Reviewed By
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3- General anesthesia Techniques

Objectives

- Define General Anesthesia.
- Learn about several equipment, adjuncts and agents used for induction of general anesthesia including intravenous agents, inhalation agents, neuromuscular blocking agents and reversal agents.
- Understand basic advantages and disadvantages of these agents.
- Anesthesia Workstation anesthesia machine structure.
- Complications commonly encountered during general anesthesia.

Color Index:

- Main Text
- 41 Doctor's notes
- 39 Doctor's notes
- Reference
- Important
- Golden notes
- Extra

Editing file

Case discussion

General Anaesthesia Technique

What is Anaesthesia?

"Without sensation" 1846 by Wendell Holmes to describe 'state of sleep from ether'.

Early drug: Opium, Alcohol, Cocaine, N2O (1844) & CO2, Ether (1846, Morton in Boston), Chloroform (1847, Simpson), NMBDs (1942), Halothane (1956), Thiopental, Propofol, Iso/Sevo/Desflurane.

General anesthetics : Have been used since 1846 when Morton demonstrated the first anesthetic (using ether) on 16th of Oct 1846 in Boston, USA.

Local anesthetics: Arrived later, the first being scientifically described in 1884. First used local anesthetic is cocaine

Definitions

General anesthesia

A state of reversible unconsciousness, analgesia Loss of sensation, and amnesia Forgetting all events happened during surgery but not affecting past or future memories with skeletal muscle relaxation and loss of reflexes.

Inhalation anesthesia

Anesthesia induced by inhalation of drug. Pharmacologically induced, changes drugs into vapors for patient to inhale either spontaneously or via intubation

Minimum alveolar concentration (MAC)

The alveolar concentration required to eliminate the response to standardized painful stimulus in 50% of patients.

Analgesia

A stage of decreased awareness of pain sometimes with amnesia.

Balanced anesthesia

Anesthesia produced by a mixture of drugs, often including both inhaled and intravenous agent.

General Anaesthesia Technique

Anaesthesiologist is a superman doctor; not just in the operating room. You can find them in:

- Operating room (hospital, surgicenter)
- Other procedural areas
- PACU
- Emergency medicine
- Respiratory therapy
- Administration (operating room, hospital, medical school)
- Research
- Labor & delivery suite
- Intensive care unit (ICU)
- Pain management (acute, chronic, cancer pain)
- "Code blue" team
- Education (health professionals, public)
- Managers

General Anesthesia Goals

Primary goal : SAFETY AND PATIENT CARE IS THE PRIORITY

- Oxygenation
- **Ventilation** Means removing CO_2
- **Monitoring**
- **Amnesia:** patient should forget any unpleasant feeling
- **Hypnosis**: unconscious state
- **Analgesia:** no pain sensation
- **Autonomic Block:** reflexes blocked e.g., gag reflex
- **Optimal conditions:** all the above along with good muscle relaxation
  For surgeons to perform the surgery well

Assessment: Preanesthesia (Wards or clinic)

Planning I Monitoring	Planning II Drug	Planning III Fluids	Planning IV Airway management

Process of Anesthesia:

Premeditation	Induction	Maintenance	Emergency	Postoperative Care
ex. For anxiety we give Benzo 2hr before surgery	ex. IV Ketamine			Almost all pts get sent to postoperative care but a few pts might get sent to HDU or ICU where they are further ventilated

General Anaesthesia Preoperative

Preoperative Anaesthetic evaluation:

1. Physical status classification
2. Airway examination
3. NPO status
4. Anesthetic plan

1) Physical status classification

This classification is based only on medical issues present in the patient and has nothing to do with the surgical conditions.
More details in (pre anesthesia assessment lecture).

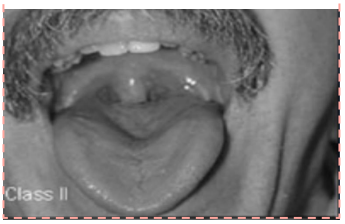
Class I	A normal healthy patient. Ex. Pt came for hernia repair without other medical issues.
Class II	A patient with mild systemic disease (no functional limitation). Well controlled disease (DM,HTN)
Class III	A patient with severe systemic disease Uncontrolled(some functional limitation).
Class IV	A patient with severe systemic disease that is a constant threat to life bedridden or (functionality incapacitated).
Class V	A moribund patient who is not expected to survive with or without the operation within 24 hours.
Class VI	A brain-dead patient whose organs are being removed for donor purposes. In critical care for harvesting)
Class E	Emergent procedure. They Have higher morbidity and mortality rate

2) Airway Examination (Mallampati Classification):

Ask the patient to sit in front of you and fully open his/ her mouth (Say Aaa) to be able to see posterior pharyngeal. There's inter observer variations..

