Anesthesia
Handwritten Note

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Name: _________________________________________

Subject: ____________________ Anesthesia ____________________
ANAESTHESIA

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OBJECTIVES OF ANAESTHESIA:

17. Analgesia
27. Muscle Relaxation ➞ TRIAD OF ANAESTHESIA
37. Amnesia

HISTORY OF ANAESTHESIA:

1. Term 'Anaesthesia' was coined by OLIVER WANDELL HOLMES
2. FATHER OF ANAESTHESIA - JOHN SNOW
3. FATHER OF MODERN ➞ W.T.G. MORTEN
4. O₂ + N₂O SYNTHESISED BY PRIESTLY
5. N₂O ➞ provides analgesia
6. Whu property Discovered by Humphrey Davy ➞
   1st clinical demonstration of N₂O anaesthesia was given by Horace Wells ➞ he used N₂O as dental anaesthesia - 1844
7. Ether - Sweet oil of vitriol
   1st clinical demonstration was given by W.T.G. MORTEN on 16/10/1846
   World Anaesthesia Day
8. Cocaine ➞ 1st local anaesthesia.
    Also shows vasoconstriction.
    Nowadays, used 4% soln as topical anaesthesia for eye.
    It can cause addiction.
9. 1st Spinal Anaesthesia was given by August BIER
    Cocaine was the 1st drug to be used for spinal anaesthesia
Harold Guildin was the 1st person to use Curare for Muscle Relaxation.

1st E.T. Intubation was done by William Secow. It was made popular by Evan Magill.

ASA GRADING (American Society of Anaesthesiologist)
It determines physical status of patient. Although commonly used for Risk Assessment, it is not intended to be used for assessment of Risk.

I - Healthy Pt
No Systemic Disease
Minimal or No alcohol intake
Pt is a non smoker

II - Pt is mild systemic Disease & it well controlled
- no functional limitation
eg. Well controlled DM, HTN
Pts is BMI of 30-40

Pt is mild lung Disease
Current Smoker
Social Drinker
III - Pt. with severe systemic disease or functional limitation:
- Uncontrolled DM or HTN
- Pt. BMI > 40
- Alcohol dependence
- EF (40-45%) [Moderate reduction of EF]
- Pt. with end stage renal disease on regular dialysis.
- > 3 months H/o MI/CVA/TIA/stents.

IV - Severe systemic disease is a constant threat to life of patient:
- Unstable angina
- < 3 month H/o MI/CVA/TIA/stents
- ARDS
- End stage renal disease on irregular dialysis.
- Severe reduction of EF.

V - Moribund Pt. who is unlikely to survive:
- Tumor sx
- Ruptured thoracic or abdominal aneurysm
- Massive intracranial bleed or midline shift
- Massive trauma

VI - Brain dead pts. for organ donation:
If any of the pt come in emergency, O is written before ASA grading.
Drawback of ASA Grading:-
surgical risks are not covered

MALLAMPATI GRADING

M/c airway exam done is
It is used to assess size of tongue for laryngoscopy

1) Facial Pillars
   Uvula & Tip
   Soft palate

2) Uvula not tip
   Soft palate

3) only soft palate → Difficult Intubations

4) only hard palate

OTHER TESTS

1) Thyromental Distance = Dist Bet' Mentum & Thyroid
   should be → > 6.5 cm

2) Sternomental Distance = > 12.5 cm [mentum → sternum]

3) Adequate Mouth Opening
   Gap Betw upper & lower Incisors
   should be → > 3 fingers breadth or 2 cm

4) Movement of cervical spine
DIFFICULT IN ANKYLOSING SPONDYLITIS PD.

MANAGEMENT OF PRE-EXISTING DRUG THERAPY

I) MAO INHIBITORS -
   Older MAOI should be stopped 3 wks before surgery.
   They cause severe sympathetic Rxn & Pethidine.
   Newer MAOI SELEGILINE can be continued until 1 day before surgery.

II) LEVODOPA -
    Continued

III) ANTI CONVULSANTS -
    Should be continued
    Morning dose to be given

IV) OHD / Insulin -
    Morning dose of is omitted becoz pt is fasting.
    Ideal Fasting Period
    Adults → Solid - 6hrs
    Clear liquid - 4hrs.
    Breast feeding Infant - Solid - 4hrs
    Clear liquid - 2hrs.
    If infant is on formula feed or non-human milk → then it should be 6 hours.
For Major Sx,
Pt is shifted from OHD to Insulin (48hr) before Sx.

ORAL ANTICOAGULANTS / WARFARIN - Q

INR - 2-3
Stopped 4-5 days before Sx
For Sx INR should be <1.5
For emergency Sx, VIT K / FFP can be used.
For LMWH,
Last Dose - 12-14 hours before Sx
For unfractioned heparin, up to 6hr before Sx

OCPs - should be stopped 4 weeks before Sx
Only progestones pill can be continued

Anti-HTN - Q
All anti-HTN should be continued & possible exception of ACEI/ARB
Can cause refractory hypotension during anæsthesia

β blockers are preferred agent to 1 pers operative mortality
VIII  Anti-Anginal -

IX  Thyroid Drugs -

Continue

X  LITHIUM -

Q should be stopped 2 days before sx.
It prolongs non-depolarising m/s relaxants.

XI  STEROIDS -

Q should be continued, morning dose to be given.
Steroid intake suppresses endogeneous control, if it is withdrawn before sx, there may be refractory hypotension.

XII  SMOKING -

Q should ideally be stopped 6-8 weeks before sx.
In smokers - mucociliary clearance is inhibited.

So clearance is impaired.

If stopped 12-24 h

↓

↓ CO-Hb level

↓

will shift O2-Hb dissociation to right.

Smoking also ↓ surfactant level & also potency of amino-steroid m/s relaxants.
ANTI-PLATELET DRUGS

1) ASPIRIN-
   - Low Dose (75mg)
   - Should be continued except for closed space surgeries
   - Should be stopped >75mg
      3-5 days before sx
   - Ex: sx of brain, spinal cord & eye

2) CLOPIDOGREL-
   - Should be stopped 7 days before sx

3) TICLOPIDINE-
   - Should be stopped 14 days before sx

4) HERBAL MEDICATIONS-
   - Should be stopped 6-8 wks before sx

5) STATINS-
   - Should be continued
PRE-MEDICATION

AIMS -
1. To ↓ anxiety ⇒ Longer acting BZD - Lorazepam
   For Day Care Sx -
   Midazolam
   Temazepam

2. Provide sedation, amnesia

3. Promote hemodynamic stability

4. To ↓ aspiration.
   Gastro juice - PPI & H2 blockers

Aspiration in ▲ = MENDELSON SYNDROME
   pH < 2.5  Vol. > 25 ml

5. To provide analgesia
   Morphine or Pethidine can be used
   ↓
   Should not be used in
   Renal failure
   As its metabolite
   Nor-pethidine accumulate
   & can cause convulsions

6. To prevent Post-Op nausea & vomiting
   - Ondansetron, Metoclopramide
   ↓
   Main s/e = Headache
7) To control infections
   Broad spectrum antibiotics
   1st dose → up to 1 hour before skin incision
   If surgery prolongs for >6 hour → Antibiotic dose should be repeated

8) To control oral secretions
   Atropine or Glycopyrrolate

ANAESTHESIA MACHINE (A.M.)

1st used in 1917.
Also known as EDMUND GASKIN BOYLE Anaesthesia machine
Continuous flow- type of anaesthesia machine

Fresh gas flow both during inspiration
↓ expiration

A.M.  ↓

HIGH PRESSURE SYSTEM
- Cylinders
- Yolk Assembly
- Pressure Gauge
- Pressure Reducing Valve

INTERMEDIATE PRESSURE SYSTEM
- Flow control valve
- \( O_2 + N_2O \) Proportionating device

LOW PRESSURE SYSTEM
- Rotameter
- Vapouriser
- Common gas outlet
- Central supply lines
HIGH PRESSURE SYSTEM

1. CYLINDERS

Made up of special alloy - Mb Steel

In MRI room, cylinders are made of Aluminium

Size of Cylinder - A to H

- Smallest
- Largest

Cylinder mostly used = E.

- Contain 660 L of $O_2$

Type D - Contains 470 L of $O_2$.

COLOUR CODING OF CYLINDER

$O_2$ → Black Body & White Shoulder

$N_2O$ → Blue

$CO_2$ → Grey

Cyclopropane → Orange

Helium → Brown

Entonox = 50% $O_2$ + 50% $N_2O$

- Blue Body & Blue White Shoulder

If $O_2$ is replaced by $N_2O$ ⇒ Hypoxia occurs

H/c type of hypoxia during anaesthesia = Hypoxic Hypoxia
PIN - INDEX SYSTEM

It prevents wrong fitting of anaesthesia cylinders.

\[ \text{O}_2 = 2.5 \]
\[ \text{N}_2\text{O} = 3.5 \]
\[ \text{CO}_2 = 2.6 \]

Cy clopropane 3.6

Entonox 7

Pin Index no. can fail if wrong gas can is fitted inside cylinder & pins of Pin Index System can are damaged.

TARE WEIGHT -
wt. of empty cylinder.

FILLING RATIO -
Ratio of % of wt. of gas
wt. of water cylinder can hold at 60°F

It prevents overfilling of cylinder.
WOOD'S METAL
- Alloy of low melting point & is present between the cylinder wall & body.
- In case of fire, the metal forms a small gap through & leakage of gas occurs.

N₂O, CO₂, cyclopropane are stored in cylinders in liquid form.
O₂ can also be stored in liquid form.
Critical Temp. for O₂ is -119°C.

Each 1ml of liquid O₂ gives 840 ml of gas
Critical Temp. for N₂O is 36.5°C

27 YOLK ASSEMBLY

It attaches cylinder into anaesthesia machine. Pens of Pin Index System are part of yolk assembly.

37 PRESSURE GAUZE

It measures pressure inside cylinder.
Most commonly used is Bourdon's Pressure gauge.

It works well in O₂, as it is stored in gaseous form.

In liquid gaseous, even if amount of gas is pressure remains same until it finishes completely then becomes zero.
So, it is imp in case of LCG gases

47. **PRESSURE REDUCING VALVE**

\[ \begin{align*}
0_2 &= 2000 \text{ psig} \\
N_2O &= 750 \text{ psig} \\
\text{Cyclopropane} &= 61\text{ psig}
\end{align*} \]

May cause **BAREOTRAUMA**

Pressure Reducing value ↓ this pressure to 35-45 psig

Cyclopropane doesn’t req. Pressure Reducing value

\[ 1 \text{ atm} = 14.6 \text{ psi} \]

**INTERMEDIATE PRESSURE SYSTEM**

1> **FLOW CONTROL VALVES**

To control flow rate of gases

- **O**<sub>2</sub> - White in colour
  - Bigger = Broader Serrations

- **N**<sub>2</sub> - Blue in colour
  - Smaller = Finer Serrations

2> **O**<sub>2</sub>-**N**<sub>2</sub>O **PROPORTIONATING DEVICES**

↑ In earlier machines, initially 100% O<sub>2</sub> then 100% N<sub>2</sub>O

[**Risk of Hypoxia**]
Master & Slave Device:

N₂O is delivered when O₂ is switched off.

