hypertensive crisis. • Lithium/Mg^{2+} : – Stop 24-48 hours prior if used along with long acting muscle relaxants (Prolong their action). – Can be continued with short acting muscle relaxants like Mivacurium & Atracurium.

medications	Treatment plan prior to surgery
Oral contraceptive pills	• Estrogen : ↑DVT risk. – Low risk (Young/immediate mobilization) : Continue. – High risk (Old/long bone fractures/↑bed-rest) : Stop. • Progesterone : No risk.
Herbal medicine	• Check LFT : If abnormal ⟶ Delay by 1-2 weeks.
Anti-tubercular therapy (ATT)	• Continue ATT (Stopping drug ⟶ ↑MDR TB). • Check LFT (ATT : Enzyme inducers).
Sildenafil	• Stop 24-48 hours prior (Risk of hypotension).

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

Medications	Treatment plan prior to surgery
Diuretics	• Stop (may cause electrolyte imbalance/hypotension) – Exception : Thiazides.
Anticoagulants	• During regional anaesthesia (RA) → Bleeding in closed cavities → Nerve compression (Permanent damage). • Anticoagulants discontinued prior to RA : – Aspirin : Continued/stopped 3 days prior if ↑risk of bleeding. – Clopidogrel, Warfarin } 5–7 days prior. • Bridging with LMWH to prevent re-infarction : – LMWH → Prophylactic dose : Stop 12 hours prior. Therapeutic dose : Stop 24 hours prior. – Regular heparin : Stop 6 hours prior. • Topical anesthesia : Continue anticoagulants.

Personal History :

Condition	Features
Smoking	• Stopped 3–4 weeks prior (Ideally 6–8 weeks). • ↑ Risk of bronchospasm : – Clinical features : Sudden tachycardia, HTN, ↑airway resistance, wheeze (+).. – $EtCO_2$: Shark fin pattern. – Rx : Bronchodilators. • ↑Risk of laryngospasm (On extubation) : – Clinical features : Stridor, ↓rapid SpO_2, paradoxical chest movements/ no air entry into lungs. – Rx : 100% O_2 → f/b Propofol → If uncontrolled Add succinylcholine.
Alcohol	24–48 hours prior.
Tobacco chewing	Chances of difficult intubation (D/t restricted mouth opening).

PAC : Family & Allergy History

00:33:32

Family History :

Malignant hyperthermia :

- Etiology : All inhalational agents & Succinyl choline.
- Risk factor : Strong family h/o muscular dystrophies.
- Pathophysiology : Ryanodine receptor mutation (Sarcoplasmic reticulum) → Vigorous muscular contractions.

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

- Clinical presentation :
  - Initial : Locked jaw (masseter spasm).
  - Sudden tachycardia, HTN, ↑body temperature.
  - ↑$EtCO_2$ (most sensitive).
  - Ventricular arrhythmias (Hyperkalemia) & cardiac arrest.
- Mx :
  - 100% O_2 (1st step).
  - DOC : Dantrolene sodium (2.5 mg/kg diluted in distilled water).
  - Hyperkalemia Mx : Calcium gluconate ⟶ Insulin + dextrose or Salbutamol.
  - Hyperventilation & acidosis Mx : Sodium bicarbonate.
  - Post-operative complication :
    Acute tubular necrosis (myoglobin release) : Monitor urine output.

Allergy History :

Causes anaphylactic shock (Histamine : vasodilator & bronchoconstrictor).

Etiology :

Antibiotics > latex > muscle relaxants > local anaesthetics.

Clinical presentation :

- Sudden tachycardia, hypotension.
- Wheeze (D/t ↑airway resistance).
- Edema (Lips/face/airway).

Mx :

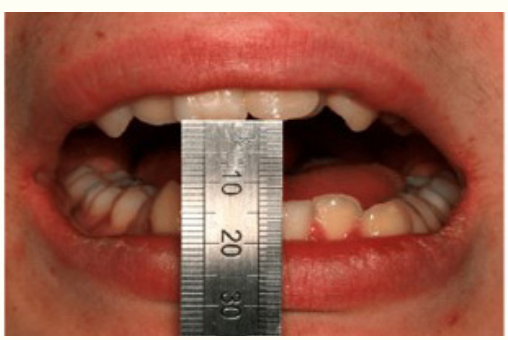
- Adrenaline (DOC) : Dosage based on route (1 mL = 1 mg = 1 : 1000).
  - IV dose : 1 mL of 1 : 10000.
  - IM / SC dose : 0.5 mL of 1 : 1000.
- Hydrocortisone.
- Adequate fluids.

Airway Examination

00:46:24

Risk Factors :

- H/o difficult intubation.
- Airway anomalies.

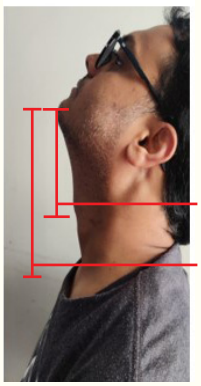


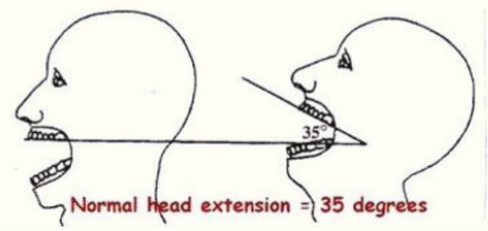
Finger breadth technique

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

Assessment :

Examination	Inference
Predictors for difficult intubation (DI)	• Mnemonic : OBESE – Obesity – Bearded – Elderly – Short – Edentulous • Pregnancy • Long upper incisors • Inability to protrude lower jaw • Small mouth opening • High arched palate
Mouth opening	Finger breadth technique (Normal = 3 fingers)
Atlanto-occipital/C-spine mobility	• Normal : 12–35° • Neck circumference (>43 cm) ⟶ DI
Thyromental distance	Normal : >6.5 cm (<6 cm ⟶ DI)
Sternomental distance	Normal : 13 cm (<12 cm ⟶ DI)

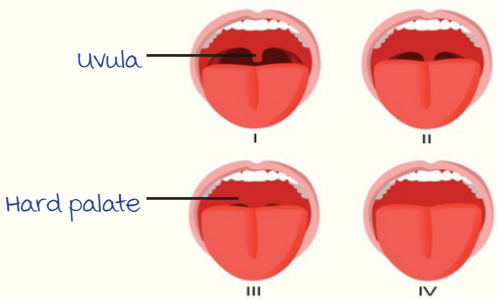




Mallampati scoring :

Mallampati scoring	
Grades	Structure seen
Grade I	Uvula hanging freely
Grade II	Tip of uvula not visible
Grade III	Half of uvula not visible
Grade IV (Introduced by Sampson Young)	Only hard palate visible
Grade 0	Clear glottic opening with large epiglottis

Difficult intubation (DI)



Mallampati scoring

ASA Grading & Pre-operative Investigations 00:55:08

ASA Grading :

Based on functional capacity.

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

Grade	Characteristics	Examples
I	Healthy patient	• Normal BMI, non-smoker, occasional alcohol use
II	Mild disease with no functional limitation	• Medical disease under control (HTN, DM,epilepsy) • Smoker, BMI = 30-40 • Pregnancy • Mild - moderate obesity
III	Severe disease with functional limitation	• Medical diseases with poor control (HTN, DM, epilepsy) • CKD, CLD, COPD • Morbid obesity (BMI >40)
IV	Severe disease with threat to life	• Recent MI, CVA, unstable angina
V	Moribund patient	• Death <24 hours
VI	Brain dead patient	-

Investigations :

Minimum laboratory parameters for various scenarios :

Parameters	Value
Minimum acceptable Hb before elective surgery	8 g/dL
Minimum acceptable Hb before elective surgery with comorbid conditions	10 g/dL
Minimum acceptable Hb before elective surgery in critically ill patients	12 g/dL
Minimum acceptable platelet count for invasive procedure (Central line/liver biopsy)	50,000
Minimum acceptable platelet count for central neuraxial block	1 lakh
Minimum acceptable platelet count for peripheral neuraxial block	80,000

Indications for ECHO vs ECG :

	ECHO	ECG
Mandatory	• Dyspnoea of unknown origin. • Heart failure patients with worsening dyspnoea.	• K/c/o IHD. • Significant arrythmia PAD, CVD. • Significant structural heart disease.
May be done	• Past h/o LV dysfunction not evaluated since 1 yr.	• Major Sx in asymptomatic patients without h/o coronary heart disease
Not performed	• As routine investigation.	• Asymptomatic patients. • Low risk surgical procedures.

Risk Stratification

01:03:43

Cardiac risk stratification :

ACC/AHA guidelines.

High risk surgery :

- Surgery above umbilicus/emergency surgery.
- Proceed with surgery.

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

Elective surgery : Thoroughly evaluate for the following & then do Sx

- ACS.
- Decompensated HF.
- Significant arrhythmias.
- Valvular heart disease.

Risk assessment for developing MI :

Parameter	Score
High risk surgery	1
H/o ischemic heart disease	1
H/o congestive cardiac failure	1
H/o cerebrovascular accident	1
H/o diabetes mellitus requiring insulin	1
Serum creatinine >2.0	1

Score	Risk of cardiac complication
0	0.4 %
1	1.0 %
2	2.4 %
≥3	5.4 %

Stress testing : Perform if functional capacity <4 METS.

Criteria for performing Sx after coronary stenting :

- Bare metal stent : Wait for 1 month.
- Drug eluting stent (m/c) : Wait for 6 months.

Criteria for giving infective endocarditis prophylaxis :

- Previous history.
- Prosthetic valves.
- Unrepaired/repaired (Residual defect) CHD.
- Cardiac transplant.

Pulmonary risk stratification :

Patient related	Procedure related	Laboratory test
• Old age • Cigarette smoker • Abnormal findings on CXR	• Aortic aneurysm repair • Upper abdominal Sx • Emergency Sx	• Albumin concentration <3.5 g/dL • Chest radiograph abnormalities

Pre-operative Instructions

01:09:53

Pre-medications :

- Anxiolytic : Short acting benzodiazepines (Midazolam).
- Anti-emetic (Ondansetron).
- Anti-sialogogues :
  - Atropine/Glycopyrrolate.
  - Indication : Children, intellectual disability, head & neck Sx.
- Analgesia : Short acting opioids (Fentanyl).
- Antibiotics : Cephalosporin for cardiac Sx.