Class I
Uvula, faucial pillars, soft & hard palate visible.

Class II
Faucial pillars, soft & hard palate visible.



Class III
Soft & hard palate visible.

Class IV
Hard palate visible.

General Anaesthesia Preoperative

Preoperative Anaesthetic evaluation:

3- NPO status:

NPO (Nil Per Os) means nothing by mouth.

Solid food
8 hrs before induction.

Liquid
4 hrs before induction.

Clear water
2 hrs before induction.

Pediatrics
Stop breast milk feeding 4 hrs before induction
formula feeding considered as solid food Stop 6 hours before induction.

4- Anesthetic plan:

Stages of General Anesthesia (Arthur Ernest Guedel 1937) based on inhalation of diethyl Ether.

Volatile anesthetic takes time so we can observe every step but nowadays we use Iv anesthetic and they work very fast.

Stage 1

Stage of analgesia start (Joseph Frank Artusio 1954):

- **Plane 1** no amnesia, no analgesia.
- **Plane 2** amnesia, partial analgesia.
- **Plane 3** full amnesia and analgesia .

Stage 2

Stage of excitement (jerky movements, restlessness) ; unconsciousness.

- This stage is dangerous as the patient may injure themselves by pulling away his arms/masks or jump from the bed yet he is still unconscious, we have to take care of the Pt.

Stage 3

Stage of surgical anaesthesia:

The Pt is calm, sleep, respiration and BP are regular. This is our target stage.

- **Plane 1** regular respiration.
- **Plane 2** eyeball movement.
- **Plane 3** intercostal muscles paralyzed.
- **Plane 4** diaphragm movement (Patient is breathing spontaneously, hemodynamically stable).

Stage 4

Stage of medullary depression(hypoperfusion); diaphragm paralysis.

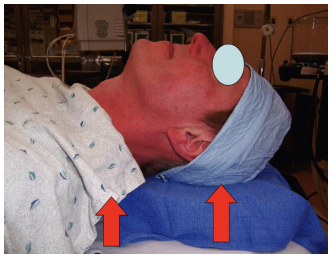
May need CPR, it's NOT our target. Happened because of Overdose

General Anaesthesia Intraoperative

General Anesthesia:

- Monitor Pre-oxygenation
- Induction (including Rapid Sequence Induction & cricoid pressure)
- Mask ventilation Muscle relaxants
- Intubation & ETT position confirmation.
- Maintenance
- Emergence
- Post operative recovery.

Sniffing Position:



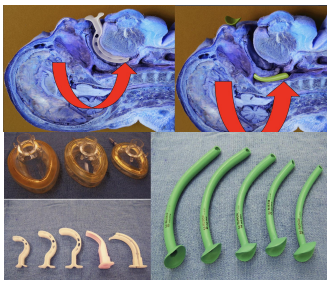
Cervical joint

Atlanto-occipital joint (10CM) to achieve flexion of the spine

Combination of flexion at the atlanto-axial joint and extension at the atlanto-occipital joint
Our aim is to align 3 axes (maximum alignment):

- Oral
- Pharyngeal
- Tracheal

Mask and airway tools:



- When we withdraw the anesthesia, Pt may be still unconscious so his muscle tone is not strong enough to ventilate by himself and it may fall, or Pt vomit making airway not clear so we need to keep airway patent and open using these.
- If the tongue falls back it may cover the epiglottis and so we use nasopharyngeal.

Mask Ventilation and intubation:

Single handed

By making a **C** shape with the thumb and index on the mask and **E** shape on the jaw with the remaining 3 fingers (the middle and the ring finger on the ramus of the mandible and the little finger on the corner).

Double handed

Using both hands, place the thumb on the mask by pushing and lifting the jaw forward to open the airway. If your hands are small or for obese patients.

General Anaesthesia Intraoperative

Difficult BMV-MOANS:

M — **Mask seal:** mask seal requires normal anatomy, absence of facial hair, lack of interfering substances like vomitus or bleeding & ability of apply mask with pressure.

