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ONE Touch Anesthesia

For NEET PG/FMGE/INI-CET/Undergraduates

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ONE Touch Anesthesia

For NEET PG/FMGE/INI-CET/Undergraduates

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Preface

What is the need of another book on Anesthesia for postgraduate entrance exam (PGEE)? I have been grappling with this question for sometimes. We need to cover multiple subjects for PGEE and to tackle this issue, we, first of all, need to know what to study and how much to study?

I wanted to focus on relevant and complete information required in the subject of Anesthesia for PGEE. This book although does not offer an in-depth information on Anesthesia, the chapters are bite-sized in length so that readers do not lose grip of their attention span.

I wanted the book to be relevant to readers for exam preparation. At the end of chapters, all recent exams questions and answers have been included.

Do let me know if you have got benefitted from this book. You are free to share your suggestions for improvement of this book, if there is any. You can convey your feedback to me so that I could know what should I do to make this book more useful.

I am indebted to all my friends, readers, publishers and well-wishers for supporting and encouraging me.

Swati Singh

Contents

9. MECHANICAL VENTILATION

INTRODUCTION

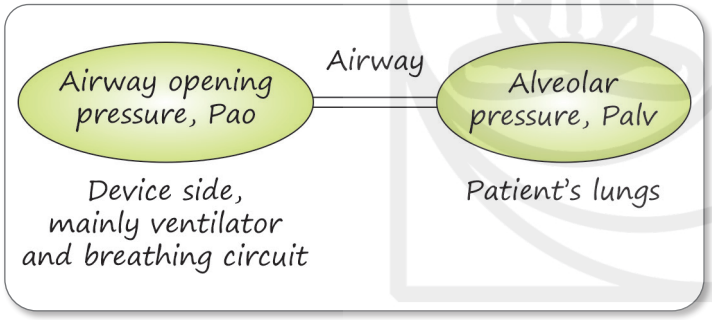
- Delivery of breath by machine.
- Mechanical ventilation is a respiratory therapy which temporarily does the work of our respiratory system and tries to maintain near normal ventilation and oxygenation.

FUNDAMENTAL OPERATION OF MECHANICAL VENTILATION

There are two ways to create a pressure difference to move in and out a volume of gas from lung, which are as follows:

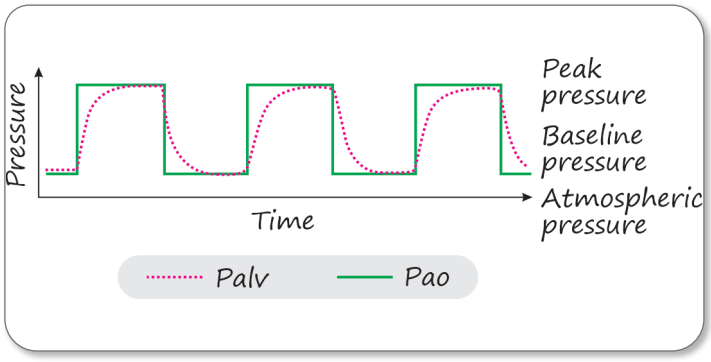
1. **IPPV:** Intermittent positive pressure ventilation **(Most common)**
2. **INPV:** Intermittent negative pressure ventilation

PRINCIPLE OF MECHANICAL VENTILATION

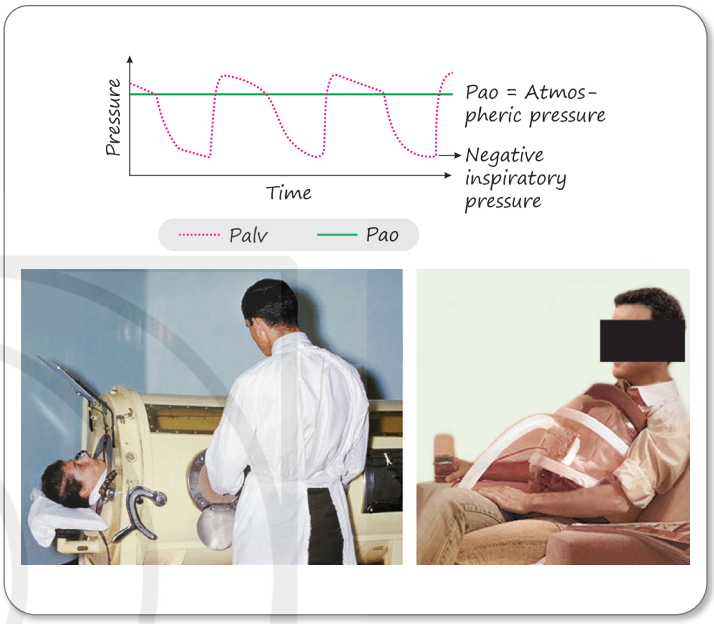


Pao – Airway opening pressure
Palv – Alveolar pressure
Pao > Palv: Gas will move from ventilator to alveoli, inspiration will happen
Palv > Pao: Gas will move out of alveoli, expiration will happen

