CONTENTS

PRE-ANAESTHETIC EVALUATION

1. History
2. [redacted]
3. [redacted]
4. Investigations

American society of Anaesthesiologist grading (ASA GRADING)

Tells about:-

1. Present Physical status
2. risk associated with surgery

* Elective surgery (I to VI)
* Emergency surgery (I_E to VI_E)

(E stands for emergency surgery)

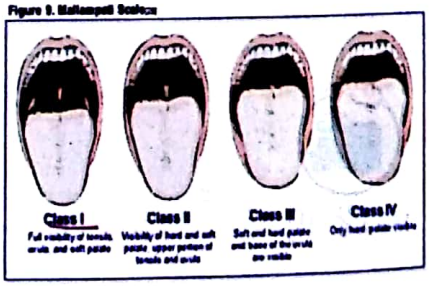
Grading:-

I → Localised problem
II → Controlled comorbidity
III→ Comorbidity with moderate limitation
IV→ Comorbidity is constant threat on his life
V→ Surgery is the only option for survival
VI→ Brain dead patient for organ harvesting

Airway Evaluation

1. [redacted]
2. [redacted]
3. [redacted]
4. Mouth opening
5. Mento hyoid / Mento thyroid distance
6. Mallampatti grading / assessment of size of tongue wrt oral cavity.

Class 1: Hard palate, soft palate, uvula, fauces, and tonsillar pillar
Class 2: Hard palate, soft palate, uvula
Class 3: Hard Palate, Soft palate
Class 4: Hard palate



- Class 1 and 2 : Normal tongue
- Class 3 and 4 : Large tongue (Difficulty in intubation)

* **Conmark lahan's grading**:- Laryngoscopic view of glottic opening

Preanaesthic order

1. [redacted]
2. [redacted]
3. Nil per oral
4. Orders regarding previous medications

→ Nil Per Oral Order

1. Adult patient → 8 hrs prior to Sx for solid
   → 6 hrs prior to Sx for liquid
2. Pediatric → 8 hrs NPO for solid
   →
   →
   → 2 hrs NPO for clear fluid
   ↓
   Further reduced to 1 hour

→ Orders regarding previous medications

1. **Oral anti hypertensive drugs** : Continue till the day of surgery.
2. **Oral hypoglycaemic drug**
   - Minor/Moderate surgery → stop 24 hours prior to surgery
   - Major surgery → Stop 24 hours prior and put the patient on insulin
3. **Antipsychotic**
   Anti depressant
   Anti epileptic
   Continue till the day of surgery
   Tricyclic antidepressant (TAD):- Stop 21 days (3 weeks) prior to surgery
   Lithium:- stop 24 – 48 hours prior to surgery
4. **Anticoagulants**

- Aspirin : Continue till the day of surgery
- Clopidogrel: Stop 7 days prior
- Ticlopidine: Stop 14 days prior
- Warfarin: Stop 3-4 days prior
- Low molecular weight heparin: Stop 12-24 hours prior
- Unfractionated heparin: stop 6 hours prior

5. **Thyroid medications**
   Continue till the day of surgery
6. **Steroid**

Contraindications of this recommendation

1.
2. Active infection
3. Immuno deficiency

* A gap of 12 weeks (3 months) required for complete reversal from all ill effects of smoking
* A gap of 1 year required between drug eluting coronary stent and elective surgery
* A gap of 1 month required between bare metal stent and elective surgery.

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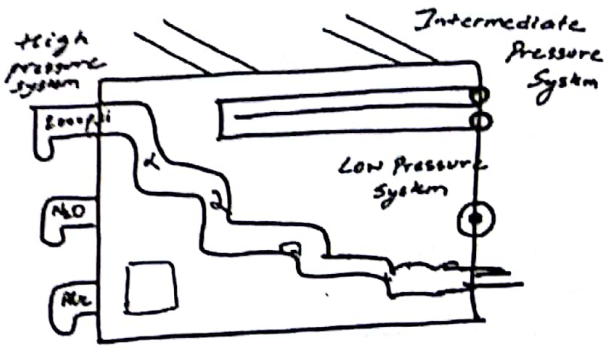
ANAESTHESIA MACHINE

1ST machine → Dr. Edmund Boyle
↓
Boyle's machine
Modern Machine → Anaesthesia work station



3 types of pressure systems
- High PS
- Intermediate PS
- Low PS

High pressure System

Gas Cylinders

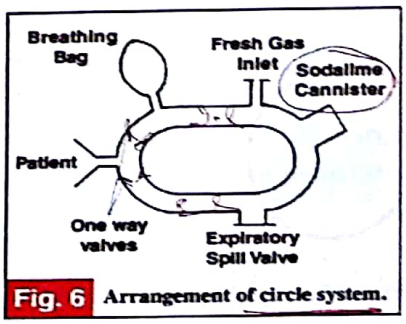


Fig. 6 Arrangement of circle system.

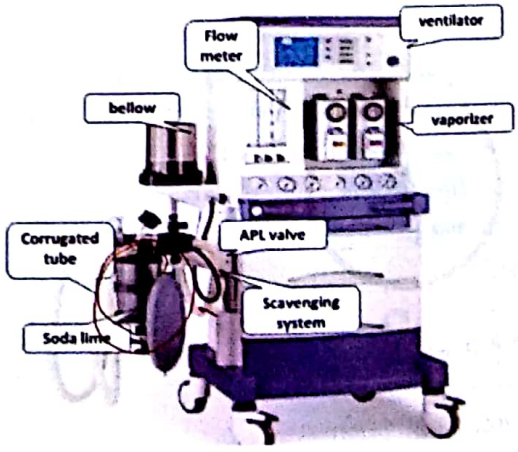
Made up of → Steel + Molybdenum
Sizes → A to HH

* MRI Compatible cylinders made up of Aluminium / Titanium.
* Type E is attached to the anesthesia machine

O_2 Cylinder

- Black body, white shoulder (Colour coding)
- PIN index = [redacted]
- Pressure = [redacted]

* Never start a case, if pressure is < 1000 psi. So minimum mandatory pressure of oxygen cylinder to start a case under GA is 1000 psi.



* Type E cylinders of O_2 at 1000 psi giving O_2 at a flow rate 2-3 liters/min would last for 2-3 hours.

Nitrous oxide cylinder

- Colour coding → [redacted]
- Pin index → [redacted]
- Pressure → [redacted]

Air

- Colour coding → Grey body, black & white shoulder
- Pin index → 1, 5

Co_2

- Colour coding → Grey

- Pin index → >7% (1, 6)
  → <7% (2, 6)

Cyclopropane

- Colour coding → Orange
- Pin index → 3,6

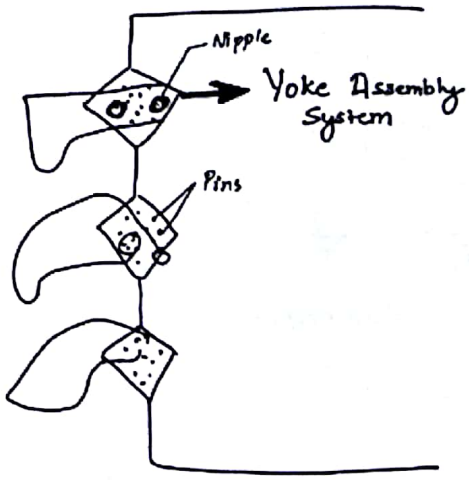
Helium Cylinder

actually is Heliox
($He + o_2$)

Roles:

- [redacted]
- [redacted]
- It decreases work of breathing

		$He + o_2$	
Pin index	2, 4	70:30	stored in Brown colour cylinder
	4, 6	60:40	



Intermediate Pressure System

(1) Pipeline Supply

(2) Color coding

White – O_2
Blue – N_2O
Black – Air
Yellow – vaccum

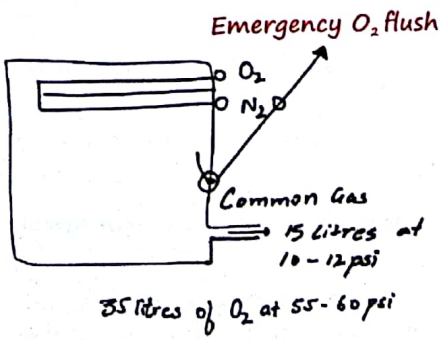
55 to 60 psi

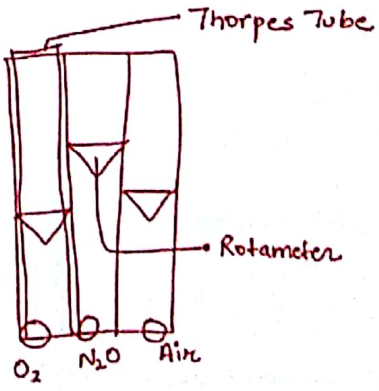
(3) DISS =>

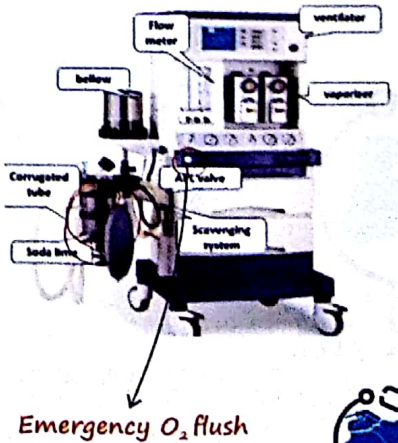
- Diameter index safety system
- It is a safety system which prevents incorrect attachment of pipeline to anesthesia machine

(4) Emergency O_2 flush

- It is located in low pressure system







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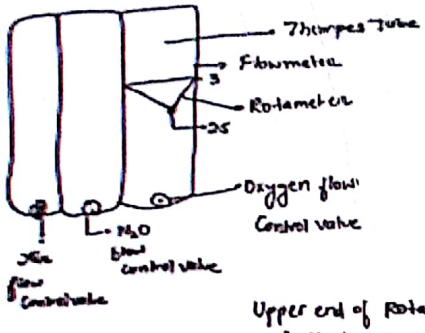
Low Pressure System

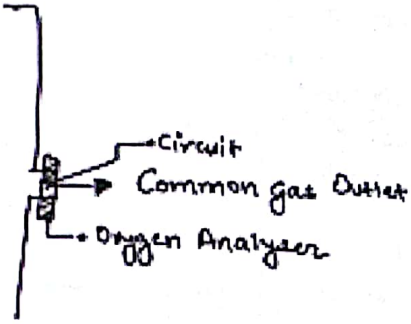
(1) O_2 and N_2O flow control valve.