O₂ + N₂O proportioning device:

The device provides fixed % of total flow of O₂.

The min. % of O₂ delivered by these are 25%.

O₂ Req. during Gen. Anaesthesia = 30%

⇒ O₂ FLUSH

It delivers emergency O₂ @ 35-75 L/min

⇒ CENTRAL SUPPLY LINE

Made up of copper.

Central lines are colour coded:

O₂ = White
N₂O = Blue
Air = Black
Suction/Vacuum = Yellow

They also have safety mechanism.

DISS (Diameter Index Safety System)

It consists of non-interchangeable different diameter screws for O₂ & N₂O.

Pressure inside central supply line = 45-55 psi.
LOW PRESSURE SYSTEM

**ROTAMETER**

- It consists of glass tubes known as Ghiope’s Tube
- Made up of special glass - K/Ha Pyrex Glass
- Glass tubes are calibrated according to the gas they carry.
- These glass tubes have variable orifice but constant pressure
- These glass tubes contain an indicator for gas flow → Bobbin

![](Al)

- upper part denotes gas flow

**CAUSES OF INACCURATE READING OF FLOW METER:**

1. Dirt
2. Static electricity
3. Vertical alignment
4. Cracked glass tubes
5. Backflow of gas
Upstream Middle Downstream → Less chance of hypoxia

O₂ should always be downstream to all other gases

**VAPOURISERS**

- Used to provide inhalational Agents like Halothane
  Desflurane
  Sevoflurane etc to the pt.

→ Most imp. Property on & delivery of agent depend on vapour pressure of agent.

→ Vapourisers are made of copper
  
  ↓
  
  Good thermal conductivity,
  specific heat.

→ Vapourisers are temp. & pressure compensated.
  
  ↓
  
  Any change in temp. & pressure doesn't affect delivery of agent.

Latent heat of vapourisation

\[ \begin{align*}
\text{Copper} & \quad \text{transfer} \\
\text{atmospheric temp} & \quad \text{to maintain}
\end{align*} \]
At higher altitude, vapourizers deliver higher O₂ to maintain same partial pressure.

Vapourizer are variable bypass vapouriser

- Higher the amount of O₂-N₂O passed through vapourizer
- Higher the Conc of gas.

- Only exception to variable bypass
- Vapourizer of Desflurane
  → Tec-6 vapouriser.

* Desflurane
  → B.P. = 23°C
  → vapour pressure.

- Desflurane vapourizer is heated to a temp. of 39°C to achieve the vapour pressure.

- To give it in clinical conc. 60-70 litres of fresh gas is required. It is not possible by variable bypass vapourizer (6-11).

- Vapours of Desflurane are directly injected into the fresh gas flow.
Desflurane is directly injected into fresh gas flow.

**Colour Coding of Vapouriser**
- Halothane - Red
- Isoflurane - Purple
- Desflurane - Blue
- Sevoflurane - Yellow

All gases come out through common gas outlet, a circuit is attached to the common gas outlet.

Wheels of Anaesthesia Machine are made Antistatic by addition of Carbon

**O₂ Concentrators**
- Consist of Zeolite and Al(OH)₃ Lattice
- Absorbs N₂ from air, only O₂ will be left
- Provide 95% O₂ not 100%
- Electronically powered
- Rest 5% air - Argon = an inert gas
O₂ ANALYSER

It measures O₂ leaving the machine
It is usually put upon inspiratory limb of circuit.

CIRCUITS

They are connection bet'w' the anaesthesia machine & the patient.
They provide oxygenation, ventilation.

3 types

1) OPEN CIRCUIT
It consists of a mask → Schimmelbusch mask.
Method is k/o/a → open drop method
Agents used are ether, chloroform.

ADVANTAGE
Easy to use

DISADVANTAGE
Can't control conc' pt inhales
L → Theatre pollution
When pt becomes unconscious, pt may hypoventilate leading to hypoxia

2) SEMI-OPEN/ SEMI CLOSED SYSTEM

N/Cly used in MAPLE, MAPLE SOM SYSTEM
6 types

A) MAPLESUM A

1. MAGILL CIRCUIT

→ Best for Spontaneous Ventilation

→ Fresh gas flow required to prevent Re-breathing

= Minute vol. of Patient

Q. Minute vol = Tidal vol. X R.R.

500 mL X 14 = 7L

T.V. = 7 mL / kg Body wt.

Expiration valve

Modification of Maplesum A = LACK CIRCUIT

↓

Coaxial Circuit

Outer tube = Inspiratory

Inner tube = Expiratory

B) Obsolete

C) Also K/h/e = Waters to free circuit

Used for transportation

Resuscitation.

D) Also K/h/a = Bain Circuit

Best for controlled Ventilation

Fresh gas flow req = 1.6 x minute vol. of pt.
Coaxial Circuit
outer: expiratory
inner: inspiratory

also Kn/Ha - AYRE'S T PIECE

\[ O_2 \]

E.T.

used in spontaneously breathing pt

Neonates

No valve thus no breathing bag

JACKSON-REES MODIFICATION OF
AYRE'S T PIECE

used in children < 6yrs or < 20 kg

Both E & F are valveless circuits
Do not contain any valves
CLOSED CIRCUIT

\[ O_2 + N_2O + \text{Inhalational Agent} \rightarrow O_2 + N_2O + I: A. + CO_2 \]

Inspired gas \rightarrow \text{Expired gas} \rightarrow \text{If CO}_2 \text{ removed} \rightarrow \text{gases can be reused}

SODALIME

Gas is passed through soda lime
- It absorbs CO\(_2\)
- Leading to ↓ req. of fresh gas flow.
- At consists of Ca(OH)\(_2\) - 94%
- NaOH - 5% as Catalyst
- KOH - 1% as activator
- Silica for Hardness.

Each 100 g of soda lime absorbs 23-26 L of CO\(_2\).

Indicator is added to change colour of \( \text{NaOH} \)
- Ethyl violet → white to violet
- Phenolphthalein → white to pink
- Clagtan yellow → Red to yellow
- Memosa 2 → Red to white

Size of granule = 4-8 mesh size in soda lime
TRILENE

17. TRILENE

It reacts with trilene to form Dichloroacetylene
neurotoxic or
phosgene → ARDS

Alternative to sodalime - BERYLIME

Ca(OH)₂ - 80%
Ba(OH)₂ - 20%

This mix is less caustic
hardness occurs due to H₂O of
crystallization.

Berylume causes higher incidence of airway
issue, ðŸ‘ less commonly used

* Management of airway issue.
   → It occurs most commonly during vocal cord
   injury ðŸ‘€ Laser

STEPS
1) stop ventilation, remove tracheal tube
2) given off O₂, disconnect circuit from
   anaesthesia machine
3) submerge tube in water
4) ventilate with 100% O₂, re-intubate
5) perform fibre optic bronchoscopy, assess airway
damage
6) Bronchodilators, Steroids, Antibiotics as indicated.

7) The closed circuit is best for maintaining depth of Anaesthesia.
8) Removal of expired gas
9) Humidification.

**EQUIPMENTS IN ANAESTHESIA**

1) AMBU (Artificial Manual Breathing Unit)

Max % of $O_2$ that can be delivered to AMBU Bag = 100%

It comes in various sizes:
- Neonate - 250 mL
- Children - 500 mL
- Adults - 1-2 L

2) FACE MASK
- It is used to provide seal for Positive Pressure Ventilation.
- Made up of Anti-Static Rubber
3) Guedel's Oropharyngeal Airway
   - Prevent fall of tongue during anaesthesia
   - Correct size depends upon
     * Angle of Mouth
     * Traque

4) Nasopharyngeal Airway
   - Prevent fall of tongue
   - Correct size depends upon Distance Between
     * Top of Nose
     * Traque

5) LMA (Laryngeal Mask Airway)
   - Supraglottic Devices
   - They are not definitive airway

- Advantage
  - Easy to Insert
  - They do not require laryngoscopy or MI
  - Can be used for difficult airway & CPR

Size of LMA depend upon wt. of pt
   - 1-5 kg - 1
   - 5-10 kg - 2, 1.5
   - 10-20 kg - 2
   - 20-30 kg - 2.5
30-50 kg → 3 → In children
50-70 kg → 4 → In adult
70-100 kg → 5
>100 kg → 6

Largest possible size of LMA should be inserted as it forms better oropharyngeal seal.

Disadvantage
Higher incidence of sore throat

C/I of LMA:
1) Full stomach
   +
   TEF
   Recent meal

2) Pts having low pulmonary compliance
   eg. morbidly obese pts.

3) Pts with oral pathologies
   eg. Pharyngeal abscess
   Ludwig angina
   Inadequate lax/smaller mouth opening
TYPES

1) CLASSICAL

Can be autoclaved up to 40 times.
Tip of LMA corresponds to oesophagus.

2) FLEXOMETALLIC LMA -
Tube does not kink.

3) FAST TRAC LMA / INTUBATING LMA -
Designed for difficult intubation.