POSITIVE PRESSURE VENTILATION (PPV)



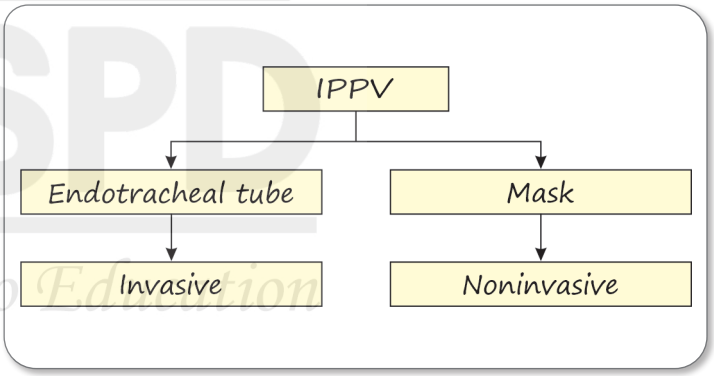
INTERMITTENT NEGATIVE PRESSURE VENTILATION (INPV)



INTERMITTENT POSITIVE PRESSURE VENTILATION (IPPV)

Depending on the basis of patient's interface, it is divided in two types:

1. Endotracheal tube
2. Mask



MODES OF VENTILATION

Operating principle set by the operator according to which ventilator delivers the breath:

- Invasive/noninvasive
- IPPV/INPV – Operating principal
- Supine/Prone – Depends on patient's position

MECHANICAL BREATH

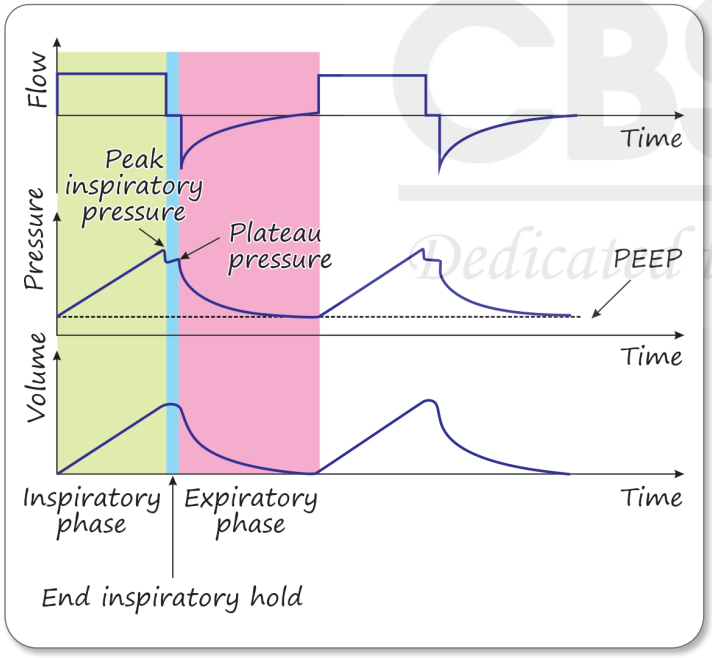
- Delivered by ventilator
- **Triggering:** How inspiration starts → Time triggered
  → Patient triggered
  - **Totally controlled mode:** All breaths taken by ventilator
  - **Totally spontaneous mode:** All breaths taken by patients
  - **Semi control:** Both patients and ventilator can trigger
- **Cycling:** End of inspiration
  - **Time cycled:** I (Inspiration): E (Expiration)
  - Flow cycled
- Controlling:
  - Volume control
  - Pressure control

Volume Control Mode

- Preselected tidal volume (TV) = 500 mL/6 mL/kg BW
- Inspiratory flow is initiated and it will last till the TV is achieved.