(2) Vapouriser.

(3)

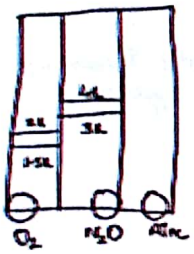
(4)





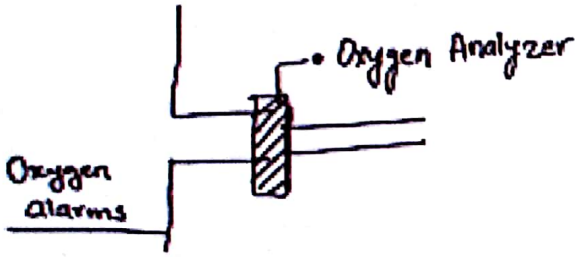
Hypoxia guard

(1) Basal O_2 flow of anesthesia machine



(2) N_2O opens in fixed proportion with O_2

(3) Oxygen analyzer



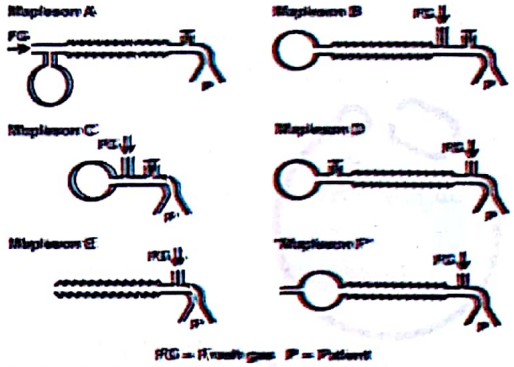
* Flow of O_2 in modern anesthesia workstation in downstream.

ANAESTHESIA CIRCUIT

Def.→ Two way connection b/w patient and machine, brings inspiratory gas towards patient & take expiratory gas away from patient

3 types of circuit

- **Open circuit** → No longer in clinical use
- **Semi-closed circuit** or **Mapleson circuit** → used clinically
- **Closed circuit** → used clinically



- When expiratory valve is near the pt. end then it is good circuit for spontaneous ventilation.
- When fresh gas inlet is near the pt. end then it is good circuit for controlled ventilation.

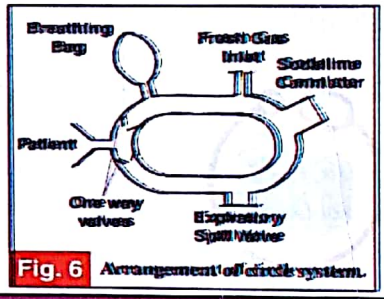
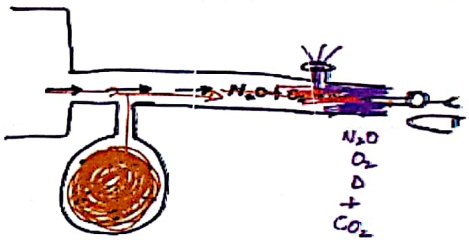


Fig. 6 Arrangement of circle system.

Semi closed



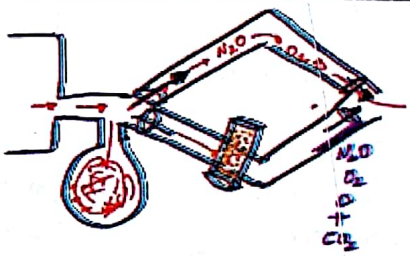
When pt. is paralysed.
↓
Ventilation has to be controlled
↓
[redacted]

* When pt. is not paralysed
↓
Resp. effort of pt. is working
↓
Spontaneous mode of ventilation.

Procedure/ working :-

From machine fresh gas enter
The circuit continuously ($N_2O + O_2 + D$)
↓ Potent agent

Closed



Advantages

1. Have separate inspiratory & expiratory
2. [redacted]
3. [redacted]
4. Minimal pollution.
5. Advanced Monitoring

Procedure / working

From machine fresh gas enter the circuit
($N_2O + O_2 + D$)
⇓
squeeze the bag & gas enters the inspiratory arm.
⇓
Reach the alveoli of patient.
⇓
expiratory gas ($N_2O + O_2 + D + Co_2$)

Squeez the bag 10 -12 times / min
↓
Fresh air enters the alveoli of patient.
↓
Expiratory air enter backs the tube
($N_2O + O_2 + D + Co_2$)
↓
Removed out completely into atmosphere from expiratory valve

→ Disadvantage:-

(i) The expired gas Have to be removed out completely, We cannot reuse N_2O, O_2 present in it again.

(ii) Continuous fresh gas supply Have to be maintained.
→ To avoid mixing of fresh air gas & ex--pired gas both of them should reach the expiratory value at same time

iii) Less economical

iv) OT / Atmospheric pollution

Advantage

(1) Light weight, simple & portable Circuit

expiratory arm
↓
CO_2 absorber attached to this limb, absorbs all the Co_2 from expired air.
↓
rest of the gases i.e. ($N_2O + O_2 + D$) / reused.

Disadvantage

(i)

(ii)

(iii) If D reacts with Co_2 absorber agent. It results in formation of toxic substance / by product
↓
this will reach the pt. alveoli and may result in health hazards.

Eg. Triline
+
Co_2 absorber → Phosgene → Coronial nerve palsy

* It requires advanced monitoring

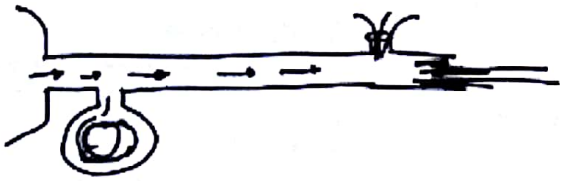
Types of Semi – closed circuits / Mapleson system :-

There are 6 types of circuit.

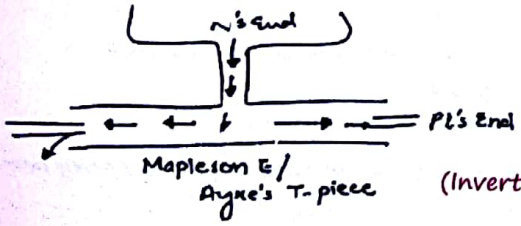
It gives :

I) High pressure

II) High resistance



Not every circuit can be used for pedo-patients



(Inverted T Shaped Circuit)

Mapleson E/ Ayre's T- piece

→ This circuit is used in pedo pts.

→ This is a useless system, becoz this system has no interpretation for the tidal volume used.

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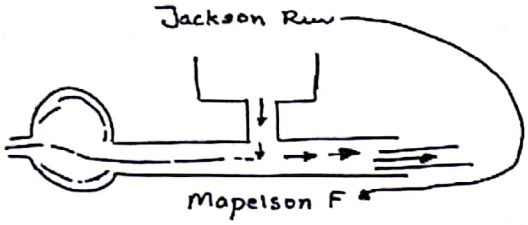
Jackson Reev- AKA Mapleson F or Jackson Reev's modification of Ayre's T-piece circuit



In this system, a bag is attached towards the expiratory end, thus movement of bag is informing about the tidal volume generated by child pt.

Mapleson System

A B C D E F

Adult system

Pediatric system (<20kg., < 6 yrs.)

A

Magill circuit

↓

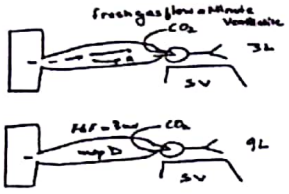
Circuit of choice for spontaneous ventilation.

↓

FGF = M.V

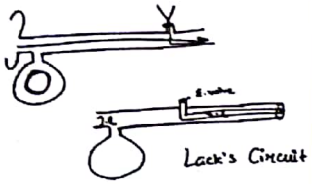
In controlled controlled

FGF = 3 mv



FGF = fresh gas flow

M.V = Minute Ventilation



Modified mapleson A k/a Lack's circuit / co axial Mapleson A

B

not of any use

C

Circuit of choice for controlled ventilation

↓

FGF = 1.8 M.V

In spontaneous

FGF = 3 M.V

Modified D k/a Bain's circuit/ coaxial mapleson D

AKA

Universal Circuit

E

Ayres's T – piece circuit

F

Jackson reev's modification of Ayre's T – piece

→ Circuit of choice for pediatric pt for both controlled venti-lation & spontaneous ventilation.

For Adults (In spontaneous ventilation)

A>D>B = C

For Adults In controlled ventilation

D>B = C>A

Closed circuit

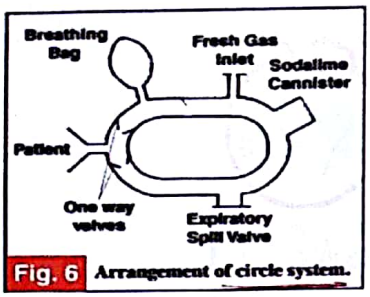


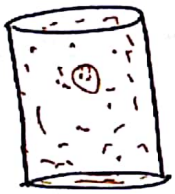
Fig. 6 Arrangement of circle system.

Carbon dioxide absorber eg Sodalime, Paralime etc

↓

(MC in India)

Sodalime



Sodalime Constituents:

NaOH
KOH
$Ca(OH)_2$
Water
Silica
dye

The containers have granules of Co_2 absorber instead of powder because:-

1. To ↑se surface area of Co2 absorption
2. [redacted]
   (Total free space b/w granules > 50%)
3. To prevent dusting of the gas.

Component

NaOH → 4% → (main component for Co_2 absorption)

KOH → 1%

$Ca(OH)_2$ → rest highest conc. Of component. (major component)

Water → 11-18%

Silica → gives hardness to sodalilme

Dye → Phenolphthalein dye

Pink → At basic pH

Colourless → at acidic pH.