O — **Obstruction/obesity:** obstruction of upper airway, obesity (BMI greater than 26) is an independent marker. Redundant upper airway tissue, chest wall weight & resistance from abdominal contents impede airflow.

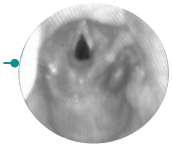
A — **Age:** general loss of elasticity & increased incidence of restrictive /obstructive lung disease with increasing age.

N — **No teeth:** edentulous creates difficulty.

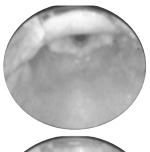
S — **Stiffness:** resistance to ventilation with COPD, Asthma, Pulmonary edema.

Intubation:

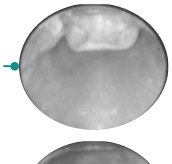
Laryngeal view scoring system (Cormack-Lehane grading system)



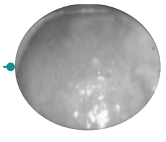
Grade 1
Everything is visible.



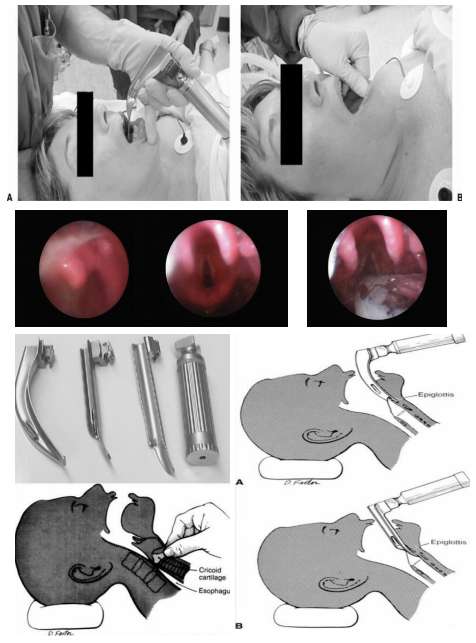
Grade 2
Anterior glottis is not visible.



Grade 3
Only epiglottis is visible.



Grade 4
Nothing visible.

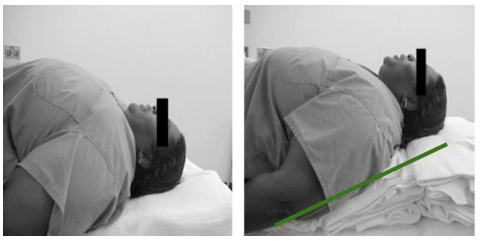


tracheal cartilage incomplete ring Cricoid cartilage complet ring So if we press on this cricoid cartilages esophagus will come between cricoid cartilage and 5th cervical vertebrae.
Advantage: Stop regurgitation and aspiration
Disadvantage: desterp the anatomy (depends on who's applying it)

General Anaesthesia Intraoperative

Difficult Airway:

E.g. morbidly obese, short neck, rheumatological diseases, kyphosis → minimal neck movement



Inclined surface (ram)

The LEMON approach:

L — **Look externally:** abnormal facies, unusual anatomy or facial Trauma.

E — **Evaluate (3-3-2 rule):** 3 fingers between the incisors, 3 fingers along the floor of the mandible b/w the mentum and the neck mandible junction and 2 fingers in the superior laryngeal notch. This predicts difficulty in visualizing the glottis.

M — **Mallampati score:** III predicts difficulty, and IV predicts extreme difficulty.

O — **Obstruction/obesity**

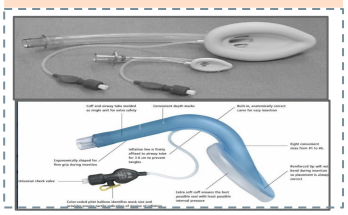
N — **Neck mobility:** if patient can't move his neck he won't be able to do sniff position.

Difficult Airway Management:

Glidescope

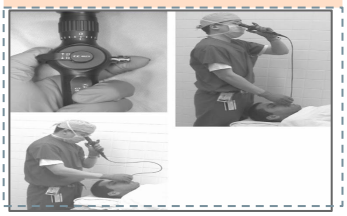
Video assisted monitor that helps watch the structures as you go inside.