Scalar Graph between:

- Volume and time
- Flow and time
- Pressure and time



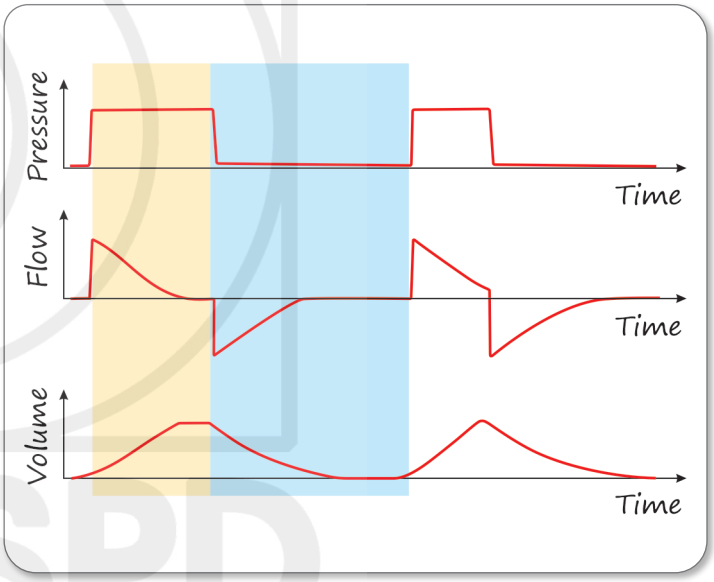
Volume Control Flow

At end of inspiration, flow is constant this creates a difference in peak pressure and alveolar pressure.

Advantage	Disadvantage
Fixed tidal volume	Peak pressure cannot be controlled Uneven filling of alveoli Patient's discomfort because of inflexible inspiratory flow

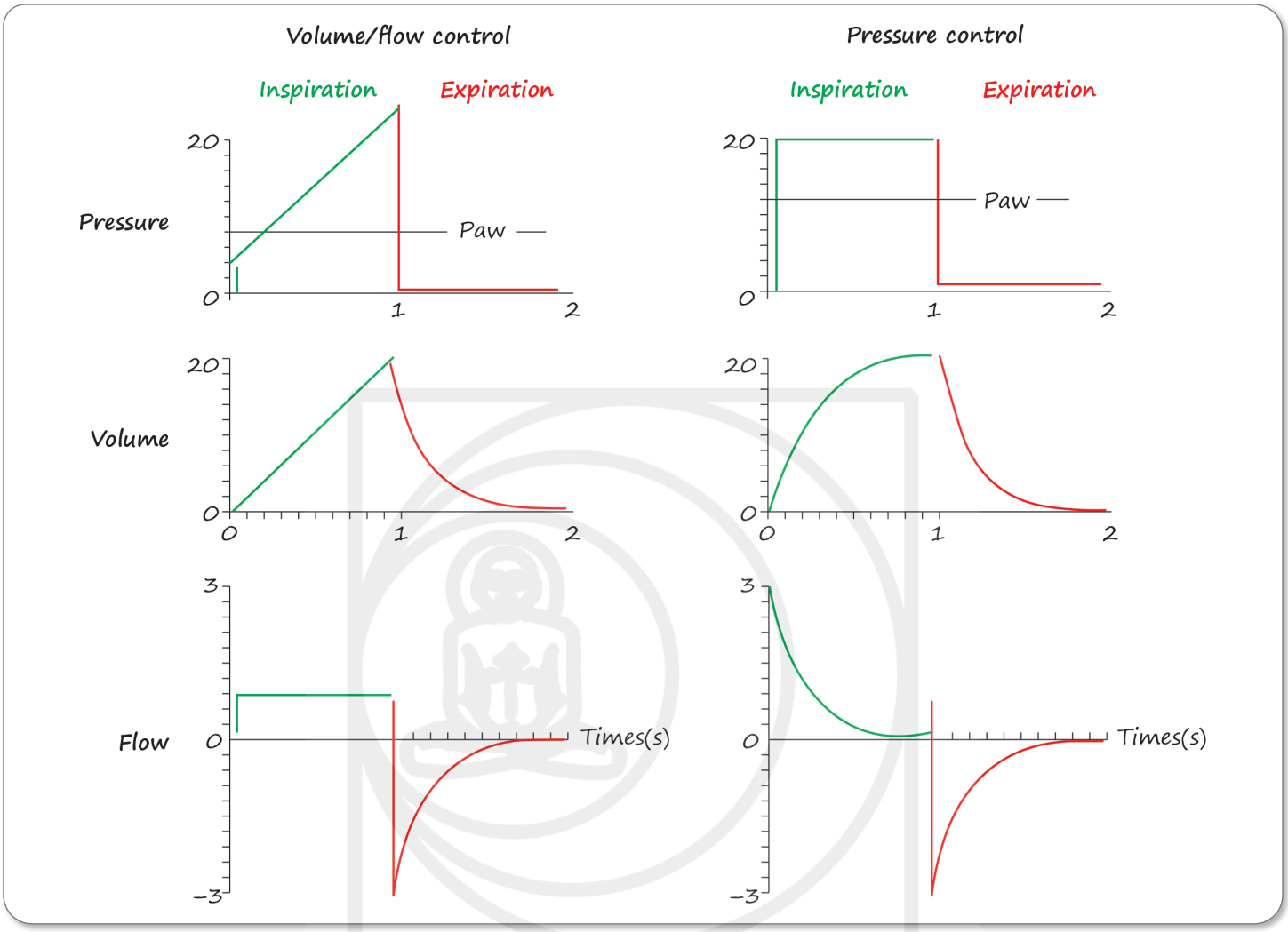
Pressure Control Mode

- Preselected pressure
- To achieve peak inspiratory flow at start of inspiration