Change in colour indicated exhaustion of Co_2 absorber.

$$Co_2 + H_2O \rightleftharpoons H_2Co_3$$

Catalyst

$$NaOH + H_2Co_3 \rightleftharpoons Na_2Co_3 + H_2O$$ (main reaction)

KoH

$$Ca(OH)_2 + Na_2Co_3 \longrightarrow CaCo_3 + NaOH$$

As NaoH is highly toxic, thus to ↓se its side effects it is kept at low conc. & instead $Ca(OH)_2$ is used in higher concentration

→ 100 gm of sodalime absorbs 21 – 28 l of Co_2

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Clinical Features of CO_2 rebreathing:-

(1) [redacted]
(2)
(3) ↑sed oozing of blood from surgical site
(4) ↑sed sweating in anaesthetized patient.
(5) [redacted]
(6)

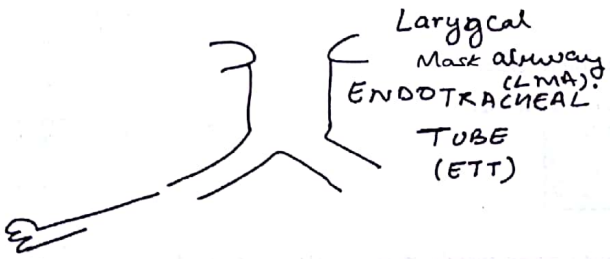
Predisposing factors for carbon monoxide production in closed circuit:-

(1) Caused by or formed by → D I E

D → Desflurane
I → Isoflurane
E → Enflurane

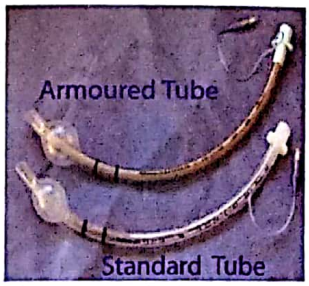
(2) Very high concenteration of DIE
(3) Dry Co_2 absorber.
(4) Use of baralyme [$Ba(OH)_2 + Ca(oH)_2$] instead of sodalime.

AIRWAY



Endotracheal tube (ETT)

- Most primitive & one of the commonest used device.



Parts of ETT

Proximal end/ bevelled end

- Bevelling help in visualising the tube crossing the glottic opening.

Murphy eye

- Distal to proximal end.
-

Cuff

- Cuff is inflated to prevent aspiration

2 black markings

-

- Marking just at glottic opening, 1st marking goes inside & 2nd remain outside

Universal connector

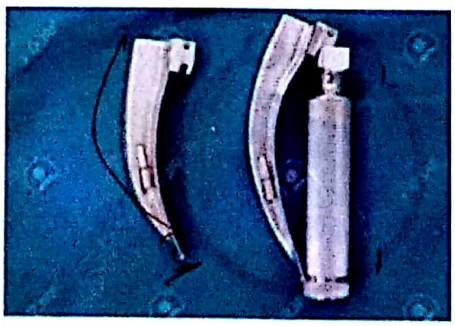
- Present at distal end having diameter of 22 mm.

This tube can be introduced either from nasal opening or oral cavity.

* Nasotracheal intubation is mostly avoided because it is very vascular & not clean area which may lead to infections & bleeding.

* Oral intubation is done with help of laryngoscope. / curved blade laryngoscope / macintosh laryngoscope /

ADULT LARYNGOSCOPE



3 parts

Curved Blade Handle Tip

Orotracheal Intubation

1st done by Macewan

(A) Laryngoscopy :-

(a) **Positioning**→ Morning sniffing position / barking dog position.

(atlanto occipital joint is extended & neck joint is flexed)

↓

Hold laryngoscope in left hand (if operator is right handed & vice versa) & open aral cavity with right hand.

↓

Introduce from right end of mouth & with laryngoscope shift tongue from middle to left side

↓

Take laryngoscope above epiglottis & locate aryepiglottic fold or glossoepiglottic fold

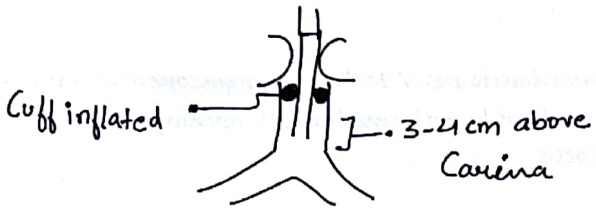
↓

Hinge the tip in this fold & lift it up

↓

This will lift epiglottis & unveil the glottic opening

(b) Intubation



* hold the tube in dominant hand & introduce it inside & leave black mark just at glottic opening.

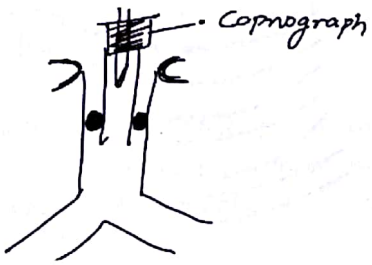
↓

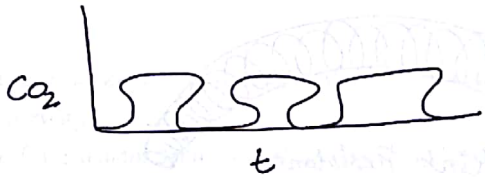
Cuff is inflated to form seal in trachea to prevent any aspiration only.

* To prevent displacement of tube do tapping of tube at corners of lips.

Optimal cuff pressure → 25-30 cm of H_2O

(c) Sure short confirmation of correct placement of ETT is done by capnography.





If graph shows up it confirms the location of tube in trachea.

But if graph shows straight line, it shows that tube is not in trachea

(d)

Dead space → Area where O2 – [redacted]

→ Starts from nose till respiratory bronchioles

→ So it↓ses by half during this process bcoz we start directly from trachea

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

Resistance ↑ses because area or radius decreases.

(e) In pedo pts. if we lift the aryepiglottic fold, just like adult, the glottic opening is still not unveiled because of long epiglottis

Miller's Larygoscope

So we use straight blade laryngoscope in pediatric pts. / Miller's laryngoscope.
Adv. → It is very compact, thus can be used easily with small mouth opening
→ With this we left complete epiglottis.

Variation in pediatric pts:-

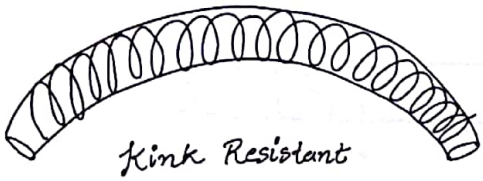
(i) [redacted]
(ii)

According to recent advancements, cuffed tubes are used in pediatric patients.

Narrowest part of pediatric airway is now considered as glottic opening

(f) Some Special ETT

a) Flexometallic / Reinforced / Armoured tube:-



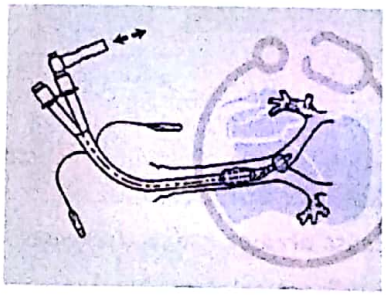
Kink Resistant

Tube is reinforced with metallic wire to make it kink resistant

→ Tube of choice for:-

(i) [redacted]
(ii)
(iii) Dental Sx
(iv) Prone position Sx

(b) Double Lumen tube (DLT)



Uses: - (i) Thoracic Sx
(ii) Lung separation
(i) [redacted]
(ii) Haemoptysis

The right placement of double lumen tube confirmation is done by fibre optic bronchoscopy

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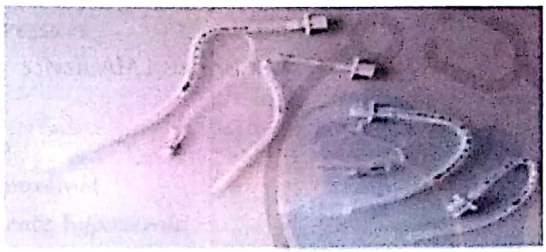
(c) Uncuffed tubes

< 6 yrs pediatric pt.

(d) RAE tube



→ The pre-bend tube is specially designed for cleft lip & palate pts., where tube is fixed at the centre of the tube.

RAE is named after name of 3 persons – Ring Adair Elwyn

Indication of intubation:-

(i)

(ii)

(iii)

(iv) Pulmonary toileting

Management of difficult airway:-

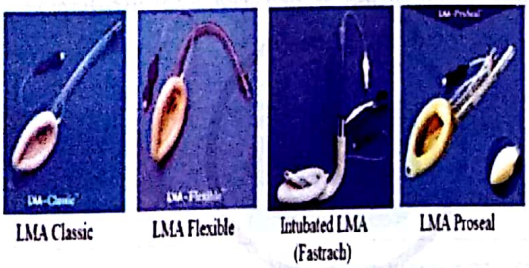
Plan A:→ Reoptimization i.e. check for position, check for size of tube, check for bulb of tube, check for laryngoscope etc.

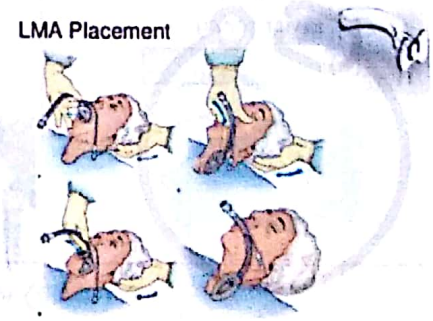
Plan B: → If still we fail after plan A then use of alternative airway devices is indicated.

Ex. → L.M.A (laryngeal mask airway)

Plan c→ When above plan also fails, then go for surgical securement i.e Tracheostomy.

Laryngeal mask airway (L.M.A)





→ It is supro-glottic airway device i.e does not cross the glottis.

