NEET SS 2024 Diploma Anaesthesiology Question Paper 3 with Solutions

Time Allowed :3 Hours	**Maximum Marks :**100	**Total Questions :**10

General Instructions

Read the following instructions very carefully and strictly follow them:

1. The test is of 3 hours duration.
2. The question paper consists of 10 questions. The maximum marks are 100.
3. Each Question is of 10 marks.

Q1. a) Role of Ultrasonography (USG) in airway assessment. [5]

Solution:

Step 1: Introduction to the Role of USG in Airway Assessment.
Ultrasonography (USG) has become a valuable tool in assessing the airway in various clinical settings, especially in emergency medicine and anesthesia. USG offers non-invasive, real-time imaging to evaluate anatomical structures and detect potential issues that could complicate airway management.

Step 2: Applications of USG in Airway Assessment.

(1) Assessment of the Airway and Intubation Site:
- USG can be used to assess the position and patency of the airway structures, including the larynx, trachea, and bronchi, before intubation. It can help identify obstructions or narrowing that may complicate intubation.

(2) Pre-intubation Assessment:
- Ultrasound-guided assessment of the thyroid cartilage, cricothyroid membrane, and airway landmarks can help identify anatomical variations or difficulty in intubation, particularly in patients with obesity, or those with a short neck or limited mouth opening.
- USG can also evaluate the size of the trachea and subglottic area, assisting in choosing the appropriate endotracheal tube size.

(3) Confirmation of Endotracheal Tube Placement:
- After intubation, USG can be used to confirm correct tube placement by identifying the tracheal lumen and ensuring the absence of esophageal intubation. It helps in real-time confirmation of correct tube placement in emergent situations.

(4) Assessment of Airway Collapse or Distortion:
- Ultrasound of the trachea can help assess for tracheal collapse or compression, especially in patients with tumors or other pathologies that may obstruct the airway.

- It can also be used to assess laryngeal and tracheal injuries in trauma patients.

(5) Use in Pediatric Airway Assessment:
- In pediatric patients, USG can help assess the laryngotracheal complex and detect conditions such as laryngomalacia or tracheomalacia, which could complicate airway management.

> **Quick Tip**
> USG is a valuable tool for assessing the airway in real-time, especially in difficult or emergency intubation situations, offering non-invasive visualization and reducing the risk of complications.

Q1. b) Discuss use of vasopressors in septic shock as per surviving sepsis campaign guidelines. [5]

Solution:

Step 1: Introduction to Septic Shock and Vasopressor Use.
Septic shock is a life-threatening condition characterized by circulatory failure and persistent hypotension despite adequate fluid resuscitation, usually caused by infection. Vasopressors are medications used to increase blood pressure by constricting blood vessels, which is crucial for maintaining perfusion to vital organs in septic shock. The Surviving Sepsis Campaign (SSC) guidelines provide evidence-based recommendations for the use of vasopressors in septic shock management.

Step 2: First-Line Vasopressor: Norepinephrine.
- According to the SSC guidelines, norepinephrine is the first-line vasopressor for septic shock.
- Mechanism of Action: Norepinephrine acts primarily on alpha-adrenergic receptors, causing vasoconstriction, but it also has some beta-adrenergic effects, which help increase heart rate and improve cardiac output.
- Dosing: Norepinephrine is typically administered at a starting dose of 0.01-0.03 mcg/kg/min and titrated based on the patient's blood pressure response.

Step 3: Second-Line Vasopressors.
(1) Vasopressin:
- Vasopressin can be used as an adjunct to norepinephrine in patients who require higher doses of norepinephrine to achieve target mean arterial pressure (MAP).
- Mechanism of Action: Vasopressin acts on V1 receptors in vascular smooth muscle, causing vasoconstriction.
- Dosing: It is typically administered at a dose of 0.03 units/min.

(2) Dopamine:
- Dopamine can be used as a second-line agent, particularly in patients with low heart rate or bradycardia. However, it is generally less preferred compared to norepinephrine.

- Mechanism of Action: Dopamine exerts its effects via dopaminergic, beta-adrenergic, and alpha-adrenergic receptors, depending on the dose. At lower doses, it primarily increases renal blood flow; at higher doses, it has vasopressor effects.

(3) Epinephrine:
- Epinephrine may be used in severe cases where other agents are ineffective or in patients with refractory shock.
- Mechanism of Action: Epinephrine has both alpha-adrenergic and beta-adrenergic effects, leading to vasoconstriction and increased heart rate and contractility.

Step 4: Use of Inotropes and Monitoring.
In patients with septic shock and low cardiac output, inotropic agents such as dobutamine can be used in conjunction with vasopressors.
- Dobutamine improves cardiac output by increasing contractility, especially in patients with septic shock who are also at risk of cardiac dysfunction.
- It is important to closely monitor the patient's hemodynamics, including MAP, heart rate, and urine output, to guide treatment.

Step 5: General Considerations and Guidelines for Vasopressor Use.
- Target MAP: The SSC guidelines recommend maintaining a MAP of 65 mmHg in septic shock patients to ensure adequate organ perfusion.
- Titration: Vasopressor doses should be titrated to the desired blood pressure and organ perfusion goals, with careful monitoring for side effects.
- Fluid Resuscitation: Vasopressors should only be used after adequate fluid resuscitation (typically 30 mL/kg of IV fluids) to ensure that the patient is not in a hypovolemic state before starting vasopressors.

> Quick Tip
>
> Norepinephrine remains the first-line vasopressor for septic shock, with vasopressin as a second-line option, and careful titration is key to maintaining optimal organ perfusion.

Q2. a) Define brain death. Enumerate the steps to diagnose brain death. [2+4]

Solution:

Step 1: Definition of Brain Death.
Brain death is defined as the irreversible cessation of all functions of the brain, including the brainstem. It is legally and clinically recognized as death. Brain death occurs when there is complete and irreversible loss of function in the cerebrum and brainstem, leading to the absence of all cerebral and brainstem activities, including respiration. Brain death is distinct from coma or vegetative state, as there is no possibility of recovery.

