1 INTRODUCTION OF ANESTHESIA

Introduction of anesthesia 00:01:52

Types of Anesthesia

- Anesthesia is divided into two broad divisions:
- General anesthesia
- Regional anesthesia

General Anesthesia

Components of general of anesthesia

a. **Loss of consciousness:** It makes the patient unconscious. It is a must during general anesthesia but not required during regional anesthesia.

b. **Loss of reflex response:** It takes away all the sympathetic and parasympathetic reflexes of the patient and provides a smooth plane for the surgeon to operate.

c. **Amnesia:** Any surgery is a very stressful situation. So, anterograde amnesia is provided to the patient. It is the time period in which the patient is under anesthesia and does not remember anything of that time period.

d. **Muscle relaxation:** All the skeletal muscles of the body are relaxed by either paralyzing or using agents which decrease the tone depending on the surgical demand. For example:
   - If the surgery requires paralysis like in abdominal surgery, a neuromuscular block is given and the patient is paralyzed.
   - If the surgery doesn't require paralysis then a little bit of relaxation can be achieved with other anesthetic agents as well.

e. **Analgesia: Path of consciousness and the path of pain is different,** drugs which we use used for producing loss of consciousness are not necessarily the drugs that will provide analgesia.
   - This is because the path of consciousness and the path of pain is different. There are a few situations to consider:
   - The drug may act upon the path of consciousness but may not act on the path of pain.
   - The patient may be unconscious but feel the pain.
   - Need drugs which provide analgesia.
   - It is not one drugs which is use to provide all these.
   - Multiple drugs are used for multiple components of general anesthesia.

Important Information

Previously(Historical)	At present
Triad of Anesthesia • Narcosis • Relaxation • Analgesia	**Pentad of Anesthesia** • Loss of consciousness • Loss of reflex response • Amnesia • Relaxation • Analgesia

Lundi: Came up with the concept of Balanced Anesthesia and we are practicing this even today.

Balanced Anesthesia 00:12:37

- When using multiple drugs for providing all 5 components of general anesthesia.
- It is a concept given by Dr Lundi.
- The multiple drugs are given in a titrated way for producing different components of anesthesia.
- The multiple drugs used in these 5 components are:
  1. **Loss of consciousness:** Inhalation or IV anesthetic agents are used.
  2. **Loss of reflex response:** Inhalation or IV anesthetic agents are used.
  3. **Amnesia:** Inhalation or IV anesthetic agents are used.
  4. **Muscle relaxation:** Neuromuscular blocks are used which caused paralysis and get a very good muscle relaxation.
  5. **Analgesia** is achieved by using opioids.

Important Information

- All the drugs that provide a loss of consciousness also provide loss of reflex response and amnesia.
- Giving a neuromuscular blocker, always have to ventilate the patient from outside. Apart from other muscles.
- It will also paralyze the respiratory muscles and the patient will not be able to breathe.
- The neuromuscular blockers will never produce loss of consciousness. They only produces muscle paralysis by which muscle relaxation is achieved.

Steps of General Anesthesia 00:17:40

- Attach mandatory monitors
  - ECG
  - Pulse oximeter
  - Temperature probe
  - A blood pressure cup for non-invasive BP monitoring.
  - Capnography.
- Securement of intravenous canula.
  - After securing IV line inject drug and the patient become unconscious

Induction

- Intravenous anesthetic agent: Means loss of consciousness

(i.e. patient has been made unconscious) by giving IV anesthetic agent or

- Inhalational anesthetic agent incase patient doesn't have canula or some other reason cannot give IV anesthetic agent that go for inhalational anesthetic agents
  - Through the mask
  - Anesthesia Machine → Circuit → Facemask → Systemic Circulation → patient Unconscious
- To maintain the unconsciousness have to secure an airway so that continuously some anesthetic agent and gases can be given throughout course of anesthesia.
- **Bag and mask ventilation:** 100% oxygen
- **IV neuromuscular and intubation:** Patient becomes paralyzed
- **Laryngoscopy and intubation:** Secure and airway
- **Maintenance of anesthesia**
  - Continuous inhalational anesthetic agent
  - Continuous IV anesthetic agent
  - Induction can be done be inhalational and IV & maintenance can be done by inhalational and intravenous
  - When we use intravenous both for induction and maintenance, then it called TIVA (Total Intravenous Anesthesia)

Reversal of Anesthesia

- Unconscious to conscious.
- Stop the infusion of IV anesthetic agents or stop the inhalational agents.
- Can use reversal for some particular drugs.

Important Information

- The most common reversal agent is neostigmine which is used for reversing the effects of neuromuscular blockers.

Important Point

General anesthesia comprises 3 steps/components:

- Induction
- Maintenance
- Reversal

Regional Anesthesia

00:32:20

- By giving local anesthetic agents.
- Local anesthetic is deposited locally (intravenously) near the nerve fiber to be blocked.
- The drug blocks the autonomic sensory and motor outflow of the nerve fiber.
- Area supplied by that particular nerve fiber gets anesthetized.

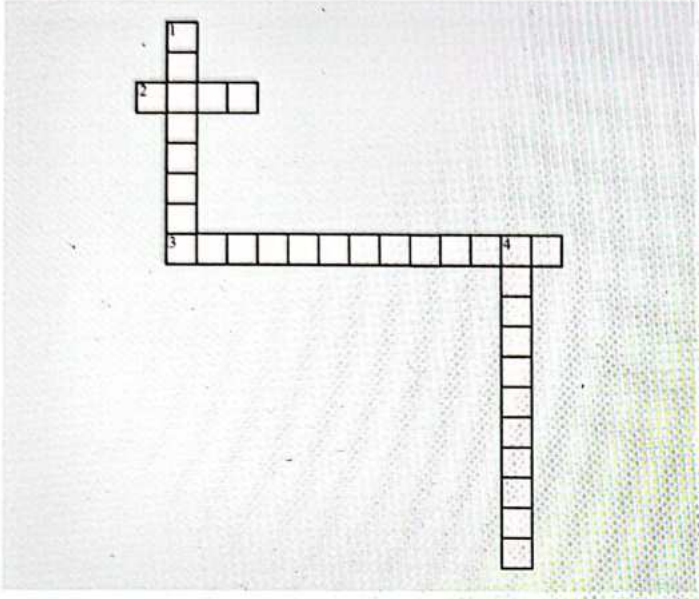
Types of Regional Anesthesia

Regional anesthesia is divided into 2 parts:

1. **Central neuraxial blockade:** This includes subarachnoid block and epidural block.
   - It is the blockage of spinal nerves either by spinal anesthesia (the drug is given directly into the CSF) or epidural.
2. **Peripheral nerve block:** These can be -
   - Brachial plexus block
   - Femoral nerve block
   - Sciatic nerve block

CROSS WORD PUZZLES

Crossword Puzzle1



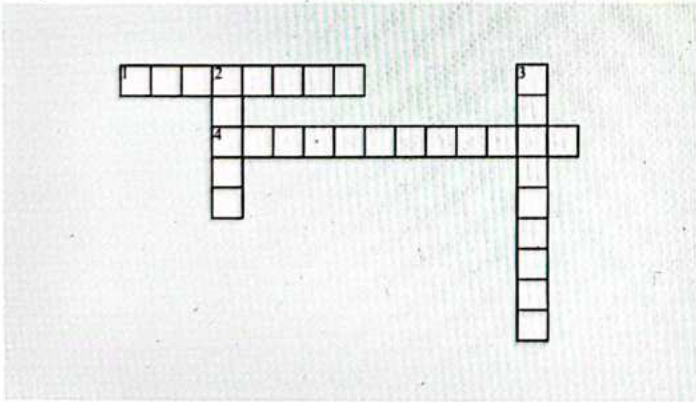
Across

2. There are _____ components of balanced anesthesia.
3. _____ block is given in case of a broken ulna.

Down

1. _____ are used to provide analgesia.
4. The patient is _____ under general anesthesia.

Crossword Puzzle2



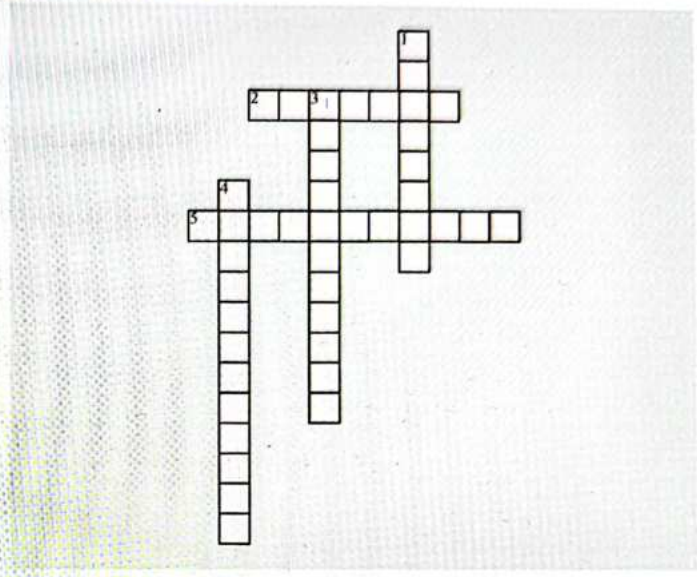
Across

1. Muscle relaxation includes only _____ muscles.
4. _____ block is given to paralyze the patient.

Down

2. Balanced anesthesia was given by Dr John _____.
3. The five components of balanced anesthesia are loss of consciousness, loss of reflex response, amnesia, relaxation, and _____.

Crossword Puzzle3



Across

2. All the drugs that provide a loss of consciousness also provide loss of reflex response and _____.
5. The three components of general anesthesia are induction, _____, and reversal.

Down

1. In central neuraxial blockade, there is the blockage of spinal nerves either by spinal anesthesia or _____.
3. The most common reversal agent is _____.
4. _____ and intubation are done to secure the airway of the patient.

2 HISTORY AND STAGES OF ANESTHESIA

History of Anesthesia

00:00:42

Father of anaesthesia	WTG Morton
Father of GA	John Snow
Father of IV anaesthesia	Prof. Helmut Weese
Father of spinal anaesthesia	August Karlgustav Bier – Invents Bier Block
Father of LA anaesthesia	Dr. Heinrich Friedrick's Wilhelm Brown He coined term procaine
17th century	Joseph Priestley (N_2O, O_2)
1844	GA by N_2O- Horace Wells (Dentist)
1846	Word anaesthesia coined by Oliver Wendell
1846 16th Oct	WTG Morton – Ether Anaesthesia – World Anesthesia Day
1847	Chloroform, Prof. J.Y. Simpson
28th Jan 1848	1st Death Under Chloroform
1853 to 1857	John Snow Gave Anaesthesia to Queen Victoria for Her Delivery
1878	Mac Ewan 1st Blind Oral Intubation
1885	Magill – 1st blind nasal intubation Joseph O'Dwyer – used metallic tubes
1884	1st LA cocaine by Dr. Karl Kohler
1885	1st peripheral brachial block by cocaine – William Halsted
1913	Laryngoscope by Jackson
1917	Boyles machine by Edmund Boyles
1930	Circuit System – Mapleson
1934	Thiopentone- Dr. John Lundy (Concept of balanced anaesthesia) i/v Anesthetic Agent
1937	Stage of Anaesthesia by Arthur Guedel
1943	1st NMB – d tubocurarine by Harold Griffth Laryngoscope modified by Magill, Miller, Mangitosh
1950	Halothane
1965	Ketamine by Steven
1977	Propofol

The Stages of Anesthesia

00:12:50

Stage 1	**Stage of analgesia**	1. Normal reflexes maintained till LOC 2. Eyelash reflex abolished
Stage 2	**Stage of Excitement**	1. Irregular breathing 2. Struggling and resisting 3. Regurgitation 4. Coughing 5. Laryngeal spasm 6. Pupillary dilatation
Stage 3	**Stage of Surgical anaesthesia**	1. Plane 1 • Loss of conjunctival reflex • Eye central • Swallowing, vomiting are depressed • Pupil are normal or smaller in size • Increase lacrimation 2. Plane 2 • Intercostal muscle paralysis begin • Regular deep breathing • Loss of corneal reflex • Pupils are dilated now • Lacrimation increase furthermore 3. Plane 3 • Intercostal muscle are completely paralysed • Shallow breathing • Laryngeal reflexes are depressed • Lacrimation decreases 4. Plane 4 • Complete paralysis of diaphragm and cranial nerve and reflexes are depressed
Stage 4	**Overdose**	• Apnea • Pupils are maximally dilated

CROSS WORD PUZZLES

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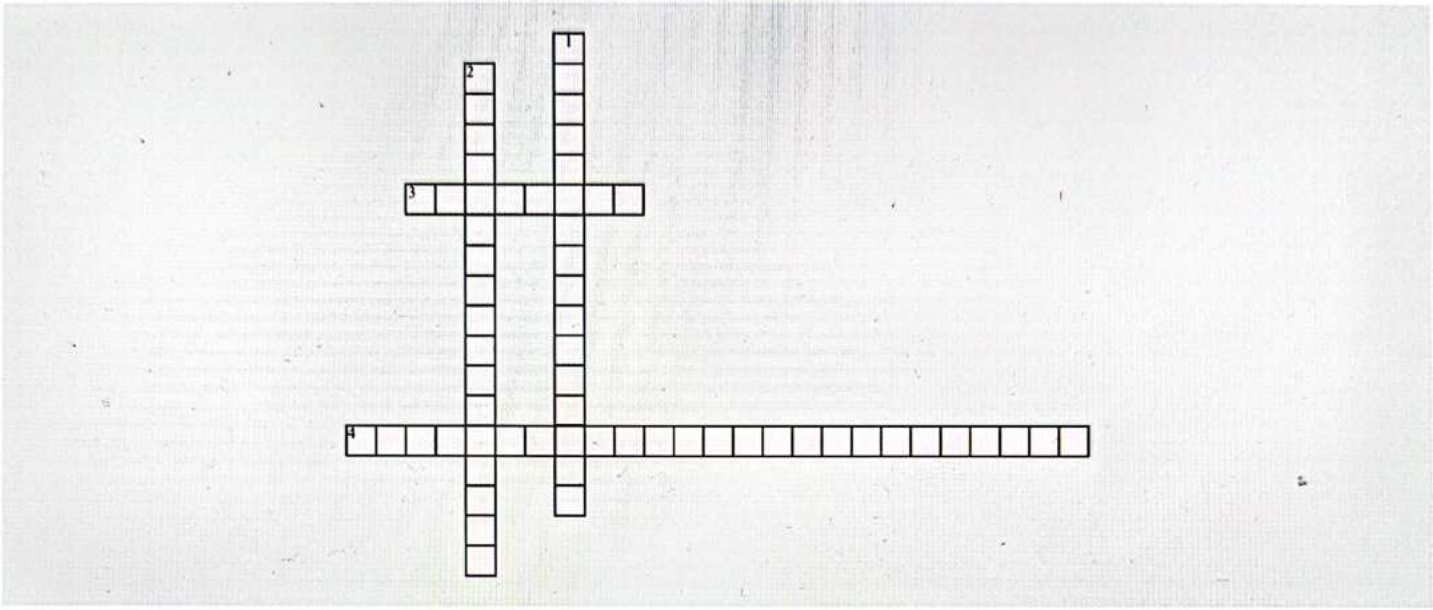
Crossword Puzzle1

Stages of anesthesia



Across

3.Fourth Stage of Anesthesia

4.Stage of surgical anesthesia

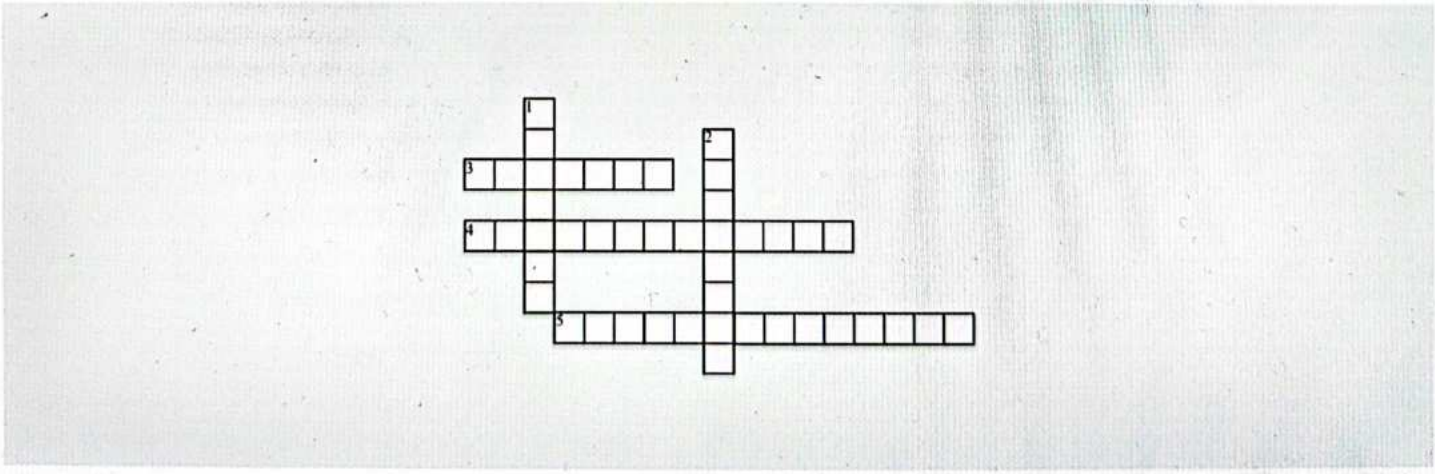
Down

1.First stage of anesthesia

2.Second stage of anesthesia

Crossword Puzzle2

History of Anesthesia



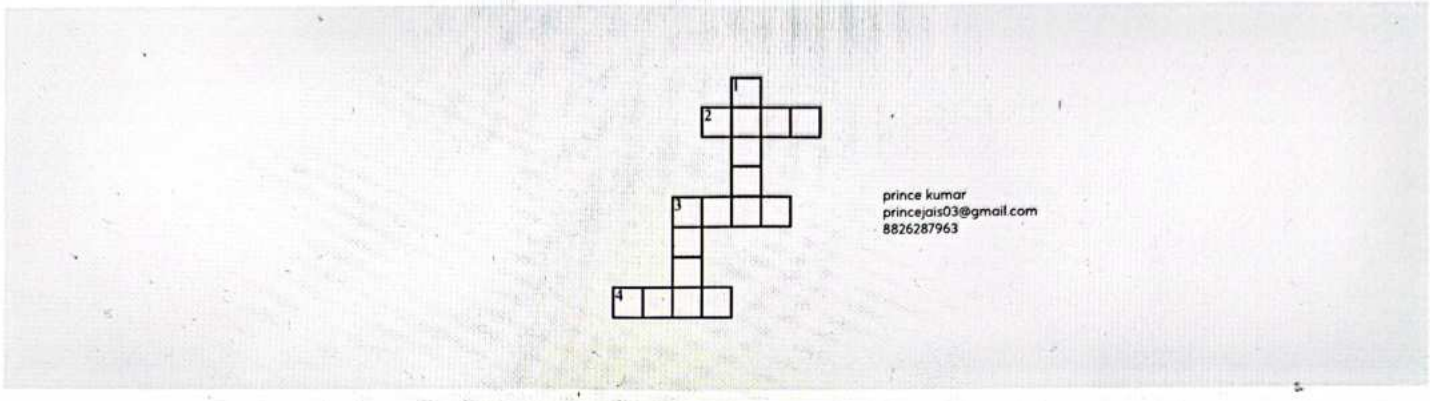
Across

3. First laryngoscope was made by
4. coined the term anesthesia
5. First neuromuscular blocker

Down

1. First local anesthetic
2. Father of general anesthesia

Crossword Puzzle3
Years of discoveries



Across

2. Concept of balanced anesthesia
3. First blind oral intubation
4. Halothane was discovered in the year

Down

1. Propofol was discovered in the year
2. Ketamine was discovered in the year

3 PRE-ANAESTHETIC EVALUATION

Pre-anaesthetic evaluation

- For pre-anesthetic evaluation guidelines were made by the American Society of anesthesiologists, they specifically divided every patient depending upon their normal condition or comorbid condition.

ASA Grading 00:02:18

American society of Anesthesiologist

ASA classification	Definition	Example
I	Normal patient	• Healthy • Non smoker • No or minimal alcohol
II	Mild systemic disease	• No substantial functional limitation • Smoker • Pregnancy • BMI >30
		• Controlled DM/HTN/BA
III	Severe systemic disease	• Substantial functional limitation • One or more superadded disease
		• Poorly controlled DM/HTN/ • BMI >40 • Morbid obesity • ESRD with dialysis
IV	Severe systemic disease which is a constant threat to patient's life	• Recent MI • CVA • TIA • Decrease EF • DK • ESRD without dialysis
V	Patient is moribund , can't survive without surgery	• Ruptured abdominal or thoracic aneurysm • Massive trauma - bleeding • Intracranial bleed
VI	Brain dead patient	• Organ harvesting

ASA (I - VI) E - Emergency

Airway Evaluation -

- Mouth Opening
- Neck Movement
- Atlanto- Occipital Movement
- Mento- Hyoid & Mento Thyroid Distance
- Mallampati Classification

Important Information

- ASA I II III and IV patients can be taken up for routine surgeries, but some additional investigations should be done with these patients.
- ASA V patient's surgeries can't be delayed for normalization, sudden surgery is done and the patient's condition is managed intraoperatively.
- ASA gradings are needed for a general understanding between two anesthetics.

Mallampatti Classification

- Patient is asked to open the mouth widely, to see whether intubation is going to be easy or difficult.
- There are four grades of MPC.
- In grade I Tonsillar pillar, hard palate, soft palate, uvula, and fauces everything is visible.
- As the grade is increasing, structures of the oral cavity keep on decreasing.

Mallampati classification

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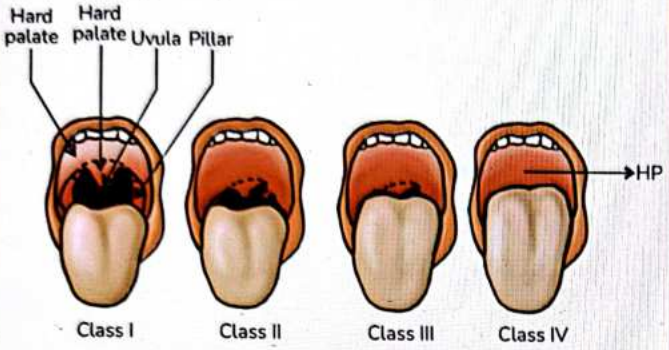
- MPC-I, II easy intubation
- MPC-III,IV- difficult intubation

Involvement	Grade 0 tip of epiglottis is visible	Grade I	Grade II	Grade III	Grade IV
Hard palate		+	+	+	+
Soft palate		+	+	+	
Uvula		+	+	Only base of uvula	
Fauces		+	+		
Tonsillar pillar		+			

Important Information

G0/G1/G2- small tongue- intubation easier

G3/G4- Large tongue- intubation might be difficult



Pre-Anesthetic Orders

00:22:00

- Whenever a patient is operated on for routine surgery, pre-anesthetic orders must be seen.
- There should be written and oral consent from the patient.
- Patient should be aware of every complication and comorbid condition (medicine has to be taken or not)
- When the patient is given oxygen from outside, it gives oxygen supply to the lungs but if some amount of oxygen reaches the abdominal cavity there may be bloating inside the patient's stomach and in case the patient has eaten something, those might regurgitate. Patients might land up into aspirations to prevent this, **Nil Per Oral Guidelines** are there.
  1. **Consent**
  2. **Pre-op- medication**
  3. **NPO orders (Nil per oral)**

Adult		Pediatrics	
8 hour	Solid food	8	Solid food
6 hour	Semisolid food	6	Formula milk
2 hour	Clear fuids	4	Breast milk
		2	Clear fuids

- 1 hours (clear fuids) - GB / Ireland anaesthesia society
- If the patient is in a comorbid condition, then there should be a proper idea of which drug has to continue and which has to stop.

4. Order Regarding Previous Medication

- Oral Anti Hypertensive Drug To be continued
- Steroid - they have to be continued
  - Supplementation prior to surgery
  - Supplementation has to be avoided - DM/IMMUNOCOMPROMISED/infection
- Anti- Diabetics
  - Hold Medication 24 Hours prior to surgery (Minor Surgery)
  - Major Surgery shift the patient on Insulin
- Blood thinner / Anti-coagulants
  - Aspirin - Continued till the day of surgery
  - Unfractionated Heparin - stop 6 hours prior to surgery
  - LMW Heparin - stop 12- 14 hours prior to surgery
  - Warfarin - stop 3 days prior to surgery
  - Clopidogrel - stop 7 days prior to surgery
  - Ticlopidine - stop 14 days prior to surgery

As we move down: The duration of medication to be stopped is increasing.

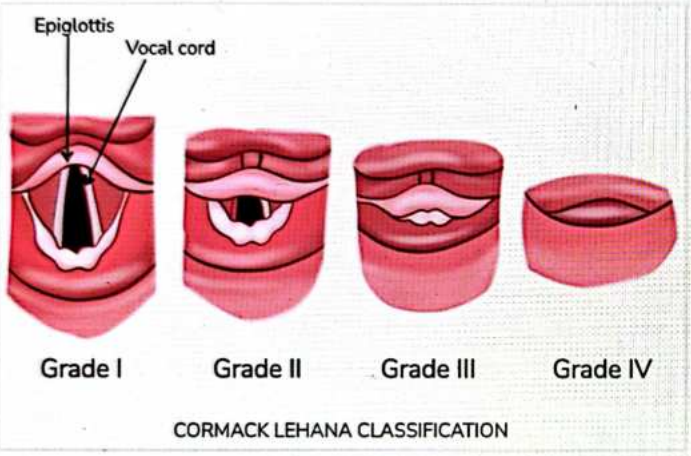
- Herbal Medication- stopped → 4-6 weeks prior
- Anti Psychotics, Anti depressants, Anti epileptic → Continued.
  - Except tricyclic Anti depressants → Stop 3 Weeks prior
  - Lithium → 24-48 hours prior
  - Stents -
  - Medicated/Drug Elluting – 1 year gap
  - Bare metal – 1 month gap
- Smoking – 3 Month prior to surgery
- Hormonal medication- stopped 6-8 weeks prior to surgery

Lemon Airway Classifications

00:40:26

L	Look	1. Facial trauma 2. Large incisor 3. Facial hair 4. Size of tongue → 1 points	1 Point for each criteria
E	Evaluation	1. Inter Incisor Distance - >3 Finger breath 2. Hyoid Mental distance- > 3 Finger breath 3. Thyroid To mouth distance - 2 Finger (3-3-2)	1 point for each criteria (3 points)
M	Mallampati	Anything on and above MPC III	1 Point
O	Obstruction	Epiglottitis, oral cavity tumors	1 Point
N	Neck Movement	Ask the patient to touch his chest with his chin	1 Point
• Higher lemon score corresponds to more diffcult intubation			10 points

Modified Cormack lehane classification is used in Direct Laryngoscopy	
Grade 1	Most of vocal cords are visible
Grade 2	a. Post vocal cord visible b. Only arytenoids visible (Only post. Commisure is visible)
Grade 3	a. Epiglottis is visible and liftable b. Epiglottis adherent to posterior pharyngeal wall
Grade 4	No laryngeal structure is seen



CORMACK LEHANA CLASSIFICATION

Visualization of the epiglottis and Vocal cord using a laryngoscope

Difficulty in incubating patients may occur due these conditions.

Sr.	Acquired	Congenital
1	Facial trauma	Down Syndrome
2	Epiglottis	Thyroid abnormalities
3	Tumor	Piere's robin Syndrome
4	Acromegaly	Treachercollin syndrome
5	Tumor/ mass in oral cavity	Goldenhar Syndrome
		Congenital goitre

These things have to be considered while incubating the patients. This can lead to compromised airways.

PAC In Patients With Known Cardiovascular Disease

00:55:30

- There is a criterion called Goldman Cardiac Risk score which tells about whether the surgery is going to be helpful or detrimental for the patient.
- Any patient having ischemic heart disease, congestive heart failure, cerebrovascular disease, or any other patient who requires insulin before the surgery will have to undergo Goldman cardiac risk evaluation.

Goldman Cardiac Risk Score

1. To evaluate risk of surgery.
2. For all cardiac pts. Coming for surgery.
3. For pts. With H/O IHD, Conjecture cardiac failure, cerebrovascular disease.
4. Any pre-operative insulin requirement.
5. Pre- operative creatinine > 20 mg/dl for patients >50 years of age

Patients with these conditions are at a higher risk than normal patients because the drugs which are given might interact in one way or another way.

Patient may fall in the condition ASA IV

Investigations-

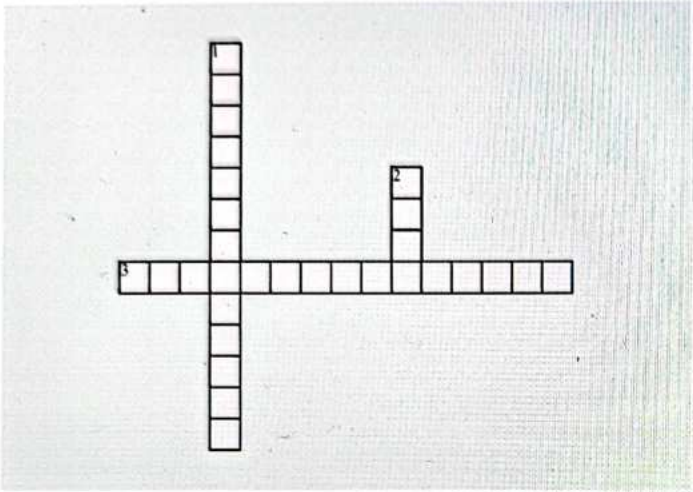
1. 12 Lead ECG.
2. Stress echo (Holter ECG Motioning)
3. Echo:
   - Thallium Scan/Dobutamine scan
   - Exercise stress
4. Roll of angiography :
   - Invasive
   - Note done routinely

Important Information

- Stress monitoring is throughout the day monitoring.
- 2D echo i.e., thallium scan and dobutamine scan, and exercise stress are the same tests but patients who are not able to perform a stress test those patients are given thallium or dobutamine (because they have positive inotropic effects on patients).
- Angiography tells the pros and cons of the surgery.

CROSS WORD PUZZLES

Crosswords puzzle1



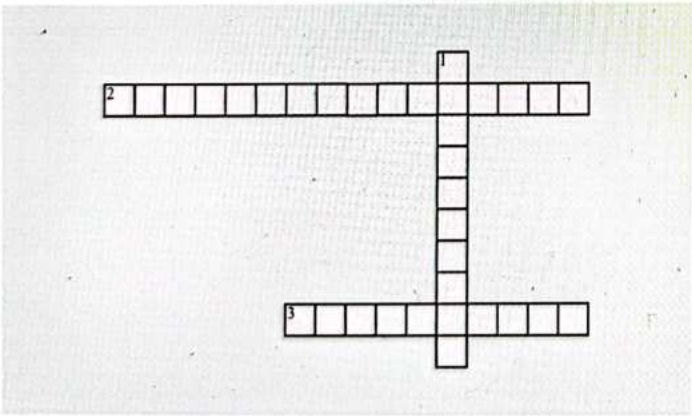
Across

3. ASA I II III and IV patients can be taken up for_____.

Down

1. _____ evaluation guidelines were made by the American Society of anaesthesiologists.
2. _____grades of MPC are there.

Crosswords puzzle2



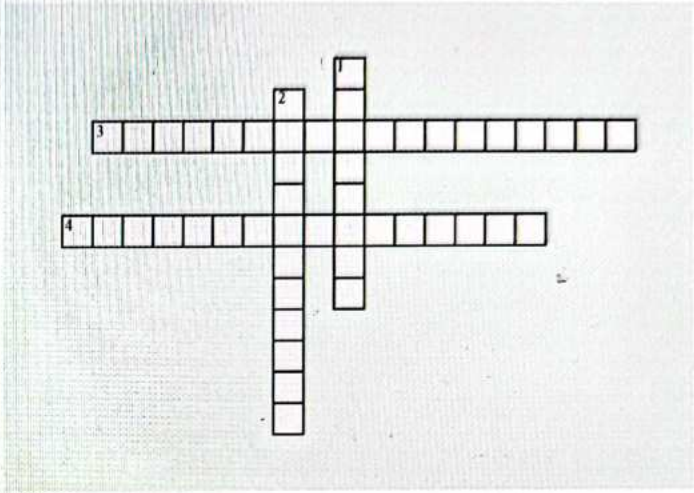
Across

2. ASA V category patient's conditions are managed_____.
3. As the grade MPC grade increases, structures of the oral cavity keep on_____.

