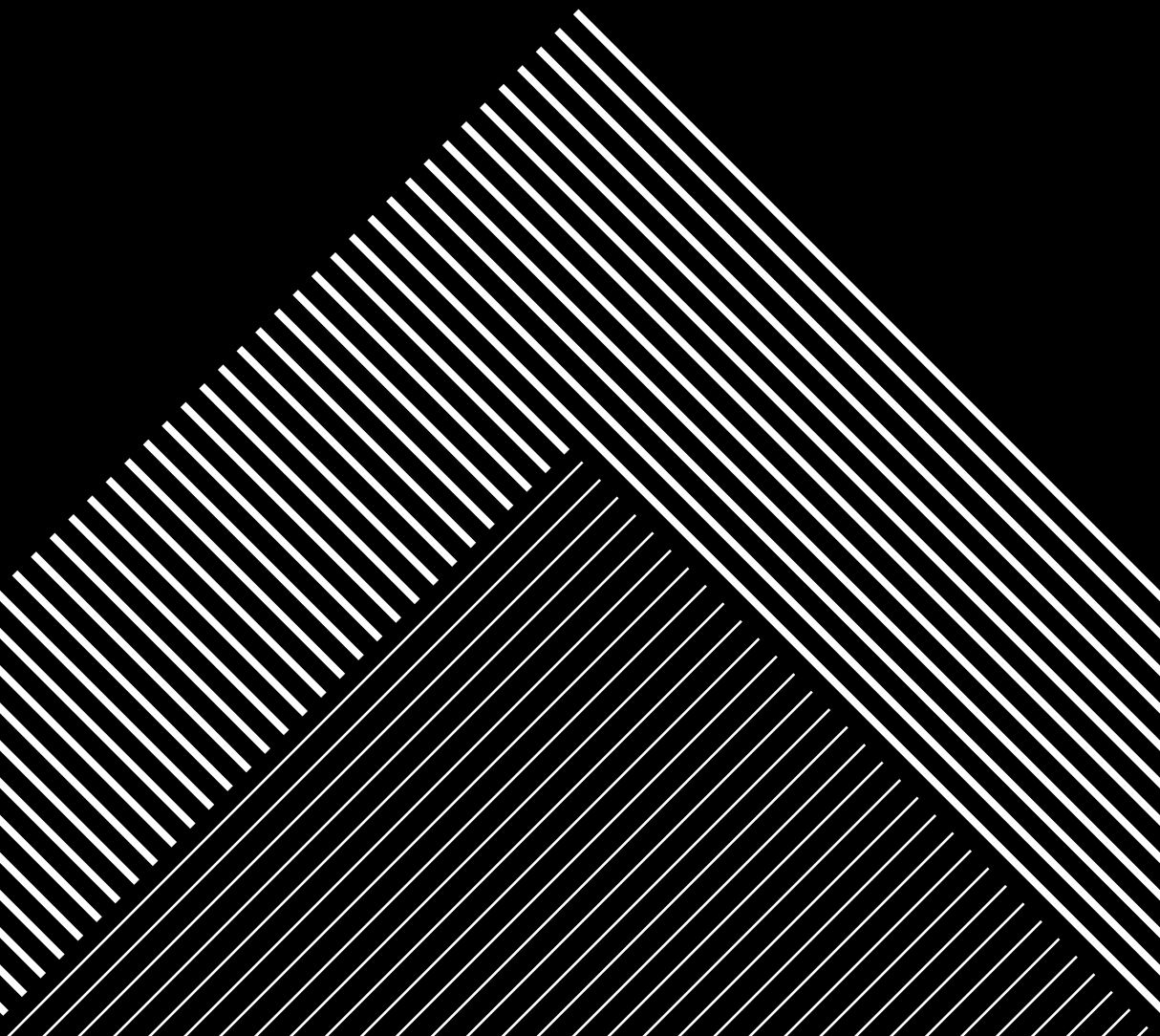
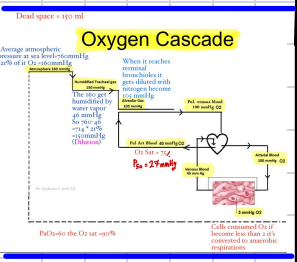
Anesthesia

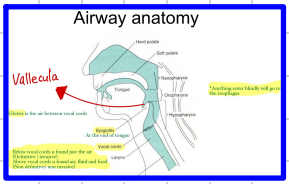
By:-Mahmoud Alhalawani



★1- Airway management

- introduction
  - ABC
  - cardiopulmonary by-pass (CPB)
    - extracorporeal oxygenation.
    - need 45min to 1hour.
  - oxygen cascade
  - oxygen Reserve
    - lung
      - Expired air O_2 tention ~ 120mmHg
      - Alveolar O_2 tention ~ 100mmHg
      - can use it mouth to mouth (B)
    - Hb
      - O_2 flux (20.1 x50 = 1000mL)
      - O_2 consumption ~ 250 mL
      - 750 mL will Remain → 3min
    - cytoplasmic
      - intracellular O_2 tention 5-40
      - mitochondrial O_2 tention 1-3
      - <2mmHg → anaerobic





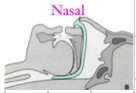
Some Calculations:
*** In Normal 70kg male -> Hg = 15ml/dL of blood
-> in fully saturated Hg (carrying 4 molecules of o2) -> there's 1.34 mL of o2 / gram of Hg (1.34*15=20.1 mL of o2 in 1 dL of blood)
-> Cardiac output = 5 L => 50 dL of blood is going to the cell each min.
-> 20.1* 50 = 1000 mL of o2 is visiting the cell each minute (AKA Oxygen flux)
-> The consumption of o2 in our bodies each minute is only 250 mL/min (So there's about 750 ml of o2 \ min in mixed venous Blood :) -> So Hg saturation in mixed venous blood is 75%)

- Airway Anatomy
- General managment
  - Shout & shake the pt → pickwickian (OSA) syndrome.
  - Look & mouth & tongue → tongue fall → obstruction.
  - maneuvers
    - Head tilt - chin Lift
    - Jaw thrust
    - Face mask + Jaw thrust (C/E maneuver)
    - Air assistance diveces (oral/Nasal)
    - Combitube
    - Laryngeal mask
    - Endotracheal intubation
    - cricothyrotomy
    - Tracheostomy.

- Airway assistant devices
  - oral Airways
    - By mouth
    - Less invasive
    - Less flexible (rigid)
    - inserted between tongue & posterior wall
    - Suitable Length → Btw earlope & mandiblar angle

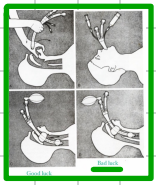
Bite blocker to prevent bite it from the CPR patient when wake

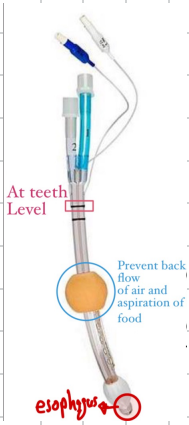
- Nasal airways
  - By nose
  - more invasive
  - flexible :- nose have ↑Risk of bleeding
  - Suitable Lenght → Between nose & targus of the ear



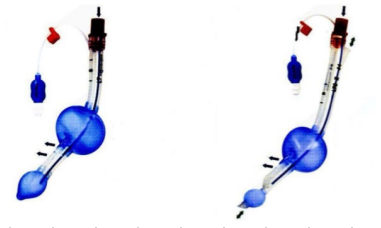
- insertion technique
  - enter the mouth when directed upward → turn it down (180°) when reach soft palate.
  - enter directed downward → take tongue posteriorly → obstruction.

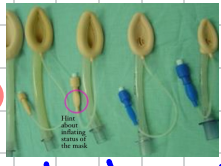
- **combitube :-** An esophageal-tracheal combined tube (2 Lumens + 2 cuffs).
  - Blindly inserted to esophagus.
  - wrongly inserted
    - abdomen raise
    - abs of breathing sounds
    - you should :- switch from 1 to 2
  - Disadvantages
    - only 1 size → >15y pts.
    - Expensive
    - can't be used to guide fiber-obtic intubation
  - Contraindication
    - pediatrics
    - Gag Reflex.
    - esophageal pathology.
    - caustic substance ingestion.



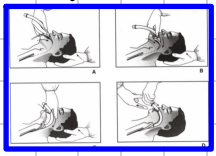


- **Laryngeal tube**
  - Single Lumen + esophageal & pharngeal cuffs.
  - single pilot ballon → inflate both cuffs.
  - multiple sizes.
  - insertion by non-anesthetists
  - open esophageal end for → drainage & suctioning





- **Laryngeal mask Airway (LMA).**
  - insertion → Blindly
    - feel Resistance (esophagus) → insert the tube (forward) → push air



Choice of LMA size

Mask Size	Patient Size	Weight (kg)	Cuff Volume (mL)
1	Infant	<6.5	2–4
2	Child	6.5–20	Up to 10
2½	Child	20–30	Up to 15
3	Small adult	>30	Up to 20
4–5	Normal and large adult		Up to 30

Advantages of LMA compared with Endo-tracheal tube

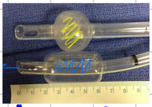
Less stimulation of sympathetic system
- Less invasive
- Less anesthetic depth required
- Useful in difficult airway management
- Less tooth and laryngeal trauma
- Less laryngospasm and Bronchospasm
- Does not require muscle relaxation
- Does not require neck mobility
- Less effect on B/P,H/R,ICP,IOP
- Less risk of Esophageal, or endo-broncheal intubation

Disadvantages of LMA compared with Endo-tracheal tube

- Increased Risk of GI content aspiration
- Not practical in prone or jackknife positions
- Unsafe in Morbidly obese /pregnancy
- Limits maximum PPV (Pulse pressure variation)
- Less secure airway
- Greater Risk of gas leak and pollution
- Can Cause gastric distention (>20cm of water)

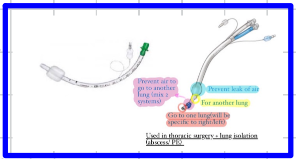
• Endotracheal intubation (EtT) :- invasive + direct Laryngoscope → oral. / nasal.

- sealing of trachea
  - Cuffed → prevent Leakage. / prevent aspiration.
  - Non-cuffed → Babies / Tracheal stenosis & elderly. / ↑diamiter (r) to maintain flow

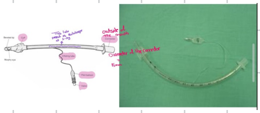


- type of cuff
  - High pressure – Low volume :- ↓perfusion → pressure ischemia
  - Low pressure – High volume :- 25–28 with more surface area.
- shape of tube
  - Regular (MC) :- Knikable
  - pre-formed → S (nasaL) :- Nasal & maxillary surguries. / N (mouth) :- maNdibullar & tooth surjuries
  - Armored → Reniforced / non-Kinkable :- expensive.

- Lumen
  - single
  - Double :- thoracic + Lung isolation.



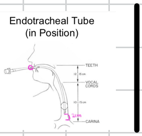
- usage time
  - Disposable :- extra-care.
  - Non-Disposable



Endotracheal Tube (Choice)

Age		Internal Diameter (in mm) (size)	Depth of Insertion (in Cm) (DoI)
Newnate or (full-term infant <3.5 kg weight)		2.5 - 3	9 - 10
Full term infant (non cuffed tube)		3.5	9 - 11
Child	Non-cuffed tube	4 + (Age/4)	12 + (Age/2)
	cuffed tube	3.5 + (Age/4)	
Adult	Male	7.5 - 9	21 - 24
	Female	7 - 7.5	21 - 24

Endotracheal Tube (in Position)

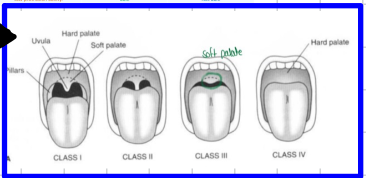


Endotracheal Intubation

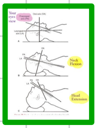
- Airway assessment:

Feature	Visualization of Larynx during laryngoscopy	
	Likely Easy	Likely Difficult
History	free	Previous difficulty/snoring/ Neck pathology/radiation
Facial Features:	symmetry	Asymmetry/Jaw recession
Pharyngeal view	Non-crowded	Crowded
Dental condition	Good	Protruding teeth/ mobile teeth
Head extension:	> 35 °	< 35 °
Neck length	Normal	Short
Mouth opening: > 2 fingers width	> 2 finger breadths (3 cm)	< 2 finger breadths
Thyro-mental distance: < 6 cm >	> 6 cm	< 6 cm
Jaw protrusion ability.	able	Not able

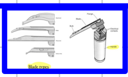
- mallampati classification (pharyngeal view) →



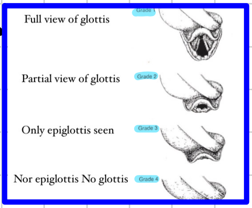
- Sniffing position
  - Neck flexion
  - Head extention

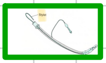


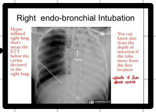
• Laryngoscopy :- Direct or indirect, Handle + Blade →



- insert it to vellucula
- cormack-Lehane (Laryngeal view) →
- + stylet :- to add rigidity (> class 2)







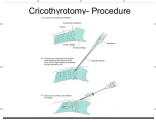
Principles of Direct Laryngoscopy

- Ideal Patient Position
- Ideal table Height: Head of patient at the Level of the operator's Xiphi-sternum.
- Proper size of Laryngoscope Blade
- Check adequacy of laryngoscope light
- Proper Endotracheal tube size

- Hold the Laryngoscope handle firmly with your left hand
- Introduce the laryngoscope blade at the right side of the tongue, with the right tongue border lying on the laryngoscope's blade flange.
- Slide the blade gently inward along the tongue, with gentle elevation of the tongue in the upward and forward axis direction until you see the epiglottis
- Advance the tip of the laryngoscope blade anterior to the Epiglottis ((i.e. in the vellucula against the Hypoid bone)
- Moving the tip of the laryngoscope blade anteriorly *(upward for you since the patient is supine)*, will move the epiglottis away from the laryngeal inlet

Principles of Intubation

- Hold the curved endotracheal tube with your right hand with its distal end directed forward.
- Introduce the tube through the Vocal cords into the trachea for an adequate distance *(until the horizontal black line mark on the tube is at the vocal cord level)*
- Avoid undue force when introducing the tube *(try slight rotation of the tube of it did not bypass the laryngeal inlet, otherwise, check the tube size)*
- Gently withdraw the laryngoscope blade out with your right hand firmly holding the tube in place
- Inflate the tube Cuff with proper volume(adequate to provide the seal, and not exceeding 30 cmH_2O)
- Ventilate through the tube and check that both lungs are equally ventilated by auscultating both lungs
- The tube distal end should ideally be 1 to 2 cm above the Carina, otherwise right bronchial intubation is likely with only the right lung being ventilated
- Adapt the depth of the tube up or down according to you check and record the required depth
- Firmly secure the tube by plaster taping it to the face or by the use proper tying tape



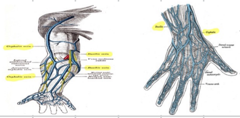
- **Cricothyrotomy**
  - in can't intubate-can't ventilate scenario (CICV)
  - temporary life saving awaiting fiber-optic intubation / tracheostomy.
  - transtracheal jet ventilation adopted.

- **Tracheostomy** → Same as cricothyrotomy except
  - site: 2nd & 3rd tracheal rings
  - tube (shorter)

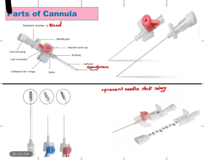
★ 2 - Vascular access

1 peripheral IV acess (canula)

- Anatomy & physiology
  - 2/3 of TBV
  - Thin wall, fibrous, ↑diamiter, ↓pressure.
  - small veins (Lower limb) contain valves.
  - Skeletal muscles pump influences VR.
  - major veins
    - Dorsum of Hand (NC)
    - cephalic vein
    - Basilic vein
    - cubital fossa



- parts:-



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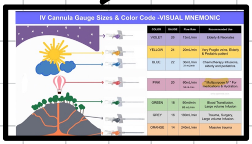
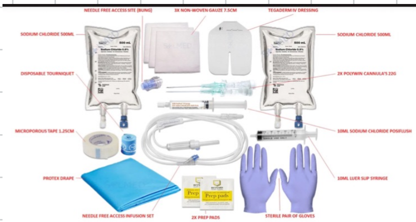


- Hagen-poiseuille equation :-

$$Q = \frac{\pi P r^4}{8 \eta L}$$

Q → flow; P → ΔP; r → radius; η → viscocity; L → Lenght

- equipment
  - cannula (size)
  - Alcholic chlorhexidine
  - Tourniquent
  - Dressing
  - Gloves
  - Sharp container
  - IV fliud.
  - syringe 10mL with 0.9% Normal saline.
  - fliud balance sheet.

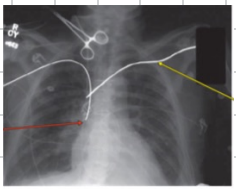


- Tips
  - Smallest possible size to prevent intima damge.
  - emergency → Large size
  - upper extrimites → ↓Risk of phlebitis & thrombosis.
  - straight portion of a vein → ↓hitting valve chance.
- diffucult to find vein
  - opposite extremity
  - opening & closing fist
  - using gravity:- arm down
  - Gentle tap or strok the site
  - Heat
  - vein viewer device
  - Tighten the vein

- preparation & technique (Read the slides)
- complications
  - phlebitis
    - progressive intimal inflammation
    - chemical, mechanical, bacterial
    - mangement
      - Remove the cath + culture
      - warm moist compressors.
  - Hematoma
    - Blood outside the vessels → Hard, painful Lump.
    - mangement:- pressure + elevate extrimities.
  - infiltration
  - Extravasction :- simple or sever.
  - peripheral nerve palsy
  - skin & soft tissue necrosis.
  - cellulities

2 Central venous acess:- near Heart, Bjg with fast-flowing Blood

- Anatomy → svc, brachiocephalic, subclavian, Ivc, iliac, femoral.
  - Rt. IJV :- most common.
  - SCV :- ↑vascular injury risk → pneumothorax & Bleeding.
  - Femoral :- ↑Risk of infection.
- indications
  - central venous pressure (cvp)
  - ↑volume fliud resuscitation → Burns.
  - ↑osmolar fliud & Drugs → HypoKalemia.
  - Rt. Heart catheterization.
  - Diffucult peripheal IV acess.
  - placment of transvenous pacemaker
  - Hemodialysis
  - TPN
  - chemotheraphy & Antibiotics.
- seldinger Technique (catheter over guidewire).
  - Anterior, central & posterior approach are not used.
- position :- tip on SVC & RA Junction if not → pneumothorax
  - PICC :- peripherally inserted central line.



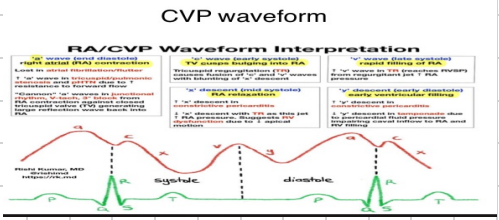
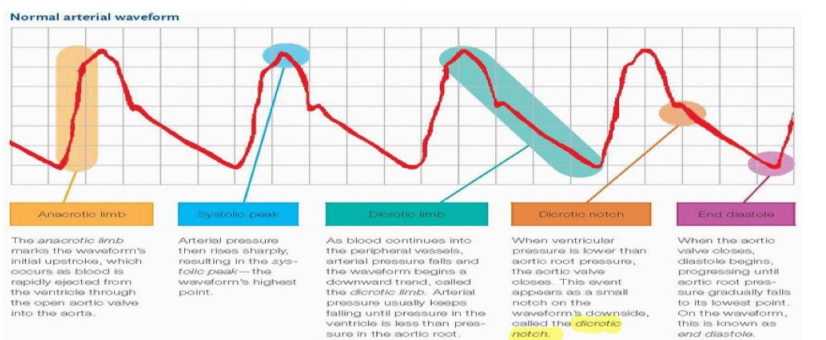


Table 5. Complications of central venous catheterization

Immediate	Infectious	None
	Mechanical	Arterial puncture Haemorrhage Intra-arterial placement of catheter Haemothorax Pneumothorax Arrhythmia Injury of thoracic duct Cardiac tamponade
	Thrombo-embolic	Air embolism Guidewire embolism
Delayed	Infectious	Colonization of catheter Catheter-related bloodstream infection
	Mechanical	Erosion or perforation of vessel Fracture and embolism of catheter Venous stenosis Cardiac tamponade
	Thrombo-embolic	Air embolism Catheter-related thrombus Pulmonary embolism

3 Arterial catheter

- indications
  - Arterial Blood gas
  - sever Hypotention.
  - Surgery
    - swing in BP (pheochromocytome, CNS, spinal)
    - major blood loss
  - Frequent Blood sampling (ICU)
- contraindication → Drugs → vasospasms → ischemia.
- insertion
  - most common:- Radial Artery
    - superficial
    - palbable
    - collateral (Allen's test)
  - Less Common
    - dorsal pedis
    - brachial
    - femoral
  - Seldinger technique vs cannula (special, with valve)

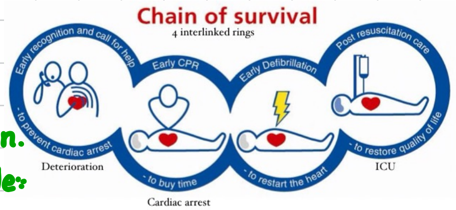


★ 3 - BLS

★ introduction

- cardiac arrest can lead to pulmonary arrest (vas versa).
- O_2 reserve supply vital organs for 3 min (Golden mintues).

- chain of survival
- Early recognition
  - prevent cardiac arrest
  - Admition to ICU.
  - inappropriate resuscitation.
  - Most arrests are predictable:
    - Hypoxia
    - Hypotention
    - Hypothermia
- most of cardiac arrests are non shockable.
- Shockable type have better prognosis.



• ABCDE, underlying principles

- Complete initial assessment.
- Treat Life threating problems.
- Reassessment.
- Assess effects of Tx / interventions.
- Call for Help early.
- personel safety.
- patient responsiveness
- first impression.
- vital signs.

Chart 1: The NEWS scoring system : National early warning scoring system

Physiological parameter (Vital signs)	Score 3	2	1	0	1	2	3
Respiration rate (per minute)	≤8		9–11	12–20		21–24	≥25
SpO_2 Scale 1 (%)	≤91 PaO2=60	92–93	94–95	≥96	Why doesn't reach 100%? Bcz of the physiological shunt 5% from bronchial and coronary veins		
SpO_2 Scale 2 (%) COPD pts (apnea risk)	≤83 PaO2= 55 (anaerobic)	84–85	86–87	88–92 ≥93 on air	93–94 on oxygen	95–96 on oxygen	≥97 on oxygen
Air or oxygen?		Oxygen		Air			
Systolic blood pressure (mmHg)	≤90 Shock	91–100	101–110	111–219			≥220
Pulse (per minute)	≤40		41–50	51–90	91–110	111–130	≥131
Consciousness				Alert GCS= 15			CVPU (confused; responsive to verbal stimuli; responsive to painful stimuli; un responsive)
Temperature (°C)	≤35.0		35.1–36.0	36.1–38.0	38.1–39.0	≥39.1	

ALS Resuscitation Council (UK)

Chart 2: NEWS thresholds and triggers

NEW score	Clinical risk	Response
Aggregate score 0–4	Low	Ward-based response
Red score Score of 3 in any individual parameter	Low–medium	Urgent ward-based response*
Aggregate score 5–6	Medium	Key threshold for urgent response*
Aggregate score 7 or more	High	Urgent or emergency response**

* Response by a clinician or team with competence in the assessment and treatment of acutely ill patients and in recognising when the escalation of care to a critical care team is appropriate.