Step 2: Steps to Diagnose Brain Death.
The diagnosis of brain death involves a series of clinical and neurological examinations, as well as confirmatory tests, to establish that there is no cerebral or brainstem activity. The following steps are required:

(1) Clinical Criteria: - Neurological examination to ensure that the patient is in a comatose state with no response to external stimuli, including pain, and no purposeful movement or facial grimacing. - Absence of cranial nerve reflexes (brainstem reflexes): This includes:
- Pupillary light reflex: No reaction to light.
- Corneal reflex: No blink when the cornea is touched.
- Gag reflex: Absence of the reflex when the back of the throat is stimulated.
- Oculocephalic reflex (doll's eyes): No eye movement when the head is turned.
- Oculovestibular reflex (caloric test): No eye movement with cold water irrigation in the ear canal.
- No facial muscle movement in response to stimuli.

(2) Absence of Respiratory Effort (Apnea Test):
- The patient must be off the ventilator, and the arterial PaCO should rise above 60 mmHg or 20 mmHg above baseline without any respiratory effort. A lack of respiratory effort despite high CO levels is a key indicator of brain death.

(3) Duration of Observation:
- The patient must be observed for a specified period (often 6 hours for adults, and 24-48 hours for newborns and infants) after fulfilling the clinical criteria to confirm irreversibility.

(4) Confirmatory Tests (if needed):
- EEG (Electroencephalography): Shows no electrical activity in the brain (electrocerebral inactivity).
- Cerebral Blood Flow Studies: No blood flow to the brain, as evidenced by CT angiography or nuclear medicine scans.
- Transcranial Doppler: No blood flow detected in the intracranial vessels.

Quick Tip

Brain death is an irreversible condition, and its diagnosis requires strict adherence to clinical criteria and confirmatory tests to ensure legal and ethical validity.

Q2. b) Anaesthetic management of brain dead for organ retrieval. [4]

Solution:

Step 1: Introduction to Anaesthetic Management for Organ Retrieval.
Once brain death is diagnosed, the patient may be considered for organ retrieval for transplantation. The primary goal of anaesthetic management in brain-dead patients is to maintain

circulatory stability and organ perfusion to optimize the function of organs for transplantation.

Step 2: Key Aspects of Anaesthetic Management.

(1) Hemodynamic Support:
- Maintain blood pressure and adequate perfusion to the organs using vasopressors (e.g., norepinephrine), if necessary, to maintain mean arterial pressure (MAP) 65 mmHg.
- Volume resuscitation may be required, especially if the patient has signs of hypovolemia or low cardiac output. IV fluids like crystalloids or colloids can be used to stabilize hemodynamics.

(2) Maintain Cardiac Output:
- Inotropic agents such as dobutamine or milrinone may be used if the heart's pumping ability is insufficient to maintain tissue perfusion.

(3) Oxygenation and Ventilation:
- Mechanical ventilation should be continued to ensure adequate oxygenation and maintain arterial oxygen saturation (SpO) ¿90- Adjust the ventilator settings to maintain normal CO levels (PaCO 35-45 mmHg) to prevent respiratory acidosis or alkalosis.

(4) Electrolyte and Acid-Base Balance:
- Monitor electrolytes (e.g., potassium, calcium, sodium) closely and correct any imbalances. Acid-base status should be maintained within normal range to optimize organ function.
- Blood glucose levels should be monitored, and insulin may be administered if the patient becomes hyperglycemic.

(5) Temperature Management:
- Maintain normothermia (body temperature around 36-37°C). Hypothermia can decrease metabolic demand and negatively impact organ function.
- Avoid hypothermia during the retrieval process as it can adversely affect organ quality.

Step 3: Preventing Organ Injury.
- Ensure adequate perfusion of organs during transport to the transplant site.
- Avoid overdistention of organs during mechanical ventilation, as this can damage delicate tissues.
- Use of specific medications to preserve organs, such as heparin to prevent clotting and glucocorticoids to minimize inflammatory responses, may also be employed.

> **Quick Tip**
>
> Anaesthetic management of brain-dead patients aims to maintain hemodynamic stability, adequate oxygenation, and organ perfusion to optimize the quality of organs for transplantation.

Q3. a) Different roles of Magnesium in Anaesthesiology. [5]

Solution:

Step 1: Introduction to Magnesium in Anaesthesiology.
Magnesium is a vital mineral with various physiological functions in the human body, and its role in anaesthesiology is becoming increasingly recognized. It acts as an NMDA receptor antagonist, which helps in analgesia, muscle relaxation, and reducing the need for other anaesthetic agents. Magnesium is also involved in neuromuscular transmission and has cardiovascular effects, making it important for anaesthesia management.

Step 2: Roles of Magnesium in Anaesthesiology.

(1) Analgesic Effects:
- Magnesium works as an NMDA (N-methyl-D-aspartate) receptor antagonist, which helps reduce the perception of pain. This property is utilized in perioperative pain management, particularly in multimodal analgesia regimens.
- It has shown to decrease the requirements for opioids and reduce postoperative pain, making it especially useful in chronic pain management and acute perioperative pain.

(2) Muscle Relaxation:
- Magnesium enhances neuromuscular blockade and is often used as an adjunct in induction of anaesthesia. It potentiates the effects of neuromuscular blocking agents (NMBA), allowing for reduced doses of muscle relaxants like vecuronium and rocuronium.
- Magnesium can also reduce shivering in the postoperative period, which is beneficial for post-anaesthesia care.

(3) Cardiovascular Benefits:
- Magnesium is used in the management of arrhythmias such as torsades de pointes and ventricular arrhythmias. It stabilizes the cardiac membrane potential by blocking calcium channels.
- It is particularly useful in hypomagnesemic patients or in those undergoing procedures that increase the risk of arrhythmias, such as cardiothoracic surgery.
- Magnesium helps in maintaining normal heart rate and blood pressure, particularly in eclampsia or pre-eclampsia.