Down

1. _____are issued for fluid intake guidelines before any surgery.

Crosswords puzzle3



Across

3. _____ score tells about whether the surgery is going to be helpful or detrimental for the heart patient.
4. _____is the throughout day monitoring.

Down

1. _____has positive inotropic effects on patients.
2. _____tells the pros and cons of the surgery in heart patients.

4 OXYGEN THERAPY

Categories of Oxygen Therapy

- Depending on this, there are two categories of oxygen therapy.
  - Low-flow oxygen therapy
  - High-flow oxygen therapy
- These therapies are being given because the patient is not able to maintain their saturation in the natural atmosphere.
- Oxygen therapy is therefore given to the patient if their O2 saturation is low due to any kind of illness or injury, be it at a cellular or a bigger level.
- It is administered at a concentration of pressure greater than that found in the atmosphere.

Low Flow System Vs High Flow System 00:04:09

Low flow system/ Variable performance	High flow system/ Fixed performance
• Contribute partially to inspired gases FiO_2 is dependent of TV, RR	• Delivers Specific and constant % of O_2
Eg. 1. Nasal Cannula 2. Simple mask / Hudson mask 3. Non rebreakable mask 4. Partial rebreaking Mask	Eg. 1. Venturi mask 2. High flow nasal cannula

Low Flow System

Nasal Cannula 00:08:26

- Used in low to medium concentration of O_2 (22-44%)
- Amount delivered-
  - 1 l/min – 24%
  - 2 l/min -28%
  - 3 l/min – 32%
  - 4 l/min – 36%
  - 5 l/min – 40%
  - 6 l/min – 44%
- This device is used for providing preliminary oxygen to the patient.
- These can deliver oxygen with a concentration of 22 to 44%.
- When these are attached to the flow metre which is connected to the central pipeline supply of an ICU or cylinders and is turned on at 1L per minute, these deliver oxygen of about 24%.
- Atmospheric oxygen is from 20 to 21%.
- When the concentration of oxygen is increased, it leads to an increase in the concentration of FiO2.
- This device can only deliver up to 6L per minute.
- Every litre corresponds to its subsequent FiO2.
- This device is not beneficial for a capacity of > 6 litres.

Advantages

- Patients are able to talk and eat with O2 support when using a nasal cannula.
- A nasal cannula can be used in home settings.

Disadvantages

- It may cause irritation of nasal and pharyngeal mucosa.
- If the flow is given for more than 6L, the FiO2 may vary.

Face Mask 00:13:54

- It is a simple O2 mask.
- There are partial rebreather masks and non rebreather masks.
- These face masks are used when the oxygen requirement of the patient increases.
- These have a flow rate of 6 to 10 litres per minute.
- These supply 35 to 60% O2.

Advantages

- An increased delivery of oxygen can be made but for a shorter duration due to damage to the skin surface from the mask.

Disadvantages

- Tight seals are required, which can make many patients feel claustrophobic.
- There lies a potential for skin breaching.
- It can be uncomfortable for the patient while eating or talking.

Partial Rebreathing Mask 00:17:45

- This consists of a mask and a reservoir bag.
- The bag should be inflated all the time during inspiration and expiration to avoid any rebreathing.
- The flow rate is from 6 to 8 L per minute, with the FiO2 being at 80%.

Advantage

- The patient can inhale room air through the opening of the oxygen supply is cut.

Disadvantage

- This device has a tight seal which can be uncomfortable for patients.

Non-Breathing Mask

00:20:26

- These are instruments through which oxygen with a concentration of 95 to 100% (0.9 -1% FiO2) is delivered.
- This oxygen percentage is the maximum among all instruments.
- The flow rate is 10 to 15 L/m in this case.

Advantage

- These instruments deliver the highest possible oxygen concentration for patients suffering from severe hypoxemia.

Disadvantage

- This instrument is not good for long-term oxygen use.
- It can cause suffocation.
- It is expensive.

Important Information

- All these devices are of variable performance since these are dependent on the tidal volume and the respiratory rate of the person.

Fixed-Performance Devices

00:24:25

- If the patient's tidal volume or respiratory rate is not normal, fixed performance devices provide the accurate volume of oxygen to the patient.

Venturi Mask

- Oxygen is delivered at a concentration of 24 to 60% with the help of a Venturi Mask. The flow rate is 4 to 15 litres per minute.
- A constant amount is delivered through this mask which is not dependent on the respiratory rate and the tidal volume of the patient.
- Colour coding is done on these masks, according to which they deliver a specific percentage of oxygen to the patient.

Colour Flowrate	Oxygen Concentration
Blue	2L - 24%
White	4L - 28%
Yellow	6L - 35%
Red	8L - 40%
Green	12L - 60%

Advantage

- A very precise concentration of oxygen is provided.
- It does not dry out the mucosa and does not cause irritation.

Disadvantage

- It might be uncomfortable.
- It might cause skin irritation.

High-Flow Nasal Cannula (HFNC)

00:27:23

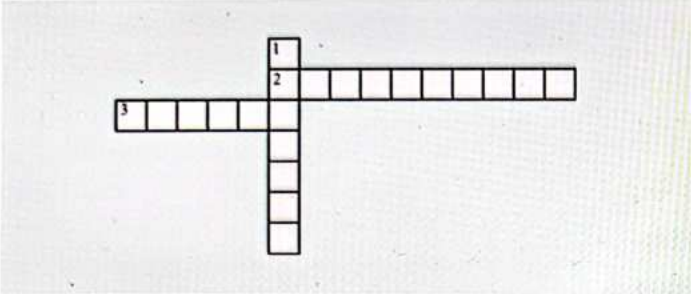
- These have humidifiers, heated tubes, a nasal cannula, and an oxygen blender.

Advantage

- There is Peak End Expiratory Pressure (PEEP). At the end of respiration, the alveoli collapse. And in order to avoid a complete collapse, Peak End Expiratory pressure has to be present.
- There is the delivery of constant FiO2 at 100%.
- These decrease the anatomical dead space and provide the maximum amount of oxygen possible to the patient.

CROSS WORD PUZZLES

Crossword Puzzle 1



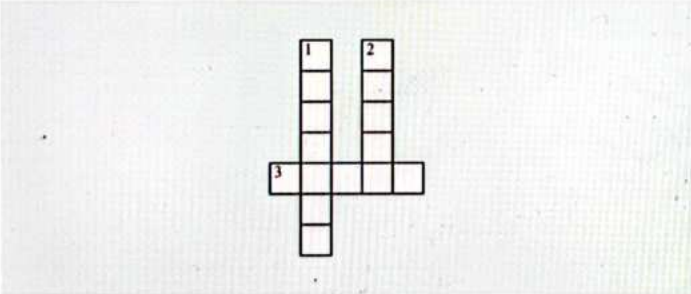
Across

2. At the end of respiration, the alveoli collapse. And in order to avoid a complete collapse, Peak End -------- Pressure has to be present.
3. In -------- therapy, different types of devices are used, which provide the patient with the appropriate amount of oxygen that is required by the patient.

Down

1. In a -------- mask, the blue colour means 2L of flow rate and 24% of oxygen.

Crossword Puzzle 2



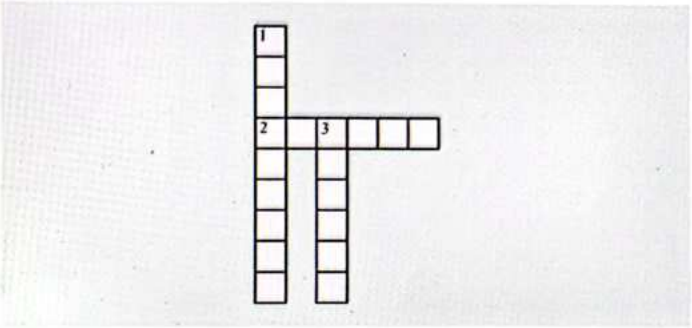
Across

3. If the person does not have adequate tidal volume or respiratory rate, there will be no proper amount of gaseous exchange at the alveolar level, and that is when ------ - performance devices will come into question.

Down

1. In a ------- breathing mask, two holes are present in the mask because in cases of emergency when the oxygen supply is cut from the mask, the patient can inhale the air in the room till the time the oxygen supply is replenished.
2. In a Venturi mask, the ------ colour means 4L of flow rate and 28% of oxygen.

Crossword Puzzle 3



Across

2. Low-flow systems can be used in these patients because ------ – intake depends on the patient's requirements.

Down

1. These instruments deliver the highest possible oxygen concentration for patients with severe -------.
3. In a Venturi mask, the ------- colour means 6L of flow rate and 35% of oxygen.

5 AIRWAY DEVICES

Categories of Airway Devices 00:01:10

There are two broad categories of airway devices:

1. **Supraglottic device** - above laryngeal inlet
2. **Infraglottic devices**- below laryngeal inlet

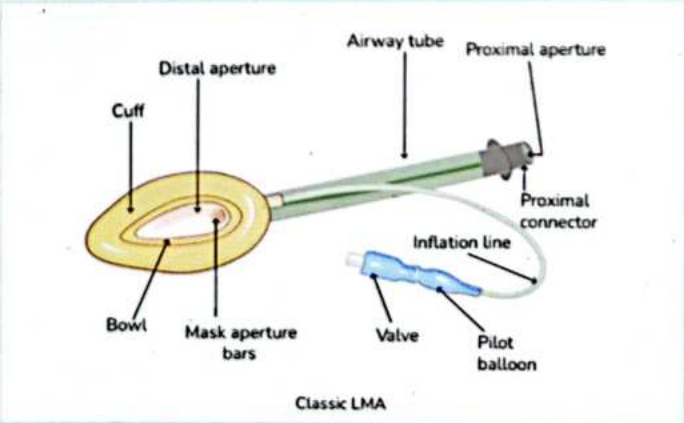
Important Information

- **There are two broad categories of airway devices:**
  - Supraglottic devices: These rest above the laryngeal inlet. Different types of supraglottic devices have been categorized into generations, like the first generation (the oldest) and the third generation (the newest).
  - Infraglottic devices: These rest below the laryngeal inlet. These include the endotracheal tube, the south pole tube, the north pole tube, the flexometalic tube, etc.

Supraglottic Devices 00:01:53

- Supraglottic devices are divided into three broad generations, as follows:
  - **1st generation:** Classic LMA, flexible LMA, and cobra peri laryngeal airway. The first generation is the oldest of all. The classic LMA has been described in broad terms. Classic LMAs were the first device to be discovered and are used due to their low cost and easy availability.
  - **2nd generation**: Proseal LMA, I-gel, and Slipa.
  - **3rd generation:** Baska mask (modern).

Classic LMA 00:02:51



Classic LMA

- Designed by Dr. Archie brain (1982)
- It is used in difficult airway management situations, e.g., accidental cases.
  - It can't protect against aspiration
  - Easy placement
  - Lower incidences of sore throat
  - Gastric insufflation
  - Air leak with PPV

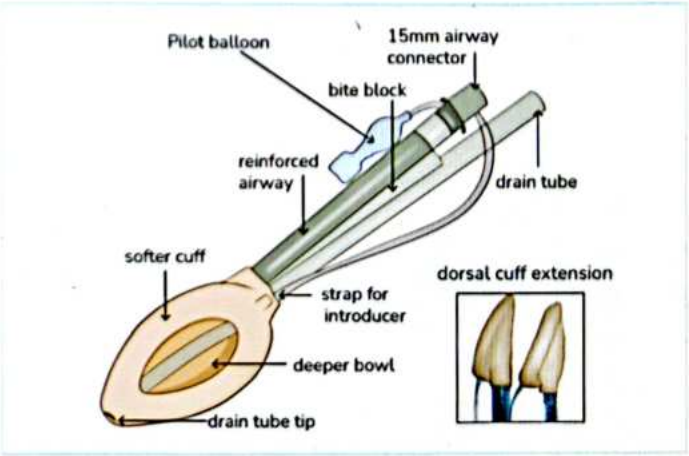
The parts of a classic LMA are as follows:

- **Proximal aperture:** This is the proximal connector. It is a universal connector that gets attached to the machine (a modern anesthesia machine). Through it, we can provide all the inhalational agents like oxygen and nitrogen oxide.
- **Cuff:** First, this device needs to be introduced inside the oral cavity of the patient. This cuff is deflated while introducing the classic LMA into the oral cavity of the patient.
- **Inflation line:** Once the cuff is introduced inside the oral cavity, an inflation line is used to inflate the cuff.
- **Valve:** The one-way valve prevents the backflow of air from the inflation line. The cuff takes the proper shape of the oral cavity after inflation.

Flexible LMA 00:08:02

- Flexible LMA is similar to classic LMA.
- It is not kinkable.

LMA Proseal 00:08:56



- LMA Proseal decreases the risk of aspiration.
- The structure of LMA is similar to classic LMA, but it has a drain tube.
- The advantage of a drain tube is that we can introduce a suction catheter or a Ryle's tube so that the stomach can be aspirated and the patient can be saved from gastric aspiration.
- It also has a bite block to prevent the tube from collapsing due to patient biting.
- It decreases gastric insufflation.

- It has better seal than classic LMA since it has a deeper bowl.
- It is more difficult to place.
- It is suitable for longer duration of surgery.

LMA Supreme 00:11:54

- It has a similar sealing procedure as proseal LMA.
- It is easy to use.
- It has a drainage tube.
- It is latex-free and is useful for patients allergic to latex.
- It has an integral bite block.
- It has a wider bend.

I-Gel 00:12:45

- It is a single-use thermoplastic device that swelled up in the oral cavity.
- When it is placed inside the oral cavity, the contents of I-gel mix with the saliva of the patient and take on the shape of the oral cavity.
- It has no cuff.
- Gastric drainage is present in it.
- It has a better seal.
- It has a bite block.

LMA size for patient 00:15:47

- The size of the LMA is dependent on the body weight of the patient and not on age.

Size of LMA	Patient weight
1	2-5 kg
1.5	5-10 kg
2	10-20 kg
2.5	20-30 kg
3	30-50 kg
4	50-70 kg
5	>70 kg
6	>100 kg

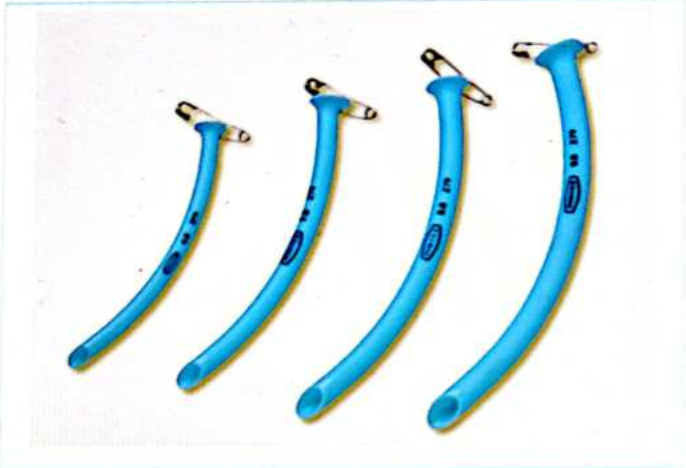
Oropharyngeal device (Guedel's airway) 00:16:32

- They are dependent on the length. The length is measured from the antitragus of the ear to the mouth of the patient.

Size	Length (mm)
000	30
00	40
0	50
1	60
2	70
3	80
4	90
5	100
6	110

- **Uses of Guedel's airway:**
  - These are not suitable to provide proper oxygen or anesthesia.
  - These are used to maintain a patent airway.
  - These are made of thickened or hardened plastic.
  - Thus, these prevent endotracheal tube occlusion and bite.
  - These also prevent the tongue bite as these fit above the tongue.
  - These also facilitate oral suctioning.
  - These are better mask fit and help provide oxygen.
- **Contraindications of Guedel's airway:**
  - intact gag reflux
  - Oropharyngeal growth. It can lead to bleeding as it is made of plastic.

Nasopharyngeal devices 00:20:26

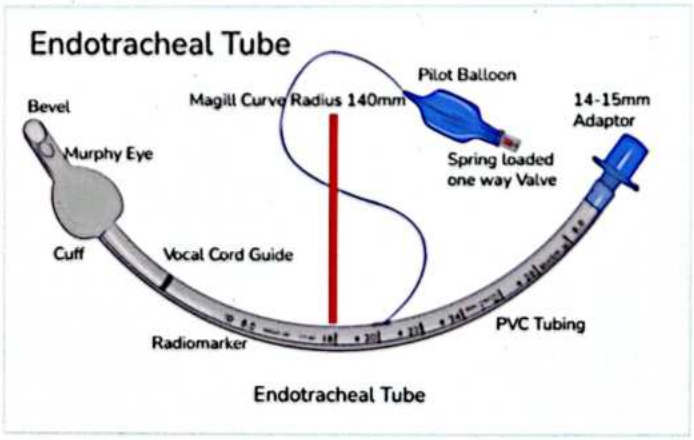


- These are used only to provide a little oxygen to the patient or support system to the supraglottic and infraglottic airway devices.
- These are used only to provide a little oxygen to the patient or a support system to the supraglottic and infraglottic airway devices.
- If the patient isn't maintaining proper oxygen saturation after the surgery, then a nasopharyngeal device is put in the patient's nose. It is made of soft rubber, so patients can tolerate it.
- Nasopharyngeal devices are contraindicated in patients with coagulation disorders, nasal pathology, or a fractured nose because, after the operation, the patient can end up having aspiration through these bleedings.

Infraglottic Devices 00:22:02

- **The different types of infraglottic airway devices are as follows:**
  - Endotracheal tube-cuffed and uncuffed.
  - Flexometallic tubes, armored tubes, or reinforced tubes
  - Double-lumen tube (DLT)
  - RAE tube.

Endotracheal tube (PVC) 00:22:56



Endotracheal Tube

- Endotracheal tubes provide proper anesthesia for the patient.
- **This tube has markings as follows:**
  - ID: the internal diameter of the tube.
  - OD: the outer diameter of the tube.
- Endotracheal tubes can be oral or nasal. It is an infraglottic airway device.
- It can be single-use or multiple-use and has the name of the manufacturer.
- It has the length marking and the indicator for the position of the vocal cord.
- At the end of the tube, it is a bit laterally cut so that we can see whether it is going while introducing it. This is the bevel end.
- The bevel end can get obstructed due to secretions. It can prevent oxygen administration. Thus, Murphy's eye is an alternative to providing oxygen or an inhalational anesthetic.
- The vocal cord guide has to be below the vocal cord when the cuff is inflated. Otherwise, the tube can get dislodged.
- The cuff can be inflated with the help of a pilot balloon.
- The universal adapter is connected to the machine end to provide oxygen or inhalation anesthetic.

Size of the endotracheal tube 00:28:10

- The distal end of the endotracheal tube is beveled to visualize the crossing of the vocal cords when the patient is intubated.

Used to determine the size of tube	
Size	depth of insertion
female, 7-8 mm ID.	20-22.
Male, 8-9 mm ID.	21-23.
Pediatric: older than 6 years of age: (Age/4) + 4.5 mm. Younger than 6 years of age: (Age/3) + 3.5 mm.	

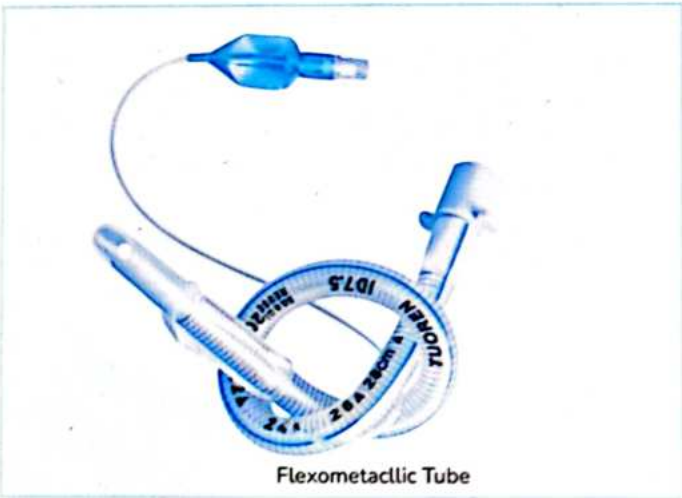
- We have to osculate the patient to determine whether the air entry is bilateral or not before fixing the tube.

Other parts of the endotracheal tube 00:30:40

- The proximal end is the machine end, which has a universal connector through which oxygen and inhalational anesthetics are provided.
- A pilot balloon is used to inflate the cuff. The pressure in the cuff should be 25–30 mm of water.
- The Murphy's eye is an alternative pathway for ventilation.
- The cuffs can be a high-volume, low-pressure cuff or a low-volume, high-pressure cuff.

Flexometallic tube

00:31:58

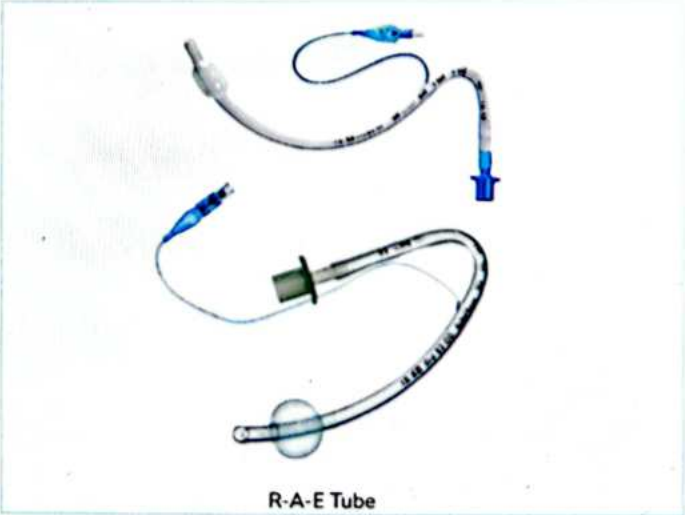


Flexometacllic Tube

- These have metallic wiring inside, which makes them kink-resistant.
- The tube bends easily. Hence, we have to use stellate.
- These are used in the prone position for neurosurgery and spine surgery. A normal PCV tube can get compressed, leading to obstruction of oxygen or inhalational agents. This is prevented by the flexometallic tube.

R-A-E tube (Ring Adair Elwyn)

00:35:02

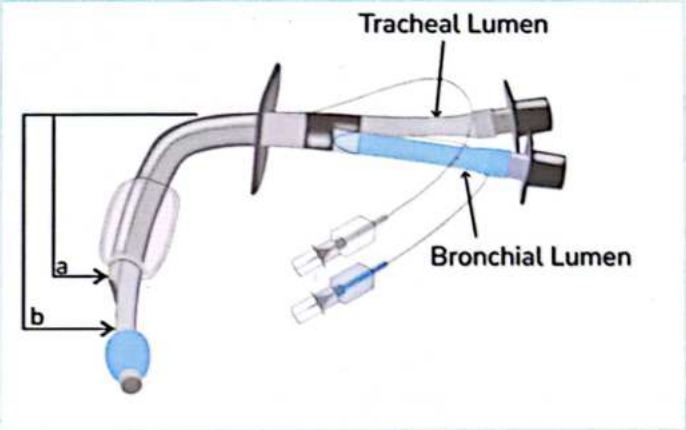


R-A-E Tube

- The three scientists named Ring, Adair, and Elwyn had discovered this tube.
- The RAE tube is also known as the "south pole tube" (universal connector facing towards the lower part of the patient) or the "north pole tube" (universal connector facing towards the head of the patient), depending on the bend of the tube.
- These are easy to secure and keep the breathing circuit away from the surgical field.
- They are used for oro-maxillofacial surgery.

D-L-T (double lumen tube)

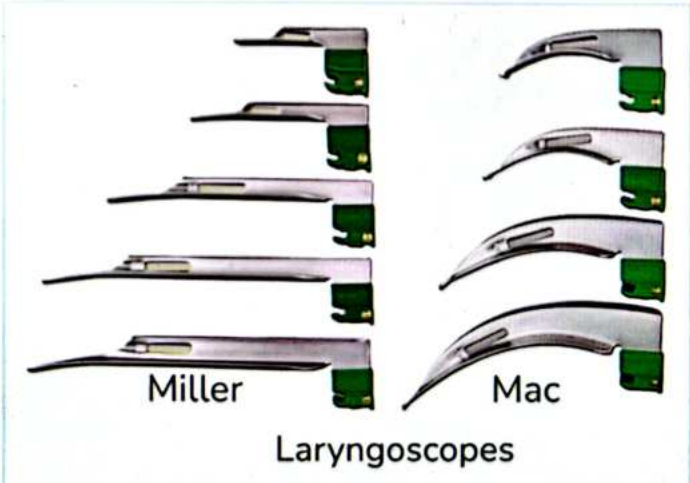
00:37:20



- A double-lumen tube is a modification of an infraglottic device.
- It has two lumens, the tracheal and bronchial lumens.
- Tube size includes no. 35, 37, 39, and 41 Fr. For pediatrics, 26 Fr. is used.
- **Uses are as follows:**
  - It is used in the isolation of one lung (lung protective technique).
  - It is used in thoracic surgery.
  - It is used for the isolation of the healthy lung from the infected one.
- The confirmation of its placement is done with fiber optic bronchoscope.
- The cuff has low pressure.

Laryngoscopes

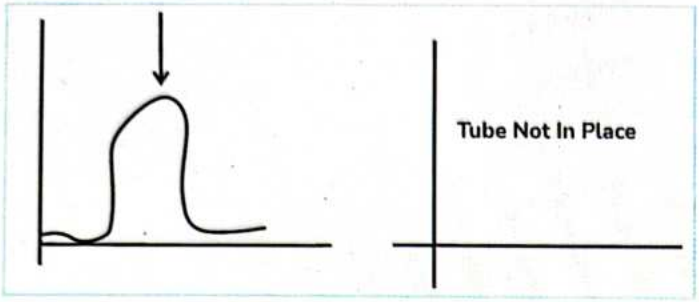
00:41:30



Laryngoscopes

- Laryngoscopes are used to introduce the airway devices. These help in the visualization of the airway.
- Different types of laryngoscopes include the curved-blade laryngoscope (Macintosh laryngoscope) and the straight-blade laryngoscope (Miller's laryngoscope).

Position of the oral cavity for intubation 00:42:13



- We have to see the position of the oral cavity during intubation.
- The morning sniffing position, or barking dog position: In this, the head is taken back.
- The confirmation of the endotracheal tube placement is done by capnography.

Infraglottic device uses 00:43:51

- These can be used in an emergency or ICU (for airway access or maintenance of the airways).
- The patient requiring long-term ventilation cannot be put on an endotracheal tube due to the risk of infection, infraglottic devices can be used in such patients.
- In the case of a motor vehicle accident where the patient cannot be validated or intubated (CVCI), then different maneuvers are required.

Techniques when ventilation or intubation isn't possible 00:45:27

Technique

- Percutaneous jet intubation
- Retrograde intubation.
- Cricothyrotomy (percutaneous or surgical)
- tracheostomy (percutaneous or surgical).

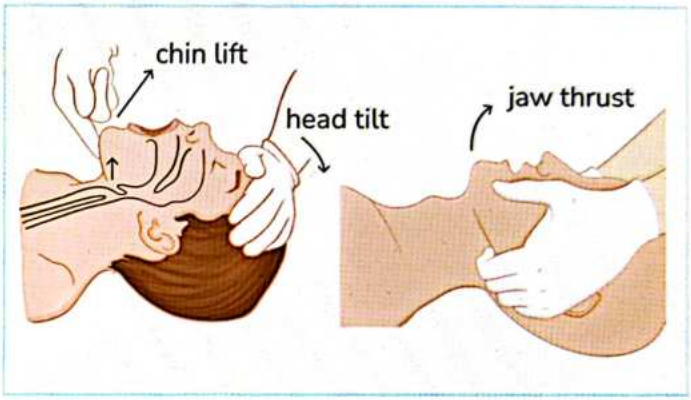
Surgical

- Tracheostomy
- Percutaneous

Percutaneous jet ventilation 00:46:24

- Percutaneous jet ventilation is trans- tracheal jet ventilation.
- We do not put any airway device and are unable to secure a normal airway in these patients.
- We have to insert a 12–16-gauge needle and provide high-pressure oxygen.
- This provides a high oxygen concentration.
- The inspiration-to-expiration (I:E) ratio has to be 1:1.
- The rate has to be high as it is an emergency procedure.
- The venture principle is involved.
- The complications are as follows:
  - Hemorrhage.
  - Unsuccessful placement.
  - Subcutaneous emphysema: The needle might get inside the subcutaneous tissue.
  - Pneumothorax.
  - Esophageal perforation.
  - Injury to the vocal cords.
  - Infection.
  - Trans-esophageal fistula.
  - Tracheomalacia.

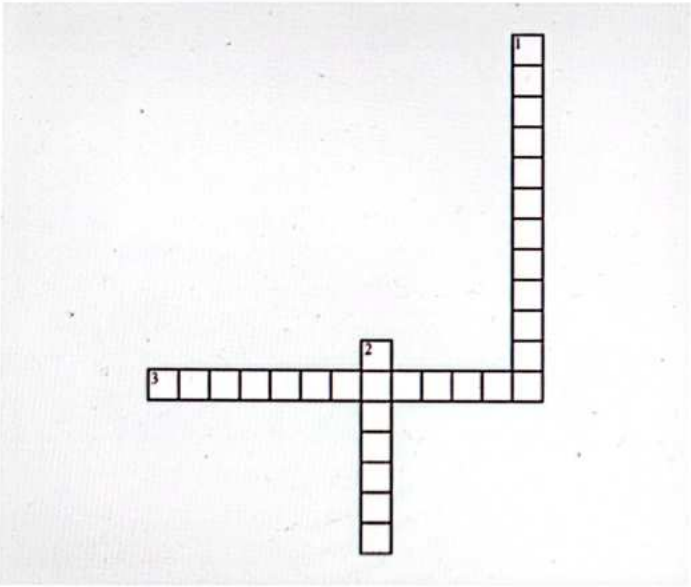
Maneuvers to open Airway 00:49:08



- While intubating the patient, we use certain types of maneuvers.
- These include head tilt and chin lift, and jaw lift and jaw thrust.
- With a head tilt and chin lift, we are utilizing the cervical column of the patient. In cases of road traffic accidents, we cannot extend the cervical vertebrae of the patient due to a suspected cervical injury. In such cases, we use the jaw lift or jaw thrust method to open the airway.

CROSS WORD PUZZLES

Crossword Puzzle1



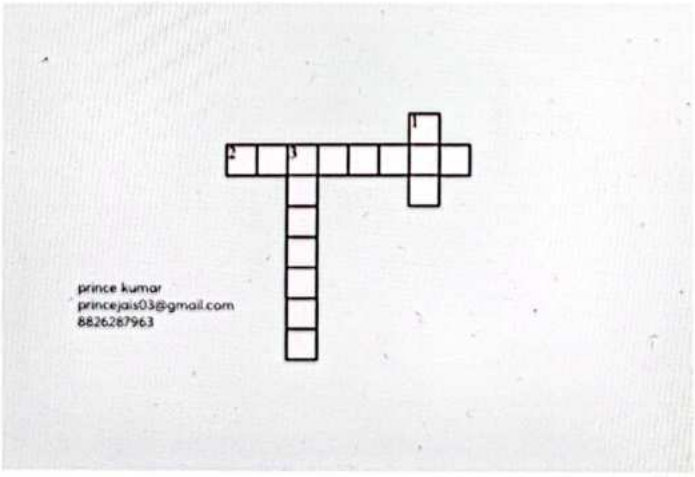
Across

3. _____ devices rest above the laryngeal inlet.

Down

1. _____ devices rest below the laryngeal inlet.
2. _____ LMAs were the first device to be discovered and are used due to their low cost and easy availability.

Crossword Puzzle2



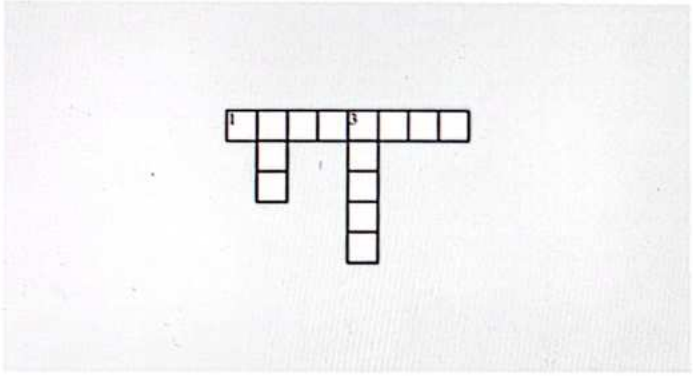
Across

2. _____ aperture is the proximal connector.