4) PROSEAL LMA -
Designed for PPV
Any rise in gastric pressure → come out through drain tube
Disposable Proseal LMA > Supreme LMA

DEAD SPACE
Decreasing Order →
Face Mask > LMA > Endotracheal tube > Tracheostomy
6) **LARYNGOSCOPE**

- Highly used - Macintosh Blade
- Straight → MILLER BLADE
- Laryngoscope should be always be held in **G** hand
- Inserted from **L** side of mouth. +
- Tongue deviated to **R** side
- Laryngoscope blade should never be levered upon upper incisors

- **Position of Laryngoscopy**
  - Extension @ atlanto-occipital Jb. → sniffing position
  - Flexion in neck.
  - It brings oral, laryngeal, pharyngeal axis on a straight line

- **He structures Damaged during Laryngoscopy**
  - Upper Incisors

- **STRESS RESPONSE TO LARYNGOSCOPY**
  - Sympathetic Response
  - HTN, Tachycardia, Arrhythmia

- Response can be ↓ by → β blockers
  - Opioids
  - Deepening anaesthesia and volatile agents
  - Lignocaine
7) ENDOTRACHEAL INTUBATION

2 most commonly used Tubes

RED RUBBER TUBE \[\rightarrow\] PVC TUBE

\[\Rightarrow\] Disposable
\[\Rightarrow\] Less tendency to kink

\[\Rightarrow\] Reusable
\[\Rightarrow\] More expensive
\[\Rightarrow\] Less tendency to kink

\[\Rightarrow\] Murphy eye

\[\Rightarrow\] Murphy eye

\[\Rightarrow\] Cuff \[\rightarrow\] High pressure
\[\Rightarrow\] Low volume

Due to high pressure,
\[\Rightarrow\] More chances of tracheal injury
\[\Rightarrow\] Used for shorter duration

\[\Rightarrow\] Non-transparent

\[\Rightarrow\] Radiolucent

\[\Rightarrow\] They have lower incidence of sore throat

\[\Rightarrow\] Murphy's Eyes

- When tube gets blocked, through Murphy's eye ventilation can be continued
- Small hole is present in lateral wall of tube to prevent blockage.
Mic size of tube used for adult $\sigma = 8, 8.5$

$\sigma = 7, 7.5$

Length of tube comes at upper incisor

$\sigma = 21-22\,\text{cm}$

$\tau = 20-21\,\text{cm}$

Cuff of tube should lie in upper trachea

$2-2.5\,\text{cm below vocal cord}$

Cuff pressure should never exceed $30\,\text{cm H}_2\text{O}$

If $>30\,\text{cm H}_2\text{O}$ → Tracheal mucosal necrosis

M/c of vocal cord paralysis → Compression of ant. Br. of recurrent laryngeal n/v.

\[ \text{\textbf{c\ is\ compressed\ by\ cuff\ of\ tube}} \]

\textbf{CONFIRMATION OF TUBE IN TRACHEA}

1) \text{up - down of chest}

2) Fogging of tube → seen in PVC tube

3) CXR → seen in PVC tube

4) Auscultation

\begin{align*}
\text{RA} & \quad \text{LA} \\
\text{RB} & \quad \text{(LB) → Most imp area for auscultation.} \\
\text{Breath sound confirms tube is above Carina} 
\end{align*}
GOLDEN STD FOR INTUBATION

\[ \text{CAPNOMETRY} \]

\[ \text{ETCO}_2 \rightarrow 35-45 \text{ mmHg} \]

\[ \text{EP} \quad \text{EU} \quad \text{ID} \]

\[ \text{EU} - \text{exp. upstroke} \]
\[ \text{EP} - \text{exp. plateau} \]
\[ \text{ID} - \text{infl. downstroke} \]

* FLAT CAPNOMETRY *

1) Disconnection of circuit
2) Incidental extubation
3) Ventilatory failure
4) Esophageal intubation
5) Cardiac arrest

* Sudden ↓ in \text{ETCO}_2 -

1) Venous air embolism

\[ \text{Occur typically in sitting position for} \]
\[ \text{Post-fovea surgeries} \]
\[ \text{Most lethal complication of sitting position} \]

* SUDDEN ↑ in \text{ETCO}_2 -

1) Malignant Hyperthermia
2) Bronchospasm

SHARK - FIN APPEARANCE.

CURARE NOTCH

Notch shows requirement of H/S relaxant during anaesthesia

EXP. VALVE LEAK

\[
\begin{align*}
\text{When there is CO}_2 & \text{in inspiration} \\
\text{Hypoventilation}
\end{align*}
\]

SPECIAL TYPE OF ENDOTRACHEAL TUBE -

17 RAE tube [8 angled endotracheal tube]

- These tubes have preformed shape & are used for cleft lip & cleft palate sx

27 FLEXOMETALLIC TUBE/ SPIRAL EMBEDDED TUBE

- Do not kink

- Used for head & neck sx in prone position

- Spine sx
DOUBLE LUMEN TUBE

Used for Single Lung or 1 Lung ventilation.

1 Lung can be ventilated by the

In single lung ventilation, shunt fraction = 50%.
If shunt fraction >50% ⇒ Hypoxia.

Final position of double lumen tube is confirmed by fibre optic bronchoscopy.
The cause of hypoxia during single lung ventilation is shunt fraction.

E.T. in Children

→ Uncuffed tube are used ≤ 6 yrs
→ Minimal permissible leak is allowed
→ Leak should be audible
→ If leak is ↑ Bellows of ventilator may collapse
  ↓
  ▼
  change the tube to a bigger size
Flow Rate \( \alpha \theta^4 \)

Small \( \theta \) in airway causes large \( \theta \) in flow rate.
So uncuffed tube used.

\[ \Rightarrow \text{SIZE of TUBE in children depend upon} \]
\[ \text{Age of child} \]

- Premature: 2.5-3
- Neonate: 3-3.5
- Infant: 3.5-4
- 1-3 yrs: 4-4.5
- 3-6 yrs: 4.5-5.5
- 8-12 yrs: 5.5-6 - cuffed tube

\[ \text{No. of tube } \rightarrow \text{Internal diameter } \theta \text{ in mm} \]

\[ \Rightarrow \text{Length of tube}, \quad L = \frac{\text{Age (yrs)}}{2} + 12\text{cm} \]

**NASOTRACHEAL INTUBATION**

**INDICATIONS**:
1) # Mandible
2) Oral Sx
3) Inadequate mouth opening
4) Awake fiberoptic intubation.
5) If tube is to be kept for longer time
C/I 2.  

- Base of skull
- CSF Rhinorrhoea
- Nasal mass -
- Adenoid
- Coagulopathy
  - e.g. hemophilia
  - Platelet disorder

Other Features:
1) Movement of E.T.
2) Good oral hygiene
3) Infev rate of 15-20%
4) Nasal mucosal Damage

C/I to B) NASAL / ORAL INTUBATION

1) Sev. Laryngeal oedema
2) Sev. Epiglottitis
3) Laryngotracheal bronchitis

Tracheostomy should be done in these cases
DIFFICULT AIRWAY ALGORITHM

PLAN A → Laryngoscopy + Intubation → Success

Fall

PLAN B → Use of Assisted Device

LMA / LMA → Confirm É Fibreoptic Bronchoscope

Fall

PLAN C

Maintain O₂, Saturation

Bag, Mask → make pb. ventilation

Conscious

Postpone Sx

Fall

PLAN D

Retry LMA → Needle Verricthryotomy

Ventilation used in HFJV

(High Frequency Jet Ventilation)

→ Tracheostomy
I.V. ANAESTHETIC AGENTS

BARBITURATES

- Thiopentone
- Methohexital

NON-BARBITURATES

- BZD
- Ketamine
- Propofol

All these drugs except xenon act upon GABA except ketamine except ketamine

NMDA

- Xenon
- N₂O

STERoidal ANAESTHETIC

- Althesin
- Eltanolone
- Propanidid

MAX ALLERGic Rxn

M/s Relaxant > Latex Products > Antibiotics

Potency of Anaesthetic Agent & Lipid Solubility
THIOPENTONE

- Used 1st time in 1934
- Yellow amorphous powder & contains 6% anhydrous sodium carbonate
- Prepared, stored in N₂ atmosphere as it reacts to atmospheric CO₂ & precipitates
- pH ~ 10.5
  - Highly alkaline
  - Shouldn't be mixed with RL
  - Can be mixed with NS 5% Dextrose, distilled water
- Dose: 3-5 mg/kg body wt
  - Adequate dose → Loss of eyelash reflex
- Conc.: 2.5%
  - > 2.5% causes Pain of injection
  - Venous thrombosis
  - < 2.5% causes awareness during anaesthesia

Bispectral Index

- Type of Frontal EEG Use
- Used to detect awareness / depth of anaesthesia
For Adequate sedation, BIS value: 65-85
Adequate anaesthesia – 40-65
Cortical depression – <40

ONSET of thiopentone – 30 sec
Last for 15-20 min.
Pt regains consciousness by thiopentone by

½ life of thiopentone: 10-12 hrs

Thiopentone contains sulphur atom
↓
markedly ↑ lipid solubility

It is metabolised in Liver (Hepatic Oxidation)
It is a microsomal enzyme inducer

SYSTEMIC EFFECTS
↓ CVS → peripheral vasodilatation
↓ venous return
↓
↓ BP
↑ HR

Thiopentone cause hypotension & tachycardia
Tachycardia also occurs due to central vagolytic action.
2) Resp - a) cause Resp. depression
   b) Absence
   c) Rx: IPPV & Bag & Mask

3) Histamine Release
   a) shouldn't be used in Asthmatic pt
   b) may cause Reflex Bronchospasm, Laryngospasm

3) CNS
   a) Potent Cerebral Vasoconstrictor
   b) also markedly ↓ cerebral Metabolic Rate
   c) Potent Anticonvulsant

4) Anti-analgesic
   a) lower threshold for Pain.

5) Poor H/le Relaxant

6) Crosses Placenta → Fetal Depression

7) May show Antithyroid Action
C/I For Thiopentone

1) Acute Intermittent Porphyria
   Variegate Porphyria
   can be safely used in Porphyria Cutanea Tarda
   *other drugs ppt: porphyria-
   - etomidate
   - pentazocine
   - ketamine (Cratv)

Doc for Porphyrea ppt - Propofol

2) Accidental Intra-arterial Inje
   It occurs most commonly in antecubital fossa
   Thiopentone ppt in arterial blood
   ↓
   Cause intense vasospasm of artery

C/I → Pt complain of
   Sharp severe pain
   Loss of Digital Pulse
   Whiteness + Blanching of hands

Hx - → Do not remove the needle
   2) Flush w/ NS
   3) Vasodilators → lignocaine
   4) Heparin to prevent thrombosis
   5) Stellate ganglion block for
Brachial plexus block for peripheral (muscle) vasodilatation (upper limb)

2. METHOHEXITAL

1. Potent & short acting
2. Cardio stable
3. May cause convulsions in small doses
4. Doc for ECG QRS

BZD

- Not used as induction agents.
- But as co-induction agents to b dosage of main induction agents.
- BZDs act upon cerebral cortex
  Unlike other agents which act upon reticular activating system
- BZDs + Cl- ion conductance

M/c by used BZD

DIAZEPAM
- Oil Based
- Propylene glycol
- Pain on "
- IV/IM

MIDAZOLAM
- Water soluble
- Short acting
- IV/IM / Intranasal / orally
SYSTEMIC EFFECTS

17 CVS -
   ↓ BP
   ↓ syst. vascular resistance
   ↑ HR

25 Resp. -
   resp. depression
   specially given along w/ opioids

37 CNS -
   ↓ ICP
   ↓ Metabolic rate
   provide anterograde amnesia
   anxiolytic
   anticonvulsants

Midazolam is 1st line of drug for convulsions

47 Provide M/s Relaxation @ Spinal cord level Q

ETOMIDATE

- Lipophilic
- Rapid onset of action
- Causes pain on inject
- Doesn't cause histamine release
- Most cardiovascular stable agent
  Doc severe cardiovascular or cerebrovascular disease
→ causes highest incidence of nausea, vomiting
→ cause of myoclonic activity
→ cause adrenocortical suppression
   ↓ inhibit steroid synthesis
   ↑ mortality

→ Vit C supplement can prevent adrenocortical suppression.