**The response team must also include staff with critical care skills, including airway management.

	Causes	Recognition	Treatment

A

Causes
- CNS depression (Less conscious level Tongue obstruct airway due to lose of its tone)
- Blood (Trauma, surgery, hypercoagubility)
- Vomit
- Foreign body
- Trauma
- Infection Epiglottitis, dental abscess on lower jaw cause accumulation of pus on submandibular area cause edema on airway
- Inflammation
- Laryngospasm
- Bronchospasm

Recognition
- Talking
- Difficulty breathing, distressed, choking
- Shortness of breath
- Noisy breathing
  - Stridor, wheeze, gurgling
- See-saw respiratory pattern, accessory muscles
  Abdomen move against the direction of the chest due to complete upper airway obstruction (worse)

Treatment
- Airway opening
  - Head tilt, chin lift, jaw thrust
- Simple adjuncts (simple devices: oral airway, nasal airway)
- Advanced techniques
  - e.g. LMA, tracheal tube
    ↳ Laryngeal mask airway
- Oxygen

B

Causes
1. Decreased respiratory drive
   - CNS depression
2. Decreased respiratory effort
   - Muscle weakness GBS, polio , myasthenia Graves
   - Nerve damage
   - Restrictive chest defect Ankylosing
   - Pain from fractured ribs
3. Lung disorders
   - Pneumothorax
   - Haemothorax
   - Infection
   - Acute exacerbation COPD
   - Asthma
   - Pulmonary embolus
   - ARDS

Recognition
- Look
  - Respiratory distress, accessory muscles, cyanosis, respiratory rate, chest deformity, conscious level
- Listen
  - Noisy breathing, breath sounds
- Feel
  - Expansion, percussion, tracheal position

Treatment
- Airway
- Oxygen 100%
- Treat underlying cause
  - e.g. drain pneumothorax
- Support breathing if inadequate
  - e.g. ventilate with bag-mask

C

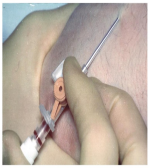
Causes
- Primary
  - Acute coronary syndromes (MCC)
  - Arrhythmias
  - Hypertensive heart disease
  - Valve disease
  - Drugs
  - Hereditary cardiac diseases
  - Electrolyte/acid base abnormalities
- Secondary
  - Asphyxia
  - Hypoxaemia
  - Blood loss
  - Hypothermia
  - Septic shock

Recognition
- Look at the patient
- Pulse - tachycardia, bradycardia
- Peripheral perfusion - capillary refill time
- Blood pressure
- Organ perfusion
  - Chest pain, mental state, urine output
- Bleeding, fluid losses

Treatment
- Airway, Breathing
- Oxygen
- IV/IO access, take bloods
- Treat cause
- Fluid challenge 20 ml/ kg / 30 minutes
- Haemodynamic monitoring
- Inotropes/vasopressors → vasoconstriction
  Adrenaline; α-receptors; β-receptors ↳ contractility
- Aspirin/nitrates/oxygen (if appropriate) and morphine for acute coronary syndrome
  ↳ 300 mg
  1) Sedation/ 2) pain killer/ 3) histamine release

No response (Fluid challenge → Haemodynamic monitoring → Inotropes/vasopressors)

MONA → Aspirin 300mg; ↳ Nitrates; ↓ O_2; ↙ morphine



ALS Resuscitation Council (UK)

D

Causes
[redacted]

Recognition
- AVPU or GCS
- Pupils
  Normal size = 2-4 mm
  Pinpoint pupils = opioids , pontine hemorrhage, organophosphate poisioning
  Dilated → sick cranial N

Behaviour	Response
Eye Opening Response	4. Spontaneously 3. To speech 2. To pain 1. No response
Verbal Response	5. Oriented to time, person and place 4. Confused 3. Inappropriate words 2. Incomprehensible sounds 1. No response
Motor Response	6. Obeys command 5. Moves to localised pain 4. Flex to withdraw from pain 3. Abnormal flexion 2. Abnormal extension 1. No response

Treatment
Treatment
- ABC
- Treat underlying cause
- Blood glucose Hypoglycemia <50
  - If < 4 mmol l^{-1} give glucose
- Consider lateral position Prevent tongue obstruction
- Check drug chart

E

- Remove clothes to enable examination
  - e.g. injuries, bleeding, rashes
- Avoid heat loss
- Maintain dignity

- cardiopulmonary arrest :- cessation of the spontanous function of CVS or RS.

- cardiopulmonary resuscitation :- Artificial delivery of the oxygenated blood through the vascular beds of vital organs to maintain there functions.
  - vital organs :- Brain, Heart, Kidney, Liver, Lungs.

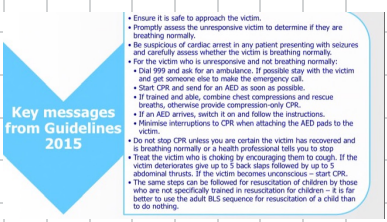
- BLS
  - no equipment use
  - Aim to keep ventilation & circulation
  - Golden min 3-4 min.

Safety → check response (shaking) → Response → yes → Leave Him → check regulary

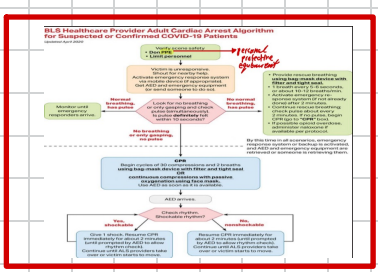
Response → No → Help → open Airway → check B & C

- open Airway
  - Head tilt
  - chin lift
  - Jaw thrust
- check B & C
  - Look
  - Listen
  - Feel

No pulse
- Middle of sternum, btw nipples.
- external cardiac massage 30:2 breaths
- use heels of Hands
- finger interlocked
- vertical above patient chest
- arms should be straight (Locked).
- 5-6 cm, 100-120/min
- CPR cycle :- x5 (30:2) ≈ 2 min.

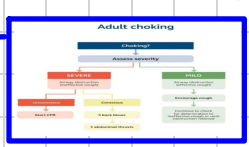


don't stop until
- pt shows sign of Life.
- CPR time arrives.
- you become exhausted.



Recovery position (Lateral)
- unconsciouss but breating & circulation restored.
- Benefits
  - maintain airway opening (tounge).
  - prevent inhalation of Gastric content.

Notes
- if pulse restored but no Breathing → stop CPR → 1 breath / 6 sec (8-12 b/min)
- if the patient have Respiratory disease (covid) → PPE
- choking



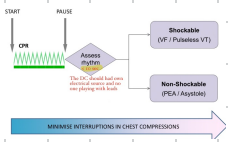
★4 - AIS

• introduction

- Resuscitation team
  - Roles planned in advance
  - identify team Leader:- MDs or Anesthesia High-grade.
  - importance of non-techincal skills.
    - Task management
    - Team working
    - situational awareness
    - Desicion making
  - Structured communication.
  - at Least 5 without Leader.
- Defibrillation energies
  - vary with manufacture.
  - check Local equipment.
  - Do not delay shocks:- every min ↓chance of Life by 10%
  - if unsure, deliver highest available energy.
  - types
    - monophasic (360J)
    - Biphasic (200-300J)
- BLS
  - confirm Cardiac arrest & call for Help
  - compression:- 30:2, 5-6cm, 100-120/min

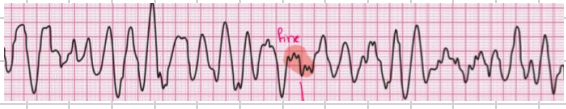
Monophasic Defibrillation	Biphasic Defibrillation
current travels only in one direction	deliver current in two directions
It requires more electrical energy	It requires less electrical energy
It causes more trauma	It causes less trauma
It has more chances of burn	It has fewer chances of burn
It causes more myocardial damage	It causes less myocardial damage
First shock success rate is 60%	First shock success rate is 90%

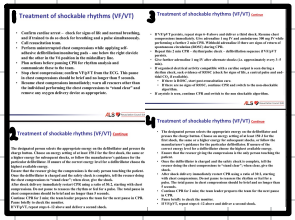
★DC Leads at apex & Rt side of sternum★



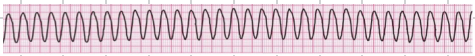
1 shockable

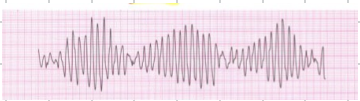
- ventricular-fibrilation (coarse):- minimal contraction of Heart muscle
  - Bizarre irregular waveform
  - no recognisable QRS complexes
  - Random frequency & amplitude
  - uncoordinated electrical activity
  - coarse (shockable), fine (asystole)
  - Exclude artefact
    - movement
    - Electrical interference.





- pulseless ventricular tachycardia
  - monomorphic
    - Broad complex rhythm.
    - Rapid rate.
    - constant QRS mc.
  - polymorphic
    - Torsede de pointes
      - Tx:- Mg sulfate 2g/10 min.

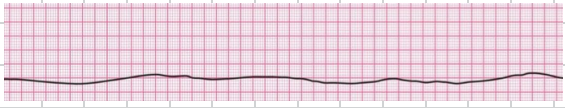




- AIS
  - compression → monitor attached → stop compression & feel the pulse for (10 sec) → Resume chest compression → charge → diliver → 1st shock → 2 min → stop & check pulse & moitor → charge & diliver 2nd.
  - Resume → charge → clear → shock → Resume (2 min) → check
  - After 3rd shock
    - adrenaline 1mg (α agonist) :- every other cycle (3,5,7,9,11)
    - amidorone 300mg or Lidocaine 1-1.5 mg/kg
      - cvs Reason → another 150 mg at 9th or 10th shock.

1 non-shockable

- Asystole
  - fine VF
  - Abs QRS
  - p wave may persist
  - Rarely a straight Line trace



- pulseless electrical activity (PEA)
  - clinical features of cardiac arrest.
  - ECG normally associated with an output.

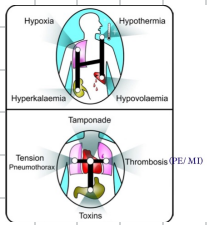
- AIS → non-shockable → 1mg Adrenaline → compression (2 min) → check
  - every other cycle (3-5 min)

Treatment of PEA and asystole

- Start CPR 30:2
- Give adrenaline 1 mg IV as soon as intravascular access is achieved
- Continue CPR 30:2 until the airway is secured – then continue chest compressions without pausing during ventilation
- Recheck the rhythm after 2 min:
- a. If electrical activity compatible with a pulse is seen, check for a pulse and/or signs of life
  - i. If a pulse and/or signs of life are present, start post resuscitation care
  - ii. If no pulse and/or no signs of life are present (PEA OR asystole):
- Continue CPR
- Recheck the rhythm after 2 min and proceed accordingly
- Give further adrenaline 1 mg IV every 3–5 min (during alternate 2-min loops of CPR)
- b. If VF/pVT at rhythm check, change to shockable side of algorithm.

- During CPR
  - Ensure high-quality CPR:- Rate, depth, recoil
  - plan actions before interrupting CPR
  - give O_2
  - Airway
    - Capnography:- exhaled CO_2 (Ett if <15mL CO_2)
    - Secure airway:- supraglottic device (LMA) or Ett.
    - trained intubation only.
    - don't interrupt chest compression for ventilation
    - Avoid Hyperventilation → Hypocapnia → vasoconstriction.
  - vascular access:- peripheral/central veins or intraosseous (tibia or humerus).

- **Reversible causes of cardiac Arrest (5H, 5T)**

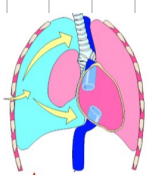


- **Hypoxia**
  - Ensure airway.
  - Give ↑flow O_2.
  - Avoid hyperventilation.

- **Hypovolaemia**
  - History:- vomiting, diarrhia, bone fracture
  - Examination
    - internal & external haemorrhage
    - surgical drains
  - control haemorrhage
  - give IV fluids.

- **Hypo/hyperKalaemia & H⁺(acidosis)**
  - Near pt. testing:- K & glucose
  - check Lab results.
  - HyperKalaemic (>5.5)
    - calcium chloride.
    - insulin/dextrose.
  - Hypo (K, Mg) → Electrolyte supplementation.

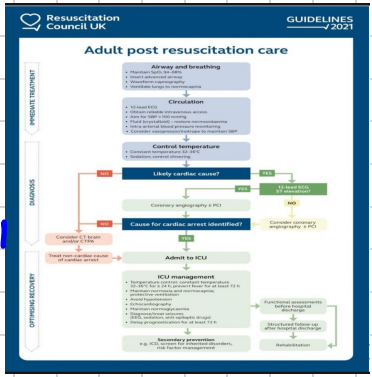
- **Hypothermia**
  - Rare in in-patient
  - use Low reading thermometer.
  - Tx with active rewarming techniques
  - Consider cardiopulmonary bypass.
  - CPR → until 34°C → CPR for 30 min only.
- **Tension pneumothorax**
  - check tube position if intubated.
  - clinical signs
    - ↓Breath sounds
    - Hyper-resonant percussion
    - Tracheal diviation
    - distended neck veins.
  - initial Tx with needle decompression or thoracostomy
    - 2nd ICS midclevicular.
    - 5th ICS midaxillary.



- **Tamponade**
  - dx by echo
  - consider in chest trauma or after cardiac surgery.
  - Tx with needle pericardiocentesis or resuscitative thoracotomy.
- **Toxins**
  - Rare unless evidence of deliberate overdose.
  - Tx:- antidote & Gastric Lavage.
- **Thrombosis (cardiac/pulmonary)**
  - ↑Risk of PE → fibrinolytic
  - if fibrinolytic given → 60-90 min CPR.

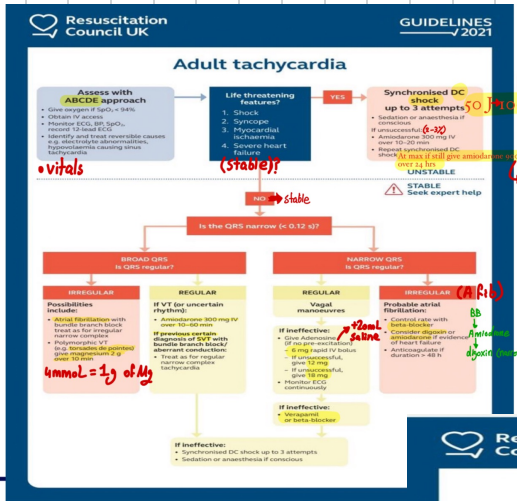
- **ultrasound:-** during rhythm checks, Do not interrupt CPR.

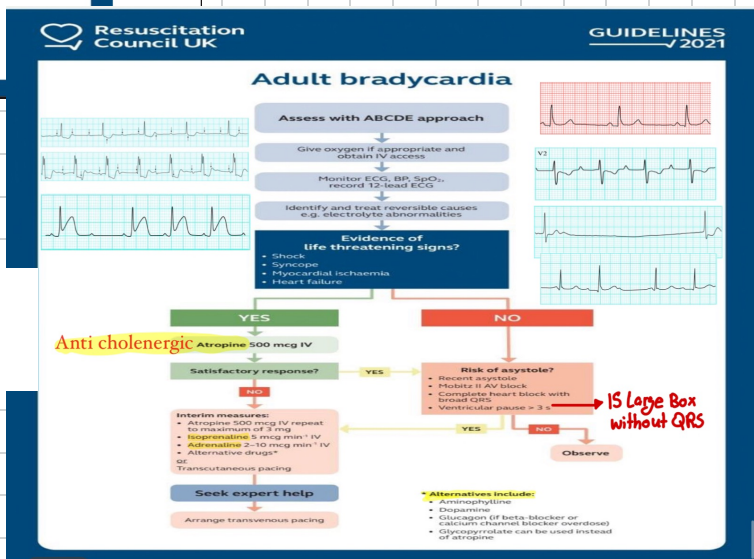
- After resuscitation → ABCDE
  - Temp
  - ICU



- ECG
  - HR
    - Regular:- 300/Large box or 1500/small
    - irregular:- QRS/30 Large Box x10
  - How to Read it
    - any activity ?
    - ventricular Rate ?
    - rhythm (Regular, irregular)
    - QRS width (narrow (N) or broad) :- 0.12sec (3 small box)
    - Atrial activity ?
    - Atrial-ventricular activity relation ?

2021





Chemical pacemaker is isoprenaline

5- Local & Regional Anesthesia

1 Local Anesthetics

- **Def**
  - substance which reversible inhibits nerve conduction, directly to tissues, non-toxic conc
  - block generation, propagation & oscillation of electrical impulses.
  - acting of Na^+ channels (prevent depolarization).
- **pharma**
  - Lipid-soluble, substituted benzene ring + amine (amide or ester) via alkyL.
  - Esters (1)
    - aminoesters (in Liver or plasma cholinestrase).
    - short-acting
    - ↑SE:- metabolites paraamidobenzoic acid (PABA) → Allergy.
  - Amides (2 i)
    - most common used.
    - Long acting.
    - ↓SE.

Esters [1°]	Amides [2°]
Cocaine	Bupivacaine
Chloroprocaine	Lidocaine
Procaine	Ropivacaine
Tetracaine	Etidocaine
	Mepivacaine

- **formulation:-** Biologically active substances are frequently use as very dilute solutions which can be expressed as active drug / 100 part of solution (gram percent)
  - 2% → 2g/100 mL → 2000mg/100 mL → 20 mg/mL.
- **vasocontrictors**
  - why?
    - ↓ Bleeding
    - ↑ safety margin By ↓ drug washout to plasma → ↓ toxicity
    - ↓ drug absorption → ↑ duration
    - Local anesthesia cause vasodilation.
  - allowed dose of epinephrine not more 1:100000 (1:1000 + 99 saline).
  - not used in :- fingers, Toes, Nose, Ear Lobes, penis (no collaterals → ischemia).

- **Bupivacaine (Amide)**
  - injected sc & skin
  - infiltration Dose
    - 2 mg/Kg
    - 3 mg/Kg with epi.
  - concentration
    - 0.25% ↑ area
    - 0.5% ↓ area
  - contraindicated IV → cardiotoxic (Hypertention & arrest).

Epidural anesthesia: Use 0.5-0.75%, moderate onset, 2- to 5-hr duration, max dose 175 mg (225 mg with epinephrine)
- Spinal anesthesia: Use 0.5-0.75%, fast onset, 1- to 4-hr duration, max dose 20 mg
- levo (-) bupivacaine less cardiotoxic than racemic bupivacaine, same

50 Kg .....max 2mg/Kg
50x 2= 100 mg
0.25% .....2.5 mg/ml
So maximum mls for infiltration is 100/2.5 = 40 ml

- **Lidocaine (Amide)**
  - infiltration dose
    - 5 mg/Kg
    - 7 mg/Kg with epi
  - concentration (2-8h)
    - 1%
    - 2%

Epidural anesthesia: use 1.5-2%, fast onset, 1- to 2-hr duration, max dose 300 mg (500 mg with epinephrine)
- Spinal anesthesia: use 1.5-2%, fast onset, 0.5- to 1-hr duration, max dose 100 mg
- Topical anesthesia: use 4%, fast onset, 0.5- to 1-hr duration, max dose 300 mg
- IV regional: Use 0.25-0.5%, fast onset, 0.5-1 hr duration, max dose 300 mg

- **Allergy (rare)**
  - mostly esters → PABA-Like Compounds.
  - previous intravascular injections.

- Toxicity (Rare)
  - Tissue (local) → ↑doses
    - preservatives added to solution.
  - systemic → Related to blood LvL of drug, 2° to absorption from injection site.
    - CNS, RS, CVS.
    - Range from Lightheadedness, tinnitus to seizure & CNS/CVS collapse.
    - Tx:- intra-Lipid.

2 Regional anaesthesia (spinal, epidural, caudals).

- Deff
  - Regional → Drug directly to spinal cord or Nerve to locally block A&E Nerve
    - alone or with general anesthesia.
    - prevent or ↓ nerve conduction of painful impulses to higher center
  - spinal :- into CSF within sub-arachnoid space.
  - epidural :- into the potential space outside the dura.
  - caudal :- into caudal canal → Block of sacral or Lumbar Nerve roots.

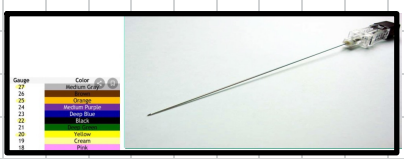
	Spinal	epidural
LvL of insertion	Below cauda equina (L_1-L_2) at L_4-L_5 or L_3-L_4	At any LvL of spinal cord
site of insertion	Subarachnoid space	epidural space
catheter use	No (single shot)	yes (Long time)
onset of Action	minutes	slower
Nature of effect (sensory, Muscle, sym)	complete sensory & motor block	sensory, with time & ↑ dose → motor
Type of Surgery	Any surgery below T_{10} (Hernia, knee replacment)	pain control in delivery C section

- Symphatic Loss in both but more in spinal → Hypotention & vasodilation
  So give prophylatic IV fliud & ephedrine (vasocontrictor)

- Contraindications
  - Absolute
    - patient refusal
    - Anticoagulation/coagulopathy → Spinal hematoma
    - Allergy
    - Localised infection.
    - untreated Hypovolaemia.
    - fixed CO state (Aortic stenosis).
  - Relative
    - systemic sepsis
    - Raised ICP
    - Skeletal anomalies
    - Neurological disease (MS)
    - previous Local surgery.
    - unco-operative patient.

- CSF
  - production :- 450 mL.
  - Volume :- 150 mL.

- Spinal needle
  - Sharp tip :- cut fibers of Dura.
  - pencil tip :- separate fibers of Dura.
  - Layers to reach csf
    - skin
    - Subcutaneous tissue
    - Supraspinous Ligament
    - interspinous Ligament
    - Ligamentum flavum (Resistance).
    - epidural space
    - Dura (0.5 cm)
    - Subarachnoid space (CSF)



- epidural → potential space, ⊖ pressure, after ↑ Resistance of Ligament flavum
  - Touhy needle
    - Gauge :- 16-18 (adults)
    - epidural depth :- 5cm
    - no PDPH unless it reach subdural space.

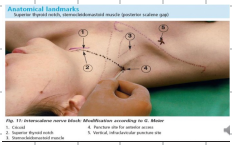
- Complications → post dural puncture Headache (PDPH) :- Leakage of csf → epidural
  - factors
    - young Age
    - Female
    - tall
    - sharp needle
    - ↓ gaude
    - ↓ experiance
  - Tx :- analgesia, Rest, caffeine, epidural blood patch.

+ post Dural Puncture Headache Because Decrease The CSF volume <150

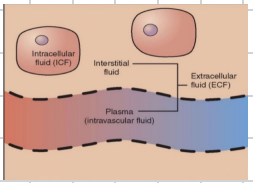
Complications	Estimated frequency	Comments
Direct nerve damage	1:10,000 – 1:30,000	No effective treatment
Spinal Haematoma	1:150,000 – 1:220,000	Requires urgent evacuation
Spinal infection	1:100,000 – 1:150,000	Aggressive Abs +/- evacuation
Drug error	Unknown	Avoidable, may be fatal
Systemic toxicity	Unknown	May be fatal without treatment
Respiratory depression	Unknown	Especially using opiods
Hypotension	Common	Early treatment needed
Confusional states	Common in elderly	Especially using opiods
Pruritis / nausea / urinary retention	Up to 16% incidence	Treat effectively
Technical failure	5-25%	Accept failure Consider alternative

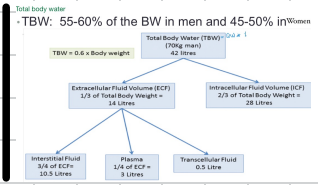
3 peripheral nerve block

- plexuses
  - brachial
  - lumber
- Nerve
  - median
  - ulner
  - femoral ....
- Techniques
  - Blind
  - Nerve stimulator (stimulation needles)
    - completely insulated, except the tip.
    - no sharp edges
    - monopolar or unipolar
    - very small exit opening for electrical current.
    - Higher current density at needle tip
    - exact Localisation, ↓Risk of injury.
  - ultrasound :- ↑success, ↓complications.