(4) Neuroprotective Effects:
- Due to its role as an NMDA receptor antagonist, magnesium is being studied for its potential to reduce neurological injury. This may be useful in conditions such as traumatic brain injury, spinal cord injury, and stroke.
- It may reduce excitotoxicity and neuronal injury following cerebral ischemia.

(5) Prevention and Treatment of Eclampsia:
- Magnesium is a cornerstone of the management of eclampsia, preventing seizures and lowering the risk of maternal morbidity and mortality. It is given intravenously in loading doses followed by a maintenance infusion.

Quick Tip

Magnesium's analgesic and muscle-relaxing properties, along with its role in arrhythmia management, make it a valuable adjunct in anaesthesia and perioperative care.

Q3. b) Segmental spinal anaesthesia. [5]

Solution:

Step 1: Introduction to Segmental Spinal Anaesthesia.
Segmental spinal anaesthesia (SSA) is a form of regional anaesthesia in which the anaesthetic is administered to specific segments of the spinal cord to provide targeted sensory and motor blockade. It is most commonly used in spinal blocks where the goal is to achieve pain relief and muscle relaxation in specific regions, usually for procedures involving the lower body. SSA is commonly used for lower limb surgeries, abdominal surgeries, or pelvic surgeries.

Step 2: Mechanism of Segmental Spinal Anaesthesia.
- Segmental spinal anaesthesia involves the injection of local anaesthetic (LA) into the subarachnoid space (spinal canal) to block nerve roots at specific spinal levels. The level of anaesthesia depends on the amount and concentration of the LA injected.
- The local anaesthetic used for SSA blocks the conduction of nerve impulses in the dorsal root ganglia and nerve roots. This leads to the desired motor and sensory blockade in a specific segment or region.

Step 3: Applications of SSA.
(1) Surgical Applications:
- SSA is particularly useful for lower abdominal, pelvic, and lower limb surgeries. It provides effective pain control during surgery while allowing for conscious sedation in some cases. Examples include:
- Caesarean sections.
- Hernia repairs.
- Hip or knee surgeries.

(2) Obstetric Anaesthesia:
- SSA is widely used in obstetric procedures for pain relief during labour or Caesarean section. It provides good segmental pain control, allowing the mother to be conscious during the delivery.

Step 4: Advantages of SSA.
(1) Targeted Blockade:
- Unlike general anaesthesia, SSA provides segmental control, allowing the surgeon to perform the procedure without affecting other parts of the body.
- The anaesthesia can be tailored to specific levels, depending on the surgery.

(2) Reduced Risk of Systemic Effects:
- The risk of systemic side effects (e.g., respiratory depression, nausea, vomiting) is reduced

compared to general anaesthesia.

(3) Faster Recovery:
- Patients recover quickly from SSA, with a rapid return of motor and sensory function post-procedure.

Step 5: Technique and Considerations.
(1) Positioning:
- The patient is usually positioned sitting or lateral (on their side), with the back arched to facilitate access to the lumbar spine.
- Aseptic technique is crucial to prevent infection.
- Needle Placement: A fine needle is inserted between the lumbar vertebrae, typically at L3-L4 or L4-L5, into the subarachnoid space.
- Volume and Type of Anaesthetic: The volume and type of local anaesthetic (e.g., bupivacaine, lidocaine) are chosen based on the surgical site and duration of the procedure.

(2) Complications:
- Hypotension: A common complication, especially if the block spreads too high. It can be managed with fluids and vasopressors.
- Postdural puncture headache (PDPH): Caused by leakage of cerebrospinal fluid from the puncture site.

> **Quick Tip**
>
> Segmental spinal anaesthesia provides effective regional analgesia, particularly for lower abdominal and lower limb surgeries, with fewer systemic effects compared to general anaesthesia.

Q4. a) Discuss accidental awareness during anaesthesia, and its prevention. [5]

Solution:

Step 1: Definition of Accidental Awareness During Anaesthesia.
Accidental awareness during anaesthesia refers to a situation where a patient becomes conscious and aware of their surroundings or events occurring during surgery or anaesthesia but is unable to move or communicate due to muscle relaxants used during the procedure. This condition can be distressing and lead to psychological trauma, including nightmares, anxiety, or post-traumatic stress disorder (PTSD).

Incidence:
- Accidental awareness is a rare but serious occurrence, with reported incidences ranging from 0.1- It is more likely to occur in cases of light anaesthesia or when inadequate doses of anaesthetic agents are administered.

Step 2: Causes of Accidental Awareness During Anaesthesia.

(1) Inadequate Dose of Anaesthetics:
- The most common cause is insufficient dosing of volatile agents or intravenous (IV) anaesthetics like propofol, resulting in light anaesthesia and partial consciousness.

(2) Equipment Failure:
- Faulty anaesthesia machines or miscalibration can lead to improper delivery of anaesthetics, allowing awareness during surgery.

(3) Patient Factors:
- Certain patients, especially those with high drug tolerance, obesity, or those undergoing long surgeries, may require higher doses of anaesthetics to maintain unconsciousness.
- Emergent surgery may also require rapid anaesthetic induction without sufficient monitoring.

Step 3: Prevention of Accidental Awareness During Anaesthesia.

(1) Adequate Monitoring:
- Depth of anaesthesia can be monitored using bispectral index (BIS) monitoring, which measures the brain's electrical activity to assess the level of consciousness.
- End-tidal anaesthetic concentration should be continuously monitored to ensure appropriate levels of anaesthetics.

(2) Proper Anaesthetic Dosing:
- Weight-based dosing and titration of anaesthetic agents should be individualized according to the patient's age, health status, and surgical requirements.

(3) Use of Muscle Relaxants:
- In cases where muscle relaxants are used, adequate doses should be administered to ensure that the patient is fully unconscious and unaware of the surgery. Muscle relaxants should be titrated according to the depth of anaesthesia to avoid unnecessary paralysis.