**KETAMINE**

→ Cause dissociative anaesthesia
   ↓ Dissociation of Thalamus from Limbic System
   Pt. apparently remain conscious but unresponsive

→ Phencyclidine derivative
   → All Hallucinations and delirium seen in Ketamine are due to Phencyclidine

Ketamine → Metabolised → Non-Ketamine
          ↓ anaesthetic potency

**SYSTEMIC EFFECTS**

→ CVS - Sympathetic stimulation
   ↑ BP, ↑ HR
   Doc for acute hypovolemic shock pts.
↑ myocardial O₂ demand

↑ CI → HTN,  
   THD,  
   Aneurysm pts

2> Resp - minimal resp. depression  
   maintains upper airway reflexes  
   Doc for full stomach pts.

   Potent Bronchodilator  
   Doc for asthmatic pts

cause marked ↑ in oral secretion  
   so always given → glycopyrrolate

3> CNS - potent cerebral vasodilator

   ICP ↑ & ↑ metabolic rate  
   CI↓ in space occupying lesion  
   Head Injury  
   Epilepsy pts

cause Hallucinations  
   occurs more commonly in young pts

Auditory > Visual hallucination  
   Hallucinations can be ↑ by BZDs

4> ↑ IOP → ↓ CI in Glaucoma pts.
USES

1) Short surgical procedure
2) Astec procedure
3) Burn dressing
4) For field anaesthesia

Ketamine is considered close to complete anaesthetic agent.

PROPOFOL

- Also L/n/a- 2,6 Disopropyl phenol
- Milky white liquid is come as 1.12% Emulsion
- Contains Soyabean oil
  - Glycerol
  - Egg Lecithin

- Open propofol vial is discarded after use
- Causes pain on injection can be t by
  - Mixing lignocaine in propofol
- Associated with quick recovery
  - Doc for Day Care Sx.
- Doc for porphyria
  - Myasthenia Gravis
  - Liver Disease
  - LMA/emergency intubation
  - TIVA
  - Neuro Sx. - Mild used drug
**SYSTEMIC EFFECTS**

17 CVS -  
1. Syst. vascular resistance
2. B.P. + Bradycardia
3. Blunt cerebral body response
4. May cause bradycardia

27 Resp. -  
1. Cause Apnoea longer than thiopentone
2. Causes max depression of upper airway reflex
3. Doc for LMA / emergency intubation
4. Causes Histamine release but can be safely used in asthmatic pts

8 CNS -  
1. ICP, Cerebral metabolic rate
2. Anticonvulsant
3. May cause involuntary movements
4. Antineurotoxic
5. Anti-pruritic
6. Anti-oxidant

47 Metabolism remains intact in advanced liver disease
Doc for Liver Disease
Metabolism of Propofol
70% → 30%
Liver
Kidney & Lung
**PROPPOF INFUSION SYNDROME**

Metabolic acidosis

Skeletal myopathy  
Acute cardiomyopathy

- Seen in children on prolonged infusion due to failure of metabolism of FFA
- Causes increased mortality rate

* TIVA (Total I.v. Anaesthesia)

⇒ DOC = Propofol + Remifentanil  
  ↓ associated ultra short acting opioid
  quick recovery

⇒ USE - neuro Sx  
  Day care Sx
  Malignant Hyperthermia

⇒ ↓ nausea, vomiting

* NEUROLEPT ANALGESIA

Droperidol + Fentanyl  
20mg 50μg
50:1

Characterised by  
→ Immobility
→ Analgesia
→ Variable amnesia
When given along with N₂⁰ → Neuromuscular blockade

**DEXMEDETOMIDATE**

- prodrug (α₂ agonist) → like clonidine
- provides sedation
  - Analgesia
  - Amnesia
  - anxiolysis

- used for short term in mechanically ventilated pts
- does not cause resp. depression
- may cause airway obstruction

→ S/E -
  1. Bradycardia
  2. Hypotension
  3. shouldn't be used in pt with beta blocker & heart block.

- Drugs Producing Active Metabolites
  - Thiopentone
  - Methohexital
  - Midazolam
  - Ketamine
<table>
<thead>
<tr>
<th>STAGE 1 (Anaesthesia)</th>
<th>RESP</th>
<th>TV</th>
<th>PUPILS</th>
<th>EYE POSITION</th>
<th>REFLEXES \abolished</th>
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<tbody>
<tr>
<td></td>
<td>Irregular</td>
<td>Small</td>
<td>Constricted</td>
<td>Divergent</td>
<td>Nil</td>
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</table>

**STAGE 2 (Excitement)**

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<thead>
<tr>
<th></th>
<th>Large</th>
<th>Dilated</th>
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<th>Eyelash</th>
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</table>

**STAGE 3 (Surgical Anaesthesia)**

<table>
<thead>
<tr>
<th>Plane 1</th>
<th></th>
<th></th>
<th></th>
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<tbody>
<tr>
<td></td>
<td>Regular</td>
<td>&quot;</td>
<td>Constricted</td>
<td>&quot;</td>
</tr>
<tr>
<td></td>
<td>Phenylephrine</td>
<td></td>
<td>Skin Conjunctival</td>
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<table>
<thead>
<tr>
<th>Plane 2</th>
<th>Medium</th>
<th>½ Dil</th>
<th>Fixed</th>
<th>Central</th>
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<tbody>
<tr>
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<td></td>
<td></td>
<td>Corneal</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Plane 3</th>
<th>Small</th>
<th>¾ Dil</th>
<th>Central</th>
<th>Laryngeal</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Laryngeal</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Plane 4</th>
<th>Jekky</th>
<th>Fully Dilated</th>
<th>Central</th>
<th>Corneal anal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

| STAGE 4 | —      | —               | Apnoea | —           |

**Goodell's Stages of Anaesthesia**

seen in Ether
Plane 3 → Plane of surgical anaesthesia
Stage 4 → Brainstem paralysis, Brainstem paralysis
Laryngation ↑ in Stage 3 Plane 1, 2
Laryngation ↓ in Stage 3 Plane 3
Pupillary Light Reflex is lost in Stage 4.

[Brainstem Reflex]

INHALATIONAL AGENT

ETHER

1) Pungent smelling
2) Decomposes in presence of light
3) Stored in amber coloured bottle
4) Highly inflammable & explosive
   Looks like caustic
5) Good analgesia, H/S Relaxant, complete anaesthetic
   agent
6) Doesn't depress heart or myocardium
7) Potent bronchodilator
8) Only agent & depresses mucous activity
ETHEROMANIA
- Dependence or addic' of ether

**METHOXY FLURANE**
- Most potent inhalational agent
- Lowest MAC - 3%
- Highest B.P. - 105°
- Highest Blood gas coefficient 15
- Intensively absorbed in rubber tubing
- "o metabolised to fluorocelone
  (high level)"
  ↓
- can cause vaso pressin resistant high output
  Renal failure.
- Hepatotoxic

**TRIELENE**
- Most potent analgesic agent
- Reacts to soda lime
  ↓
- Used for Labour Analgesia

**CYCLOPROPANE**
- Causes sympathetic stimulation
- Useful in shock pts.
CHLOROFORM

Very sweet smelling

Cause ↑ incidence of nausea, vomiting

Cause sudden death by Ventricular fibrillation

Cause hyperglycemia - avoided in DM

Hepatotoxic

24/5/18

MAC (Min. Alveolar Cone)

Min. alveolar cone at ≤ 50% of pt's will not respond to stimulus.

Stimulus = usually an abdominal skin incision

MAC = potency of anaesthetic agent

Low MAC = more potent

eg. methoxyflurane 0.8%

High MAC = low potent

eg. N₂O 105%

FACTORS ↑ MAC

17 children [Infants > Neonate] 5) Acute amphetamine

27 Anxiety

37 Hyperthermia > 42ºC

47 Hyponatremia

57 CHA: ingestion of alcohol, cocaine
Infants > Neonate > Adults

FACtors ↓ MAC

1) Old age
2) Opioids
3) Sedatives
4) Hypoxia
5) Hypothermia
6) Hyponatremia
7) Hypercalcemia

* MAC ↓ by 6% for every decade of life.

\[ \text{MAC}_{50} = \min \text{ alveolar conc. at which } 50\% \text{ of patients will not respond to stimuli} \]

\[ = 1.3 \times \text{MAC} \]

\[ \text{MAC}_{awake} = \min \text{ alveolar conc. at which } 50\% \text{ of pts will become awake} \]

\[ = 0.3 \times \text{MAC} \]
**Blood Gas Partition Coefficient**

It is the solubility of the agent in the blood. Less soluble the agent = lower is B/La coefficient →

\[ \text{Faster Induction & Recovery} \]

E.g., xenon, desflurane

- Xenon = 0.17
- Desflurane = 0.42
- \( \text{N}_2\text{O} \) = 0.46
- Sevoflurane = 0.60

Agents with lower B/La coefficient:
- Low Induction & Recovery

E.g., ether = 12
- Methoxyflurane = 15

**Oil Gas Partition Coefficient**

It is the solubility of agents in lipid. Higher solubility = more potent:

Less → Less →
**N₂O**

**Laughing Gas**
- Prepared by heating \( \text{NH}_4\text{NO}_3 \rightarrow 250^\circ \text{C} \rightarrow 2\text{H}_2\text{O} + \text{N}_2\text{O} \)
- Colourless, odourless gas
- Supports combustion like \( \text{O}_2 \)
  - hence not used for laparoscopy
- 1.5 times heavier than \( \text{Ar} \)
- 35 times more soluble in blood than \( \text{N}_2 \)

**MAC** \( \text{N}_2\text{O} = 105\% \)

**B/L coefficient = 0.46**

**SYSTEMIC EFFECTS—**

**CVS** - PR, BP Stable
- ↑ Pul. Vasculare Resistance
  - Shouldn’t be used in Pulmonary HTN pts

**Resp** - ↓ Tidal Volume
- ↑ RR
  - Inhibits carotid body hypoxic drive

**CNS** - ↑ Cerebral metabolic rate
- ↑ ICP
- Provides analgesia
  - Doesn’t affect C/E secretion, absorption
Toxicity of N₂O:

- Expands any air containing cavity

* If given for > 6 hr → irreversibly oxidises cobalt atom of vit B₁₂

↓

Inhibition of enzymes

Methionine Synthetase + Thymidilate Synthetase

↓

Bone marrow Depression

↓

Megaloblastic anaemia

Peripheral neuropathy

Pernicious anaemia

* It may be teratogenic

Female anaesthetists tend to have a rate of 1 in 10000 abortion

* Causes max. greenhouse effect among anaesthetic agents

* Chronic exposure → Spinal Degeneration.