6 - Fluid management & Blood Transfusion



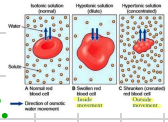


AGE	TBW AS % OF TOTAL BODY WEIGHT
Neonate Highest	80
6 months	70
1 year	60
Young adult	60
Elderly Lowest	50

Age and TBW inversely correlated to each other

Ion (mmol/L)	Intravascular Plasma (mmol/L)	ICF
Na+ Extra cellular >>>>	135-145	9
K+ Intracellular >>>>	3.5-5	135
Ca2+	1.3	<0.8
Mg2+	0.9	25
Cl- Extracellular>>>>	103	9
HCO3-	24	9
HPO42-	0.4	74
Sulphate-	0.4	19
Proteinate-	1.14	64

- **Essential principles.**
  - **osmolarity:-** No. of osmoles of solute particle/volume (osmoles/L or millosmole).
  - **osmolality:-** No. of osmoles of solute particle/weight (osmoles/Kg).
  - **plasma osmolality** → 2 (Na + K) + glucose + urea.
    - Range :- 275 - 299.
  - **Tonicity** → the relative solute concentration of 2 solutions which are separated by a selectively-permeable membrane (semi-permable membrane).
    - isotonic :- normal, No movement.
    - Hypotonic:- dilute, inside movement → swallon RBC.
    - Hypertonic:- concentrated, outside movement → shruken RBC.



  - **input:-** oral, Enteral, IV.
  - **output**
    - sensible (measurable) :- easily seen (urine, GIT).
    - insensible (non-measurable) :- not easy Quantify (sweat, vapor).

  - **maintainence :-** Surgery requirement Fluids. → Rule of 4/2/1 or Kg+1comL/h
  - **deficit :-** Before surgery (Fasting)
  - **Surgical Fluid Loss**
    - min. tissue trauma (Herniorrhapy) :- 0 - 2 mL/Kg/h
    - moderate tissue " (cholecystomy) :- 4 - 6 mL/Kg/h
    - sever tissue " (bowel resection) :- 8 - 10 mL/Kg/h
  - **Adjust blood Loss**
    - 1mL of Blood Loss → 1 colloid (Blood product). 3 crystalloid (normal saline).
    - Lap pads :- 100 - 150 mL
    - small pads :- 10 mL

Ex. In the 1st hour of laparotomy there was 200ml of pure blood in the suction jar, 2 fully soaked lap pads, and 10 fully soaked small gauzes
200 ml + 2 * 150 ml + 10 * 10 ml = 600 ml (= that hour) to be replaced with either 600 * 4 of cryst. or -if indicated- 600 ml of blood

  - **Allowable Blood Loss** → EBV x (Hi - Hf)/Hi
    - Hf → final Hb (Lowest acceptable)
    - Hi → intial Hb (current)
    - Estimated Blood volume = Kg x Avarge Blood volume (mL/Kg)

Men	75 ml / kg
Women	65 ml / kg
Infants	80 ml / kg
Neonates	85 ml / kg
Premature Neonates	95 ml / kg

    - Normal HcT → M :- 42 - 52 %, F :- 37 - 47 %
    - 20% of total blood in adults, 10-15% pediatrics

$$\left(= \frac{Hi - Hf}{Hi}\right)$$

- example:- 70Kg man → EBV = 70 x 75 = 5250 mL. → ABL = 5250 x 20% = 1050mL.

- intraoperative Fluid Loss
  - crystalloids
    - 1:3, ↑Hydrostatic pressure, stay in interstitial.
    - solution of water + electrolytes.
    - Balanced (Ringer's Lactate) & Hypotonic (D5W).
  - 1 Ringer's Lactate (Hartman's)
    - Na^+ :- 131 mmol/L
    - Cl^- :- 111 mmol/L
    - Lactate :- 29 mmol/L
    - K^+ :- 5 mmol/L
    - Ca^{++} :- 2 mmol/L
    - PH :- 6.5
    - Osmolality :- 279 mosm/L
    - problems :- Accumulation of K^+ → HyperKalemia
  - 2 Normal saline (0.9%)
    - NaCl :- 9g/L
    - Na :- 154 mmol/L
    - Cl :- 154 mmol/L
    - Osmolarity = 308 mosm/L (isotonic).
    - PH :- 5
    - problem :- Hyperchloraemic metabolic acidosis. more Likely with renal insufficiency.
  - 3 others
    - Hypertonic (3%)
      - NaCl :- 30 gm
      - osmolality :- 1027
      - PH :- 4.5 to 7.
      - Hyponatremia.
    - Half normal saline
      - NaCl :- 77 meq/L
      - osmolality :- 154
      - Hypernatremia
      - contraindication :- cerebral edema.
    - 8.4% Bicarbonate → Acidosis
    - mannitol 20% → Brain edema, pulmonary edema.

- Colloids
  - 1:1, ↑oncotic pressure (in vessels), don't diffuse
    - Harmful in capillary Leakage (sepsis, ARDS).
  - Exerts an osmotic pressure in blood, causing fluid to remain (↑IVV).
  - Categories
    - Natural (Albumin).
    - Artificial (gelatins, dextran & HES).

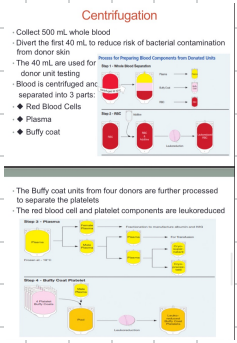
1
- Albumin
  - t½ :- 1.6 h
  - stay in intravascular space unless capillary permability is abnormal
  - 5% solution (isotonic) , 20% solution (Hypertonic).
  - expands volume 5x in 30min (preserve renal function).
  - SE
    - Volume overload
    - Fever (pyrogens)
    - Defects in haemostasis.

2
- Dextran
  - High MW polysaccharide.
  - 2 types
    - 40 :- MW 40,000
    - 70 :- MW 70,000
  - 10% in NS or D5W (Hypotonic).
  - SE
    - anaphylaxis
    - Coagulopathy
    - Renal feliure
  - Dose :- 20 mL/Kg/day.
  - used as antiaggrejant in pts. undergoing vascular surgy

- Whole blood
- Packed Red Blood Cells (PRBCs)
- Platelets
- Cryoprecipitate
- Human albumin
- Fresh Frozen Plasma

- Blood products (contraindicated unless it's indicated).
  - purpose
    - maintain organ transfusion.
    - Normal (BP, HR, metally, O_2, urine output, well perfused extremities
  - preperation
    - Syphilis
    - Hepatitis B & C
    - HIV 1 & 2
    - +/- CMV
  - compatibility testing (ABO, Rh)
  - check before transfusion:-
    1) group
    2) expire day
    3) pt. Name
    4) medical record No.
    5) unit No.

Type	Naturally Occurring Antibodies in Serum	Incidence
A	Anti-B	45%
B	Anti-A	8%
AB (Universal recipient)	—	4%
O (Universal donor)	Anti-A, anti-B	43%



1 PRBCs

- 70% Hematocrit → pt Requiring RBC but not volume (anemia, CHF)
- 1-6°C (+hypertonic glycerol → 1gw) → warming to 37°.
- 250 mL + saline preservative = 350 mL
- 1 unit → +1g/dL Hgb. (<6 Require, >10 don't).
- 170 µm filter :- to trap clots & debris.
- Storing → Left shift of Hb-O_2 curve (↓temp & ↓2-3-DPG).

2 Fresh Frozen plasma (FFP) :- plasma proteins & clotting factors.

- once thawed must transfused within 24h, 200mL.
- indications
  - isolated factor deficiencies.
  - Reversal of warfarin therapy.
  - coagulopathy associated with liver disease.
  - CABG, Bleeding + NL, ACT
  - Massive blood transfusions.
  - Antithrombin III def.
- 10-15 mL/kg.
- INR 1.4-1.6 (>1.6 require, <1.4 not Require).

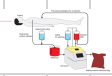
3 platelet

- 50-70 mL
- 20-24°C (Room temp) for 5d
- indications
  - thrombocytopenia.
  - dysfunctional platelets.
- 1 unit → +10,000-20,000 x 10^9/L
- compatible test are desirable but not necessary.

4 cryoprecipitate

- 1 unit (15mL)
  - fibrinogen 150mg
  - factor VIII 100 unit.
  - von willebrand factor (vWf) 100
- indications
  - DIC
  - hemophilia A.
  - vWf disease.
  - thrombolytic therapy.
- fibrinogen < 1g/dL.

- cell saver :- machine to give autologous blood transfusion :- we take the pt. blood, go to reservoir → clean & watched → Red bag → to pt.
  - used we suspect Large blood Loss during surgeries.
  - Never used in cancer patients.

- Lvl 1 (A) infusion pump
  - Large volume in short time.
  - use Large cannula or central Line.
  - used in
    - trauma.
    - ruptured AAA.
    - emergency casses.

- complications of Blood Transfusion
  - Hemolytic reactions (Acute Vs delayed).
  - febrile Non hemolytic reactions.
  - infectious complications.
  - Transfusion Related Acute Lung injury (TRALI) /ARDS
    - Accumulation of fliud in alveoli.
    - morbility :- mechanical ventilation.
    - mortility (5-10%)
    - Tx:- O_2 therapy.
    - Lung injury is generally transient with PO_2 LvLs returning to pretransfusion LvLs within 48-96h & CxR returning to normal within 96 h.

7 - preoperative Assessment

- introduction
  - Aims
    - identify co-morbidites → complication during peri-op period.
    - venue
      - elective :- pre-op clinic or wards (anesthesia clinic)
      - emergency :- ED / ward.
    - Estabish a rapport.
  - conduct of Assesment :- History/PE/ investigations → Anaesthetic plan.

1 History

- profile
  - Name/age/Gender/weight (Dosage), Height
  - Type of surgery
  - smoking History :- affect cilia
  - fasting hours :- prevent aspiration.

Cardiovascular	Respiratory	Neurologic	GIT	Renal	
IHD (CP /Angina/ stent) CHF (PNDs/ orthopnea) Exercise intolerance Palpitations	Asthma COPD OSA Recent URTI/LRTI Cough/ sputum Smoking	-Epilepsy -CVA/TIA -Denervation disease	GERD PUD Hiatus Hernia Intestinal obstruction.	CRF ARF On dialysis	Blood disorders Antiplatelet Anticoagulation

- ROS (focused)
- past medical
  - DM, HTN, thyroid, mesthesia gravis .....
  - Drug History (β-blocker, statins).
  - allergies :- penicilln & muscle Relaxant.
  - Surgical History.
- prevous Anaesthesia
  - previous difficult airway.
  - previous airway surgery/burn.
  - Snoring/obstructed breating

- Previous anesthesia
- Type of anesthesia
- Complications: difficult airway management/delayed emergence / PONV)-post op nausea & vomiting
- Family hx (malignant hyperthermia/collen apnea)

2 physical Examination

- General :- apperance, obesity, malnutrition, pregrency, Head & neck.
- Vitals :- BP, HR, RR
- cardiac exam.
- Respiratory exam.
- neuro exam.

Check rate and rhythm
Auscultate heart sounds

Look for signs of resp. distress
Respiratory rate
Auscultate lung sounds

Mental status
Gross motor/ gross sensory

3 Airway examination

- purpose :- anticipate any possible difficulty in ventilation & intubation, ↓Hypoxia risk.
- importance :- airway & Respiratory events are the most common events during anaesthesia (MC :- sore throat & dental damge).

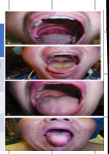
- inspection
  - 1) difficult?
    - obesity
    - Beard
    - Deformaties, masses, scars & burns.
    - Large Breast (♀)
    - Neck deformity or Large neck fat pad (sniffing position), Range of movement
    - mandible
      - excessive protrusion
      - Recession (Micrognenthia).
    - Nasal :- deformity, deviation, patency of nostrils.
    - mouth :- asymetry, deviation, High arch palate (marfan), Large tonsils.
    - Dentition :- protrusion, Lose, hyigene, crowns & caps.
    - 2) mouth opening :- 3 fingers.
    - 3) mobility of Lower Jaw & neck
      - ability to protrude Lower Jaw above upper
      - Neck extention & flexion.
    - 4) Mallampati Score :- patency of mouth & throat cavities (tongue/mouth)

Method of Assessment (L.E.M.O.N)

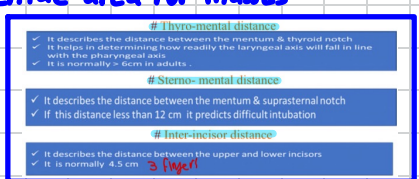
- L — Look externally: face / mouth opening/ teeth / tongue
- E — Evaluate the three distances: interincisal / thyromental / sternomental distance
- M — Mallampati score (3 or 4)
- O — Obstruction (presence of any obstruction like: peri-tonsillar abscess , thyroid mass , VC nodule)
- N

4. Mallampati score

class	Structures identified when pt seated
1	Tonsillar pillars, Uvula , soft & hard palate
2	Uvula ,soft & hard palate
3	Base of uvula ,soft & hard palate
4	Only hard palate is can be seen



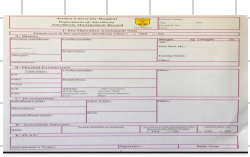
- palpation
  - submandibular & submental area for masses
  - Tracheal centralization
  - 3 distances ➡



4 investigations

- Routine test
  - test ordered in abs of specific clinical indication.
  - does not add much to pre-op assessment.
- Guided by :- History, PE, nature of surgery.
- Haemoglobin / haematocrit
- urine analysis
- Chest radiography
  - pt. with Respiratory / cardiac disease
  - Smokers
  - pt. with Recent LRTI.
- ECG
  - pt. with Respiratory / cardiac disease
  - Advanced age (M: 55y, F: 65y).
  - CAD risk factor :- HTN, DM, ↑Lipid, exercise intolerance.
- PFT :- identifying pt. Respiratory Risk.
  - indication :- obstructive / Restrictive, Neuromascular disorders.
  - include
    - spirometry.
    - ABGs.

- CBC — Advanced age / Anemic pt / Bleeding / chronic disease (kidney liver heart)
- KFT — Diabetics / HTN / chronic disease / on medications like diuretics, digoxin, ACEI
- Sugar — Diabetics / HTN / chronic disease / on steroid
- LFT — Liver disease / malnourished pt
- Coagulation — Bleeding disorder / Kidney disease / Liver disease / pt on anticoagulants



ASA risk score +E=Emergency.

Category	Health status	Examples
ASA I	A normal healthy patient	Nonsmoker, BMI <30, Not pregnant or alcholic.
ASA II	A patient with mild systemic disease	No functional limitations and a well-controlled disease (e.g., treated hypertension, obesity with BMI under 35, frequent social drinker, or cigarette smoker
ASA III	A patient with a severe systemic disease that is not life-threatening	Some functional limitation due to disease (e.g., poorly-treated hypertension or diabetes, morbid obesity, chronic renal failure, a bronchospastic disease with intermittent exacerbation, stable angina, implanted pacemaker)
ASA IV	A patient with a severe systemic disease that is a constant threat to life	(e.g., unstable angina, poorly controlled COPD, symptomatic CHF, recent (less than three months ago) myocardial infarction or stroke)
ASA V	A moribund patient who is not expected to survive without the operation	(e.g., ruptured abdominal aortic aneurysm, massive trauma, and extensive intracranial hemorrhage with mass effect)
ASA IV	A brain-dead patient whose organs are being removed with the intention of transplanting them into another patient.	• Brain death

Prevention of aspiration ASA Fasting Guidelines

Clear fluid	2 hours	Water , Fruit juice without pulp,
Milk		
Human	4 hours	
Infant formula	6 hours	
Light Foods	6 hours	Fruits , juice with pulp, Vegetables
Heavy foods	8 hours	Fatty meals , meats

- plan
  - Depends on
    - History
    - physical examination (PE).
  - After pt consest to proceed with surgery & anesthesia.
  - Decision about
    - further consultations.
    - further investigations.
    - patient's medications.
    - preperation of blood & blood products.
    - Type of admission.
    - ICU bed reservation
    - fasting time
    - ordering pre-medication.

5 premedication

- Anxiolysis
  - visit & interview & establishing good rapport with pt.
  - Benzodiazepine
    - Diazepam
    - midazolam (IV, Po, shorter acting).
  - opioids
    - morphine
    - pethidine
- ↓Aspiration
  - Risk factors
    - incomplete fasting
    - intestinal obstruction & sever pain.
    - opoid use
    - others (obesity, GERD, Hiatus Hernia, presrency).
  - H_2 blockers (-tidine) → ↓acid, ↓gastric fluid volume.
  - Antacids
    - 30 mL sodium citrate
    - ½ before induction, ↓acidity only.
  - PPI (-prazole) → 40 mg, IV, ½h, ↓voulme & acidity.
  - metoclopromide (D_2) → ↑gastric motility & LES tone.

- DVT
  - Risk factors
    - Hx of DVT
    - Hypercoagulable state
      - ↓Antithrombin III
      - ↓ protein C & S
      - ↓ plasminogen activator
    - carcinoma
    - HF
    - obesity
    - smoking
    - prolonged surgery/preop immobility
    - Long Bone fracture
    - ocp, pregnency, post-partum
    - pelvic & lower extremity surgeries.
  - Recommidation
    - Low:- early ambulation (walk)
    - Modrate :- intermittent pneumatic compression (IPC)
    - High:- Heparin (LMWH/UH) or IPC.
    - Highist :- Heparin (LMWH/UH) + IPC or elastic stocking.

- Antibiotics
  - Aim
    - ↓ Surgical site infection
    - ↓infection in immunocompromised pt.
  - time
    - 60 min before surgery (Better tissue concentration).
    - 2 exceptions
      - vacomycin Before 2h (slow infusion)
      - use of Tourniquent.
  - MC used
    - vacomycine
    - pencilline
    - 2nd generation cephalosporines (cefuroxime, cefazolin)

- Choice of antibiotic is surgery dependent, patient dependent (kidney and liver function), and Hospital dependent (specific types of antibiotics depends on presence of local strains of bacteria resistant/susceptible to common antibiotics).

Table 1. Antibiotic Prophylaxis to Prevent Surgical Site Infections

Surgery	*Common pathogens*	*Recommended antimicrobials**
Cardiothoracic	*Staphylococcus aureus*, coagulase-negative staphylococci	Cefazolin, cefuroxime sodium (Zinacef), or vancomycin
Gastrointestinal	Enteric gram-negative bacteria, anaerobes, enterococci	Cefoxitin (Mefoxin), cefotetan (Cefotan), ampicillin/sulbactam (Unasyn), or cefazolin plus metronidazole
Gynecologic (vaginal, abdominal, or laparoscopic hysterectomy)	Enteric gram-negative bacteria, group B streptococci, enterococci, anaerobes	Cefoxitin, cefotetan, cefazolin, or ampicillin/sulbactam
Orthopedic	*S. aureus*, coagulase-negative staphylococci	Cefazolin, cefuroxime sodium, or vancomycin
Vascular	*S. aureus*, coagulase-negative staphylococci, enteric gram-negative bacilli	Cefazolin or vancomycin

**—Antibiotics are given intravenously within one hour before surgery, except for vancomycin or fluoroquinolones (infusion should start one to two hours before incision). Some authors recommend weight-based dosing of cephalosporins and vancomycin: cephalosporins, 1 g for patients weighing < 176 lb (80 kg) and 2 g for patients weighing ≥ 176 lb; vancomycin, 1 g or 15 mg per kg for patients weighing > 165 lb (75 kg) up to a maximum of 1.5 g. Ampicillin/sulbactam should be administered as a standard 3 g dose. Metronidazole can be administered as a 0.5 g to 1.0 g dose. For patients with normal renal function, an additional intraoperative dose of antibiotic can be administered for surgeries lasting more than four hours or if blood loss > 1,500 mL occurs. Redosing intervals should be based on one to two times the half-life of the drug. Vancomycin can be used when methicillin-resistant S. aureus or coagulase-negative staphylococci are common causes of postoperative wound infections, for patients allergic to beta-lactam antibiotics, or when clindamycin (Cleocin) is not appropriate therapy. For patients allergic to penicillins and cephalosporins, clindamycin with ciprofloxacin (Cipro), levofloxacin (Levaquin), or aztreonam (Azactam) is a reasonable alternative.*

Information from references 8 and 9.

8 - intravenous Anesthetics

• introduction

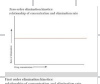
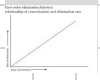
- Anesthesia
  - Local infiltration:- Nerve ending.
  - Single nerve block:- all area supplied by the nerve
  - plexus block:- group of nerves
  - Neuraxial block:- Regional (spinal/epidural).

- signs & stages (Reversable/controlled Loss of Consciousness).
  - sedation → mild CNS depression
    - for surgical procedures, not requiring muscle Relaxation.
    - Most anesthetics don't produce analgesia.
  - Delirium → cortical motor depression → excited state.
    - avoided with rapidly acting potent anesthetics.
  - Surgical Anesthesia → subdivided into stages (↑ muscle Relaxation)
    - final stage → No muscle tone
  - Deep Anesthesia & Respiratory paralysis → not desirable
    - Hypotension apnea + SE.

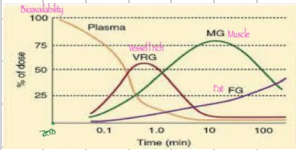
- Traid of (Balanced) general Anesthesia
  - Anesthetic (Hypnosis):- unconsciousness
  - Analgesia:- pain killer (opoids).
  - Amnesia:- No Recall (Bezodiazepines).
  - ± muscle Relaxation & ↓autonomic Reflex

• Basic pharmacology principles

- pharmacoKinetics:- How the body processes the drugs. (ADME)
  - Administration → mostly anesthetic by IV or inhaled
    - Sometimes IM.
  - Metabolism → first pass metabolism (P_e) :- pass through portal system before systemic circulation → ↑metabolism by Liver (↓Bioavailability).
    - IV drugs → No first pass metabolism → 100% Bioavailable → ↓dose needed
  - Excertion → through Liver, Kidney & Lungs.
    - Zero-order:- metabolized at fixed rate, regardless of concentration.
    - first-order → most drugs.
      - Rate of metabolism is proportineal to concentration.
      - 5 half-times → 96.9% of drug Elimination.

- Distribution :- systemic circulation to target organs (Brain).
  - protein bound → inactive (free portion → active).
  - Vd (volume of distribution → total dose / plasma concentration.
    - Lipophilic vs Hydrophilic drugs.
  - Redistribution → ↑perfusion organs :- takes drug fast.
    - ↓perfusion organs :- after ↑prefusion organs are saturated during intial distrubition the greater mass of ↓prefused organs countinue to take up drug from Blood.



- drug in the Body But not in the Brain after 1o min → awakness.

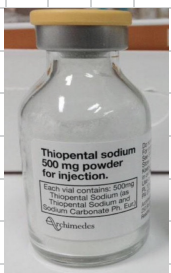
- pharmacodynamics
  - potency :- dose of drug required to achieve a therapeutic effect.
  - Efficacy :- max. effect achievable with the drug.
  - Toxicity :- when undesiarable SE of its administration occur.
  - Therapeutic index :- Ratio of dose producing a toxic effect to therapeutic effect.

- IV drugs
  - uses
    - To induce & maintain GA in op-Room.
    - For sedation
    - For procedures outside op-Room.
    - in the ICU.
  - MoA
    - potentiation of GABA Receptors → inhibitory neurons.
      - ↑Cl flux → promotes hyperpolarization.
    - inhebiting NMDA Receptors (Ketamine) :- excitatory neuron.
    - α_2 receptor activation (Dexmedetomide).
  - ampuls (one use), vials (multi-use).

1. propofol :- most common used (induction & maintance)
   - induction dose :- 1.5-2.5 mg/kg
   - 1% pre-prepared → 10mg/mL
   - MoA :- GABA + $GABA_A$ Receptor
   - onset :- 30-60 sec, arm-Brain circulation time
   - contains :- 1% egg lecithin emulsion, glycerol & soybean oil (Relevant to pt allergies to egg white, not contraindicated with egg allergy).
   - administration :- only IV (↑Lipid soluble).
   - $T_{1/2}$:- 2-8 min (metabolism take 40-50 min).