Down

1. _____ tubes are used for oro-maxillofacial surgery.
3. _____ valve prevents the backflow of air from the inflation line.

Crossword Puzzle3



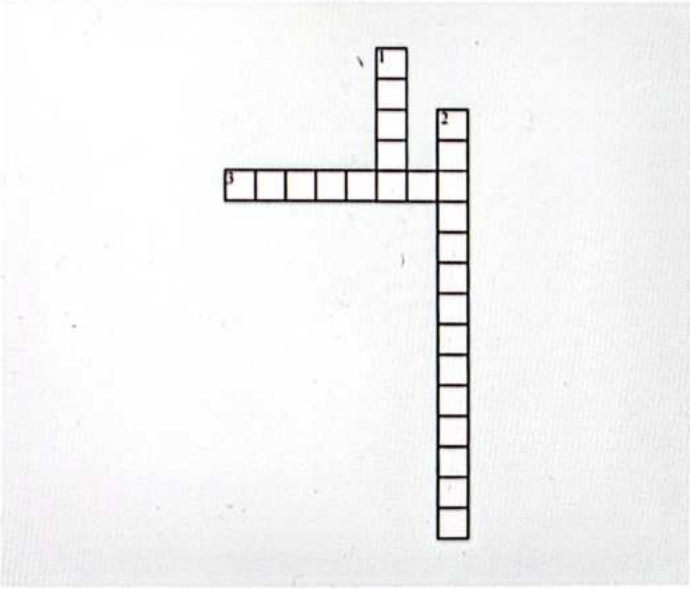
Across

1. _____ LMA is not kinkable.

Down

2. _____ Proseal decreases the risk of aspiration.
3. _____ is a single-use thermoplastic device that swelled up in the oral cavity.

Crossword Puzzle4



Across

3. _____ airway device is contraindicated in intact gag reflux.

Down

1. _____ cord guide has to be below the vocal cord when the cuff is inflated. Otherwise, the tube can get dislodged.
2. _____ devices are used only to provide a little oxygen to the patient or support system to the supraglottic and infraglottic airway devices.

6 ANESTHESIA MACHINE

- The first anaesthesia machine was known as Boyle's machine.
- Dr. Edmund Boyle discovered it, and later on, as time progressed, a very advanced machine known as Workstation was developed.

Different Parts Anesthesia Machine 00:01:21

- The anaesthesia machine is divided into three basic parts.
  - High-pressure system
  - Intermediate pressure system
  - Low-pressure system
- The gases which are present in the cylinders are compressed and kept at very high pressure so that more and more gases can be kept in this cylinder.
- But our lungs can not tolerate those pressures, and that can eventually lead to barotrauma, which the patient does not want.
- So, basically, anesthesia machines have different pressure systems which down-regulate the pressure of the gases, and the optimum amount of pressure is delivered to the patient.

Historical Aspects of Boyle's Machine 00:02:19

- Dr. Edmund Boyles discovered the first anaesthesia machine and named it Boyle's machine.
- This machine is the prototype of all the machines which are used.
- The machines or workstations presently available are more complex. It had a ventilator attached to it and a scavenger system which absorbed the carbon dioxide and led the fresh gas flow to the patient.
- This machine also has a high-pressure, intermediate, and low-pressure system.
- From this low-pressure system, the oxygen and all the inhalation anaesthetic agents were delivered to the patient at a pressure which was tolerable by the patient's lungs.

Boyle's Machine 00:03:21

- This is a general depiction of Boyle's machine.
- Boyle's machine had various features which were added to the workstation and in the workstation.
- There are many more advances like the
  - Monitors are attached,
  - Carbon dioxide scavenger system, and a
  - Ventilator attached.
- All these benefits are present in the recent anaesthesia workstation.
- Different flow meters and bain circuits are present.
  - The Bain circuit delivers the fresh gas flow, including inhalation anesthetic agents, oxygen, and nitrous to the patient.
  - Flow regulators and cylinders are represented with red colour in the image of Boyle's machine.

High-Pressure System 00:04:45

Contents of High-Pressure System

- Gas cylinder and
- yoke assembly system.

Refer Table 6.1

Important Information

- Boyle's machine or any other machine, some safety mechanisms are present. Because there can be chances that
  - Something wrong might happen or techniques or staff, or an anesthetist might put the wrong cylinder at the wrong place.
  - So to prevent these things, there was a Pin index system.

Type of Cylinder Pin Index 00:08:00

- On the cylinder or on the machine there were 7 points like 1,2,3,4,5,6,7.
- Every cylinder had a different pin index.

Easier Way to Learn Pin Index Systems 00:10:46

N_2O / 760 Psi	3, 5	Blue
Air	1, 5	Gray & Black / White
Co_2 (>7%)	1, 6	Grey
Co_2 (<7%)	2, 6	Grey
Entonox 50% O2 : 50% N_2O	7	Blue & white
Cyclopropane	3, 6	Orange
Heliox (He + O_2) – 70:30	2, 4	Brown
Heliox (He + O_2) – 60:40	4, 6	Brown

- Air is a single component and remembers its basic pin index as 1,5.
- Oxygen has two components and the pin index is 2,5.
- Nitrous oxide has three components and its pin index is 3,5.
- The pressure in an oxygen cylinder is around 2000 psi and the pressure of a nitrous oxide cylinder is around 760 psi.
- This is way to higher pressure for the lungs to be tolerated.
- Lungs can tolerate about 10-12 mm of Hg pressure.
- This is the reason there are different pressure systems to down-regulate the pressure of these gases and to give the optimum amount of pressure that can be tolerated by the lungs.

Carbon dioxide cylinders are needed

- Sometimes used in reversal of the patients.
- Certain amount of carbon dioxide is also required for the normal breathing of the patients.
- If the concentration of carbon dioxide is >7% in the cylinder then the pin index is 1,6. If the concentration of carbon dioxide is <75, then the pin index is 2,6.

Other gases which are present in the cylinder.

- Entonox, it had a combination of 50% of oxygen and 50% of nitrous oxide.
- It has a separate pin index which is designated by 7.
- Gaseous agent, known as cyclopropane has a different pin index 3,6.
  - Heliox, as the name suggests,is the combination of helium and oxygen. There can be two cylinders in different concentrations of,
    - → A ratio of 60% of Helium and 40% of oxygen, the pin index of 4,6.
    - → A ratio of 70% of Helium and 30% of oxygen, the pin index of Heliox is 2,4.

Colour Coding 00:16:02

- Colour coding is one of the other options for safety measures.
- For every gas cylinder the top part is known as the shoulder, and the lower part is known as the body.
  - Oxygen has white shoulder and black body
  - Nitrous oxide has a blue colour.
  - Air has grey and black /white colour.
  - Carbon dioxide has grey colour.
  - Entonox is in blue and white colour.
    - → Entonox is the combination of oxygen and nitrous oxide. It has white colour from oxygen and blue colour from nitrous oxide.
  - Cyclopropane has an orange colour.
  - Heliox has a brown colour.

Labels of Cylinder 00:18:29

- Labels on cylinders are most accurate to identify the content of the cylinder.
  - As over usage of the cylinder can lead to removal of colour from the gas cylinder.
- Every part in the anaesthesia machine has a pressure reducing system because the lungs can only tolerate a pressure of 10-12 psi.
- All these pressure systems have pressure reducing valves so that about 10-12 psi is being delivered to the lung and prevent any barotrauma.

Intermediate Pressure System 00:19:28

- It is the second part of Boyle's machine.
- After different pressure reducing valves, the gas comes to a low pressure.i.e, from a high pressure to an intermediate pressure system.
- But there are different parts of the intermediate pressure system as well.

Gas Pipes Having Central Supply

- A cylinder is directly attached to the cylinder and it varies from different operation theatres (OT) to OT. Some OT might have an extra oxygen cylinder and some OT might have nitrous oxide/ oxygen cylinder.
  - But the gas pipelines have a common outlet.
    - → That there is a unit designated in the hospital which supplies oxygen all over the hospital. It supplies oxygen/ nitrous oxide/air.
  - It is centrally located.
  - The gas pipelines are centralized air conditioners.
  - Whereas gas cylinders are designated to the room itself.
- Colour coding of gas pipelines

Intermediate Pressure System

(1) Gas Pipelines	(2) Emergency O2 Flush
1. O_2 – White	• Release at least 35 litre of O2 at 55-60 Psi
2. N_2O – Blue	
3. Air – Black	

- The gas pipelines have the same colour coding as that of cylinders because they are accepted worldwide.

Emergency Oxygen Flush Button

- The basic parameter which has to be fulfilled by companies who are making these anaesthetic machines is that
  - Emergency oxygen flush button is pressed, so that at least 35 litres of oxygen at a pressure of 55-60 psi need to be supplied. in case of emergencies like

→ Patients might be desaturated (or) may have bronchospasm.

DISS: Diameter Index Safety System

- In the cylinder, we have a diameter index safety system.
- It was a standard of engineering standards preventing compressed gases from linking pressurised gas holding tanks to wrong tubing.
- It means that the wrong placement of the pipe lines can be avoided by following DISS.
- Bare minimum delivery by oxygen flush button has to be 35 litre/minute with a pressure of 55-60 psi.

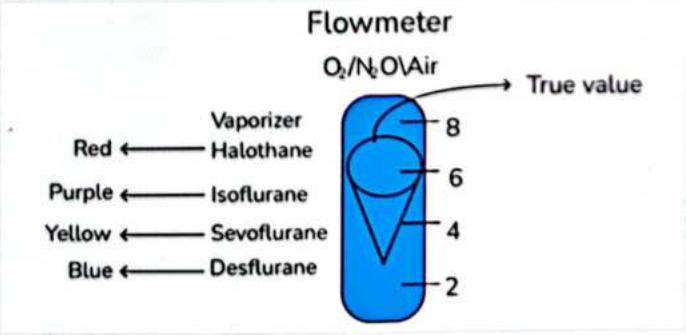
Low Pressure System

00:24:22

- It is the last part of the pressure system.
- In the initial phase of Boyle's machine, there was a green colour bain circuit which was attached to the machine.
- It was the common gas outlet.
- Low-pressure system consists of a common gas outlet which means a mixture of oxygen, nitrous oxide and the mixture of inhalation agents which is being given to the patient to provide anesthesia to him or her.
- Vaporizers are the containers in which different inhalation agents are maintained.

Flow Meter

- In the flow meter, there was an oxygen flow meter, nitrous oxide flow meter and air flow meter.



- Flow meter can be of oxygen, nitrous oxide and air as depicted in the picture.
- Flow meters had different values like 2,4,6,8. These are the values that measure the amount of these gases which are delivered per minute.
- The amount of air, oxygen, and nitrous oxide being delivered to the patient can be determined by thorpe's tube in the flow meter.
- The conical shape of the tube in the flow meter is known as thorpe's tube.
- This thorpe's tube is varying from around 7 to 3 litres.
- The conical surface on the top of the thorpe's tube depicts the true value that means around 7 litres of any gases is being delivered to the patient.
- The true value is depicted by the above circular portion of the thorpe's tube.

Vaporizers

- Different inhalation anaesthetic agents are kept in separate containers; those containers are known as vaporizers.
- The four different types of inhalation anaesthetic agents which are using are
  - Halothane
  - Isoflurane
  - Sevoflurane
  - Desflurane
- Easily can be remembered by HISD.
  - The vaporizer of halothane is in red colour.
  - The vaporizer of Isoflurane is in purple colour.
  - The vaporizer of sevoflurane is in yellow colour.
  - The vaporizer of desflurane is in blue colour.
- These are again safety mechanisms.
  - The colour codings are very important in all of the pressure systems.
  - Top end of the flow meter is known as the true value, and that tube is known as thorpe's tube.
- Some mechanisms which are present in the boyle's machine or any other workstation which are being used.
- The mechanism which is present in the case of mishap or there is a breakage of oxygen delivery something happens in the system when there is oxygen not delivered to the patient. This is known as hypoxic guard.

Hypoxia Guard

00:30:09

- Master and Slave mechanism of oxygen has to be delivered if by mistake only nitrous oxide flow meter is turned on.
- If oxygen is turned on then only a nitrous oxide cylinder is to be turned on.
- For instance the cylinder gets empty and the anesthetist does not come to realise that the oxygen is going down and it has gone down to such a level that nothing is being visible on the flow meters. So, the nitrous oxide cylinder was full, but the oxygen cylinder had gone empty.
- In the normal circumstance there should be a flow of nitrous oxide to the patient but that does not happen.
- A bare minimum oxygen supply has to be there so has to deliver a bare minimum amount of nitrous oxide.
- This is one of the examples of Master and slave mechanism or hypoxic guard.

Important Information

In this Master and Slave mechanism,

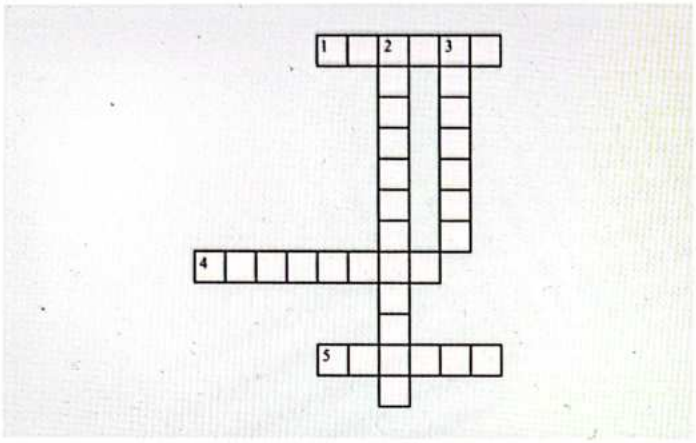
- Oxygen is the Master.
- Nitrous oxide is the Slave,
- So, without the deliverance of the oxygen, the nitrous oxide cannot be delivered to the patient.

Table 6.1

Gas Cylinder	Yoke Assembly System
• The materials used mostly for the gas cylinder are steel or molybdenum. • Different materials are used for MRI machines because an MRI machine sucks everything which is in its magnetic range. o Titanium or aluminium is used to make cylinders which are compatible with the MRI machine. o Titanium and aluminium is used for making gas cylinders, which can be used during MRI procedure. • The different sizes range from A-HH-size. • All the cylinders can not be attached to Boyle's machine. • But only Type E cylinders are attached to the boyles machine.	• It is basically an apparatus that consists of a nipple, which is required for proper attachment of the cylinder. o If the cylinder is placed on the Boyles machine. It should be properly attached to its designated area. o Over Here nitrous oxide cylinder should not be attached in place of the oxygen cylinder. → To prevent this mishap, there was a yoke assembly system which consisting of a nipple, which fixed to the desired gas cylinder. That can prevent any leakage. • It maintains a unidirectional flow of gases. o That means the gas cannot flow back from the machine to the cylinder, the gas can only be delivered from the cylinder to the machine.

CROSS WORD PUZZLES

Crossword Puzzle 1



Down

2 .....system which consists of a nipple for proper attachment of the cylinder.

3 ..... had a combination of 50% of oxygen and 50% of nitrous oxide.

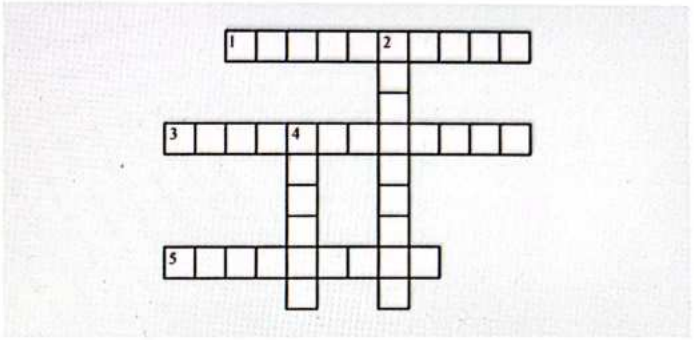
Across

1 .....machine is the first anesthesia machine.

4 .....system helps to place the correct cylinder at the correct place.

5 .....is the combination of helium and oxygen.

Crossword Puzzle 2



Down

2 .....is the container in which different inhalation agents are kept.

4 ..... is the master in the Master and Slave mechanism.

Across

1 .....basically is a pressure reducing valve.

3 .....the gas cylinder has blue colour coding.

5 .....system absorbs carbon dioxide and leads the fresh gas to flow towards the patient.

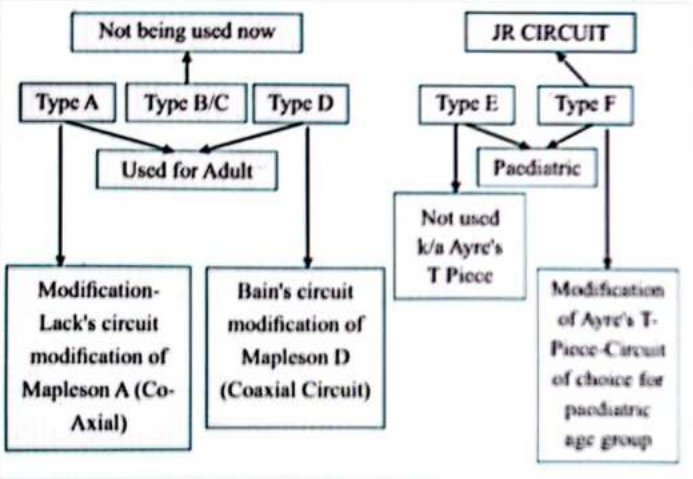
7 ANAESTHESIA CIRCUIT

Classification of Anaesthesia Circuit 00:01:06

There are three types of anaesthesia circuits:

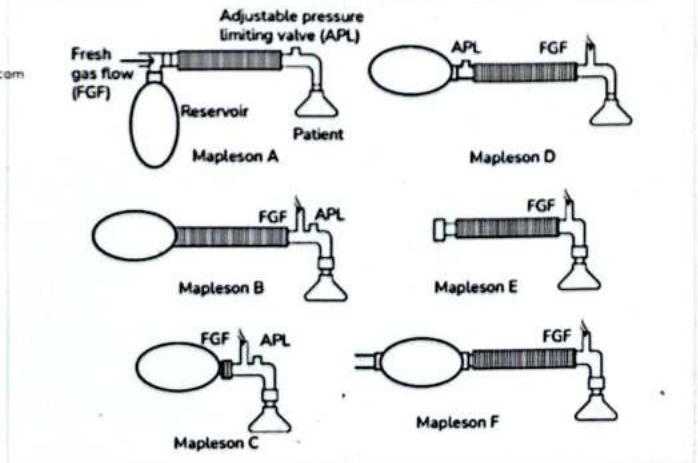
- Open (Obsolete)
- Semi-closed is also known as Mapleson circuit
- Closed circuit
- Open circuits are not used these days. They are obsolete circuits. The circuits that are used on a day-to-day basis are semi-closed and closed.

Classification of Semiclosed Circuits/Mapleson



- Semi-closed circuits were discovered by Mapleson, which is why they are also known as Mapleson circuits. There are a few types of semi-closed circuits like Type A, Type B, Type C, Type D, Type E, and Type F. Only Type A, Type D, and Type F are to be studied.
- Types B and C are not used now. Because of severe disadvantages, Type E is also not used. These disadvantages were overcome by Type A, Type D, and Type F.
- In the anaesthesia machine, there are cylinders, flowmeters, and a fresh gas outlet where green colour tubing was hanging out. That green tubing allowed us to give oxygen nitrous and inhalation anaesthetic agents to maintain. To maintain a fresh gas flow in the patient when the surgery starts, during the surgery, and when the patient comes out. Different modalities are being used to bring down the nitrous oxide and inhalational agents and 100% oxygen is given to the patient. This is a Mapleson circuit.
- Type A, Type B, Type C, and Type D are semi-closed Mapleson circuits and are used for adults.
- Type E and Type F are used for paediatrics up to the weight of 20 kilograms.
- Though Type B and C and Type F are obsolete now and they are not being used.
- Type A semi-closed circuit had a modification and was known as Lack's circuit. The lack circuit was a modification of Mapleson A.
- Type D semi-closed circuit had a modification and was known as Bain's circuit.
- Meaning of coaxial circuit. Two tubes one over the other. The advantages of these tubes are they were overlapped as an outer tube and an inner tube. The difference between these tubes is that one tube gives the patient the fresh gas flow, and the other consists of the exhaled gases from the lungs of the patients.
- One of the tubes in both the coaxial circuit carried fresh gases such as oxygen, nitrous oxide, and inhalational anaesthetic agents to the patient, while the other tube brought all these things out because when exhaled, these things come out of the circulation.
- To maintain the anaesthesia, we must keep giving these fresh gas flows to the patient. When the patient exhales, the same chemicals are present in the circuit along with Carbon dioxide.
- So, the meaning of a coaxial circuit is one pipe consisting of fresh gases while the other pipe utilizing the exhaled gases consists of fresh gases with carbon dioxide.
- Fresh gas flow is equal to oxygen + nitrous oxide + inhalational anaesthetic agent.
- Exhaled gases consist of all + carbon dioxide.
- In adults, the most used semi-closed Mapleson circuits are Type A and Type D.
- Type E and Type F are used for paediatrics.
- Type F is the modification of Type E and is known as the JR circuit, named after the scientist Jackson and Rees. It is the circuit of choice for paediatrics.
- Type B, C, and E are not being used nowadays only Type A, D, and F are used.

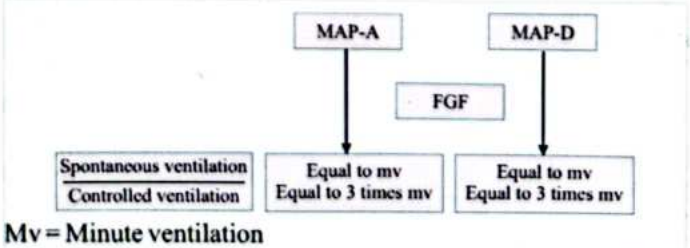
Different types of Mapleson circuits 00:09:46



- These two lines depict a coaxial circuit. A fresh gas flow is going. There is an adjustable pressure limiting valve (APL). The pressure is increased or decreased by revolving it.
- Every Mapleson circuit except for E does not have a reservoir bag. There is no reservoir bag in Mapleson E.
- The circuit where fresh gas flow is written, was attached to a Boyle's machine or an anaesthesia machine. It's the workstation under use. The end of the fresh gas flow is attached to that part.
- The oxygen, nitrous oxide and inhalational anaesthetic agents enter the lungs of the patients through this fresh gas flow in the laminar flow. The APL valve can be regulated to see how much pressure is needed for the patient. In the same unidirectional flow, the contents will go out. The fresh gas flow consists of oxygen, nitrous oxide, and inhalational anaesthetic agents, and exhaled contents consist of all these things and carbon dioxide.
- Now when these gases which were mixed went out, they went into this reservoir bag. On pressing this reservoir bag, all the contents can again go into the patient's lungs. The disadvantage is that this bag had carbon dioxide inside it, and when pressing it, it gives the patient another breath.
- Under anaesthetic effect, the patient is not able to breathe so this bag acts as an outside lung for the patient. With the help of a face mask, all the contents get delivered.
- Now after exhaling all the contents are gathered in this bag and the bag is ready for another breath. This bag contains all the fresh gases and carbon dioxide. The disadvantage is that when the next breath will be given it contains carbon dioxide as well in less concentration because most of the gases are vanished because of this APL valve.
- This leads to the loss of oxygen, nitrous oxide, and inhalational agents in the atmosphere.
- This is the general fundamental behind the semi-closed circuit.
- In Mapleson A, D, and F, there is a reservoir bag, fresh gas flow, and an APL valve, but there is no APL value in the JR circuit because the lungs of paediatrics are fragile, so any barotrauma to the patient is avoided.
- The bags are closed in other circuits but an opening is there in Mapleson F, so the pressure is released.

Spontaneous and Controlled Ventilation 00:16:26

- Minute ventilation is the total litres a patient consumes in 1 minute.



Mv = Minute ventilation

- It reduces the amount of FGF required for specific types of surgery.
- Minute ventilation is tidal volume times the respiration rate.
- A patient who comes to the anaesthesia table breathes spontaneously as well.
- After giving medications, breathing can get suppressed. It can stop by giving certain muscle relaxants.
- The difference between spontaneous and controlled ventilation is that spontaneously breathing patients require no or minimal support of oxygen from outside.
- That means if a mask is placed on the patient's face who is spontaneously breathing, there's no need to press the reservoir bag again and again because the patient is breathing independently.
- Spontaneously breathing patients do not require the full support of ventilation. They require partial support.
- They might not be able to maintain their oxygen saturation in that case, ventilation support is needed, but that does not mean the patient is not breathing. They just can't maintain their oxygen saturation.
- Control ventilation is when all the respiratory muscles of the patient are paralyzed, and the patient is being ventilated by the reservoir bag. They are totally in our control.
- The usage of MAP-A and MAP-D is different in spontaneous ventilation and controlled ventilation.

Q. What happens when using MAP-A and what happens when using MAP-D?

- A fresh gas flow is given for all the gases to go back into the reservoir bag, now spontaneously ventilating the patient. If MAP-A is used to avoid any rebreathing, the fresh gas flow must be equal to minute ventilation.

Q. What is minute ventilation?

- For example, if the tidal volume patient takes 400 ml × 12 (respirate rate of the patient) that makes 4800 ml the minute ventilation of the patient.
- Now, if MAP-A is used, a fresh gas flow equal to 4800 ml must be given.
- Using MAP-D in spontaneously ventilating the patient to avoid any rebreathing, a fresh gas flow equal to 3 times minute ventilation which means if minute ventilation is 48,00 ml. 15,000 ml of fresh gas flow to avoid rebreathing.

Important Information

- If using MAP-A in a patient who is breathing spontaneously then to avoid rebreathing that is breathing in all the anaesthetic agents + carbon dioxide the fresh gas flow must be equal to minute ventilation.
- If using MAP-D in a patient who is spontaneously.

breathing, to avoid rebreathing the fresh gas flow must be 3 times a minute ventilation.

- In spontaneous ventilation, a smaller number of gases are used in MAP-A as compared to MAP- D because the minute ventilation is equal to fresh gas flow in MAP-A while the fresh gas flow is three times as compared to minute ventilation in MAP-D.

- Controlled ventilation when the patient's lungs are under our control. In a patient on whom MAP-A is being used in controlled ventilation to avoid rebreathing the fresh gas flow must be three times.
- Now in this, on the contrary, MAP-A is utilizing three times the minute ventilation to avoid rebreathing while MAP-D is utilizing 1.8 times of minute ventilation.
- For Spontaneous ventilation, MAP-A is the circuit of choice.
- For Controlled ventilation, MAP-D is the circuit of choice.

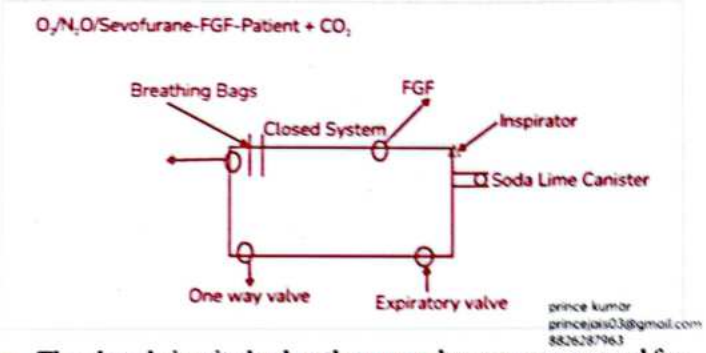
Advantages and Disadvantages of Semi Closed Circuits

- As told APL valves vented out all the inhalational anaesthetic agents into the atmosphere. It is causing a lot of OT pollution.
- With carbon dioxide, all agents are vented out it is a lot of wastage.

Uses

- These can be easily ported from here to there.
- Different cases have different circuits, in cases, in which less amount of anaesthesia is required, or only opioids, or the patient must be be spontaneously ventilating but should not feel any pain. If the patient is spontaneously ventilating, the MAP-A circuit is used.
- In laparotomies or major surgery, the patient is needed to have control ventilation which can be achieved by MAP-D.
- MAP-F known as the JR circuit is the circuit of choice for paediatrics. Weight is 20 kgs. Above 20 kgs adult Mapleson circuits are used.
- For spontaneous ventilation, MAP-A is used.
- For controlled ventilation, MAP-D is used.
- If a patient is getting operated on under spontaneous ventilation, but a MAP-A circuit is not available, then MAP-D must be used.
- For spontaneous first option is MAP-A second option is MAP-D last options are B and C which are obsolete now. (A>D>B>C)
- For controlled first option is MAP-D the second option is B and C and the third is MAP-A. (D>B=C>A)
- If they don't mention which kind of ventilation is given to the patient, then the circuit of choice must be MAP-D.

Closed Circuit



- The closed circuit also has the same phenomenon as used for semi-closed circuits.
- The closed circuits are also known as the workstation.
- It is a big machine in the OT with different monitors, ventilating support, tubing, and all the precautions kept in mind.
- The biggest advantage is the soda lime canister. In the semi-closed circuit, there was an APL valve and because of that valve, the gas is vented out causing a lot of OT pollution and loss of anaesthetic drugs.
- But this being a closed circuit the gas keeps on revolving inside the soda lime canister and absorbs the carbon dioxide.
- What happens is, that fresh gas is given to the patient. Under the anaesthetic effect, the patient exhales out or is made to exhale as they are under controlled ventilation.
- These gases with carbon dioxide go into the circulation of the closed system. They reach the soda lime canister.
- The soda lime canister absorbs the carbon dioxide and then releases the other useful gases which go into the circulation of the patient again an give the next breath.

Properties of Carbon Dioxide ABSORBANT

Constituents	(%) Percentages
NaOH	4% (Main Comp.)
$Ca(OH)_2$	Maximum (Remain Amount)
H_2O	11-18%
KOH	1%
Silica	Hardness to soda lime
Dye	Color

- It comprises sodium hydroxide, calcium hydroxide, water, potassium hydroxide, silica, and dye. Every constituent has a different responsibility.
- It is not necessary always that the constituent having the maximum amount is the main constituent.

27

- In this table, the maximum amount is of calcium hydroxide.
- But the main constituent of carbon dioxide absorbent is Sodium Hydroxide.
- Why it is in less quantity can be known by seeing the reaction that takes place in carbon dioxide absorption.
- Water is 11-18%.
- Potassium hydroxide is 1%.
- Silica is used to give hardness to soda lime if it becomes a little soft it is time to change the soda lime.
- Dye, which gives colour. Carbon dioxide is pink in colour. When it keeps on absorbing carbon dioxide, it will change its colour to white. That means it's time to change the soda lime.

Reaction

$$CO_2 + H_2O \rightleftarrows H_2CO_3 \rightarrow NaOH$$
$$\downarrow KOH \text{ (Catalyst)}$$
$$Na_2CO_3 + H_2O \text{ (Main reaction)}$$
$$\downarrow$$
$$+ Ca_2(OH)_2 \rightarrow CaCO_3 + NaOH$$

- The patient is breathing out carbon dioxide.
- This carbon dioxide combines with water and forms carbonic acid.
- This carbonic acid combines with sodium hydroxide under the effect of potassium hydroxide which acts as a catalyst forms sodium carbonate + water and this water is being used again and again. This is the main reaction.
- That is why sodium hydroxide is the main component. After this reaction occurs, calcium hydroxide is formed, then calcium carbonate and sodium hydroxide. And this sodium hydroxide is used back again.

Properties of Sodium Hydroxide

- It is kept in a smaller amount as it is highly toxic. Rest of the work is done with calcium hydroxide.
- But NaOH is the main component.
- Dye gives colour to carbon dioxide absorbent.
- When the dye is fresh and has not absorbed too much amount of carbon dioxide it is pink in colour.
- As carbon dioxide is acid for our body it must be removed again and again, and when carbon dioxide is added to the soda lime the colour changes from pink to colourless which is white.
- Use of silica gel is it gives hardness and increases the surface area if the surface area increases more and more amount of carbon dioxide is absorbed and preventing dusting as well.

Uses

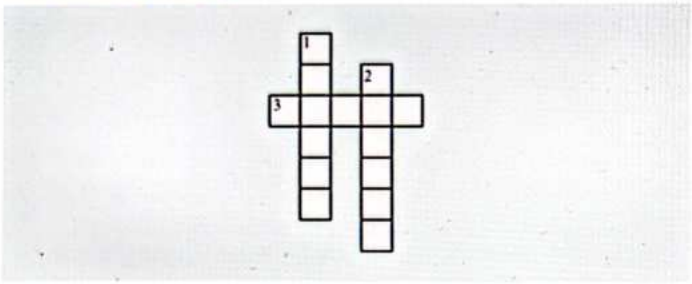
- As it is a closed circuit, no gases go out, so there will be less OT pollution, and the same thing is used again, making it more economical.

