



10 -Intraoperative , Postoperative Complications & Management

Objectives

- Students at the end of the lecture will be able to:
- Learn a common approach to emergency medical problems encountered in intraoperative and postoperative period.
- Understand post-operative respiratory and hemodynamic problems and learn how to manage these problems.
- Learn about the predisposing factors, differential diagnosis and management of PONV.
- Understand the causes and treatments of post-operative agitation and delirium.
- Learn about the causes of delayed emergence and know how to deal with it.
- Learn about different approaches of post-Operative pain management

Color Index:

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

Editing file

Case discussion

Intraoperative Anesthetic Emergencies

Introduction

Emergencies are not common but when they do occur they are often life threatening and require immediate action.

Factors in the mnemonic COVER ABCD accounts for approximately 95% of critical incidents:

Colour ¹	Saturation, central cyanosis.
Oxygen	Ensure adequate and correct delivery by monitoring the inspired gas, expired gas and pulse oximetry. If the brain does not receive oxygen within 3 minutes it will die.
Ventilation ²	Check equipment. e.g. breathing circuit, air entry, CO ₂ trace, ETCO ₂ and vaporizer, oxygen supply. Do not start the operation until you check your equipment.
Endotracheal Tube	Kinks, obstruction, endobronchial > different intensity breath sound in both of the lungs, secretions. The tube should be the correct size and should be in place (above the carina).
Review Monitors	Correct site, checked, calibrated; Don't rely 100% on the monitor check the patient's color through monitors his lips, conjunctiva or mucous membranes.
Airway	Failed intubation, laryngeal spasm, foreign body, aspiration. The most important thing is to maintain the airway so if there's difficulty in intubation try to insert LMA or wake the patient up or move on to regional anesthesia if the surgery is below the umbilicus.
Breathing	Difficult to ventilate, e.g. tube occlusion, bronchospasm, pneumothorax, aspiration, lack of neuromuscular blocking drug (NMBD), pulmonary oedema, the tube might be inserted too further inside or not inserted enough.
Circulation	Hypotension: excess anaesthetic agent, dysrhythmia, myocardial ischaemia/MI, Circulation hypovolaemia from any cause (e.g. dehydration, bleeding), sepsis, tension pneumothorax, sympathetic block (e.g. spinal or epidural anaesthetic). Maintain hemodynamics.
Drugs ³	anaphylaxis, wrong drug/dose/route. Some drugs cause severe respiratory depression, so you should know the exact pharmacodynamics/ pharmacokinetics.
Embolism	Air/fat/cement (during total hip arthroplasty) /amniotic fluid. very rare
Others	Related to CVP line If you're not experienced it will lead to (pneumothorax which can be converted to tension pneumothorax if not detected because you keep on ventilating and the air will escape to the pleura /cardiac tamponade), awareness, endocrine and metabolic (malignant hyperthermia (MH), pheochromocytoma).

1- Pink means well saturated, central cyanosis is apparent as a bluish discoloration at the lips, tongue, and sublingual tissues. Peripheral cyanosis, on the other hand (pun intended!), spares the oral mucosa but cause bluish discoloration of the hands and feet; it is the result of vasoconstriction and diminished peripheral blood flow

2- Important because we give the patient NMBD and we are ventilating the patient mechanically.

3- Should be given in small doses in the beginning and wait for some time, if there is no reaction give the rest to avoid anaphylaxis

Intraoperative Anesthetic Emergencies

The most dangerous complication in anesthesia is aspiration → cause ARDS/
Aspiration pneumonia → hypoxia → death if not treated quickly

Aspiration:

Definition: inhalation of gastric contents can occur in patients who have impaired protective airway reflexes. gastric acid will burn the lungs

- Regurgitation of gastric contents can happen in any patient who does not have fully functioning upper airway protective reflexes¹. Non fasting patients will lose their sphincter control once they're under anesthesia → regurgitation. So make sure the patient is NPO.

Those at risk²:

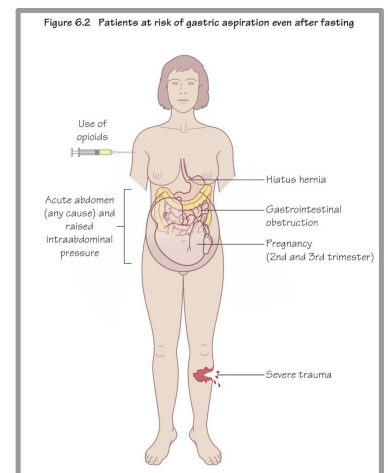
- **Inadequate period of preoperative starvation. (Rapid sequence induction)** RTA/ emergencies/unconscious. Stress → increase sympathetic stimulation → Delayed gastric emptying.
- **Delayed gastric emptying** (e.g. opiates, pain, bowel obstruction, pregnancy at term) Also diabetics due to neuropathy so their stomach does not empty properly.
- **Insufficient /lack of cricoid pressure at induction of anaesthesia.**
- **Early extubation in an at-risk patient (Obese/ pregnant) in supine position³** because they cannot maintain their airway.