- excertion:- By Kidney (Rapid hepatic metabolism).
- Special
  - formulation can support bacterial growth:- 6h → discharge.
  - pain on injection:- +1% Lidocaine.
  - antipruritic & antiemetic properties → Used in TIVA (Total IV anesthesia).
    - prevent PONV.
- SE
  - CVS & RS depressant:- Hypotention, apnea, bradycardia.
  - ↓BP, ↓contractility, ↓SVR, ↓preload:- ↓Symphatic tone & direct vascular SM effect.
  - Avoid in hemodynamic unstable pt.

2 Barbiturates → thio-barbiturates:- thiopental.
→ oxy-barbiturates:- methohexital.



- indiction dose:- 3-5 mg/Kg.
- each vial contains 5g (500mg) powder of STP:- +normal saline (20mL).
- 2.5% soultion (25mg/mL), Highly alkaline (pH=10):- cause burn.
- onset:- 30-60 sec, arm_Brain circulation time.
- MoA:- Enhance $GABA_A$ receptor transmission.
- elimination:- Hepatic metabolism.
- Special
  - ↓crebral metabolic rate of O_2 ($CMRO_2$)
  - ↓crebral Blood Flow (CBF).
  - ↓ intracranial pressure
  - → protective effect at neurosurgery
- contraindication:
  - pt. with porphyria (↑porphyrin formation → Acute crisis).
  - pregrancy & Lactation (narrow safety margin).

3 Etomidate

- induction dose:- 0.2-0.3 mg/Kg (potent).
- 2 mg/mL solution.
- MoA:- Binds to $GABA_A$ Receptor.
- Special
  - pain on injection: Lidocaine.
  - ↓$CMRO_2$, CBF & ICP while maintain good CPP (crebral prefusion pressure). → ↓seizures
  - Hemodynamic stability (↓HR):- Don't cause vasodilation or myocardial depression
- SE
  - ↑PONV
  - ↓11-β-Hyroxlase (production of steroids) → adrenal suppression (4-8h).
- Contraindication
  - sepsis
  - steroid use

4 Ketamine

- Dose
  - IV :- 1-2 mg/Kg.
  - IM :- 4-6 mg/Kg.
  - (several Routes)
- MoA :- NMDA antagonism (N-MethyL-D-aspartate).
- Specific
  - Analgesic effect
    - Blocking pain signals at spinal cord.
    - disassociating the signal between thalamus & Limbic.
  - Stimulate Symphatic Nervous system.
  - ↓Respiratory depression (Bronchodilation).
  - ↑CBF, $CMRO_2$, ICP
  - ↑catecholamines → ↑BP, HR & Co.
- SE
  - dissociative amnesia :- conscious but unresponsive to sensory input.
  - emergence reactions + Hallucination & fear → Benzadezepine.
- contraindication :- space-occuping CNS Lesion.

5 Dexmedetomidine (precedex).

- MoA :- α_2 agonist
- $T\frac{1}{2}$:- 2 hr
- Doses
  - Loading :- 0.5-1 mcg/Kg/10 min
  - infusion :- 0.2-0.7 mg/Kg
- effects :- sedative, analgesic, sympatholytic, anxiolytic (↓Respiratory depression).
- indication :- awake fiberoptic intubation.

6 Benzodiazepens :- midazolam (short), Diazepam (Long), Lorazepam (intermediate).

- effects :- anxiolytic, amnestic, sedative, Hypnotic, anticonvulsant (Not analgesic).
- MoA :- Binds to GABAA at diffrent sites.
- $T\frac{1}{2}$:- 3 HR.
- Dose (midazolam)
  - pre-medication :- 0.04-0.08 mg/Kg (1-2 mg).
  - induction :- 0.1-0.2 mg/Kg
- uses :- premedication, sedation & anxiolysis before GA.
- SE :- mild RS & CVS & upper airway reflex depression.
- Antidote :- FlumazeniL (competitive antagonist).

	CVS			RS		CNS	
	HR	SVR	MAP	Ventilation	CBF	CMRO2	ICP
				Mechanical			
Barbiturate	+	-	--	---	---	---	---
Propofol	0	--	---	---	---	---	---
Benzodiazepines	+	-	-	--	--	--	--
Etomidate	0	0	-/0	-	---	---	---
Ketamine	++	0	++	+/-/0	+++	+	+++
				Spontaneous			

Drug	Speed of Induction and Recovery	Pain on injection	Delirium	PONV	analgesia
Thiopental	Fast < 1 minute Accumulation occurs, giving slow recovery	No	-	0	-- antanalgesic
Etomidate	Fast onset Fairly fast recovery	Yes	-	+	0
Propofol	Fast onset Very fast recovery	Yes	-	--	0
Ketamine	Slow onset	No	++	++	++
Midazolam	Slower than other agents	No	-	0	0

need more analgesia post op

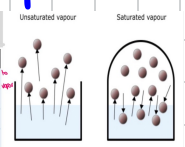
- Rapid onset
- High lipid solubility
- Rapid recovery, no accumulation during prolonged infusion
- Analgesic effect
- Minimal cardiovascular and respiratory depression
- No emetic effects
- No pain on injection
- No excitation or emergence phenomena
- No interaction with other agents
- Safe following inadvertent intra-arterial injection
- No toxic effects
- No histamine release /No hypersensitivity reactions
- Long shelf-life at room temperature

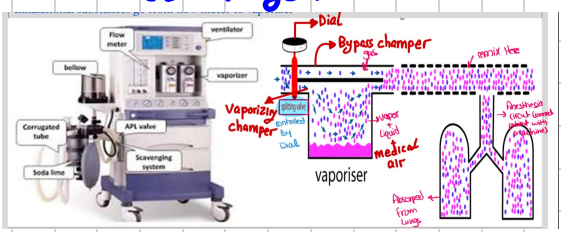
9 - Inhalational Anesthetics

- **introduction**
  - vapor :- mixed gas + Liquid, can go back to Liquid in ↑pressure, All Agents.
  - gas :- N_2O, O_2, medical air, can't go back to Liquid.
  - inhalation drugs :- Liquids with tendency to vaporise dilivered through RS, usually halogenated hydrocarbons or eitheirs, via a vaporizer.
  - critical temp :- temp above which a substance can't be Liquified (only gas), Below this Liquid co-exist with their gas form (vapor). water 374°c.
  - saturated vapour pressure (SVP) → pressure exerted by vapour phase of a substance when in equilibrum with the Liquid phase, determines the effect of agents

Agent	Boiling point (°C)	SVP at 20°C (kPa)
Desflurane	23	89
Sevoflurane	59	21
Isoflurane	49	32
Halothane	50	33
Water	100	

↓Boiling ↑Tendency to vaporize ↑ Loss of vapor ↑SVP

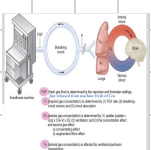




Inhalational anesthesia refers to the delivery of *gases or vapors* from the respiratory system to produce or maintain anesthesia

Exposure to the pulmonary circulation allows build up of concentration in arterial blood. It is slower than IV induction.

- **pharmacoKinetics**
  - uptake & distribution
    - depth of GA depend on partial pressure (gas fraction) exerted to brain.
    - $P_I > P_A > P_a > P_b$ → equilibrium → gas analyzer A=B.

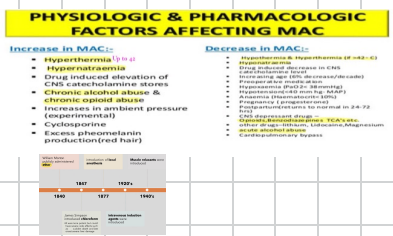


  - partition Coefficents :- Relative solubilities of an air/Blood/tissue.
    - Ratio of concentration of the anesthetic vapour in each of two phases of steady state
    - steady state :- equal partial pressure in the two phases.
    - in Blood → some will Become Liquid (ineffective) → ↑Gas.
  - Blood : Gas partition coefficient (λb/g)
    - onset & offset
    - compares conc. of undissolved vapor in Blood to undissolved vapor in alveoli at equal pressure.

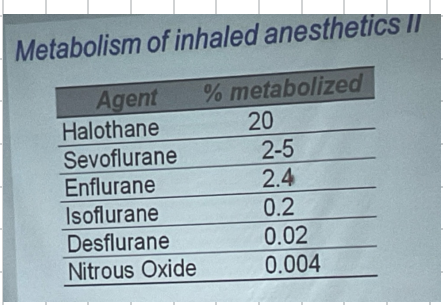
- **oil:Gas partition coefficient**
  - Diffrence of concentration of undissolved vapor from brain to blood
  - Related to Lipid solubility & potency (MAC :- ↑mac = ↓potency).

- **minimum Alveolar concentration (MAC)**
  - Deff
    - partial pressure of gas in (A) which will equilibrate with conc. in (B) is the most important factor.
    - MAC that prevent movement in 50% of pt. in Response to surgical stimulation (skin incision).
    - = ED_{50} :- Effective dose of 50% of population at 37°c & 1 atm.
  - provide a standart way of estimating anesthetic depth & comparing agents.
  - values
    - 0.3-0.4 (MAC-awake) :- awakening from anesthesia (abs of others).
    - 1.3 (ED_{95}) :- blunting of Response in 95% of pt.
    - 1.5 (MACBAR) :- Blocking of adrenergic response to surgical stimulus.
  - Rationale
    - easily measured (A) conc.
    - (A) = (B).
  - Adv
    - invariant with a variety of noxious stimuli.
    - ↓individual variability.
    - don't alter by (sex, Height, weight, duration).
    - doses of anaesthetic in MAC's are additive.

Agent	MAC (%)
Desflurane	6.6
Sevoflurane	2.0
Isoflurane	1.1
Halothane	0.75 highest potency Slow onset+offset
N_2O	104 least potency



- **Inhalational agents**
  - Adv
    - ↓traumatic :- child, needle phopic, Learning disability.
    - Difficult IV acess (vasodilation).
    - Spontaneous ventilation & airway tone.
    - Titration of dept of anaesthesia.
    - Bronchodilation (Asthma, COPD).
    - Brief anaesthesia (Dental).
  - Disadv
    - Bad smell
    - Airway irritation (Desflurane).
    - Excitation phase of anaesthesia
    - cardiac & respiratory depression.
    - Theatre pollution (Leaking).
    - Malignant Hyperthermia (except No).



- MoA
  - mutisite Hypothesis
    - fronto-parietal cortices
    - thalamus.
  - inhibitory receptors
    - GABA$_A$
    - NMDA
    - glycine
    - (+)
  - Exitatory receptors
    - nAch
    - 5-HT$_3$
    - glutamate
    - (-)

All agents depress CNS, RS, CVS & exert muscle relaxation.

- ideal one
  - ↓Blood:Gas coefficient → Rapid induction.
  - Non-flammable.
  - Non-pungent (odourless)
  - Non-irritant to airway.
  - Non-cardiac or Respiratory depressant.
  - Non-toxic to Liver & Kidney.

xenon in the closest But expensive & Hard to use.

1 isoflurane

- Halogenated methyl ethyl ether.
- nonflammable, pungent (maintance).
- MAC :- 1.2%
- VCR :- 0.5%

Physiological effects	
CNS (Good for neurosurgical)	↑ CBF, ICP at >> 1 MAC : reversed by hyperventilation ↓ Cerebral metabolic oxygen requirement
CVS	Most significant reduction in SVR → ↓ BP
Respiratory	↓ Minute ventilation, Blunt the normal ventilatory response to hypoxia and hypercapnia, Irritate upper airway reflex, a good bronchodilator
Neuromuscular	Relaxes skeletal muscle
Renal	↓ Renal blood flow: ↓ GFR and U/O
Hepatic	↓ Total hepatic blood flow

2 Sevoflurane

- Fluorinated methyl-isopropyl ether
- Non pungency & ↓MAC → Kids induction
- MAC :- 2.0%
- VCR :- 0-8%
- Biotransformation & toxicity :- Degraded by alkaline (barium hydroxide Lime, Soda Lime) → producing nephrogenic end products (compound A)
- contraindicated :- Renal impairment.

Physiological effects	
CVS	Mildly depress myocardial contractility ↓ Systemic vascular resistance: ↓ arterial BP small rise in HR: CO not maintained well
Respiratory	Rapid shallow breathing, Depress respiration, Reverses bronchospasm
Cerebral	↑ CBF and ICP, ↓ Cerebral metabolic oxygen requirements
Neuromuscular	Adequate muscle relaxation for intubation of children
Renal	Slight ↓ Renal blood flow Associated with impaired renal tubule function
Hepatic	↓ Portal vein blood flow

3 Desflurane

- Halogenated ether.
- ↑SVP :- Requires special vaporizer
- ↓solubility :- Rapid onset & offset.
- irritant not for induction just maintance.
- MAC:- 6 %
- VCR:- 0-18%
- Degraded by desiccated CO_2 absorbent (Soda Lime) into CO.

Physiological effects	
CNS	↑ CBF, ICP:, lowered by hyperventilation ↓ Cerebral metabolic rate of oxygen
CVS	↓ Systemic vascular resistance: ↓ BP, CO: unchanged or slightly depressed (inc. in HR). Rapid increases in concentration lead to transient elevation in HR, BP, catecholamine levels
Respiratory	↓ Tidal volume:, ↑ respiratory rate: ↓ Alveolar ventilation: ↑ resting PaCO2, Depress the ventilatory response to ↑PaCO2 Pungency and airway irritation

4 Halothane

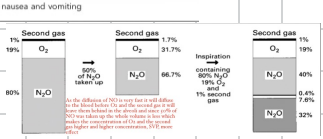
- Halogen substituted ethane.
- nonflammable , sensitive to Light (Dark bottles).
- Most potent
- Soulbility:- ↑ in Blood & adipose (prolonged emergency).
- Mac :- 0.75%
- VCR:- 0-5 %
- Hepatitis
  - oxidized by cytochrome P-450 2E1 to trifluoacetic acid.
  - ↑Alt , ↑Ast, ↑ bilirubin , ecephalopathy, Arrythmia.
  - pathogenisis
    - immunologically mediated (Anti-Hepatocytes Antibodies).
    - Hypoxic (ischemia)
  - Exposure depent.

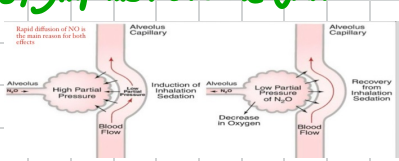
Physiological effects	
CVS	Direct myocardial depression → dose-dependent reduction of arterial BP, SVR: unchanged, Coronary artery vasodilator, but coronary blood flow↓ due to systemic BP_2 Blunt the reflex: hypotension inhibits baroreceptors in aortic arch and carotid bifurcation → vagal stimulation↓→ compensatory rise in HR Sensitizes the heart to the arrhythmogenic effects of epinephrine
CNS	↑ CBF, Blunt autoregulation, ↑ ICP, ↓ Metabolic oxygen requirement Contraindicated in neurosurgery
Respiratory	Rapid, shallow breathing: ↓ Alveolar ventilation and ↑ resting PaCO2, Hypoxic drive severely depressed A potent bronchodilator, reverses asthma-induced bronchospasm
Neuromuscular	Relaxes skeletal muscle
Renal	↓ Renal blood flow: ↓ GFR, U/O
Hepatic	Hepatic blood flow: ↓

5 Nitrous oxide

- only inorganic , pure gas
- insert nature with minimal metabolism.
- colorless, odorless, tatseless
- weak anesthetic good analgesic.
- Mac :- 105%
- No malignant hyperthermia, ↓B12 , diffuse into closed spaces.
- second gas effect:- ↑ other gasess at the beginnig.
- Diffusion hypoxia:- Turn off → from blood to alveoli → Hypoxia → Tx:- 100% O_2.
- contraindication
  - diffuse to cavities:- pneumothorax , IO , tympanic membrane graft.
  - pulmonary HTN.

Physiological effects	
CNS	↑ CBF, cerebral blood volume, ICP, ↑ Cerebral oxygen consumption
CVS	Depress myocardial contractility but Arterial BP, CO, HR: unchanged or slightly↑ due to stimulation of catecholamines Constriction of pulmonary vascular smooth muscle → increase pulmonary vascular resistance Contraindicate in PHT? Peripheral vascular resistance: not altered
Respiratory	↑ Respiratory rate and ↓Tidal volume: minimal change in minute ventilation and resting arterial CO2, ↓ Hypoxic drive
Neuromuscular	Not provide significant muscle relaxation
Renal	↓ Renal blood flow: ↓ GFR and U/O
Hepatic	↓ Total hepatic blood flow
GIT	Increase nausea and vomiting





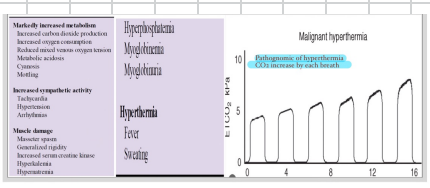
- **obstetric effects (1 → 5)**
  - Dose dependent ↓uterine contractility & Blood flow (↑Risk post partum bleeding).
  - May cause uterine atony & PPH.
  - Rapidly cross the placenta & Reach the fetus (causing RS depression).

6 Xenon

- Nonexplosive, non-pungent, chemically inert, ↓PONV
- No metabolism & ↓toxicity.
- ↑cost & Hard to use.
- Mac:- 71 %
- Have some analgesic effect.
- minimal hemodynamic effect.
- seems not to trigger malignant hyperthermia.

• Malignant Hyperthermia

- Def:- Genitic (AD) Hypermetabolic disease to inhalation or Succinylcholine (except N_2O)
- features
  - Gene for Ryanodine (Ryr1) in chromosome 19 (↑Ca relase from SR).
  - induction, intra-op, post-op.
  - 50% occurs in second exposure.
  - Adult young males.
- pathophysiology
  - ↑Ca → ↓inhibition of troponin → Sustained muscle contraction.
  - ↑Atp activity → Hypermetabolic → $\uparrow O_2$ consumption & $\uparrow CO_2$ production → (Hypoxia & Hypercapnia) → Lactic acidosis & ↑Temp.
- Tx:- dantrolene sodium + supportive.



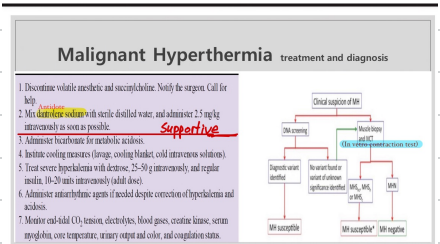


TABLE 8–6 Clinical pharmacology of inhalational anesthetics.

	Nitrous Oxide	Halothane	Isoflurane	Desflurane	Sevoflurane
Cardiovascular					
Blood pressure	N/C[1]	↓↓	↓↓	↓↓	↓
Heart rate	N/C	↓	↑	N/C or ↑	N/C
Systemic vascular resistance	N/C	N/C	↓↓	↓↓	↓
Cardiac output[2]	N/C	↓	N/C	N/C or ↓	↓
Respiratory					
Tidal volume	↓	↓↓	↓↓	↓	↓
Respiratory rate	↑	↑↑	↑	↑	↑
$Paco_2$					
Resting	N/C	↑	↑	↑↑	↑
Challenge	↑	↑↑	↑	↑↑	↑
Cerebral					
Blood flow	↑	↑↑	↑	↑	↑
Intracranial pressure	↑	↑↑	↑	↑	↑
Cerebral metabolic rate	↑	↓	↓↓	↓↓	↓↓
Seizures	↓	↓	↓	↓	↓
Neuromuscular					
Nondepolarizing blockade[3]	↑	↑↑	↑↑↑	↑↑↑	↑↑
Renal					
Renal blood flow	↓↓	↓↓	↓↓	↓	↓
Glomerular filtration rate	↓↓	↓↓	↓↓	↓	↓
Urinary output	↓↓	↓↓	↓↓	↓	↓
Hepatic					
Blood flow	↓	↓↓	↓	↓	↓
Metabolism*	0.004%	15% to 20%	0.2%	<0.1%	5%

[1]N/C, no change.
[2]Controlled ventilation.
[3]Depolarizing blockage is probably also prolonged by these agents, but this is usually not clinically significant.

Figure 29.5 Ranking of clinical properties of volatile agents. D = desflurane, H = halothane, I = isoflurane, S = sevoflurane

	Worst	Worse	Better	Best
Induction	D	I	H	S
Cardiovascular stability	H	I	D	S
Respiratory irritation	D	I		H & S
Ease of titration	H	I	S	D
Emergence	H	I	S	D
Metabolism/toxicity	H	S	I	D

Figure 29.6 Grading of clinical properties of volatile agents. ○○○○ = least effect, ●●●● = maximum effect

	Halothane	Isoflurane	Desflurane	Sevoflurane
Pungency	●○○○	●●●○	●●○○	○○○○
Respiratory irritation	○○○○	●●○○	●●●○	○○○○
Respiratory depression	●●○○	●●●○	●●●●	●●○○
Cardiovascular depression	●●●○	●●○○	●○○○	●○○○
Coronary vasodilatation	●○○○	●●○○	●○○○	●●○○
Muscle relaxation	●●○○	●●●○	●●●○	●●●○
Intracranial pressure elevation	●●●●	●●○○	●●●○	●●○○

1o .Neuromascular blocking agents (muscle Relaxant).

- **introduction**
  - produced by Inhalation, Regional or NMBA.
  - does not ensure unconsciouss, amnesia or analgesia.
  - Deff:- Drugs acts peripherally at NM-Junction & muscle fibers to block transmission
  - Adv
    - muscle Relaxent in surgery (mechinical ventilation)
    - Rapid sequence induction to ↓risk of aspiration.
  - NM-Junction
    - synaptic cleft:- narrow gap (20-nm) between neuron & muscle.
    - Neurotransmitter:- Ach (acetylcholine):- choline + Coenzyme A (by choline acetyl transferase)
    - ca influx → vesicles of Ach → Relase Ach → +nicotinc cholinergic R.
  - Ach Ⓡ
    - 5 protein subunits:- 2α (+Ach), 2 β, δ, ε
    - Sodium channel :- perijunctional, voltage time dependent

- **Groups**
  - Depolarizing:- Ach Receptor agonists (not metabolized by Acetylcholinestrase) → prolonged deporization
    - phase I Block:- can't Repolarize, Agent ↑Ⓡ
    - phase II Block:- After time → poorly understood change in Ⓡ.
  - Non-Depolarizing:- competitive antagonists.
  - non-classical Blockage:- without agonist or antagonist properties.
    - include:- Inhaled, Local, Ketamine (unKnown MoA).
    - interfere with normal functioning of ach binding site ± opening or closing of R channel
    - closed channel Block:- physically plugs up the channel
    - open channel Block:- enters & obstructs Ach R after opening (Antibiotics, cocaine, quinidine) (interfers with blockade reversal).

quanternary ammonium
- don't Cross BBB
- don't cross placenta

Depolarizing	Non-depolarizing
Short-acting	Short-acting (Metabolized by cholinesterase)
Succinylcholine	Mivacurium
Only in short surgery and intubation	Intermediate-acting
	Atracurium; Cisatracurium (Hoffman)
	Rocuronium; Vecuronium (Liver)
	Long-Acting
	Doxacurium
	Pancuronium; Pipecuronium

1 Succinylcholine (Suxamethonium).

- onset:- Rapid 30-60s :- Rapid sequence induction.
- ↓ Lipid solubility as well as relative overdose given.
- duration of action:- short <10min
  - ↑ by ↑dose or abnormal metabolism
    - Hypothermia:- ↓rate of hydrolysis.
    - ↓pseudocholinesterase:- pregnency, Liver disease, RF, drugs
    - Genetically variable:- Heterozygous or Homozygous.
- metabolism:- pseudocholinesterase in plasma.
- interaction (cholinestrase inhibitors :- Neostigmine, pyrodostigmine).
  - prolong phase I block
    - ↑Ach → ↑depolarization
    - ↓Hydrolysis of Succinylchine (↓ pseudocholinestrase).
- Dose
  - Adult
    - intubation :- 1-1.5 mg/Kg, 5 mg/Kg (alone)
    - Maintance:- Repeated small bolus (10mg) or drip (1g/500-1000mL).
  - child → intubation :- infants 2mg/Kg, older 1mg/Kg. (Imature Receptors).
- SE
  - CVS
    - ↓dose:- ⊖ chronotropic/inotropic effects.
    - ↑dose :- ↑HR & contractility, ↑catecholamine.
    - children:- Bradycardia (Tx:- atropine).
  - fasciculation:- Signals onset of paralysis, prevented by non-depolarizing agents.
  - Myalgia:- unsychronized contraction, ↑CK & myoglobinemia, ↓By NSAIDs.
  - ↑K:- normal muscle relase K to 5meq/L, >7 meq/L, may lead to cardiac arrest.
  - malignant hyperthermia (Topic 9).
  - intracranial pressure :- ↑ICP & CBF (non-dep. + Lidocaine 2-3min pre-intubation).
  - ↑intragastic pressure :- ↑LES tone, not Reflux/aspiration.
  - ↑intraocular pressure :- extra-ocular M prolonged depolarization → ↑IOP (glucoma)

TABLE 11–3 Drugs known to decrease pseudocholinesterase activity.