(4) Preoperative Assessment:
- Thorough preoperative assessment should be done, particularly in high-risk patients, to determine the required anaesthetic dose and any potential risk factors for awareness.

> **Quick Tip**
>
> Regular monitoring of anaesthetic depth and correct dosing is essential to prevent accidental awareness during surgery, especially in high-risk cases.

Q4. b) Advantages and disadvantages of colloids intravenous (IV) fluids. [5]

Solution:

Step 1: Introduction to Colloid IV Fluids.
Colloid IV fluids contain larger molecules, such as proteins or polysaccharides, that are used to restore blood volume and maintain intravascular volume. Unlike crystalloids, which are smaller molecules, colloids have a higher oncotic pressure, which helps draw fluid into the blood vessels. Common types of colloid fluids include albumin, dextran, hydroxyethyl starch (HES), and gelatins.

Step 2: Advantages of Colloid IV Fluids.

(1) Effective Volume Expansion:
- Colloids are effective in increasing intravascular volume and are often preferred in cases of hypovolemic shock, especially when large fluid volumes are required for resuscitation. They help restore circulating blood volume quickly, which is beneficial in patients with severe blood loss or burns.

(2) Longer Duration of Effect:
- Because colloids stay in the intravascular space longer than crystalloids (which tend to shift to the interstitial space), they can provide more sustained hemodynamic support. This makes them useful in conditions requiring prolonged volume expansion.

(3) Reduced Fluid Requirements:
- Due to the larger molecular size, colloids are more effective in retaining fluid within the blood vessels, allowing for smaller volumes to be administered compared to crystalloids to achieve the same effect.

(4) Oncotic Pressure Support:
- Colloid fluids help maintain oncotic pressure (osmotic pressure exerted by proteins in the blood), which helps in preventing edema and ensuring proper fluid distribution between the vascular and interstitial spaces.

Step 3: Disadvantages of Colloid IV Fluids.

(1) Risk of Allergic Reactions and Side Effects:
- Certain colloid fluids, such as dextran and hydroxyethyl starch (HES), are associated with allergic reactions, renal impairment, and coagulopathy. These can be particularly problematic in patients with kidney disease or those undergoing major surgeries.

(2) Expensive:
- Colloid fluids are generally more expensive than crystalloids, which can be a concern in large-volume resuscitation settings.

(3) Limited Use in Certain Populations:
- Some colloid solutions, particularly HES, have been shown to increase the risk of kidney injury and bleeding, and their use has been restricted in some countries due to safety concerns.
- In patients with liver disease, the use of albumin as a colloid may be limited due to the

inability of the liver to synthesize adequate protein.

(4) Fluid Overload:
- Excessive administration of colloids, particularly albumin, can lead to fluid overload, especially in patients with heart failure or renal impairment. This can result in complications such as pulmonary edema or congestive heart failure.

Quick Tip

Colloid solutions are effective for volume expansion and maintaining oncotic pressure but should be used cautiously in patients with renal impairment or in large volumes due to potential complications.

Q5. a) Cardiopulmonary Resuscitation (CPR) in a hypothermic patient in cardiac arrest. [5]

Solution:

Step 1: Introduction to CPR in Hypothermic Cardiac Arrest.
Cardiac arrest in hypothermic patients presents unique challenges in terms of both resuscitation techniques and decision-making. In hypothermic cardiac arrest, the patient's body temperature is significantly lower than normal, and the body's metabolic processes, including cardiac function, are slowed down. The management of such patients requires modified CPR protocols to optimize the chances of successful resuscitation.

Step 2: Key Considerations for CPR in Hypothermic Cardiac Arrest.

(1) Avoiding Overzealous Chest Compressions:
- In hypothermic patients, chest compressions should be gentle and controlled, as excessively forceful compressions can potentially cause rib fractures or damage to internal organs.

(2) Delayed Defibrillation:
- Defibrillation in hypothermic patients may be ineffective at temperatures below 30°C (86°F). Therefore, CPR should be continued until the patient's temperature is warmed to a point where defibrillation is likely to be effective (typically 32-34°C).

(3) Rewarming During CPR:
- Active rewarming should be initiated as soon as possible during the resuscitation process. Warm IV fluids, heated blankets, or warming devices such as humidified oxygen can be used to raise the core temperature gradually.

(4) Avoiding Medications at Low Temperatures:
- Medications, particularly epinephrine, may be less effective at low temperatures. Additionally, drug metabolism is reduced in hypothermia. Therefore, the use of medications should be

minimized, and doses may need to be adjusted once the body is rewarmed.

(5) Prolonged Resuscitation Attempts:
- In hypothermic cardiac arrest, the brain and organs tolerate ischemia better at low temperatures, and prolonged resuscitation attempts (up to 60 minutes or more) may be appropriate in cases of severe hypothermia. This approach is based on the concept of cold ischemic tolerance, where survival can occur even after prolonged cardiac arrest.

Step 3: Modified Resuscitation Guidelines.
- High-quality chest compressions should be performed, with minimal interruptions.
- Rescue breathing should be continued, and airway management (e.g., intubation) should be done if needed.
- Defibrillation attempts should only be made once the patient's core temperature is raised to a level where electrical activity can be restored.

> **Quick Tip**
>
> In hypothermic cardiac arrest, avoid immediate defibrillation until the body temperature reaches at least 30°C. Focus on gentle CPR and active rewarming.

Q5. b) Etomidate. [5]

Solution:

Step 1: Introduction to Etomidate.
Etomidate is a short-acting intravenous anesthetic agent commonly used for induction of anaesthesia and for sedation in critically ill patients. It is a imidazole derivative that provides rapid and smooth induction without causing significant respiratory depression. Etomidate is frequently used in emergency and intensive care settings due to its favorable pharmacokinetic profile.

Step 2: Mechanism of Action.
- Etomidate works by potentiating GABA (gamma-aminobutyric acid) activity at the GABA-A receptors, leading to central nervous system depression. This results in sedation, hypnosis, and anesthesia.
- Unlike barbiturates or propofol, etomidate has a relatively minimal effect on cardiovascular function, making it a suitable option in hemodynamically unstable patients.