Signs:

- **Gastric contents visible within breathing circuit/airway adjunct** (e.g. LMA)/ in the mouth.
- **Silent Airway**
- **↓SaO₂** due to bronchospasm. The lung's ability to take up O₂ reduces because the alveoli are burned.
- **Wheeze/stridor** due to reflex bronchospasm.
- **Tachycardia/ Hypotension**
- **↑ Airway pressure** due to severe bronchospasm and pneumonitis.

Treatment: Mainly supportive

- The first treatment is always prevention: Keep the patient NPO, give metoclopramide to increase emptying of the stomach, antiemetics, Ranitidine to reduced acidity of stomach (premedications)
- 100% oxygen & cut off all anesthetics
- **Call for help**
- 30% Head-down position to prevent/limit aspiration
Before intubation, we keep the patient 30% up so he does not regurgitate
- Oropharyngeal suction
- Tracheal intubation if needed, including tracheal suctioning⁴
- Some advocate antibiotics and steroids
- Postoperatively: physiotherapy, oxygen. Admit to ICU for monitoring + give positive end expiratory pressure which will keep the alveoli open during the expiratory phase → increase the functional residual capacity → oxygenation at the alveoli will increase
- **Remember! Endotracheal intubation protect the lung from aspiration**



Aspiration pneumonia.
Notice the white area indicates pneumonia while black indicates air.

1- Why does it happen to anesthetic patients? Because if this happen in normal person he can cough the food particles (protective reflex), but if it happens to patients under anesthesia they will not be able to cough up and therefore increase the incidence of aspiration.

2- Patients with gastric motility problems, recent RTA where the stomach is not emptying probably bc of the anxiousness, diabetic patient with gastroparesis

3-To avoid aspiration the patient should be in left lateral, head-down position to maintains the airway patency by positioning the tongue away from the posterior pharyngeal wall and also protects the airway from aspiration, if patient is obese or anything that make it difficult to position him, semi-upright position will be fine.

4- Don't use any saline to wash the trachea because it will take the food particles down to the lungs

Intraoperative Anesthetic Emergencies

Air Embolism

Very rare

- **Definition:** air embolism results from inadvertent introduction of air into the circulation, usually via the venous system. **Diagnosis made by TEE**

Causes:

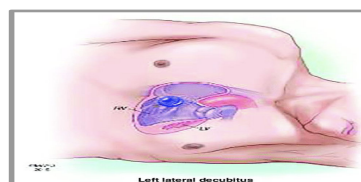
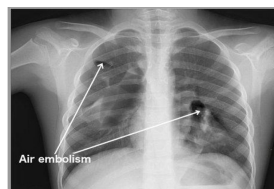
- **Neurosurgery** (dural sinuses are non-collapsible). The pressure in the head is (-) during standing & (+) when lying down flat. Once the dura is open and since the veins don't collapse, air will be sucked in due to (-) pressure. So you should put the patient in a flat position, flush it with saline to avoid further air embolism. Normally the veins would collapse when you cut it.
- **Caesarean section** (e.g. if exposed veins are raised above the level of heart) The veins of the uterus will be open, so amniotic fluid can go inside & cause amniotic fluid embolism.
- **Central line insertion/removal**¹ first complication is pneumothorax then air embolism. The patient should be head down during insertion of the central line in order to make the vein engorged (blood will follow gravity) & it will increase the pressure in the neck (it will become more than that of the heart). As soon as you puncture blood will come out, preventing the air from entering thereby preventing embolism.
- **Epidural catheter placement** (if loss of resistance to air is used)
- **Entrapment through an intravenous line** (especially if pressure-assisted). Usually, the pressure in the vein prevent air from entering but if you're using a pressure bag, an embolism can happen.
- Situations where high pressure gas is used (laparoscopy)

Signs: Sudden decrease in saturation. Cardiorespiratory symptoms

- ↑ HR
- ↓ BP. There's a block in the circulation → no Blood flow
- ↓ SaO₂, because there is no proper circulation to bring the O₂. The air embolism obstruct the pulmonary vasculature → no blood flow → no gas exchange → hypoxia
- ↓ **ETCO₂ End-Tidal Carbon Dioxide (acute due to ventilation-perfusion mismatch)**². Due to blockage of pulmonary veins → no gas exchange
- Murmur (millwheel, due to air circulating around the cardiac chambers). Like the sound of a windmill

Treatment: Prevention is the best treatment. Follow proper procedure

- 100% oxygen
- Airway, breathing, circulation and call for help
- Flood surgical site with saline³ to avoid further entering of air
- Position patient in Trendelenburg/left
- Consider inserting a central venous catheter to aspirate gas if the air embolism reached the right atrium
- lateral decubitus position
- Consider hyperbaric chamber if indicated. Used in diving, the gas bubbles will dissolve when a patient is put in the chamber then it will slowly return to gas again & exhaled slowly



1- Happens especially if you're using pressure bag that's why patient's head should be down 15-20° to avoid air embolism.

2- There is ventilation but no perfusion.

3- To cover the area and prevent further air from getting inside.