Advantage	Disadvantage
• Fixed peak pressure so less risk of lung injury • More comfortable inspiratory flow • More even TV	Not fixed TV

Volume/flow control	Pressure control
• Pressure ascending type • Fixed TV • Flow is square • pattern	• Pressure fixed • TV varies • Flow is decelerating pattern



BASELINE PRESSURE

Baseline pressure is positive end expiratory pressure (PEEP)

- There is risk of alveolar collapse at the end of expiration, to prevent PEEP from being applied.
- PEEP is baseline pressure above which inspiration and expiration happens.
- There is a valve, placed in the expiratory limb of the ventilator circuit. This allows exhalation only till preselected pressure.

Advantage	Disadvantage
• Prevents atelectrauma • Increases surface area for gas exchange • Alveolar recruitment • Improve oxygenation	• Increases intrathoracic pressure • Decreases venous return • Decreases cardiac output • Decreases BP

PARAMETERS ON WHICH BREATH IS DELIVERED

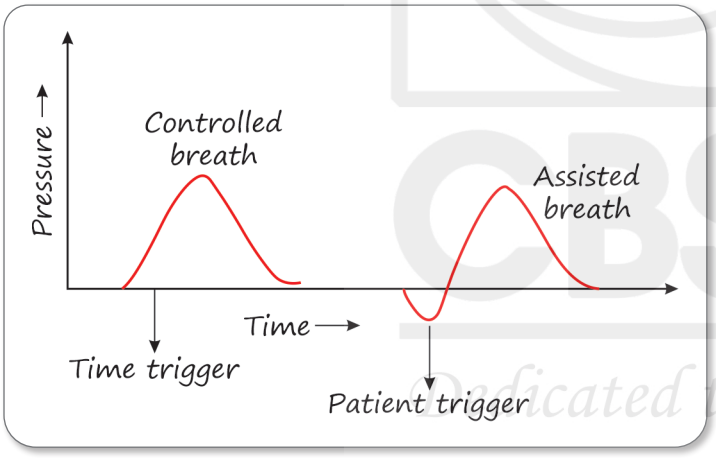
- Triggering : Rate fixed
- Cycling : I: E fixed
- Controlling : Select volume or pressure
- Baseline pressure : Select PEEP pressure
- How much O_2 concentration will go to the patient we select FiO_2 i.e., fractional inspiratory oxygen concentration
- FiO_2 = 1 (100% O_2)
  ↓
  Nontoxic (<60% As soon as possible)
- Whenever we put a patient on ventilation, we either have to improve oxygenation or ventilation
- If PaO_2 is ↓ : FiO_2 ↑
  : PEEP ↑
- To improve ventilation: Minute ventilation should be improved

CLASSIFICATION OF MODES

- **Conventional mode**
  - Most common, Simplest
  - Ventilator works according to setting of operator
- **Adaptive mode**
  - Intelligent ventilation
  - One or two parameters can be changed by ventilation according to monitoring input
- **Biphasic mode**
  - Inspiration and expiration happen at positive pressure
  - BiPAP: Bi-level positive airway pressure
  - APRV: Airway pressure release ventilation

Conventional Mode

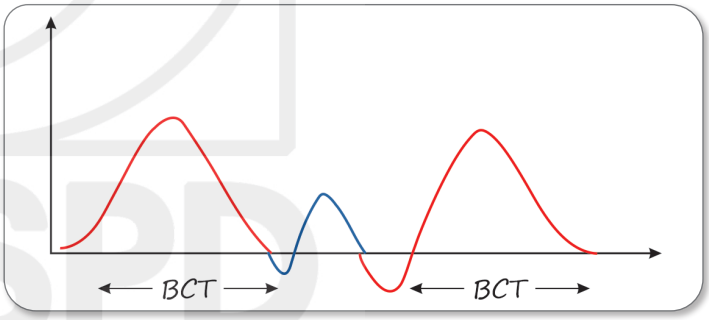
- **Assist control mode (A/C mode):** It is full control mode
  - **Triggering:**
    - Time triggered
    - Patient triggered
  - **Cycling:** Time
  - **Controlling:** Volume/Pressure