Step 3: Indications for Etomidate Use.

(1) Induction of Anaesthesia:
- Etomidate is commonly used for induction of general anaesthesia in patients who may have compromised cardiovascular function. It is especially beneficial in patients with hypotension,

shock, or cardiac disease, as it causes minimal changes to blood pressure and heart rate.

(2) Sedation in Critical Care:
- It is often used for sedation in mechanically ventilated patients or for procedures like endotracheal intubation in the emergency department or intensive care unit.

(3) Rapid Sequence Intubation (RSI):
- Etomidate is a preferred drug for rapid sequence intubation due to its fast onset and short duration of action. It can be used in combination with muscle relaxants to facilitate intubation in emergent settings.

Step 4: Pharmacokinetics and Administration.

(1) Onset and Duration:
- Etomidate has a rapid onset of action, typically within 30-60 seconds after intravenous administration, with a duration of effect lasting around 5-10 minutes. It is metabolized by the liver and excreted in the urine.

(2) Dosing:
- The typical dose for induction of anaesthesia is 0.2-0.3 mg/kg IV, which can be adjusted based on the patient's clinical condition.

Step 5: Side Effects and Contraindications.

(1) Adverse Effects:
- Adrenocortical Suppression: One of the most significant adverse effects of etomidate is suppression of adrenal steroid synthesis, leading to adrenal insufficiency, particularly when administered repeatedly or for prolonged periods. This effect may last for up to 24 hours after a single dose.
- Injection Site Pain: Pain at the injection site is a common complaint, although it is usually transient.
- Myoclonus: Involuntary muscle movements or myoclonus may occur during induction. This is generally not clinically significant but can be alarming.
- Nausea and Vomiting: These side effects may occur postoperatively in some patients.

(2) Contraindications:
- Etomidate should be used with caution in patients with adrenal insufficiency or those at risk for it. It is generally avoided in pregnancy unless absolutely necessary.
- Severe allergic reactions or hypersensitivity to etomidate or its components may be a contraindication.

Quick Tip

Etomidate is ideal for induction in patients with cardiovascular instability due to its minimal impact on blood pressure, but its use should be cautious in patients with adrenal insufficiency.

Q6. a) Opioid free anaesthesia. [5]

Solution:

Step 1: Introduction to Opioid-Free Anaesthesia (OFA).
Opioid-free anaesthesia (OFA) refers to a technique of anaesthesia where opioids (such as morphine, fentanyl, and remifentanil) are avoided in the perioperative period. Instead, the anaesthetic plan focuses on the use of alternative agents to achieve analgesia, hypnosis, and muscle relaxation. This approach aims to reduce the side effects and complications associated with opioids, such as nausea, vomiting, respiratory depression, and postoperative ileus.

Step 2: Components of Opioid-Free Anaesthesia.

(1) General Anaesthesia Without Opioids:
- Inhaled anaesthetics (e.g., sevoflurane, desflurane) or IV anaesthetics (e.g., propofol) are used for induction and maintenance of anaesthesia.
- The analgesic effect is achieved using non-opioid drugs, including NSAIDs (non-steroidal anti-inflammatory drugs), acetaminophen, local anaesthetics, and ketamine.

(2) Use of Ketamine:
- Ketamine, an NMDA receptor antagonist, is often used in opioid-free anaesthesia for its analgesic and amnesic properties. It provides significant pain relief and can prevent central sensitization, which is important in major surgeries.
- Ketamine is also known for its cardioprotective and neuroprotective effects, making it particularly useful in patients with cardiovascular instability or neurological conditions.

(3) Alpha-2 Agonists (Dexmedetomidine):
- Dexmedetomidine, an alpha-2 adrenergic agonist, is used to achieve sedation and analgesia without respiratory depression. It has a sympatholytic effect, reducing blood pressure and heart rate, and it also provides analgesic effects by inhibiting norepinephrine release in the central nervous system.

(4) Regional Anaesthesia:
- Techniques such as epidural anaesthesia, spinal anaesthesia, or peripheral nerve blocks can provide effective pain relief in major surgeries, reducing or eliminating the need for opioids.

Step 3: Advantages of Opioid-Free Anaesthesia.

(1) Reduced Postoperative Nausea and Vomiting (PONV):
- By avoiding opioids, OFA significantly reduces the incidence of nausea and vomiting, which are common opioid-related side effects.

(2) Faster Recovery:
- Opioid-free anaesthesia is associated with faster recovery times, particularly in terms of gastrointestinal function, as opioids are known to cause postoperative ileus.

(3) Improved Respiratory Function:
- Avoiding opioids can reduce the risk of respiratory depression, leading to better postoperative oxygenation and a lower incidence of respiratory complications.

(4) Decreased Risk of Opioid Dependence:
- Reducing opioid use in the perioperative period may help mitigate the risk of opioid dependence or misuse, especially in patients with a history of substance abuse.

Step 4: Challenges of Opioid-Free Anaesthesia.

(1) Need for Alternative Analgesics:
- Effective analgesia may be difficult to achieve in some cases without opioids, requiring higher doses of non-opioid analgesics or the use of additional agents such as ketamine or local anaesthetics.

(2) Increased Cost and Complexity:
- The use of alternative agents like ketamine and dexmedetomidine may increase costs and complexity of anaesthesia management.

> **Quick Tip**
>
> Opioid-free anaesthesia can reduce opioid-related side effects and improve recovery times, but requires careful management of alternative analgesics.

Q6. b) Enumerate the causes and discuss the management of a patient in Type I respiratory failure. [2+3]

Solution:

Step 1: Causes of Type I Respiratory Failure.
Type I respiratory failure, also known as hypoxemic respiratory failure, is characterized by a PaO ¡ 60 mmHg with normal or low carbon dioxide levels (PaCO ¡ 50 mmHg). It occurs when there is inadequate oxygenation of the blood despite normal or low carbon dioxide retention.