Disadvantage

- The machine is too big.
- It Cannot be transported, so a semi-closed circuit is used.

CROSS WORD PUZZLES

Crossword Puzzle 1



Across

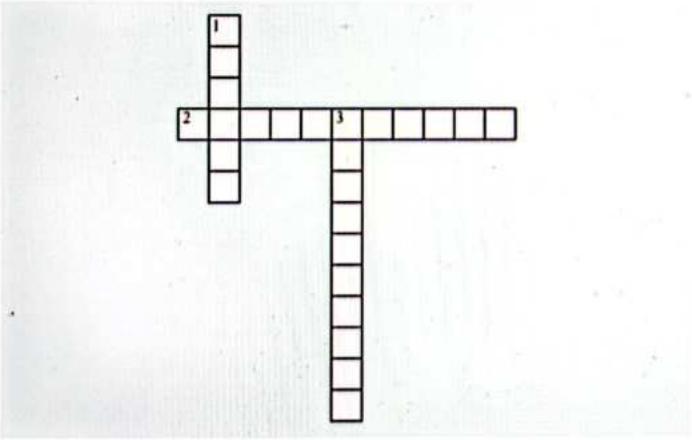
3- Sodium Hydroxide is kept in a smaller amount as it is highly _____

Down

1- The machine is too big is a disadvantage of _____ circuit.

2- _____ gives hardness and increases the surface area.

Crossword Puzzle 2



Across

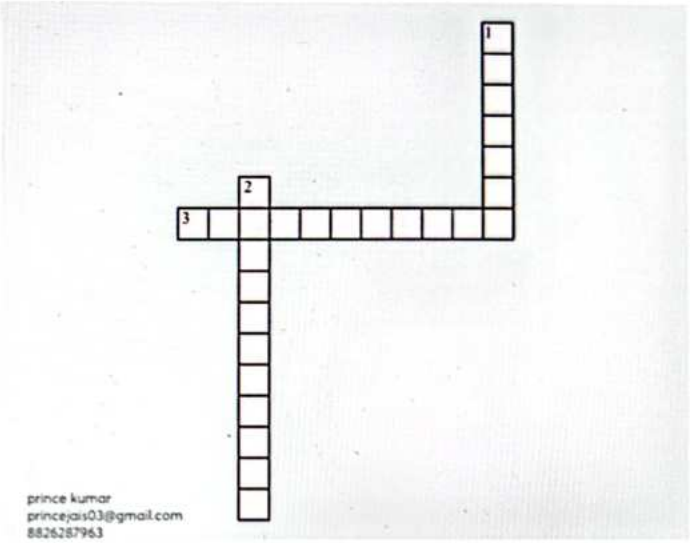
2- OT Pollution is a disadvantage of _____.

Down

1- _____ is the circuit of choice for the pediatric group.

3- MAP-D is the circuit of choice for _____ ventilation.

Crossword Puzzle 3



Across

3- MAP-A is the circuit of choice for _____ ventilation.

Down

1- The soda lime canister _____ carbon dioxide.

2- The closed circuit is also known as _____.

8 MONITORING IN ANAESTHESIA

00:00:01

Clinical Monitoring

- Oxygenation: Proper oxygenation should be available for every patient undergoing surgery.
- Circulation: The patient's circulation, including the BP and heart rate fluctuation, should be checked. These provide a useful guide for the management of patients.
- Respiration: This helps in the clinical monitoring of the patients. After the muscle relaxants are given, the patient goes into respiratory paralysis and is monitored under controlled ventilation.
- Depth of anesthesia: This means how deep the patient has gone into the anesthesia.
- The function and duty of the anesthetist are to maintain and check all the above features mentioned.

Mandatory Monitors

00:04:51

- The mandatory monitors were made by the American Society of Anesthesiologists (ASA).
- The mandatory monitors are as follows:
  - ECG:
  - NIBP: Non-Invasive Blood Pressure.
  - Capnography
  - Pulse Oximetry
  - Temperature

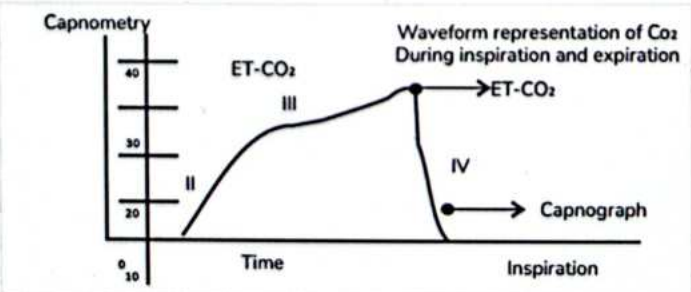
Additional Monitors

- Echocardiography
- CVP monitoring: Central Venous Pressure monitoring.
- TEE: Transesophageal echocardiography.
- Neuromuscular monitoring: To check the effect of the muscular relaxant.
- Evoked potential monitoring: This is totally related to neurosurgery.
- Bispectral Index (BIS)
- Entropy

Capnography

00:08:16

- Normal range of capnography- 35-45 mmHg (end tidal CO_2 monitoring)



- Capnography is used to measure end-tidal Co_2.
- The normal range of capnography is 35- 35 mmHg.
- The numerical value along the Y- axis is called capnometry.
- The above-drawn graph is called a capnograph.
- During inspiration, there is a gaseous exchange; the oxygen returns to circulation, and the CO_2 returns to the alveoli.
- The roman numbers represent the different stages of the capnograph. There are four stages.
  - Stage 1: Shows the dead space ventilation, which means it is the start of the ventilation. This stage is not helping with any kind of ventilation.
  - Stage 2 : Shows the dead space ventilation with the alveolar ventilation; this gaseous exchange now occurs inside the lungs.
  - Stage 3 : The graph peaks, marking the total alveolar ventilation.
  - Stage 4 : This shows the fall of CO_2 level, which means there is a proper inspiration.

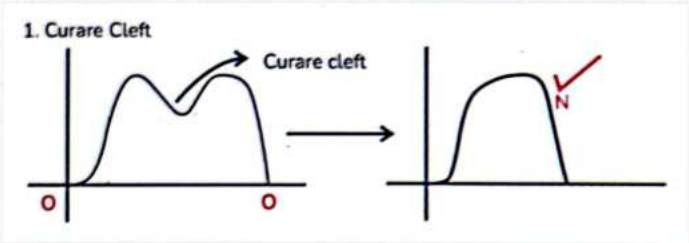
↓ETCO$_2$	↑ETCO$_2$
Hyperventilation	Hypoventilation
↓ Temperature	↑ Temperature (Malignant hyperthermia)
Pulmonary Embolism	Thyroid storm

Malignant Hyperthermia

- Malignant hyperthermia is an autosomal disease.
- **Clinical features include:**
  - Increase in CO_2 level.
  - It is a hypermetabolic state, so the BP and temperature will increase.
  - There will be an acidosis condition, i.e., H+ ions will increase.
  - Potassium ions will increase.
  - Ultimately leading to renal failure.
- **The causes of malignant hyperthermia are as follows:**
  - Succinylcholine, is also the only depolarising muscle relaxant.
  - Halogenated compound.
  - Lignocaine.
- **Treatment:**
  - Stop the causative agent.
  - The treatment of choice in malignant hyperthermia is IV dantrolene.
  - Symptomatic management.

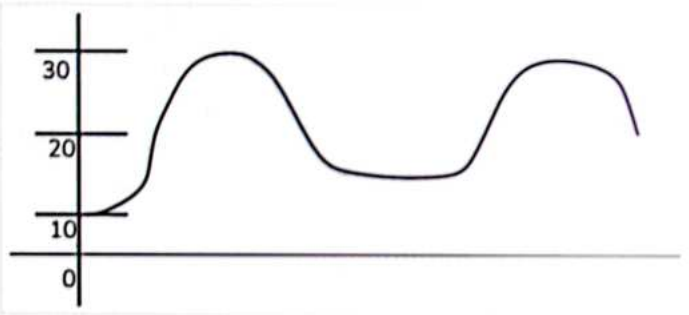
Types of Etco$_2$ Graph and their Implication 00:24:18

Curare Cleft



- The curare cleft in the graph shows the sign of spontaneous breathing efforts.
- This indicates it is time to repeat the dose of muscle relaxant.
- A reversal agent is given, which reverses the effect of the neuromuscular blocking drugs only after the cleft is seen. Because if the patient is under the effect of the neuromuscular blocking agent, they are given an antagonist, and the drugs can be potentiated.

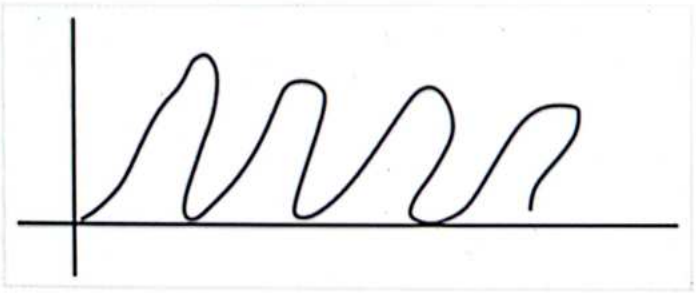
Co$_2$ Rebreathing



A soda lime canister is used to absorb the CO_2 and let in all the gases in circulation. In the following three cases, the graph does not start at 0.

- Soda lime is exhausted and cannot absorb the CO_2, it will start circulating in the ventilation system, and there will be a change in $ETCO_2$.
- Inadequate FGF.
- Inadequate ventilation.

Shark Fin Pattern



Shark Fin pattern graphs are the side effects of airway obstruction.

- Obstruction of the air, such as COPD or bronchial asthma.
- Bronchospasm.
- Circuit Kinking/ tube block.

Conditions Leading to a Fall in $ETCO_2$ or a Flat Graph

The fall in the graph is caused due to the following reasons:

- Circuit disconnection.
- Accidental extubation.
- Esophageal intubation.
- Malfunctioning of the ventilator.
- Bronchospasm.
- Cardiac arrest.

Law Pulse Oximetry

- The law of plethysmography measures the pulsatile flow of blood in capillaries.
- Beer lambert's law/ law of oximetry-linear relationships of a solution enables us to measure the concentration of that thing by measuring its absorbance (Oxy and decoy Hb).
- **False reading can be there in the following cases:**
  - Poorly fitted probe.
  - Poor arterial flow.
  - Electrical or mechanical interference.
  - Decrease in temperature (hypothermia).
  - Decrease in BP.
  - Dark skin.
  - Hemoglobinopathy.
  - Nail polish.

Temperature Monitoring

- Pulmonary artery is the best site for temperature monitoring.
- Tympanic membrane - It is the second best site for temperature monitoring.
- Lower esophagus- Third-best Nasopharynx, oral cavity, and urinary bladder.

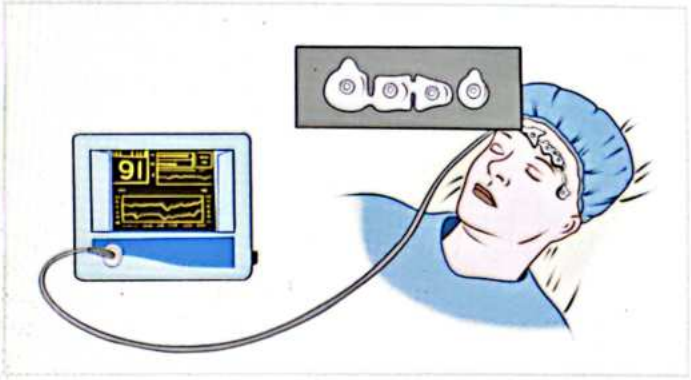
ECG

- ECG has been used intra Op monitoring of rhythm-related issues.
- Lead II best to judge arrhythmias.
- V4-5 is the most sensitive to diagnose intra-OP myocardial infarction (99% sensitive).
  - Transesophageal echocardiogram - most sensitive monitor.
  - The cardiovascular monitor is used to detect air embolisms.
  - TEE is the best for cardiac evaluation.

Bispectral Index and Entropy

Aspect Co.	Bispectral index	Entropy
	EEG	EEG & EMG
	Monitor Depth of Anaesthesia	Monitor Depth of Anaesthesia
	Range- 0-100	
	0- coma	
	100- fully aware	
	Range 40-60 is target of BIS monitoring	

- Bispectral index and entropy Monitoring the frontal-parietal temporal.
- With the help of a band having 3 electrodes attached to 3 different lobes.



Evoked potential monitoring

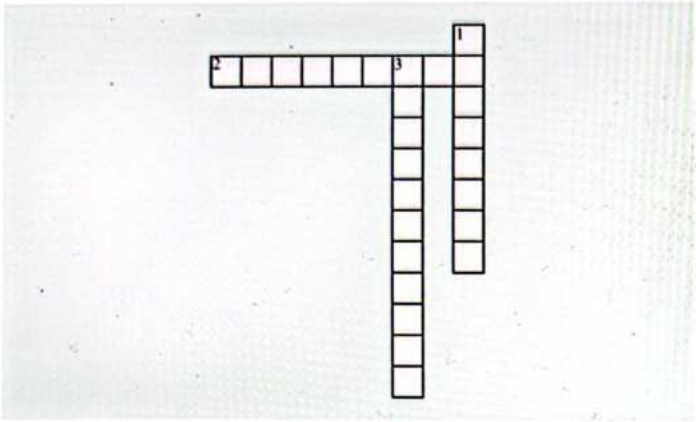
- The sensory pathway is used for sensory-evoked potential monitoring.
- The motor pathway is used in motor-evoked potential.
- The somatosensory pathway is used for somatosensory EPP.

Q. Which evoked potential, is not affected by anaesthetic agents?

Ans. Brainstem auditory evoked potential

CROSS WORD PUZZLES

CROSSWORD 1



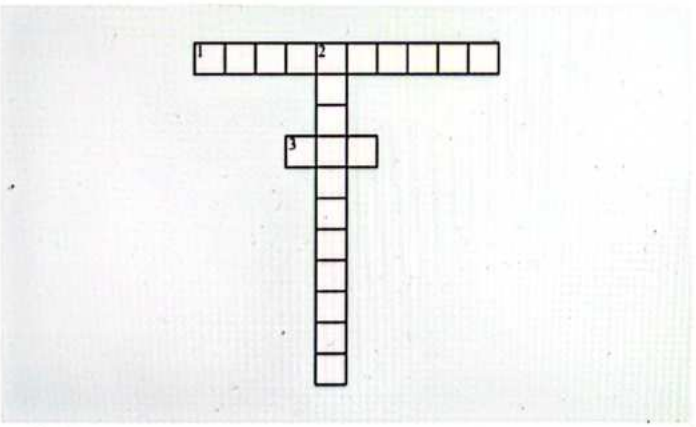
Across

2. artery_____is the best site for monitoring the temperature.

Down

1. membrane_____is the second best site for monitoring the temperature.
3. Lead II best to judge _____.

CROSSWORD 2



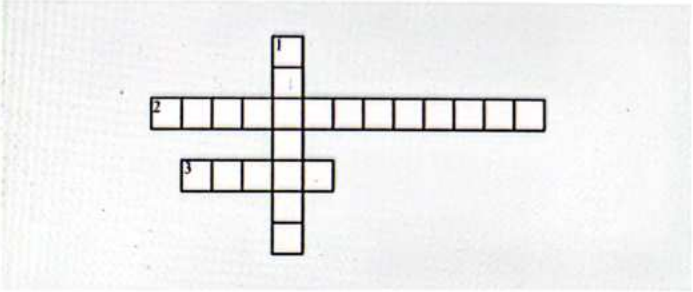
Across

1. V4-5 is the most sensitive to diagnose intra-OP _____ infarction
3. _____ is the best for cardiac evaluation.

Down

2. The cardiovascular monitor is used to detect _____.

CROSSWORD 3



Across

2. _____monitoring To check the effect of the muscular relaxant.
3. _____of anesthesia: This means how deep the patient has gone into the anesthesia.

Down

1. Bispectral index and entropy Monitoring the _____ and parietal temporal.

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9 MODES OF VENTILATION

- Ventilation is the air movement between the environment and the lungs via inhalation and exhalation.
- Mechanical ventilation using artificial methods to assist breathing

1. CMV (Controlled Mode Ventilation) also known as IPPV (intermitted positive pressure ventilation)
2. SIMV (Synchronized Intermittent Ventilation)
3. PCV- Pressure Control Ventilation
4. PS- Pressure Support
5. CPAP- Continuous Positive Airway Pressure

- Modes of ventilation is one of the most important aspects of using mechanical ventilation.
- The mode refers to the method of inspiratory support.
- Mechanical ventilation machines are available with invasive and non-invasive modes.

Refer Table 9.1

CMV (Controlled Mode Ventilation) 00:12:30

- Control ventilation is a mode of ventilation in which the respirator delivers the preset volume or pressure regardless of the patient's inspiratory efforts.
- It is indicated in patients with severe neurological alterations, deep sedation, shock, or respiratory failure.

Feature	To avoid any kind of synchrony
The patient weighs 50kg.	V/Q is mismatched.
Tidal volume is 7-8 ml/kg.	There is more hemodynamic imbalance.
There is no effort from the patient's side.	It is not a weaning mode.
The patient is heavily sedated/paralyzed.	It is used for a patient under general anesthesia.

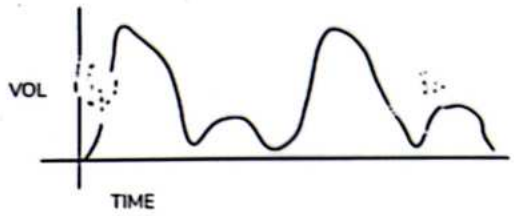
SIMV (Synchronized Intermittent Mode of Ventilation) 00:18:23

- Synchronized intermittent mandatory ventilation is a ventilator mode that enables partial mechanical assistance.
- This ventilator mode will provide a set number of breaths at a fixed tidal volume, but a patient can trigger a spontaneous breath with the volume determined by patient effort.

- TV – 400ML/KG
- RR – 14/MIN

SIMV (SYNCHRONIZED INTERMITTENT VENTILATION)

- TV-400ML/KG
- RR-14 /MIN



Graph description:

I. The patient's tidal volume is 400 ml, as shown in the 1st slope of the graph.
II. 2nd slope: If the patient breathes only 250 ml, the ventilator will provide an additional 150 ml to make it 400 ml of tidal volume.

Feature	Avoid any synchrony
• The tidal volume of the patient is 400ml/kg	• There is less V/Q mismatch. • There is less hemodynamic imbalance.
• The respiratory rate of the patient is 14/min	• No/slight sedation is required.
• The Patient and the ventilator are working in synchrony.	• It is a weaning mode.

Important Information

- Assist control mode is one of the most common methods of mechanical ventilation in the intensive care unit.
- It works by setting a fixed tidal volume.
- It supports the breath taken by the patient.

Pressure Control Ventilation (PCV) 00:21:25

- Pressure-controlled ventilation is utilized in patients with an indwelling endotracheal tube or tracheostomy tube that affords the practitioner the ability to ventilate a patient with a maximal peak pressure.

Features	Used in
• The Pressure is being controlled.	• ARDS.
• The Upper limit of intra-alveolar pressure is fixed.	• Pediatric.
• It is not a weaning mode.	
• It is a Lung protective ventilation.	

Important Information

CPAP + BIPAP

- CPAP- continuous positive airway pressure.
- BIPAP- Biphasic positive airway pressure.
- It is a weaning mode.
- The patient is breathing spontaneously.
- The patient may or may not intubate.

PS Ventilation 00:25:20

- Pressure support ventilation (PSV) is a spontaneous mode of ventilation in which each breath is initiated by the patient but is supported by constant pressure inflation.
  - o The person is spontaneously breathing.
  - o It works on two mechanisms
  - o CPAP-continuous positive airway pressure.
  - o PEEP- positive end-expiratory pressure = Enables the alveoli to open.

PEEP (Positive End-Expiratory Pressure) 00:26:16

Features

- It enables the alveoli to be open at the end-expiration.
- To improve the oxygenation of the patient.

Applied

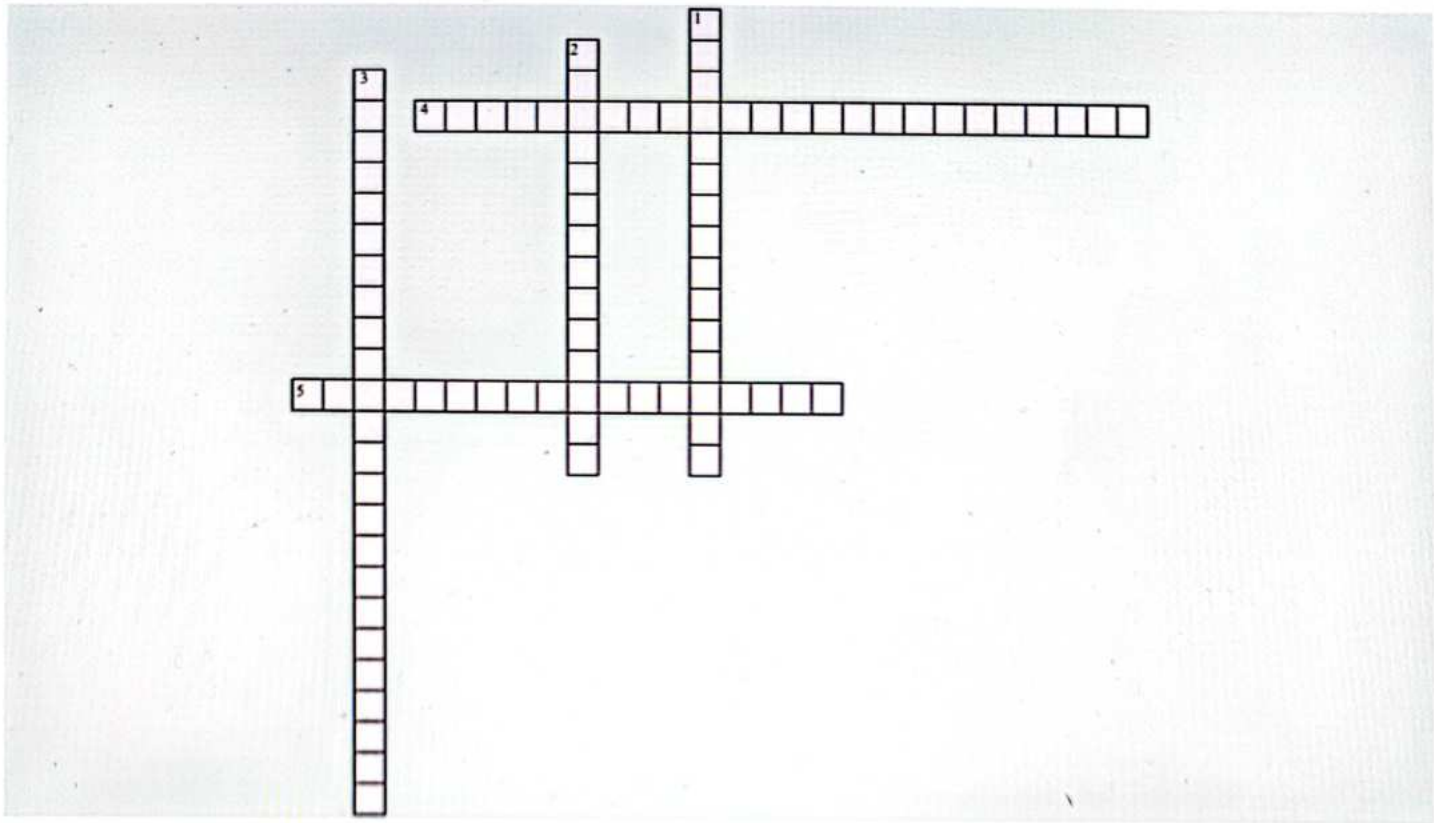
- An increase in intrathoracic pressure leads to a decrease in venous pressure and a decrease in CO_2
- BP is decrease in perfusion of a vital organ.
- A decrease in urine output.

Table 9.1

Mode of ventilation	Controlled mode ventilation (CMV)	Synchronized intermittent mode ventilation (SIMV)	Pressure control ventilation (PCV)	Ps-pressure support	Continuous positive airway pressure (CPAP)
Physical character	The patient's weight is 50kg	RR 14/min	Pressure is being controlled	Spontaneous breathing	PEEP +CPAP
Tidal volume	Tidal Volume 7-8 ml/kg	Tidal Volume 400ml/kg	Not a weaning mode	Works on two mechanisms	It enables the alveoli to be open
Patient efforts	No efforts from the patient's side	Less V/Q mismatch	Less protective ventilation	CPAP	To improve the oxygenation
Usage	Heavily sedated	No/slight sedation	Paediatric	BIPAP	Decrease in BP and urine output

CROSS WORD PUZZLES

Crossword Puzzle 1



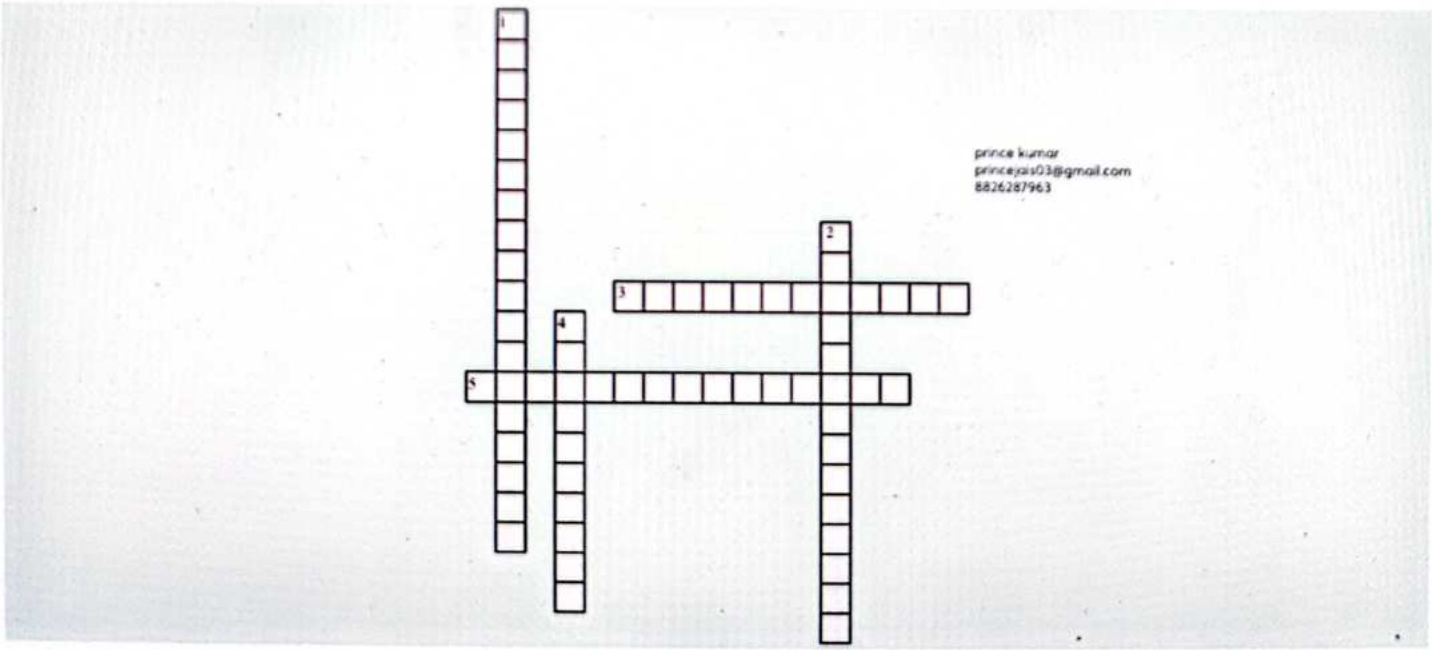
Across

4. PEEP+CPAP is ____.
5. Pressure is controlled by _____.

Down

1. _____ works on two mechanisms.
2. Tidal volume is 7-8 ml/kg in_____.
3. Tidal volume is 400ml/kg in ____.

Crossword Puzzle 2



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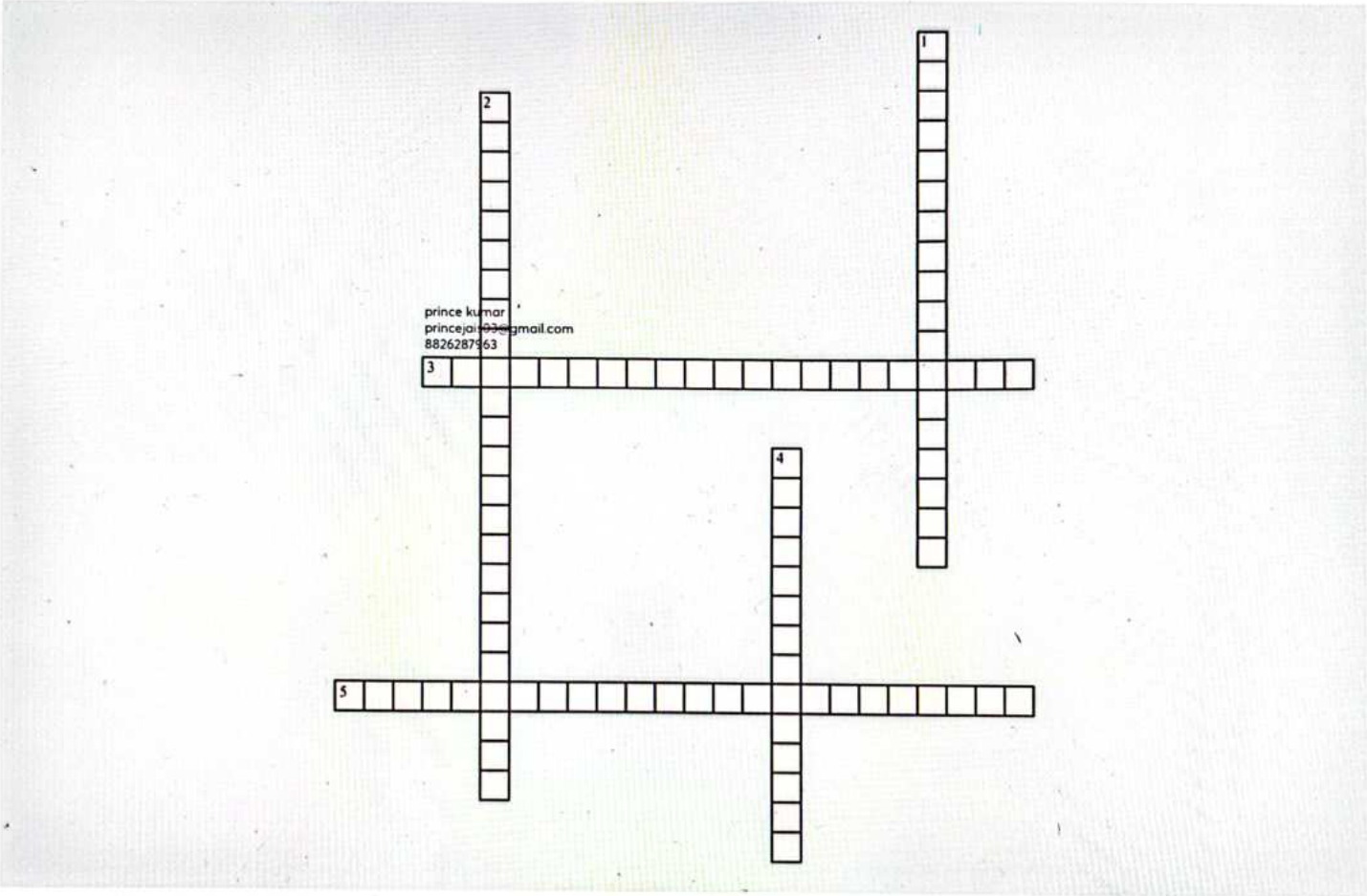
Across

3. _____ Is intermittent weaning.
5. ____ is spontaneous breathing.

Down

1. ARDS are present in __
2. _____ is not a weaning mode.
4. ____ supports breath.

Crossword 3



Across

3. _____ helps in opening alveoli.
5. Respiratory rate is 14/min in ____.