Volume A/C	Pressure A/C
• TV = 8 mL/kg BW • Respiratory rate = 12/min • I: E = 1:2 • Patient trigger: ▪ Flow ▪ Pressure • PEEP = 5 mm Hg • FiO_2	• PC = 20 mm Hg • Respiratory rate = 12/min • I: E = 1:2 • Patient trigger: ▪ Flow ▪ Pressure • PEEP = 5 mm Hg • FiO_2

- Each breath was delivered at a fixed time according to respiratory rate
- Cannot be used as weaning
- Synchronized Intermittent Mandatory Ventilation (SIMV)
  - **Triggering:**
    - Patient triggered
    - Time triggered
    - Patient supported breath
  - **Cycling:** I: E
  - **Controlling:** Volume/Pressure

SIMV volume control (Fixed)	SIMV pressure control (Fixed)
TV	PC
Respiratory rate	Respiratory rate
I: E	I: E
Patient trigger	Patient trigger
PEEP	PEEP
FiO_2	FiO_2
Pressure Support Breath	Pressure Support Breath
Breath Cycle Time	Breath Cycle Time



- In between these two breaths, there is a time hence, patient can generate breath here also.
- It will be pressure supported breath.
- Can be used as weaning.

Adaptive Mode

Adaptive mechanical ventilation automatically adjusts respiratory rate (RR) and tidal volume (V_T) to deliver the clinically desired minute ventilation, selecting RR and V_T based on Otis' equation on least work of breathing. However, the resulting V_T may be relatively high, especially in patients with more compliant lungs. Therefore, a new mode of adaptive ventilation (adaptive ventilation mode 2, AVM2) was developed which automatically minimizes inspiratory power with the aim of ensuring lung-protective combinations of V_T and RR.

Adaptive Support Ventilation

Adaptive Support Ventilation (ASV) is a positive pressure mode of mechanical ventilation that is closed-loop controlled, and automatically adjusts based on the patient's requirements designed to ensure optimization of the patient's work of breathing.

CLOSED LOOP CONTROL

- Closed-loop control involves a positive or negative feedback of the information on the respiratory mechanics of the patient
- It is based on measurements made almost continuously which can be modified or adapted in a more physiological and individualized ventilatory support manner.

Two Basic Methods

- Control between breaths (inter-breath) which refers to the setting of control between each breath, but keeping it constant throughout the breath cycle (e.g. ASV)
- Intra-breath control, which does it within the same breath.

Other modes are all variations of PSV

- Proportional Assist Ventilation (PAV)
- Neurally-Adjusted Ventilatory Assistance (NAVA)
- Knowledge-Based Systems (KBS)

ASV combines modes

- PSV, if RR is higher than the target
- PCV if there is no spontaneous breathing
- SIMV when patient's RR is lower than target

VENTILATOR SETTINGS

These are set by the user:

- Height of the patient (cm): Based on this it calculates the ideal body weight and dead space 2.2 mL/kg
- Gender
- % Min Vol: 25-350% Normal 100%, asthma 90%, Acute Respiratory Distress Syndrome (ARDS) 120%, others 110%, Add 20% if T body >38.5°C (101.3°F) or add 5% for every 500 m (1640 feet) above sea level
- Trigger: Flow trigger of 2 l/min
- Expiratory trigger sensitivity: Start with 25% and 40% in Chronic obstructive pulmonary disease COPD
- Tube resistance compensation: Set to 100%
- High pressure alarm limit: 10 cm H_2O be the limit of ↓ and ↑ least 25 cm H_2O of PEEP/continuous positive airway pressure (CPAP)
- PEEP
- FiO_2

Then:

- ASV selects the respiratory pattern in terms of RR, VT, Inspiratory: Expiratory time (I:E ratio) for mandatory breathing and reaches the respiratory pattern selected
- Starts with test breaths to obtain measurements
- Ventilation is pressure and volume limited
- % VM can be titrated by the operator according to clinical criteria and ABG results

PROS AND CONS

Advantages

- Versatile
- Can ventilate any patient group
- Safe
- Prevents tachypnea, auto peep and dead space
- Less operator dependent and less need for operator involvement
- Decreases time on mechanical ventilation
- Adjusts to patient inspiratory effort

Disadvantages

- Cannot directly program VT, RR and I:E ratio
- Limited pediatric experience
- Algorithm tends to ventilate with low tidal volume and high RR

BIPHASIC VENTILATION

Two Modes: APRV and BiPAP

The principles of airway pressure release ventilation and biphasic positive airway pressure

APRV and BiPAP ventilate by time-cycled switching between two pressure levels in a high flow or demand valve Continuous Positive Airway Pressure (CPAP) circuit, and therefore they allow unrestricted spontaneous breathing in any phase of the mechanical ventilator cycle.

The degree of ventilatory support is determined by the duration of both CPAP levels and V_T during APRV/BiPAP.