*慢性暴露 → 脊柱退化。
C/I of N\textsubscript{2}O -

1. N\textsubscript{2}O expands any air containing cavity.
   \[ \text{C/I} \rightarrow \text{venous air embolism} \]
   occur rarely in setting position for post fossa surgeries.

   \[
   O \quad \overset{N\textsubscript{2}O}{\rightarrow} \quad O
   \]
   \[
   \text{embolus} \quad \uparrow \text{size.}
   \]

Most sensitive monitor to detect venous air embolism is:

- Trans esophageal echo > Doppler > ET N\textsubscript{2}O >
- ET CO\textsubscript{2} > CUP > Mill wheel murmur

2. Pneumothorax
   \[ N\textsubscript{2}O \uparrow \text{the size} \]

3. Lung cyst or bulla

4. Intracranial Sx
   L. especially post fossa Sx
   Post. fossa is a bony space.
   So, N\textsubscript{2}O \rightarrow \text{pressure at vol. can't be}\n   \[
   \downarrow \quad \text{Pons \& medulla can be affected}
   \]
5) Pneumocephalus
   \[ N_2O \rightarrow 1/1 \text{ for 7 days} \]

6) Vitreoretinal Sx-
   - Vitreous fluid will come out during Sx.
   - To maintain vol. bcvn Ant. Post.
     chamber \rightarrow Surgeon puts bubble of SF₆

   Later vitreous come back

   If \( N_2O \) is used \( \rightarrow \) it \( \downarrow \) the size of bubble

   Surgeon opens it immediately

   Sudden decompression

   \( \uparrow \)
   Retinal detachment

7) Sympomoplastic
   Due to \( \uparrow \) pressure, graft gets dislodged

8) Acute Intestinal Obstruction
   \( N_2O \) cause further dilatation of loop.

9) Pulmonary HTN
   \( N_2O \) deploys into endotracheal tube cuff

   Cuff pressure should be intermittently monitored.
Conc' Effect :-

\[ \rightarrow \text{\( N_2O \) is 35 times more soluble in blood than \( N_2 \).} \]

\[ \text{blood vessel} \]

\[ \text{\( N_2O \) reduced absorb of \( N_2O \) in blood} \]

\[ \text{alveoli} \]

\[ \text{\( N_2O \) conc gradient in alveoli} \]

\[ \text{more absorb of \( N_2O \) in alveoli} \]

\[ \text{shortening induc} \text{"} \text{time} \]

2nd Gas Effect :-

\[ \text{\( N_2O \) also raise the conc of other inhalational agent this way.} \]

\[ \text{Rapid induction of anaesthesia} \]

Diffusion Hypoxia / Fink's Phenomenon :-

\[ \text{seen in old, sick pts. in the breathing room} \]

\[ \text{are at end of anaesthesia} \]

\[ \text{\( O_2 + N_2O \) \rightarrow \text{Room air} \]

\[ \text{\( N_2 + O_2 \) (anaesthesia)} \]

So, \( N_2O \) comes back from blood to alveoli due to conc gradient

\[ \text{Diffusion Hypoxia} \]
Rapid diffusion of $\text{N}_2\text{O}$ from blood to alveole
dilute alveolar $\text{O}_2$

$\downarrow$

Hyponxia

Prevention:
- $\text{O}_2$ by giving 100% $\text{O}_2$ at the end of anaesthesia

ENTONOX
$\left[50\% \text{O}_2 + 50\% \text{N}_2\text{O}\right]$

Used for labour analgesia
Dental anaesthesia

POYNTING EFFECT:
- At $-6^\circ\text{C}$ - $\text{O}_2$ & $\text{N}_2\text{O}$ separate into layers
- Pt: 1st breathe only $\text{O}_2$ \Rightarrow no pain relief
  then only $\text{N}_2\text{O}$ \Rightarrow hyponxia.

Prevention:
- By shaking cylinder before use
HALOGENATED INHALATIONAL AGENT

HALOTHANE

1) It is alkane other agents are ether
2) contains Bromine atom, Cl, F
3) very sweet smelling
4) undergo spontaneous decomposition & is retarded by thymol preservative (0.01%)
5) absorbed in rubber tubings
6) heats & metals in vapourisers

SYSTEMIC EFFECTS:

CVS - Direct myocardial depression

Leading to fall in BP

- Halothane blunts carotid body receptor response

So, Bradycardic occur

- It makes heart sensitive to arrhythmogenic effects of adrenaline

[Coarse is 1/1 to halothane].

Resp - Potent Bronchodilator

DOE for astmatic pts.
- Causes severe depression of hypoxic ventilatory drive

\[ \text{CNS} \text{ potent cerebral vaso dilator.} \]

\[ \uparrow \text{ICP.} \]

**Q How to \( \downarrow \text{ICP?} \)**

1. Mannitol
2. Glycerol
3. **

\[ \text{Hyperventilation} \Rightarrow \text{for acute} \ \uparrow \text{ICP} \]

4. Raise head of bed by 30°
5. UP shunt
6. 3% saline \( \Rightarrow \) acute exchange \( \uparrow \text{ICP.} \)
7. Extra ventricular drainage

\[ \text{CO}_2 \text{ is most potent vaso dilator.} \]

**On Hyperventilation**

\[ \downarrow \text{arterial CO}_2 \]

\[ \downarrow \text{cerebral vaso constriction} \]

\[ \downarrow \text{cerebral blood flow} \]

\[ \downarrow \text{ICP} \]

- Inhalational agent require prior hyperventilation

\[ \text{HALOTHANE to prevent rise in ICP.} \]
→ Halothane does not provide analgesia. Can cause shivering: HALOTHANE SHAKES
  ↓
  Best Antidote
  PETHIDINE

→ Potent uterine Relaxant
  Doc for manual removal of placenta

→ Use of halothane for LSCS ↓ G.A.
  ↓
  PPH


→ Maximally metabolised > 20%
  Metabolised to → 5-fluorodeoxy acid
  ↓
  Immune mediated hepatitis

Pathology - Centrilobular necrosis

Mortality: 30-50%

Predisposing Factors:
→ Multiple exposures at short interval of time
  Time interval should be > 3 months
→ Medullar age obese women
→ Family H/o toxicity
c/I

I↑ ICP

2) Unexplained liver dysfunction after exposure
3) Pheochromocytoma → ↑ adrenaline levels.
4) Malignant Hyperthermia
5) Aminophylline → cause arrhythmia

TRIGGER

**ENFLURANE**

- It is ether
- Cause tonic-clonic convulsions
  c/I → epilepsy pts
- Trigger for Malignant Hyperthermia
- Meldly ↑ Renal concentrating ability
  so. c/I in pre-existing renal diseases

**ISOFLURANE**

- Chemical isomer of enflurane
- Pungent smelling ether

**SYSTEMIC EFFECTS**

**CVS** → Peripheral Vasodilatation
  ↓ B.P. → ↑ H.R.
  DOC for deliberate hypotensive anaesthesia
BP can be lowered up to 20% of baseline value
- powerful coronary artery vasodilator.
  - Decrease cardiac sx
- It may be associated with coronary steal syndrome but clinically insignificant

Resp:
- Cause mild bronchodilatation, Tachypnoea

CNS:
- Cerebral vasodilatation.
  - ↑ ICP
  - Can be ↓ by simultaneous hyperventilation
  - Causes isoelectric EEG at 2 MAC

Cond causing EEG activation
1) Subanaesthetic doses of inhalational agent (<MAE)
2) Low dose of Barbiturates
   - Thiopental
   - Ketamine
3) N₂O
4) Ketamine
5) Sensory stimulation
6) Mild hypercapnoea
7) Early hypoxia
COND’ CAUSING EEG DEPRESSION

1) MAC of inhalational agents
2) Normal dose of Barbiturates
   Opioids
   Propofol
   Ketamine

3) Hypercapnoea
4) Marked Hypercapnoea
5) Hypothermia
6) Late hypoxia

- Isoflurane maintains total hepatic blood flow
- Portal vein flow
- Also maintains hepatic venous oxygenation.
  Doc for Liver Transplant SX

1/1

1) Severe hypovolaemia
2) Malignant hyperthermia
DES FLURANE

Most pungent smelling ether

Desflurane > Iso > Sevo > Halothane

Most pungent

It has lowest Blood gas affinity and coefficient among fluorinated agents - 0.42

Rapid induction & recovery

Causes airway irritation

1) Breath holding
2) Coughing
3) Salivation
4) Laryngospasm

Has low B.P. 23°C + very high vapour pressure

Requires a special vapouriser - heated to a temp. of 39°C.

Sudden rise in desflurane conc. causes sympathetic stimulation → HTN + Tachycardia.
- minimally metabolised < 0.1%
- max. greenhouse effect among fluorinated agents.
- React with dry CO₂ absorbent to form CO
- cause Emergence Delirium in children.

C₃H₆O₇
1) severe hypovolemia
2) malignant Hyperthermie
3) SEVO FLURANE

- It is mildly sweet smelling ether
- Max no. of fluorine atoms = 7
- has low Boiling Coefficient ⇒ FAST Induction, Recovery

Agent of choice for inhalational agent
Induction
2) Day care Sx
3) neuro Sx
4) cause minimal cerebral vasodilatation
so, ICP doesn't ↑

can cause emergence delirium in children
doesn't show hepatic toxicity since not metabolised to trifluoroacetic acid
Sevo flucone + Sodalamo \( \Rightarrow \) Compound A

\[ \text{Compound A formation can be prevented by using fresh gas flow rate } \geq 2 \text{ L/minute} \]

Sevo degraded by metal/environment \( \Rightarrow \) HF (Hydrogen fluoride) acid burn of resp. mucosa

C/I:
1) Severe hypovolemia
2) Malignant hyperthermia

\[ \text{HELIUM} \]

Non-fluorinated agent

79% Helium + 21% \( \text{O}_2 \) \( \Rightarrow \) HELIOX

\[ \text{Density is lighter than air} \]

\[ \text{Useful in larger airway obstruction} \]
XENON

- Weak anaesthetic like N₂O
- MAC - 70%
- Lowest B.I.C coefficient - 0.17%
- Most closest to Ideal anaesthetic agent
- Provide Analgesia
  Agent of choice for Liver Disease Patients

ADVANTAGE -
1) Minimal CVS & resp effect
2) Rapid Induction & Recovery
3) Low B.I.C coefficient
4) Minimum metabolism
5) Is inert
6) Doesn't react to sodium
7) Non-inflammable, non-explosive

DISADVANTAGE
1) High cost
2) Low potency
**MUSCLE RELAXANTS**

- **CENTRALLY ACTING**
  - **DANTROLENE**
  - **BECLOFENE**

- **ACTING AT N-MJ**
  - **Depolarising**
    - **Succinyl choline**
    - Resembles Acetylcholine (Non-competitive Blockade)
    - **Non-Depolarising** (Competitive Blockade)

→ *Mus Relaxants used in anaesthesia act upon N-MJ.*

**DEPOLARISING BLOCK**

- Cause non-competitive blockade
- Cause muscular fasciculation
- Muscle remains unresponsive to other stimulus
- Not reversed by neostigmine

\[ \text{Neostigmine} \xrightarrow{\Theta} \text{Ach} \]

↓

\[ \text{↑Ach} \]

→ Succinyl choline ↑
Potentiated by:
- Mg
- Hypothermia
- Met. alkalosis
- Isoflurane

Antagonised by:
- Non-depolarising: Tensilon
- Antagonist

Do not fade on train of four

Drug should be:
- Stored in refrigerator: 2-5°C
- Once removed from refrigerator, it should be used in 2 weeks

Dose:
- 1-1.5 mg/kg
- Adults: 1 mg/kg
- Children: 1.5 mg/kg

If given in dose of 7-10 mg/kg B.W.