→

→

→ Less invasive & less complication causing device

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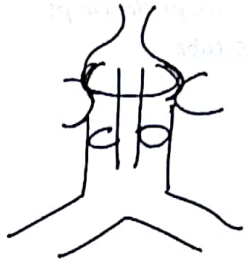
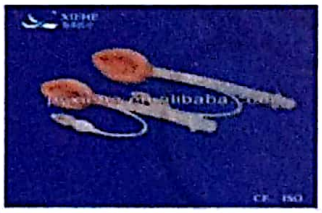
- Aspiration cannot be prevented therefore it is not a definitive airway device



→ Classic LMA is deviced by Dr. Archie Brain k/a Brain's LMA device



→ LMA proseal (PLMA) is variant which is comparable to ETT in preventing aspiration
→ It is having two opening, two cuffs and two tubes.
→ Size of LMA is decided by Wt. of the body

Wt. in kg	Size of L.M.A
< 5kg	[redacted]
5-10 kg	
10-20 kg	
20-30 kg	
30-50kg	
50-70 kg	
> 70 kg	
> 100	

(used for both classical & PLMA)

Injury	Management
Maxillofacial injury	Tracheotosmy
Cervical spine injury	
(I) Emergency	Manual in-line stabilization & oro-tracheal intubation
(ii) [redacted]	Fibreoptic Nasal intubation. ↓ [redacted] ↓ Blind nasal intubation

MODES OF VENTILATION

PEEP→ Positive End Expiratory Pressure

Normal PaO_2 → 90 -100 mm Hg
PaO_2 → < 60 mm of Hg → Hypoxemia
PaO_2 → 50-60 mm of Hg → Mild Hypoxemia
40-50 mm of Hg → Moderate hypoxemia
< 40 mm of Hg → Severe Hypoxemia

Basic methods of improving oxygenation
(1) Increasing FiO_2 (fractional inspiratory oxygen concentration)
↓
Risk of oxygen toxicity.
(2) Applying PEEP

Complications of PEEP
(I) Intra – alveolar pressure ↑es – Barotrauma
(ii) Intra thoracic pressure increases
(iii) Venous return ↓es
(iv) [redacted] ↑es
(v)
(vi)
(vii) Perfusion ↓es
(viii) Urine output ↓es

CONTROL MODE VENTILATION (CMV)

TV = 500 ml
RR = 12 breaths/minute

Disadvantages
1) Requires heavy sedation or paralysis
2) Ventilation / perfusion mismatch increases
3) [redacted]
4)
5) Not a weaning mode

SYNCHRONIZED INTERMITTENT MINUTE VENTILATION (SIMV)

TV = 500 ml
RR = 12 breaths/minute

Advantages
1) Minimal sedation required
2) [redacted]
3)
4)
5) Weaning possible

Assist Control mode→ All the breaths by the patient are delivering adequate tidal volume.
Difference from SIMV → All the breaths are supported / assisted by ventilator.

Pressure Control Ventilation (PCV)

ARDS: → Acute Respiratory Distress Syndrome

TV = 500 ml
RR = 12 breaths/min
↓
100 mm of Hg
↓
Barotrauma → Alveoli fails to expand
↓

(1) [redacted]
(2) Pressure control ventilation – Upper limit of the intra alveolar pressure is fixed.
(3) Mode of choice – (1) Pediatrics
(2) ARDS
(4) Not weaning mode

CONTINUOUS POSITIVE AIRWAY PRESSURE

→ Spontaneous mode
→ Spontaneous ventilation even on non- invasive ventilation

PRESSURE SUPPORT VENTILATION

→ [redacted]
→ Pressure support Ventilation = CPAP (For upper airway) + PEEP (for lower airway)

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MONITORING IN ANAESTHESIA

- According to ASA guidelines, 5 Mandatory monitors

(1) ECG
(2) NIBP – (Non invasive Blood pressure)
(3)
(4)
(5) Temperature

1. BIS-BISPECTRAL INDEX

- 1992, Aspect company
- Monitors depth of Anaesthesia
- Principle – EEG
- Range – 0 to 100
  0 – coma
  40 – 60 – Target Intra OP BIS
  100 - Fully aware.

USES –

(1) Prevention of Intra operative awareness
(2)
(3) Fast post operative recovery

2. ENTROPY

- Monitors depth of Anaesthesia
- Principle – EEG & EMG
- Better monitor than BIS

3. CAPNOGRAPHY

- Graphical representation of expired Co_2 against time

D/D of flat capnogram

(1) Accidental Extubation
(2)
(3)
(4)
(5) Cardiac arrest
(6) Esophageal intubation

Monitor K/A Capnograph
Graph K/A Capnogram
Numerical value – Capnometer

Respiratory cycle
- Inspiratory phase – N_2O+O_2+Des
- Expiratory phase – (a) Dead space Ventilation.
  (b) Dead space + alveolar gas
  (c) Alveolar gas

- Phases of capnogram

Phase I – Dead space ventilation

Phase II – Dead space + Alveolar ventilation

Phase III-

Phase IV -

Caprnometer

- Expired ($Etco_2$) – 35 – 45 mm Hg.

$Etco_2$ value

↑ se	↓se
1. Hyper metabolism	1. Hypometabolism
2. Hypoventilation	2. Hyperventilation
3. -	3. Hypoperfusion

1. $Etco_2$↑

Temp – ↑

- A Hyper metabolic state that can double/triple co_2 value
- ↑ In core temperature

↓

Malignant Hyperthermia.

2. $Etco_2$ ↓

SCO_2 ↓

BP ↓

Sudden

-> EMBOLISM (Venous Air embolism)

-> Most commonly happen in neurosurgery

(Post. Fossa tm surgery mc)

3. Co_2 rebreathing

(a)

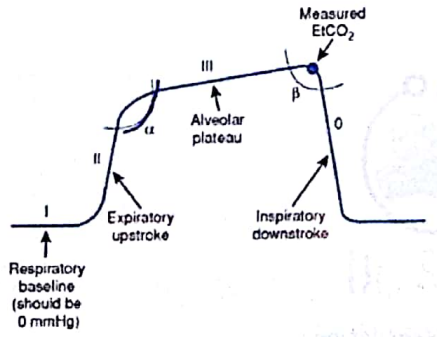
(1)

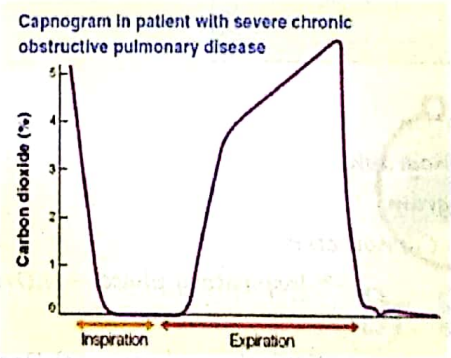
(2) Unidirectional valve malfunction

(b) Semiclosed circuit

- Fresh gas flow inadequate

4.





Graph of partial obstruction

- Shark finn patter

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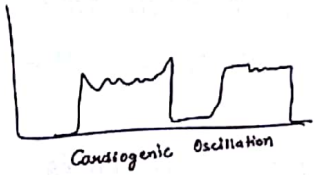
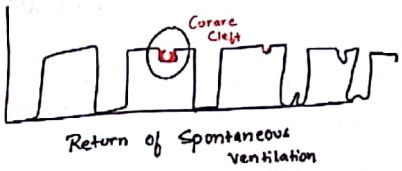
Seen in

1. [redacted]
2. [redacted]
3. [redacted]
4. Bronchial Asthma
5. Circuit kinking

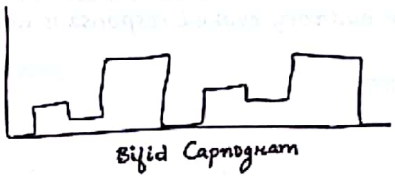
5. - Cardiogenic oscillation
   - Seen in – Pediatric pt.
   - Thin Pt.



6. - Pt operated ↓ GA, paralysed on ventilator.
   - Cleft appear in Capnogram
   - Clefts signify – return of spontaneous ventilation
   K/A CURARE CLEFT
   - Repeat a dose of Neuro muscular blocker



7. Bifid capnogram
   - Severe Kyphoscoliosis



4. Pulse oximetery

- Measure oxygen saturation of arterial blood
- Other ways – ABG – k/a Spo_2
- By pulse oximetery – k/a spo_2
- 2 principle

(a) Law of plethysmography
- measure the pulsatile flow of blood in capillary.

(b) Law of oximetery / BEER LAMBERT's LAW

- Inaccuracies in pulse oximetery reading

(1) [redacted]
(2)
(3) Other haemoglobins (sulph Haemoglobin)
(4) Dyes or pigments
(5) Dark skin color
(6) Nail polish (Blue)

Pulse oximetery = $\frac{HbO_2}{HbO_2 + HbH}$

CO oximetery = $\frac{HbO_2}{HbO_2 + HbH + Hb\ sulp + Hb\ meth}$

Reflectance Oximeter (for forehead attachment)

(5) TRANSESOPHAGEAL ECHO CARDIOGRAPHY (TEE)

- Perioperative monitor
- Most sensitive perioperative cardiovascular monitor
- Most sensitive intraoperative monitor to detect air embolism.

TEE > Doppler ultrasonography > ECG = NIBP = CAPNOGRAPHY

IMPORTANT FACTS

1. ECG
   - Lead II – Intra operative arrhythmias
   - Lead V_5 -70 % sensitivity for MI diagnosis
   - Lead V_4 - V_5 -> 99% sensitivity for MI diagnosis
2. Evoked potential monitoring
   - Non invasive monitor of neural pathways
   - Sensory pathway –
   - Motor pathway –
   - Mixed pathway –

Q- Brain stem auditory evoked response is not affected by Anaesthetic agent.