Fasting guidelines before Sx :

- Adult : 6–8 hours.
- Children :
  - 2 hours : Clear liquids.
  - 4 hours : Breast milk.
  - 6 hours : Non-human milk, solids
  - 8 hours : Heavy fatty meal.

ANESTHESIA REVISION - 2

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

Monitoring of Patient : CNS, CVS, RS

00:01:48

CNS Monitoring

Depth of anesthesia (Absence of awareness) is monitored.

Bispectral Index

Bispectral Index :

- Analyzes EEG waveforms.
- 40 to 60 : Recommended range for GA.

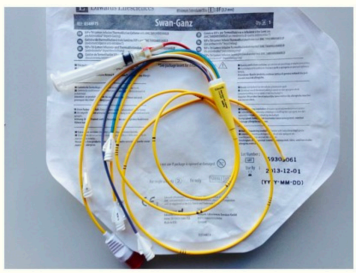
CVS Monitoring :

- HR
- BP
  - Non-Invasive : Sphygmomanometer
    - Palpation.
    - Auscultatory.
    - Oscillatory. (Automatic)
  - Invasive (m/c : Radial) :
    - Major Sx.
    - Allens test : Ensures adequate collateral circulation
      - Allens Test (AT) :
        - Compress B/L radial A. with 2 hands.
        - Negative : Normal.
      - Modified AT :
        - Compress both radial & ulnar A.
        - Positive : Normal.
- ECG
  - Arrhythmias : Lead II
  - Ischemia
- Central venous pressure
- Pulmonary Capillary Wedge Pressure (PCWP)
- Echocardiography

Central Venous Catheter vs. Pulmonary Artery Catheter :

	Central Venous Catheter	Pulmonary Artery Catheter
Features	• Measures : Right heart functioning → CVP (Normal : 0–5 cm H_2O) • Monitor fluid status : – ↓CVP + ↓BP → Rx : Fluids. – ↑CVP + ↓BP (Pump failure) → Don't administer fluids. • Long term IV cannulation for : TPN, inotropes, cardiac medications.	• Measures : Left heart functioning → PCWP Normal : 12–16 mmHg ↑ : LV dysfunction • Reduntant method

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

	Central Venous Catheter	Pulmonary Artery Catheter
Complications	Arrhythmias (m/c)	• Arrhythmias : m/c • Pulmonary capillary rupture : most dreaded
Image	Triple lumen • Size : 7 Fr (20 cms) • Inserted in IJV.  CV Catheter	 Swan-ganz catheter

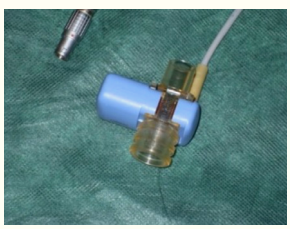
RS Monitoring :

Pulse Oximeter :

- Measures oxygenation.
- Principle : Beer Lambert's law.
- Emits :
  - Red light (660 nm) $\xrightarrow{\text{Absorbed by}}$ Reduced Hb.
  - Infrared light (940 nm) $\xrightarrow{\text{Absorbed by}}$ Oxygenated Hb.
- Limitations :
  - CO poisoning : SpO_2 falsely ↑
  - Meth Hb, dyes : SpO_2 ↓

Capnography :

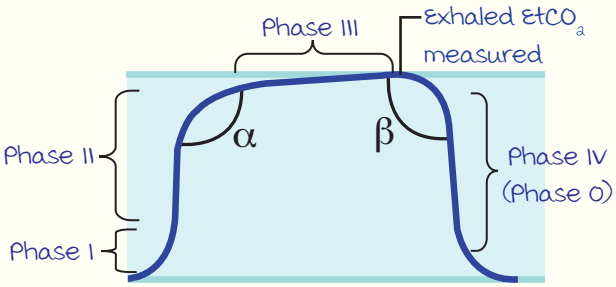
- Monitors exhaled CO_2
- Principle : Infra red spectroscopy.
- Normal $EtCO_2$: 35–45 mmHg.


Main stream capnography


Side Stream Capnography

Waveforms :

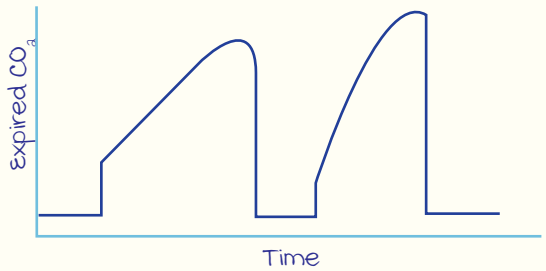
Normal : Top hat shape.



Phase	Characteristics
I	Exhaled from dead space (No CO_2)
II	Expiratory upstroke (Gases exhaled by upper alveoli)
III	Alveolar plateau phase (Gases exhaled from middle & lower alveoli)
IV	Inspiratory downstroke

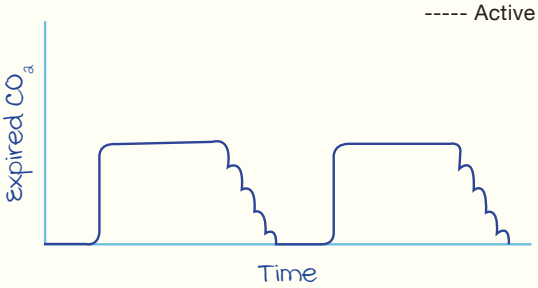
Abnormal Waveforms :

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



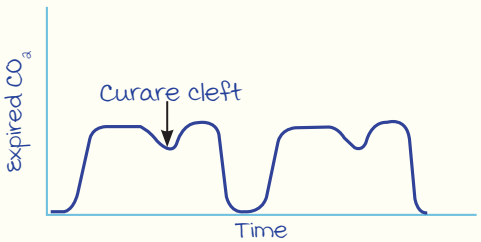
Bronchospasm/Partially obstructed ET tube

- Increased upstroke of phase III.
- Shark fin pattern.



Cardiogenic oscillations

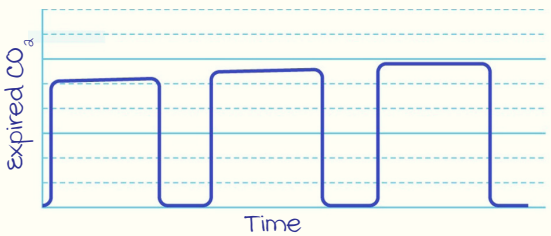
Physiological in children (D/t thin chest wall).



Recovering from the effect of muscle relaxant

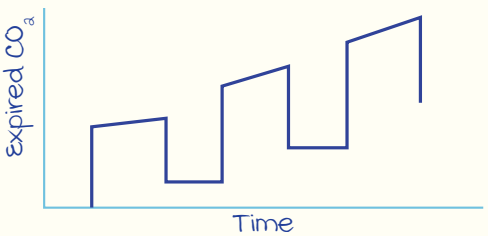
If curare cleft seen :

- During Sx : Supplement with muscle relaxant.
- End of Sx : Start reversal.

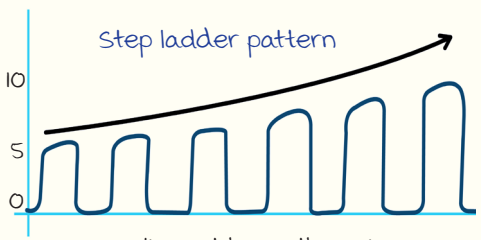


Hypoventilation

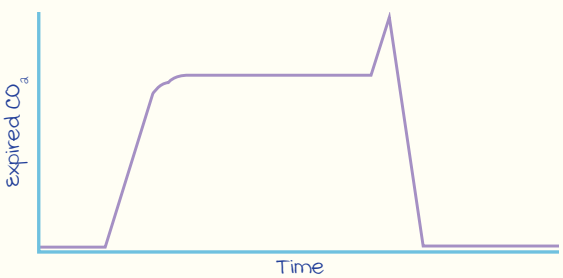
Seen in opium poisoning (CNS depressant)



Malignant hyperthermia

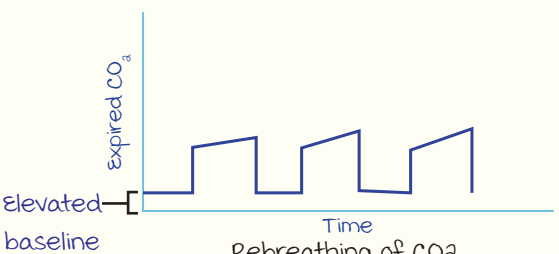


Malignant hyperthermia



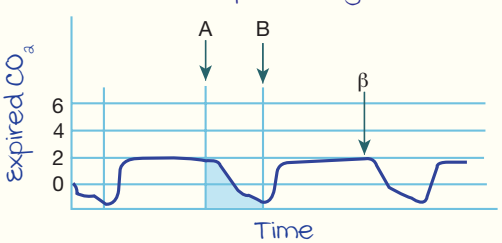
Leaky sampling line

Dual plateau sign.



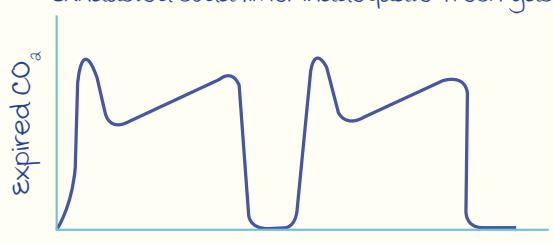
Rebreathing of CO2

Exhausted soda lime/inadequate fresh gas flow



Incompetent inspiratory valve

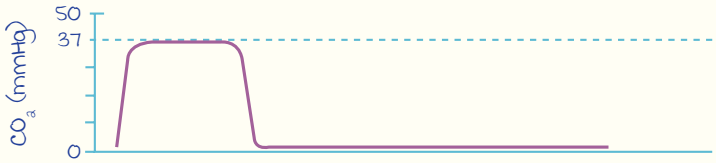
Slaying of phase IV.



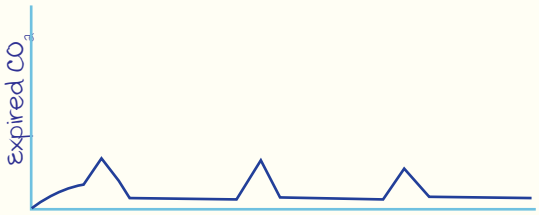
Single lung transplant

2 peaks in phase III

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



Sudden zeroing of $EtCO_2$



Intubation into esophagus

- Accidental extubation/circuit disconnection (m/c)
- Venous air embolism

Monitoring of Patient: Neuromuscular & Temperature

00:34:59

Neuromuscular Monitoring :

Use : To check adequate muscle relaxation after Sx.