Causes conformational change in receptor

Block starts behaving like non-depolarising

Block = Phase 2 Blockade

Features of phase 2 block are similar to
non-depolarising Block
ONSET Time = 30sec — Last for 5-10min
M/s Relevant of choice for full stomach Pts.

→ Brady cardia especially in children after 2nd dose
→ cause masseter m/s spasm in children

These children are more prone to malignant Hyperthermia

↑ ICP
  IOP
  BP
  Gastric Pressure
  LE sphincter Tone

→ Metabolised by Plasma Pseudo cholineresterase ↓
controlled by 2 set of genes

↑ pt. is homozygous ⇒

→ Atypical Pseudo cholineresterase
→ Produce of pseudo cholineresterase is Aβ △ is both genes are absent ↓

leads to ↑ duration of

CHOLINE APNDEA

Rx - continue i mech. ventilation , FFP
**Dibucaine**

% Inhibition of Plasma pseudo cholinesterase by dibucaine

\[ \text{N} \rightarrow 75-80\% \]

\[ \text{Ab (N)} \rightarrow < 30\% \]

+ Plasma pseudo cholinesterase DEF.

- seen in Hepatic failure
  - Renal failure
  - Cancer
  - Malnutrition
  - Hypothyroidism

- S. choline \( \uparrow \) by \( 0.5 \text{mg/l} \)

Thi: \( \uparrow \) occur more after

- Burns
  - Spinal cord injury
  - Stroke
  - C. B. syndrome
  - Prolonged ICU stay
  - Severe intra-abdominal injury
  - Tetanus

Sch \( \uparrow \) \( 1/L \)

48 hrs-9 months after these condn.
S.Ch. cause muscular fasciculation.
& lead to post-op myalgias
↓
Fasciculation can be less by giving small dose of non-depolarizing m/s relaxant before S.Ch.
→ Agent of choice = Rocuronium.

S.Ch is M/c triggering factor for malignant Hyperthermia.

C/I

1) muscular dystrophy
2) In Dystrophic myotonia → it cause severe m/s rigidity preventing effp. intubation.

Mx of Pt. suffering from M/s Dystrophy

1) Sch C/I
2) Inhalational agent to be avoided
   2) i.v. Induc' preferred

S.Ch cause Histamine release
   " " " Ganglionie stimulation
17. Common Features

Bet DMR, NDMR

b) Atropine
b) Cu.- atropine
b) Scholine
b) Mivacurium

23. Order of Paralysis by M/s Relaxant

Phoria → Diplopia → Face → Jaws → Neck → Limbs → Diaphragm

1st yrs. to recover from paralysis

Histamine releasing drugs

Atropine

Mivacurium

Scholine

D-Tubocurarine → Max Histamine Release

47. Sch caregiver → ganglionic stimulation

D-Tubocurarine → ganglionic blockade

57. Vagolytic activity

Galamine → Max.

Pancuronium
Sympathetic stimulation occurs in
- Gallamine
- Pancuronium

* N.M. MONITORING

- N/C nerve used = ULNAR
- N/C muscle used = ADDUCTOR POLLICIS M/C
- N/C corresponds to laryngeal paralysis
  = orbicularis oculi

- N/C mode of NM Transmission = Train of
  Four
  
  4 stimulus → frequency of 2Hz
  Duration bet 2 stimulus is 0.5 sec

ToF measured at interval of 10 sec

A

B

N

C

after NDMR = Ht ↓ gradually (FADE)

After s. ch.
Height ↓ but equal intensity
\[ \frac{T_4}{T_1} = \text{TOF Ratio} \]

**Non-depolarising M/s Relaxant**

- Benzyl
- Aminosteroids
- Chlorofumarates

**Benzyl Isoquinidium**

- Atracurium
  - Intermediate acting
  - Metabolised \[ \rightarrow \frac{1}{3} \] by Hoffman degradation
  - \[ \frac{2}{3} \] by alkaline ester hydrolysis
  - Produces metabolite Laudanosine
    - Can cause convulsions
  - Causes histamine release
    - Doesn't require any reversal agent
  - Does not cause renal failure
  - Does not cause hepatic failure
  - Pt's with atypical pseudocholinesterase
    - Pt's with myasthenia gravis
      - Use \[ \frac{1}{10} \] th of usual dose used
**CIS-ATRAVURINUM**

- Isomer of atracurium
- Metabolized 100% by HOFFMAN degradation
- Laudanosine level are lower
- Preferred over atracurium
- No histamine release

**MIVALURINUM**

- Slow onset
- Short duration of action
- Given by continuous infusion
- Mls relaxant of choice for Day Care Sx

**D-TUBOCURIN**

- Long acting
- Mainly metabolised in kidneys
- Causes ganglionic blockade
  Preferred in arterial Sx
- Causes max. histamine release

**DOXALURINUM**

- Most potent
- Longest acting HR
AMINO STEROIDS MR

VECURONIUM
- Intermediate Acting
- Mainly Hepatic Metabolism
- Host is a stable agent (HR)

ROCURONIUM
- Most rapid onset among NDMR
- NDMR of choice for full stomach pts.
- Causes pain on inject
- Less potent
- Specific Reversal Agent = Sugammadex

RAPACURONIUM
- Rapid onset of action
- Causes high incidence of Bronchospasm in children — so withdrawn.

PANCURONIUM
- Long acting
- Vagolytic
- Causes sympathetic stimulation
  So useful in SHOCK Pts.
should be avoided in Ischaemic Heart Disease pl.

**GALLAMINE**

- Only MR to cross placenta → C/I in Placenta
- Least potent HR
- Metabolised 100% by kidneys → C/I in Renal diseases.
- Max. vagolytic activity

**METOCLURINE**

- Metabolised 100% by kidneys
- Contains iodine → C/I in Iodine sensitivity Pt.

**CHLORDIURARATES**

**GANTACURIUM**

- Ultra-short acting HR
- Metabolised to Cystine
- Specific reversal agent: L-Cysteine

*FACTORS PROLONGING NM BLOCKADE:*

1) newborns
2) old age
3) Renal / Hepatic failure
4) Inhaled anaesthetic agent
   - L Max: Desflurane
   - Min: N<sub>2</sub>O
5. Aminoglycoside → They themselves cause NM blockade

6. Local anaesthetics

7. Hypokalemia

8. Hypocalcemia

**DRUGS ANTAGONIZING NM BLOCKADE**

1. Phenytoin
2. Carbamazepine
3. Calcium

**REVERSAL OF NM BLOCKADE**

1. Neostigmine
   - ↑ Ach by blocking AchE enzyme
   - Advantage: It is Quaternary Ammonium Compound
     - So doesn't cause BBB
     - So no central effects seen

S/E: Bradycardia → may cause cardiac Bronchospasm Standstill
   - ↑ Bladder tone
   - ↑ secretion
   - ↑ Peristalsis
   - Meosis
Neostigmine always combined with Atropine or Glycopyrrolate.

27 Pyridostigmine
37 Edrophonium
47 Suxamethonium - for Rocuronium
57 L-cystine - for Gantrisinum.

*SIGNS OF ADEQUATE REVERSAL*

1) Spontaneous limb movement
2) Able to follow command
3) Able to show tongue
4) Spontaneous help is adequate Tidal volume
5) BEST SIGN - Head lift > 5 sec.

BEST OVERALL SIGN = T.O.F RATIO > 0.9

\[
\begin{align*}
\text{T}1 & \quad \text{T}2 & \quad \text{T}3 & \quad \text{T}4 \\
\text{T}4 & \approx 90\% \text{ of T}1 & \text{T}3 & \text{T}2 & \text{T}1
\end{align*}
\]
Pt Divided into 2 Groups

**ELECTIVE**

NPO.

Preoxygen + I.V. induction +
(3min) MR

100% O₂

Ventilate & Bag, Mask

Intubate the pt

**EMERGENCY**

Full Stomach

Preoxygenate (100% O₂)

for 3min.

+ I.V. Induction

+ MR having faster action
  s.ch Rocuronium

No IPPV

Bag, Mask

Pressure applied on
Cricoid pressure
(SELLICK'S MANEUVERE)

Intubate w/ cuff tube

Rapid Sequence Induction.
LOCAL ANAESTHETIC AGENT

Weak bases
N/V fibres - A B C

Largest
Myelinated

Smaller
Unmyelinated

Efferent to Mls → Ad
Mediate motor func

Autonomic preganglionic fibres

Autonomic postganglionic fibres

Dorsal root
Pain, Touch

Efferent from skin & joints
Mediate Tactile proprioceptors

ANS

Efferent to mls
Spindle
Mediate ml's tone

ANS

Efferent to sensory n/v
Mediate temp. pain, touch sensation
Sensitivity to LA: (Peripheral nervous)

Ay > Aβ > Aα = Aβ > Bγ c

Sensitivity to Hypoxia

Bγ Aγ C

Sensitivity to Pressure

A > B > C

Order of Blockade:

Autonomic → Sensory → Motor

↓ Temp.

↓ Pain

↓ Touch

↓ Pressure

↓ Proprioception

Recovery in reverse order
AMINO ESTERS
- Metabolized by plasma pseudo cholinesterase
- Except cocaine
- Unstable salt
- Metabolized to PABA

Amido ANIMIDES
- In liver
- Stable

Responsible for high incidence of allergic Rxs
Less incidence of allergic Rxs.

SEQUENCE OF ALLERGIC Rxs -
MR > Later products > Antibiotics

SHORTEST acting LA > CHLORPROCAINE

INTERMEDIATE “” > LIGNOCAINE COCAINE

LONG Acting “” > BUPIVACaine ROPIVACaine

Single "i" in spelling = ester
Double "i" in "" = amide
PHARMACOKINETICS

1) ABSORPTION -
   Depend on:
   a) Site of injection:
      more vascular site = faster absorption
      = shorter duration of action.