3. Temperature monitor
   -
   -
   -
   - Urinary Bladder
   - Pulmonary (A)
   - Lower Oesophagus

1. Pulmonary (A) – Most sensitive site for temperature monitoring for correlation with core temperature.
2. Tympanic membrane
3.
4. Neuro Muscular Monitor
   (a) Most common stimulus – Train of four
   (b) Most common (N) - Ulnar (N)
   (c) TOF ration - > 0.85 - Reversal started

Historical aspect

Capnography - LUFT
Bispectral Index - ASPECT Company

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NEUROMUSCULAR BLOCKERS

2 types:-

Depolarising	Non- Depolarising
E.g. Succinylcholine	
1. MoA:- Persistent/ Prolonged. Depolarization of nicotinic Cholinergic receptor.	1. MoA:- Competitive antagonist
2.	2.
3.	3.
4. Not reversed by neostigmine	4.
5. Train of four response not seen.	5.
6. TOF ratio (B/A =1)	6.
7. Neuromuscular monitoring not done.	7. Neuromuscular monitoring done.
8.	8. Post tetanic facilitation seen.

Most common nerve in neuromuscular monitoring = ulnar nerve

Succinylcholine/ Suxamethonium/ Scoline

It is fastest & shortest neuromuscular blocker.

Onset (30-45 sec) Duration (5-6 min)

1. Paralyzing dose => 1.52 mg/kgBw
2. Suxamethoninum apnea.
   Single normal dose of **succinylcholine**
   Producing Prolonged apnea.
   Due to:- (1) Deficiency of pseudo cholinesterase.
   (2) Atypical pseudo cholinesterase.

Management:-> Ventilators.

3.

Phase I	Phase II
Depolarizing NMB.	1.5 mg/kg Bw
ToF resp = -ve.	1 mg/kg Bw - 1 mg/kg Bw
ToF ratio = 1	1 mg/kg Bw – P.A
PTF resp = -ve	- Start resembling Non-depolarising
	ToF resp = +ve.
	ToF ratio = <1
	PTF resp = +ve
	Management: Ventilation

Side effect:->

1.
2.
3. ↑IOP, ↑ICP, ↑IGP

4. Hyperkalemia
   i) 
   ii)
   iii)
   iv) Burn.
   v) Trauma.
5. Bradycardia
6. It can trigger malignant Hyperthermia

Uses :->

A. Rapid Sequence induction / intubation

Steps of RSI:-

1. Pre oxygenation is mandatory
2. Cricoid pressure (Sellick's maneuver).
3. IV thiopentone + IV succinylcholine.
4. Positive pressure ventilation by Bag & Mask (contra indication)
5. Laryngoscopy + Intubation.

B. Very short general anaesthesia as electroconvulsive therapy, Endoscopy.

C. Intubation in anticipated difficult airway

Shelf life :->

* 2- 4°C 2 years.
* Room temp 6 months

Non-depolarizing NMB :-> 2 types

Amino steroid	Benzylisoquinoline
PANCURONIUM LA PIPECURONIUM	D – tubocurarine. Doxacurium
VECURONIUM G.A ROCURONIUM	ATRACURIUM CISTATRACURIUM
S.A (RAPACURONIUM)	MIVACURIUM
No histamine release CVS-Stable	Histamine release Hypotension, Tachycardia, Flushing, Bronchospasm. CVS unstable

- All aminosteroid except pancuronium cvs stable. CVS unstable.

↓

It causes.

Vagal blockade ↑BP, ↑HR

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Extra Notes :->

* Fast NMB -> succinylcholine. 30 – 45 sec (onset)
* Fastest non dep . NMB -> Rapacuronium - 75 sec.
* 2nd fastest Non dep. NMB -> Rocuronuim 90 sec. Onset)
* -> Rest all -> late onset -> 3-5 mins

Drugs

Rocuronium:->

- Fastest clinically available non depolarising NMB
  onset -> 90 Sec.
- Can replace succinylcholine for RSI
- IV injection cause pain.

d-Tubocurarine:->

- It is 1st neuro Muscular Blocker.
- Histamine release.

d-tubocurarine >>> atracurium = Mivacurium.
> Doxacurium
Metabolite

Atraucurium:-> **CIS Atracurium = 5 x more potent**

1. [redacted]
2. [redacted]
3. Histamine releaser.
4. Causes hypotension, Bronchospasm, tachycardia, flushing.
5. CVS Unstable
6. Metabolism -> **Hoffmann degradation.**
   ↓
   It is non-enzymatic time bound Self destruction of drug.
7. Muscle relaxant of choice in:->
   i. Acute/chronic liver disease.
   ii. Acute/chronic kidney disease
   iii. Pregnancy.
   iv. Pediatric
   v. Old age.
8. By product :-> Laudanosine.
   ↓
   Its accumulation causes epilepsy.

-> Diff. Between:->

Atracrium	Cistacurium
1. [redacted] 2. [redacted] 3. CVS unstable. 4.Dose-> 0.5-0.6 mg/kg Bw	1. [redacted] 2. [redacted] 3. CVS stable 4. Dose-> 0.1-0.15 mg/kg Bw It is 5X more potent 5. Less dose ↓ Less by product

Mivacurium:-

- S.A
- Benzylisoquinoline.
- Histamine releaser.
- CVS Unstable.

Onset – Late onset (3-5 min)

Duration – shortest among non- depolarising.

Metabolism:- Pseudocholinesterase.

Drugs & conditions potentiating the neuromuscular blockers:

(1) Antibiotics – Aminoglycosides.
Tetracyclines.
Polypeptides.

(2) Antiarrhythmics-> Quinidine
- Ca^{+2} channel blocker

(3) $Mg^{+2}\uparrow$

(4) Acidosis

(5) Hypothermia

(6) Potent inhalational anaesthetic agents, des, sevo, ISO, halo.

(7) Neuromuscular disease.

-
-
- More susceptible to non depolarising.

Reversal agents:-

1. Neostigmine + Atropine/ glycopyrolate
   To counteract – muscurinic side effect.
2. Sugammadex:- It is cyclodextrin compound.
   i.
   ii.
   iii. Best against vecuronuim & Rocuronium.

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INHALATIONAL ANAESTHETIC AGENTS
PART – 1

Potent inhalational Anesthetic agents→

New agents	Old agents
* HALOTHANE	* ETHER
* ISOFLURANE	*
* SEVO FLURANE	*
*	*
* Methoxy Flurane	
* Enflurane	

MAC:→ Minimum alveolar concentration of inhalational anesthetic agents required to produce no movement on surgical stimulus in 50% of test population

MAC_{50}

$MAC_{95} = 1.3 - 1.5\ MAC_{50}$

MAC_{awake} → Pt. start regaining his consciousness

Sub maximal MAC → Sympathetic stimulation

	MAC/doses
Halothane	0.75
Isoflurane	1-13
Sevoflurane	2
Desflurane	6

* Less MAC → high potency

High MAC → Low potency

H > I > S > D

Most potent inhalational agent → Methoxy flurane

Least potent inhalational anesthetic agent → N_2O (MAC = 104)

Meyer Overton's rule → Potency of inhalational anesthetic agent is directly proportional to its lipid solubility.

MAC ↓es	MAC ↑es
H	
H	
H	
Hypothermia	42°c (Hyperthermia)
Hyponatraemia	Hypernatraemia
Hypercalcemia	
- As age ↑es MAC ↓es by 6% /decade	- Infant has highest MAC
Pregnancy	
- Acute alcohol intoxication	- Chronic alcoholic
- Any drug contributing in any component of GA.	
- Chronic amphetamine	- Acute amphetamine

Blood gas partition coefficient/ Blood gas solubility / Diffusion Coefficient

Halothane $\frac{B}{G}$ = 2.25

CNS concentration of inhalation agent ∝ alveolar concentration

(1) High B.G solubility → slow speed of induction

(2) Low B.G solubility → fast speed of induction

(3)

	B:G solubility
Halothane Isoflurane Sevoflurane Desflurane	

B: G solubility

H > I > S > D

Fast to slow speed of induction

D > S > I > H

(4) Sevoflurane is inhalational induction agent of choice.

* Sevoflurane is most appropriate inhalational agent in pediatrics.

(5) Low B: G solubility → fast recovery

* Sevoflurane & Desflurane very appropriate for day care surgery.
* Sevoflurane & desflurane has shown an incidence of post operative delirium and hallucination with them, especially in pediatric.

Q:- Rate of induction of the anesthesia is increased by all of the following except

A)
B)
C) Second gas effect
D) High alveolar ventilation

Ans: - B) high cardiac output

	HALOTHANE	ISOFLURANE	SEVOFLURANE	DESFLURANE
Chemistry	Halogenated ethane	← Cl^- C-C-O-C ↕ isomers Enflurane C-O-C-C	Halogenated ether	→ Fl^- C-C-O-C * highest fluoride content

* Desflurane is structural analogue of isoflurane / flurinated isoflurane
* Sevoflurane → 7 atoms of fluoride
  Desflurane → 6 atoms.

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* Highest fluoride release in serum ->
Methoxyflurane
↓
Most nephrotoxic

	H	I	S	D
Boiling point		50 ± 2°c		Boil at room temperature * TEC 6

* TEC 6 is a special vapouriser used for storage and delivery of desflurane

	H	I	S	D
Color coding	Red	Purple	Yellow	Blue

	H	I	S	D
MAC	0.75	1.12	2	6
Blood gas solu.	2.25	1.3	0.63	0.42
			(fast induction / fast recovery)	

MAC↑ -> Potency↓
Blood gas solubility ↓es, speed becomes faster.