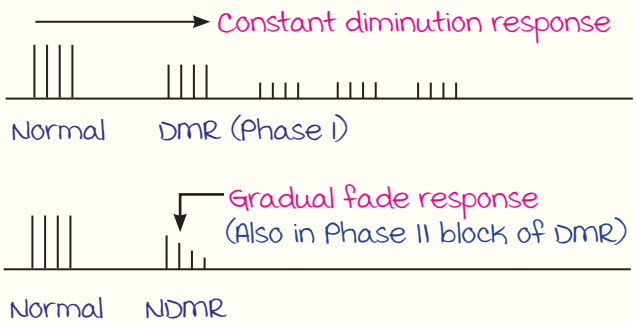
Train Of Four (TOF) stimulation :

- Muscle contraction noted on 4 equal supramaximal stimulus.
- TOF ratio (4^{th} stimulus/1^{st} stimulus) : > 0.9

Ulnar nerve monitoring (m/c)
(Adductor policis muscle)

↓

Safe to extubate (Fully recovered from muscle relaxant).



Temperature Monitoring :

Hypothermia :

- D/t depressed hypothalamus, chilled OT & IV fluids.
- Under anesthesia : ↓Shivering threshold.

Hyperthermia :

Malignant hyperthermia, sepsis.

Monitoring :

Site		Areas for measurement
Core body temperature	Neuro Sx	Tympanic membrane, nasopharynx
	Cardio Sx	Pulmonary artery (most accurate)
	Other Sx	Lower esophagus (m/c done)
Intermediate		Rectum (Wards, casualty)
Not reliable		Skin, Axilla

Note : Bladder temperature → Not performed since values affected by urine flow.

Airway Management & Equipments

00:44:37 ----- Active space -----

Pre-oxygenation :

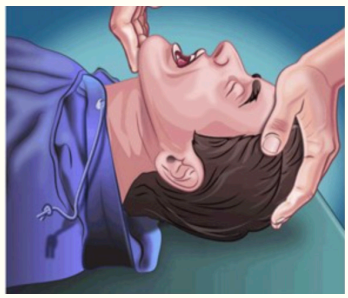
Anatomical face mask :

	100% O_2 with tight fitting mask	Time
Normally	10–12 L (↑Apnea time up to 10 min)	3 min
Emergency	Preferred : 8 Vital Capacity (VC) breaths	1 min
	Least preferred : 4 VC breaths	30 sec

Anatomical face mask

- Position : Slight head up.
- Triple manoeuvre (Prevents tongue falling back)
  - Head tilt
  - Chin lift
  - Jaw thrust

Jaw thrust



Head tilt & chin lift

Recent updates :

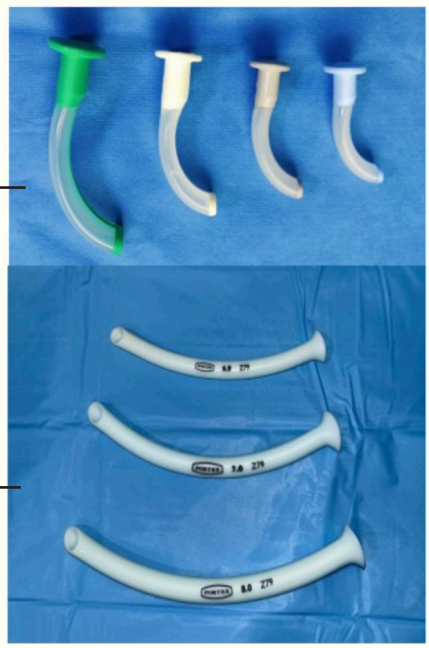
	O_2	↑Apnea time by
Trans-nasal Humidified Rapid Insufflation Ventilatory Exchange (THRIVE)	60 L for 3 min	13 minutes
NO DESAT : Directly to pharynx	15 L/min	9 minutes

Guedel's airway :

- Prevents tongue fall back.
- Disadvantage : Stimulates Gag reflex.
- Size : Angle of mouth to tragus/mandible.

Nasopharyngeal airway:

- Prevents collapse of pharynx.
- Contraindications :
  - Children with adenoids.
  - Base of skull fracture (Raccoon's eye).
  - Coagulopathy.



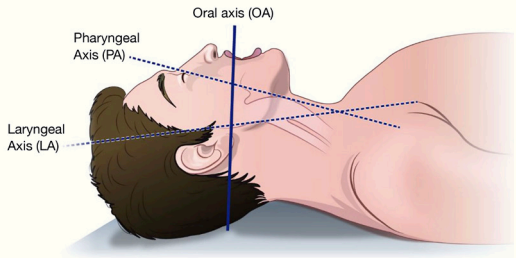
Guedel's airway

Nasopharyngeal airway

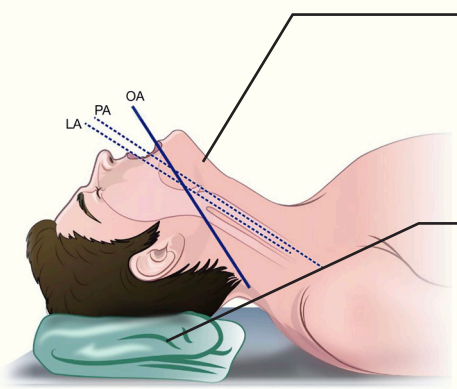
----- Active space -----

Laryngoscopy :

Head & neck position :



Scissor's method
(To extend the lower jaw)



Neck extension
↓
Oral axis is aligned with the other 2 axes.

10–15 cm pillow/head ring behind the occiput
↓
Helps align pharyngeal & laryngeal axes.

Sniffing of morning air/Drinking of pint beer position

- Flexion : At lower cervical spine
- Extension : At atlanto-occipital joint

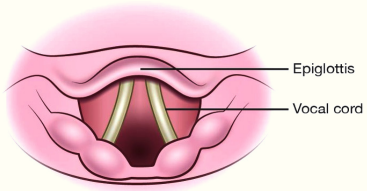
Laryngoscopes :

	Macintosh/Curved blade	Miller's/Straight blade
Used in	Adults	Children.
Method	Hold laryngoscope in left hand ↓ Insert from right corner of mouth ↓ Push tongue to side till blade reaches its base ↓ On visualising epiglottis (Don't include) : Lift hand using triceps & deltoid Note : Do not bend at wrist joint. (Causes upper teeth injury.)	Same as adults except : • Inserted from center of oral cavity • Include epiglottis, while lifting the hand
Visualisation	Indirect	Direct
Image		

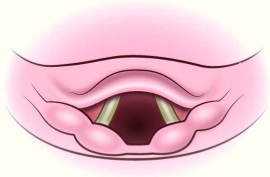
Corkmack lehane grading :

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

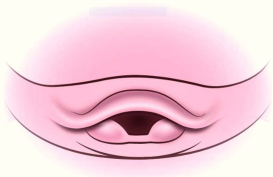
To assess visibility of glottic opening after laryngoscopy.



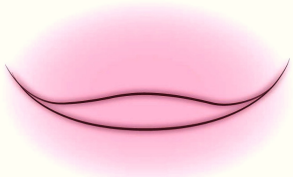
Grade I : Complete laryngeal aperture seen



Grade II : Only posterior portion of laryngeal aperture seen



Grade III : Only epiglottis seen



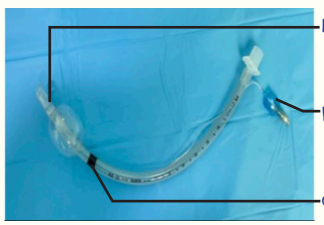
Grade IV : Epiglottis not seen

ETT & Miscellaneous Equipments for Intubation

01:06:41

Endotracheal Tube (ETT) :

Types :



Murphy's eye : Alternate ventilation

Pilot balloon : Inflates cuff

Guide : Crosses vocal cords

Cuffed ETT (Prevents aspiration)

Uncuffed ETT

Types of Cuffed ETT → ↓Pressure, ↑Volume (PVC)

↑Pressure, ↓Volume (Red rubber) → Disadvantage : Pressure >25 cmH_2O damages tracheal mucosa.

↑Pressure, ↓Volume cuff

Narrowest part of larynx :

- Glottis : Adults → Cuffed ET tube.
- Subglottis : Children → Microcuffed (Recent recommendation) : Distal placement.
  → Uncuffed

Microcuffed ETT

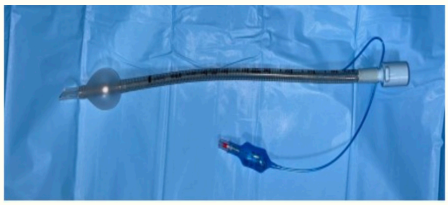
----- Active space -----

Modification :

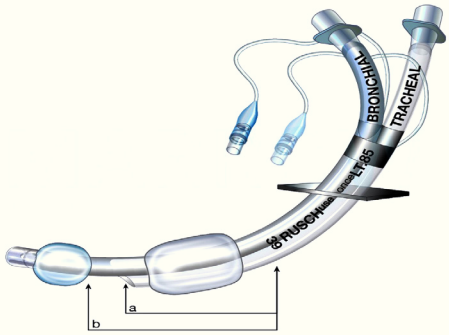
Flexometallic/Armoured tube :

Use :

- Head & neck Sx.
- Prone position Sx.



Double lumen ETT : Used in lung Sx



RAE ETT :

- South facing : Cleft lip surgeries.

- North facing : Lower lip Sx

Accessory Gadgets :

- Passed in ETT

Stylet

- Direct tracheal insertion

Bougie

- For foreign body removal

Magill's forceps

Advanced Gadgets :

Flexible fiber optic bronchoscope :

- Gold standard for ETT position.
- Used in restricted mouth opening & lung Sx.

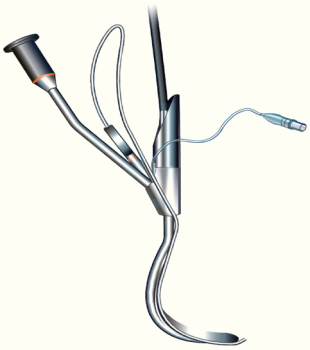
Note : Capnography → Surest sign of intubation.