Common causes of Type I respiratory failure include:

(1) Ventilation-Perfusion (V/Q) Mismatch:
- Conditions such as pulmonary embolism, pneumonia, or atelectasis can lead to V/Q mismatch, where areas of the lung receive oxygen but cannot adequately exchange gases.

(2) Pulmonary Edema:
- Conditions like cardiogenic pulmonary edema, where fluid accumulates in the lungs, impairing oxygen diffusion into the bloodstream.

(3) Acute Respiratory Distress Syndrome (ARDS):
- ARDS is a severe condition caused by inflammation and alveolar damage, which decreases the ability of the lungs to oxygenate the blood effectively.

(4) Pneumonia:
- Bacterial or viral pneumonia can impair gas exchange in the alveoli, causing low oxygen levels in the blood.

(5) Interstitial Lung Disease:
- Conditions like pulmonary fibrosis or sarcoidosis can cause scarring and inflammation of the lung tissue, which impairs oxygen absorption.

(6) Atelectasis:
- Collapse of lung tissue (often due to post-surgical complications or airway obstruction) leads to poor oxygenation and can result in Type I respiratory failure.

Step 2: Management of Type I Respiratory Failure.

(1) Oxygen Therapy:
- The mainstay of management is oxygen supplementation to raise the PaO to adequate levels. This can be done via nasal cannula, face mask, or more invasive methods like mechanical ventilation if needed.

(2) Positive Pressure Ventilation:
- In cases where oxygen therapy is not sufficient, non-invasive positive pressure ventilation (NIPPV) (e.g., BiPAP) or invasive mechanical ventilation may be required to improve ventilation and oxygenation.

(3) Treatment of Underlying Cause:
- Management should also focus on treating the underlying condition, such as administering antibiotics for pneumonia, using diuretics for pulmonary edema, or providing anticoagulants for pulmonary embolism.

(4) Positioning and Physiotherapy:
- In conditions like ARDS or pneumonia, prone positioning (turning the patient on their stomach) can improve oxygenation. Chest physiotherapy may also be used to help clear secretions from the lungs.

(5) Supportive Care:

- In severe cases, sedation and analgesia may be needed for comfort, especially in patients requiring mechanical ventilation. Regular monitoring of ABGs and oxygen saturation is essential to assess the effectiveness of interventions.

> **Quick Tip**
>
> Oxygen therapy is crucial in managing Type I respiratory failure, but treating the underlying cause and supporting ventilation are key to improving outcomes.

Q7. Enumerate modalities available for pain relief during labor. How will you conduct labor analgesia for a 32-year-old female in true labor, with 2 cm os dilation and 50% effacement of cervix, who has presented to the labor room and demands analgesia? Enumerate possible complications. [3+5+2]

Solution:

Step 1: Modalities Available for Pain Relief During Labor.

Pain relief during labor is crucial for the comfort of the mother and the progress of labor. Several modalities can be used for analgesia and anesthesia during labor, depending on the patient's preferences, the stage of labor, and the clinical situation. These include:

(1) Non-pharmacologic Methods:
- Breathing Techniques and Relaxation: Methods like Lamaze or hypnobirthing teach the patient to focus on controlled breathing and relaxation to reduce pain perception.
- Massage and Touch: Gentle massage or counter-pressure applied to the lower back can help alleviate discomfort, particularly in cases of back labor.
- Water Immersion: Laboring in warm water (e.g., birthing pools) can help reduce pain and relax the muscles.
- Acupressure/Acupuncture: These techniques, though less commonly used, are thought to help reduce pain and discomfort by stimulating certain points on the body.

(2) Pharmacologic Methods:
- Systemic Analgesia:
- Opioids (e.g., meperidine, fentanyl) can provide relief from pain during labor but are less effective for intense pain and can cause sedation or nausea in the mother.

- Regional Analgesia:
- Epidural analgesia is the most common method, involving the injection of local anesthetics (e.g., bupivacaine) and opioids (e.g., fentanyl) into the epidural space. It provides effective pain relief, especially during the later stages of labor.
- Spinal analgesia (single injection) can provide rapid, effective pain relief, particularly in the setting of cesarean section or operative vaginal delivery.
- Combined spinal-epidural (CSE) technique provides rapid pain relief (from spinal injection)

with the option for continuous analgesia (from the epidural).

(3) Local Anesthesia:
- Perineal infiltration with lidocaine or other local anesthetics may be used for pain relief during the second stage of labor, particularly before an episiotomy or during the delivery of the baby.
- Pudendal block may also be used to provide analgesia for the perineum and vagina, especially in the second stage of labor.

Step 2: Conducting Labor Analgesia for a 32-Year-Old Female with 2 cm Os Dilation and 50% Effacement.

For a 32-year-old female in true labor with 2 cm os dilation and 50% effacement of cervix, who demands analgesia, the following steps would be taken:

(1) Initial Assessment:
- Monitor Maternal and Fetal Well-being: Check vital signs (blood pressure, pulse, temperature) and fetal heart rate to assess for any signs of distress.
- Examine for Progress of Labor: Check cervical dilation and effacement to confirm active labor and assess the stage of labor.

(2) Pain Relief Options Based on Progress:
- Early Labor (¡4 cm dilation): For early labor, non-pharmacologic methods (e.g., breathing techniques, relaxation, water immersion) can be offered for pain relief. If these are ineffective, opioid analgesics (e.g., fentanyl) can be administered to reduce pain.

- Epidural Analgesia: Since the patient is in true labor, with 2 cm dilation, she is eligible for epidural analgesia. A small-dose epidural can be administered, as she is not yet in the active phase of labor (typically over 4 cm). The epidural will provide significant pain relief, and continuous infusions can be adjusted as the labor progresses.

(3) Consent and Preparation:
- Explain the procedure for epidural analgesia, including the risks and benefits. Obtain informed consent.
- Set up an IV line for hydration and administer any necessary pre-epidural bolus fluids to reduce hypotension risk.