V_T depends mainly on respiratory compliance and the difference between the CPAP levels. BiPAP

is identical to APRV except that no restrictions are imposed on the duration of the low CPAP level (release pressure).

Based on the initial description, APRV uses a duration of low CPAP (release time) that is equal to or less than 1.5 s.

Asynchronous interference between spontaneous and mechanical ventilation may increase the work of breathing and reduce effective ventilatory support during APRV/BiPAP.

PRESSURE SUPPORT VENTILATION/ CONTINUOUS POSITIVE AIRWAY PRESSURE (CPAP)

- Pure spontaneous mode
- Only one time of breath is delivered, i.e., pressure supported breath

Fixed Parameters

- Pressure support: 10 mm Hg
- Trigger: Flow
- Cycling: Pressure cycle/Flow cycle
- PEEP
- FiO_2
- Weaning mode

NONINVASIVE VENTILATION

When a tight fitting mask is used as patient's interface.

Major benefits → less incidence of ventilator associated pneumonia.

Indications:

- Obstructive sleep apnea syndrome
- Chronic obstructive pulmonary disease with exacerbation
- Bilateral pneumonia
- Acute congestive heart failure with pulmonary edema
- Neuromuscular disorders
- Acute lung injury
- Weaning from ventilator

Contraindications:

- Respiratory arrest or unstable cardiorespiratory status
- Uncooperative patients
- Inability to protect airway (impaired swallowing and cough)
- Trauma or burns involving the face
- Facial, esophageal or gastric surgery
- Apnea (poor respiratory drive)
- Reduced consciousness

Note: For noninvasive ventilation we need conscious cooperative patient

Modes:

There are three modes of noninvasive ventilation, which are as follows:

1. CPAP
2. BiPAP
3. Pressure support ventilation

CPAP	BiPAP	PSV
• Continuous positive airway pressure • Spontaneous breathing at a positive airway pressure • Increases functional residual capacity • Limited use • Good mode in: **Obstructive sleep apnea congestive heart failure**	• Bi-level positive airway pressure • IPAP (High pressure) • EPAP (Low pressure) • Low Pressure will be served as PEEP • Pressure support = IPAP – EPAP • Augments TV • Good mode in: **COPD**	• Pressure support ventilation. • It augments tidal volume (TV)

Criteria for terminating noninvasive positive pressure ventilation and switching to invasive mechanical ventilation:

- Worsening pH and arterial partial pressure of carbon dioxide ($PaCO_2$)
- Tachypnea (over 30 breaths/min)
- Hemodynamic instability
- Oxygen saturation by pulse oximeter (SpO_2)
- <90%

- Decreased level of consciousness
- Inability to clear secretions
- Inability to tolerate interface

PRONE VENTILATION

Ventilation in prone position with any suitable mode.

Benefits:

- Homogenous distribution of TV
- Increases resting lung volume by decreasing pressure of heart and abdominal organs
- Homogenous distribution of pleural pressure. All this improves oxygenation
- In moderate to severe **ARDS:** Proven benefit of prone ventilation