Flexible fiber optic bronchoscope

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

Video laryngoscope

Airtraq laryngoscope



Bullard laryngoscope

Health care worker protection : D/t
↓chances of aerosol contamination

Supraglottic Airway Devices

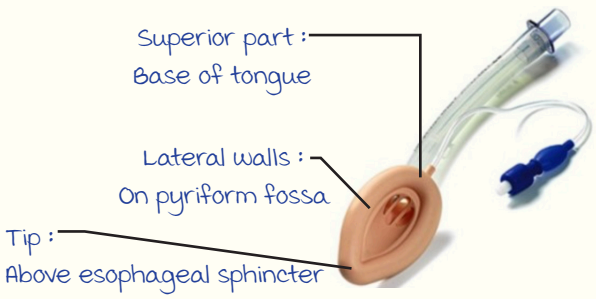
01:17:40

LARYNGEAL MASK AIRWAY (LMA) :

First Generation :

Classical LMA : (made of Latex)

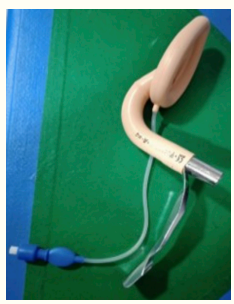
- Advantages : Easy to use, minimal neck movement.
- Disadvantages : Doesn't prevent aspiration.
  ↓
  Avoid in : Emergencies, Prone position, Laparoscopy, Pregnancy.



LMA Unique :

- Made of PVC.
- Single use.

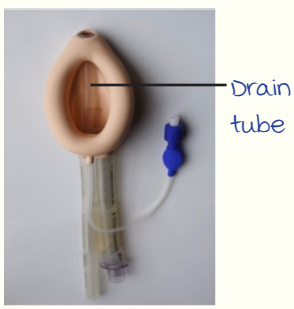
Intubating LMA



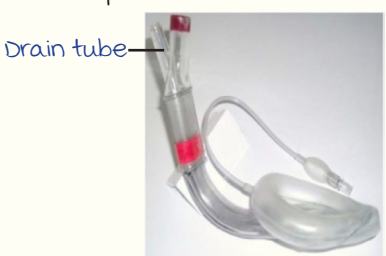
Second generation :

D/t drain tube (For removal of aspirate).

Proseal LMA :



LMA Supreme :



- Made of PVC (Better sealing pressure)
- Used in laparoscopic Sx & pregnancy. (But intubation preferred)

IGEL :

- Made of silicon gel. (mimics shape of pharynx.)
- No pilot balloon.

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

Modifications for Intubation

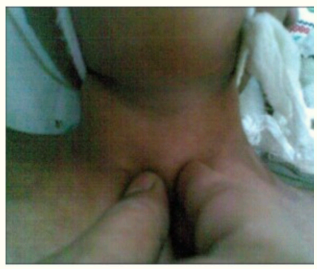
01:24:50

Manual in-line stabilization : ↓Neck movement after RTA.

Rapid sequence/Emergency intubation :

Sellick's Maneuver : Applying pressure on cricoid cartilage (Esophageal lumen occlusion).

Ramp position
(For obese patients)

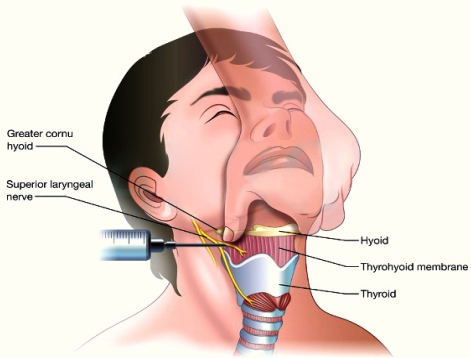


Selick's Maneuver

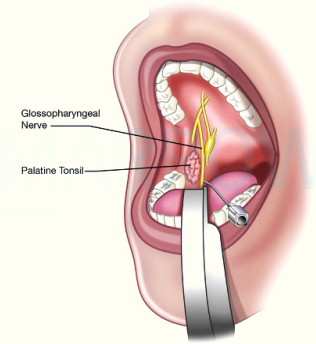
Feature	RSI	Modified RSI
Procedure	Induction agent & muscle relaxant administered quickly → Cricoid pressure applied (30 N) → Cricoid pressure removed after : Intubation & cuff inflation.	
Muscle relaxant	Succinylcholine (Short acting)	Rocuronium
Induction AOC	Thiopentone sodium	Propofol
PPV	C/I (↑Risk of aspiration)	Gentle PPV (<20 cm) permitted

Awake intubation :

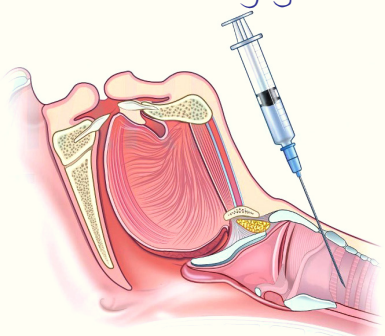
- Superior laryngeal nerve block



- Glossopharyngeal nerve block

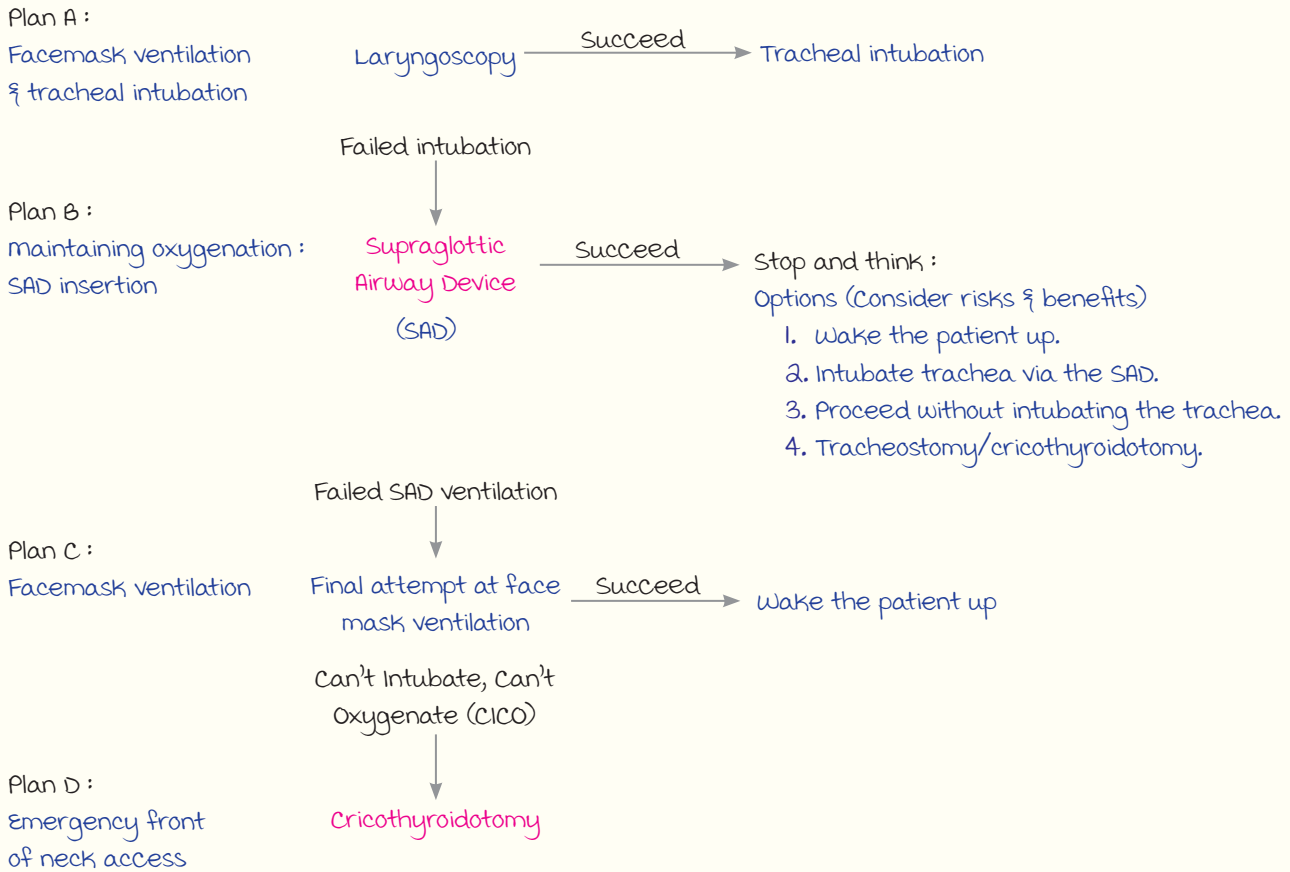


- Transtracheal injection :
  Blocks recurrent laryngeal nerve



Failed Intubation Algorithm

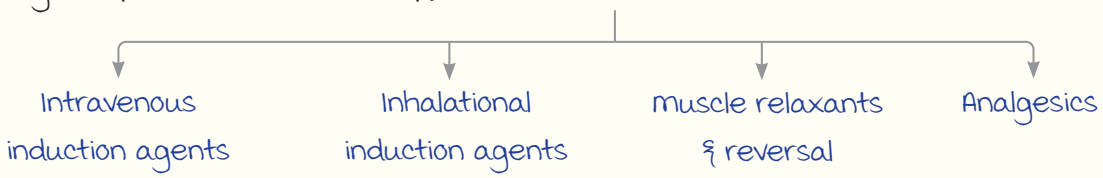
01:33:39 ----- Active space -----



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

ANAESTHESIA REVISION - 3

Drugs in General Anaesthesia (GA) :



Intravenous Induction Agents

00:01:47

Induction agents : Depressants.

- Act on GABA receptors : ↑Chloride conductance → Membrane hyperpolarization.

BARBITURATES

Good antiepileptic action (Except Methohexital).

Thiopentone Sodium :

General properties : Yellow powder of pH 10.5 (most alkaline) with garlic/onion smell.

Onset : 15 sec (Arm brain circulation time).

Metabolism :

- Highly lipophilic.
- Termination of action by redistribution (Brain ⇌ Fat).
  - Patient will have a hangover effect.

Dose : 3-5 mg/kg.

Use :

- AOC :
  - Neurosurgeries (Max. ↓ICP).
  - Hyperthyroidism
- Truth serum.

Complication :

- Accidental intraarterial administration : Pain, pallor, edema, gangrene.
  Mx : Retain cannula (To prevent vasospasm).
  - Saline/heparin flush.
  - Stellate ganglion block (Lower cervical sympathetic ganglion).