(LMA)

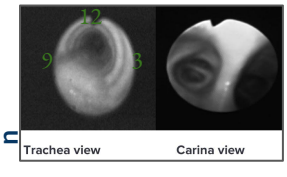


Fast track LMA

Fiberoptic intubation



Fiberoptic intubation



The gold standard, used in cases of difficult intubation. In trachea view you can see the trachea has a cartilage ring then there is a deficit in the posterior wall which indicate the tracheal muscles, this deficit is the landmark of trachea. There is NO more tracheal muscles when you reach the carina -left and right bronchus , so this will help you to differentiate and identify when you enter the right and left bronchus during intubation.

Anesthesia Machine

Anesthesia is delivered via a machine from the main gas supply to the patient.

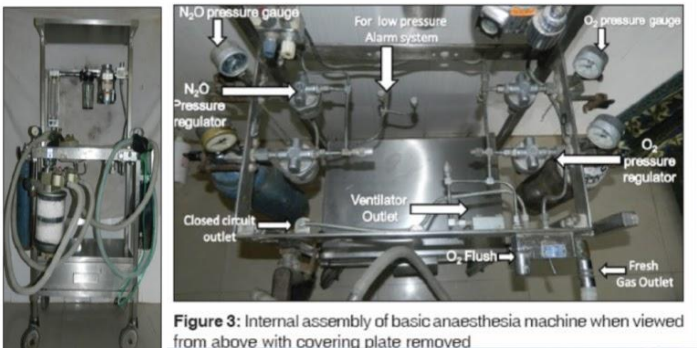


Figure 3: Internal assembly of basic anaesthesia machine when viewed from above with covering plate removed

Anesthesia Workstation:

Functions of anesthesia machine:

1. Provides O2
2. Accurately mixes anaesthetic gases and vapours.
3. Enables patient ventilation.
4. Minimises anaesthesia related risks to patients and staff by strictly controlling the doses of medications.

Anesthesia Machine:

1- **Gas supplies:** from the central pipeline to the machine as well as cylinders.
2- **Monitoring.**
3- **Scavenging** The system remove gases to the atmosphere so there will be air pollution in the OR, there will come the **scavenging role to get rid of it.**
4- **Fresh gas delivery:** breathing systems and ventilators.
5- **Vaporizers** Store, control, and deliver anesthetic agents.
6- **Flow meters.**

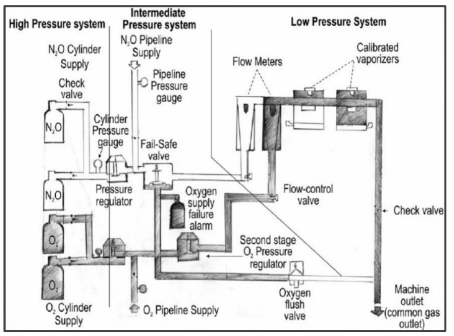


Diagram of Anesthesia Machine
Cylinder: provide gases / valves: provide directions of gases / pressure regulators : lower the gases pressure so Pt get suitable pressure.

Safety Features:

Pin index safety system (PISS):

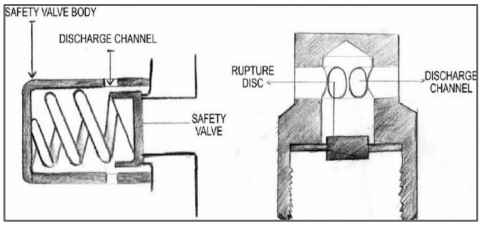
- ➔ We can only fix nipples and holes
- ➔ Previously instead of using O2 you might introduce NO and so the patient will die. Here the pin is like a USB cord, you have 2 sides and it'll help avoid giving NO. If you want to give O2 there's a specific type of pin that is specific only to O2 (e.g. the diameters are different to help differentiate).

Anesthesia Machine

Safety Features:

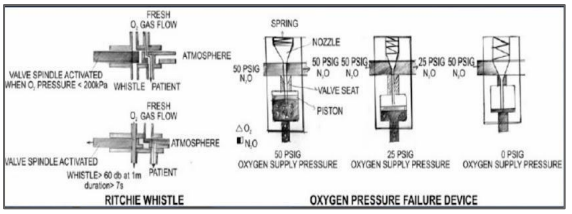
Pressure Regulators:

Reduce high pressure into low pressure bring to normal body pressure to protect the lungs.