	H	I	S	D
Stability	Most unstable Thymol .01% is preservative added.	Q. stable	Q. stable	Most stable

Halothane Hepatitis

1. Type I → Acute self limiting hepatitis in which 3-6 weeks post exposure to halothane.
LFTs deranged.
2. Type II →
* Acute necrotising hepatitis
* 1 in 35/45000

Predisposing factors

(1) 
(2)
(3)
(4) Pre-existing liver dysfunction
(5) Reuse of halothane within 3-6 months

	H	S	I	D
Metabolism	>30% * aceyl halide * Auto immune hepatitis	0.1 - 0.2%	2 - 4% compound A ↓ nephrotoxic	not metabolised

	H	I	S	D
Uses	good smell Induction + Maintenance	irritant Maintenance	sweet smell Inducton + Maintenance Ind. agent of choice	irritant Maintenance Main agent of choice

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INHALATIONAL ANESTHETIC AGENTS – PART-2

Effects of Anesthetic Agents on different systems of Body

SYSTEM	HALOTHANE	ISOFLURANE	SEVOFLURANE	DESFLURANE
CNS	↓ $CMRO_2$ CBF ↑↑↑ ICP ↑↑↑	↓ $CMRO_2$ CBF ↑ ICP ↑	↓ $CMRO_2$ CBF ↑ ICP ↑	↓ $CMRO_2$ CBF ↑ ICP ↑
Neuro surgery	C/I for neurosurgery	They can be used for neurosurgery		
CNS	↓ EEG	↓ EEG	↓ EEG can cause seizures	↓ EEG

* Ketamine and N_2o increase EEG activity

- decrease EEG activity -> Hypoxia, Hpercapnia, Hypovolemia, Hypothermia
All inhalational & intravenous anaesthetic agents

CNS Coupling:- Cerebral blood flow (CBF) α cerebral metabolic O_2 requirement

↓ $CMRO_2$; ↓ CBF -----> ↑ $CMRO_2$; ↑ CBF

Enflurane: - Isomer of Isoflurane, not used in clinical practice

- It precipitates epilepsy.

SYSTEM	HALOTHANE	ISOFLURANE	SEVOLURANE	DESFLURANE
CVS	i.Direct Myocardial depressant ↓ ↓es the activity of SA node ↓ HR ↓ CO = ↓HRxSV ↓ BP	Des > sevo > Iso ↓ es systemic vascular resistance ↓ es mean arterial pressure ↑ es heart rate	Cardiostable	
	ii. Sensitizes the heart maximum to arrhythmogenic effect of catecholamine	-	-	-
	iii. -	Coronary steal Phenomenon		
Cardiovascular Surgery	not used	can be used	can be used	can be used (Agent of choice)
Respiratory system	1. Respiratory system depressed 2. Hypoxic/ Hyper capnic drive blunted 3. Bronchodilation * Best broncho-dilator (Halothane) 4. Hypoxic Pulmonary Vasoconstriction blunted by inhalational		* 2nd best broncho-dilator (Sevoflurane)	

Hepatic Hepatic surgery	- Cause auto immuno hepatitis - Disrupts dual blood supply of liver Contraindicated			can be used (Agent of choice)
Renal system		No bad effect	Nephrotoxic	No bad effect
Uterus	Best Uterine relaxant			
Loss of consciousness	Yes	Yes	Yes	
Loss of Reflex Response		Yes	Yes	Yes
Amnesia		Yes		
Muscle Relaxation	Yes		Yes	Yes
Analgesia	No	No		No

Methoxyflurane

→
→
→
→ Most nephrotoxic
→ High output diuretic
- Resistant vasopressin
- Resistant renal failure

Enflurane

→ Not in use
→ Isomer of Isoflurane
→

Malignant Hyperthermia / Malignant Hyperpyrexia

1. It is a pharmacogenetic disease.
2. Autosomal dominant form.
3. Drugs triggering → (I) Succinylcholine
   (ii) Halogenated inhalational agent
   (iii) Lignocaine
4. Clinical features

- **Hypermetabolism**
  - H
  - H
  - H
  - Tachycardia
  - Arrhythmia
- **Cell lysis**
  - Acidosis
  - Hyperkalemia
  - Myoglobinuria
  - Rhabdomylosis
  - Renal failure

5. Management

(1) Stop the triggering agent
(2) IV Dantrolene infusion
(3) Symptomatic management

Intravenous Anesthetic agents safe in malignant hyperthermia

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- Propofol – Anesthetic agent of choice

16th October – World Anaesthesia Day
Ether was first time used on 16th October, 1846

Ether

ADVANTAGES	DISADVANTAGES
(1) Cardiovascular stable (2) (3) (4) (5) Cheap	(1) Slow induction / slow recovery (2) Irritant can cause laryngospasm (3) Hyperstimulation of tracheo bronchial mucous & serous gland (4)

Oxygen cylinder

Nitrous oxide Cylinder

→ There were different color coding for cylinders of different gases
→ But still, mistakes occured
→ So, a system called PIN INDEX SYSTEM WAS USED.

NITROUS OXIDE(N_2O)

→ [ ] colour cylinder
→ Pin Index → 3, 5
→ MAC → 104 (least potent)
→ Blood gas solubility = 0.45
→ Fast agent
→ Good analgesic
  (1) ENTONOX→ 50% N_2O + 50% O_2
  • Blue Body
  • White shoulder
  • Pin index = 7
• Used for analgesia < labour / Dental
  • Cannot be used for Anaesthesia
→ Sympathomimetic agent – ↑ BP, ↑ HR CVS unstable
→ Supporter of combustion
→ C/I for laser surgery -> (cannot be used for anesthesia)

Management of Airway fire

(1) Disconnection of circuit

(2) Normal saline / Distilled water filled syringes used to extinguish fire

(3)

(4)

(5) IV antibiotic + IV steroid

→ Expands air containing cavity in body.

Absolute contraindication of N_2O

- Pneumothorax/ Pneumopericardium
-
-
-
- Laser surgery

→ N_2O inhibits vit B_{12} dependent enzyme

→ Peripheral Neuropathy

→ Megaloblastic Anaemia.

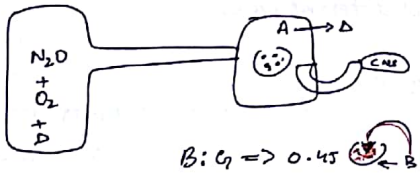
→ Bone Marrow Depression

Second Gas effect

→ Effect of N2O on second gas (accompanying gas) to increase the concentration of accompanying gas in the alveoli

→ Makes the speed of induction fast

Diffusion Hypoxia



→ Hypoxia due to rapid diffusion of N_2O from blood to alveoli during reversal of G.A

Treatment & prevention of diffusion hypoxia → 100% O_2

→ Also k/a fink effect or 3rd Gas effect (Dr. Albert fink)

XENON

→ Inert gas

→ MAC = 70

→ B: G = 0.19

→ Better analgesic

→ Not a supporter of combustion

→

→

→

→ Very costly

All agents act on GABA receptor in brain.

Ketamine, Xenon, N_2O acts on NMDA receptor

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INTRAVENOUS ANESTHETIC AGENTS

Non – opiod

- Sodium thiopentone
- Propofol
- Etomidate
- Ketamine
- Dexmedetomidine

→ CVS Unstable

Opiod

Morphine
Fentanyl
Sufentanyl

→ CVS Stable

1 Sodium thiopentone

- Ultrashort acting barbiturate (because of redistribution)
- pH > 10.5
- Normal saline / distill water to prepare it
- Anaesthetic concentration: 2.5%
- [redacted]

↓

Absorbs CO_2 and prevents precipitation of drug

Induction dose:

- 4-5 mg/kg body weight
- Within 11 seconds (one brain arm circulation): patient becomes unconscious

↓

4-5 mins – Patient gains conscious (because of redistribution)

Uses:-

- Induction
- DOC for narcoanalysis
- DOC for neuroprotection (↓ brain metabolism by 50%)

Effect on CNS:

1. ↓ $CMRO_2$
2. ↓ CBF
3. ↓ ICP
4. ↓ EEG
5. Cerebroprotective

- Anti- analgesic
-
- **Effect on CVS**

1. Peripheral vasodilatation
2. ↓ BP
3. HR ↑

Contraindicated in shock

- **Effect on Respiratory system:**

1. Respiratory centre depressed
2. [redacted]
3. [redacted]

Contraindicated in Bronchial asthma

- Effect on hepatic/ renal system : No effect
  Metabolism : Hepatic & Renal

Contraindicated in Porhyria

II Propofol

Appearance : Milky white
Chemically : Diisopropyl phenol
Additive : E → egg lecithine
G → glycerol
S → Soyabean oil

Emulsifying agents

Single best agent for day care surgery

Advantages:-
(1) Rapid metabolism / no residual effect
(2) ↓ ed incidence of post operative nausea and vomiting (PONV)
(3) Pleasant recovery

Effect on:-

- CNS:
  1. ↓ $CMRO_2$
  2. ↓ CBF
  3. ↓ ICP
  4. ↓ Cerebroprotective
  5. ↓ EEG
- CVS:
  1. Peripheral vasodilation
  2. ↓ BP
  3. ↓ HR

C/I in shock

- Respiratory system :
  1. [redacted]
  2.
  3.
  4. Hypoxic pulmonary vasoconstriction maintained
  5. Upper airway reflex inhibited
- Hepatic/ Renal : No effect
- Metabolism : 80% - Liver & kidney
  20% - Extrahepatic
  Extra renal

Anaesthetic agent of choice
(1) Day care surgery
(2) Neuro surgery
(3) [redacted]
(4)
(5) Pre-existing liver & kidney dysfunction
(6) Malignant hyperthermia
(7) Porphyria

Induction & maintainance

Other uses:-
- Sedation
- Antiemetic
- Antipruritic

Side effects:-
(1) Local pain on IV injection (most common)
(2) **Propofol infusion syndrome** (>48 hrs a metabolite accumulate and inhibits the mitochondrial enzyme leading to Lactic acidosis)

III. Etomidate

- [redacted]
- [redacted]
- Pain on IV injection

* Cardiovascular stability

- Adrenal suppression

↓

Adrenal cortex

↓

11 βeta hydroxylase inhibited

↓

Cortisol synthesis inhibited

- Mild / moderate CVS compromised it is used under cortisol and under vitamin C coverage

Side effects:-
(1) Adrenal gland suppression
(2) Increased incidence of nausea & vomiting
(3) Myoclonus

IV. Ketamine

- Phencyclidine derivative
- Routes of administration: IV / IM / Oral / Rectal / Intrathecal
- Dissociative anaesthesia: Thalmocortical dissociation
- Sympathomimetic i.e increase ↑ BP
  ↑ ICP
  ↑ IGP
  ↑ IOP
  ↑ HR
  - Stops the metabolism of catecholamine
  - In absence of catecholamine it is myocardial depressant