Methohexital :

Disadvantage : Proconvulsant (Avoided in neurosurgeries).

Indication : Electroconvulsive therapy.

Dose : 1-1.5 mg/kg (more potent than thiopentone).

NON BARBITURATES

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

	Propofol	Etomidate	Ketamine
Form : (Oily ↓ Painful injection)	• White : Egg lecithin (used within 6 hours). • Oily preparation : Soya bean oil. • Mixed with lignocaine to ↓pain.	Oily preparation : Propylene glycol.	Phencyclidine derivative
Properties	Antiemetic & antipruritic	Most cardiostable	• Dissociative anaesthesia, Depressant (In vivo). • NMDA receptor antagonist (↑Catecholamine release).
Dose	1–2.5 mg/kg	0.2–0.3 mg/kg	• IV : 1–2 mg/kg. • IM : 4–6 mg/kg.
Onset	15 sec	–	–
Duration	8–10 min (Without hangover)	–	Intrathecally used with LA to ↑duration
Agent of choice	• Day care/ambulatory Sx & monitored anaesthesia care. • Ophthalmic Sx (max ↓IOP). • LMA insertion & Rx of laryngospasm (↓ reflexes). • Total IV anaesthesia. • Office based anaesthesia : Endoscopy & colonoscopy.	• Cardiac & aneurysm Sx. • DC cardioversion.	• Shock (↑HR & BP). • Asthma/COPD : Good bronchodilator. • Tetralogy of Fallot. • Low resource settings (Burns, I & D). • Paediatric Sx.
Side effects	Propofol infusion syndrome (On prolonged infusion) : • Green wine, severe metabolic acidosis, asystole. • Addictive d/t pleasant hallucinations.	• Myoclonus • Emetic & Epileptogenic. • Inhibits adrenocortical synthesis.	• ↑Oral secretions (Rx : Atropine/ Glycopyrrolate). • Unpleasant hallucinations/ Emergence (Reduces with midazolam). • C/I : – HTN & cardiac conditions. – Ocular Sx (↑IOP)

Inhalational Induction Agents

00:38:27

Characteristics :

- Maintain depth of anaesthesia.
- Induce sleep (Paediatric).
- Depressants.
- Enter & exit the circulation via lungs.

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

Classification :

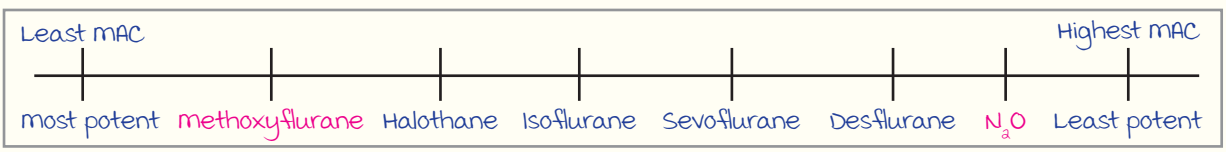
- **Newer agents (Non flammable) :**
  - Halothane.
  - Isoflurane.
  - Desflurane.
  - Sevoflurane.
- **Older agents (Flammable) :**
  - Ether.
  - Chloroform.
  - Trilene.
  - Cyclopropane.

Meyer Overton Rule :

Potency ∝ lipid solubility.

Minimum alveolar concentration (MAC) :

- Minimum amount of drug required to produce immobility to painful stimulus.
- Potency $\propto \frac{1}{\text{MAC values}}$.



FACTORS AFFECTING UPTAKE

Machine to Alveoli :

a. Concentration effect :

- Higher inspired concentration ⟶ Quicker induction.

b. Second gas effect (Augmented in flow effect) :

- In presence of one gas (N_2O) ⟶ Concentration of IA increases.
- Reason : Rapid diffusion of N_2O from alveoli to pulmonary circulation.

Both effects seen simultaneously at start of surgery.

Note :

Diffusion hypoxia/Fink effect (End of Sx) :

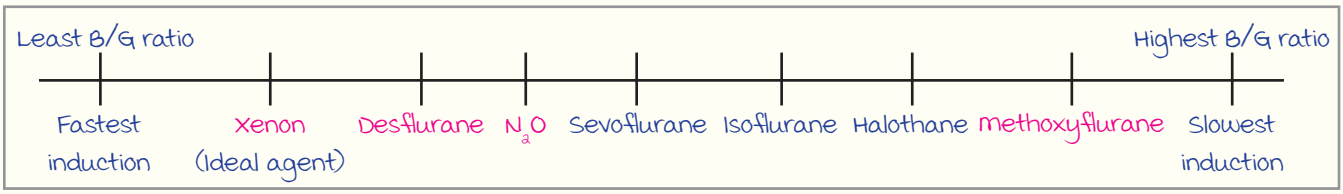
- Rapid diffusion of N_2O from pulmonary circulation ⟶ Dilution of O_2.
- Mx : O_2 supplementation.

Alveoli To Pulmonary Circulation :

Blood gas partition coefficient (B/G ratio) : $\frac{\text{Concentration of agent in blood}}{\text{Concentration of agent in alveoli}}$

↑ B/G ratio ⟶ ↑Concentration in blood ⟶ ↑ Solubility in blood ⟶ Delayed induction

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



Systemic Effects Of Inhalational Agents

01:06:15

<table>
<tr><th></th><th>Halothane</th><th>Isoflurane</th><th>Desflurane</th><th>Sevoflurane</th></tr>
<tr><td rowspan="2">Pulmonary system :
↓RR</td><td>• Maximum bronchodilation.
• Sweet scent (2nd choice in children)
Note : Contains thymol (Preservative)</td><td>• Pungent : Avoid in asthmatics.</td><td>• Irritant : Avoid in asthmatics.</td><td>AOC :
• Paediatric Sx (Sweet scene).
• Daycare Sx.
• Lung injury.</td></tr>
<tr><td colspan="4">• ↓ Pulmonary vascular resistance.
• Mild hypoxic pulmonary vasoconstriction.</td></tr>
<tr><td>CVS :
↓HR, ↓BP</td><td>• Max ↓ HR (Bradyarrhythmias)
• Sensitises myocardium to adrenaline.</td><td>• AOC : Cardiac patient (↓Preload & afterload)
• Complication : Coronary steal phenomenon.</td><td>• Avoided in cardiac patients (↑HR temporarily)</td><td>AOC for cardiac patients</td></tr>
<tr><td rowspan="2">CNS :
↑ Cerebral blood flow (CBF)
↓
↑ ICP.</td><td>• Max ↑CBF, ↑ICP.
• C/I in neurosurgery</td><td colspan="3">The rise in ICP is countered by hyperventilation (↓$EtCO_2$ = ↓ICP).
Used in neurosurgery.</td></tr>
<tr><td colspan="4">Note : Enflurane causes seizures.</td></tr>
<tr><td rowspan="2">GIT, liver and biliary tract :
↓Liver blood flow (LBF)</td><td rowspan="2">• Max ↓LBF.
• Metabolite causes Halothane hepatitis in old age, female, 40 yrs, obese, multiple exposure.</td><td>-</td><td>Minimally metabolised.</td><td>-</td></tr>
<tr><td colspan="3">Hepatic insufficiency : Either of 3 used</td></tr>
</table>

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

	Halothane	Isoflurane	Desflurane	Sevoflurane
Renal system : Fluoride ions (Added to make it non inflammable) Causes nephrotoxicity.	-	Best agent : Desflurane > Isoflurane (Least metabolized)		• Max fluoride ions. • Prolonged use of Sevoflurane (High. conc.) + soda lime = Compound A (Nephrotoxic in lower animals).
	Note : Max nephrotoxicity → Methoxyflurane.			
Reproductive system	Good uterine relaxants (↑risk of PPH).			
Ocular	↓ IOP			
Metabolism	Max	-	• Minimal • Green house gas	-

Note : Trilene → Only analgesic.

Effects of N_2O :

- Proven teratogen.
- Disrupts Vit B_{12} metabolism :
  - Megaloblastic anemia.
  - Subacute combined degeneration of spinal cord.
- C/I in :
  - Pneumothorax/pneumomediastinum.
  - Middle ear & retina sx.

ANAESTHESIA REVISION - 4

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

Muscle Relaxants : DMR

00:00:09

Aids in intubation/Surgical relaxation.

Depolarizing Muscle Relaxants (DMR) : Succinylcholine

	Succinylcholine (2 molecules of ACh)
Dosage	1-2 mg/kg
Duration	<10 minutes
Onset of action	30 seconds
AOC	Difficult intubation/rapid sequence intubation
Mechanism of action	• Non competitive blockade : Ach receptor. • Metabolised by pseudocholinesterase. (PSE : Produced by liver).
Systemic effects	• Bradyarrhythmia (Rx with Atropine/Glycopyrrolate). • Muscle fasciculations : – Post-operative myalgia. – ↑ICP, ↑IOP, ↑Intragastric pressure (↓Chances of aspiration) • Anaphylaxis
C/I	• Family h/o malignant hyperthermia & muscular dystrophies. • Preexisting hyperkalemia. • Burns. • Acute liver failure. • Sepsis. • Hemiplegia/paraplegia.

Reasons for prolonged duration of action :

↓Concentration of PCE :
- Acute liver failure.
- Neonates, pregnancy.
- Drugs :
  - Pyridostigmine.
  - Organophosphate poisoning.

↓PCE enzyme activity :
Atypical pseudocholinesterase.

Phase II block :
- Succinylcholine >5mg/kg : Receptor damage.
- Rx : Mechanical ventilation.
- Resembles NDMR block, but Neostigmine is C/I.

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

Atypical pseudocholinesterase :

- Qualitatively assessed by dibucaine number.
  (↑Affinity to pseudocholinesterase).
- Rx :
  - Continue Mechanical ventilation.
  - Fresh frozen plasma.

Type of Pseudocholinesterase	Dibucaine number	Duration of action
Normal	80 : 20	<10 min
Heterozygous variant	50 : 50	45 min – 1 hour
Homozygous variant	20 : 80	6 – 8 hours

Muscle Relaxants : NDMR

00:24:23

Non Depolarizing Muscle Relaxants (NDMR)

Types :

: Steroidal compounds. : Benzylisoquinolone compounds.