Drug	Description
Echothiophate	Organophosphate use for glaucoma
Neostigmine Pyridostigmine	Cholinesterase inhibitors
Phenelzine	Monoamine oxidase inhibitor
Cyclophosphamide	Antineoplastic agent
Metoclopramide	Antiemetic/prokinetic agent
Esmolol	β-Blocker
Pancuronium	Nondepolarizing muscle relaxant
Oral contraceptives	Various agents

TABLE 11–5 Conditions causing susceptibility to succinylcholine-induced hyperkalemia.

Burn injury
Massive trauma
Upper motor neuron abdominal infection
Spinal cord injury
Encephalitis
Stroke
Guillain-Barré syndrome
Tetanus/Parkinson's disease
Tetanus
Prolonged total body immobilization
Preexisting hyperkalemia
Polyneuropathy
Closed head injury
Myopathies (with metabolic acidosis: Myopathies (eg, Duchenne's dystrophy)

Non-Depolarizers

Drug	Structure	Metabolism	Primary Excretion	Onset	Duration	Hist. Release	Vagal Blockade Vagolytic
Atracurium	Benzylisoquinolone	+++	x	++	++	+	0
Cisatracurium	Benzylisoquinolone	+++	x	++	++	0	0
Mivacurium	Benzylisoquinolone	Cholinesterase enzymes	x	++	+	+	0
Doxacurium	Benzylisoquinolone	Insignificant	Renal	+++	+++	0	0
Pancuronium	Steroidal	+	Renal	+++	+++	0	++
Pipercuronium	Steroidal	+	Renal	+++	+++	0	0
Vecuronium	Steroidal	+	Biliary	++	++	0	0
Rocuronium	Steroidal	insignificant	Biliary	+	++	0	+

Drug	Intubation dose (mg/kg)	Onset of action for Intubating dose (min)	Duration of action (min)	Maintenance dosing by boluses (mg/kg)	Maintenance dosing by infusion (ug/kg/min)
Succinylcholine	1-1.5	.5-1	5-10	.15	2-15 mg/min
Rocuronium	.6	1.5-2.5	35-75 (Renal/Biliary)	.15	9-12
Mivacurium	.2	2.5-3.0	15-20 (Enzymatic metabolism)	.05	4-15
Atracurium	.5	2.5-3.0	30-45	.1	5-12
Cisatracurium	.2	3-4	40-75	.02	1-2
Vecuronium	.12	2-3	45-90	.01	1-2
Pancuronium	.12	2-3	60-120	.01	x
Pipercuronium	.1	2-3	80-120	.01	x
Doxacurium	.07	4-5	90-150	.05	x

- **Non-Depolarizers**
  - Types
    - Benzylisoquinolines :- Relase Histamine (Bronchospasm, ↑HR, hypotention)
    - steroids :- vagolytic, Allergic History.
    - others :- Like chlorofumarates.
  - intubation
    - not Rapid as succinycloline
    - Quicked by ↑dose or priming dose
      - 5min before → occupe R → faster
      - does not lead to clinically paralysis
      - cause dyspnea, dysphagia, diplopia.
  - Maintance
    - variable in dose response
    - Requires close monitoring with Neuro-stimulator + (movement, vent.)
    - allow return of NM-Transmission.
  - Inhalation
    - volatile agents ↓dose 15% (↑enchanced affinity).
    - Des > sevo > Iso & Enflurane > Halothane > N2O
    - pancuronium > Vancuronium & atracrurium.
  - Autonomic SE
    - tubocurarine / metocurine :- old, Block ganglia (↓contractility).
    - pancuronium :- ↓vagal → tachycardia.
  - Excretion
    - Hepatic
      - pancuronium / vecuronium metabolized by Liver.
      - Liver faliure
        - ↑pancuronium & rocuronium Blockage.
        - ↓effect on vecuronium.
        - no effect on Cisatracurium / antacurium
    - Renal :- Doxa, pan, vecu, pipe.
  - factors
    - Temp :- ↓Temp → prolonged action (↓metabolism & excretion.
    - Acid-Base :- RA → prolonged action.
    - ↓K / ↓Ca :- prolong
    - ↑Mg :- prolong (competing Ca, in preeclampsia).
  - Age :- neonate have ↑sensitivity (don't ↓dose), ↑extracellular space (↑V_d).

2 Antracurium (Benzylisoquioline)

- Hoffman elimination :- metabolized indepdent of Renal & biliary routes.
- doses :- Histamine relase above 5mg/Kg (intubation, HTN, ↑HR, flush)
- Laudanosine toxicity
  - Breakdown product.
  - CNS excitation → seizures (cross BBB).
  - only relevant at exteremly ↑doses or hepatic faliure.
- precipitate as free acid if placed in IV Line with alkaline solution (thiopental).

3 Cisatracrium (steroisomer of atracrium).
- x4 potent.
- Hoffman elimination
- Doesn't produce dose-dependent ↑Histamine, ↓Laudanosine toxicity.
- pH/Temp sensitivity → secondary to unique metabolism
  → prolonged action by hypothermia/acidosis.

4 Mivacurium
- metabolism:- pseudocholinesterase.
- cause Histamine relase.
- duration:- Breif (Half of atra/vec/ro...).
- markedly prolonged by prior adminestration of pancuronium.

5 Doxacuronium (Benzylisoquinoline).
- excretion:- Renal (as Long acting).
- onset:- slow 4-6 min (0.05mg/Kg for intubation).
- No cardiac or Histamine-Release SE.
- Duration:- 60-90 min.

6 pancuronium (steroid Base).
- excretion → primary by Renal
  → some by Bile (cirrhosis → ↑dose).
- SE → HTN & ↑HR:- vagal bbck + symphatic ⊕.
  → Arrhythmias:- ↑AV conduction & catecholamine relase (↑ with TCA & halothane)
  → Allergic:- Hypersensitivity to bromide.

7 pipecuronium
- Same As 6
- no cvs SE
- Renal excretion

8 Vecuronium
- excretion:- Renal & biliary.
- SE → No cvs (↑opoid-bradycardia).
  → Bulidup 3-Hydroxy → ↑clearance → polyneuropathy.

9 Rocuronium (Rapid-Vecuronium)
- No active metabolite:- Long-term infusion
- elimination:- Hepatic & Renal (↑ in presrency)
- quick onset, short duration (↑ in elderly)

TABLE 11-8 Additional considerations in special populations.

Pediatric	Succinylcholine – should not be used routinely Nondepolarizing agents – faster onset Vecuronium – long-acting in neonates
Elderly	Decreased clearance – prolonged duration, except with cisatracurium
Obese	Dosage 20% more than lean body weight; onset unchanged Prolonged duration, except with cisatracurium
Hepatic disease	Increased volume of distribution Pancuronium and vecuronium – prolonged elimination due to hepatic metabolism and biliary excretion Cisatracurium – unchanged Pseudocholinesterase decreased; prolonged action may be seen with succinylcholine in severe disease
Renal failure	Vecuronium – prolonged Rocuronium – relatively unchanged Cisatracurium – safest alternative
Critically ill	Myopathy, polyneuropathy, nicotinic acetylcholine receptor up-regulation

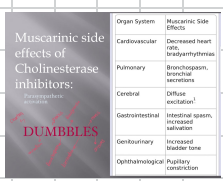
- 1mg/Kg :- ↓ post-op myalgia for Succinylcholine.
- Slight vagolytic tendencies.

10 Gantacurium (chlorofumarates).

- as Lypohilized powder bec its not stable as an aqueous solution
- duration:- Ultrashort. (1-2m)
- metabolism:- nonenzymetic degradation by 2 chemical Reactions
  - Rapid inactive cysteine
  - ester Hydrolysis
- Dose :- 0.2 mg/Kg. (ED95)
- duration :- 5-10 min
- Antidote :- edrophonium , cysteine.
- SE:- after x3 (ED95) → CVS (Histamine).

• Reversal of NMBA:-

- cholinergic (R)
  - Nicotinic:- Ach , ⊖ by muscle relaxant
  - muscarinic:- Ach, ⊖ by atropine (anticholinergic)
- cholinesterase inhibitors (neostigmine)
  - ↑Ach → Reestablishing normal NM-Transmition.
  - also ↑Ach in muscarnic
    - CVS :- Bradycardia
    - GIT :- Diarrhea, vomiting, nausea.
    - → atropine sulfate or glycopyrolate
  - the only time after Succinylcholine is when there is phase II block & sufficient time has passed.
- Sugammadex (cyclodextrin)
  - selective relaxant-binding agent → tight complex 1:1 with steroidal NMBA.
  - 2 mg/Kg , 2-4 min (↑dose → ↑effect)
  - no CVS, RS, Coagulation SE.
  - not effective on Benzylisoquinoline

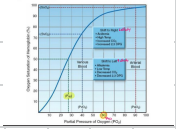


The newer neuromuscular blocking agents, such as gantacurium, which are still under investigation, show promise as ultrashort-acting nondepolar- izing agents; they undergo chemical degradation by rapid adduction with L-cysteine.

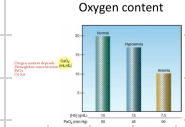
11. Hypoxia & O_2 therapy.

- Nomally O_2
  - From atmosphere to alveoli → in air 21%, ⊖pressure → Alveoli → capillary
    - partial pressure
      - Atmospheric air = 160 mmHg (21 Kpa).
      - Humidified tracheal gas:- 150mmHg (19.8)
      - Alveolar gas:- 106 mmHg (14Kpa).
      - Arterial blood:- 100mmHg (13.3Kpa).
      - Capillary blood:- 45-55 mmHg (6.7Kpa).
      - Mitochondria:- 7.5-40 mmHg (1-5Kpa).
  - Arterial/venous O_2 content:- $(1.34 \times Hb \times Sv_{O_2}) + (0.003 \times P_{O_2})$.
  - Amount O_2 flux normally:- 850-1200mL/min or 500-700 mL/min/m^2
  - O_2 consumption:- $CO \times (A\ content - mixed\ v\ content)$ = 240-270 mL/min (Rest)
    - ↑:- fever, sepsis, shivering, Restlessness, Hypercatabolism
    - ↓:- cooling, paralysis, mechanical ventilation.

Oxyhemoglobin dissociation curve



Oxygen content



- Hypoxia:- ↓O_2 for tissue respiration
  - Anoxia:- abs of O_2 in tissue (cardiac arrest).
  - Hypoxemia:- ↓O_2 LvL in arterial blood.
  - Acute (<3w)
    - causes
      - Respiratory depression
      - Airway obstruction
      - Atelectasis
      - ventilation/perfusion mismatch
      - ↓ functional residual capacity.
    - Direct effects (signs)
      - Cynosis
      - confusion, Drowsiness
      - Excitment
      - Headache
      - Nousea
      - Myocardial Depression
      - Arthymia
      - Bradycardia
      - Renal impariment
    - indirect effect (signs)
      - stimulation of baroreceptors
      - Tachycardia
      - HTN
      - Hyperventilation

- O_2 saturation
  - 85%:- metal impairment.
  - 75%:- sever metal impairment
  - 65%:- unconsciousness.

- chronic (>3w)
  - causes
    - High altitude
    - chronic Lung disease.
  - effects
    - compensatory mechanisms.
      - Hyperventilation
      - polycythemia
      - ↑ 2-3-DPG (↓affinity).
      - proliferation of peripheral capillaries.
      - Alteration in intracellular oxidative enzymes.

	O2 Content	PaO2	% Sat
Hypoxemia	↓	↓	↓
Heart Failure	Normal	Normal	Normal
Anemia	↓ slightly affected	Normal	Normal
Carbon Monoxide	↓	Normal	↓* low Sat Normal Sat* mildly affected

- Hypoxic Hypoxia:- Respiratory problems, normal Hb & blood flow.
  - causes
    - ↓ inspired Po_2 (High altitude).
    - ↓ventilation due airway obstruction (asthma).
    - Defect at capillary-alveolar interface (ARDs)
    - A-V shunts.
  - pathophysiology:- ↓partial pressure of O_{2a} → chemoReceptors → ↑ventilation
    - ↓Co_2
    - shift to Lt.
- Anemic:- ↓Hb LvL or ↓Hb carrying capacity.
  - causes
    - anemia
    - gas poisoning (co):- ↑x250 affinity → ↓Respiratory center → Tx:- 100% O_2
  - ↑:- execrise, ↓:- Rest.
- Circulatory:- cvs problems, ↓CO, normal PaO_2 (no Respiratory center stimulation).
- Histotoxic:- cells unable to utilize O_2, normal Po_2, capacity & blood flow.
  - due to:- cyanide poisioning.

• oxygen delivery systems

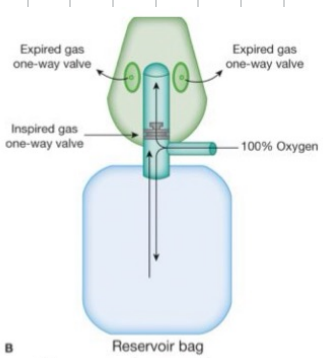
- indications
  - CPR
  - RS & cvs faliure
  - Shock
  - ↑metabolic demands
  - CO poisoning
  - post-op state
- Target O_2sat
  - Normal person:- >94%
  - copD or RF type 2:- 88-92%
  - ICU pt.:- >90%.
- Types
  - variable preformance:- vairable FiO_2 depending on pt's inspiratory flow rate.
  - fixed preformance:- Fixed FiO_2.

1 Variable performance

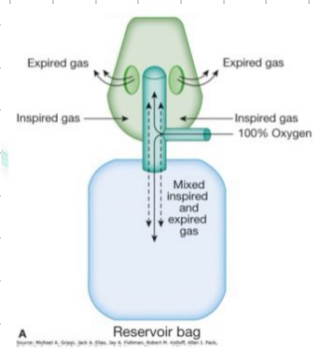
- **Face mask** → Flow:- 5-10L, FiO_2:- 40-60%, allow entery of room air, ↓flow system
  - plastic body + 2 side holes + port (O_2) + elastic band (↑face).
  - FiO_2 dependent on O_2 flow rate, size of O_2 reservior & Respiratory pattern.
  - indications :- when fixed oxygen concentration is not critical.
  - contraindications:- pt who depends on hypoxic drive (COPD).
  - Adv:- comfort, simple, ↓cost, manipulate FiO_2 without changing appliance, +bronchodilator
  - disadv:- no expiratory phase, Rebreating (dead space), Tight fitting → ↑Rebreathing, no oral feedi
- **Face mask with reservoir bag** (600-800 mL)
  - partial rebreather:- Flow:- 6-10L/min, FiO_2:- up to 70%
    - Adv:- plastic bags are transparent under chin (comfortable).
    - disadv:- same as face mask, ⊖Bronchodilator therapy, Bad seal → Bad O_2 delivery
  - Non-Rebreather:- Flow:- 10-15 L/min, FiO_2:- up to 100%
    - expiratory parts covered with flaps → one way valve :- expired air out, no room air inhalation.
    - Disadv:- Risk of suffocation if the gas flow is interrupted.
  - indications:- hypoxemia (+face mask) with normal respiratory pattern.
- face mask can cause dryness of eye (Leaking), not sativable for pt. who are claustrophobic.

• Allows the gas exhaled in initial phase of expiration to return to the reservoir bag. As exhalation proceed the flow rate will decrease becoming less than the oxygen flow rate at this point the exhaled gas can no longer return to reservoir bag. Since the initial expired gas is the anatomical dead space gas it is largely devoid of CO_2 because the gas in the reservoir bag is under positive pressure inhalation will draw primarily from the gas in the bag.

- **Nasal cannula**:- Flow:- 1-6 L/min, FiO_2:- 24-40%
  - 2 prongs which protrude 1cm in nose held by head strap.
  - Adv:- Long term usage, ↑compliance, pt. can eat, drink & talk.
  - disadv:- trauma & irritation of nasal mucosa.
  - contraindication:- pt. who requires ↑flow of O_2 (↑ventilatory demands).



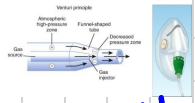
Non rebreather mask

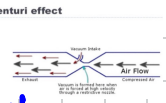


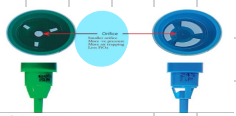
Partial rebreather system

Table 6.2 Factors that affect the delivered FiO_2 in the variable performance masks

High FiO_2 delivered	Low FiO_2 delivered
Low peak inspiratory flow rate	High peak inspiratory flow rate
Slow respiratory rate	Fast respiratory rate
High fresh oxygen flow rate	Low fresh oxygen flow rate
Tightly fitting face mask	Less tightly fitting face mask







2 Fixed performance

- venturi mask :- High-airflow oxygen enrichment.
  - plastic+2 holes + venturi device (colored ➡)
  - indications :- dependent on hypoxic drive (COPD).
  - Adv :- No rebreathing & no ↑ in dead space.
  - disadv :- Bulky & noisy.

Venturi valve

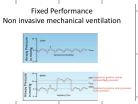
Color	FiO2	O2 Flow
Blue	24%	2 L/min
White	28%	4 L/min
Orange	31%	6 L/min
Yellow	35%	8 L/min
Red	40%	10 L/min
Green	60%	15 L/min

- non-invasive positive pressure mechanical ventilation.
  - used to treat acute or chronic Respiratory Failure, no risks of tracheal intubatio
  - Requirement
    - conscious pt.
    - cooperative.
    - protected airway reflexes.
    - monitor vitals & Respiratory pattern & ABGs.
  - BiPAP (Bilevel positive airway pressure).
    - Mask with silicon caution to form a seal.
    - pressure
      - ↑ :- inspiratory positive airway pressure.
      - ↓ :- expiratory positive airway pressure.
    - ↑mean airway pressure (than CPAP) → Recruiment of alveoli → ↑Lung compliance → ↑Tv.
    - Disadv :- abrade the nose . claustrophopia.
    - indications
      - signs of RS failure (dyspnea, tachypnea, use of accessory muscle).
      - Gas exchange abnormalities (pH<7.5)
      - $PaCO_2$ >45 mmHg , PaO_2 : FiO_2 <200
      - Acute exacerbation of COPD with hypoxemia & cardiogenic edema.
    - contraindication
      - Absolute :- RS & CVS arrest.
      - Relative
        - discomfort from the mask.
        - ↑Risk of aspiration (impaired mental status)
        - Active vomiting.
        - Large volume of secretions
        - Recent upper airway or GIT surgery.
  - CPAP (continuous positive airway pressure).
    - Spontaneously breating at a positive end-expiratory pressure, ↑FRC
    - indications :- OSA + BiPAP indications.
    - Disadv :- does not augment the tV which Limit it use in Acute RS failure.

- PEEP (positive end expiratory pressure).
  - unconcious pt.
  - intubated by ETT.
  - pressure kept in the alveoli to keep it open at the end of expiration.
  - No ⊕ pressure is applied to inspiration.


CPAP versus PEEP

Mechanical ventilation and CPAP/PEEP



- Bag-Mask ventilation :- Manual IPPV
  - Bag + O_2 , one-way valve + 3 ports (inlet, outlet, mask & tube), reservor for O_2.
  - Requires good seel & practice.
  - Difficult:- fascial Hair, obese, Age >55, Lack of teeth, History of snoring.
  - Types
    - +valve:- more than 90% O_2 to ventilated & spontanous breathing pts.
    - -valve:- ↑conc. O_2 during PPV but only 30% during spontanous breaths.
  - indications:- RF (<8 breath/min), transport of intubated pts, short term ventilation.
  - Contraindication:- obstructed upper airway.
  - Adv:- simple, portable, ↑FiO_2, PEEP.
  - disadv:- opens LES (aspiration), need practice, uncontrolled hyperventilation

- pediatrics (variable performance device).
  - incubator
    - neonates & infants only.
    - Flow rate:- 8-15 L/min, FiO_2:- 40-50%
    - provide neutral thermal environment, humidification & O_2 delivery.
    - Transparent :- allow visualization of the pt.
  - Hood
    - neonates & infants only.
    - flow rate:- 10-15 L/min, FiO_2:- 80-90%
    - provide control of temp, humidity & O_2.
    - Transparent :- allow visualization of the pt.
  - tent
    - pt. can move around in his bed without face mask.
    - used for kids.
    - maintain humidity.
    - flow rate:- 12-15 L/min, FiO_2:- 40-50%


Pediatric incubator


Oxygen hood


Oxygen tent

Guideline for oxygen therapy in acutely hypoxemic patient

- Assess Airway, Breathing and Circulation
- When the patient is at risk of Respiratory type II failure:
  - Target saturation is 88-92% whilst waiting for ABGs result
  - ABGs result :
  - When pH<7.35 and PCO2>45mmHg (6.0 kPa) seek immediate senior review and consider NIV or invasive ventilation. Treat with the lowest FiO2 to keep SpO2 88-92% either via venturi system or NIV/MV
  - When pH>7.35 and PCO2>45mmHg (6.0kPa) treat with the lowest dose venturi mask to maintain SpO2 88-92%. Then repeat ABGs at 30-60 minutes, if pH<7.35 and PCO2 <45mmHg (6.0kPa) seed immediate senior review and consider NIV/MV. Consider reducing FiO2 if PO2 ≥ 60mmHg (8.0kPa)

- If there is no risk for respiratory failure type II:
  - Aim for SpO2 94-98%
  - When SpO2 ≤ 94% on air or oxygen:
    - Commence oxygen at 2-6 L/min via nasal cannula or simple face mask 5-10L/min. Reservoir Bag 15L/min if SpO2<85%
    - when ABGs results are:
      1. PCO2 ≤ 45mmHg (6.0kPa) treat appropriately aiming to keep SpO2 94-98%.
      2. PCO2 ≥ 45mmHg (6.0kPa) or respiratory deterioration seek immediate senior review and consider invasive ventilation . Treat urgently aiming for SpO2 94-98% consider COPD or undiagnosed chronic type II respiratory failure. If likely aim SpO2 88-92%
      3. Repeat ABGs in 30-60 minutes for all at risk of type II respiratory failure
    - When SpO2 >94% monitor SpO2, oxygen is not required unless SpO2 falls below 94%.

12 - Anesthesia monitoring in OR & ICU

- introduction
  - past
    - Visual monitoring of Respiration & overall clinical apperance.
    - Finger on pulse & BP.
  - why?
    - Maintain normal physiology & hemeostasis throughout anesthesia & surgery.
    - Surgery is very stressful :- symphatic stimmulation, HTN, tachycardia, arrhythmi
    - SE of anesthetics :- hemodynamic instability, myocardial depression, Hypotention.
    - Blood loss, hypo or hyperventilation, Hypothermia.
  - 2 critical times :- induction & Recovery.
  - consist of
    - sensory for data collection (ECG Lead, pulse oximetry).
    - system dat analysis.
    - system for interpretation & display (on screen)
  - Degree of invasiveness
    - Non-invasive :- attached to skin (ECG)
    - penetrating :- Normal passage through the body (ECHO)
    - invasive :- Abnormal passage (Arterial Line, CVP).
    - Highly invasive :- inside organ (PAC, Brain).
  - Limitation (5D)
    - Delay.
    - Danger.
    - Decrease skill.
    - Doubt of Results.
    - Distracting set up.
  - ASA Guidelines
    - standard I :- Qualified anesthesia personnel shall be present.
    - standard II
      - oxygenation (FiO_2, O_2 conc, oxygenation - pulse oximetry)
      - ventilation (capnography (TV)
      - circulation (3Lead ECG, BP (q5 min)
      - temp (temp probe)

      → continually evaluated
  - Select a monitor Depends on :-
    - Aim
    - Experience
    - Type of anesthesia
    - Facilites & availability.
    - Nature of surgery.
    - pt. General condition

Cvs
- Peripheral pulse.
- Tissue perfusion.
- ECG.
- Arterial blood pressure.
- Central venous catheterization
- Pulmonary artery catheterization.
- Cardiac output measurement.
- TEE.
- Blood loss measurement.