Duration: >17–20 hrs/day

Notes

ONE LINERS IMPORTANT TOPICS

- WTG Morton—Father of modern anesthesia, Did first successful demonstration of anesthesia using ether on October 16, 1846.
- August Bier—gave first spinal anesthesia.
- Continue all antihypertensives till the day of surgery; ACE inhibitors and ARBs should be decided depending on the nature of surgery.
- All OHAs—stop on the day of the surgery except SGLT-2 inhibitors—to be stopped 24 hours before surgery (euglycemic ketoacidosis).
- Continue all antiepileptics and antithyroid drugs, ATT, Steroids, ARTs and supplemental doses of Methadone on the day of the surgery.
- Enflurane and methohexital precipitate seizure.
- Continue all antipyschotic medications except MAO inhibitors (causes catecholamine surge with Meperidine/Pethidine).
- Duration of medications to be discontinued before surgery: Lithium—24–48 hours, Clopidogrel—7 days, Ticlopidine—10 days and herbal medicines- 2 weeks.
- Low dose Aspirin—to be continued. Stop 3 days before vascular surgery or with major risk of bleeding.
- Drug of choice for anaphylactic shock—Injection. Adrenaline 1 mL of 1: 10000 dilution intravenously.
- Fasting guidelines: 6–8 hours for Adults. Children: 2 hours—Clear liquid (water), 4 hours—Breast milk, 6 hours—Nonhuman milk, semisolid food and 8 hours—Heavy fatty meal.
- High risk for postoperative nausea and vomiting—Female gender, History of motion sickness, Nonsmoker, Use of postoperative opioids and Procedures (Ocular like Squint/ENT/Laproscopic surgery).
- Signs of inadequate/lighter plane of anesthesia: Lacrimation, Reflex movements, Tachycardia, Raised BP, Sweating.
- Treatment of carboxyhemoglobin (CO poisoning): 100% Oxygen in Hyperbaric environment.
- Treatment of Methemoglobinemia (seen with Prilocaine toxicity): Methylene Blue.
- Normal capnography is top hat shaped and normal Value is 35–45 mm Hg.
- Fade of TOF is seen with NDMR and Phase 2 of DMR (Succinlycholine).
- High pressure system in Boyle's system includes: Cylinders, Hanger yoke, Cylinder pressure indicator, Pressure regulators.
- Intermediate pressure system includes: Master switch, pipeline inlet connection, pressure indicators, gas power outlets, oxygen pressure failure devices, gas selector switch, 2nd stage pressure regulator, oxygen flush and flow adjustment control.
- Low pressure system includes: Flow meter, Hypoxia prevention safety devices, Unidirectional valves, Pressure relief devices, low pressure piping, Common gas outlet.
- Color coding of cylinder: Oxygen—Black body with white shoulder, Nitrous oxide—Blue, Carbon dioxide—Gray, Nitrogen—Black, Air—White body with black shoulder, Entonox—Blue body with white shoulder and Cyclopropane—Orange.
- In MRI- Aluminum made cylinders or AMBU bag.
- Pin- Index for different gases: Air—1, 5; Oxygen—2, 5; Nitrous oxide—3, 5; Carbon dioxide (<7.5%)—2, 6; Carbon dioxide (>7.5%)—1, 6 and Entonox—7.
- Spinal cord ends at L1 (Adult) and L3 (infant).
- Contraindications of Spinal Anesthesia: Absolute- Bleeding disorders, Raised ICP, Infection at the site, Patient refusal, Severe hypovolemia/hypotension, Severe hypertension, Severe mitral/aortic stenosis, Allergy to the drug. Relative—Spinal deformities, Previous history of spine surgery, Chronic backache, Progressive Neurological disorders, Septicemia, Heart blocks.
- Example of dura cutting needle—Quincke-Babcock needle; Dura splitting needles—Whitacre and sprotte.
- More the Gauge = Finer the needle. Finer needle = smaller hole, less CSF loss, less incidence of headache.
- PDPH: Onset 24–48 hours after administration of spinal anesthesia; Site—occipital and frontal region; Nature—dull boring kind of headache; Associated with nausea, vomiting, photophobia; Treatment—NSAIDs, Caffeine, Epidural blood patch.
- Armitage formula (dose of local anesthetics): 0.5 mL/kg—lower limb surgery, 0.75 mL/kg—lower abdominal surgery, 1–1.5 mL/kg—upper abdominal surgery.

ANESTHESIA SNAPSHOT

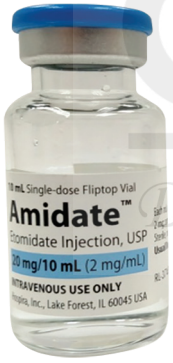
1. What are the characteristics of the given drug? How is it different from etomidate?

Answer

Propofol – Milky white

Propofol	Etomidate
• CVS unstable • Antiemetic • Not seen with propofol	• CVS stable • Causes postoperative nausea and vomiting present • A/W adrenal suppression and myoclonus

2. What are the properties and side effects of this drug?



Answer

Etomidate
Milky white
The most prominent side effect:
Adrenal suppression

3. Properties of this drug?

Answer

Ketamine
Transparent liquid
Other properties:
- A/W dissociative anesthesia
- Good analgesic
- Postoperative delirium and hallucination

4. Which inhaled anesthetic agent is A/W the given color of the vaporizer?

Yellow Red Purple

Orange Blue

Answer

- Red – Halothane
- Purple – Isoflurane
- Yellow – Sevoflurane
- Blue – Desflurane
- Orange – Enflurane