(4) Administration of Epidural Analgesia:
- The epidural needle is inserted into the epidural space (usually in the lumbar region), and local anaesthetics (e.g., bupivacaine) combined with opioids (e.g., fentanyl) are injected to achieve effective pain relief.
- Monitor for any adverse reactions such as hypotension or spinal headaches.

(5) Reassessment and Monitoring:
- Regularly reassess maternal pain levels, vital signs, and fetal heart rate to ensure the efficacy and safety of the analgesia. Adjust the dose or switch to a different analgesic technique if necessary.

Step 3: Possible Complications of Labor Analgesia.

(1) Epidural Complications: - Hypotension: A common complication of epidural analgesia due to sympathetic blockade, which can lead to fetal distress. This can be managed by IV fluids and vasopressors.
- Postdural Puncture Headache (PDPH): Caused by cerebrospinal fluid leakage, resulting in a headache that worsens when the patient is upright. This can be managed with a blood patch.
- Infection or Hematoma: Rare but serious complications from epidural placement, especially if sterile technique is not followed.
(2) Systemic Effects of Opioid Analgesia: - Nausea, Vomiting, Sedation: Common side effects of opioids, although they are generally less frequent with the use of fentanyl or remifentanil in labor.
- Respiratory Depression: In extreme cases, opioid-induced respiratory depression can be dangerous for both mother and fetus, though it is rare with low-dose administration.

Quick Tip

The choice of analgesia in labor depends on the stage of labor, maternal preferences, and potential complications. Regional analgesia (epidural) is the most common and effective method in the later stages of labor.
In early labor, non-pharmacologic methods can be tried initially, but if pain is significant, epidural analgesia is an effective option once the cervix is dilated to 2-3 cm.
Epidural analgesia is generally safe, but complications such as hypotension and headache should be monitored and managed promptly.

Q8. Classify supraglottic airway devices (SADs). What are the modifications done in 3rd generation SADs? Enumerate the possible complications associated with use of SADs. [3+4+3]

Solution:

Step 1: Classification of Supraglottic Airway Devices (SADs).
Supraglottic airway devices (SADs) are used to maintain an open airway in patients during anaesthesia or in emergency settings when endotracheal intubation is difficult or contraindicated. SADs are designed to sit above the glottis, providing a secure airway while minimizing trauma to the vocal cords. SADs can be classified based on their design and the generation to which they belong:

(1) First Generation SADs:
- Laryngeal Mask Airway (LMA): The LMA consists of a cuffed tube that fits over the laryngeal inlet to form a seal, with no need for tracheal intubation. It is commonly used for general anaesthesia and in emergency settings.
- Combitube: A dual-lumen airway device, one lumen is placed in the esophagus and the other in the trachea, providing a means of ventilation if the first lumen fails.

(2) Second Generation SADs:
- LMA ProSeal: A modification of the standard LMA that includes a more secure gas-tight seal and an esophageal drain tube, reducing the risk of gastric aspiration.
- I-gel: A non-inflatable device that forms a seal against the pharyngeal and laryngeal structures. It is typically used in difficult airway management.

(3) Third Generation SADs:
- LMA Supreme: A modification of the ProSeal LMA that improves the seal and allows for better positive pressure ventilation. It includes an integrated bite block and esophageal drainage port.
- Air-Q: A newer design that features a soft, non-inflatable cuff, with an integrated bite block and gas-tight seal, providing better protection against aspiration.
- Cuff Pressure Monitored Devices: Devices with built-in mechanisms to monitor and adjust cuff pressure to prevent complications associated with excessive cuff inflation.

Step 2: Modifications Done in 3rd Generation SADs.

Third generation SADs incorporate several modifications designed to improve airway security, reduce complications, and provide better performance during ventilation. These modifications include:

(1) Improved Sealing Mechanism:
- Devices like the LMA Supreme and Air-Q have enhanced designs that ensure a more secure, gas-tight seal, which is important for positive pressure ventilation. This reduces the risk of air leaks, especially when high ventilatory pressures are used.

(2) Esophageal Drainage Port:
- Many third-generation devices, such as the LMA Supreme, have an esophageal drainage port to reduce the risk of gastric aspiration by allowing the drainage of stomach contents. This provides better protection against aspiration, which is a significant risk during anaesthesia.

(3) Integrated Bite Block:
- Devices like the LMA Supreme incorporate an integrated bite block, which prevents the patient from biting the device and potentially obstructing the airway or causing damage to the device.

(4) Cuff Pressure Monitoring and Adjustment:
- Modern third-generation SADs often come with built-in mechanisms for cuff pressure monitoring. This feature helps maintain optimal cuff inflation, preventing high cuff pressures, which can lead to mucosal injury or nerve damage.

(5) Improved Ease of Insertion:
- Devices like the Air-Q have a more anatomically conforming shape that facilitates easy insertion and minimizes trauma to the airway structures.

Step 3: Possible Complications Associated with the Use of SADs.

Despite their advantages, the use of supraglottic airway devices (SADs) is associated with potential complications, which include:

(1) Aspiration:
- Aspiration of gastric contents is one of the major risks associated with SADs. Even with devices like the LMA ProSeal and Air-Q that have esophageal drainage ports, there is still a risk of gastroesophageal reflux during anaesthesia, leading to pulmonary aspiration.

(2) Airway Obstruction:
- Improper positioning or poor-fitting SADs can cause partial or complete airway obstruction, resulting in hypoxia. This can occur due to inadequate seal or device displacement, especially when positive pressure ventilation is used.

(3) Trauma to Airway Structures:
- Insertion of SADs can cause oral or pharyngeal trauma, including teeth damage, lacerations to the oropharynx, or injury to the epiglottis. While the risk is lower than that associated with endotracheal intubation, it still exists, particularly in patients with difficult airways.
- Pressure necrosis from prolonged use or high cuff pressures can lead to mucosal damage or nerve injury.