Agent of choice	C/I
(1) Shock/ Acute shock	(1) [redacted]
(2) Bronchial Asthma (Best Bronchodilator)	(2) [redacted]
(3) Cyanotic heart disease	(3) Uncontrolled hypertension
	(4) Elective Ns_x
	(5) H/O of Epilepsy, glaucoma

Effects on

- CVS:- In presence of catecholamine:
  ↑ BP, ↑ HR
  In absence of catecholamine:
  Myocardial depressant
- CNS:- • ↑ $CMRO_2$ • ↑ CBR • ↑ ICP • ↑ EEG
- Good analgesic
- Mc side effect:- Post operative delirium and hallucination

V Dexmedetomidine

- α_2 agonist (Pure)
- Good sedation
- Good analgesia
- Less respiratory depression
- Less cardiovascular compromise
- Offers "Conscious sedation" (Sleep like state from which one is easily arousable)
- Agent of choice for sterotactic S_x

Colonidine:
α_2 antagonist
$\alpha_2 : \alpha_1$
90:1

Total Intravenous Anesthesia (TIVA)

(1) Most common combination
Propofol + Fentanyl (Best: remifentanyl)
(2) ↓ $CMRO_2$, ↓ CBR, ↓ ICP (Cerebroprotective)
(3)
(4)
(5) Rapid metabolism
(6) ↓ Incidence of nausea & vomiting
(7) Safe in malignant hyperthermia
(8) Pleasant recovery

→ Accidental Intrarterial injection of drug

1st symptom - Pain | 1st sign- Pallor

Management

(1)
(2)
(3) 10 ml 1% lignocaine (to decrease pain)
(4)
(5)

Signs of successful stellate ganglion block

(1) Flushing
(2) ↑ d temperature
(3)
(4)
(5) Ipsilateral nasal stuffiness (Guttman sign)
(6) Ipsilateral tympanic membrane redness (Muller's sign)
(7) ↟ temperature of upper limb & redness

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REGIONAL ANAESTHESIA

- Local Anesthesia
- Central Neuraxial Blockade

Local Anaesthetics

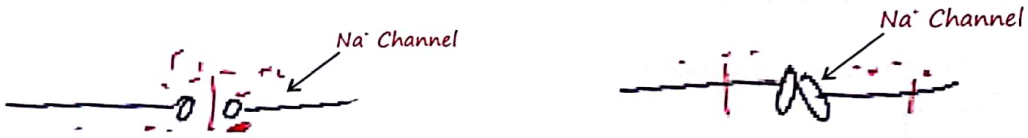
(1)

- Na^+ Channel blocked by LA.
- LA also have an effect on K^+, Ca^{+2}, NMDA channel

(2)

Nerve fibres present in 3 states

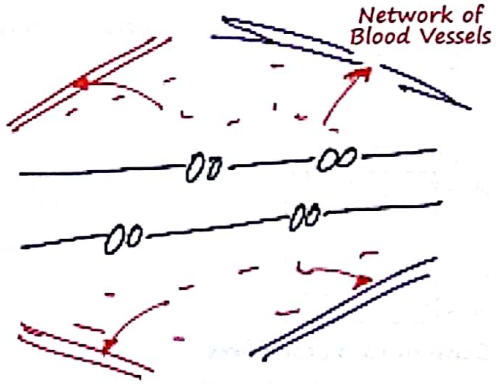
- Active → Na^+ channel wide open
- Inactive → Na^+ channel tightly closed
- Resting → Na^+ channel tightly closed



* Action of LA is best when the nerve fibre is in its active state

(3) Action of LA is both voltage gated and time gated

(4)



* If 20 ml 0.25% bupivacaine

- 10 ml (IV) absorbed
- 10ml
  - Onset → 45 mins
  - Duration → $1\frac{1}{2}$ hrs

* If 20 ml 0.25% bupivacaine + vasoconstrictor

- 2 ml (IV) absorbed
- 18ml
  - Onset → 5 min
  - Duration → 3 hrs

LA + Vasoconstriction

Advantages	Disadvantages
1) ↓sed systemic toxicity 2) ↓sed onset time 3) ↑sed duration 4) Better intensity	(1) ↑sed pain at the site of injection (2) C/I for the sites where endarteries located (like finger block, toe block)

$P_{ka} \neq P_h$

(Dissociation constant) P_{ka} →7.5-8.2

LA ⇄ to reach equilibrium

Dissociate/ionized → Cannot bind to Na+ Channel

Undissociated → Can bind to Na+ Channel

Advantages of adding $NaHCO_3$ to local anaesthetic

1. [redacted]
2. [redacted]
3. [redacted]
4. Decreased pain on injection

5. Types of Nerve Fibres

A	B	C
Carries	Carries	Carries
• A – [redacted] • A – • A – • A –	[redacted]	* Pain * Post ganglionic sympathetic fibres

- Sensory to motor fibres

* Most sensitive → least sensitive

- B > C > A
- Autonomic > Sensory > Motor
- Temperature (cold) > Pain > Touch > proprioception
- [redacted]

* Differential block

Blocking sensory sparing motor

6. Systemic absorption of local anesthetic

Iv > Tracheal > Intercostal block > Paracervical block > caudal > Lumbar epidural > Branchial Plexus > Sciatic > Sub-cutaneous

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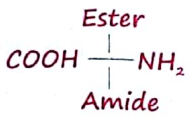
7. * Local Anesthetic has aromatic group and amino group attached by either ester bond or amide bond.



* LA divided into 2 groups

Ester		Amide	
- Cocaine	SHORT ACTING	- Lignocaine	INTERMEDIATE ACTING
- [redacted]		- [redacted]	
- Chloroprocaine		- Prilocaine	
- Benzocaine	LONG ACTING	- Bupivacaine	LONG ACTING
- [redacted]		- [redacted]	
		- Dibucaine	

* All ester LA except cocaine is metabolised by Pseudocholinesterase
* Para amino benzoic acid (PABA) causes allergy

* Cocaine & amide metabolised by liver
* No PABA, no allergy

Cocaine – (1) 1st LA to be used
(2) [redacted]
(3)
(4) Sympathomimetic

Chloroprocaine – (1) Shortest acting
(2) Most commonly used for Day care surgery

Benzocaine & Prilocaine – Cause Methemoglobinaemia
& EMLA (Prilocaine + Lignocaine)

LAST – Local Anaesthetic systemic toxicity

CNS toxicity	CVS toxicity
- [redacted]	- Arrhythmia
- Seizures	- Cardiac arrest

Example:-

	CNS toxicity	CVS toxicity
Drug A	200 mg	1400 mg (Safer drug)
Drug B	250 mg	500 mg

* CC/CNS ratio: Higher the ratio, safer the drug
For drug A : Ratio is 7
drug B : Ration is 2

* Drug with highest CC/CNS ratio : Lignocaine (only LA that can be given IV as anti-arrhythmic) safest
* Drug with low CC/CNS ratio: Bupivacaine (most cardio toxic)

Management:-

- Symptomatic management
- 20% intralipid emulsion infusion

Lignocaine :-

- Intermediate acting
- Amide LA
- Hepatic metabolism
- No allergy
- Safest LA

* LA of choice for IVRA : (Intravenous regional anesthesia/ Bier's block)
* C/I is Bupivacaine

Contraindication of IVRA

(1)
(2)
(3) Scleroderma

Maximum safest dose of Lignocaine + Adrenaline – 7 mg/kg body weight
Maximum safest dose of lignocaine alone :- 3 mg/kg body weight

EMLA

- Eutetic mixture of local anaesthetic.
- Lignocaine + Prilocaine (1:1)
- Concentration : 2.5% each
- Contact Period : 1 hour
- Surface anaesthesia : 5-6 mm
- Maximum application : 2000 cm^2

Contraindication:-

- Not given in neonates
-
- Mucous membrane

Bupivacaine

- Long acting
-
-
- No allergy
- Most cardio toxic

Best LA for differential block

Ropivacaine

S - isomer of Bupivacaine

Difference from Bupivacaine

-
-
- Less potency

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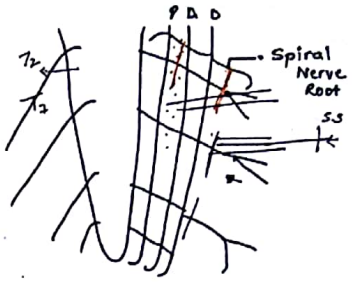
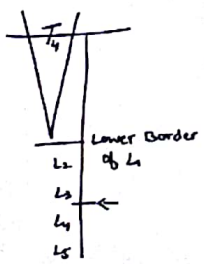
CENTRAL NEURAXIAL BLOCKADE

(i) Difference between spinal anaesthesia & epidural anaesthesia
(ii) Complications of CNB
(iii) C/I of CNB
(iv) [redacted]



I Difference b/w spinal and epidural Anaesthesia.

Subarchnoid block/spinal	Extradural block / Epidural
1. Drug in subarchnoid space	1. Drug in extradural space
2. Onset -> Immediate	2. Onset -> Delayed
3. Minimal amount of drug is adequate	3. Pre segment 1.5 – 2 ml of drug 10 segment = 15 – 20 ml ↓ More drug ↓ More systemic toxicity
4. Drug -> Hyperbaric/ Heavy/ Drug + Dextrose	4. Plain drug
5. Pierce skin ↓ [redacted] ↓ Supra / Infraspinatous ligament Ligamentum flavum ↓ Duramater ↓ [redacted] ↓ Subarchnoid mater ↓ Return of CSF	5. skin ↓ Subcutaneous fosssa ↓ Supra / Infraspinatous ligament ↓ Ligamentum falvum ↓ Epidural space ↓ Loss of resistance
6. Easy/ fails less	6. 7. 8. [redacted]
7. [redacted]	9. Segmental block practised
8. Intra operative anaesthesia	10. Minimal haemodynamic imbalance
	11. 12. [redacted]
	13. Caudal Anaesthesia Sacral epidural

9. Segmental block not possible 10. More haemodynamic imbalance 11. L2-3, L3-4, L4-5 12. Needles Quincke, Sprottee, Whitacre 13. Saddle anaesthesia->↓[redacted]+ Sacral nerve roots by spinal anaesthesia	

II Complications of CNB

(A) Hypotension

- MC complication of CNB
- - It occurs due to vasodilation.