	Properties	Advantages	Disadvantages
Pancuronium	Excretion : Kidney	AOC : Shock	• Avoid in day-care Sx • C/I : HTN & cardiac patients (↑HR & BP)
Vecuronium	Excretion : Bile	AOC : Cardiac & neuro Sx	Avoid in hepatic insufficiency
Rocuronium	• Onset : 30 sec. • Duration 30 min. • Dose : 0.6–1.2 mg/kg.	AOC : • Rapid Sequence Intubation. • Day Care Sx.	–
Atracurium	Metabolism : Hoffman's degradation (Non-enzymatic/non organ dependant clearance)	AOC : Liver & renal transplant/ failure patients.	• Anaphylaxis (D/t histamine release). • Seizures (D/t laudosine released on prolonged infusion)
Cisatracurium (Isomer of atracurium)	Preferred over Atracurium (D/t lesser S/E)	• Similar to atracurium. • No histamine & minimal laudosine release.	–
Mivacurium	• Onset : 2–3 sec. • Duration : 10 minutes (Shortest). • Metabolism : Plasma esterases.	• Day-Care Sx : 2nd preferred AOC.	–

Reversal Of Block :

Neostigmine :

- Dose : 0.05 – 0.07 mg/kg.
- Administered on spontaneous breathing ($EtCO_2$: Curare cleft).
- Side effect : Bradycardia/↑Oral secretions → Rx : Atropine/Glycopyrrolate.

Sugammadex (New reversal agent) :

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

- Cyclodextrin molecule.
- Used for reversal of Vecuronium/Rocuronium (In day care Sx).
- Side effects :
  - Anaphylaxis
  - Contraceptive failure.

Signs of adequate reversal :

- Regular respiration & adequate tidal volume.
- Spontaneous eye opening.
- Spontaneous limb movement.
- Able to protrude tongue, cough (No cyanosis).
- Able to lift head >5 sec (most reliable bedside test).
- Able to hold tongue depressor b/w central incisors.
- Train of four ratio > 0.9 : Guaranteed recovery.

Paediatric Surgeries

00:43:53

Preoperative Preparation :

To ↓anxiety :

- Benzodiazepine syrup (Midazolam).
- Ketamine IM : 4-6 mg/kg.
- Parental accompaniment in OT.

} Children > 6 months age

Fasting guidelines :

- 2 hours : Clear liquids.
- 4 hours : Breast milk.
- 6 hours : Solids (Except breast milk).
- 8 hours : Heavy fatty meal.

Note : EMLA Cream → Eutectic mixture

- Lignocaine (2.5%) + Prilocaine (2.5%).
- Used for superficial procedures (IV cannulation).

Intraoperative Considerations :

Induction of anaesthesia
- Inhalational.
- AOC : Sevoflurane > Halothane (Inhalational agents).

Muscle relaxant
- AOC : Vecuronium/Atracurium.
- Avoid : Succinylcholine in <1 year (D/t undiagnosed myopathy).

Analgesic : Fentanyl 1-2 mcg/kg (Short acting agent).

Airway Management
- ETT : Microcuffed > Uncuffed ETT.
- Laryngoscope : Miller's blade.

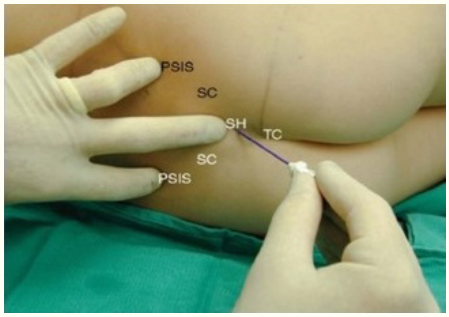
Prevention of hypothermia
- OT temperature : 27-28°C.
- Warm fluids & heating devices.

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

Post-Operative Analgesia :

Caudal anaesthesia :

- No risk of spinal cord injury.
- Administered only in postoperative phase in children.
- ↑Risk of infection (D/t bowel & bladder immaturity).



Caudal anaesthesia :
Insertion at S4-S5 vertebral junction & directed towards S2 segment.

Day Care Anaesthesia

00:59:32

- Same day admission, operation & discharge.
- ↓ Risk of hospital infection.
- All regional anaesthesia procedures can be done in day care setting.

Prerequisites :

Patient factors :

- Consider ASA grades → I & II.
  → III (In well-controlled diseases).
- Avoid extreme ages : Premature babies/>85 years.
- Stays near the hospital & has a responsible attender.

Procedure factors :

- Indications : Laparoscopic Sx.
- C/I → Procedures anticipating post-op complications.
  → Duration >90 minutes.

Anaesthetic factors :

	Agent of choice (Short acting with no residual effects)
IV induction	Propofol
Inhalational	Sevoflurane (Sweet smelling) > Desflurane (Irritant)
Muscle relaxant	Rocuronium & Sugammadex > Mivacurium
Opiod	Remifentanyl (Shortest), Fentanyl (India)
Local anaesthesia	Chlorprocaine (Shortest)

Post Operative Considerations :

Discharge of patient : Modified Aldrette Scoring System → Fit for discharge if >9.

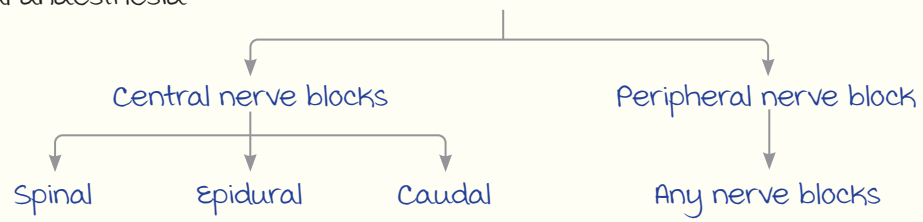
Complication :

- m/c : Drowsiness, nausea & vomiting.
- m/c cause for readmission : Hemorrhage.

ANAESTHESIA REVISION - 5

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

Regional anaesthesia :



Spinal Anaesthesia/Subarachnoid Block

00:01:07

Indications :

Below umbilical surgeries.

Absolute C/I :

- ↑ICP.
- Bleeding tendencies.
- Local site infection.
- Patient refusal.
- Severe hypovolemia.
- Severe mitral & aortic stenosis.
- Drug allergy.

Site :

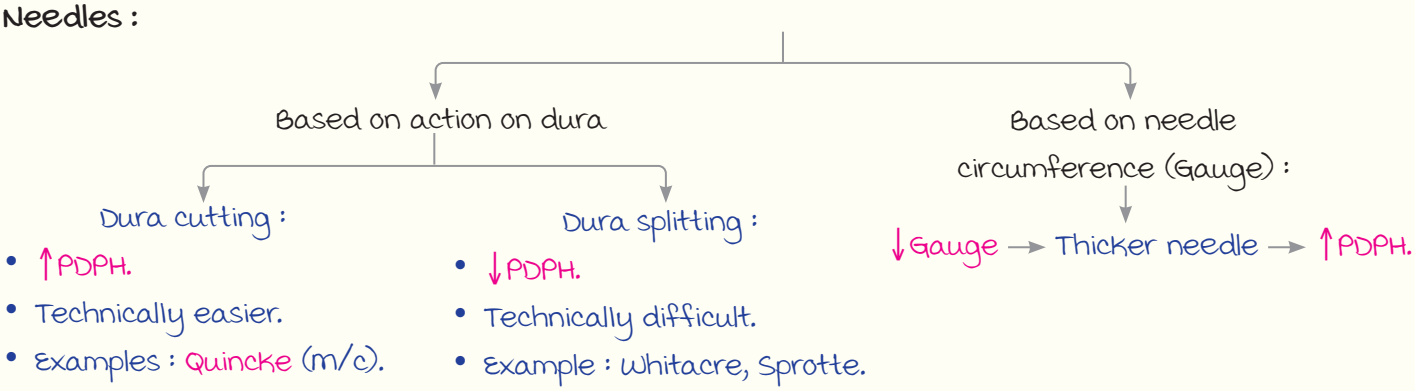
- Adults : L3 – L4.
- Children : L4 – L5.

Procedure :

- Preparation : Strict aseptic precaution.
- Position : Sitting/left lateral/prone.
- Projection of needle :

Layers encountered : Skin → Subcutaneous tissue → Supraspinous ligament → Interspinous ligament → Ligamentum flavum → Dura mater → Arachnoid mater

Needles :



- ↑PDPH.
- Technically easier.
- Examples : Quincke (m/c).
- ↓PDPH.
- Technically difficult.
- Example : Whitacre, Sprotte.

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

Post Dural Puncture Headache (PDPH) :

Incidence : m/c after LSCS.

Characteristics :

- Dull boring type with mild – moderate intensity.
- Seen 24 to 48 hours after Sx at occipital & frontal region.
- Aggravating factors : Change in posture.

Mx :

- Adequate bed rest + Plenty oral fluids.
- Analgesia : Caffeine + paracetamol.
- Severe cases : Epidural blood patch.

Factors Affecting Level of Anaesthesia (LOA) :

Patient factors :

- Height ∝ 1/LOA.
- CSF ∝ 1/LOA.
- Pregnancy : ↑Blockade d/t → ↑Intraabdominal pressure → ↑Subarachnoid & epidural venous pressure.
  → Progesterone (Nerves become sensitive).

Procedure factors :

Position : Related to baricity.

Drug	Trendelenburg (Head down)	Reverse Trendelenburg (Head up)
Hyperbaric	Higher level of block	Lower level of block
Hypobaric	Lower level of block	Higher level of block

Drug factors :

- Volume & level of injection ∝ Level of anaesthesia.
- Baricity of drug = Density of drug compared to CSF.
  - Hypobaric (Drug floats) : ↑Blockade.
  - Hyperbaric (Drug settles down) : ↓Blockade.

Side Effects :

Spinal anaesthesia → Sympathetic blockade.

Side effects of spinal anesthesia	
CVS	1. ↓HR (Rx : Atropine/glycopyrrolate) 2. ↓BP : a. Prevention : Preloading IV fluids b. Rx : Pregnant → Phenylephrine (DOC) Non-pregnant → Ephedrine (DOC)/mephentermine
Respiratory system	1. Low LOA : No effect 2. High LOA : Only Intercoastal muscles paralysed (C/o shortness of breath)
GIT	Sphincters relaxed → Reverse peristalsis
GUT	• Urinary retention (m/c) → Rx : Foley's catheter • Penile enlargement

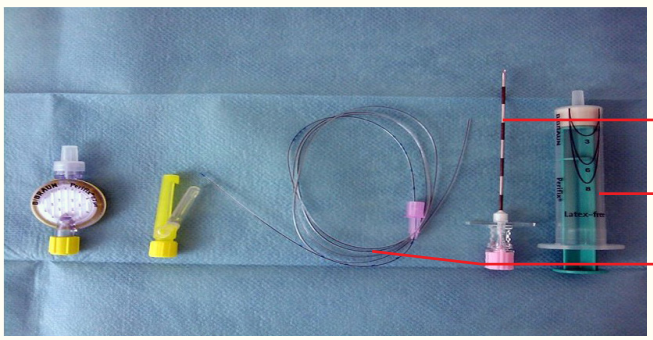
Epidural Anaesthesia

00:31:00

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

Technique :

Loss of resistance (LOR) technique.