Down

1. Paediatric is available in___.
2. Peep+cpap is ___.
4. Weight is 50kg in ___.here is less hemodynamic imbalance_____.

10 INHALATIONAL ANAESTHETIC AGENTS

Properties

00:01:44

MAC (Minimum Alveolar Concentration) subtopic

- Drug required to produce no movement after surgical stimulus in 50% of the population.
- It tells us about the potency of the drug.
- If MAC is less the potency is high and vice Versa

Blood Gas Coefficient

- It is the CNS concentration at alveolar concentration
- If the drug stays in the blood for a longer duration, induction will be slow. And in case drugs do not stay in the blood for longer, that means faster induction.
- Halothane is the most potent and has slower induction. On the other hand, Desflurane is less potent and has the fastest induction.
- Desflurane is the inhalational anesthetic agent of choice for daycare surgery.
- Other older agents are ether and chloroform.

New Drug	MAC	BGC
Halothane	0.75	2.25
Isoflurane	1.13	1.3
Sevoflurane	2	0.63
Desflurane	6	0.42 (Fast Induction agent)

MAC- Decreases	MAC- Increases
1. Hypothermia	1. Hyperthermia
2. Hypovolemia	2. Hypernatremia
3. Hyponatremia	
4. Hypoxia	
1.Hypercapnia	
2.Hypercalcemia	
Acute alcohol intoxication	Chronic alcohol intoxication
Chronic amphetamine	Acute amphetamine
Pregnancy	

Meyer Overton Law

- The potency of the inhalational agent is directly proportional to lipid solubility.
- Lipid-soluble drugs are more potent than water-soluble drugs

Properties:

00:16:52

Refer Table 10.1

- Sevoflurane (inhalational agent) doc for paediatrics
- Desflurane - best for daycare surgery

Halothane hepatitis

Type 1

- Acute, self-limiting
- LFT deranged (1-2 month)

Type 2

- Necrotizing hepatitis→
  - Permanent damage to liver tissue
- Compound A – Sevoflurane Nephrotoxic

Important Information

- Enflurane and Methoxyflurane are two anesthetic agents that are not used. Because methoxyflurane has the highest fluoride content and has nephrotoxic effects. And enflurane precipitates epilepsy. Isoflurane is an isomer of enflurane.
- Desflurane is a structural analog of isoflurane. And it has the highest fluoride content.
- Desflurane is costliest drug.

Effect on Various Systems

00:29:10

- All of them reduce cerebral metabolic requirement O_2 (CMRO2).
- If CMRO2 is reduced it means the brain is working less, and the EEG will be suppressed.
- All inhalational anesthetic agents increase the cerebral blood flow and this cerebral blood flow is coupled with intracranial pressure. Whereas IV anesthetics decrease cerebral blood flow and intracranial pressure.

- Halothane severely increases cerebral blood flow, so halothane is not safe for CNS surgery.

CNS

NAME	CMRO2	CBF	ICP	EEG
Halothane	↓	↑↑↑↑	↑↑↑↑	↓
Isoflurane	↓	↑	↑	↓
Sevoflurane	↓	↑	↑	↓
Desflurane	↓	↑	↑	↓

CVS

NAME		
Halothane	Myocardial depressant	↓HR, ↓CO, ↓BP
Isoflurane	Coronary steal Phenomenon	Cardio stable
Sevoflurane	Cardiostable	Cardio stable
Desflurane	Doc for cardiovascular Surgery	Cardio stable

- Halothane and sevoflurane can be used in bronchial asthma and COPD, as they are bronchodilators.
- Since halothane increases ICP and CBF, sevoflurane is the second-best option in emergency neurosurgery of a patient who is having bronchial asthma and COPD.
- Desflurane is used in patients who are undergoing hepatic and renal surgeries because it has low blood gas partition coefficients, it goes into circulation, and reaches the respiratory system, CVS, and CNS. It acts and comes out of the body without getting metabolized. It does not hamper the already hampered organs of the body.
- That is why it is DOC for hepatic and renal surgeries.

RS

Name		
Halothane	• Best bronchodilator • Best for uterine Relaxation	
Isoflurane	• Depress the respiratory system • Depress the hypoxic / hypercapnic drive • Depress the pulmonary vasoconstriction	
Sevoflurane	All are same	2nd best bronchodilator
Desflurane	All are same	Doc - hepatic & renal Surgery

- No analgesia is provided by inhalational agent

Recent Drugs

00:44:33

Ether

- 1st used on 16 oct 1846 (World Anaesthesia Day)

Uses

1. Cheap
2. Cardio stable
3. Good bronchodilator
4. Good analgesic
5. Hypoxic hypercapnic drive was minimally affected

Disadvantage

1. High inflammable
2. Rate of induction was slow
3. Lead to laryngospasm
   - Increase in secretion

Nitric Oxide (N_2O)-

- MAC - 104
- BG Co- efficient - 0.45
- Good analgesic

C/I

- Subacute / acute intestinal obstruction
- Cochlear implant surgery
- Eye surgery
  - Laser
  - Vitreo retinal surgery

Pneumothorax

- N_2O causes 2nd gas effect
- N_2O potentiates the effect of the gas which is given alongside with it
- N_2O inhibits Vit-B_{12} dependent enzyme
- Peripheral neuropathy
- BM suppression
- Megaloblastic anaemia

Entonox

- O_2: N_2O = 50 % : 50%
- Uses - for labour / dental analgesia
- C/I- ↑BP, ↑HR, Support Combustion, Laser Surgery

XENON

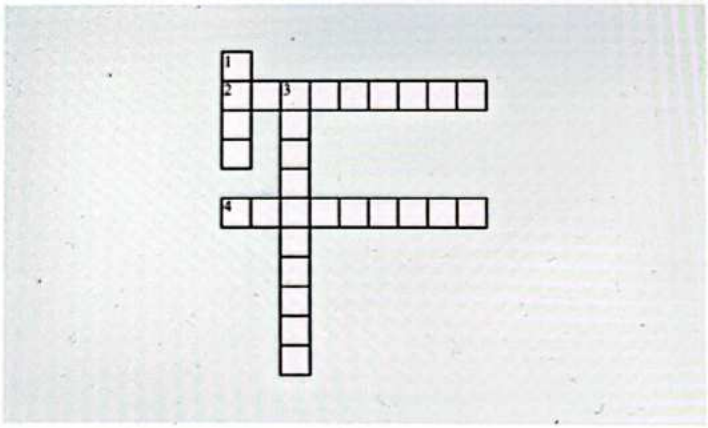
- INERT GAS
- MAC - 70
- BGC - 0.19
- CVS- Stable
- Does not support combustion
- Costly

Table 10.1

	Drug	Metabolized	Smell	Uses	Boiling points
	Halothane (Halogenated Ethane)	>30 % (Acyl Halide)	Good smell	1. Induction 2. Maintenance	50 2°C
Halogenated ether	Isoflurane	0.1 - 0.2 %	Irritant smell	1. Maintenance	
	Sevoflurane	2- 4 % (Compound A)	Sweet smell	1. Induction 2. Maintenance	
	Desflurane	Not metabolised	Irritant (max.)	Best for maintenance	23°C (TOC for Sx)

CROSS WORD PUZZLES

Crossword Puzzle1



Across

2. Blood gas coefficient tells about_____.
4. _____is the most potent and has slower induction.

Down

1. If MAC is less the potency is_____.
3. _____ is the inhalational anesthetic agent of choice for daycare surgery.

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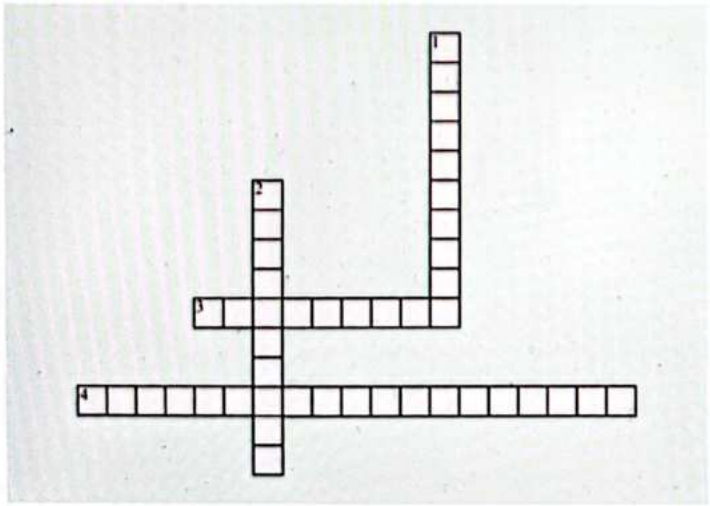
Crossword Puzzle2



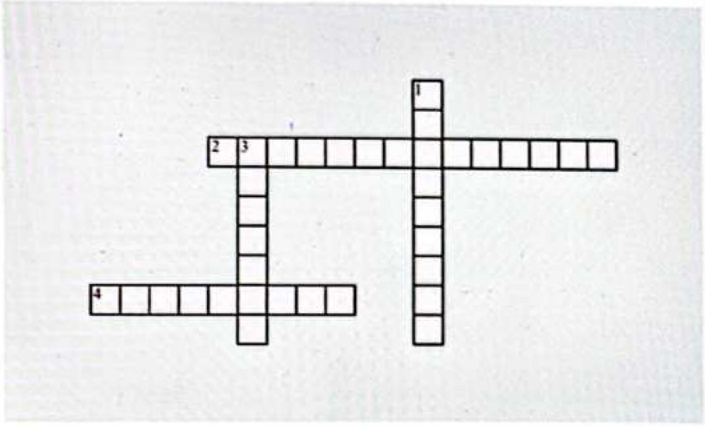
Across

3. _____ severely increases cerebral blood flow.
4. _____ is the CNS concentration at alveolar concentration.

Down

1. _____is the drug of choice for cardiovascular surgeries.
2. _____is a structural analogue of isoflurane.

Crossword Puzzle3



Across

2. _____has the highest fluoride content.
4. _____is world anesthetic day.

Down

1. Isoflurane is an isomer of_____.
3. _____supports combustion and is used in laser surgery

11 INTRAVENOUS ANESTHETIC AGENTS

00:02:06

- Opioids are derived from the greek word "opium", which means juice/nectar.
- In 1805, the chemist Frerichsertumer isolated the active ingredient in opium.
- Opium which was later called morphine, was derived from the Greek word "morpheus", the Greek god of dreams.
- Morphine is used as an analgesic and postoperative analgesia for a longer time.

Opioids can act on 3 receptors

- Mu
- Kappa
- Delta

Classification of Opioids

00:04:00

Based on Source	Based on Action on Receptor
Natural Opioids • Phenantherene - Codeine, Morphine. • Benzylisoquinolines- Papaverine.	**Agonist:** These are prototype drugs. • Morphine, Fentanyl and Pethidine. • Sufentanil and Remifentanil.
Semisynthetic • Thebaine Group - Buprenorphine.	**Partial Agonist** • Buprenorphine.
Synthetic • Phenylpiperidine 2, Butorphanol Meperidine, Fentanyl, Alfentanil, Sufentanil. • Mophinan - Buterphenol. • Phenylethylamine- Methadone. • Benzomorphan- Pentazocine.	**Agonist** • Pentazocine. • Butorphanol. • Nalbuphine, • Nalorphine **Antagonist:** Used in case of Opiod toxicity. • Naloxone. • Naltrexone. • Nalmefene.

Prototype Drug: Morphine

00:07:22

Protype drug is a drug which has most of the properties of an opioid. Some features of morphine are as follows:

- **Analgesia:**
  - It is strong analgesia without any loss of consciousness.
  - It increases the threshold of pain.
  - It also decreases apprehension and fear.
- **Sedation:** Morphine causes drowsiness.
  - Larger doses can produce sleep.
  - EEG is similar to normal sleep waves.
- **Skeletal muscle rigidity:** High dose can cause stiff Chest syndrome.
- **Mood Effect** includes Euphoria.
- **Depresses Pontline and medullary ventilator centre** - Rate decrease depth of breathing decreases.
  - Depresses medullary cough centre.
  - Temperature regulatory centre is depressed, leading to a fall in temperature.
  - Higher doses can also lead to a fall in BP.
- **Simulates** - When morphine stimulates the CTZ centre, it leads to Nausea and vomiting.
  - It stimulates Edingerwestphal Nucleus, which is responsible for Miosis.
  - It stimulates the Vagal centre, which decreases the heart rate causing Bradycardia.
  - It can lead to convulsion - Inhibits GABA.
  - Stimulate smooth muscle contraction of the biliary and G.I trait, leading to gastric emptying time.
- **Effect on hormone-**
  - Morphine increases the release of ADH (anti-diabetic hormone). As a result, the patient will be unable to urinate, more known as oliguria.
  - However it will decrease the secretion of other hormones as FSH, LH, sex hormones, ACTH, corticosteroids.
- **Effect on CNS**
  - Morphine has no direct effect on myocardium.
  - Morphine induce release of histamines which Suppresses the vasomotor centre.
  - Suppression of vasomotor centre will further cause decrease in symphathetic tone of blood vessels leading to decrease in Blood pressure (orthostatic hypotention).

Pharmacokinetics

00:22:43

Morphine can be given through various routes

- I/M - Good absorption, onset takes 15-30 mins with duration is about 4 hours.
- I/V - it gives wider distribution with poor CNS penetration.
- Oral route
- Epidural
- Morphine has poor lipid solubility, as it is hydrophilic drug with poor-protein binding because of that, it can not cross the blood-brain barrier and has poor CNS penetration.
- When morphine is given to pregnant patients, it rapidly crosses the placental barrier as placenta is weak barrier.

- When morphine is given to pregnant patients in high doses, it may cause apnea in the fetus and decrease the patient's BP and compromise the fetus blood circulation.

Metabolites of Morphine

- Morphine 3-glucuronide (70-80%) in the inactive form.
- Morphine 6 - glucuronide (5-10%) is active form, it acts on Mu receptors and providing analgesia.
- Morphine is excreted via kidney. So, it should not be given to the patients with impaired kidney functions.

Side-effects

Tolerance and dependence

- Therapeutic doses (>50mg), morphine does not cause apnea, but if the dose of morphine increases to 250 mg, it depresses the ventilatory system, which progresses to apnea.
- In opioid or morphine poisoning, these drugs stimulates the Edinger Westphal nucleus, which leads to miosis.
- Less oxygen reaches the brain, resulting in hypoventilation and coma.
- The antidote to reverse the action of opioids is Naloxone in the dose of 0.4-0.8 mg/i.v till the patient receives normal respiration.

Important Information

Morphine triad

- Miosis
- Hypoventilation
- Coma

Uses

- Pre-anesthetic analgesia
- Surgical analgesia
- Myocardial Infarction (morphine, oxygen, nitrates, aspirin).
- Palliative therapy for cancer.

Contraindications

- **Bronchial asthma** as respiration is already compromised and morphine further will manifest hyperventilation.
- **Head injury-** the consciousness is already compromised , and opioids or morphine further cause sedation.
- Metabolism of these drugs occurs through the liver and kidney. So, morphine is contraindicated in patients with hepatic and renal failure because the duration of these drugs will be prolonged in these patients, which leads to toxicity.

Meperidine 00:40:43

- Meperidine has structural similarities with a local anaesthetic and can block Na+ channels comparable to lidocaine.
- Mainly acts on mu and kappa receptors.
- 1/10 as potent as morphine.
- Route- IM, IV, oral, intrathecal.
- It is short acting drug with short action of duration (2-3 hrs)
- Regardless of potency it produces equal amount of sedation, euphoria and respiratory depression produced by morphine.

It leads to lesser side effects than morphine.

- Less spasmodic action
- Lesser amount of miosis
- Less constipation
- Less urinary retention - lesser oliguria than morphine
- Less histamine release - low chances of orthostatic hypotension

Uses

- Meperidine is used as labour analgesia.
- Meperidine is used as a Postoperative analgesia.
- It is very effective against Post-op shivering

Side-effect

- Atropine-like effect- The effect of Atropine is mydriasis. It will increase heart rate and cause blurred vision.
- Overdose of the drug will lead to tremor, mydriasis, delirium, convulsion, serotonin syndrome.
- Contraindications due to the effect of these drugs on CNS. It is contraindicated in patients with MAO therapy.
- Metabolism- 90% of meperidine gets metabolized in liver. It undergoes demethylation producing normeperidine which causes myoclonus seizures.

Fentanyl

- Fentanyl is 75-125 times more potent than morphine.
- It has Shorter duration and Shorter action because of the greater lipid solubility.
- Total i.v. anaesthesia is given in those patients who have compromised cardiac state.

Uses

- Analgesic- 1-2 µg/kg
- Adjuvant dose: 2-20 µg/kg.
- Total IV anaesthesia - 50-150 µg/kg
- Orally or transmucosal- 5-20 µg/kg
- The Transdermal and the transmucosal route requires a high dose because of the less bioavailability via these routes.

Advantage

- Fentanyl doesn't have direct effect on myocardium.
- Unlike morphine it doesn't release histamine.
- It also suppresses the stress response.

Side-effect

- It has similar side effects like morphine
- It can lead to respiratory depression.
- If given in over dose it leads to bradycardia and a slight increase in intracranial pressure.

Sufentanil

- Sufentanil is more potent than fentanyl that is the reason it is an agent of choice to decrease the stress response during intubation.

- It is a Lipophilic drug which means it is able to cross the blood-brain barrier leading to CNS side effects
- It is fast acting and short duration of action.
- Since it is more potent fentanyl, the dosage is less to produce desired effect.
- Analgesic dose - 0.1 -0.4 µg/kg/iv.
- Anesthesia dose - 10-30 µg/kg/iv.
- Metabolism: N-dealkylation in the liver.

Alfentanil

- Alfentanil is not used that frequently because it is less potent (1/10 of fentanyl).
- It has a shorter duration of action.
- It is in highly non-ionized state.

Uses

- Blunt's hemodynamics response to laryngoscopy.
- Decrease the incidence of post-operation nausea and vomiting.

Side effects:

- Increased incidence of muscle rigidity.

Remifentanil

- Ramifentanil has a smaller volume of distribution and rapid clearance.
- Metabolism takes place through non-specific plasma and tissue esterases.

Uses

- Beneficial in liver and kidney dysfunction patients.
- Beneficial in pediatric patients
- Beneficial in labour analgesicia.

Tramadol

- It has a moderate affinity to µ receptor and weak affinity to kappa and delta receptors.
- It it does not cause any respiratory depression.
- It is good analgesic agent.

Side effects

- Seizures
- Decrease in heart rate.

Uses

- It can be used in chronic pain.

Pentazocine

- This drug belongs to benzomorphone group.
- It is an weak µ antagonist, agonist on kappa and delta receptors.
- It can be administered via orally, IV and intramuscularly.

Side effects

- Tachycardia
- Hypertension

Butorphanol

- It is 20 times more potent on kappa and delta receptors.
- It is more potent than pentazocine
- It is 15-30 times more antagonists on µ receptor.

Buprenorphine

- It is 30 times more potent than morphine.
- It is thebaine derivative
- It has 50 times more affinity to Mu receptor on the compound to morphine.
- It has Local anaesthetic properties so it can be used as an adjuvant.

Nalbuphine

- It is an Agonist on kappa and antagonist on µ receptors.

Opioid Antagonist 01:07:31

These are pure antagonist of all opioid receptors:

- Naloxone
- Nalmefene
- Naltrexone.

Clinical uses include:

- To treat opioid-induced respiratory depression.
- To treat overdose of opioids.
- To treat opioid-induced depression in a pediatric patient.

Naloxone

- It has rapid onset as It starts acting within 1-2 mins of the use.
- It is a short-duration drug which lasts upto 30 to 45 min.

Side effects

- Nausea
- Vomiting.

Uses

- Septic and Hemorrhagic shocks.
- In alcoholic patients who have higher thresholds of any other drugs.
- In patients who have had opium overdosage intraoperatively lead to apnea-like conditions.

Nalmefene

- The more potent antagonist on µ receptor.
- It is an long acting drug.
- It is a pure antagonist.
- It can be administered via oral and parentral route.

Naltroxone

- It is an long acting drug.

Neuraxial Opioids

- These drugs get attached to Substantialgelatinosa (µ receptor) in spinal cord

Advantages

- These are not accompanied by sympathetic nervous system block.

- These drugs give no motor blockade (only sensory blockade).

Side effects

- Most common - Pruritus (itching)- μ receptor of the trigeminal nucleus.
- Most frequently, itching can be seen in pregnant women on the eyes, nose, and upper trunk.
- Naloxone can reverse side effects.

Epidurally	Intrathecally (in the CSF)
• Morphine • Fentanyl • Alfentanil • Sulfentanil • Pethidine	• Morphine • Fentanyl

Neurolept Analgesia/Neurolept Anesthesia

- It is combination of two or more drugs to provide complete anaesthesia to the patient.
- It helps to reduce the dosage of drugs and side effects.
- **Neurolept analgesia** involves a combination of two or more tranquillisers. Example: Butorphanol with potent opioid (Fentanyl).
- **Neurolept anaesthesia** combines with an inhalational agent. Examples: Halothane, Isoflurane, Sevoflurane, and Desflurane.

Features

- Lack of motor activities
- Suppression of autonomic reflexes
- Stablity of CVS.

Non-Opioids 01:19:18

- Propofol, thiopentone, Etomidate acts on GABA receports. GABA is an inhibitory type of neurotransmitter.
- Ketamine acts on NMDA receptor. NMDA is an excitatory type of neurotransmitter.
- Dexmeddetomidine acts on alpha 2 adrenergic agonist.

Propofol

- The structural formula of propofol is 2,6 diisopropyl phenol.
- The colour of propofol is milky white.
- It has emulsifying agents egg lecithin, glycerol, and soyabean. Yet it is safe for patients allergic to eggs.

Refer Table 11.1

- Metabolism – hepatic & renal – 80%
- Extra hepatic & extra renal – 20%
- Drugs that act upon the GABA receptors decrease the cerebral metabolic oxygen requirement and reduce intracranial pressure and cerebral blood flow. These drugs are cerebro-protective drugs.
- These drugs are cardio-depressant drugs but during intubation patient will already have exaggerated response. Thus, the BP will be stabilized in sometime.
- Metabolism of propofol occurs most in hepatic and renal about 80%, and extrahepatic and extra-renal 20%.
- The inhalational drug of choice for day care surgery is desflurane.
- The drug of choice for porphyria and malignant hypothermia is propofol.

Uses

- Anaesthetic agent of choice for day care surgery because it does not have a residual effect.
- It is best drug for malignant hyperthermia, and porphyria.
- It does not cause post-op nausea and vomiting.

Side effects

- Propofol leads to pain. So, it is combined with lignocaine.
- It causes severe bradycardia because of central anticholinergic response.
- Propofol infusion Syndrome - 12-72 hours use of this drug can lead to lactic acidosis.
- In some cases myoclonic movements were observed when propofol was administered.
- It can easily cross placenta as placenta is a weak barrier.
- Prolonged used of propofol leads to hepatocellular injury causing green color urine because of phenol.

Sodium Thiopentone

- Sodium Thiopentone is kept in powder form (concentration-2.5%) and mixed with normal saline and distilled water.
- The PH is around 10.5-11.
- It causes rapid induction and rapid recovery because of redistribution of the drug.
- It decreases cerebral metabolic oxygen requirement. Thus, ICP is reduced.
- It increases the heart rate initially, but when the drug attains full action, decreases the heart rate.
- Thiopentone is the drug of choice for neurosurgery and narco-analysis.
- The side effect of using sodium thiopentone is Retrograde amnesia.

Refer Table 11.2

Contraindications

- COPD
- Bronchial asthma
- Porphyria. The treatment for porphyria is propofol.
- Severe shock.
- DOC for "Electro Convulsive Therapy". As in ECT long seadtion is not desired.
- Used for the short duration of action because of short onset and rapid removal from circulation.

Inadvertent intra-arterial injection leads to:

- Pain
- Blanching of hands
- Loss of radial pulse

Treatment

- Leave the cannula insitu
- Sympathetic blockage - phentolamine/papaverine or brachial plexus block or stellate ganglion block to counter pain.
- Bolus of heparin
- Infiltration with lidocaine.

Etomidate

CNS	CVS	RS
↓ CBF, ↓ICP, ↓IOP, ↓EEG	• No effect on BP Cardiac output or coronary perfusion • Myocardial O_2 Requirement	• Depress the respiratory system • Bronchodilator

- It is an imidazole derivative.
- It is of milky white color.
- It is painful when injected. The therapeutic dose is 0.2-0.5 mg/kg.
- It does not have any effect on cardiac output.

Side effects

- It decreases the synthesis of both mineralocorticoid and glucocorticoid.
- It causes Post operative nausea and vomiting
- It causes Emergent Delirium.
- No analgesia is provided by IV anaesthetic agents.

Ketamine

- Ketamine acts on NMDA receptors. It is phencyclidine derivative.
- There is R and s type of ketamine. R is Racemic mixture but S is 3 times more potent than R.
- Dosage of ketamine Via IM is 4-6mg/kg and via rectum is 8-10mg/kg.

CNS	CVS	RS
↑ CBF, ↑ICP, ↑IOP, ↑EEG	↑ HR, ↑BP, ↑CO, Myocardial O_2 Consumption	• Bronchodilator • Depresses the RS • Pharyngeal reflexes are preserved

- It causes dissociative anaesthesia and causing breakage of the link between the thalamus and cortex.
- Ketamine is the best bronchodilator.
- Ketamine increases blood pressure and is contraindicated in uncontrolled blood pressure patients.
- Ketamine is also contraindicated in ischemic heart disease patients because it increases the heart rate.
- It is DOC in patients with shock, bronchial asthma, and COPD.

Side effects

- Nystagmus
- It raises pressures of the body.
- Hallucination and delirium is the most common side effect.
- It can precipitate arrhythmia by increasing the heart rate.
- Because of thalamic-cortical dissociation, it causes mood and memory disturbances.

Contraindications

- It increases Intracranial pressure.
- Penetrating eye injury
- Uncontrolled hypertension
- IHD

Dexmedetomidine

- It is an Alpha 2 adrenergic agonists. Its dosage is 0.5 ug/kg

Uses

- It is used given Pre medication as it is cardio stable drug.
- It is used as infusion is ICU patients.
- It is also used in Awake craniotomy.

CNS	CVS	RS
• Sedative / anxiolytic • Decrease shivering	• Decrease HR • Decrease BP	• No effect

Important Questions

Q. What is the most common side effect of ketamine?
Ans: Hallucination and delirium is the most common side effect

Q. What is the active form of morphine that acts as an?
Ans: Morphine 6-glucuronide (5-10%) is present in active form

Q. Morphine 6-glucuronide acts on which receptor?
Ans: μ receptor that leads to analgesia and depression

Q. Remifentanil metabolism takes place through?
Ans: non-specific plasma and tissue esterases

Q. Agent of choice to decrease the stress response while intubation?
Ans: Sufentanyl

Q. Fentanyl is 75-125 times more potent than?
Ans: Morphine

Q. What are the advantages of Fentanyl?
Ans: No direct myocardial infarction, no suppression of the stress response, and no histamine release.

Q. What are the side effects of Mepridine ?
Ans: Mepridine produces an atropine-like effect- increases heart rate, blurred vision, mydriasis, etc.

Q. Normeperidine can cause?
Ans: Normeperidine can cause Myoclonic seizures.

Q. Which drug is effective against postoperative shivering?
Ans: Mepridine is effective against post operative shivering.

Q. Which drug has structural similarities with a local anaesthetic?
Ans: Mepridine has structural similarities with the local anaesthetic "lidocaine," which blocks Na+ channels.

Q. What is the major problem with all opioids?
Ans: Tolerance and dependence.

Q. When morphine is given to pregnant patients in high doses, it may cause?
Ans: Apnea in the fetus.
Q. What are the byproducts of morphine?
Ans: Morphine 3-glucuronide (70-80%), which is present in the inactive form and morphine 6-glucuronide (5-10%) present in active form.

Q. Morphine increases the release of ADH (anti-diabetic hormone). As a result, the patient will be unable to_____.
Ans: Urinate, also known as oliguria.

Q. The antidote to reverse the action of opioids is_____.
Ans: Naloxone is the antidote to reverse the action of opioids.

Table 11.1

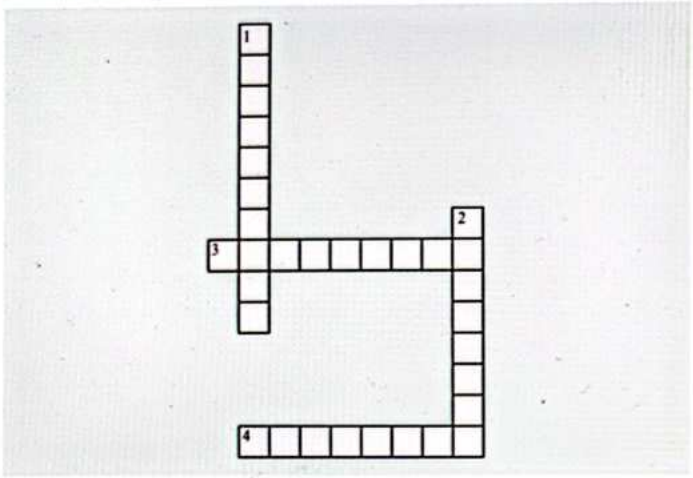
CNS	CVS	RS
1. Cerebral vasoconstrictor • That means it is cerebro Protective	1. It is cardiodepressant	1. Respiratory System is Depressant • Bronchodilator • Hypoxic/hypercapnic drive blunted • Upper airway reflexes are inhibited pulmonary vasoconstriction maintained
↓CMRO2, ↓ICP, ↓CBF, ↓EEG	↓ BP, ↓ HR, ↓ Systemic Vascular Resistance	

Table 11.2

CNS	CVS	RS
1.Cerebroprotective	1.Cardiodepressant	1.Bronchoconstrictor
↓CMRO2, ↓ICP, ↓CBF, ↓EEG It is a cerebral vasoconstrictor	↓BP, ↑HR, peripheral vasodilation	Hypoxic hypercapnic drive blunted Laryngeal reflexes remain intact

CROSS WORD PUZZLES

Crossword Puzzle 1



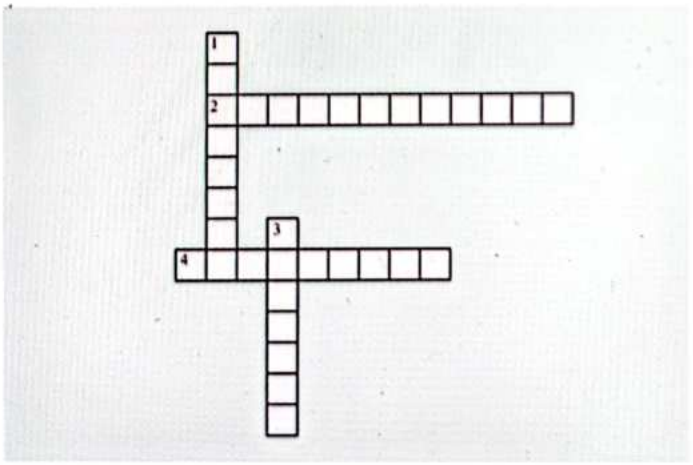
Across

3. ___ decreases the synthesis of both mineralocorticoid and glucocorticoid
4. ___precipitate arrhythmias by increasing the heart rate.

Down

1. ___ is the drug of choice for neurosurgery and narco-analysis.
2. ___ is the DOC in patients who are in shock, have bronchial asthma, or have COPD.

Crossword Puzzle 2



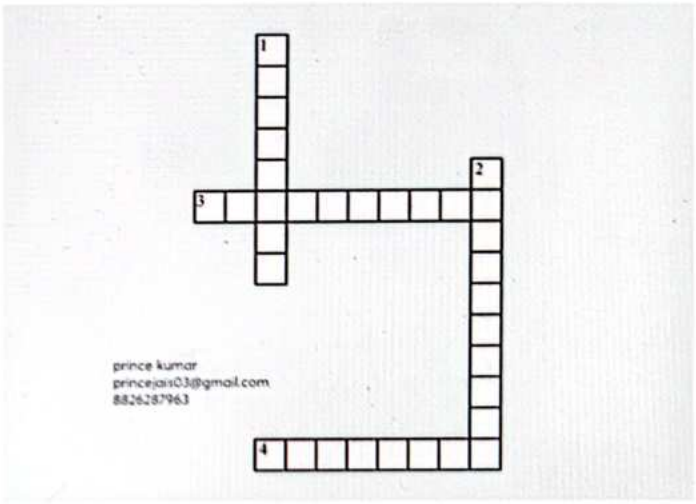
Across

2. _____ is beneficial to patients with liver and kidney dysfunction.
4. _____ has structural similarities with a local anaesthetic and can block Na+ channels comparable to lidocaine.

Down

1. ___ is the prototype drug having similar chemical structures, mechanisms of action, and modes of action.
3. _____ provides strong analgesia without loss of consciousness.