Rs
- Clinical monitors.
- Airway pressure measurement.
- Disconnection alarm.
- Stethoscope.
- Spirometery.
- O2 monitoring.
- Co2 monitoring.
- Anesthetic gas analysis.
- H+ ions measurement.

Invasive
- Arterial line
- Central venous pressure
- Pulmonary artery catheterization
- ICP monitoring

Metabolism
- Temperature monitoring.
- Tissue oxygenation monitoring.
- Indirect calorimetry.
- Fluid & electrolyte status
- Blood gases & acid base status monitoring.

Ns

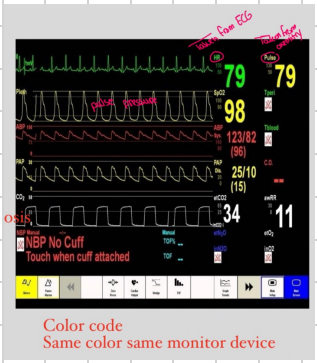
Peripheral nerve stimulation:

1) Single twitch.
2) Train of four twitches.
3) Tetanic stimulation.
4) Double burst stimulation.

Cns
- Clinical monitoring.
- EEG.
- Evoked potentials.
- Cranial nerve monitoring.
- Cerebral blood flow
- cerebral oxygenation.
- depth of anesthesia.

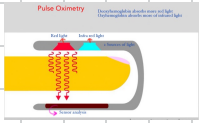
• RS monitors

- **oxygenation :-** Ensure adequate O_2 conc. in inspired gas & Blood & delivered to tissue.
  - **methods**
    - Exposure to asses color
    - inspired gas oxygen analyzer
    - pulse oximetry.
  - monitor O_2 delivery to pt.
    - O_2 faliure alarm (gas supply pressure monitor).
    - O_2 conc. in the gas mixture (FiO_2 analyzer).
  - monitor O_2 delivery to tissues
    - clinically :- cap. Refilling, state of extremities
    - O_2 transport :- Hb LvL, SaO_2 & PaO_2
    - O_2 uptake (utilizing) :- SVO_2 (PAO), Lactic acid LvL.



Color code
Same color same monitor device

- **pulse oximetry**
  - Deff :- % of oxy-Hb / Total Hb.
  - Timing :- Before induction → after recovery.
  - optical plethysmography :- detect pulsatile (changes in Blood volume, pulse wave).
  - spectrophotometry :- measure pulsatile (Hb-saturation).
  - Value
    - SpO_2
    - HR
    - peripheral perfusion state (↓waveform → Hypoperfusion :- hypotention & cold)
    - idea about rhythm from plethysmography wave (irregularity not type).
    - cardiac arrest (Abs of wave).
  - How?
    - finger or toe (without nail polish & stains).
    - to the Limb with IV Line (opposite the limb with BP cuff).



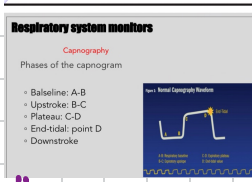
  - Readings
    - normal person on room air (O_2 = 21%) :- >96%
    - pt. under GA (100% O_2) :- 98-100% (not accepted under 96%).
    - Hypoxemia :- <90% (PaO_2 = 60 mmHg).
    - sever Hypoxemia :- <85%
  - inaccuracies
    - misplaced on the pts finger, slipped.
    - pt movement, shivering.
    - poor tissue perfusion (cold extrimities. Hypotension, shock).
    - cardiac arrest
    - interferance
      - intrinsic :- co-Hb, Met-Hb, IV dyes, fetal-Hb
      - Extrinsic :- motion, cautary, nail bed infection, polish

Ventilation

- methods
  - qualitative signs
    - chest excursion
    - observation of reservoir bag
    - Auscultation of breath sounds.
  - quantitive measurment
    - End tidal CO_2 (capnography).
    - volume of expired gas.
    - Airway pressure.

capnography:- CO_2 waveform

- $EtCO_2$:- point in capnogram, endpoint expiratory (Highest CO_2).
- Normal range:- 30-35mmHg (Lower than $PaCO_2$ by 5-6mmHg).
- value
  - ETT: esophageal intubation
  - ventilation:- hypo or hyper, curare cleft
  - pulmonary perfusion:- pulmonary embolism
  - Breathing circut:- disconnection, Kink, obstruction, rebreathing .....
  - cardiac arrest:- prognostic value, adequacy of resucitation during arrest.
  - metabolic state



• CVS Monitors

- methods
  - continous electrocardiogram monitoring
  - Arterial BP
  - HR
- ECG
  - value
    - HR:- R wave counting
    - Rhythm :- II → supraventricular arrhythmia, All Leads → ventricular.
    - ischemic changes & ST segment analysis. (II, V_5, V_4)
  - Timing:- throughout the surgery: Before induction until after extubation & recovery
  - Types
    - 3 Leads:- Red:- Rt, yellow: Lt, Black:- Apex.
    - 5 Leads:- Red & yellow same, Black:- under red, Green:- under yellow, white:- center.
  - Rules
    - QRS beep must be Heard at all times. No Silent monitors.
    - Cautery artefacts ECG → check radial pulse.
    - Arrhythmias →
- Non-invasive BP
  - methodology:- Oscillometric algorithms. / Automated.
  - Limitation:- cuff size
    - Small → false ↑BP
    - Large → false ↓BP.
- Gives Readings for:- Systolic, diastolic & MAP.

- value
  - Avoid & manage Hypo or HTN.
  - Avoid ↓MAP < 60 mmHg (cerebral & renal prefusion).
  - Avoid ↓diastolic BP.
  - Risk of HTN
    - CVS:- MI, PE
    - CNS:- hemorrhagic stroke, HTN encephelopathy.
  - Risk of hypotension
    - CVS:- MI
    - CNS:- ischemic stroke, Hypoperfusion (MA) .....
- Timing :- throughout the surgery: Before induction until after extubation & recovery.
- Frequency
  - every 5 min
  - every 3 min :- after spinal Anesthesia, Hemodynamic instability.
  - every 10 min :- awake + Local (monitored anesthesia care).

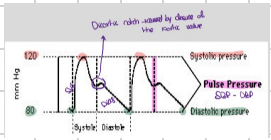
- **monitoring of metabolism**
  - Temp
    - sites
      - Tympanic
      - Esophagus
      - Bladder
      - Rectum
      - Blood (PA cath, most sensitive)
      - Skin.
    - normal Loss:- 0.5-1°c /hr, not more than 2-3°c.
    - complications of hypothermia
      - cardiac arrhymias:- VT & arrest.
      - myocardial depression
      - Delay recovery (delay drug metabolism)
      - ↑Risk of infection.
      - metabolic acidosis (Lactic acidosis)
      - Hyperkalemia
      - Coagulopathy.

- **Nuromuscular function** (Evaluation of Block)
  - peripheral nerve stimulaton
    - Single twitch.
    - Train of four twitches.
    - Tentanic stimulation.
    - Double brust stimulation.
  - clinically Blockade Reversal
    - Head lift > 5 seconds
    - Sustained hand grip
    - Negative inspiratory force
      - At least -55 cmH_2O for adults
      - At least -32 cmH_2O for children
    - Vital capacity 15 ml/kg
    - Absence of nystagmus or diplopia
      (ocular muscles are the last muscles recover from muscle relaxant)

- **invasive monitoring**

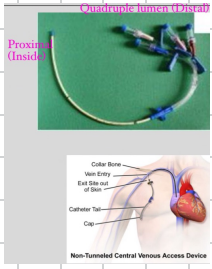
Arterial Line :- beat-to-beat monitoring of ABP.

- **indications**
  - Rapid moment to moment BP change (pheochrocytoma surgery)
  - frequent Blood sampling (ABGs)
  - circulatory therapies (Bypass, IABP, vasoactive drugs).
  - faliure to inderict BP (Burns, morbid obesity).
- **Radial Artery cannulation**
  - Technically easy
  - good collateral (ulnar)
  - complication uncommon.
- **Brachial**
  - Longer catheter to traverse elbow Joint.
  - postop keep arm extended
  - no good collateral.
- **Femoral**
  - use guide-wire technique.
  - puncture femoral artery below inguinal ligament (easier to compress).



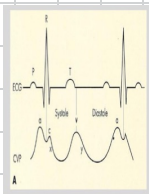
- **complications**
  - **Early**
    - Hematoma
    - vasospasm
    - Nerve damge
  - **late**
    - Thrombosis
    - Embolization (air or thrombus).
    - skin necrosis, infection
    - Disconnection & fatal Blood Loss.

central venous Line



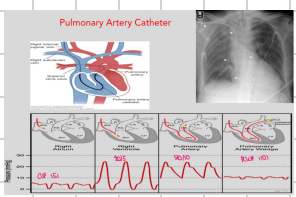
- **indications**
  - CVP monitoring
  - Advanced CV disease + major-op.
  - secure vascular acess for drugs (vasoactive)
  - acess for fluids
  - inadequate peripheral IV acess (obese).
  - Pacer, Swan Ganz (pulmonary cath).
- **Rt. internal Jugular**
  - consistent, predictable anatomic Location.
  - Readily identifiable Landmarks.
  - short straight course of SVC
  - Easy intra-op acess for anesthesiologist at pt's Head.
  - ↑sucess rate (90-99%).
  - Disadv:- discomfort

- Subclavian
  - Easier to insert if c-spine precaution
  - Better pt. comfort.
  - ↑Risk of pneumothorax 2%.
- External Jugular
  - Easy cannulate, no risk of pneumothorax.
  - 20% cannot access central circulation.
- Femoral
  - ↑infection rate
  - No access for CVP readings.
- CVP
  - vena cava + RA pressure
  - driving force for filling RA+RV.
  - estimate of
    - IV blood volume.
    - RV preload.
  - measure at end-expiration (transthoracic pressure = 0).



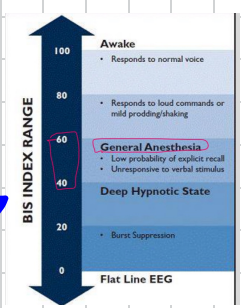
Component	Phase of Cycle	Event
a wave	End diastole	Atrial cont
c wave	Early systole	Isovol vent cont
x descent	Mid systole	Atrial relaxation
v wave	Late systole	Filling of atrium
y descent	Early diastole	Vent filling

- pulmonary Artery catheter (PAC) :- Swan, Ganz
  - clinical variables :- CO, PAP (pulmonary Arterial pressure), PCWP (p. capillary wedge p).
    - cvp to estimate LV filling, guide fluid/vasoactive drug & calculate core temp.
  - Complications
    - minor (50%) :- arrhythmias.
    - Transient RBBB (0.9-5%)
    - serious (0.1-0.5%)
      - p. infraction
      - PA rupture
      - endocarditis (damage)
    - Death (0.01b%).



- CNS monitor
  - indications
    - Long surgery (CNS, CVS)
    - TIVA.
  - EEG :- for frontal Lobe.
  - Bispectral index monitor :- degree of awarness of pt.
  - clinically
    - Tachycardia
    - HTN
    - movement (facial)
    - pupil dilated
    - Lacrimation

    → signs of pt awarness (BIS > 60)



Monitoring After Extubation & Recovery

Before removing the monitors and sends the patient to recovery room :

- BP:
  - within 20% of baseline.
- SpO2:
  - > 92% on RA Room air
- Breathing:
  - regular, adequate tidal volume.
- Muscle power:
  - sustained head elevation for 5 seconds, good hand grip, tongue protrusion.
- Level of consciousness:
  - 1) obeying orders 2) eye opening 3) purposeful movement.

MOST IMP: Pt MUST be able to protect his own airway. To prevent aspiration if vomiting occurs after the recovery

RULES NEVER to FORGET

NEVER start induction with a missing monitor: ECG, BP, SpO2.

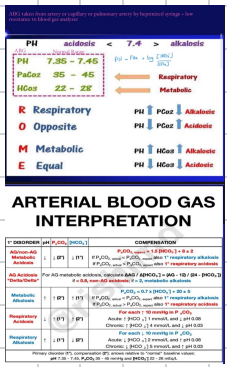
NEVER remove any monitors before extubation & recovery.

NEVER ignore an alarm.

ALWAYS
- Remember that your clinical sense & judgement is better than & superior to any monitor.
- You are a doctor u are not a robot.
- The monitor is present to help you not to be ignored and not to cancel your brain.

14 - Acute Respiratory Faliure

- **Respiratory faliure**
  - **introduction** → inability of Lung to meet the metabolic demands of the body.
    - Hypoxemia or Hypercapnea.
  - **Hypoxemia :-** ↓O_2 in Arterial blood system (P_aO_2 < 60 mmHg)
  - **Tissue hypoxia :-** ↓O_2 delivered to the tissues.
  - **Hypercapnea :-** arterial CO_2 partial pressure > 50 mmHg.
  - **depends on** → CNS (medulla & phrenic N)
    - Drug overdose (opoids).
    - stroke .
    - Trauma.
    - Tumors.
    - NM-Junction (diaphrgsm & RS muscles)
      - myasthenic Graves
      - polio.
      - Guillian Barre syndrome
      - Amyotrophic Lateral Sclerosis.
    - upper airway
      - Disorders of Reflexes muscles.
      - obstructive sleep apnea.
      - infection (epiglottitis).
      - foreign body obstruction.
      - Laryngospasm
      - paralysis.
    - thorax & pleural
      - mechanical (Kyphosis & scoliosis)
      - functional (effusion & pnemothorax)
    - Alveolar & parenchymal
      - pulmonary edema (HF).
      - Lung fibrosis
      - COPD
      - ARDS
  - **mechanisms**
    - pulmonary :- incapacity of thoracic-pulmonary system.
    - CVS :- ↓perfusion.
    - cellular LvL :- ↓use of O_2 (septic shock, cyanide poisoning).
  - **classification**
    - Acute :- sudden, emergency, ↓PH (↑pco_2, ↓Pa_2O_2, ↑$Paco_2$), ↑mortality
    - chronic :- d→M, PH preserved (↑HCO_3), corpulmonale, polycythemia
    - Type I (Hypoxemic RF)
    - Type II (Hypercapnic RF).



ARTERIAL BLOOD GAS INTERPRETATION

pathophysiologic causes of Acute RF

- **Hypoventilation (II)**
  - ↓4-6 L/min ventilation
  - causes
    - depression of CNS from drugs (opoids & sedative)
    - NM-disease of Respiratory muscles.
  - ↑$PaCO_2$ & ↓PaO_2 (↓TV, ↓O_2, ↑CO_2, ↓MV, normal TV)
  - Alveolar-arterial PO_2 gradiant is normal
  - COPD.
- **V/Q mismatch (I)**
  - most common cause of hypoxemia.
  - caused by
    - ventilation of non-perfused alveoli (Ratio:-∞).
    - perfusion to non-ventilated alveoli (Ratio:0).
  - 100% O_2 → eliminate hypoxemia.
- **shunts (I)**
  - physiologically bronchial coronary veins → A-a gradiant <10.
  - deoxy blood + oxygenated blood → Hypoxemia → ↑A-a gradiant.
  - 100% O_2 → persistant hypoxemia.
  - >60% shunts → hypercapia.
  - causes
    - cardiac (Rt→Lt)
      - fallot tetralogy
      - Eisenmenger's syndrome
    - pulmonary
      - A/V malformation
      - pneumonia
      - pulmonary Edema.
      - Atelectasis/collapse.
      - pulmonary Hge.
      - pulmonary contusion.
- **Diffuse abnormality (I)**
  - Less common
  - Due to
    - abnormality of Alveolar membrane.
    - ↓number of the Alveoli.
  - causes
    - ARDS
    - fibrotic lung disease.
    - Edema.

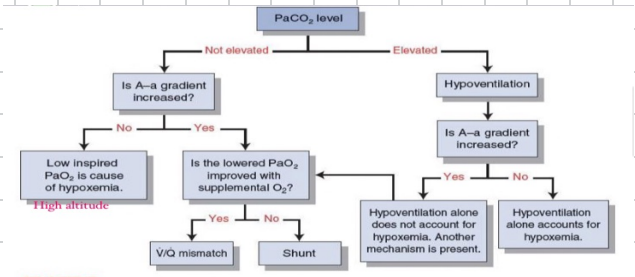
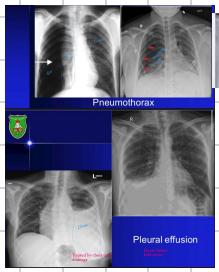


FIGURE 2.12 **Evaluation of a patient with hypoxemia.**

• Type I (Hypoxemic RF)

- Deff:- PaO_2 < 60 mmHg with normal or ↓ $PaCO_2$. + Acute disease of Lungs.
- causes
  - Heart
  - Lung
  - Blood
  - Focal
    - Atelectasis
    - pneumonia 
  - Diffuse
    - cardio-pulmonary Edema.
    - non cardio-pulmonary edema (ARDS) 
    - interstial pneumonitis or fibrosis
    - infection.
  - Normal CXR
    - cardiac shunts
    - Asthma, COPD 
    - pulmonary embolism



• Type II (Hypercapnic RF).

- Deff:- $PaCO_2$ > 60 mmHg , Hypoxemia always present
  - pH depends on LvL of HCO_3 → duration of hypercapnic.
  - Renal Response occurs over days to weeks.
- Acute
  - ↓ Arterial PH.
  - causes
    - Drug overdose (sedative)
    - muscle weakness (myasthenia gravis)
    - Lung disease:- ventilation can't maintained (Asthma/pneumonia)
    - Acute on chronic.- CO_2 retention (COPD) + ↑CO_2 / ↓PH (viral infection).
- causes
  - RS center (medulla) dysfunction :- Drug, CVA, tumor, ↓T_3, central hypoventila
  - NM-disease:- Guillian-Barre , MG, polio, spinal injury.
  - chest wall/pleural disease :- Kyphoscoliosis, pneumothorax, effusion.
  - upper airway obstruction :- tumor, foreign body, Laryngeal edema.
  - peripheral airway disorder :- asthma, COPD.

• Diagnosis

- History
  - cough, dyspnea, chest discomfort . (fever, chills, rigors)
  - Acute & severe :- tachypneac & can't talk clearly.
  - History taken carefully from pt. family & companions.
  - History of allergy & Acute events.
- physical
  - cynosis
  - tachypnea
  - paradoxical breathing & subcostal retractions

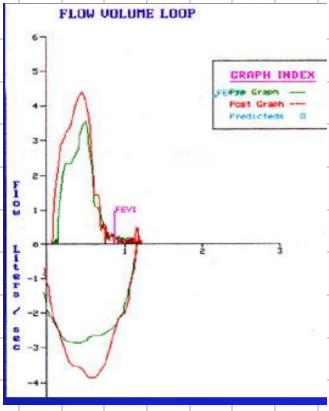
smoking, cough, sputum - COPD
chest pain, orthopnea, PND- HF+ pulmonary edema
fever, Chills- sepsis
cough, sputum, chest pain-pneumonia
Dyspnea , chest pain - PE

- Silent chest (↑obstruction)
- confusion, somnolence & coma & convulsions
- wheezes & crackles, Drooling.

- Acute RF
  - wheezing (A/w obstruction)
    - Bronchospasm.
    - upper/Lower airway pathology.
    - secretion, pulmonary edema.
  - stridor :- upper airway obstruction.
  - ↑JVP :- pulmonary HTN → Rt.V dysfunction.
  - crackles.- pulmonary edema.

- clinical & Laboratory manifestations.
  - Circulatory :- tachycardia, HTN or Hypotention.
  - polycythemia (COPD) :- chronic Hypoxemia → ↑erythropoietien.
  - pulmonary HTN :- cor-pulmonale/Rt.V faliure.

- Laboratory assessement
  - ABGs
  - Lung function
  - vitalogram
  - CXR
  - ECG
  - Echocardiography.
  - CBC & Blood culture.
  - Bronchoscopy.



• mangment of RF

- principles
  - Hypoxemia may cause death in RF.
  - primary objective to reverse & prevent hypoxemia.
  - secondary objective to control $PaCO_2$ & respiratory acidosis
  - Tx of underlying cause.
  - pt. CNS & CVS must be monitored & treated.
  - Target :- overcome hypoxemia by O_2, $PaO_2 > 60$, O_2sat >90.

- Acute RF
  - ABC's
  - Ensure airway is adequate
  - oxygen theraphy & assisted ventilation if needed.
  - support circulation.

- O_2 Therapy
  - supplemental O_2 therapy essential.
  - titration based on :- SaO_2, PaO_2 & $PaCO_2$.
  - Goal :- prevent tissue hypoxia (PaO_2 :- 60 mmHg, SaO_2 >90%, venous >60

- Not favorable Long time for COPD → RS depression.
- Risks → O_2 toxicity → CNS toxicity & seizures:- >1000 mmHg.
  - capillary damge, Leak & pulmonary fibrosis:- Long exposure.
  - Retrolental fibroplasia:- PaO_2 >150.
  - Retinopathy of prematurity
- Risks → CO_2 necrosis → ↑$PaCO_2$ → R.acidosis, somnolence, coma.
  - ↑$PaCO_2$ secondary to combination of → No Breath
    - ↑dead space.

Hypoxemia (I):- O_2 (nasal, face, intubation, mechainical), PaO_2 >60mmHg (SO_2 >90%).

Hypercapnia (II) → control underlying cause
- 1-3 L/min, titrate (O_2 saturation:- >90, <93 to avoid hypercapnia).

• mangment of sever ARF

ICU (Airway mangment) ETT → indications → sever Hypoxemia
- Altered mental status (GCS<8).

ETT → importance → precise O_2 dilivery to the Lungs.
- remove secretions.
- ensure adequate ventilation.

mechanical ventilation (MV) → indications → persistence hypoxemia despite O_2 supply.
- ↓Lvl of consciousness.
- Hypercapnia with sever acidosis (pH<7.2).

mechanical ventilation (MV) → function → ↑PaO_2, ↓$PaCO_2$
- Rest RS muscles
- ventilator

mechanical ventilation (MV) → Lowest FiO_2 that give SO_2 >90% & PaO_2 >60mmHg (toxicity).

PEEP → +MV → ↑intra-thoracic pressure, Keep alveoli open.
- ↓shunting, ↑gas exchange.

PEEP → type I RF (ARDS, pneumonia).

IPPV (CPAP/BiPAP) → mild-modrate RF

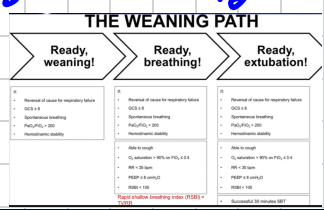
IPPV (CPAP/BiPAP) → pt. should have → normal airway
- Alert & protective reflexes.

IPPV (CPAP/BiPAP) → Nasal or full face → ↑oxygenation
- ↓work of breathing.
- ↑CO

IPPV (CPAP/BiPAP) → COPD, Asthma, CHF.