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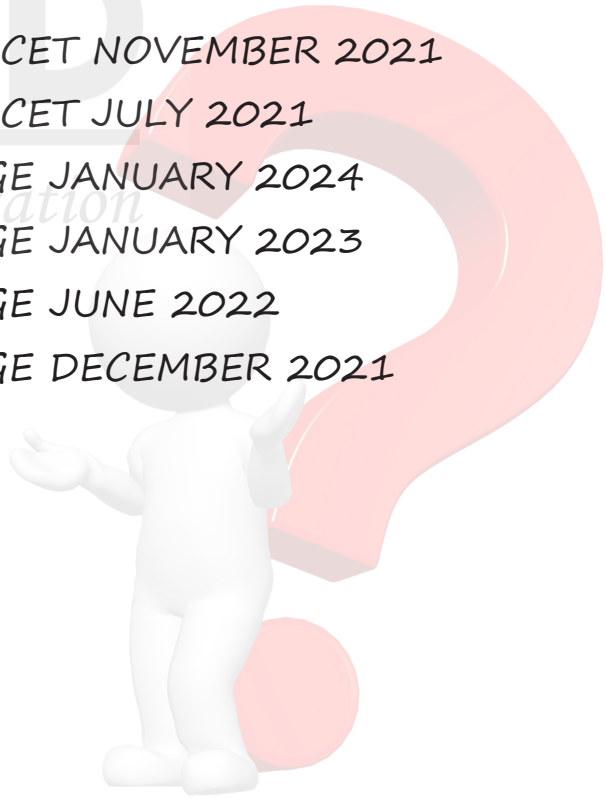


NEET PG 2023

1. Which of the following maneuver is performed in the given image?

a. Head tilt, chin lift
b. Jaw thrust
c. Head extension
d. In-line manual stabilization

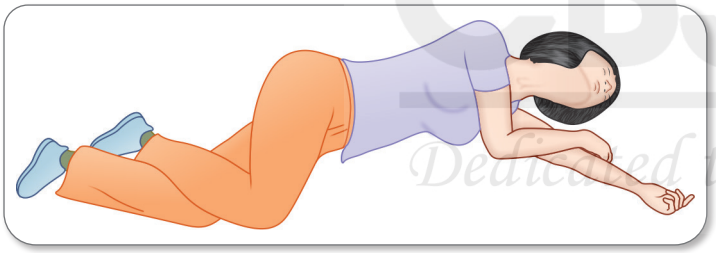
Ans. b. Jaw thrust

2. What is the drug of choice for preoperative antibiotic prophylaxis in a patient undergoing cardiac surgery?

a. Penicillin G
b. Erythromycin
c. Azithromycin
d. Cefazolin

Ans. d. Cefazolin

3. During resuscitation, when is the given position indicated?

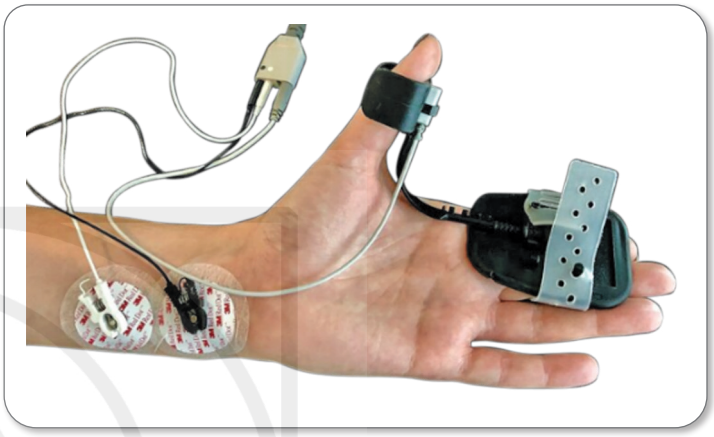


a. Unconsciousness with pulse and breathing absent
b. Unconsciousness with pulse present and breathing absent
c. Unconsciousness with pulse and breathing present
d. Unconsciousness with pulse absent and breathing present

Ans. c. Unconsciousness with pulse and breathing present

NEET PG 2022

4. The given image shows neuromuscular monitoring of the patient after anesthesia. Which of the following is the most commonly used nerve for monitoring?



a. Ulnar nerve
b. Median nerve
c. Radial nerve
d. Metacarpal nerve

Ans. b. Median nerve

5. Identify the type of mask given in the image used for patients with COVID-19 infection.

a. Venturi mask
b. Hudson mask
c. Nebulizer
d. Nonrebreathing mask

Ans: d. Nonrebreathing mask

ONE Touch Anesthesia

Salient Features

- **Theory**—A concise form of text (about 100 pages), and most important points to remember are given from the examination point of view. The text is designed in accordance with the recent CBME and NEXT exam curriculum.
- **High Yield Tables**—Frequently asked points and clinical correlates are tabulated for easy learning and more visual impact for long-term memory.
- **Clinical Images and Illustrations**—Clinical images and Illustrations are given along with their descriptions.
- **Previous Year Qs**—Important Topics/Qs have been highlighted in-between the text covering the important topics from the examinations point of view—questions have been asked from the respective topic in previous year examination.
- **Recent Questions**—Last 3 years' exam question papers up to Jan 2024 are provided to develop an idea about the trend of questions and also to know about the recently asked topics.

About the Author

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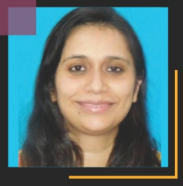

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