Crossword Puzzle 3



Across

3. _____ metabolism occurs through N-dealkylation in the liver.
4. _____ is 75-125 times more potent than morphine.

Down

1. ___ is safe for patients who are allergic to egg lecithin, glycerol, and soybean.
2. ___ decreases the incidence of post-op nausea and vomiting.xide and leads the fresh gas to flow towards the patient.

12 NEUROMUSCULAR BLOCKERS

- Neuromuscular blocking agents are muscle relaxants that slow down muscle activation during surgery. They have a similar composition as neurotransmitters present in our body, like, acetylcholine. Their function is to stop nerve impulse transmission at neuromuscular junctions.
- Every muscle has a nerve ending. If there is no nerve ending present, no action will be produced on the muscle fibers.
- Stimulus or action potential is needed for the contraction and relaxation of muscles.

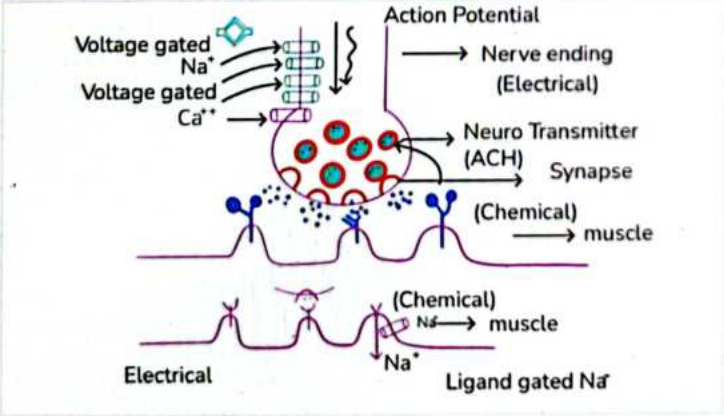
Physiology of Neuromuscular Junction

- The junction between the terminal nerve ending and a highly folded skeletal muscle membrane is called the neuromuscular junction.
- The terminal nerve ending has acetylcholine, which is synthesized in the cytoplasm of this nerve.

Postsynaptic Nicotinic Cholinergic Receptors

- **They are of two types:** Junctional and extra junctional.
- The junctional receptors are present at the neuromuscular junction, and extra junctional receptors are away from the junction.

Steps for Neuromuscular Action



- Inside the nerve, the terminal is negatively charged.
- When the electric action potential is generated, Na+ voltage-gated channel is opened.
- It allows the influx of Na+ inside the nerve ending and makes the positively charged inside the nerve endings.
- Stimulating more Na+ voltage-gated channels eventually opens the voltage-gated Ca+ channel.
- Vesicles present at the nerve endings are filled with neurotransmitters (acetylcholine).
- When Na+ and Ca+ act on the acetylcholine-containing vesicles, acetylcholine moves to the nerve endings and release into the synaptic cleft (junction between the nerve ending and muscle plate).
- Few receptors are present at the muscle end plate, where acetylcholine binds with these receptors.
- As a result, it opens Ca+ and Na+ channels, allowing an influx of Na+ and Ca+ inside the muscle membrane.
- These Na+ and Ca+ transfer inside the muscle cell. Ca+ binds with actin-myosin filament, which leads to the contraction of muscles (twitches in the muscles).
- After acetylcholine is rapidly metabolized, the receptors go back to the vesicles' nerve endings.
- Muscles will again relax due to no availability of Na+ and Ca+.
- This blocks neuromuscular transmission and causes paralysis of the muscle.

Depolarizing Muscle Relaxant

- Depolarization is the process when the nerve cell undergoes an electrical shift or when a contraction happens.
- Acetylcholineesterase - a depolarizing muscle relaxant, breaks acetylcholine and sends it to the nerve terminal.

There are 4 subtypes of acetylcholine receptors:

- 2 Alpha
- Gamma
- Delta
- Epsilon

Succinylcholine

- Succinylcholine has a structural similarity with acetylcholine. It leads to prolonged depolarization of nicotinic cholinergic receptors.
- Exogenous succinylcholine (intravenous route) binds with the receptors present at the muscle end plate, which leads to the persistent opening of Ca+ and Na+ channels.
- Ca+ goes inside and acts on the actin-myosin filament. Hence, it causes continuous fasciculation and contraction of muscles.
- Exogenous succinylcholine does not go back to vesicles, and there will be no relaxation of muscles because succinylcholine continuously blocks those receptors.
- No reversal agents are present for succinylcholine because of its rapid mobilization, and its effect is terminated by diffusion.
- Succinylcholine is the shortest-acting neuromuscular blocker with 2 acetylcholine molecules attached by the acetate methyl group.
- The effects of Succinylcholine can be terminated by diffusion.
- Plasma cholinesterase/butyrylcholinesterase/pseudo

cholinesterase is present in the blood and acts upon the succinylcholine, leading to succinylcholine decomposition.

- When SCh is given intravenously, plasma cholinesterase starts acting upon sch.
- 80-95% of SCh is metabolized immediately. Only 5-15% are able to interact with receptors.
- Succinylcholine is the only drug, as compared to other drugs, available in anaesthesia that needs to be injected rapidly so that it reaches the desired location immediately before the action of plasma cholinesterase.
- Sch leads to paralysis for 4-5 minutes.

Properties

- Fastest and shortest acting
- 30-45 sec 5-6 min

Dose: 1.5-2 mg/kg

Side effect

- Fasciculation – Post op-myalgia
- Increase in pressure (IOP/ICP/IGP)
- Hyperkalemia – extra junctional K+ releases – S/E – hyperkalemia

Golden Point

- Patient at risk
  - Muscle dystrophy
  - NM disease
  - Paraplegia
  - Burn patient
  - Trauma
  - Bradycardia due to stimulation of SA node
  - Can trigger malignant hyperthermia
- Rapid sequence intubation – (1. Sch, 2. Rocuronium)
  - Full stomach patient
  - Aim – to prevent aspiration

- Too many fasciculations involve vigorous muscle contraction, leading to postoperative myalgia.
- Because of continuous fasciculation in the muscles, increased intracranial, intraocular, and intragastric pressure.
- Sch should be avoided in this condition (ocular surgery, neural surgery), where there is a risk of an increase in pressure.
- K+ is also released when there is action at the nerve terminal. When sch is given, more extra junctional K+ is released, which causes hyperkalemia.
- If the patient has muscle dystrophy, NM disease, or paraplegia. The neuromuscular junction of these patients is already compromised.
- These patients may have delayed recovery from the neuromuscular relaxant.
- In burnt and traumatic patients, because of extravagant of K+ ions.
- Bradycardia can be seen after subsequent doses of sch. Because sch interacts with the cardiac receptors and leads to bradycardia.
- Sch can trigger malignant hyperthermia like another hallucinated compound.
- Rapid sequence intubation is the preventative measure for patients with a "full stomach", or other hazards of pulmonary aspiration. The rapid sequence intubation (RSI) procedure is employed when quick airway control is required. the approach aims to protect the airway with a cuffed endotracheal tube (ETT) as soon as possible while reducing coughing.
- The drug for rapid sequence intubation is Sch, and Rocuronium is used as the second choice.

Steps

- Preoxygenation is mandatory
- Cricoid pressure / Sellicks maneuver
- i/v thiopentone + i/v Scoline
- Ppv is contraindicated
- Laryngoscopy and intubation
- Very short duration of surgery

Example

- ECT
- Endoscopy
- Intubation for anticipated difficult intubation.

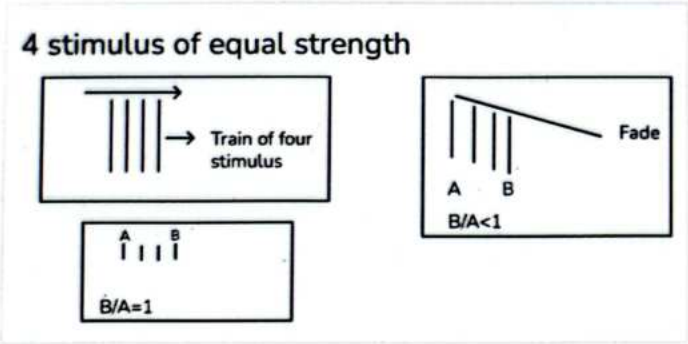
- Preoxygenation is mandatory.
- Circoid pressure/Sellicks maneuver: Sellick's maneuver, applying pressure to a patient's cricoid cartilage during endotracheal intubation, is supposed to prevent aspiration.
- Positive pressure ventilation (PPV) is contraindicated: We can breathe because of the negative intra-thoracic pressure. When exogenous oxygen is given to the patient, called PPV.
- It can be used for Electro-Convulsive Therapy (ECT), Endoscopy. Because the duration of action is very short (only 4-5 minutes).

Sunnicylcholine Vs NDNMB

NDNMB- Competitive antagonist

Succinylcholine	NDNMB
• Fasciculation +	• --
• Post-op myalgia +	• ---
	• Reversal by neostigmine (increasing the quantity of Ach by inhibiting Ach esterase)

Train of Four Stimulus



- Four equal-intensity stimuli are delivered, such as a 1 Hz stimulus, four times.
- It is used to visualize at what level muscle relaxation has been received or how much muscle is relaxed.
- Scholine works on the "all or none" phenomenon. Scholine binds with receptors, shows action, is impeded by the muscle relaxant, and leads to muscle relaxation.
- When we mark the two points from the first stimulus to the last stimulus and then compare them, there will be no difference in the train of 4 responses because all the receptors acted simultaneously.

Neuromuscular Monitoring	
• Not possible (Sch)	• Possible (NDNMB)
Tetanic stimulus – (One stimulus of high frequency)	
• Less or small amplitude (Seen with Sch)	• Again we see a fade (NDNMB)
Post Tetanic stimulation	
• No post tetanic facilitation (Sch)	• Facilitation (NDNMB)

- Most common nerve for neuromuscular monitoring is Ulnar nerve.
- Neuromuscular monitoring is impossible in succinylcholine because it cannot define whether any electric stimulus has an effect.
- In post-tetanic stimulus, facilitation is not seen with succinylcholine (sch).
- NDNMB has a gradual effect on the receptors. It shows a fade in the train of four responses.
- Receptors are blocked gradually. So, there will be a difference in the ratio.
- Neuromuscular monitoring is possible in NDNMB because differences can be seen in the stimulus.
- In the case of a tetanic stimulus (one high-frequency stimulus), a fade change can be seen.
- In post-tetanic stimulus, facilitation is seen with NDNMB.
- The most common nerve for neuromuscular monitoring is the ulnar nerve.

Golden Point

- **Phase 1 block** – Sch showing normal properties and behave like depolarizing muscle relaxant
- **Phase 2 block** – Repeated doses -prolonged paralysis / prolonged apnea cumulative dose is more than 4-6mg/kg
  - It starts behaving like NDNMB
  - TOF response is positive
  - TOF ratio < 1
  - PTF positive

- When sch acts on the receptor shows fasciculation. It means sch is in the phase 1 block (showing normal properties and behaving like a depolarizing agent).
- Sch starts behaving like NDNMB at higher doses (4-6 mg/kg), this time, sch enters the phase-2 block which leads to prolonged paralysis of the patient, and no fasciculation is present. Hence, it will show all the properties like NDNMB.
- Train of four response (TOF) becomes positive, TOf<1, and post-tetanic facilitation (PTF) property.
- The non-depolarizing agent comes in the phase 2 block. It interacts with receptors but does not show any fasciculation.

Prolonged Paralysis

- Suxamethonium apnea – Single dose producing prolonged apnea
- Because of absence or faulty or deficiency of pseudocholinesterase

Rx

- Continuous positive pressure ventilation
- Patient require ventilatory support

Causes

- Hypothermia
- Pregnancy
- Liver / kidney disease
- Myasthenia gravis
- Abnormal gene
- After multiple doses of sch, the patient goes into a stage of apnea called suxamethonium apnea because the patient may have a deficiency of pseudocholinesterase.

Non-Depolarizing Neuromuscular Blockers (NDNMB)

- Non-depolarizing agents work by competitive inhibition with acetylcholine receptors.
- Non-depolarizing agents come and bind with receptors, but these agents do not allow the opening of Na+ and Ca+ channels and no interaction between the nerve fiber and muscle. As a result, the muscle comes into a state of paralysis without any twitching, fasciculation, or contraction.

- No postoperative myalgia occurs in non-depolarizing agents because no fasciculation occurs.

Non Depolarising Muscle Relaxant

2 groups – depending on chemical structure

Refer Table 12.1

NDNMB- Competitive antagonist

Succinylcholine	NDNMB
• Fasciculation +	• - -
• Post-op myalgia +	• - --
	• Reversal by neostigmine (increasing the quantity of Ach by inhibiting Ach esterase)

- Drugs- Pipercuronium, Vaecuronium, Atracurium, Rocuronium.
- Pipercuronium, Vecuronium, Atracurium, Rocuronium, and Cisatracurium are the only drugs that act upon the muscles and do not have any action in providing analgesia, or CNS depression.
- Aminosteroid category drugs are cardiac stable drugs. They do not have any action on the heart.
- The fastest-acting NDNMB is Rapacuronium because the onset of action is 70-80 seconds and the second fastest drug is Rocuronium (90 seconds).

Pancuronium- Long acting

- Duration of action – 40-80 min
- Only aminosteroid which is CVS unstable because of vagal blockade leads to increase BP/HR
- Renal / hepatic clearance
  - Fastest NMB- SCH
  - Fastest NDNMB- Rapacuronium- 75 sec- Not being used
  - In the year 2000 in the US it lead to mortality of paediatric patient – Bronchospasm
  - 2nd Fastest NDNMB- rocuronium (90sec)- used in RSI

Vecuronium

- Dosage- 0.08-0.12 mg/kg
- Primary excretion- biliary system
- Secondary- renal system
- Active metabolite is 3 Cisvecuronium

D-Tubocurarine	Atracurium
• First NMB • It causes intense histamine release • (D-tub > Atra = Miva > Doxa)	• Hoffmann's degradation • Non enzymatic time bound self-destruction at physiological PH and temperature • Doses- 0.6 mg/kg • Laudanosine- accumulation can cause epilepsy

- 5 times more potent than atracurium
- No side effect of benzyl quinolones group
- Laudonosine produced is very less
- Doses – 0.1-0.15 mg/kg

Atracurium	Cis-atracurium
• Mixture of 10 isomer	• Pure Cis-isomer
• Histamine released	• Minimal /-
• CVS unstable	• CVS stable

- Cis-atracurium is 5 times more potent than atracurium.
- The benzyl quinolones group has no side effects.
- It produces a lesser amount of Laudonosine.

Atracurium	Cis-atracurium
It is a mixture of 10 isomers.	It is made of pure cis-isomer.
Histamine is released.	Minimal histamine released.
The CVS is unstable.	The CVS is stable.

Gantacurium	Mivacurium
• Newer drug • Doses not belong to any group • Ultra short acting, rapid onset • Similar to Scoline • Metabolism of chemical degradation to L-cysteine • Ph sensitive hydrolysis • Non renal/hepatic involvement	• 0.25 mg/kg, 12-18 min • Metabolized by pseudocholinesterase

- This is a new drug which doesn't belong to any group.
- It has a rapid onset with ultra shirt-acting properties.
- This drug is similar to Scoline.
- It has a Ph sensitive hydrolysis.
- It does not involve renal or hepatic organs.

Mivacurium

- This drug is metabolized by pseudocholinesterase.
- It produces neuromuscular block in 12-18 minutes with a dose of 0.25mg/kg.
- NDNMB action can be reversed by the action of neostigmine. It increases the quantity of acetylcholine by inhibiting acetylcholine esterase, which is responsible for breaking down acetylcholine and sends back to the pre-synaptic terminal.

Reversal Agent	Suggamadex
• Neostigmine (Mc used-0.04-0.08 mg/kg) • Pyridostigmine (0.1-0.4 mg/kg) • Edrophonium • Physostigmine (0.5-1mg/kg)	Cyclodextrin compound Similar to aminosteroids Acts only on(vecuronium, rocuronium)

Suggamadex

- This reversal agent is similar to aminosteroids.
- It is made of cyclodextrin compound.
- Suggamadex acts only on vecuronium and rocuronium.
- The common reversal agents are Neostigmine, Pyridostigmine, Edrophonium, Physostigmine.

Calabadion

- Specific agent which can capture both amino steroids and benzylisoquinolines
  Calabadion are reversal agents which can reverse the effects of amino steroids and benzylisoquinolines.
- Once the quantity of acetylcholine is increased, the action of NDNMB is automatically decreased.
- The majority of the drugs are metabolized rapidly, and only 5-15% of the drug is available for action on the receptors.
- Sch metabolizes very fast; scholine action needs to be fast for muscle relaxation by the enzyme.

Golden Point

Drugs and Condition leading to potentiate NMB

- Antibiotics – Tetracycline, aminoglycosides
- Mg++ - Increase
- Increase H+ - acidosis
- Antiarrhythmic – quinidine / CCB
- Potent inhalational Agents
- Hypothermia
- NM disease – myasthenia gravis

Drugs and Condition Leading to Potentiate NMB

- Antibiotics like Tetracycline and aminoglycosides lead to Mg++ increase and an increase in H+, leading to acidosis.
- Potential inhalation agents can cause hypothermia, NM disease, and Myasthenia Gravis.

Important Questions

Q. Which drug has the most severe unstable CVS?
Ans: Pancuronium.

Q. Why is pancuronium CVS an unstable drug?
Ans: Because pancuronium leads to blockage of the vagal nerve, which increases heart rate.

Q. Which is the fastest neuromuscular blocking agent?
Ans: Succinylcholine.

Q. Which is the fastest-acting non-depolarizing neuromuscular relaxant?
Ans: Rapacuronium.

Q. Which is the second fastest acting agent for rapid sequence induction?
Ans: Rocuronium.

Q. Why is rapacuronium banned?
Ans: Rapacuronium is banned because it causes mortality in pediatric patients.

Q. What is the active metabolite of vecuronium?
Ans: 3-cis vecuronium

Q. Which is the first neuromuscular blocking agent?
Ans: D-tubocurarine

Q. Which drug releases the maximum amount of histamine?
Ans: D-tubocurarine

Q. What does Atracurium undergo?
Ans: Hofmann degradation

Q. Byproduct (Laudanosine) of atracurium can cause
Ans: Epilepsy

Q. What metabolizes Mivacurium?
Ans: Pseudocholinesterase

Q. Gantacurium is similar to
Ans: Choline

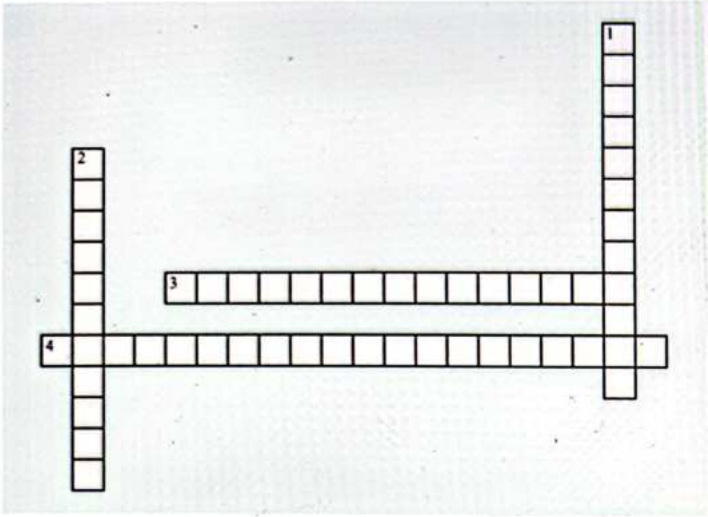
Q. What is acetylcholine?
Ans: Depolarizing muscle relaxant

Table 12.1

Aminosteroids	Benzylisoquinolines
1. Pancuronium (long acting) 2. Pipercuronium (long acting) 3. Vecuronium (intermediate acting) 4. Rocuronium (intermediate acting) 5. Rapacuronium (short acting)	1. D-tubocuranine (long acting) 2. Doxacurium (long acting) 3. Atracurium (intermediate acting) 4. Cis-atracurium (intermediate acting) 5. Mivacurium (short acting) Release Histamine 1. Vasodilation 2. Decrease BP, Increase HR 3. Flushing, bronchospasm • Unstable cardiovascular

CROSS WORD PUZZLES

Crossword Puzzle 1



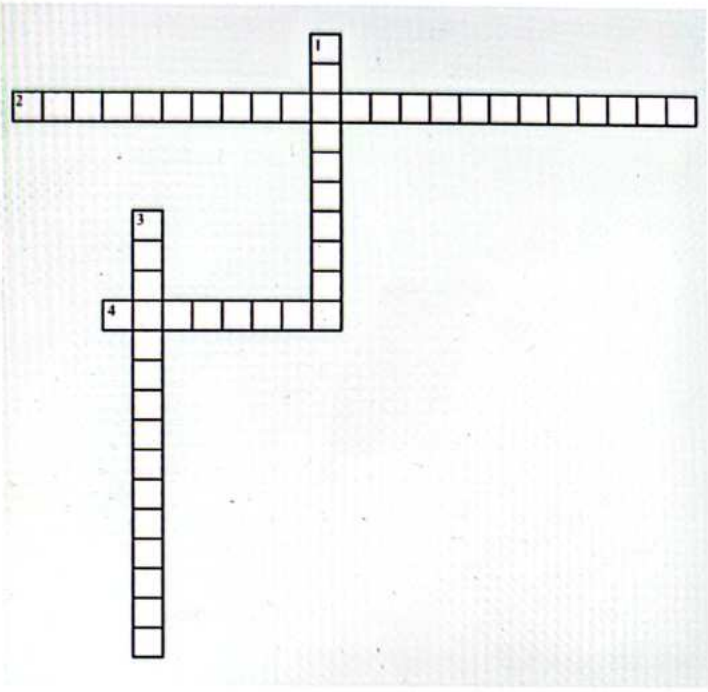
Across

3. _____ is the only drug that needs to be injected rapidly.
4. _____ results from too many fasciculations involving vigorous contractions in the body.

Down

1. _____ is the side effect of succinylcholine.
2. _____ is the byproduct of atracurium.

Crossword Puzzle 2



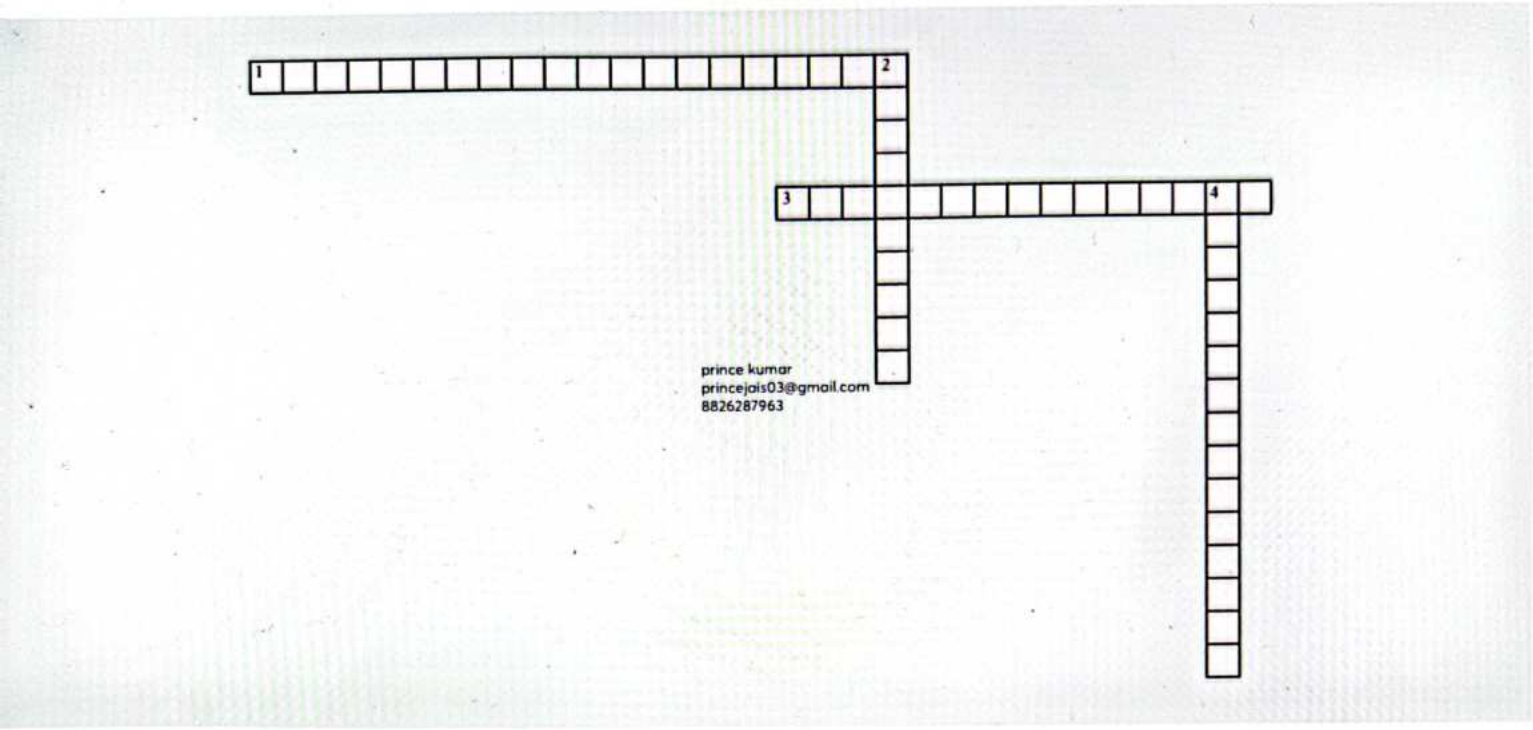
Across

2. _____ is the preventative measure for patients with pulmonary aspiration hazards.
4. ___ works on the "all or none" phenomenon.

Down

1. _____ is the most common nerve for neuromuscular monitoring.
3. _____ has a structural similarity with acetylcholine.

Crossword Puzzle 3



Across

1. ___ is not seen in non-depolarizing agents because no fasciculation occurs.
3. ___ starts behaving like NDNMB at higher doses (4-6 mg/kg).

Down

2. ___ undergoes Hofmann degradation.
4. ___ agents work by inhibiting acetylcholine receptors in a competitive manner.

13 REGIONAL ANAESTHESIA

- Local/regional anesthetics give anesthesia only to the applied region, and the patient is fully conscious.
- For the case of a person with injury in the femur/inguinal hernia/ umbilical hernia, spinal anesthesia is given to the person.

Types of Local Anaesthetic

- Central Neuraxial Blockade comprises a Subarachnoid and Epidural Blockade.
- Local Anaesthesia consists of only Regional anesthesia.

Central Neuraxial Blockade 00:03:48

- Layers pierced during the administration of the central block.
- Spinal cord → Pia mater → arachnoid mater → dura mater → ligamentum flavum → supra and interspinous ligament → subcutaneous fascia → skin
  - Between the piamater and arachnoid mater – Subarachnoid space
  - Between the dura mater and arachnoid mater – Subdural space
- From outside to inside, it includes skin, subcutaneous fascia, supra and interspinous ligament, ligamentum flavum, dura mater, arachnoid mater, pia mater, and spinal cord.
- Subarachnoid space contains CSF, whereas Epidural space (outside dura mater) is an air-containing cavity.

Difference between Spinal and Extradural Anaesthesia

00:09:30

- Subarachnoid anesthesia is also called spinal anaesthesia (giving the drug in the CSF), and epidural anesthesia (air-containing cavity) is also known as extradural anesthesia.
- The difference between spinal and extradural anesthesia is given in the image below.

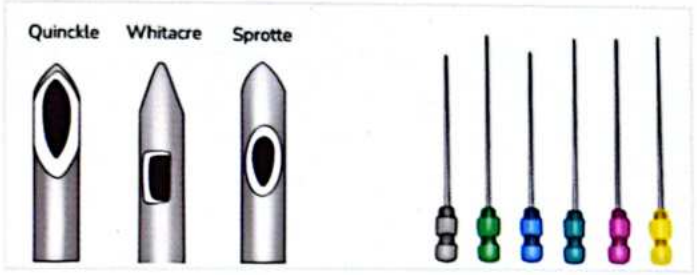
Refer Table 13.1

Important Information

- The specific gravity of the LA is more than that of CSF

- Various instruments used during the procedure are shown in the diagram:

Refer Table 13.2



Important Information

- Spinal anaesthesia is given at the level of L3-L4 or L4-L5 whereas epidural can be given in higher levels (thoracic and lumbar).

How to use the instruments

1. Tuohy's needle is put inside the epidural space.
2. Lor syringe is used to pump air, and to attain loss of resistance, the syringe is removed.
3. The epidural catheter is attached.
4. The most commonly used needle is the quincke's needle.

Side Effect 00:29:41

- Most common intraoperative complication- Hypotension which can be prevented by Preloading (administering 1-2L of fluid before surgery).
- Treatment of hypotension includes IV fluids, IV inotropes, drugs – phenylephrine (best as it does not increase HR and is used in pregnancy), ephedrine, and mephentermine.
- Most common postoperative complication- Urinary retention.
- Other postoperative complications include bradycardia, respiratory distress, high spinal hematoma formation, neurological syndrome, backache, and post-dural puncture headaches.

Important Information

- **Few important points on post-dural puncture headache are:**
  - They occur mostly in spinal anaesthesia.
  - They occur in the occipital region.
  - They mainly appear Due to the traction of nerves which aggregate in the change of position.
  - Causes: Multiple attempts, use of wide bore needle, dura cutting needle.
  - Onset can be within 12-72 hr and can be prolonged to 8-10 days.
  - Treatment includes IV fluids, NSAIDs with caffeine, or an epidural blood patch.

Contraindications 00:40:00

- Patient refusal is an Absolute Contraindication.
- Localised infections are an Absolute Contraindication.
- A platelet count of less than 50,000 is an Absolute Contraindication.
- Hypovolemia is a relative contraindication.
- Increased intracranial pressure is a relative contraindication.
- Any Kind of heart disease is a relative contraindication.

Special Anaesthetic- Labour Analgesia 00:42:10

- In pregnancy, an epidural catheter in epidural space can produce analgesia without giving anesthesia by titrating a dose of local anesthetic.
- The sensory pathway is blocked, but the motor pathway is normal.
- Composition is Bupivacaine 0.125% + Fentanyl
- Walking epidural

Local Anaesthetic 00:48:37

- Local anesthesia is the condition where there is reversible loss of sensation which is circumscribed to an area by decreasing excitation nerve ending by decreasing conduction.
- They act by blocking Na+ channels.
- They consist of aromatic and amino groups attached by ester and amide bonds.
- An active nerve fiber is the best state of a nerve for maximum action of local anesthetic.
- Systemic absorption: Intravenous (best) > tracheal > intercostal > paracervical < caudal > lumbar > brachial plexus > sciatic > subcutaneous

Desirable Properties of Local Anaesthetic 00:51:55

- No permanent alteration to nerve fibre.
- Systemic toxicity is low.
- It should have short onset of action.
- No allergic reaction should be precipitated.
- Not initiating to tissue.

Different Types of Nerve Fibres 00:54:34

- **There are 3 different types of nerves: A (Aα, Aβ, Aγ, Aδ), B, C.**
- Fibres most sensitive to local anesthetics are B > C > A
- Desensitisation order: autonomic > sensory > motor > temperature > pain > touch > proprioception.
- Reversal is in the opposite direction.

Different Types of Nerve Fibres are given in the image.

Different types of Nerve Fibres	
Aα	Motor
Aβ	Touch, Pressure via Touch
Aγ	Afferent Muscle Spindles
Aδ	Fast Pain and Temperature
B	Autonomic Preganglionic
C	Slow Pain, Post Ganglionic

Local Anaesthetic Combined with Vasoconstrictor 00:54:49

- When a local anesthetic is combined with vasoconstrictor, constriction of vessels and hence less absorption.

Advantages	Disadvantages
Increased duration of drug action	Painful on injection
Increased Intensity of action of drug	Tissue edema
Decrease systemic toxicity	Necrosis
Decrease blood loss	

Groups of Local Anaesthetic and their Classification 01:01:13

- It consists of ester and amide groups.
- Chloroprocaine is the shortest acting.
- The most widely used are lignocaine, bupivacaine and ropivacaine.