Oxygen Failure device:

When the oxygen supply is cut off, an alarm will turn on.

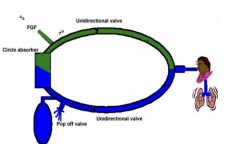


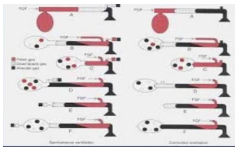
DISS safety connections non-interchangeable screw thread:

Diameter index safety system: is a gas station outlet system used in the hospital setting for the supply of medical gases. DISS connectors are threaded and have a unique diameter for each type of gas to prevent erroneous connections.

Breathing Circuit:

We use a low flow system after a while from starting the anesthesia so the Pt will have enough gases to circulate. When Pt breathes, the expired air will pass to a unidirectional valve until it reaches the circle observer which will clear CO2 and makes O2 circulate again so the Pt benefits from it.





Intraoperative Management

Induction Agents:

- IV induction.
- Inhalation induction Used in: 1) small babies or adults where IV line is difficult 2) pts w/partial airway obstruction; if we give IV induction pt will develop complete airway obstruction but if we use inhalation induction the airway will remain patent

1 **Analgesics**
Opioids – Fentanyl, Sufentanil, Remifentani long acting Morphine, Oxycodone.ı

2 **Induction of unconscious**
Propofol, Thiopental and Etomidate, Benzodiazepines.

3 **Muscle relaxants**
Depolarizing –Succinylcholine.
Non- depolarizing. Reversal agents for muscle relaxants: Atropine, Glycopyrrolate, Neostigmine, Sugammadex (especially for vecuronium).

438: (Note from Dr.Jummana) IV induction agents are given in the following order: Fentanyl (analgesic) —> Lidocaine —> Propofol (hypnotic) —> Rocuronium bromide (muscle relaxant), note that lidocaine is given 10 to 30 seconds before propofol to decrease the propofol-induced pain and tachycardia

Intraoperative Management

Maintenance

- Inhalation agents: N2O, Sevoflurane, Desflurane, Isoflurane. Contraindication: malignant hyperthermia surgeries done under neurophysiological movements
- Total IV agents: Propofol.
- Opioids: Fentanyl, Morphine.
- Muscle relaxants.
- Balance anesthesia. .Usage of multiple agents but in low doses.

Monitoring

- Depends on the patient's condition (ECG, capnograph, pulse oximeter, blood pressure cuff, temperature measurement, urine output & blood loss measurement) in all patients + nerve stimulator if you give muscle relaxant.

Positioning during surgery

- Supine most common position Some modifications can be done based on the need of the surgery.
- Lateral e.g. Kidney procedure.
- Prone e.g. Neurosurgical procedure.
- Sitting e.g. Posterior fossa surgery.
- Lithotomy.

Fluid management

Crystalloid vs colloid.

NPO fluid replacement:	➔ **1st 10kg** weight-4 ml/kg/hr ➔ **2nd 10kg** weight-2 ml/kg/hr ➔ 1ml/kg/hr **thereafter**
Intraoperative fluid replacement: The insensible fluid losses from open body cavities, should be replaced	➔ **Minor** procedures 1-3 ml/kg/hr ➔ **Major** procedures 4-6 ml/kg/hr ➔ **Major abdominal** procedures 7-10 ml/kg/hr

Intraoperative Management & Recovery:

- Waking up is a crucial time where there is short period when the patient is aware of emergence without a full return to consciousness.

- Turn off the agent (inhalation or IV agents).
- Reverse the muscle relaxants.
- Return to spontaneous ventilation with adequate ventilation and oxygenation.
- Suction upper airway.
- Wait for patient to wake up and follow command.
- Hemodynamically stable.

Postoperative Management

Post-anesthesia care unit (PACU)

- Oxygen supplement.
- Pain control.
- Nausea and vomiting.
- Hypertension and hypotension.
- Agitation.

Surgical intensive care unit (SICU)

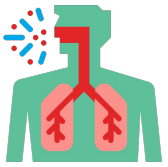
- Mechanical ventilation.
- Hemodynamic monitoring.

General Anesthesia Complications and Management

Most common complications (physiological): Hypoxia, Pain, Dehydration, and electrolytes imbalance

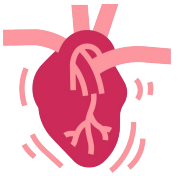
Respiratory

- Aspiration – airway obstruction and pneumonia.
- Bronchospasm.
- Atelectasis.
- Hypoventilation.