Epidural catheter set

Advantages :

- ↑Duration of anaesthesia.
- Used in post-op analgesia.
- No risk of PDPH (As long as dura is not accidentally punctured).
- Stable hemodynamics.

Disadvantages :

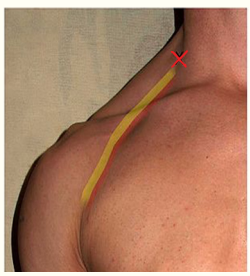
- Technically difficult & not suitable for emergencies.
- Inadequate blockade.
- Severe PDPH if accidental dural puncture.
- Accidental catheter migration → Subarachnoid Space : Total spinal anaesthesia (Mx : Intubation).
  → Blood vessel : Local anesthesia toxicity.

Peripheral Nerve Block

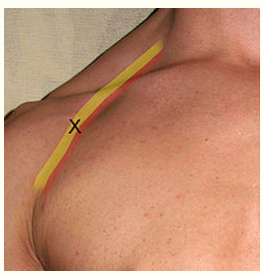
00:39:36

Brachial Plexus Block :

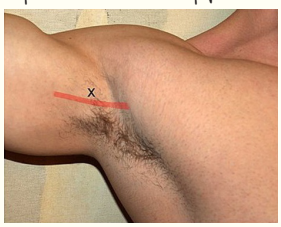
Interscalene approach



Supraclavicular approach



Infraclavicular approach



Axillary approach

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

	Indications	Disadvantages
Interscalene (Root)	Shoulder & upper arm Sx	• Horner's syndrome • Phrenic nerve is blocked • Ulnar N. spared
Supraclavicular (Distal trunk)	Distal arm & forearm Sx	• Horner's syndrome • Pneumothorax
Axillary (Nerves)	Forearm & hand Sx (No risk of pneumothorax)	Sparing of : • Musculocutaneous N. • Intercostobrachial N. (T2)
Infraclavicular (Cords)	Arm & hand Sx (Includes musculocutaneous & axillary N.)	Requires peripheral nerve stimulator

Local Anesthetics

00:52:27

Classification :

	Amides	Esters
Physical property	• Stable solution • ↓Incidence of allergic reaction	• Unstable solution • ↑Incidence of allergic reaction
Metabolism	In liver Except : Articaine	By plasma esterase Except : Cocaine.
Examples	• Lignocaine • Bupivacaine	• Procaine

MoA :

- Voltage gated sodium channel blockade.
- Action of LA↓ in infected areas (↓pH → Ionized form of LA → Poor penetrance).

Sequence of Blockade :

Regional anesthesia : B > C = Aδ > Aγ > Aβ > Aα

Autonomic > Sensory > motor

Experimental model : A > B > C.

Characteristics :

	Factors
Onset	Quicker onset : • Small myelinated fibers • Addition of $NaHCO_3$ (↑pH → Non-ionized form → Quick onset of action)
Absorption	Intercostal N. block : Maximum absorption (Risk of toxicity)
Duration	↑by : • Addition of adrenaline (1 : 200,000) → ↓Systemic absorption – Don't inject in end arteries (Causes gangrene) (Fingers, toes, tip of nose, ear lobule, circumcision Sx involve end arteries) • Addition of opioids (morphine, fentanyl)

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

Max. dose :

- Lignocaine : 3–4.5 mg/kg.
- Bupivacaine & ropivacaine : 2–3 mg/kg.
- Lignocaine + adrenaline : 7 mg/kg.

Toxicity :

Lignocaine : Seizures mainly.
Mx : Midazolam.

Bupivacaine : Ventricular arrhythmias mainly.
Rx : 20% Intralipid (1.5 ml/kg bolus, 0.25 ml/kg/hr infusion).

Cocaine : ↑BP & causes angina.
Rx : Nitroglycerine.

Prilocaine : Methemoglobinemia d/t ortho-toluidine..

Applications :

EMLA Cream : 2.5% lignocaine + 2.5% prilocaine (IV Cannulation).

Bier's block :

- IV regional anaesthesia with tourniquet.
- Drugs :
  - Approved : Lignocaine 0.5%.
  - C/I : Bupivacaine.
- Indication : Short procedures (Long procedures : Tourniquet pain).
- C/I : Sickle cell anemia.

Labour Analgesia :

Bupivacaine → 0.125% : Aδ & C fibers blockade.
Bupivacaine → 0.25% : Aβ & Aα fibers blockade.

Anaesthesia Workstation

01:15:07

Designed by Sir Henry Edmund Gaskin Boyle.

ZONES

- High pressure (main : Gas cylinders).
- Intermediate pressure.
- Low pressure.

High Pressure Zones : Gas Cylinders

Classification :
- Liquifiable : N_2O
- Non-liquifiable : O_2

Work station

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

Identification :

Gas	Cylinder
O_2	Black body with white shoulder
CO_2	Grey
N_2O	Blue
He	Brown
N_2	Black
Air	White body with black shoulder
Cyclopropane	Orange
Entonox	Blue body with white shoulder

Material used :

- Molybdenum steel alloy.
- Aluminum (For use in MRI rooms).

Measurement :

Non-liquifiable gas : Bourdon's pressure gauge.

Liquifiable gas : Manually weighing the cylinder.

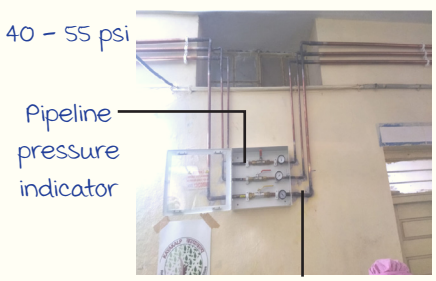
Safety features :

- Markings (Prevents explosions) → Non-liquifiable cylinders : Service pressure.
  → Liquifiable cylinders : Filling ratio/density.
- Pin Index Safety System (PISS) : To prevent wrong connections of cylinders.

Cylinder	Pin index value
Air	1, 5
O_2	2, 5
N_2O	3, 5
CO_2 <7.5%	2, 6
CO_2 >7.5%	1, 6
Cyclopropane	3, 6
Entonox	7

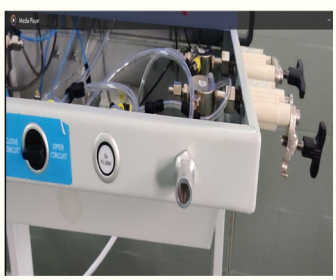
- Bodock's Pressure Seal (Gasket) : To prevent gas leakage.

Intermediate Pressure Zone :



Pipelines


Diameter index safety system


O2 flush valve (O_2^+)

- 35 – 75 L O_2/min.
- Disadvantage : Barotrauma.

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

Low Pressure Zone :

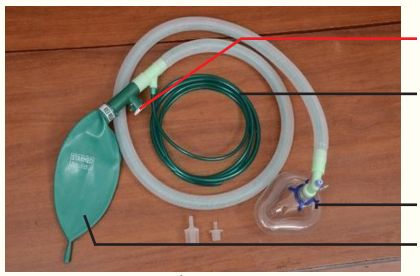
- 10 – 15 PSI.
- O_2 flow meters are always downstream.
- Safety feature : Link 25 system.

BREATHING CIRCUITS

Mapleson's/Semi Closed Circuits :

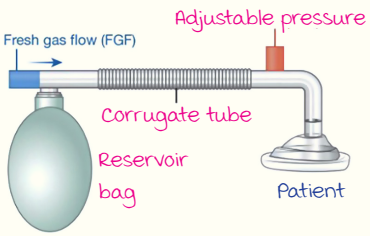
Advantage : Easy transportation.

Disadvantage : Heavy FGF.



Bain's circuit

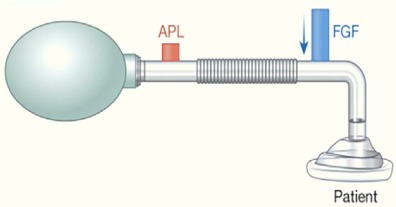
Types :



Mapelson A

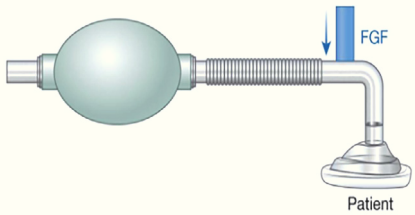
- AKA Magill's circuit
- FGF = Minute ventilation (MV)
- Use : Spontaneous ventilation

Note : MV = V_T (Tidal volume) x RR



Mapelson D

- M/c type
- FGF = 1.6 x MV
- Use : Control ventilation
- Modification : Bain's circuit



Mapelson F

- AKA Jackson Rees circuit
- Use : Pediatric Sx

Closed Circuit/Circle Systems :

- Gases are recycled.
  - Reabsorption of CO_2 with soda lime.
- Composition :