Ester (i)	Duration	Amides (ii)	Duration
Cocaine	Short acting	Lignocaine	Intermediate acting
Procaine	Short acting	Mepivacaine	Intermediate acting
Chloroprocaine	Shortest acting	Prilocaine	Intermediate acting
Benzocaine	Long acting	Bupivacaine	Long acting
Tetracaine	Long acting	Ropivacaine	Long acting
		Dibucaine	Long acting

Systemic absorption

- IV > Tracheal > Intercostal > Paracervical < Caudal > Lumbar > brachial Plexus > Sciatic > S/C

Fiber

- Most sensitive B > C > A
- Autonomic > Sensory > Motor > Temperature > Pain > Touch > Proprioception
- Reversal is opposite direction
- Last to first

Cocaine 01:04:29

- 1st local anesthetic to be used and has vasoconstrictor properties.
- Natural alkaloids.
- Side effect: pyrexia.

Procaine 01:05:40

- It is Topically ineffective.
- It Produces significant vasodilation causing more systemic absorption, so it has to be combined with adrenaline.
- It is less potent and short-duration.

Lignocaine 01:07:18

- It contains an Amide group.
- It is the safest LOCAL ANAESTHETIC; no allergies and is also an antiarrhythmic drug.
- It undergoes Hepatic metabolism.
- It is the DOC of Bier's block.
- Dose:
  - Lignocaine (plain 3 mg/kg)
  - Lignocaine (Adr 7 mg/kg)

Bupivacaine 01:09:18

- It is Added with glucose for spinal anesthesia.
- It is the most cardiotoxic drug.
- It is the shorter onset and longer duration.
- It is used in Labour analgesia.
- It is the best drug for a differential blockade.

Ropivacaine 01:12:10

- It is less cardiotoxic.
- It is less potent.

Metabolism of Local Anaesthetic 01:12:50

- **Esters**: Ester-type local anesthetics are metabolised by plasma pseudocholinesterase and their metabolites para-aminobenzoic acid being one of the main, are excreted through urine. The presence of PABA may cause allergies in some patients. The pathway is the same for all esters containing local anesthetics except cocaine.
- Hydrolyzed by pseudocholinesterase
  ↓
  PABA (para-aminobenzoic acid), which may be allergic in some patients.

- **Amide**: Hydrolyzed by Liver microsomal enzymes, even cocaine.

Dermal Anaesthetic- Emla Cream 01:14:12

- It contains a mixture of Lignocaine+Prilocaine in (1:1)-2.5%each.
- The contact period is 1 hour.

Last- Local Anaesthetic System Toxicity 01:16:12

- Toxicity is highly dangerous, and a scale is present to measure the toxic level called LAST.
- Symptoms of toxicity include Anxiety, tinnitus, seizures, arrhythmia, and cardiac arrest.

Table 13.1

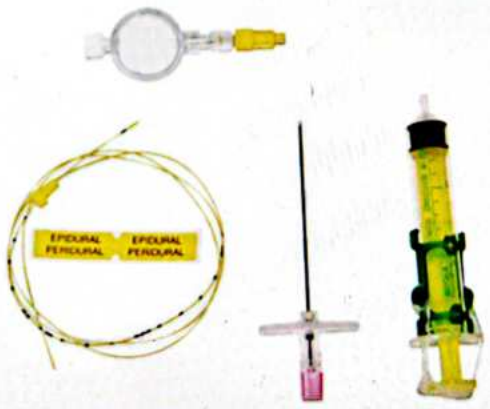
Subarachnoid / spinal anaesthesia	Epidural / extradural anaesthesia
Drug given is at the level of L2-L5	Extradural space
Fast onset because the drug mixes with CSF	Delayed effect There is no carrier fluid
Easy to control the level of the drug with positioning of the patient (drug is hyperbaric) Mixed with dextrose	1.5-2 ml/ segment To achieve that level
More haemodynamic imbalance	Less haemodynamic imbalance
Easily confirmed with return of CSF	Confirmed with loss of resistance. It require practice
Intraoperative use	Since we put an epidural catheter the duration of surgery can be prolonged and can be used for post-op analgesia as well

Table 13.2

Needle
- Quincke's
- Whitacre
- Sprotte's

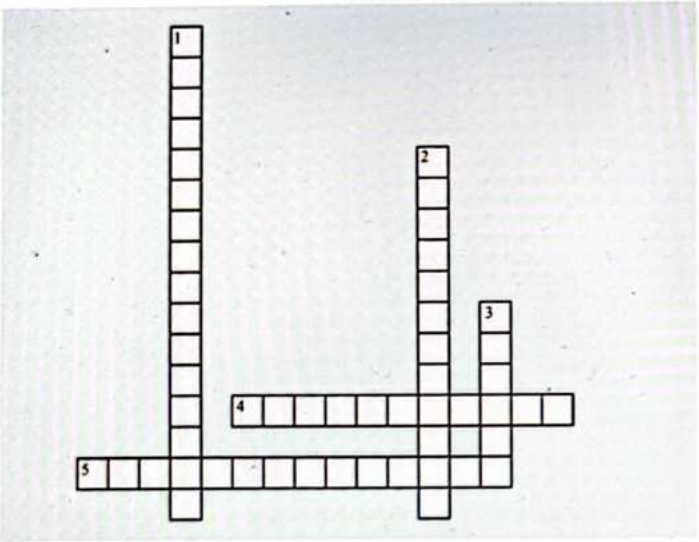
Needle
Touhy's needle
18 and 16 gauze

S/E - mc complication - hypotension
Rx:
- IV fluids
- Drugs
  - Phenylephrine (Best)
    Does not increase HR
    Use in pregnancy
  - Ephedrine
  - Mephentermine
- IV inotropes



CROSS WORD PUZZLES

Crossword Puzzle 1



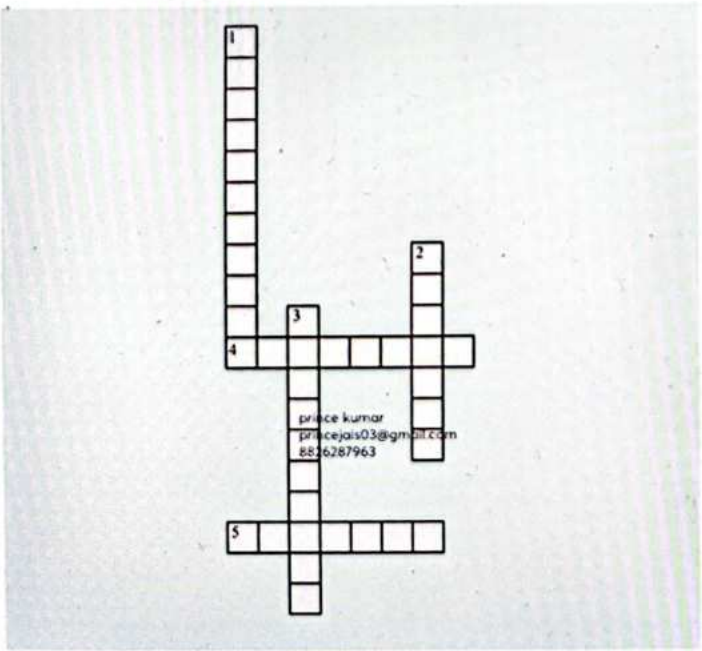
Across

4. The most common intraoperative complication is_____.
5. _____ is the shortest acting drug.

Down

1. The most common postoperative complications are _____.
2. Space that contains CSF is _____.
3. _____ state of nerve fiber is the best for local anesthetic.

Crossword Puzzle 2



Across

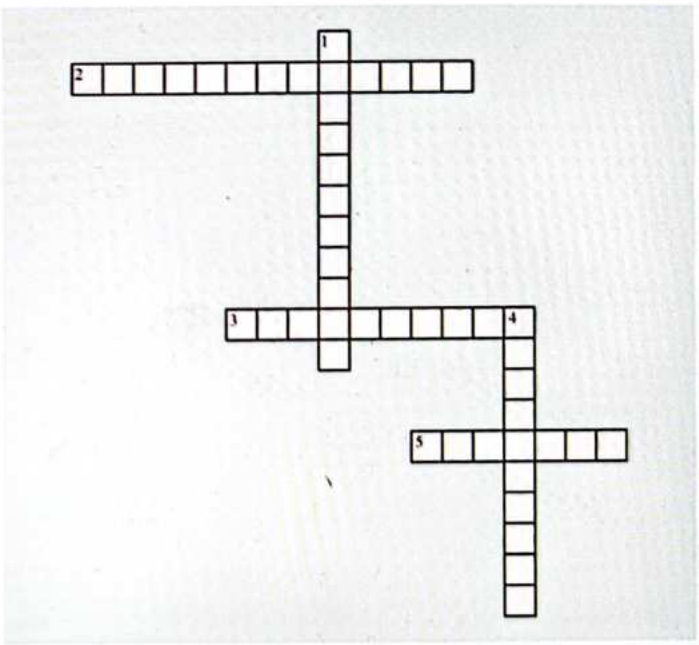
4. Space outside dura mater is _____

5. The most commonly used needle is _____.

Down

1. _____Drug used in Labour analgesia
2. 1ST local anesthetic to be used is _____.
3. _____ is the DOC of Bier's block.

Crossword Puzzle 3



Across

2. A platelet count of less than ____ is an absolute contraindication.
3. It is the safest local anaesthetic_____.
5. ester Hydrolyzed by Liver microsomal enzymes is _____.

Down

1. _____is the best drug for a differential blockade.
4. Anaesthesia, where there is less hemodynamic imbalance_____.

14 FLUID THERAPY

Fluid Content in the Body 00:01:34

- Total body water consists of 60% of the total body weight.
- Out of 60%, intracellular fluid is 2/3rd (40%) and extracellular fluid is 1/3rd (20%).
- In extracellular there are intravascular(1/4th-5%) and extravascular fluids (3/4th-15%).
- Only intravascular volumes are the targets for fluid therapy.

How to Evaluate Perioperative Fluid Status 00:05:29

- Mental status of the patient should be observed, whether the patient's mental status is altered or not, and if the mental status is altered sodium levels should be considered.
- History of fluids intake and urinary output of the patient must be investigated.
- Blood pressure should be seen in supine and standing positions.
- Heart rate is seen, tachycardic patients may have a fluid deficiency.
- Skin turgor should also be considered, if the patient is having rough skin then fluid deficiency must be there.
- **CVP (Central Venous Pressure) MONITORING:** Invasive kind of monitoring, in which Central venous lines are put into the internal jugular, then pressure is seen, and whether there is a fluid deficiency or another comorbidity is evaluated.

IV Fluid Therapy 00:08:02

- Crystalloids, colloids, or a combination of both can be given to the patient, depending on the patient's condition.
  - **Indications**
    - → Volume Resuscitation
    - → Vehicle of IV used
    - → Nutrition
- Crystalloid examples are DNS, normal saline, and ringer lactate.
- Colloid examples are hydroxy ethyl starch, albumin, and many other things.
- These fluids are not only given to OT or ICU patients, but they can also be given to patients who have trauma or blood loss.
- Fluids can be given to resuscitate patients.
- First main action of these therapies is volume resuscitation, whether the patient is tachycardic, hypotensive, or lost so much amount of blood intraoperatively (or due to trauma); drugs in powdered form are diluted and given intravenously.
- So, fluids are used for volume resuscitation and also be used as vehicles for intravenous drugs.
- Dextrose is given as an energy supplement to the patient.

Crystalloids 00:11:24

- As plasma osmolarity is 290 Mosm/l, so crystalloids may be isotonic (same osmolarity), hypertonic (osmolarity more than plasma), and hypotonic (i.e., below normal osmolarity of the plasma).
- Different concentrations of fluids are required in different conditions.
- Crystalloids are given as a blood replacement in the ratio of 3:1. It means if a patient loses 1 ml of blood, then 3 ml of crystalloids should be given for the replacement of that 1 ml of blood.
- It consists of water plus electrolytes.
- **Examples:**

NS – 0.9% 0.45% 3%

Dextrose- 5% 10% 20% 25% (given according to the severity of the hypoglycaemic condition)

DNS (Dextrose plus normal saline)- Sugar and some concentration of sodium chloride are there.

RL (Ringer's lactate fluid)- It is the most physiological fluid because contents of RL i.e., sodium, chloride, potassium, and lactate are in a physiological range, which is required by the body.

Important Information

- Colloids are given in a ratio of 1:1
- They have high molecular weight.
- They tend to stay in circulation for a longer duration as compared to crystalloids.
- Colloids are always isotonic.

NS- 0.9 % ISO- Osmolar

- NS 0.9% is considered iso-osmolar because its osmolarity is 308, which is in an around plasma osmolarity i.e., 290 Mosm/l.
- Normal saline consists of only sodium and chloride. The content of sodium is 154 mmol/l and chloride is also 154 mmol/l, if these two are combined the osmolarity of normal saline is derived

Indication

- Can be used for resuscitation of blood loss.
- If the patient is having low low levels of sodium and chloride then Normal Saline is the fluid of choice.
- As it has only sodium and chloride so it can be used for diluting drugs.

Side effect

- Larger volume may cause hyperchloremic metabolic acidosis.

- When these fluids are given, electrolyte concentration should be watched because any kind of negative ion imbalance causes acidosis.

NS- 0.45% Half NS- Hypotonic

- Content of sodium (77 mmol/l) and chloride (77 mmol/l) is reduced to half, and they combine to make an osmolarity of 154 mmol/l.
- Which is less than plasma osmolarity.
- So many amounts of sodium and chloride can not be given to pediatric patients, so 0.45% NS is used for pediatric patients.
- Maintenance fluid therapy
- There may be hypernatremia if plasma sodium is normal.
- Extra amounts of sodium in the body may lead to cerebral edema inside the brain.
- Rarely can it cause pontine myelinolysis.

3% Normal Saline

- It is hypertonic.
- Sodium content is 513 mmol/l and chloride content is also 513 mmol/l.
- Osmolarity is 1025 Mosm/l (higher osmolarity than plasma's osmolarity)
- Such a high-concentration solution is used in the following conditions-
  - If the patient is having symptoms of hyponatremia.
  - If sodium levels have gone to 120 or 125 mmol/l, then the patient should be treated with 3% normal saline.
  - If the patient is having scenarios of coma and seizures.
- It has such a high osmolarity that it can not be given through the peripheral vessels, otherwise it may lead to phlebitis (i.e., inflammation of the blood vessels).
- These drugs are given through central venous cannulation i.e., put into internal jugular vein cannulation, or femoral line, having secured lines into a larger vessel.
- Weight of the fluid is high, and the heart will perform more functions, if the heart doesn't work properly then it may cause severe complications during the therapy.
- If the Patient is having congestive heart failure, severe renal insufficiency, edema, or any kind of sodium retention in the body, then this 3% normal saline solution should be completely avoided.

5% Dextrose- Hypotonic

- Osmolarity is 252 mosm/l (hypotonic solution).
- Given for nutritional purposes.
- It can also be given in hypernatremia conditions to dilute sodium content in the body.
- If the patient is having a nutritional problem with less sugar, dehydration, or other things, then a 5% dextrose solution should be given.
- It does not have any electrolytes.

Concentration	5%	10%	20%	25%	Plasma
Osmolarity	252	505	1010	1262	290

Ringer Lactate

- Most important fluid used on a day-to-day basis.
- Ringer lactate can be given anywhere or wherever possible because it is the most physiological solution.
- Sodium content is 130 mmol/l and chloride content is 109 mmol/l. The contents are somewhere equal to the normal physiological of the body.
- Lactate is 28 mmol/l and osmolarity is 273 mmol/L. K+ 4 mmol/L Ca 1.5 mmol/L
- All the values are physiological to the body.
- It can be given in intraoperative blood loss, severe hypervolemia, and any fluid deficiency.

Side effects:

- There may be metabolic acidosis.
- Ringer lactate should not be given alongside the blood.

DNS

- DNS is 0.9% saline and 5% dextrose.
- They are hyperosmolar fluid as their osmolarity is 432 mmosm/l
- They are used for the maintenance of fluid and correction of fluid deficiency with energy
- DNS is compatible with blood as well.

Important Information

- DNS composition 0.9% saline + 5% dextrose
- Na^+ 154 mmol/L, Cl 154 mmol/L + 5gm of glucose

Colloids

00:35:43

- They are iso-osmolar.
- They have very high molecular weight.
- If 1 ml of blood loss is there, colloids must be given in the ratio of 1:1
- The half-life of colloids is 3 to 4 hours.
- There are natural and artificial colloids.
- Natural colloids are albumins, and artificial colloids are gelatin, dextran, and hydroxyethyl starch (HES).
- Hydroxy ethyl starch is complex sugars, i.e., they take longer to metabolize. In turn, they will stay for a longer duration in the circulation.

Albumin

- Albumin comprises 50 to 60% of plasma protein.
- Albumin is synthesized in the liver.
- If the liver is not working properly, exogenous albumins are given.
- Patients with liver disease, living on ventilatory support, or having albumin deficiency are given exogenous albumin. .

- It can also be given in excess amounts of blood loss.
- Used in burns and ICU patients

Side effects

- If it is not given through central venous lines, it can lead to pruritus.
- Anaphylactoid reactions may occur.

Gelatins

- Large molecular weight protein formed by hydrolysis of collagen

Types

- Succinylated / modified
- Urea cross linked
- Oxypolygelatine
  70-80% vol. help in expansion

Uses

- Rapid expansion of intravascular volume
- Severe hypotension

Side effect

- Hypersensitivity
- Anaphylactoid reaction

Dextran

- It is also used for volume expansion.
- It is a highly branched polysaccharide molecule.

Uses

- 6% dextran (70), 10% dextran (40)
- Improves microcirculatory flow in microsurgical reimplantation
- For volume expansion and extracorporeal circulation during cardiopulmonary bypass,

Side effects

- Anaphylactic reactions and coagulation abnormalities

Hydroxyethyl Starch

- HES are most commonly used because they are eco-friendly, cost-friendly, and compatible with the patient.
- Patients with blood loss who can not be resuscitated with crystalloids are treated with HES.
- 6% AND 10% HES are there, 10% HES is hypertonic.
- Duration of volume expansion is 8 to 12 hours, which is why HES should be given twice a day.

Uses

- Fluid replacement in severe hypovolemia

Side effect

- Renal impairment
- Amylase increased
- Coagulation abnormalities

Calculation of Fluid Replacement 00:46:32

- Maintenance fluid
  - 4-2-1 rule / holiday segar rule
    - 4 × 10 kg - 4 ml/kg/hr - 40 ml/hr
    - 2 × 10 kg - 2 ml/kg/hr - 20 ml/hr
    - 1 × 40 kg - 1 ml/kg/hr - 40 ml/hr
    - 100 ml/hr

    (Remaining weight beyond 20 kg)
- Fluid maintenance should be done intraoperatively so that the patient may not end up with disorders like hypotension or tachycardia.
- Fluid management is necessary because there may be incisions and blood loss during operative procedures.

Fasting deficit

- NPO hrs- (8 hr) × total maintenance fluid
- ½ replaced in 1st hour
- ¼ and ¼ - 2nd and 3rd hr respectively

Depending on type of surgery (third space loss)

- **Minor Sx**- 2-3 ml/kg/hr
- **Moderate Sx**- 4-6 ml/kg/hr
- **Major Sx**- 8-10 ml/kg/hr
- These are the calculations for the patients who are having planned routine surgery.

Important Information

- **Holiday cigar rules is**
  - For 1st 10 kg – 4 × 10 = 40 ml/kg
  - Next 10 kg - 2 × 10 = 20 ml/kg
  - 1 × 40 = 40 ml/kg

Cannulas 01:00:58

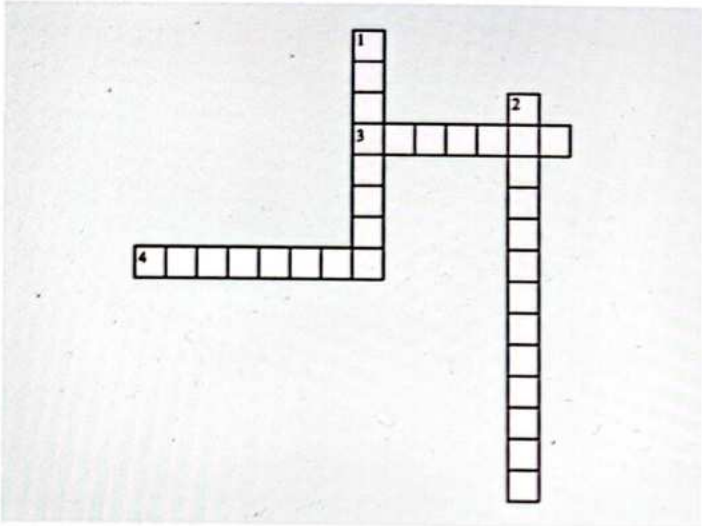
Colour coding	Size	Flow rate
Purple	26 G	11-15 ML
Yellow	24	15-23
Blue	22	22-50
Pink	20	55-80
Green	18	100-120
Grey	16	150-240
Orange	14	250-300

- Cannulas are IV lines that are secured for providing fluid to the patient.
- There can be different color coding and different sizes,
- Size purple cannula is 26 gauge which is the thinnest of all and the orange one is 14 gauge which is the thickest of all.

- Most commonly used cannulas are blue or pink for normal patients who need resuscitation.
- Green and grey are used for emergency resuscitation.
- Yellow cannula can be used for the pediatric age group.

CROSS WORD PUZZLES

Crossword Puzzle 1



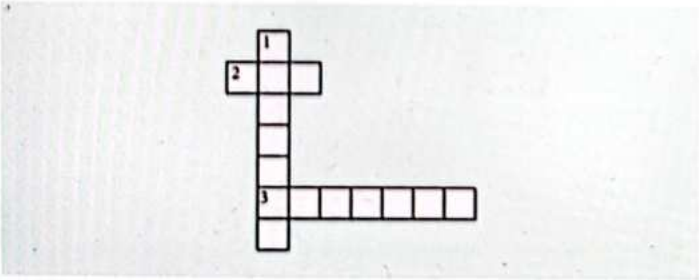
Across

3. _____is used in burns and ICU patients
4. _____have very high molecular weight.

Down

1. _____are used for the rapid extension of intravascular volumes.
2. _____ is the most important fluid used on a day-to-day basis.

Crossword Puzzle 2



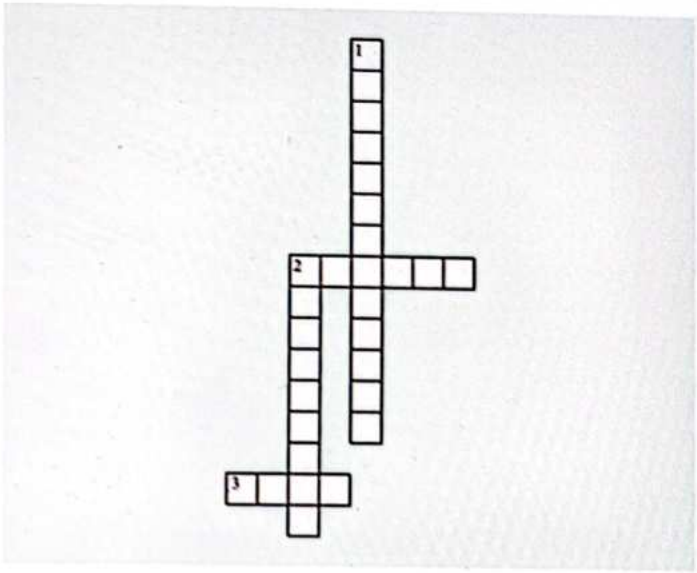
Across

2. _____are the most commonly used colloids because they are eco-friendly colloids
3. _____is synthesized in the liver.

Down

1. _____is used for volume expansion and extracorporeal circulation during cardiopulmonary bypass.

Crossword Puzzle 3



Across

2. _____can cause pontine myelinolysis.
3. _____turgor may occur in fluid deficiency

Down

1. Extra amounts of sodium in the body may lead to_____.
2. Half of NS is_____.

15 DISCHARGE SCORING SYSTEM

- A discharge scoring system is required to check the patient after the operation to determine whether the patient should be discharged to a different ward or from the hospital.
- The postoperative period is critical for the patient. Postoperative complications like pain, nausea or vomiting, mobility after anesthesia, etc., must be checked.
- The parameters to be checked include pain, mobility, respiration, etc., before a patient is discharged.
- Currently, there are two types of discharge scoring systems which can inform about the current situation of the patient as follows:
  - Modified Aldrete's Scoring System
  - Post-anesthesia discharge scoring system (PADSS)

Important Information

- A discharge scoring system is required to check the patient after the operation to determine whether the patient should be discharged to a different ward or from the hospital.

Modified Aldrete's Scoring System

00:02:30

Modified Aldrete Scoring

Criteria	Point Value
Oxygenation:	
• Sp02> 92% on room air	2
• Sp02> 90% on oxygen	1
• Sp02 <90% on oxygen	0
Respiration:	
• Breathes deeply and coughs freely	2
• Dyspnoeic, shallow or limited breathing	1
• Apnoea	0
Circulation:	
• Blood pressure ± 20 mmHg of normal	2
• Blood pressure ± 20—50 mmHg of normal	1
• Blood pressure more than mmHg of normal	0
Consciousness:	
• Fully awake	2
• Arosal on calling	1
• Not responsive	0
Movement:	
• Moves all extremities	2
• Moves two extremities	1
• No movement	0

- As shown in the scoring table above, the first criteria is oxygenation.

Oxygenation

- It needs to be checked whether the patient can maintain the O_2 saturation. The patient is observed for a longer duration.
- **Example:**
  - A patient came for orthopedic surgery and was discharged and kept in the post-operative room. This patient maintained an oxygen saturation level above 92% at room air.
  - Another patient from the same orthopedic surgery could maintain oxygen saturation above 90%, but with the help of oxygen.
  - Similarly, a third patient operated on during the same orthopedic surgery was unable to maintain oxygen saturation of more than 90%, even on oxygen.
- To determine whether the patients can be shifted to the discharge room, criteria, like respiration and circulation, apart from oxygen saturation, are checked.

Respiration

- A normal respiratory pattern is when the patient can freely cough out the foreign body. If the patient isn't maintaining their vital signs, coughing out the foreign body.

Circulation

- If the patient maintains blood pressure within +/- 20 mmHg of normal (preoperative range), it can be said to be normal. However, if the fluctuation is greater, this criterion needs to be followed when deciding if the patient can be shifted to a ward.

Consciousness

- The patient's consciousness needs to be checked, whether the patient is fully awake, has arousal on calling, or is not responsive.
- The patient's activity, whether the patient can move all extremities, can move two extremities, or has no movement, is checked.
- The patient is assigned points based on oxygenation, respiration, circulation, consciousness, and activity. After considering the score of all five points, it is decided whether the patient should be shifted or not. The highest score is 2 under each criterion, and 0 is the lowest point. Totalling 10

points are the highest score. The patient can only be shifted if the total score is 9-10.

- If any criteria give a lower score, then certain drugs are used to correct it before shifting the patient.

Post-Anesthesia Discharge Scoring System (PADSS)

00:09:18

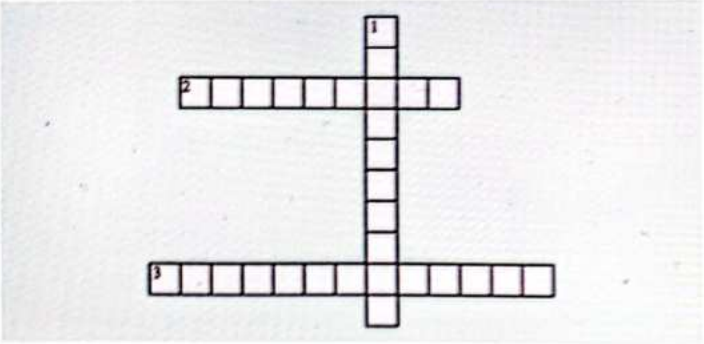
PADSS

- Name
- Surgical treatment
- Date.....time from surgery.....
- Vital signs (blood pressure, pulse, heart rate)
  - 0=>40% of preoperative value.
  - 1 = 20–40% of the preoperative value.
  - 2 = <20% of preoperative value.
- Ambulation
  - 0 = difficult/impossible.
  - 1 = toddle.
  - 2 = steady.
- Post-operative nausea and vomiting (PONV)
  - 0 = severe.
  - 1 = moderate.
  - 2 = minimal.
- Pain
  - 0 = Severe.
  - 1 = Moderate.
  - 2 = Minimal.
- **Surgical bleeding:**
  - 0 = Severe.
  - 1 = Moderate.
  - 2 = Minimal/Absent.

- PADSS is almost similar to modified Alderet's scoring. There are slight modifications.
- If there's a 20% fluctuation in the blood pressure compared to the preoperative value, then a score of 2 is given to the patient. If there's a massive fluctuation of more than 40%, a score of 0 is given. The patient is given treatment accordingly.
- Due to anesthesia, the patient cannot move the lower limbs. Thus, the patient's ambulation is checked after 4-6 hours. If the patient can move freely, it is said to be "steady ambulation." If the patient cannot move, the anesthesia hasn't worn off.
- The frequency and quantity of vomiting are checked and given points accordingly.
- Post-operative pain is evaluated. Multimodal drug therapy to used to relieve the pain.
- Pain is a very debilitating factor for the patient. The recovery is faster if the patient's pain is substantially reduced.
- The severity of surgical bleeding is evaluated. For that, the patient must be observed for tachycardia and hypotension and checked for surgical bleeding. The surgical bleeding should be minimal or absent for shifting the patient to the ward.

CROSS WORD PUZZLES

Crossword Puzzle 1



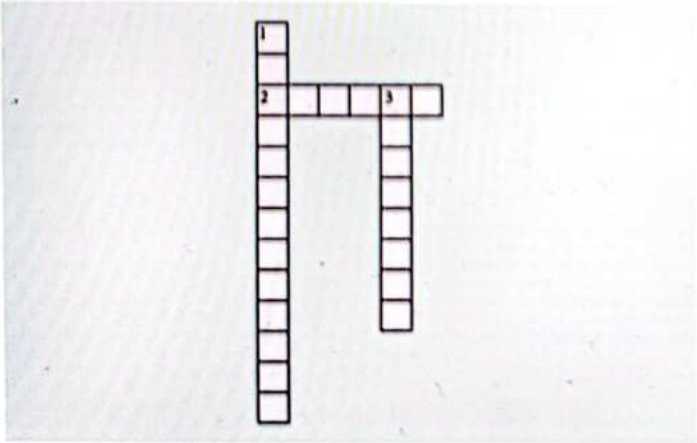
Across

2. _____ scoring system is required to check the patient after the operation to determine whether the patient should be discharged to a different ward or from the hospital.
3. _____ period is critical for the patient. The patient's pain, postoperative nausea or vomiting, mobility after anesthesia, etc., are checked

Down

1. _____ checked include pain, mobility, respiration, etc.

Crossword Puzzle 2



Across

2. _____ respiratory pattern is when the patient is able to cough out the foreign body freely.

Down

1. _____ of the patient needs to be checked, whether the patient is fully awake, has arousal on calling, or not responsive.
3. _____ of the patient includes whether the patient is able to move all extremities, able to move two extremities, or does not have any movement.

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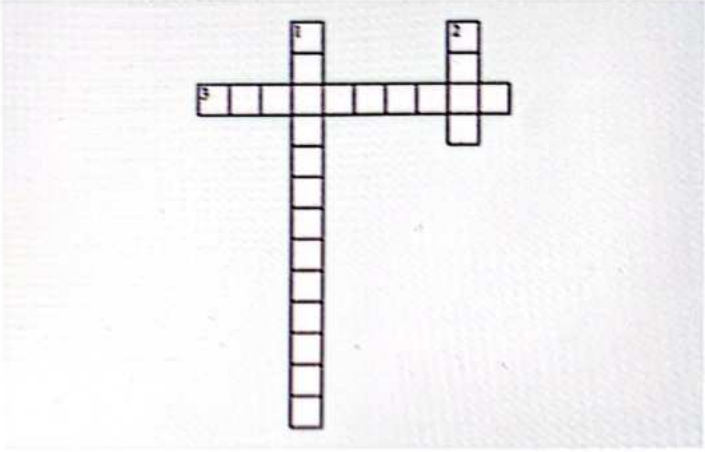
Crossword Puzzle 3



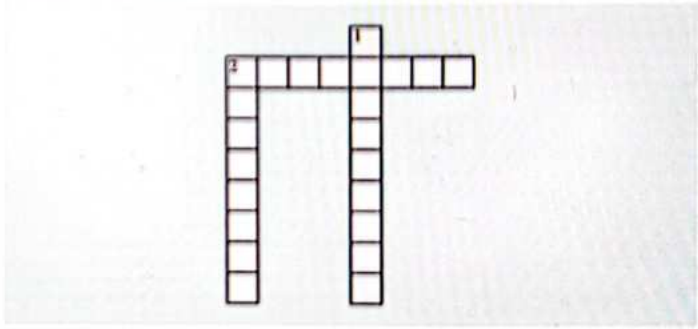
Across

3. _____ makes the patient's lower limbs immobile.