Management:

1. IV fluids
2. IV vasopressor (if patient does not respond to IV fluids)

- Phenylepinephrine (Best)
- [redacted]
- [redacted]

* Phenylepinephrine is given in also pregnant lady because it crosses placental barrier minimally and does not cause fetal acidosis.
* Phenylepinephrine is also used in mild mitral stenosis because it does not causes tachycardia.

3. [redacted]
4. Lowering of head

B. Bradycardia

T/t-> IV Atropine

C. Respiratory Depression

D. Retention of urine

MC post op. Complication of CNB

E. Total spinal anaesthesia

31 pair of SN blocked + CNS spread of drug

* Case-> A 28 yr old female wanted epidural labour analgesia. She was given 12 ml 0.25% bupivacaine for labour analgesia through epidural catheter. Immediately after putting the drug she developed, Hypotension, Bradycardia and respiratory depression.
Diagnosis: Total spinal anaesthesia

F. Systemic toxicity to the drug

G. vasovagal

H. Infection

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(I) Post Dural puncture Headache
(PDPH) / Spinal Headache

Pathophysiology -> CSF leak -> ICP ↓es
↓
Traction on nerve fibres originating from piamater

Onset -> Most commonly 12 to 72 hours post procedure can also very rarely appear immediately
Site -> Occipital > frontal > retrorbital
Duration -> 7-10 days
Pathogonomic sign -> Change in posture aggravates headache
Predisposing conditions ->
a) Dura cutting needle (Spinal needle)
b) [redacted]
c)
d) Pregnancy

Symptomatic Management
- NSAID + Caffeine
- Fluids — Oral
IV
- Supine

(b) Definitive H/N
- Epidural blood patch
90 % immediate relief
Not first line of M/N

J. Epidural / spinal Haematoma
K. Transient Neurological symptom
L. Backache

III. C/I of CNB
1. [redacted]
2.
3. Hypovolemic shock
4. Coagulation disorder -> Platelet count < 50,000 absolute C/I
5. Pt's refusal
6. Severe heart disease

Mild	Moderate	Severe
Epidural		GA

IV. Central Neuraxial Analgesia
- Neuraxial analgesia comprises of only epidural
- Epidural Catheter
↓
Give LA
0.25% of bupivacaine
↓
* Sensory, Spare the motor

- Complication
  i) Haemodynamic imbalance
- To avoid this opioid, morphine is used

L A	Opioid
- Haemodynamic imbalance	-
- Motor # possible	- No motor # better analgesia
-	-
	- Resp. depression

Post operative Analgesia

	Adult	Pediatric
Major Sx	Epidural/ Neuraxial opioids	IV Opioid
Minor Sx	IV / IM / Oral NSAID	IV / IM / RECTAL NSAID

Labour Analgesia

Gold standard
↓
Epidural technique
↓
Bolus of = 0.125% / 0.25% / [LA + Opioid]
Bupivacaine
+
100 mg Fentanyl

C/I -> 6 Absolute C/I

IV opioid infusion
↓
Remifentanyl
↓
Easily metabolized in fetus by non specific estrase

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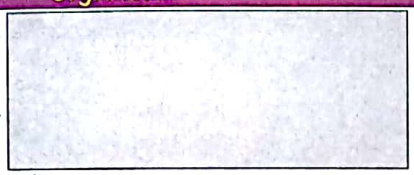
PERIOPERATIVE FLUIDS

- Total Body fluid is 60% of total body weight out of this, 40% fluid is in Intracellular space, 20% is in Extracellular space:
  - 5% Intramuscular
  - 15% Interstitial

Types of Fluids -> 1) Crystalloid 2) Colloid

Crystalloid	Colloid
1.  2. 3. $t_{\frac{1}{2}}$ is 15-20 minutes. 4. cheap 5. It is of 3 types: (a) Hypotonic e.g. 5% Dextrose (b) Isotonic e.g. Normal saline, Ringer's Lactate. (c) Hypertonic e.g. 3% Normal saline, 6% Normal saline	1. Aqueous solution of high molecular weight substance 2. Replacement ratio of colloid is 1:1 3. $t_{\frac{1}{2}}$ is 3-4 hours. 4. 5.

- 5% Dextrose is not a resusitative fluid
- Normal saline: Composition :

	Na^+	Cl^-	K^+	Lactate
	154 meq	154 meq	-	-
Ringer's Lactate: Composition:	131 meq	111 meq	4 meq	25 mmol

- Best fluid is Ringer's Lactate very commonly used in pediatric
- If physician don't want to use Ringer's Lactate or normal saline because of high Na and chloride present in it. So doctor wants to use diluted normal saline i.e. $\frac{NS}{4}$

To prepare $\frac{\text{Normal saline}}{4}$, require 25 ml NS + 75 ml 5% Dextrose

100 ml volume

$\frac{25}{100} = \frac{NS}{4}$

To prepare $\frac{NS}{5}$ => 20 ml NS + 80 ml 5% Dextrose

$\frac{NS}{2}$ => 50 ml NS + 50 ml 5% Dextrose

Calculation of Fluid Requirement:-

I Maintainance Fluid-

Holliday's segar rule or 4:2:1 rule

For 1st 10 kg 4 ml/kg Body weight/ hr

2nd 10 kg 2 ml / kg body weight /hr

Rest body weight 1 ml/kg/hr

For 60 kg
- 1st 10kg = 40 ml/hr
- 2nd 10kg = 20 ml/hr
- Rest 40kg = 40 ml/hr

Total 100 ml/hr

- Fasting fluid deficit = NPO hrs X Maintainence fluid /hr.
  = 10 hr X 100 ml
  = 1000 ml

1/2 fasting fluid deficit is replaced is 1st hour.
1/4 fasting fluid deficit is replaced is 2nd hour.
1/4 fasting fluid deficit is replaced is 3rd hour.

- Replacement fluid requirement depends upon surgery
  If minor surgery = 2-3 ml/kg body weight/hr.
  If moderate surgery = 4-6 ml/kg body weight/hr.
  If major surgery = 8-10 ml/kg body weight/hr.

- Example -> If there is 60 kg adult posted for cataract surgery. He is NPO for last 8 hrs. What is 1st hr fluid requirement?

-> M.F (A) = 100 ml/hr
F.F. deficit = 100 x 8 = 800 ml
half In 1 hr = 400 (B)
Replacement fluid = 3 x 60 = 180 ml (C)
1st her requirement = A + B + C
= 100+400+180
= 680 ml

Cannula's

Colour code	Size	Flow rate ml/min	
Orange	gauge	250 - 300	For Trauma, cardiac surgery
Grey	G	150 - 240	
Green	G	100-120	Common size in Adult
Pink	G	55 - 80	
Blue	G	22 - 50	For pediatric
Yellow	G	15 - 23	
Purple	G	11 - 15	Used in very old/ Premature infant

Central venous cannulation: - Sites:
(1) Internal Jugular vein -> for central venous monitoring, it is best site.
(2) Sub clavian vein – Best site and least chance of infection site.
(3) Femoral vein – Most infection site
- In subclavian vein cannulation, most common complication is pneumothorax.

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CARDIO PULMONARY CEREBRAL RESUSITATION

Basic Cardiac Life support

Unresponsive person
(Unwitnessed cardiac arrest)
↓
Scene safety
↓
Check responsiveness of person
↓
Start compression + call for help
100 – 120 compression / min
5-6 cm depth.
30: 2 (ratio)

Compression — Ventilation

in Pediatric
- Single Rescuer (30:2)
- >1 Rescuer (15:2)

5 cycles
Feel pulse for carotid pulse for 10 seconds
↓
Emergency medical system arrives with automated external defibrillator (AED)
Pads attached (recognizes rhythm)

If shockable Rhythm	If non shockable
↓	↓
200J AC shock	CPCR 5 cycles
↓	↓
5 cycles of c:v	feel for carotid

Feel for carotid for 10 seconds

Till–Return of spontaneous circulation
- ACLS team takes over
- Exhausted

Advanced cardiac Life support

(1) [redacted]
(2) Compression & ventilation → Independent of each other.
(3) Compression:-
100 -120 compression/min
5 – 6 cm depth
(4) [redacted]
(5) Intravenous line secured
Emergency drugs
- Adrenaline 1 in 10,000
(1 ml 1:1000 + 10 ml NS)

- Amiodarone 300 mg → 1st dose
  150 mg → 2nd dose
  5 mg / kg between Infusion

(6) Capnography

(i) effectiveness of chest compression

$Etco_2$ > 20 mm of Hg → Good compression

$Etco_2$ < 20 mm of Hg → Ineffective compression

(ii) Prognosis

>45 min CPCR done – No perfusion → Abandon CPCR of Et co_2

Cardiac Arrest rhythm

SHOCKABLE	NON SHOCKABLE
Ventricular tachy cardia	
Ventricular Fibrillation	

Infant BCLS

C: V = 3:1

Brachial pulse can also be palpated

POST ANAESTHESIA DISCHARGE SCORING

Post Anaesthesia Care unit

↓

Level II

Modified Aldrete scoring

- 5 parameters
- Max 2 scores, Max score is 10
- If max score > 8, then shift patient to Level II
- See for:-

	2	1	0
Respiration	Deep breath /cough	Shallow breathing	
O_2 Saturation	>92% (on room air)	> 90% on o_2	< 90% on o_2
Consciousness	Fully awake		Not responding
Circulation	BP ± 20 mm of Hg	BP ± 20-50 mm of Hg	BP ± 50 mm of Hg
Activity		2 limbs moving	No movement

Post Anesthesia discharge Scoring System (PADSS)

- Very important for day care surgery.
- Done when a patient is about to discharge.
- It has 6 parameters.
- If >9 -> Then only discharge the patient.

0	1	2
Vital signs	-	2
Ambulation	1	-
	1	-
	1	-
	1	-
	1	-

Modified PADSS-> showing minimum scoring needed to discharge the patient.