   Order of absorption:
   I.V. (I.A.) > Tracheal > Intercostal >
   Paracervical > Epidural > Brachial Plexus >
   Subcutaneous.

b) Dose -
   Higher dose = longer blockade
   Lower dose = shorter blockade

c) Addition of vasoconstrictor

   Adrenaline
   ↓
   ↓ absorption
   ↓ longer duration of action.
a) Pharmacological profile of drug

- Long acting
- Intermediate
- Short acting
- MOA of LA

- Acts upon node of Ranvier
- LA enter axons in undecorated form
  - Divide into axons
    - Ionic part
    - Non-ionic part

- Blocks Na⁺ channel
  - pH at 50% of drug is ionic > 50% non-ionic
  - k/n/k → pKa

- Drug having pKa value closer to physiological pH = faster acting than other drugs
  - Lidocaine 7.8 → faster acting
  - Bupivacaine 8.1 → slower

- Differential sensory blockade

- Shown by BUPIVACAINE & ROPIVACAINE
- Low conc. → only cause sensory block
- High conc. → B sensory, Motor Block
**It is used in Labour Analgesia**

**Effect of Addition of Other Agents**

1) **Adrenaline**
   - Lignocaine + Adrenaline = ↑ Motor + ↑ Sensory Block
   - Bupivacaine + Adrenaline = ↑ Sensory Block
   - Adrenaline used in Conc of 1:200000

2) **Phentylephrine** (1:20,000)
   - Causes less tachycardia

3) **Soda Bicarb**
   - Lead to faster onset
   - Longer duration of action
   - Less subcutaneous pain
   - Better quality

**Toxicity of L.A.**

17) **CNS Toxicity**
   - Circum oral numbness
   - Paraesthesia of tongue
   - Light headedness
   - Dizziness (F/B) auditory, visual disturbances
1. ms twitching
2. tremors
3. convulsions

Rx - small dose of Thiopentone or Propofol secure airway
BZDs
Anticonvulsants

2) **CNS TOXICITY**

- Bupivacaine forms irreversible complexes with Receptor of Heart → 0% should never be given as IV. Infec.

Rx = 20% Intralipid emulsion [TPN]

- Prolonged CPR
- Adrenaline + Amlodipine

3) **METH GLOBINEMIA**

- Seen in large dose of Prilocaine + Benzocaine

Rx - Methylene Blue

LA + Adrenaline → shouldn’t be used for

King Blockade of

Finger
Toe
Penile arteries
Pinna
LIGNOCAINE

- Highly used LA
- Conc. used are 5% heavy for spinal anesthesia
  4% topical
  2% epidural
  1% n/v block.
  5% IVRA
  2% jelly for urethral procedure

Max. Safe Dose = 4.5 mg/Kg i but adrenaline
7 mg/Kg i adrenalin

BUPIVACAINE

- Long acting
- Never to be used I.V.
- Conc. used are 0.5% heavy for spinal
  0.0625 - 0.125% - painless labour
  0.25% n/v blocks

Max. Safe dose = 3 mg/Kg body wt
BENZOCAINE

- 20% topical agent for endoscopy / Bronchoscopy
- Can cause Methemoglobinemia

COCAINE

- 4/1:1 adrenaline
- Used as 4% topical anaesthetic of eye

PROCAINE

- L.A. of choice for pts. C: H/o Malignant

HYPERHEMIA

CHLORPROCAINE

- Fastest acting
- 1/1 for spinal anaesthesia
- Causes neurotoxicity

TETRACAINE

- 0.5% for spinal anaesthesia
- 4% for topical anaesthesia

EMLA

- Eutectic mixture of L.A.
- Combination of 2.5% Lignocaine + 2.5% Prilocaine
- To treat needle phobia
can also be used for skin grafting

shouldn't be applied on cut surface

mutous membrane

BIER'S BLOCK / I.V.R.A.

→ Used for upper limb & lower limb ex

→ 2 Tourniquet are applied

→ Doc → Lignocaine 0.5%
Phenol 0.5%
Bupivacaine → c/I

C/I to Block

1) Sickle cell Disease
2) Scleroderma
3) Raynaud's Disease

GO CELIAC PLEXUS BLOCK

→ Given for pain relief of
Pancreatic Ca
Gastric Ca

carries blockade of Lumbar sympathetic chain
S/E-
- Hypotension : Diarrhoea - Mls
- **Brachial Plexus Block**
  - **4 Places**
  1) Interscalene Block
     - Both scalenus medius ; scalenus Ant. Mls
     - Shoulder sx can be done
     - Ulnar n/v is spared
     - Below shoulder, sx can't be done

Comp-
1) Phrenic N/v Blockade - 10% case
   1/1 in 1/1 Hemi-diaphragmatic Paralysis
2) **Horner's Syndrome**
3) Vertebro arterial by
4) Spinal/epidural anaesthesia
5) RLN Block → Hoarseness of Voice
6) Pneumothorax
27 SUPRA CLAVICULAR BLOCK

- Given just lateral to subclavian artery
- Below shoulder Sx can be performed
- Axillary + supra scapular. n/v are spared

Comp -
- 1) Pneumothorax - 50% case
- 2) Pneumothorax - 2-3% of cases
- 3) Vascular Inj

3) INFRA CLAVICULAR BLOCK

- Below elbow Sx can be performed
- Intercostal brachial n/v is spared

Comp -
- 1) Pneumothorax
- 2) Vascular puncture

4) AXILLARY BLOCK

- Given in axillary sheath
- Transarterial

- Musculo cutaneous n/v is spared

Comp -
- Vascular puncture
STELLATE GANGLION BLOCK

CERVICO THORACIC BLOCK

- It is used for pain relief of upper limb (UL) & 
  Vascular disorder of UL

- Given at Transverse process of C6 vertebrae

- Paratracheal

- Successful Stellate ganglion block accompanied by HORNER SYNDROME -

  Comp -

  1) RLN Block → hoarseness of voice

  2) Spinal/ Epidural Inf

  3) Vascular puncture

  4) Mediastinitis if oesophageal puncture occurs.

SPINAL ANAESTHESIA

SUB ARACHNOID BLOCK/ CENTRAL NEUROAXIAL BLOCKADE

CSF lies between arachnoid & pia

Spinal cord ends at lower border of L1

or upper border of L2

So Spinal anaesthesia is given L2-3 to L5S1 space
STRUCTURES PUNCTURED DURING SPINAL ANAESTHESIA

1) Skin
2) Subcutaneous tissue
3) Supraspinous (e.g. supraspinous)
4) Infraspinous (e.g. infraspinous)
5) Ligamentum flavum
6) Dura
7) Arachnoid.

Highest point of SIAC crest corresponds to L4-5 space

POSITION OF SPINAL PATIENT

1) Sitting
2) Lateral
3) Prone / Taylor approach.

SITE

1) Midline

2) Paramedian

Bypass supraspinous, infraspinous (e.g. may get calcified in old age patient)
**DRUGS USED**

1. Lignocaine 5% heavy - 1-1.5ml or 50-75mg
2. Bupivacaine 0.5% heavy - 2-3ml or 10-15mg
   - Made heavy by addition of dextrose
   - Heavy means specific gravity is more than that of CSF.

**NEEDLES USED**

1. **Pencil tip needle**
   - or
2. **Atraumatic needle**
   - Less incidence of post spinal headache
   - **Most used size = 25 Gauge**

**FACTORS AFFECTING HT OF SPINAL ANAESTHESIA**

1. **DOSE** → Host Imp. factor
   - ↑ Dose → High spinal
   - ↓ Dose → Low spinal

2. **VOLUME**
   - ↑ Volume → ↑ Dose
   - ↓ Volume → ↓ Dose
37 Baricity

It is sp. gravity of drug to eSF

47 Position of Patient

Head down → High Blockade

57 Patient Factors

i) Age

Old age pts. ligaments are calcified

↓

Space around cord ↓

↓

Pressure inside cord ↑

Hence, Drug dosage is ↓ in old age pt.

ii) Height

Taller person requires more volume

shorter; " less volume

iii) O^2

↑

In O^2 there is pressure upon IVC

↓

Epiduralplexus engorged

↓

Space around cord ↓

↓

Pressure inside cord ↑

↓

Drug dosage is ↑ in O^2.
In iv, IV endings become more sensitive to local anaesthetic agent.

iv) abdominal tumours.
  similar to iv, no hormonal effect.

FACTORS & DO NOT AFFECT HT. OF SPINAL ANAESTHESIA

1) Sex
2) Weight
3) Direction of needle
4) Speed of injection
5) Buretage
  limiting of CSF & local anaesthetic syringe
  obsolete now
6) addition of adrenaline.

SYSTEMIC EFFECT OF SPINAL ANAESTHESIA

1) **CNS** → vasodilatation of LL vessels
   ↓ venous return
   ↓ fall in BP + THR

Spinal anaesthesia cause hypotension & tachycardia
  → cardiac sympathetic supply = T1 - T4
  → high spinal may cause blockade of cardiac sympathetic supply → Hypotension + Bradycardia
Causes of hypotension during spinal:

1. ↓ VR
2. Brady cardia → ↓ CO
3. Blockade of adrenal glands
4. Local anaesthetic toxicity

While giving spinal anaesthesia, pt. can have:

- Hypotension & Bradycardia
- May become unconscious due to vasovagal

Severe hypotension + Bradycardia may also occur due to Bezold-Jarisch Reflex

27 CVS

Autonomic

↑ 2 seg. above

Sensory

↓ 2 seg. below

Motor

37 Resp

All parameters of resp. remain unaffected except Max Breathing Capacity ↓ due to Active Exhalation due to paralysis of intercostal R/S.
High spinal → can cause \textit{Phrenic n/lv Blockade}

\underline{Apnoea.}

Rx of \textit{apnoea}:
- Bag + mask ventilation.

\textbf{* CAUSES OF APNOEA DURING SPINAL ANAESTHESIA*}

1) Hypotension leading to ↓ in Blood Supply of Brainstem

2) High spinal anaesthesia

3) Total spinal anaesthesia

4) Local anaesthetic toxicity

\underline{47 CBT}
- ↑ Periatalia + Relaxation of Sphincter
  \downarrow Small contracted Gut

\underline{57 Temp}
- ↑ heat loss due to Vasodilatation
  \downarrow Pt compensates by shivering

\underline{63 Genito-Urinary}
- Urinary retention due to det block at m/l
COMP of SPINAL ANAESTHESIA

1) Hypotension - H/c comp

2. Can be prevented by preloadng pt w 1-1.5 L of colloid/crystalloid

Rx = fast fluid
- Lower head end
- Vasoressors
  l. Include
    a) Phenylephrine - vasoressor of choice for LSCS
    b) Ephedrine
    c) Mephetramine

3) Brady cardia

Rx = Atropine

3) Resp. Insufficiency / Apnoea

Rx = IPPV + Bag - mask - source of hypotension.