Down

1. _____ pain is evaluated and multimodal drug therapy is provided to relieve the pain.
2. _____ is a very debilitating factor for the patient.

Crossword Puzzle 4



Across

2. _____ of surgical bleeding is evaluated.

Down

1. _____ and quantity of vomiting is checked, and points are given accordingly.
2. _____ bleeding should be minimal or absent in order to shift the patient to the ward.

16 BLS/ACLS PROTOCOL

- BLS/ACLS protocols help us save precious lives.
- BLS stands for Basic Life Support.
- ACLS stands for Advanced Cardiac Life Support.
- Any person can provide BLS, but medical professionals can provide only ACLS.
- No drugs are needed to be given in BLS.
- In ACLS, medications are required, which a non-specialist cannot administer.
- Any person can provide basic life support to a patient until an emergency team arrives and save a precious life

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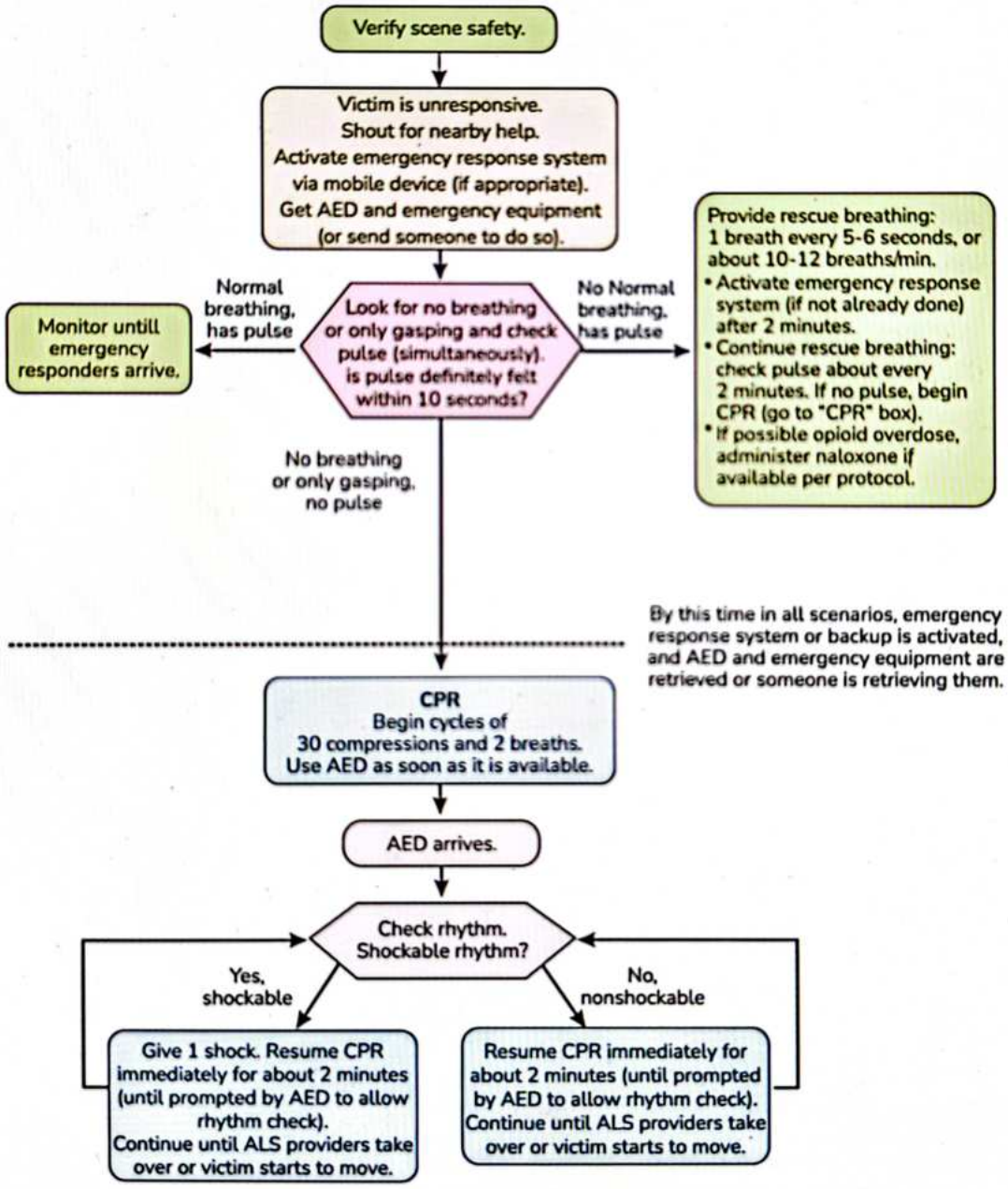
BLS Protocol

00:02:40



- American Health Association provides all the guidelines mentioned in the protocol.
- Verify scene safety: When a patient is found lying on the ground, see whether the site is safe. If not, look for a safe place. For example, if a patient is found unconscious on the road, instead of starting maneuvers right there, shift the patient to the roadside.
- If the patient is unresponsive, shout for nearby help, activate the emergency response system to call for an ambulance, etc.
- Get AED (Automated External Device) and medical equipment, or send someone else to do so. Most public places have AEDs, like malls, highways, petrol pumps, etc.
- **See whether the patient is breathing or not. There can be three scenarios in this situation:**
  - The patient has normal breathing with a pulse: In this case, monitor the patient until emergency responders arrive.
  - The patient is not breathing properly but has a pulse: In this case, CPR is not needed because the patient has a pulse. Instead, provide rescue breathing to the patient. Support the patient's breathing by giving 1 breath every 5 to 6 seconds or 10 to 12 breaths per minute. Continue rescue breathing and check pulse after every two minutes.
  - Neither the patient is breathing properly nor has a pulse: If the patient loses their pulse, initiate CPR (Cardiopulmonary resuscitation). Start with chest compressions. Give 30 compressions and two breaths. Use AED as soon as it arrives.
- AED has two patches that get attached to the sternum and apex of the heart. It allows for checking the rhythm of the patient's heart. It is well-made equipment. Only the instructions need to be followed when using it.
- AED tells whether the rhythm is shockable or not. There are four types of rhythms:
  - Ventricular Tachycardia
  - Ventricular Fibrillation
  - Asystole
  - Pulseless Electrical Activity
- Only ventricular tachycardia and ventricular fibrillation are shockable rhythms.
- If the machine detects that the rhythm is shockable, it delivers the shock and commands the user to resume CPR for two minutes.
- Resume CPR for two minutes after every shock.
- After some time, there will be a blink on the machine to check whether the patient has got his rhythm back or not.
- Keep on doing this until ALS providers take over the victim and start doing maneuvers like endotracheal intubation, administration of drugs, or shifts to the ambulance.
- If the rhythm is non-shockable, the machine will not deliver a shock. It will prompt you to resume CPR for two minutes. After that, the machine will automatically tell whether the rhythm is normal.
- A shock is not given in asystole and pulseless electrical activity.
- No medications are given in BLS protocol.

Pediatric Age Group Guidelines

Refer Flow Chart 16.1

- The BLS guidelines for the pediatric age group vary depending on the number of rescuers. There can be a single rescuer or multiple rescuers.
- In the case of a single rescuer, verification of scene safety is a must here as well. Next is shouting for help and activation of the emergency response system.
- The oxygen requirement is more in the case of pediatric patients. So, whether the patient is receiving a proper oxygen supply needs to be checked, as well as their heart rate.
- If the patient has no normal breathing but has a pulse, 1 breath every 3 to 5 seconds is given (or about 12-20 breaths a minute) because the pediatric age group has a higher respiratory rate than adults.
- If the pulse rate remains less than 60/min with signs of poor perfusion, add compressions.
- For one rescuer, begin cycles of 30 compressions and two breaths.
- If the second rescuer arrives, use a 15: 2 ratio. It means 15 compressions and 2 breaths.
- This method has a better outcome for pediatric patients.
- If there are two or more rescuers, the pediatric algorithm remains the same.
- If there's a single rescue, 30:2 is the compression-to-ventilation ratio.
- If the second rescuer arrives, use a 15: 2 ratio.

Infant	Paediatrics
C:V = 30:2	C:V = 30:2
C:V = 15:2	C:V = 15:2
Pulse – Brachial Pulse	Carotid or Femoral Pulse

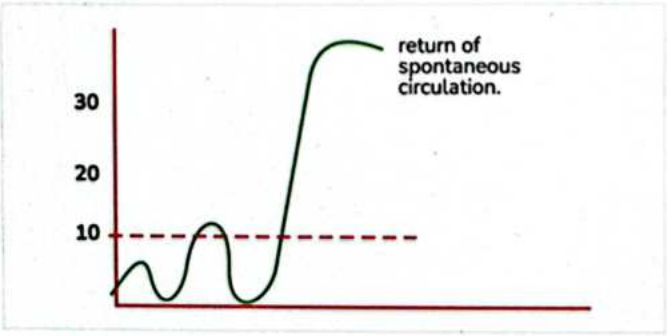
- There's a difference in guidelines between infants and pediatric age groups.
- The only difference is that brachial pulse is checked in infants to check whether there's a return of circulation. In pediatric patients and adults, the carotid or femoral pulse is checked.

ACLS Protocol 00:19:10

Refer Flow Chart 16.2

- After the initial treatment, an ambulance arrives. The technical team consisting of doctors, nurses, etc., starts to do maneuvers on the patient.

- The CPR is continued, as before.
- Now, oxygen is given to the patient via an external device.
- A defibrillator is attached to check whether the rhythm is shockable.
- If a defibrillator delivers a shock, ventricular tachycardia or fibrillation is the rhythm. If it does not give any shock, the rhythm is asystole or PEA.
- The CPR is continued if the rhythm is shockable. In the meantime, Intravenous and Intraosseous access is secured.
- Again, see whether the rhythm is shockable or not.
- If it is shockable, the patient is administered epinephrine after the delivery of the second shock.
- If the patient is not revived, CPR is to be continued.
- Epinephrine is given every 3 to 5 minutes.
- Advanced airways (securing an endotracheal airway) are considered after delivering the second shock. It's done to avoid any kind of aspiration in the patient.
- Capnography of the patient is seen afterwards to check whether CPR is effective or not.
- If the rhythm is shockable again, a third shock is delivered.
- Amiodarone or lidocaine are given after the shock.
- There are ten different types of reversible causes that may cause cardiac arrest in the patient (5 Hs and 5Ts).
  - Hypovolemia
  - Hypoxia
  - Hydrogen ion (Acidosis)
  - Hypo-hyperkalemia
  - Hypothermia
  - Tension pneumothorax
  - Tamponade cardiac
  - Pulmonary thrombosis
  - Coronary thrombosis
  - Toxins
- In case the patient only has asystole or PES, then there is no need to deliver any shock.
- CPR and epinephrine are the only two options.
- After every two minutes, it's checked whether the rhythm is shockable or not.
- Once shockable, the protocol of shockable rhythms is followed.



- The capnography graph above indicates the return of spontaneous circulation.
- If the patient's end-tidal Co2 was around 10 before revival and came out to be 30 afterward, it means the patient has been revived and can be shifted to the hospital for further treatment. If it reaches 5 or even 0, the patient is dead.

CPR Quality

- Push hard (at least 5 cm (2 inches) and fast (100-120/min) and allow complete chest recol.
- Minimize interruptions in compressions.
- Avoid excessive ventilation
- Change compress or every 2 minutes, or sooner if fatigued.
- If no advanced airway, 30:2 compression-ventilation ration.
- Quantitative waveform capnography
  - Petco 2 < 10 mm Hg, attempt to improve CPR quality.
- Intra-arterial pressure
  - If relaxation phase (diastolic) pressure < 20 mm Hg. Attempt to improve CPR quality
- For good quality CPR, a person has to push hard and fast (at least 5 cm and 100-120 times a minute). The chest should be allowed to recoil properly.
- There should be minimal interruptions in chest compressions.
- If tired, the compressor has to be changed every two minutes for the best results.
- If there's no advanced airway, the compression: ventilation ratio should be 30:2.
- Capnography shows CPR quality.
- If capnography shows below 10 mm, CPR quality needs to be improve

Defibrillation

Shock Energy for Defibrillation

- **Biphasic:** Manufacturer recommendation (eg. Initial dose of 120-200 J): If unknown, use maximum available.
- Second and subsequent doses should be equivalent and higher doses may be considered.
- **Monophasic:** 360 J
- There are two types of defibrillators: - biphasic and monophasic.
- Biphasic come in a range of 120-200 Joules.
- Monophasic comes in a range of 360 Joules.
- Irrespective of the type, maximum energy available must be used.

Drug Therapy

- Epinephrine IV/10 dose:
  - 1 mg every 3-5 minutes
- Amiodarone IV/10 dose: First dose: 300 mg bolus, Second dose: 150 mg

Or

- Lidocaine IV/10 dose:
  - First dose: 1-1.5 mg/kg.

- Second dose: 0.5-0.75 mg/kg
- Drugs like epinephrine and amiodarone are given, but only in ACLS guidelines.
- Drugs are not used in BLS guidelines.

Airways

Advanced Airway

- Endotracheal intubation or supraglottic advanced airway
- Waveform capnography or capnometry to confirm and monitor ET tube placement
- Once advanced airway in place, give 1 breath every 6 seconds (10 breaths/min) with continuous chest compressions
- Endotracheal intubation or supraglottic advanced airways are used to secure airway of the patient.

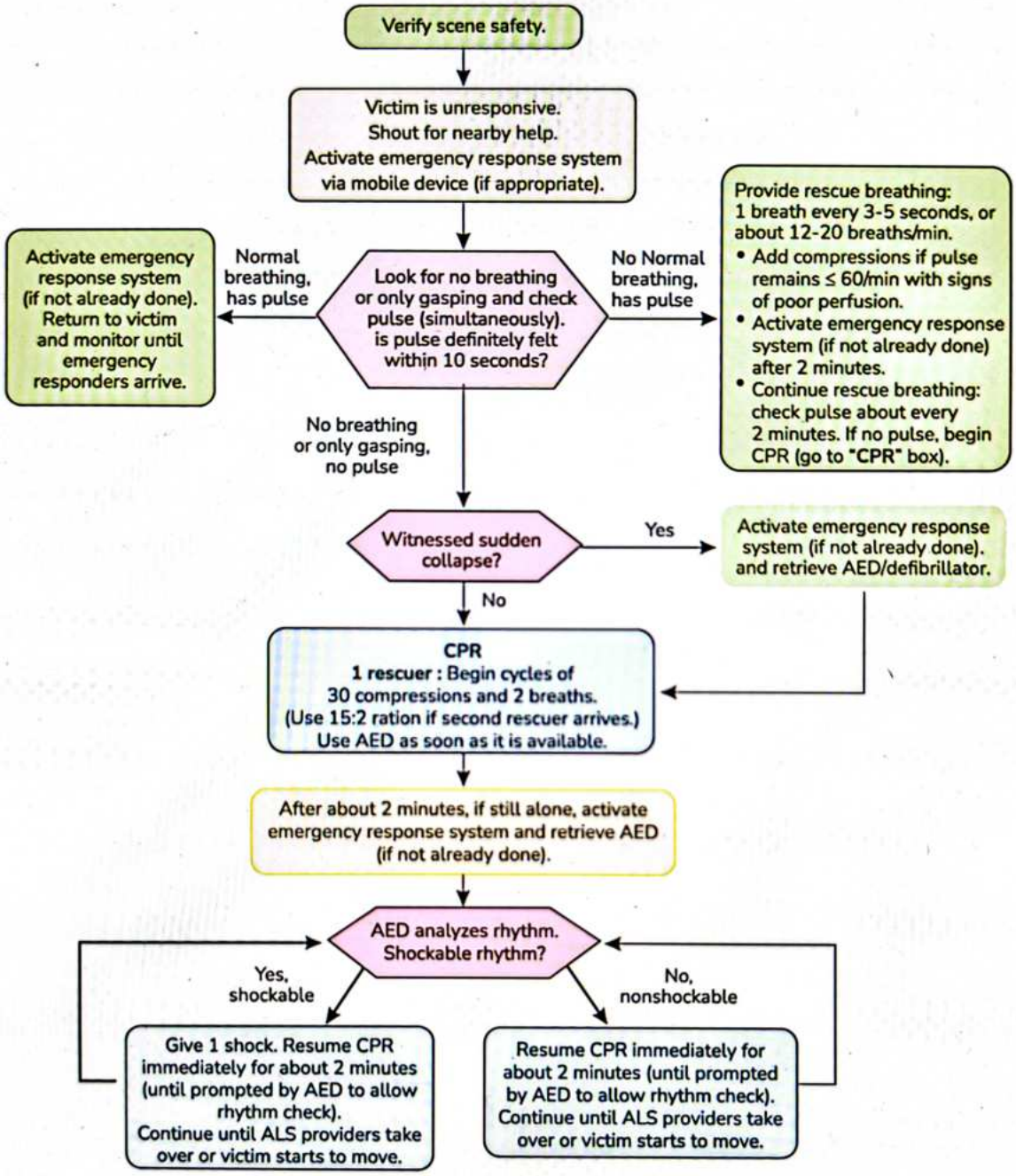
ROSC (Return of Spontaneous Circulation)

- Pulse and blood pressure
- Abrupt sustained increase in PETCO2 (typically > 40 mm Hg)
- Spontaneous arterial pressure waves with intra arterial monitoring
- ROSC is the Return of Spontaneous Circulation
- It means a patient's pulse and blood pressure return to normal after CPR.
  - There's an abrupt increase in the end-tidal Co2.
  - It can be seen in a capnograph. It makes capnography very helpful for a patient when giving CPR.

Reversible causes:

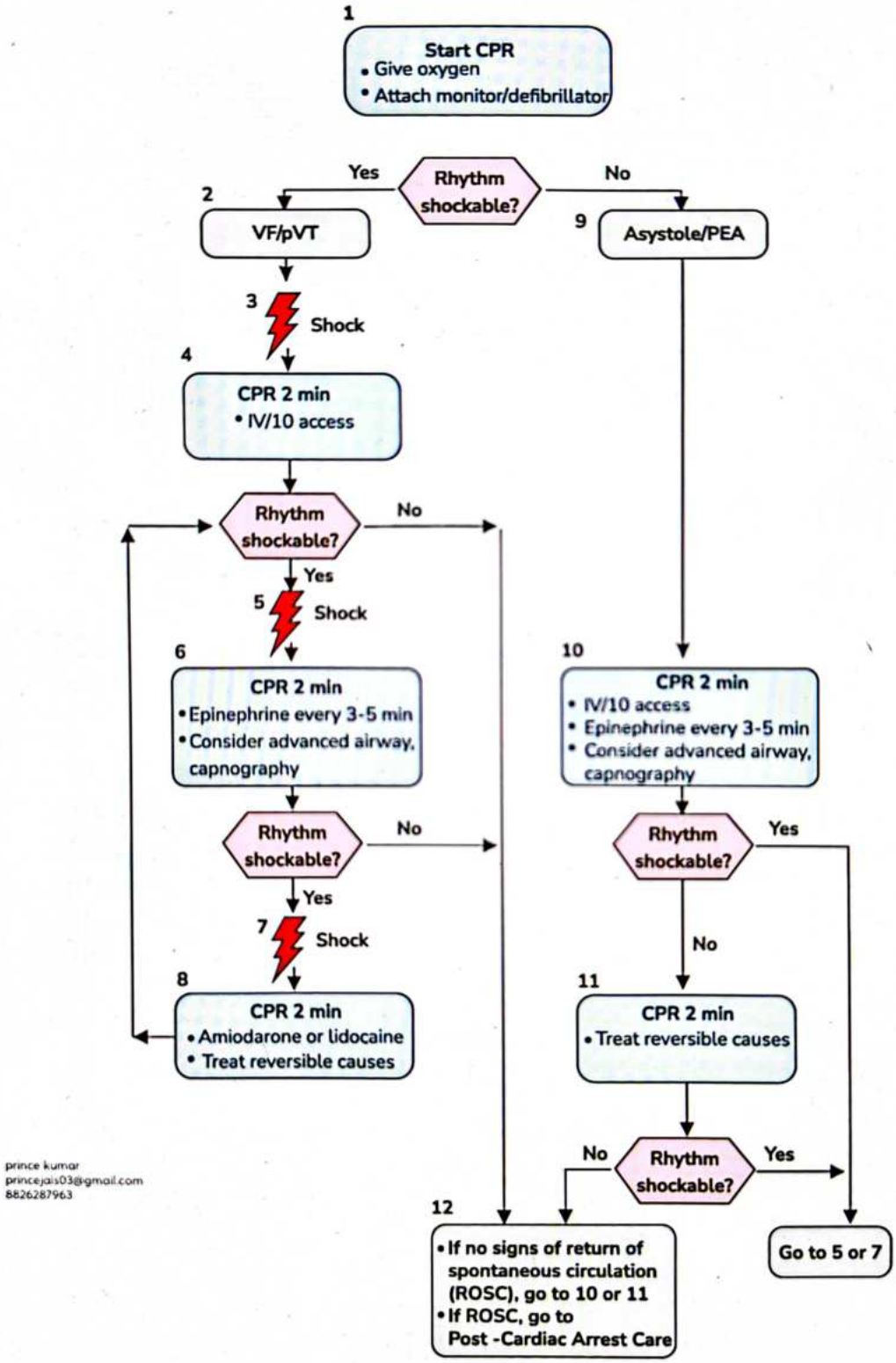
- hypovolemia
- Hypoxia
- Hydrogen ion (acidosis)
- Hypo-hyperkalemia
- Hypothermia
- Tension pneumothorax
- Tamponade: cardiac
- Toxins
- Thrombosis: pulmonary
- Thrombosis: coronary

Flow Chart 16.1



Flow Chart 16.2

Adult Cardiac Arrest Algorithm-2018 Update



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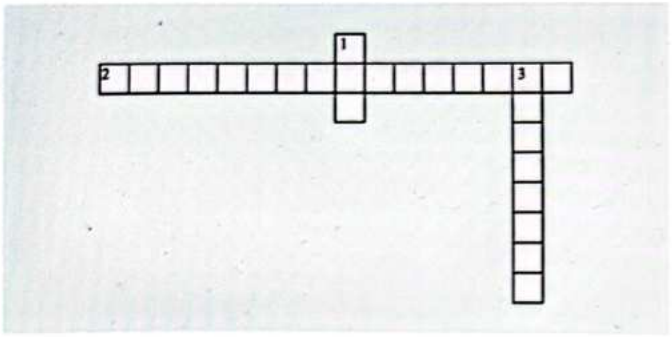
CROSS WORD PUZZLES

Crossword Puzzle 1



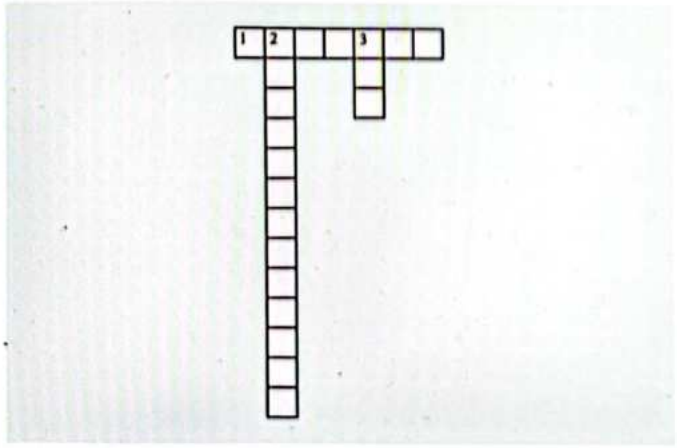
Across

2. BLS is _____.

Down

1. _____ is activated after the patient's unresponsiveness.
3. In pediatrics BLS guidelines depends on number of_____.

Crossword Puzzle 2



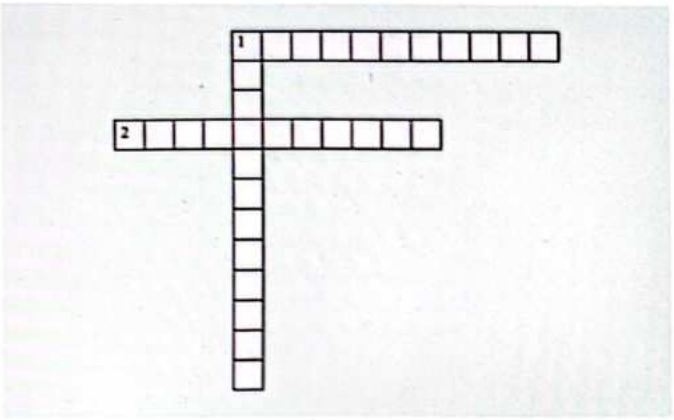
Across

1. _____ every 3 to 5 seconds is given because pediatric-age children have higher respiratory rates.

Down

2. No medications are given in _____.
3. _____ has two patches that get stuck on the sternum and apex of the heart.

Crossword Puzzle 3



Across

1. _____ is given ACLS.
2. _____ tells CPR which is being given is effective or not

Down

1. _____ airway is secured in advanced airways._

17 BRAIN DEATH

Brain death 00:00:05

- It is an irreversible destruction of brain tissue, resulting in total absence of cortical and brain stem function but spinal cord reflexes may be present.

Four Steps for Determining the Brain Deaths 00:02:25

1. Clinical Evaluation
2. Neurological Assessment
3. Ancillary Test
4. Documentation

Clinical Evaluation 00:03:12

- Irreversible coma (Known etiology and or reversible causes have to be ruled out)
- Must have absence of
  - Hypothermia
  - NMB- sedative (should be stopped)
  - Shock
  - Severe metabolic disturbance
  - Endocrine abnormalities
- Absence of cortical function
  - No spontaneous movement, eye opening
  - No response to auditory verbal or visual commands
  - No response to pain stimulus

Neurological Assessment 00:07:49

- Absence of brain stem function
- Pupillary reflex - mid dilated/ fully dilated
- Corneal reflex – cotton tip - no blink
- Gag reflex (-)
- Cough reflex (-)
- Oculocephalic reflex (Doll's eye)
- Vestibular Cranial reflex: Rapidly turn head 90 degrees to both side - no reflex
- Oculovestibular reflex/ caloric reflex: Irrigate tympanic membrane - no eye movement

- **Apnea test**
  - Prerequisite are temperature >36 degree Celsius
  - SBP > 100 mmHg
  - Normal - electrolytes
  - Normal PaCo2 (35-45)
  - Procedure - Preoxygenate and achieve $PaO_2 \rightarrow 200$
  - Monitor - PaO_2 (ABG)
  - Observe the patients of ventilator (3 to 8 mintues)

Positive test	Intermediate test	Negative test
• Support the diagnosis of brain death	• No respiratory effort	• Respiratory effort present
• No respiratory effort		
• ABG $PaCo_2 > 60$	• ABG $PaCo_2 < 60$	-

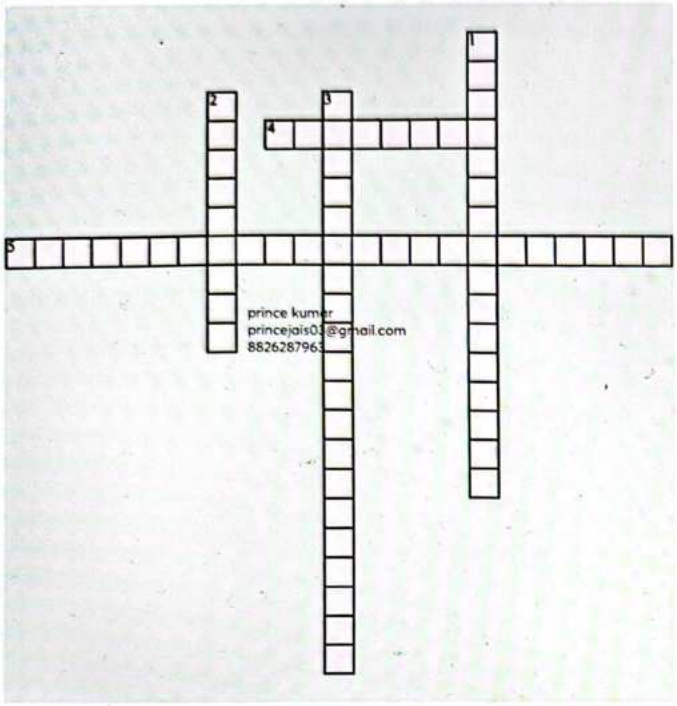
- **Contraindications**
  - SBP / BP is unstable
  - O_2 saturation is decreased.
  - Cardiac arrhythmias

Ancillary Tests 00:19:34

- Ancillary test
- EEG
- Cerebral angiography
- Glucose metabolic study
- Dynamic nuclear scan
- Somatosensory evoked potential

CROSS WORD PUZZLES

Crossword Puzzle1



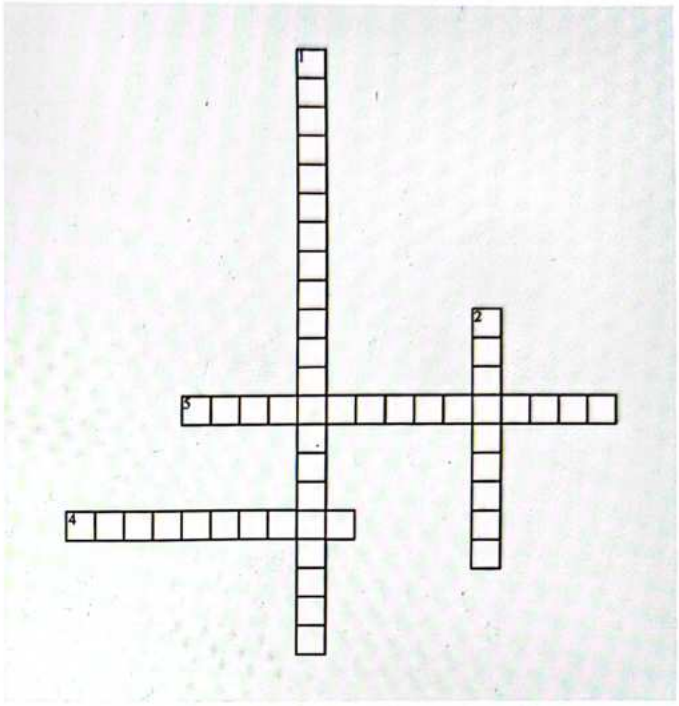
Across

4. Oculocephalic reflex is also called as
5. Rapidly turn head 90 degrees to both sides to test_____reflex

Down

1. ABG full form
2. Image based tests
3. EEG full form

Crossword Puzzle2



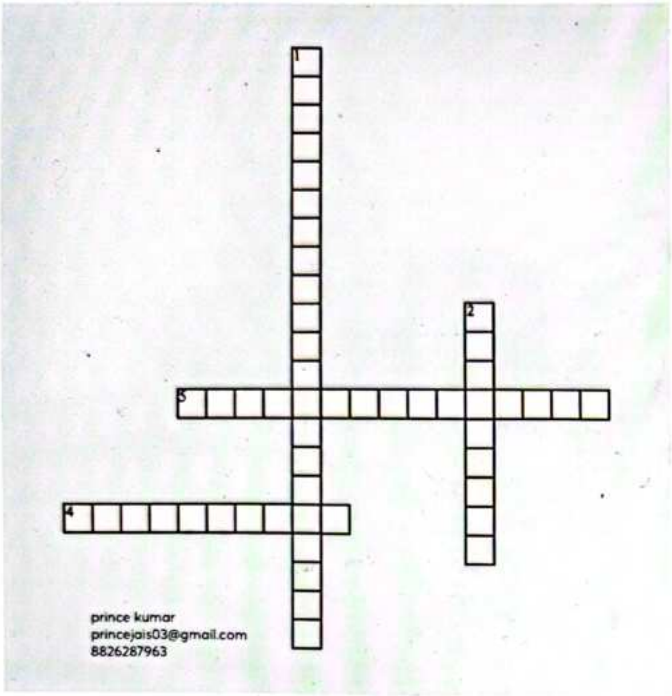
Across

3. Pupils of the patient is sujected to light to test this reflex.
4. Neuromuscular blocking drugs also called as

Down

1. VOR fullform
2. The patients ventilation is temporarily discontinued in this test

Crossword Puzzle3



Across

4. cotton tip is used to test this reflex

Down

1. patient not showing any respiratory activity in_____apnea test
2. irreversible destruction of brain tissue is called as
3. in glucose metabolic tests_____mark indicates brain death