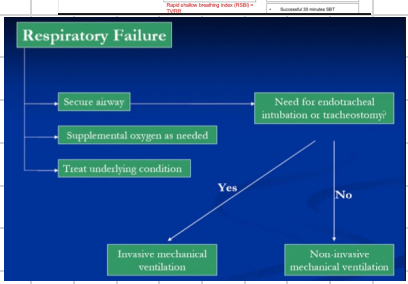
- Tx of underlying cause :- After tx of hypoxemia & hemodynamic stability.
  - Antibiotics :- pneumonia, infection.
  - Bronchodilators :- COPD, BA (↓Bronchospasm, airway resistance).
  - Anticolinergics (Ibratropium bromide) :- COPD, BA (↓vagal tone, Relax SM).
  - Theophylline :- COPD, BA (↑diaphragmatic contraction, Relax SM).
  - Diuretics (Furosemide) :- pulmonary edema.
  - metyL prednisone :- COPD, BA, Acute esionophilic pn (Reverse bronchospasm, inflamm)
  - fliuds & electrolides.
  - IV nutritional support (fat, protein & carb) :- restore strenght, Loss of muscle mass.
  - physiotheraphy
    - chest percussion to Lossen secretion
    - Suction of air way
    - Help to drain secretion
    - maintain alveolar inflation (prevent atelactasis).

- weaning from (MV)
  - stable RS & CVS status
  - Adequate oxygenation, intact Respiratory drive.
  - wake, good nitruition, able to cough & breath deeply.



• Complications of RF

- pulmonary
  - pulmonary embolism
  - Barotrauma
  - pulmonary fibrosis (ARDS)
  - Nosocomial pneumonia
- CVS
  - Hypotention, ↓COP
  - Arrhythmia
  - MI, pericarditis
- GIt → stress ulcer, ilieus, diarrhea, hemorrhage.
- infection
  - Nosocomial infection
  - pneumonia, UTI, cath-sepsis.
- Renal
  - ARF (↓perfusion, nephrotoxic drugs).
  - poor prognosis
- nutritional :- malnutrition, Hypoglycemia, electrolyte disturbance.



• Prognosis :- early tx → ↑prognosis

- ARDS
  - 40% mortality (35% mild, 40% modrate, 46% sever).
  - younger pt <60 has better survival rate.
  - 75% → impairment of pulmonary function one or more years after recovery

15 - Anaesthesia for Emergency & trauma cases

• introduction

- Elective:- ahead of time, planned (inguinal Hernia, cataract, Breast implant)
- Emergency:- Life-threatening situation (intestinal obstruction). unplanned surgery.
- urgency:- a state of priority (Bone fracture).
- Types
  - Traumatic
  - non-Traumatic (obstetrical, Neuro, vascular, Burn, GI, Genito-urinary).

• pre-operative preparation

- Definitive trauma interventions
  - History & PE & emergency procures & evaluation
    - exention of injury.
    - Resuscitation need.
    - need for out-op intervention.
  - clinical intial issue
    - adequacy of airway & vascular acess.
    - ability of pt. to tolerate anesthesia.
    - prevention of Hypothermia:- ↓coagulation cascade.
    - Blood bank supplies
    - +crystalloids (acidosis & coagulopathy) +Vasopressors (Epi:-Iperfusion)
  - Anesthesiologist participation should be the earliest assessment
  - injury & trauma:- 9% of total mortalities, 3rd most cause of death after cvs & Ca.
- Q
  - why pt. need emergency surgery?
  - How much time is available for resucitation?
  - signs of Hemorrhage (↓BP, ↑HR)?
  - quick airway assesment results for difficult intubation?
  - ventillatory support post-op? ICU?.
- ↑Recall memory:- Bez we use bloses to don't effect cvs, BIS to monitor.
- History & PE (SAMPLE)
  - Symptoms
  - Allergies
  - Medications
  - Past medical Hx.
  - Last oral intake.
  - Events prior to incident.
- Labs:- During Resucitation if possible.
- mange any uncontrolled co-morbidities:- DM, HTN, Asthma.

- OR

- preprations
  - Room should be as warm as practical.
  - IV fluids warmers & rapid infusion devices
  - pt. should be presumed to have full stomach → ↑Risk of aspiration.
  - C-collar for cervical supine → ↑intubation difficulty → fibroptic bronchoscope / videoLaryngeoscope
- IV acess
  - usually in prehospital setting or emergency department.
  - peripheral IV line are caliber & quality for Blood infusion → no need central.
  - Hypotensive & Hypovolemic → can't peripheral → Subclavian cath, intraosseous.
  - Subclavian v:- CVL for Hypotensive stent open (Between clavicle & 1st Rib).
  - Ultrasound:- ↑cavity of Large-bore or central venous cath in Jugular veins.
- intraosseous
  - proximal tibia or humerus → direct acess to venous complexes throug BM.
  - Requires
    - Bone proximal & distal be intact (extravasation will occur)
    - pressure (not gravity) to overcome the Resistant in BM.
- upon arrival
  - 2 Large caliber peripheral IV → 16G or 14G → central Line.
  - Routine monitors → invasive monitoring.
- Anesthetics (induction & maintance)
  - GA (RSI)
  - Neuro-axial
  - peripheral Nerve block
  - Local Anesthesia.
  - profound Hypotention after (↓dose 0.25-0.5 of propofol).
  - Etomidate:- preserve sympathetic tone, ↑save.
  - Ketamine:- 1omg → unresponsive pt., save.
  - Scopolamine 0.4mg:- IV, amnetic, Hemodynamic unstable (↑Hemodynamic unstable in conscious)
- complications of difficult airway
  - Hypoxemia.
  - Trauma to upper airway.
  - potential spinal cord injury in cervical injury.
  - Aspiration
    - Head & neck trauma, unable to protect airway (injury)
    - pregrency, intestinal obstruction, intra-abdominal mass, obesity.
    - pain, childrens
    - fasting time
      - Adults:- 2 (clear fliud)-6 (Food) - 8 (Hevay fatty meals).
      - childrens:- 2 (clear fliud - 4 (Breast milk) - 6 (solid or milk).

Invasive monitoring

- An **arterial line is helpful but not mandatory** in the initial resuscitation of the trauma victim.
- Even with the assistance of ultrasonography, cannulating an artery in the presence of profound hypotension may prove difficult.
- Attempts at placing invasive monitors can continue as the patient is prepared for incision, to include gowning and gloving the person attempting arterial line placement on the surgical side.
- Although arterial line placement may be a challenge, surgical incision cannot be delayed.
- **Surgical control of bleeding and Damage Control Resuscitation (DCR)** are the top priorities in trauma resuscitation, not arterial line placement.
- Patients in this degree of hemodynamic compromise can be presumed to haveTrauma Induced Coagulopathy (TIC) and be in need of massive transfusion.
- Attempts for arterial line placement can resume, and are more likely to be successful, as blood pressure improves from operative hemostasis and resuscitative transfusion.

Having an arterial line is beneficial for monitoring the BP of the patient (especially during induction) and giving an idea about the hemodynamic stability and cardiovascular function to determine the drugs and their doses , so put it if needed as soon as possible

- Rapid sequence induction (RSI):- aim is ↓Risk of aspiration.
  - The availability of suction must be confirmed before induction.
  - pre-O_2 with 100% for 3-5 min or 4 vital breaths.
  - predetermined rapid IV induction agents.
  - Rapid acting muscle Relaxant (Suxcamethonium or rocuronium) without effect of induction.
  - ± cricoid pressure:- ↓Risk of aspiration (Risk of esophageal rupture).
  - patient is not artifically ventilated.
  - insertion of NG tube after endotracheal intubation for stomach emptying.

- Fliud managment
  - major trauma resuscitations:- emphasizes blood products rather than crystalloid.
  - An massive Transefusion protocol should be requested & followed
  - All fliuds should be warmed, except for platelets, Rapid infusion → ↓cL^- (Replaced).
  - control bleeding → vasopressors (↑BP → freash clots → more bleeding).
- Analgesia
  - ASAP
  - titrated to the desire of the pt.
  - Respiratory depression.
  - No NSAIDs for Hypovolemic pts → AKI
  - Regional Anasthesia (Coagulopathy).
  - prevent Heat Loss (delay recovery & extubation).

Summary

- Inadequate History and Investigations
  Inadequate Preparation
- a- Not Fasting – Requires Rapid Sequence Induction of Anaesthesia
- b- Untreated Pre-Existing Diseases – Requires Resuscitation and Careful Choice of Anesthetic Drugs and Techniques
- c- Unavailability of Appropriate Investigations – Requires Depending on Clinical Impression and Minimal Investigations
- d- Unavailability of Appropriate Cross-Matched blood – Requires use of Type-Specific blood or Group O-Neg blood transfusion in life saving procedures until proper Cross-Matched blood is available

Damage Control Surgery

- if a trauma patient requires emergent laparotomy for intraabdominal hemorrhage, the trauma surgeon will perform an abbreviated procedure termed damage control surgery (DCS).
- Surgical intervention is intended to stop hemorrhage and limit gastrointestinal contamination of the abdominal compartment.
- After making a midline incision, the surgeon quickly searches for sources of bleeding through a quadrant-by-quadrant examination.
- Definitive repair of complex injuries is not part of DCS.
- Identification of injured blood vessels and solid organs, as well as inspection of injuries in areas relatively inaccessible to midline approaches but potentially addressed by interventional radiology techniques (eg, deep liver lacerations, retroperitoneal hemorrhage), occurs during DCS.
- Hollow viscus injuries are addressed with resection, stapling, or both. Leaving the intestines disconnected until the patient is more stable reduces intraabdominal contamination and operating time.
- Communication among the entire trauma team is essential during DCS. The surgeon must know if the patient is becoming unstable, hypothermic, or coagulopathic. The anesthesia team must speak up when there is a need to pause the surgical procedure to allow resuscitation.

- Post-op management
  - Decision for extubation depends on pt's hemodymamics.
  - stable:- Before extubation → Laryngoscopy → remove secretion.
  - Drugs:- Atropine & neostigmen (Reverse MR).
  - ↑Risk of aspiration:- recovery of airway reflex → extubation.
  - continuation of ventilatory (some).
  - ICU
    - sever chest injury.
    - Evidence of aspiration pneumonia.
    - unstable hemodynamic status.
    - sever Head injury for cerebral protection.
    - massive blood loss with massive blood transfusion with DIC.
    - polytrauma.

...Damage Control Surgery

- Pausing surgery results in the surgeon compressing or packing an area of bleeding during times of profound hypotension until transfusion restores acceptable systolic blood pressure (80-90 mm Hg).
- If this interruption of surgery is unsuccessful in improving blood pressure, the surgeon can directly compress the aorta. This intervention provides the surgeon direct feedback as to the effectiveness of transfusion—a soft aorta suggests profound hypovolemia, whereas the return of a pulsatile aorta suggests a more acceptable circulating blood volume.
- A brief episode of bradycardia/asystole may accompany direct aortic compression.
- When transfusions are ineffective maintaining perfusion, the operation should be interrupted, the bleeding areas packed, and a decision should be made between the surgeon and anesthesia team as to whether the patient can be transferred to the interventional radiology suite to treat bleeding from surgically-inaccessible sites or to the intensive care unit where rewarming, correction of coagulopathy and hemodynamic stabilization may occur.
- A key component of DCS is planned re-operation once the patient is more stable. At a later time. bowel continuitve can be restored or a colostomy can be done.

- examples (ATLS, Caesrean section & Pediatric Burn) → slide 38 → End.

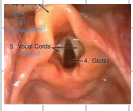
16-principles of pediatrics anesthesia.

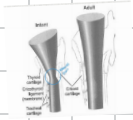
- introduction
  - children not Little adults:- different Anatomy, physiology, pharmacology & psycology.
  - Neonates (0-1m), infants (1-12m), toddlers (12-24m), young children (2-12y).
  - ↑Risk of anesthetic morbidity & mortality (inversely proportional to age).
  - prone to illnesses that requires unique surgical & anesthetic strategies.

Age	Heart rate	SBP	Resp. rate
Newborn	110-170	> 60	30-50
1 year	100-160	> 80	< 40
5 years	80-130	> 90	< 30
> 10 years	< 90	> 90	< 20

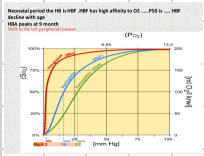
- Developmental considerations
  - CVS
    - Anatomic
      - Noncompliant Lt.V.
      - Residual fetal circulation.
      - Difficult venous & arterial cannulation.
    - physiology
      - HR-dependent-Co (sv fixed)
      - ↑HR
      - dominant parasympathetic (inhibition of cardiac function).
      - ↓BP
      - ↓able to respond to hypovolemia with compensatory vasoconstriction
    - Blood volume
      - premature:- 95 mL/Kg.
      - term:- 90 mL/Kg
      - 6w-2y :- 85 mL/Kg
      - 2y-puberty.. 80 mL/Kg

  - RS
    - Almost all cardiac arrest due to respiratory problem.
    - independent Life is not possible until a gestational age:- 24-26 w.
    - vs adults
      - Large head and tongue, short neck
      - Narrow nasal passages and small diameter of the airways
      - More cephalad and anterior larynx,C4.
      - The narrowest point of the A/W is the cricoid cartilage till 5 years (Increase resistance)
      - Long and stiff epiglottis, U to Omega shape ,touch the soft palate(easy airway obstruction)
      - The vocal cords are angled; consequently, a blindly passed tracheal tube may easily lodge in the anterior commissure rather than slide into the trachea.
      - Short trachea, 5 cm in neonates.
      - The chest wall is highly compliant, therefore the ribs provide little support for the lungs; that is, negative intrathoracic pressure is poorly maintained. (Very rapidly decrease in FRC)
      - Obligate nasal breathing until 5 months
      - Horizontal ribs so ventilation is mainly diaphragmatic
      - Small number of alveoli, low lung compliance,
      - **Low FRC and high O2 consumption(oxygen consumption is two to three times higher than adults)** (Low O2 reserve easily desaturated Cyanosis bradycardia)
      - Hypoxic and hypercapnic ventilatory drive are not well developed in neonates and infants....



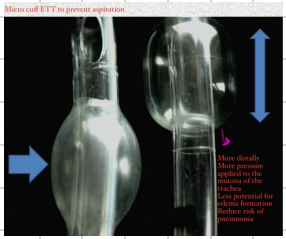


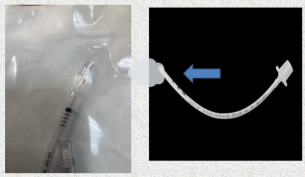
    - means
      - techincal airway difficulties (0.5-1%).
      - ↑work of Breathing.
      - Risk of edema:- Small diamiter & airway resistance.
      - ↓FRC:- ↓Rs reserves → apnea & Hypoxemia.
      - Risk of endobronchial intubation.

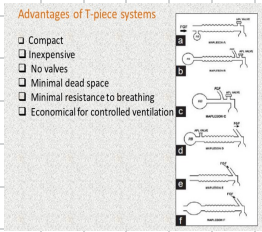


- Depth of ETT
  - Neonate :- 8-10cm
  - 1y :- 12 cm
  - After that
    - 3 x ETT size.
    - ½ age (y) +12cm.

Age	Size—Internal Diameter (mm)
Newborns	3.0-3.5
Newborn-12 months	3.5-4.0
12-18 months	4.0
2 years	4.5
>2 years	ETT size = (16 + age)/4



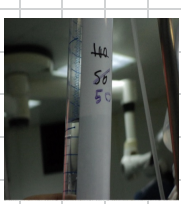




- Aspiration Risk:- ↑in <3y, Rule of 2-4-6-8.
  - Encourage water intake within 2hr
    - ↓dehydration
    - ↓agitation & crying promoter motility.
    - ↓gastric volume & PH.

- Liver & Kidney (↓)
  - ↑free fraction → ↑effect on High-protein bounded drugs.
  - ↑distrubution of water soulble drugs (muscle Relaxant, Antibiotics).
  - ↑intial peak LvL of fat-redistribute drugs (opoids more potent).
  - ↓muscle mass (sensitive to muscle relexants).
  - Delcy metabolism & excretion of the drugs.
- Thermoregulation
  - Greater Heat Loss
    - Thin skin.
    - Low fat content.
    - ↑ surface area/weight ratio.
  - No shivering until 1y.
  - Thermogenisis by brown fat.
  - ↑prone to ictrogenic hypo/hyperthermia.
  - measured by:- tympanic membrane.

- maintenance fliud therapy
  - Replace dificits, Losses & bleeding by isotonic fliud (Ringer Lactate) not G → ↑G risk.
  - older child rule 4-2-1.
  - usemicropdroppers or infusion pumps.
  - dextrose
    - maintance
      - ↑Risk of hypoglycemia
      - sick baby (melnutrition, cardiac.



• preop psychological care

- Assesment of current clinical status & allevitate fear & anxity of child & family.
  - should be explained to their parents.
  - evaluate the child psycological status & family interactions.
- parental presence induction anesthesia (PPIA)
- 1-5y:- comfortable separation in the Holding area usual.
- >6y:- child become focus, explain to Him.
- pharmacology
  - midazolam :- 0.5mg/kg, sedation, 15min onset, intranssally or IV.
  - ketamine :- (P.O, IM, Rectal), 30 min Before induction (5-10mg/kg)
    - Disadv:- excessive secretions & hallucinations.
  - propofol :- proper option.
- <8m:- no separation anxity, eduction of perents.
- Toddlers (1-2) & preschool (3-5):- upset when seperated. (↑incidence).
- use toys, accompany (parents).
- goal :- ↓apprehesion, produce sedation & amnesia.
- Route
  - oral :- older children
  - Rectal :- preschool.
  - IM :- Avoid it

↓Long lasting psychological problems
↳smooth induction.

• monitoring.

- BP
- Blood sugar (neonate):- ↓glycogen stores → ↑risk of hypoglycemia.
- precordial stethoscope.
- ECG.
- pulse oximeter & capnography.
- Temp:- Rectal, esophageal, nasopharynx.
- A/w pressure monitoring.
- MAC
  - Higher MAC.
  - Highest in 6m & 1y.

- IV acess:- may be difficult or even impossible
- intraosseous
  - During administration
  - fliud replecment & blood sampling.

- Fast induction
  - Greater Alveolar ventilation to FRC ratio.
  - ↑CO to vessels rich organs (Brain).
  - ↓tissue blood solubility.

↑ SVOFLURANE: most common and accepted.
HALOTHANE

↓ ISOFLURANE
DESFLURANE

- URTI
  - new or chronic symptoms? → infection/allergy/vasomotor.
  - viral 2-4w of GA with intubation ↑perioperative risk
    - wheezing:- x10
    - Laryngospasm :- x5
    - Hypoxemia, atelectasis, recovery room stay, ICU.

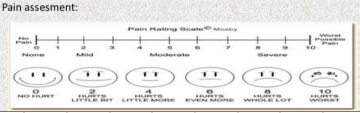
- Laryngospasm
  - etiology:- superior laryngeal N stimulation → involuntary Spasms.
  - Risk
    - Extubated while Lightly anesthetized.
    - Recent URI
    - Tobacco exposure.
  - Tx
    - PEEP >10cmH2O
    - Laryngospasm notch.
    - propofol :- 0.5-1 mg/kg IV
    - Succinylcholine :- 0.2-0.5mg/kg IV / 2-4 mg/kg IM.
    - intubation.

- peri-op pain control
  - Regional (caudal) :- extradural block of intraumbilical procudures.
    - ↓anesthetic requirments
    - op & post-op utility.
    - caudal block is most common.
    - peripheral blocks & cath:- Epidural, spinal.
  - caudal
    - peri-op
    - ↓epidural fat
    - may advance cath to thoracic region

- Ropivicaine 0.2% 1 cc/kg (up to 2 mg/kg)
- Bupivicaine 0.25% 1 cc/kg (up to 2.5 mg/kg)
- Opioids
  - Duramorph 25-50 mcg/kg
  - Hydromorphone 5-10 mcg/kg
- Clonidine 2 mcg/kg

- Acetaminophen
  - PO 10-15 mg/kg, PR 40 mg/kg, IV 20mg/kg
- NSAIDS (diclofenac sodium suppository)
- Ketorolac 0.5-0.75 mg/kg IM/IV
- Opioids
  - Morphine 50-100 mcg/kg
  - Fentanyl 0.5-1 mcg/kg

Pain assesment:



- **Malignant hyperthermia**: Acute hypermetabolic state in muscle tissue

- Triggering agents
  - Volatile agents.
  - Succinylcholine.
- family Hx
  - muscle biopsy → caffine contracture test.
  - ± Ryanodine receptor abnormality.
- ↑flow O_2 flush circut x20
- nontriggering
  - TIVA.
  - Nitrous.
- ↑RisK
  - Duchenne's muscular dystrophy.
  - central core disease
  - osteogenesis imperfecta.
  - King Denborough syndrome.
- signs
  - specific
    - Rapid ↑$EtCO_2$ (early)
    - Rapid ↑temp (Late)
    - ± muscle rigidity.
    - Rhabdomyolosis (ck)
    - myoglobureа.
  - non-specific
    - Tachycardia
    - Tachypnea
    - ↑K
    - Dysrhythmias.
    - Acidemia
      - Metabolic.
      - Respiratory.

- Tx
  - Discontniue triggering agents.
  - Hyperventilation with 100% FiO_2.
  - $NaHCO_3$ 1-2 mEq/Kg IV.
  - Dantrolene 2.5mg/Kg IV.
  - Cool pt.
  - Support as indicated → intropes, dysrhythmias.
  - monitor Labs + invasive monitoring.
  - 1800-MH-HYPER.

★ introduction to Anesthesia.

- deff

- **consciousness:-** Our contining stream of awareness of either our sourroundings or our sequential thoughts.
- **Anesthesia**
  - Loss of feeling or sensation.
  - partial or complete, ± Loss of consciousness
  - can be effected
    - Local (Block ulner n)
    - regional (spinal/epidural) → conscious.
    - general (turn cortex off) → unconscious.
- **Hypnosis:-** The state of being asleep & consequently unware of the sourronding.
  - deprivation of critical faculites by hypnotism.
  - can feel pain or withdrawl/autonomic reflexes (no algisic).
- **Narcosis:-** state of stupor produced by drugs.
  - more accurate then Hypnosis.
  - confusisly with morphine-like drugs addiction (euphoric action not stuperous).
- **Sedation:-** from allaying anxiety to inducing near sleep drugs By ↓cerebral center.
- **pain vs nociception:-** Nociceptive stimulus.
  - conscious → under GA, Reflex response (Tachycardia, HTN).
- **Analgesia:-** state of freedom from pain (Local, general).
- **Anxiolysis**
  - ↓Anxiety (Fear, apprehension & stress).
  - sedantion → Anxiolysis. But Anxiolysis can effected by non-sedative drugs (Tranquilizers).
- **Tranquilizers:-** Lower LvL of CNS to produce calming effect.
- **Antidepressant:-** alter the mood & mental Reactions of pt.
- **muscle Relaxation:-** ↓tense by ↓tone or paralyzing them.
  - obtained in
    - CNS Depression
    - Local anesthesia
    - NM-Junction block.
  - used to facilitate ventilation & open surgeries, need to mechanical ventila.

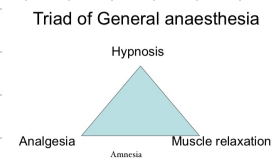
Important Notes !!

*** All hypnotic sedatives, tranquilizers and antidepressants in large doses will cause loss of consciousness, respiratory depression and abolition of the protective reflexes.

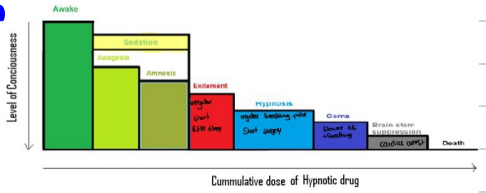
- The difference between drugs commonly used for sedation and those used for intravenous induction of general anesthesia is the therapeutic margin.