Cardiovascular

- Hypertension and hypotension.
- Arrhythmia.
- Myocardial ischemia and infarction.
- Cardiac arrest. Very rare.



Neurological

- Slow recovery from anesthesia. Due to administered volatile anesthetics
- Stroke

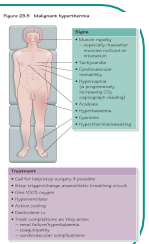
Malignant hyperthermia

-One of the signs of malignant hyperthermia (muscle Rigidity)

It's very very very rare, sensitive to depolarizing agents; triggered by **succinylcholine and all volatile anesthetic agents**. This used to have a high mortality rate. We give **dantrolene sodium** before surgery for prevention.

One of the signs of malignant hyperthermia (muscle Rigidity)

From the reference:



General Anesthesia Complications and Management

Hypothermia lead to delay recovery of anesthesia

Definition: < 35 C
Extreme ages (old patients & premature infants) are at great risk of hypothermia

Classification:
- Mild 35-32 C
- Moderate 32-28 C
- Severe 28-20 C

Mechanism: depress the hypothalamus at the temperature regulatory center.
- Heat loss
- Radiation
- Convection
- Evaporation
- Conduction

Therapeutic vs Accidental Hypothermia:
- **Therapeutic**: sometimes done during cardiac surgery to decrease the temperature between 34-36 so the patient consumes little O2 and preserve functions.
- **Accidental**: like alcohol, you get vasodilation and a lot of heat is lost.
- **Physical**: when Pt touches the cold table and things.

Adverse effects: affect all body systems because our enzymes need optimal temperature to work
- **Brain:** delayed consciousness.
- **Heart:** bradycardia, hypotension.
- **Lungs:** hypoventilation.
- **Coagulation:** bleeding.
- **Drugs:** increased half life.
- **Hospital:** costful because of the longer stay.

Prevention: increase the temperature of your surroundings or use floor warmers.

Treatment: rewarming.

Lecture quiz

Question 1: Use of a laryngeal mask airway would be most appropriate for airway management in the following patient:

A. An obese patient with acute appendicitis who, after rapid sequence induction, cannot be intubated
B. An elderly patient with restrictive lung disease scheduled for inguinal hernia repair
C. An obese male patient with a hiatal hernia and GERD scheduled for umbilical hernia repair
D. A full-term parturient brought to the OR for emergent cesarean section because of fetal bradycardia

Question 2: A 12-year-old girl is undergoing scoliosis correction. Anaesthesia is maintained with isoflurane in nitrous oxide and oxygen. A total of 10mg morphine has been administered as intermittent boluses. About 30 minutes into the procedure, the patient develops a tachycardia which is not responsive to a bolus of intravenous fluids or intravenous morphine. The EtCO2 is 7.2kPa despite adequate ventilation and the temperature is recorded as 39°C. The first step in the immediate treatment should be:

A. Dantrolene sodium 1mg/kg as an initial bolus.
B. Dantrolene sodium 2-3mg/kg as an initial bolus.
C. Send urine sample for myoglobin.
D. Measurement of arterial blood pH.
E. Insertion of central venous line.

Question 3: A 64-year-old male was listed for a lumbar laminectomy in the prone position. Following pre-oxygenation, general anaesthesia was induced using propofol and atracurium by a trainee anaesthetist. The trainee anaesthetist encountered a difficult intubation due to a grade 4 view of the larynx and the airway was secured using a laryngeal mask airway (LMA). Help was summoned from a consultant anaesthetist. The most suitable method of performing tracheal intubation by the second anaesthetist would be:

A. Waking up the patient and performing an awake fibreoptic intubation.
B. Performing a fibreoptic-assisted intubation through the LMA.
C. Removing the LMA and attempting direct laryngoscopy.
D. Removing the LMA, inserting an intubating LMA and attempting tracheal intubation.
E. Replacing the LMA with a 'Proseal' LMA to facilitate positive pressure ventilation.

Question 4: The most significant risk factor for developing pulmonary complications is:

A. Site of surgery (abdominal/thoracic)
B. Presence of respiratory infection
C. Presence of obstructive sleep apnea
D. Smoking

Key Answers: 1- A / 2-B / 3-B 4-A

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