Absorbent	$Ca(OH)_2$	NaOH	KOH	H_2O
Classic soda lime (In %)	80	3	2	16

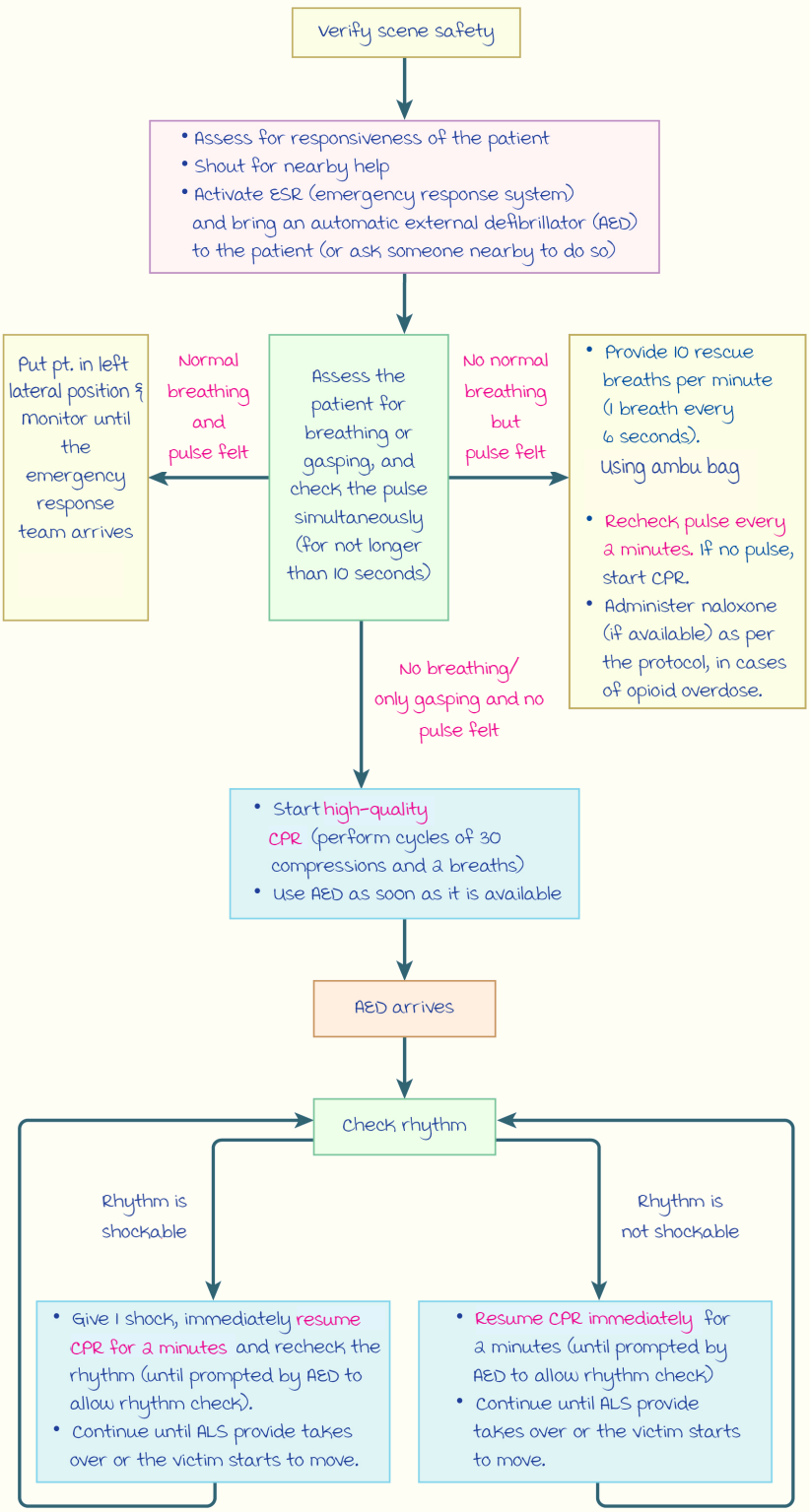
- Disadvantage : Bulky (↑Chance of disconnection).

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

ANAESTHESIA REVISION - 6

Basic Life Support (BLS) Algorithm

00:00:49

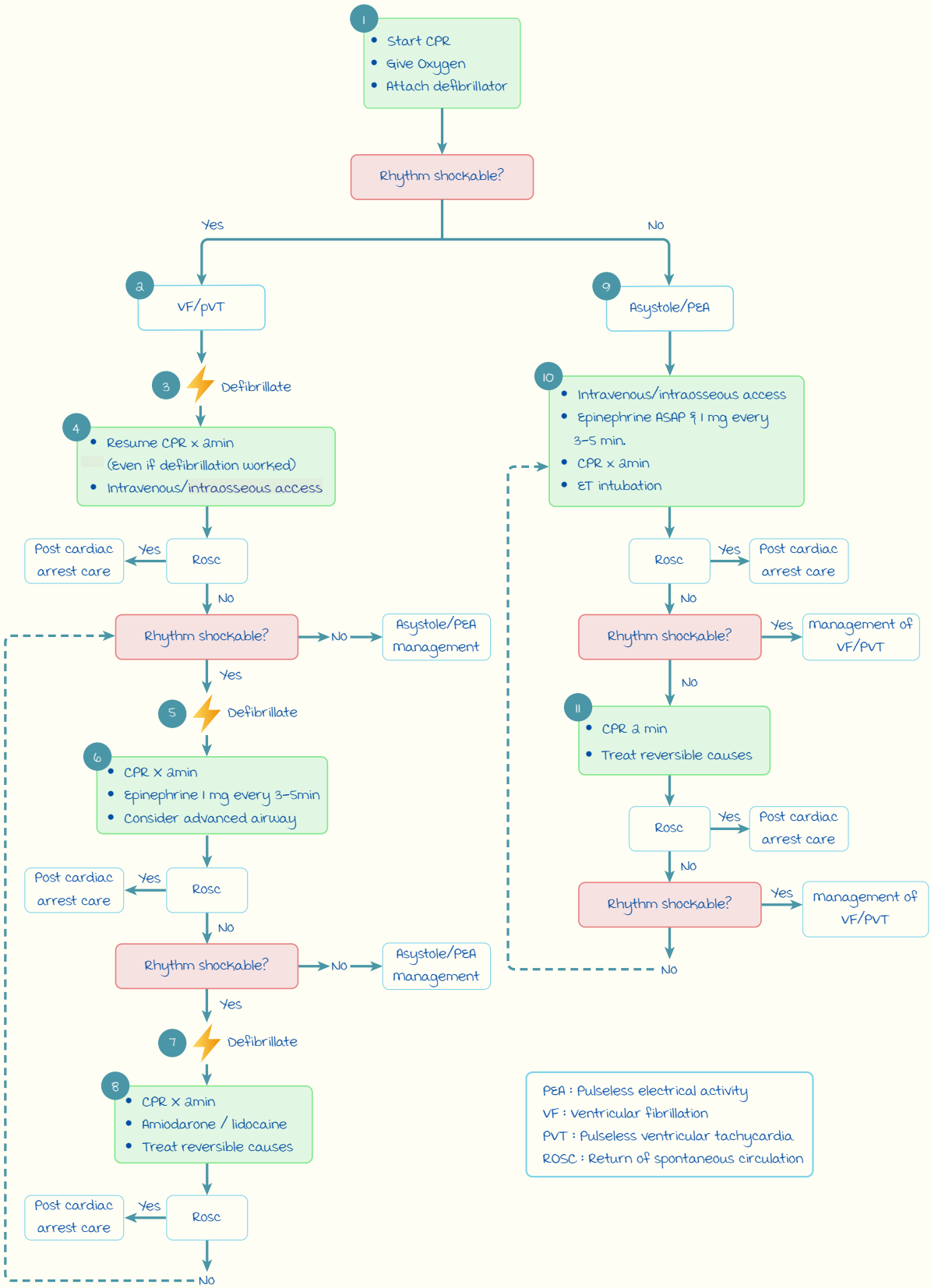


High quality CPR :

- Push hard (2 inches/5 cm) & fast on the lower sternum.
- Ensure adequate chest recoil.
- Only compressions (if alone) can be at a rate of 100–120/min.
- CPR quality can be assessed by quantitative waveform capnography.

Advanced Cardiac Life Support (ACLS Algorithm)

00:06:43 ----- Active space -----



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

Shock energy for defibrillation :

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

Drug therapy :

- Epinephrine IV/IO dose : 1 mg every 3–5 minutes (1 : 1000).
- Amiodarone IV/IO doses :
  - First dose : 300 mg bolus.
  - Second dose : 150 mg or,
- Lidocaine IV/IO :
  - First dose : 1–1.5 mg.

Reversible cause :

- Hypovolemia.
- Hypoxia.
- Hydrogen ion (Acidosis).
- Hypo/hyperkalemia.
- Hypothermia.

} 5 Hs

- Tension pneumothorax.
- Cardiac Tamponade.
- Toxins.
- Thrombosis (Pulmonary).
- Thrombosis (Coronary).

} 5 Ts

Indications that resuscitation was successful :

- ROSC (Return of spontaneous circulation).
- Monitor pulse & blood pressure.
- Abrupt sustained increase in $PETCO_2$ (Typically 40 mmHg).
- Spontaneous : BP tracing.

Indications to stop BLS & ACLS :

- Cardiac arrest not witnessed.
- No ROSC after 20 mins of CPR.
- AED unavailable/not delivered.

} BLS

- Bystanders CPR not provided.

} ACLS

Adult Tachycardia with Pulse

00:18:46 ----- Active space -----

Assess responsiveness (HR ≥ 150)

- Check Airway, Breathing, Circulation.
- Connect ECG, and IV access.
- Identify and treat underlying cause.

Persistent tachyarrhythmia

Assess hemodynamic stability

Unstable

- Synchronised cardioversion/ DC shock (50 J)
- Consider adenosine if narrow QRS complex.

Stable

Check if wide QRS complex

Yes

- Antiarrhythmic infusion.
- Consider adenosine only if regular and monomorphic.

No

- Vagal maneuvers.
- Adenosine.
- β blockers/ Ca^{2+} channel blockers.

Note :

- Tachycardia : HR ≥ 100 bpm.
- Tachyarrhythmia : HR ≥ 150 bpm.

5 features of hemodynamic instability :

- ↓BP.
- Shock.
- Altered mental status.
- Ischemic chest discomfort.
- Acute heart failure.

Antiarrhythmic infusion :

- Procainamide :
  - 20–50 mg/min until arrhythmia is suppressed.
  - Maximum dose : 17 mg/kg.
  - Maintenance infusion : 1–4 mg/min.
  - Avoid if prolonged QT or CHF.
- Amiodarone :
  - First dose : 150 mg over 10 mins.
  - Repeat if VT recurs.
  - Maintenance : Infusion of 1 mg/min for first 6 hrs.
- Sotalol :
  - 100 mg (1.5 mg/kg) over 5 minutes.
  - Avoid if prolonged QT.
- Adenosine :
  - First dose : 6 mg rapid IV push then NS flush (Peripheral line).
  - Second dose : 12 mg.

Note : Synchronised cardioversion, shock is synced with "R" wave.

Adult Bradycardia

00:24:33

Bradycardia

Hemodynamically stable

Monitor & observe.

Hemodynamically unstable

- Atropine IV 1 mg bolus
- Repeat every 3–5 mins
- Maximum dose : 3 mg

not effective

Transcutaneous pacing/Dopamine infusion/Epinephrine infusion.

Note :

- Bradycardia : HR <60 bpm.
- Bradyarrhythmia : HR <50 bpm.