Quick Tip

Supraglottic airway devices are classified based on their generation, with the third generation offering better sealing, aspiration protection, and easier ventilation.
Third-generation SADs offer enhanced features like esophageal drainage, improved sealing, and cuff pressure monitoring to improve patient safety and device performance.
While SADs offer several advantages, careful insertion, monitoring, and proper fitting are essential to avoid complications like aspiration, airway obstruction, and trauma.

Q9. a) WHO ladder for pain management. [5]

Solution:

Step 1: Introduction to the WHO Pain Management Ladder.
The World Health Organization (WHO) Pain Ladder is a guideline for the management of pain, particularly in patients with cancer or chronic pain. It was developed to provide a stepwise approach to pain management, ensuring that pain is treated effectively based on its severity. The ladder emphasizes the use of medications in increasing doses to achieve optimal pain control, while also considering the patient's individual needs.

Step 2: The Three Steps of the WHO Pain Ladder.

(1) Step 1 - Mild Pain:
- Medications: For mild pain (rated 1-3 on a 0-10 pain scale), the first-line treatment is typically

non-opioid analgesics. These may include:
- Acetaminophen (Paracetamol).
- Non-steroidal anti-inflammatory drugs (NSAIDs) such as ibuprofen or aspirin.
- Adjuvants such as antidepressants or anticonvulsants for neuropathic pain.
- Goal: To control pain using non-opioid medications with minimal side effects.

(2) Step 2 - Moderate Pain:
- Medications: If pain persists or increases, mild opioids are added to the treatment plan along with non-opioid medications. This is for moderate pain (rated 4-6 on the pain scale). Options include:
- Codeine or Tramadol in combination with acetaminophen or NSAIDs.
- Combination therapy: opioid + non-opioid for enhanced analgesia.
- Goal: To provide moderate pain relief while continuing to use adjuvant medications for neuropathic pain or inflammation.

(3) Step 3 - Severe Pain:
- Medications: For severe pain (rated 7-10 on the pain scale), strong opioids are used. This step is for severe or uncontrolled pain, and includes:
- Morphine, fentanyl, oxycodone, or hydromorphone.
- These opioids may be used alone or in combination with non-opioid analgesics (such as acetaminophen or NSAIDs) and adjuvants.
- Goal: To achieve complete pain relief and improve the quality of life for patients with severe pain, especially those in palliative care or advanced stages of illness.

Step 3: Adjustments and Special Considerations.
- Breakthrough Pain: If patients experience episodes of severe pain despite being on opioids, additional rescue doses or short-acting opioids can be used.
- Rotation of Opioids: In cases of opioid tolerance, opioid rotation (changing between different opioid medications) can be used to maintain efficacy.

> **Quick Tip**
>
> The WHO pain ladder provides a structured approach to pain management, starting with non-opioids and progressing to stronger opioids for severe pain, while also considering adjunctive therapies.

Q9. b) Drug dose modification in obese patients. [5]

Solution:

Step 1: Introduction to Drug Dose Modifications in Obese Patients.
Obesity can significantly alter the pharmacokinetics of medications, affecting their absorption, distribution, metabolism, and elimination. When managing obese patients, drug dosing must be adjusted to account for these physiological changes. Inappropriate dosing can lead to toxicity

or ineffective therapy. Therefore, dose modifications are essential to ensure safe and effective treatment.

Step 2: Considerations for Drug Dose Modification.

(1) Absorption:
- In obese patients, gastrointestinal absorption may be altered due to increased gastric pH, delayed gastric emptying, or changes in intestinal motility. However, oral bioavailability is generally not significantly affected by obesity, and the standard oral dose is usually sufficient.
- For drugs with high first-pass metabolism, oral doses may need to be adjusted, though this is often negligible in obesity.

(2) Distribution:
- Obesity increases total body fat, which can alter the volume of distribution (Vd) of lipophilic (fat-soluble) drugs, such as benzodiazepines and opioids. These drugs may accumulate in fatty tissue, requiring higher loading doses or prolonged dosing intervals.
- For hydrophilic (water-soluble) drugs, such as gentamicin or digoxin, the increased lean body mass in obesity may require higher doses to achieve the desired plasma concentration.

(3) Metabolism:
- Liver metabolism may be affected by obesity, particularly in patients with associated conditions like non-alcoholic fatty liver disease (NAFLD) or insulin resistance. Drugs metabolized by the liver may require lower doses or longer dosing intervals.
- Cytochrome P450 enzymes (CYP450) activity may be altered in obese patients, necessitating careful monitoring of drug levels.
- For example, warfarin (CYP2C9 metabolism) may require dose adjustments due to changes in metabolism.

(4) Excretion:
- Obesity may affect renal function and drug elimination. Although glomerular filtration rate (GFR) may be higher in obese individuals, the renal clearance of drugs may be altered due to changes in renal blood flow and glomerular filtration.
- Renal dosing adjustments are essential for drugs like antibiotics (e.g., vancomycin) or diuretics.
- Monitoring of renal function (e.g., creatinine clearance) is crucial in obese patients on renal-excreted medications.

Step 3: Common Drugs Needing Dose Adjustment in Obese Patients.

(1) Opioids:
- Lipophilic opioids such as morphine or fentanyl require dose adjustments to avoid accumulation and respiratory depression. These may accumulate in fat tissue and lead to delayed or prolonged effects.

(2) Anticoagulants:
- For drugs like warfarin, adjustments are needed based on body weight and INR levels. Obese patients may require higher doses or increased monitoring for anticoagulation.

(3) Antibiotics:
- Hydrophilic antibiotics like gentamicin and vancomycin may require higher doses due to the increased volume of distribution. Dosing based on total body weight (TBW) may be required, but in certain cases, ideal body weight (IBW) is used.

Quick Tip

In obese patients, both the pharmacokinetics and the pharmacodynamics of drugs may be altered. Dosing adjustments based on body weight, renal and liver function, and drug characteristics are essential for safe and effective treatment.