But antidepressants cause toxicity at the large doses which limited the usage in anesthesia induction

- **General Anesthesia:-** pt. has been rendered reversibly unconscious by drugs.
  - used in → painfull op.
    - Diagnostic (MRI who had claustrophopia).
  - signs of back of concious :- Lacrimation, salivation, tachycardia, HTN.
  - end by :- $T_{1/2}$ or antidote.
  - subdivision (Route) :- IV, Inhalation, IM, Rectal.
  - Modren (Balanced) GA → Hypnotic :- Loss of consciousness
    - Analgesic :- analgesia
    - MR :- paralysis.
  - stages (not on-off) :- cumulative development of different clinical stages of consciou
    - I (sedation) → Analgesia, ↓S.G & spinothalmic.
      - no amnesia.
    - II (Delirium) → ↓inhibitory (Golgi II) → facilitation
      - excited but amnesic
        - irrugular Respiration rate.
        - Retiching & vomiting.
        - incontinence & struggling.
        - Regular Breathing → End.
    - III :- depression of RAS + ↓spinal reflex (MR).
      - Rugular Breathing → complete cessation of spontaneous respiration.
      - plane 1 :- return of regular respiration → cessation of REM.
      - plane 2 :- Surgical plane, cessation of REM → onset of paresis of intercostals.
      - plane 3 :- onset → complete paralysis of intercostals.
      - plane 4 :- paralysis of intercostals → paralysis of diaphragm (apneic).
    - IV (medullary depression) :- cardio-RS collapse → Coma & death.
    - distinctive signs → Rapid onset of action drugs.
      - mechanical ventilation
      - pre or intra-op drugs → influence the signs of anesthesia.



Stage I - Analgesia	Stage II – Excitement	Stage III Surgical anesthesia	Stage IV - Medullary depression
The receiver of the anesthesia primarily feels analgesia followed by amnesia.	- Severe confusion and amnesia. - Irregular respiration. - Nausea and vomiting. - Struggling and panic.	- Regular respiration. - Regular HR. - Loss of eye and ms reflexes. - Normal BP	- Depression of RC. - Circulatory collapse due to ↓↓ of VMC. - Fully dilated pupil - Coma and death



Brain is painless tissue
Anesthesia level should match stimulus
2% of patient reach coma
2% of patient stay at sedation level

Scope of Anesthesia

- Work In Every Area Of Medicine
  - OR, PACU, ICU, OB, Peds, Pain Clinic
- Work With The Most Diverse Patient Population
  - Premature Infants To Geriatrics
- Provide Medical Care & Critical Care
  - Prior To, During, And After Surgical Procedures
- Work With Advanced Technology

You Might Like Anesthesia If…

- You Enjoy Performing Procedures
- You Are Interested In Critical Care
- You Enjoyed:
  - Pharm, Physio, Cardiology, Pulmonology
- You Like All Areas Of Medicine
  - You Can Specialize Though
- You Like To See Immediate Results

Role of the Anesthetist

- Anesthetist is the perioperative physician.
- Provides medical care to each patient:
  - Pre-operative evaluation.
  - Patient counceling and informed consent
  - Consultation with surgical team
  - Providing pain control
  - Supporting life functions during surgery.
  - Supervising immediate post-operative care

Brief History

- Pre-1800: Surgery Without Anesthesia
- **1846: First Ether Anesthetic:** 16th of October in Boston hospital/America
- 1847: Chloroform was introduced by James Simpson.
- 1884: Cocaine For Local Anesthesia
- 1910s-1920s: Endotracheal Intubation.
- 1921: Epidural Anesthesia Described
- 1940: Curare Clinical Trial Success (Montreal)
- Mid 1950s: halothane
- 1960: Short Acting Opioids
- 1962: Transesophageal Echo
- 1988: Laryngeal Mask Airway

Ether Day – October 16th, 1846

Before anesthesia:…

….. Surgery was a terrifying last resort in a final attempt to save life.

Liston, an eminent surgeon, was once operating for a bladder stone.
The panic stricken patient finally broke loose from the brawny assistants, ran out of the room, down the hall and locked himself in the lavatory.

Liston, hot on his heels and a determined man, broke down the door and carried the screaming patient back to complete the operative procedure.

(Rapier HR. Man against Pain London 1947;49).

Anaesthesia is now very safe, with mortality of less than 1 in 250,000 directly related to anaesthesia.

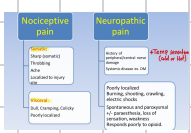
==========*cf.*==========

The global mortality rate due to traffic accidents was 19 per 100 000 population (1:5263)

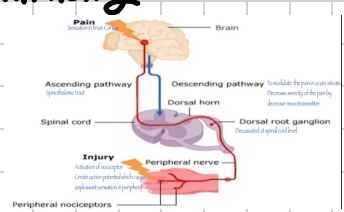
• Pain and Narcotics.

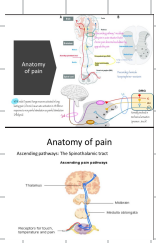
• introduction (deff).

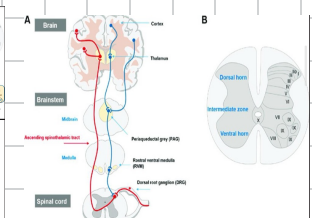
- IASP:- unspleasant sensory & emotional experience associated with actuel or poteintel tissue damge (functional pain:- without tissue damge (IBD/fibromylgia)).
  - personal experience induce by Biological, psyco & social factors (differs btw pt.).
  - Through their life experiences, individuals Learn the concept of pain.
  - pain should be respected.
  - pain has adverse effects on function & Socio-psycho well-being.
  - verbal description & non-verbal (tachycardia, Hypertention).
- Noxious:- unplesant.
- Noxious stimulus:- stimulus damging to tissue (not all feel as pain).
- Nociception:- The neural process of encoding noxious stimuli.
- Nociceptor:- ↑-Threshold sensory receptor of PNS capable of transduction & encoding stimuli.
- classification
  - duration:- Acute (<12w), chronic (>12w)
  - physical origin:- visceral, somatic, refered.
  - cause:- cancer, inflammatory, post-op, mechanical.
  - mechanism
    - Nociceptive:- damging of non-neural tissue.
    - Neuropathic:- Lesion or disease of sometosensory (PNS/CNS)
    - Nociplastic:- not either (IBD + fibromylgia).



- Anatomy





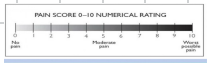


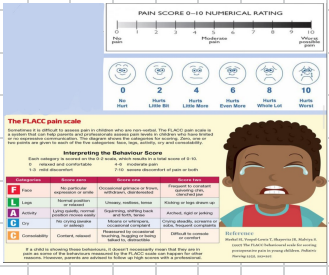
- physiology
  - Transduction:- tissue damging stumli activate Nerve ending (AP) → C & A delta fibers.
    - Mechanical (pressure, pinch), Heat, chemical (Atp, BKdyKinin, PGE_2, Na, K, H, Serotonin → R → dep cell
    - inflammation:- TNF-α, IL-1B & 6, NGF → C & A-delta fibers
      - peripheral sensitization-decrese thersthould of nociceptor → ↑painful sensitive

- Transmission
  - PNS:- AP is propagated to CNS by the first order neuron.
  - Each stimulus generate a pattern & frequency (code)
  - CNS:- 1st +2nd order N in dorsal Horn (Rexed Laminea I & II (spsy Horn)).
  - Neurotransmitters:- substance P, Glutemate, CGRP (calcitonin gene related peptide)
  - Receptors:- AMPA, NMDA, GPCR.
  - Spinothalamics (L & M) → thalamus → cortex.
- preception:- The subjective awarness produced by sensory signals; it involves the integration of many sensory messages into a coherent & meaningful whole (cortex).
- Modulation
  - ↓activity of ascending pathways by ↑descending pathways → ↓pain.
  - chemicals:- Endogenous opioids (Endorphin, Enkephalin), Serotonin, Nor-Ad.

• Acute pain

- Deff
  - pain by noxious stimulus (injury, disease), <3-6w, dissappear after tissue Healing.
  - Alarm system, survival.
  - Nociceptive
    - Somatic:- Superfical (sharp, Localized), deep (ache, not-Localized)
    - visceral:- diffuse, referred pain.
- Systemic Response to acute pain
  - CVS:- HTN, tachycardia, ↑myocardial irritability, may precipitate MI.
  - RS:- ↑total body O_2 consumption & CO_2 production.
  - GIT & urinary:- ileus & urinary retention.
  - Endocrine:- ↑catebolic hormones & ↓anebolic hormones.
- History
  - SOCRATES
  - Known cause?
  - medication?
- Assessment
  - Adults
    - NRS (0-10):- Numerical rating scale.
    - VAS (Draw):- visual analog scale
    - VRS (words):- verbal rating scale
  - peds
    - NRS (5-8y)
    - wong-Baker FACES rating scale
    - FLACC (m-7y)

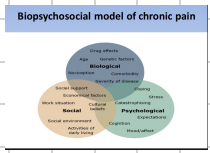


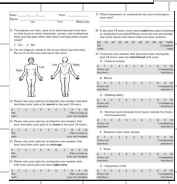


• Chronic pain

Deff
- pain has persisted beyound tissue healing, >12w.
- chronic illness by itself.
- Affects psycological aspects & Social aspects of the pt.
- can be severe & limiting all Life activities.

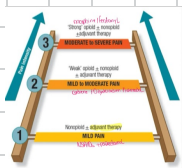
Assessment
- Requires multidimesional scale
- Brief pain inventory (BPI) :- short or Long forms

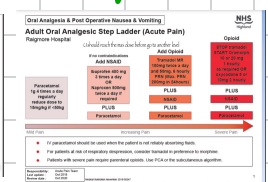




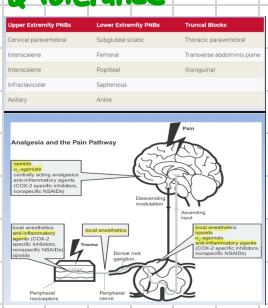
• Treatment

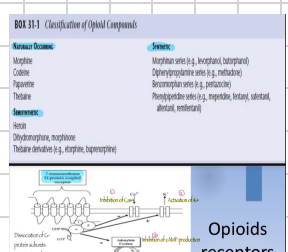
Acute
- pharmacological. WHO analgesic Ladder (paracetamol, NSAIDS, opoids)
- physiotherapy.
- simple measure (Heat, cold)
- Electrical stimulation.
- Acupuncture
- PCA (pt. controlled anesthesia) :- >30mg/day → PCA → 1mg/7min/pump.
- peripheral & neuroaxial nerve Block (Local anesthetics & steroids ± adjuvants)

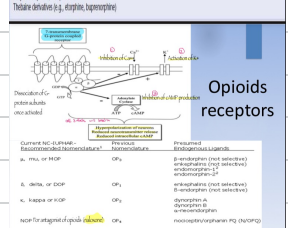




Chronic
- ↑term use of opoids → SE & tolerance
- cryoanalgesia
- Radio-frequency ablation
- chemical neurolysis (ca).







• Opoids

Effects on Body systems
- Miosis :- parasymphetic activation.
- purities :- itching.
- Bradycardia :- except in meperinide.
- ↑Histamine :- Hypotention, skin rash.
- vomiting & constipation.
- Respiratory depression :- ↓Reflexes of $\uparrow CO_2$ & $\downarrow O_2$.

Tolerance to opoids
- Long term or short term use.
- Lead to Hyperalgesia :- paradoxical effect of opoids → ↑feeling of pain.
- Min tolerance to :- constipation.

Receptor	Clinical Effect	Agonists
μ_1	Supraspinal analgesia (μ_1) Respiratory depression (μ_2) Physical dependence Muscle rigidity	Morphine Met-enkephalin[2] β-Endorphin[2] Fentanyl
κ	Sedation Spinal analgesia	Morphine Nalbuphine Butorphanol Dynorphin[2] Oxycodone
δ	Analgesia Behavioral Epileptogenic	Leu-enkephalin[2] β-Endorphin[2]
σ	Dysphoria Hallucinations Respiratory stimulation	Pentazocine Nalorphine Ketamine

Routes of administartion

- Orally: Morphine, Buprenorphine (high first pass effect)
- Transdermal: Fentanyl
- Transmucosal: Buprenorphine, fentanyl
- Epidural: Morphine, fentanyl

1 Morphine

- onset:- 1-2 min IV
- peak:- 30min
- Metabolism:- Liver (conjugation), Kidney.
- M6G (10%) of morphine metabolite & more potent on μ- receptor.
- SE:- Renal dysfunction

2 Fentanyl

- Duration:- 30-60min.
- metabolite:- Norfentanyl
- Loading dose (+induction):- 2-6 μg/Kg

3 Alfentail

- faster than 2
- ↓potent than 2, ICU.

TABLE 31-5 PHYSICOCHEMICAL AND PHARMACOKINETIC DATA OF COMMONLY USED OPIOID AGONISTS

	Morphine	Fentanyl	Sufentanil	Alfentanil	Remifentanil
pK_a	8.0 (long acting)	8.4	8.0	☆ 6.5	☆ 7.1 (Short acting ↓ infusion in ICU)
% Un-ionized at pH 7.4	23 (PCA)	<10	20	☆ 90	67?
Octanol/H_2O partition coefficient	1.4	813	1778	145	17.9
% Bound to plasma protein	☆ 20-40	84	93	92	80?
Diffusible fraction (%)	16.8	1.5	1.6	8.0	13.3?
$t_{1/\alpha}$ (min)	1-2.5	1-2	1-2	1-3	0.5-1.5
$t_{1/\beta}$ (min)	10-20	10-30	15-20	4-17	5-8
$t_{1/\gamma}$ (hr)	☆ 2-4	2-4	2-3	1-2	☆ 0.7-1.2
Vd_c (L/kg)	0.1-0.4	☆ 0.4-1.0	0.2	0.1-0.3	0.06-0.08
Vd_{ss} (L/kg)	3-5	3-5	2.5-3.0	0.4-1.0	0.2-0.3
Clearance (mL/min/kg)	15-30	10-20	10-15	4-9	☆ 30-40
Hepatic extraction ratio	0.6-0.8	0.8-1.0	0.7-0.9	0.3-0.5	☆ NA

4 Sufentanil

- x2 Lipid soulble & ↑bound to plasma proteins (α1-acid glycoprotein).
- more potent than 2.

5 Remifentanil

- structure:- ester Linkages.
- Hdyrolysis by Blood & tissue estrases → Rapid metabolism → used in Kidney/Liver failure
- Emergence.
- not influenced by pseudocholinestrase deficiency.

- opoids Antagonists
  - reverse
    - Respiratory depression
    - nausea & vomiting.
    - puritis
    - urinary retention.
    - Rigidity
    - biliary spasm.

→ Naloxone/Naltrexone

- Receptor:- orphanin.
- SE → ↑BP & HR, pulmonary edema.
- onset:- 1-2 min (IV)
- $t_{1/2}$:- 30-60 min (2nd & 3rd dose need)
  - short ½ → recurrence of Respiratory Depression.

• Shock

• introduction

Why to Learn about shock?

- Life threatening emergency that may be reversible if appropriately recognized.
- Golden Hours :- critical to avoid adverse outcome (mortality).

Deff

- inadequate perfusion of tissue ($\frac{\text{supply}}{\text{demand}}$)
- pathophysiology related to the determinant of O_2 delivery (CO, vascular integrity).

Epidemiology / pathophysiology (4 types ⬇).

Signs & symptoms & physiological respones :- Hypotention → dx to know the cause.

- preferential circulation :- ↑flow to vital organs & peripheral + splanhic vasoconstriction.
- stress hormones :- catecho, cortisol, antidiuritic, RAAS → preserve fliud volume (↑absorption).
- >30% Loss of volume → end organ damage & cellular death.

Vitals

- Temp :- Fever or Hypothermia.
- HR → ↑ in Hypotension to compensate ↓SV (CO = HR x SV).
  - Normal or Bradycardia in neurogenic & cardiogenic shock.
- BP :- Hypotention MAP < 65 mmHg (BP = CO x SVR).
- RR :- Tachypnea commonly.
- Po_2 :- preserved by ↑o_2 extraction, ↓ :- Late stage of Hypoperfusion.

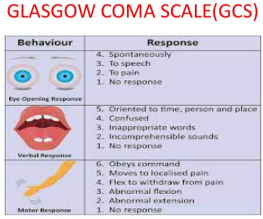
Examination (ABCDE)

- Airway :- assessed for patency.
- Breathing :- equal sounds on Both sides.
- Circulation :- peripheral pulses.
- Disability :- Glasgow come scale, <8 → intubation (↑aspiration
- Exposure :- infection, bleeding & perfusion, volume states.

Clinical picture may include

- Signs of organ hypoperfusion.
- multiorgan Dysfuction syndrome (MODS)
- Result is :- end organ faliure.

GLASGOW COMA SCALE(GCS)



Behaviour	Response
Eye Opening Response	4. Spontaneously 3. To speech 2. To pain 1. No response
Verbal Response	5. Oriented to time, person and place 4. Confused 3. Inappropriate words 2. Incomprehensible sounds 1. No response
Motor Response	6. Obeys command 5. Moves to localised pain 4. Flex to withdraw from pain 3. Abnormal flexion 2. Abnormal extension 1. No response

1 Hypovolemic Shock

- **Deff:-** ↓intravescular volume
  - Fluid Loss:- gastroentritis, vomiting, diarrhea, burn, DKA.
  - Blood Loss:- GI bleed, post partum, AAA, Hemoptysis.
- **class I**
  - 750 mL (15%)
  - compensatory tolerated
  - HR, BP, urine output are maintained.
- **class II**
  - 1500 mL (30%)
  - ↑HR (Co = HR x SV), mild anxity.
  - BP & urine output maintanied.
- **class III**
  - 1500 - 2000 mL (30-40%).
  - ↓BP & urine output, ↑HR.
  - Need replcement (Blood or fliuds).
  - PE (dehydration):- cold extrimites, clammy, dry mucous, paller
- **class IV**
  - >2000mL (>40%)
  - Lethargic, ↑HR, ↓BP & oliguria.
  - Tachycardia will be prominent fecture of sever shock before hypotention in Late class III to IV hemorrhage, Just before circulatory collapse.

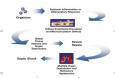
Classes of Hypovolemic Shock:

	Class I	Class II	Class III	Class IV
Blood Loss	< 750	750-1500	1500-2000	> 2000
% Blood Vol.	< 15%	15 – 30%	30 – 40%	> 40%
Pulse	< 100	**> 100**	> 120	> 140
Blood Pressure	Normal	Normal	**Decreased**	**Decreased**
Pulse Pressure	Normal	**Decreased**	**Decreased**	**Decreased**
Resp. Rate	14 – 20	**20 – 30**	**30 – 40**	**> 40**
UOP	> 30	**20 – 30**	**5 – 15**	**negligible**
Mental Status	sl. Anxious	mildly anx	**confused**	**lethargic**
Fluid	crystalloid	crystalloid	**blood**	**blood**

- **Diagnosis**
  - History:- trauma, surgeries. Bleeding.
  - PE:- cold shock picture & paller.
  - Hgb & HcT:- ↓, Normal HcT → Fliud Loss, HcT is better.
  - Metabolic Lab
    - electrolyte assessment (K & Ca)
    - Acid/Base:- ↓Blood → anaerobic → Lactic acidosis.
    - Renal function:- urea >20mg/dL, ↑parameters.
  - Coagulation:- PT/INR, PTT, fibrin-open:- ↑clot breakdown (fibrolysis) → coagulopathy.
  - SVO_2:- ↓
  - imaging
    - CXR, pelvic-xRay, US, CT (stable pt).
    - Angiography:- Localize Source of Bleeding.
    - Direct peritoneal aspiration/Lavage:- free blood → Laprotomy.
- **Tx**
  - Replacement of volume + treat the cause. (14 or 16 gauge IV).
  - ABCDE if ATLS
  - crystalloids (20-30 mL/Kg every 5-10 min up to 1-2L) or colloids
- **Goal-directed theraphy**
  - urine output:- >0.5 mL/Kg/Hr
  - CVP:- 8-12 mmHg.
  - MAP:- 65-90 mmHg.
  - central venous oxygen concentration:- >70%.

2 Distributive shock

- Deff:- inappropriate vasodilation of the peripheral blood vessels (↓SVR)
- I) septic → Deff
  - Sepsis:- Systemic host response to infection → organ dysfunction.
  - Septic shock:- infection → ↓BP requiring vasopressor
    - MAP :- >65 mmHg
    - Lactic :- >2 mmol/L



- pathophysiology:- infection relase pro & anti-inflammatory response → TNF & IL
  Machrophages & neutrophils → Systemic alteration in perfusion, microcirculation
  cell death & organ dysfunction. (each system is affected).
- Dx (≥2 SIRS)
  - Temp:- >38 or <36
  - HR :- >90
  - RR :- >20
  - WBC :- >12000 or <4000
  - + presumed existence of infection.
- Tx
  - inection source control :- culture → antibotics (within 1hr) & drainage.
  - Resuscitation & Life support
    - fliud manyment :- 30mL/Kg in 3hr.
    - urine output :- 0.5ml/Kg .
  - vasopressors :- Nor-epinephrine, vasopressin.
  - mechanical ventilation :- ARDS .
  - Renal replacement therapy :- AKI (↓K, acidosis, uremic & volume overload).

II) Neurogenic shock

- Deff
  - hemodynamic changes from sudden loss of autonomic tone (above T_6)
  - Nothing reverse vagal action.
  - 20% cervical spine injury.
  - spinal shock:- Loss of all sensation below the LvL of injury (not circulatory)
- Dx:- PE → spinal cord injury → confirmed by CT or MRI.
- Tx (supportive) :- fliuds & pressors.

III) Anaphylatic shock

- Deff
  - Allergic reaction (immunological response to antigens) → Histamine → IgE → VD
  - direct activation of complement → mast & beiophis → Histamine → Anaphylactoid
  - Both are equally Life-theratns depending of Reaction severity.
- vasodilation
  - cvs collapse
  - fascial & tounge swelling → airway compromise.
  - Bronchospasm of the airway.

- Dx
  - clinical:- ↓BP, ↑HR, Rash & itching, angioedema.
  - Antigens in:- RS, eye, skin, IV, IM or peritoneal.
- Tx
  - stop the exposure to the trigger.
  - Airway:- angioedema → early ETT & O_2 + monitoring.
  - IV acess:- normal saline to ↑BP.
  - ★Epinephrine (0.01-0.05 mg IV or IM):- every 5-15 min to maintain MAP>65.
  - Albuterol:- Bronchodilator (nebulizer).
  - H_1 & H_2 Antihistamines.
  - steroids (Hydrocortisone & dexamethezone):- airway edema & sever reactions.


Angioedema

3 Obstructive shock

- Deff:- obstruction of Heart or Great vessels → ↓CO → ↓perfusion.
- examples
  - Tension pneumothorex:- trauma, hypoxemia. (midclavicular 2nd intercostly
    - ↳ pneumothorex → 4th anterior axillary
  - pericardial tamponade
  - pulmonary emboli:- V/Q mismatch. (anticoagulation).
  - Restrictive cardiomyopathy

4 Cardiogenic shock

- Deff
  - faliure of the pump, ACS, mechanical faliure ± arrhythmia, MI, myocarditis.
  - ↑Lt. side pressure → pulmonary edema, Rt. HF → systemic congestion.
- Dx → MI
  - ↑cardiac biomarkers (troponin)
  - ECG changes or supportive imaging.
    - ↳ STEMI, NSTEMI, Unstable Angina.
  - clinically:- crushing substernal chest pain, hand, back, epigastric, Jaw pain.
- Tx
  - ABCs + IV acess & invasive blood monitoring.
  - medications
    - Aspirin 325 mg & Heparin.
    - Glycoprotein IIb/IIIa inhibitory with NSTEMI.
  - pressor to MAP > 65 mmHg:- Nor-epinephrine & dopamine.
  - PCI
    - 12 h of symptoms (STEMI)
    - cannot be administred in 120min → fibrolytic therapy
    - diffucult PCI → CABG.
  - Mechanical support:- intra-Aortic Ballon pump (IABP).

Goals of Shock Resuscitation

- Airway patency
- Control Work of Breathing
- Optimizing Circulation
- End Points of Resuscitation
  Goal-directed therapy: Use objective hemodynamic and physiologic values to guide therapy

1. Urine output > 0.5 mL/kg/hr
2. CVP 8-12 mmHg
3. MAP 65 to 90 mmHg
4. Central venous oxygen concentration > 70%

In general, support and treat the cause...