4) Post spinal headache/post dural puncture headache

- Occurs due to leakage of CSF from dural puncture site
- Starts 12-24 hrs after spinal anaesthesia
- Lasts for 7 days
Occipital headache usually but may be frontal

Low-pressure headache

Headache can be prevented
1) By using pencil tip needles
2) By a higher gauge needle
3) By adequate hydration.

Rx = analgesic
Correct of dehydration
Na coffee Benzoate
Most definitive Rx = Epidural Blood Patch.

PREDISPOSING FACTORS FOR HEADACHE

1) 0 > 0
2) Young > old
3) 0 > non 0
4) Multiple puncture > single puncture
5) Bevel to needle fibres > Bevel to parallel fibres.
6) Tendency of ambulation doesn’t affect onset of headache
   Spinal catheter doesn’t affect onset of headache
Headache ① → setting
Standing
① → lying down position

5) Epidural Haematoma
It can cause paraplegia

6) Paralysis of cranial N1, N9, N10
N1, N9, N10 are never involved
6th N only involved
Pt. complain of diplopia

7) Meningitis

8) Ant Spinal artery Syndrome

9) Backache

**ABSOLUTE CLF OF SPINAL ANAESTHESIA**

1) Fused ICT

2) Refusal of pt.

3) Severe hypovolemia

4) Sev. MS / As

5) Infe at local site

6) Coagulopathy

L. High INR → Low platelet count

For spinal, INR < 1.5

Platelet > 80,000
SADDLE ANAESTHESIA

When spinal anaesthesia is given in sitting position, pt. allowed to sit for 8-10 min.

Effect comes in form of saddle

All perineal sx can be done under saddle

EPIDURAL ANAESTHESIA

EXTRADURAL

CENTRAL NEUROAXIAL BLOCKADE

- Epidural space lies 4-5 cm from skin.
- Continuous in thoracic cavity
- so a -ve pressure space
- Broadest in Lumbar Region - 0.5 cm

NEEDLE - 16-18 Gauge (TUOHYS NEEDLE)

Lignocaine 2% Plain
Bupivacaine 0.125% Plain
15-20 ml

SITE - N/V Roots. (Both in Spinal & epidural)

ONSET TIME - 15-20 min
IDENTIFICATION OF EPIDURAL SPACE

1) Sudden loss of resistance

2) Hanggeng drop technique
   - Sudden sucking of drop into epidural space

3) DURAN SIGN
   - Rapid injection into epidural space
   - Rate & depth of breathing

4) WESTPAL SIGN
   - Rise of knee jerk after epidural anaesthesia

5) Mcintosh Indicator

ADVANTAGE OF EPIDURAL OVER SPINAL

1) Gradual hypotension

2) Any duration & can be performed

3) Post of pain relief

4) No post spinal headache

DISADVANTAGE OF EPIDURAL

1) Delayed onset

2) Patchy effect → septa in epidural space
3) Technically more difficult
4) expensive
5) Total spinal anaesthesia

**COMBINED SPINAL EPIDURAL ANAESTHESIA**

- Spinal + epidural catheter
- Faster onset, long term effect

**CAUDAL ANAESTHESIA**
- Blockade of sacral epidural space
- Used for pain relief of infraumbilical 
  in children

**MISCELLANEOUS POINTS**

1) CVS Disorder in 
2) First stage of Labour: T10-L1 Blockade required
   Epidural can be given 
   @ 4-5 cm of dilatation

3) Second stage of Labour: Pudendal N/V Block
   S2, 3, 4

4) Forceps Delivery: SADDLE Block

5) LSCS - T9 to T5 required

6) The cause of Mortality of LSCS is under 
   Spinal Anaesthesia; High spinal anaesthesia
S/E OF SPINAL OPIOIDS

1) delayed gastric emptying
2) Pruritus
3) nausea, vomiting
4) urinary retention
5) Sedation
6) delayed delayed sleep depression.

Ramifentanil is CLI for spinal anaesthesia.
It contains glycine → cause neurotoxicity.
MALIGNANT HYPERTHERMIA

Syndrome of rapidly rising temp & occurs due to Ab of Rb of Ryanodine.

Causes massive release of calcium sustained muscular contraction.

* TRIGGERING FACTORS -
  1. S. Choline - 50% of cases
  2. Ether
  3. Methoxyflurane
  4. All fluorinated inhalational agents

* C/F -
  1. Host Initial Sign - Masseter M/s Spasm.
  2. Tachycardia
  3. Rise in ET CO2
  4. Metabolic Acidosis
  5. Cyanosis
  6. Hyperkalemia
  7. Hypernatremia
  8. Hyperphosphatemia
  9. Myoglobinuria
10) Rise in temp → Late sign.
11) Renal failure

Rx -

1) Stop all anaesthetic agents.
2) Hyperventilate with 100% O₂
3) Inj. DANTROLENE - 2mg/kg B.w. every 5 min.
   Max. 10mg/kg
4) NaHCO₃ → for metabolic acidosis
5) Cooling of body
6) Other symptomatic Rx.

BEST SCREENING TEST → Creatinine kinase

Anasthesia TEST → Halothane Caffeine contraction test
ASSESSMENT OF PAIN

1) VISUAL ANALOG SCALE

2) WONG BAKER FACES
   - Used for children 1-3 yr of age
   - Best rating method

3) Children Hospital Eastern Ontario Scale (CHEOPS)
   - 1-7 yr of age children
   - Consist of:
     - Facial
     - Verbal
     - Torso
     - Legs
     - Touch

4) Magel Questionnaire
   - For minor sx in children → PCM suppository is sufficient
   - For major sx → Low dose narcotic infusion is used
PCA (Pt. Controlled Analgesia)

Route - IV

Drug - Fentanyl or Morphone

Fluid Requirement During Anaesthesia

4:2:1

1st Day
10 kg → 4 mL/kg
10-20 kg → 2 mL/kg
> 20 kg → 1 mL/kg

60 kg = 10 × 4 + 10 × 2 + 40 × 1
= 40 + 20 + 40
= 100 mL

No. of fasting hours = n

100 x n = \[ \text{100n} \]

50% - 1st hr
25% - 2nd hr
25% - 3rd hr
TYPES OF FLUID

HYPOTONIC
5% Dextrose
1/2 NS
used to correct
Hypernatremia

HYPERTONIC
3% Saline
5% Saline
used to correct hypotension
↑ ICP
7.5% NaHCO₃
5% Dextrose + 1/2 NS
DNS

ISOTONIC
RL - Intravenous
NS - Intra os
5% D. + 1/4 NS
Plasmalyte
CPR

It is done when Pulse = absent

SEQUENCE - C — A — B

COMPRESSION

**Adult**

Compression & Resp = 30:2

Depth - 2 inches

**Children/Infant** = \( > 100 \text{ min}^{-1} \)

Comp. : Resp. = 30:2 - Single person

= 15:2 - double person

Intubation → RR = 8-10/min

Depth: \( \frac{1}{3} \) rd of A-P Diameter or

atleast 1.5 inches

**Neonates**

Rate of Comp. - \( 90 \text{ min}^{-1} \)

C : R = 3 : 1

Route of neonatal resuscitation = Umbilical ven

Doc for CPR = Adrenaline

Iv - 1: 10,000

1mg every 3-5 min.
For Anaphylaxis - Doc. Adrenaline I.M. 1:1000

For Anaphylactic Shock. Doc. Adrenaline I.V. 1:10,000.

Atropine, Ca, vasopressin - not part of常规 CPR

Dextrose - not used in CPR as they worsen outcome of anaerobic neurological injury

1st Rib # during CPR = 3, 4, 5 ◐ side.

* Drugs can be safely given for through tracheal route

Naloxone
Atropine
Epinephrine
Vasopressin
Lignocaine

Dose = 2-2.5 x I.V. Dose

* Drugs can't be given through tracheal

NaH103
Calcium salts
Bretylium
MODES OF VENTILATION

Only positive pressure ventilator are used

1) CMV [Controlled Mech. Ventilation]
   - TV & RR are fixed
   - No spontaneous breathing allowed
   - Minimal work of breathing
   - ↑ level of sedation & HR reqd.
   - Used to ↓ ICP in head injury pts.

2) IMV [Intermittent Mandatory Ventilation]
   - Pt. is allowed to breathe spontaneously
     between mandatory breaths
   - ↑ level of sedation reqd.
   - No synchronisation between patient & ventilatory effort
   - ↑ TV breaths can be delivered
     now withdrawn due to volume injury

3) SIMV [Synchronised Intermittent Mandatory Ventilation]
   - Pt. allowed to breathe spontaneously between
     mandatory breaths & synchronisation
mod level of sedation reqd.
↑ work of breathing

4) PSV [Pressure Support Ventilation]
- It is used to ↑ TV in spontaneously breathing pts.
- No mandatory breaths are given
- Min. sedation is reqd.

5) High Frequency Ventilation
    3 TYPES

a) High Frequency PPV
    Rate = 60 - 120 /min

b) HF Jet Ventilation
    120 - 180 /min

c) HF Oscillation. - 600 - 3000 /min.

USE - Bronchopleural fistula
      Tracheo esophageal fistula
      Bronchoscopy
      Emergency ventilation through cricothyroid
      Bronchial s
6) **IRV** (Inverse Ratio Ventilation)  
   1:3

   Here, inspiration is longer than expiration  
   1:1, 2:1, 3:1

7) **APRV** (Airway Pressure Release Ventilation)  
   - Used for ARDS

⇒ **MODES FOR SPONTANEOUS VENTILATION**

   - IMV
   - SIMV
   - PCV
   - HPV
   - APRV

⇒ **WEANING MODES** (gradual withdrawal of ventilator)

   - IMV
   - SIMV
   - PSV

⇒ **PEEP** (Positive End-expiratory Pressure)

   - It prevents alveoli from collapsing
   - It recruits alveoli
   
   Recruitment pressure = 10-12 cm H₂O
INDICATIONS OF PEEP

- Physiological PEEP
- Pul. Edema
- ARDS
- Cardiothoracic Sx

S/E of PEEP

1) ↓ VR → ↓ BP → ↑ RV afterload
2) ↑ ICP
3) ↑ mediastinal pressure
4) ↑ intrapleural pressure
5) ↑ Dead space → 2 ml/kg

FACTORS

↑ Dead SPACE

1) Upright position
2) Neck extension
3) ↓ age
4) +ve Ppv
5) Anticholinergic drug like atropine
6) P. emboli
7) Emphysema