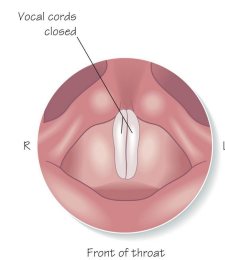
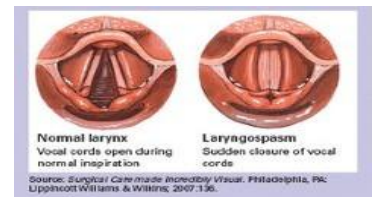
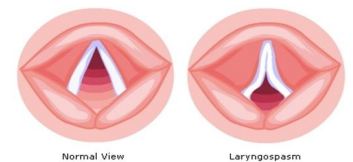
Intraoperative Anesthetic Emergencies

Laryngospasm

- is the complete or partial adduction of the vocal cords, resulting in a variable degree of airway obstruction.¹

Causes:

- Airway manipulation. If you intubate, or use a laryngoscopy the body thinks a foreign body is trying to enter the airway
- Blood/secretion in oropharynx.
- Patient movement
- Surgical stimulus²
- Failure to deliver anesthetic agent³. E.g. the patient's weight is 70kg, so you're supposed to give 200 mg of propofol, but you gave 50mg and tried to intubate→ vasospasm
- Suctioning the patient while he's awake. this will lead to gag Signs: relex and laryngospasm
- Immature intubation/ extubation
- While trying to wake the patient up he will be in pain→ can induce spasm
- While the patient is partially awake in the PACU the airway reflexes are not completely functioning (still under anesthesia) so spasm can happen due to anything that touches their vocal cord. Normal people will cough if something entered the airway (No spasm)



Signs:

- Partial/complete airway obstruction.
- Paradoxical respiratory effort in a spontaneously breathing patient (abdominal/chest see-saw movements as respiratory effort attempts to overcome the obstruction).
- Stridor

Complications:

- ↓SaO₂. severe hypoxia .
- Aspiration.
- Bradycardia (especially in children). Reflex bradycardia due to hypoxia that is not improved with atropine, so you should give 100% O₂.
- Negative pressure pulmonary oedema, because the patients try to breath against closed vocal cords.

Treatment:

Some or all might be needed:

- Positive pressure ventilation with high low oxygen. 100% (e.g. CPAP continuous positive airway pressure or IPPV intermittent positive pressure ventilation). Don't suction you will manipulate the airway
- Deepening of anaesthesia (e.g. i.v. propofol or midazolam)
- Suxamethonium (muscle relaxant) with or without tracheal intubation – causes rapid muscle relaxation and ceases vocal cord opposition

1- We have to take care very quickly because the patient may become hypoxic and cyanosed and result in cardiac arrest especially neonates & pediatric patients because they have high oxygen consumption so they become hypoxic fast

2- If the patient did not receive adequate anesthesia and analgesia

3- Due to problems with vaporizers leads to inadequate anesthesia (below the required MAC level)

Intraoperative Anesthetic Emergencies

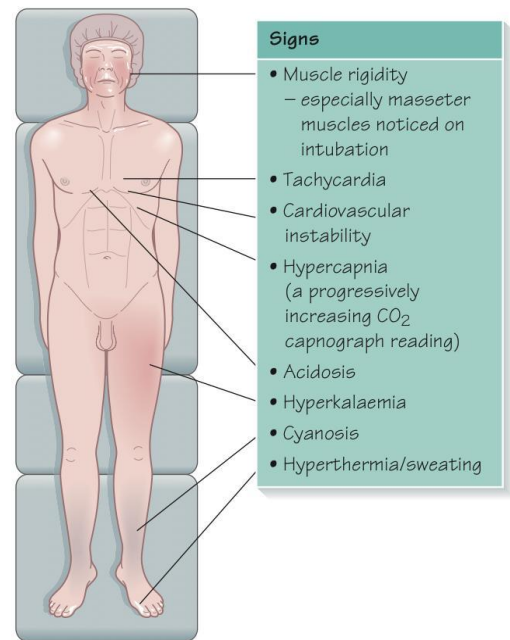
Malignant Hyperthermia Very rare

Definition: this occurs after exposure to a triggering agent (volatile anaesthetics or suxamethonium “succinylcholine”) and results in loss of normal calcium homeostasis within skeletal muscle cells

There's increased metabolism due to problems with calcium reuptake leads to muscle rigidity and contract severely leading to MH.

Signs:

- **Muscle rigidity**
- tachycardia
- cardiovascular instability
- hypercapnia
- acidosis
- hyperkalemia
- cyanosis
- hyperthermia / sweating
- **Hyperglycemia**



Treatment:

- Call for help/ stop surgery if possible
- Stop trigger/change anesthetic breathing circuit¹
- Give 100% oxygen
- Hyperventilation to treat respiratory acidosis
- Active cooling²
- IV dantrolene sodium 3-2 mg/kg rapid IV bolus, repeat as needed
- **Treat complications as they arise:**
 - Renal failure/hyperkalemia
 - Coagulopathy
 - Cardiovascular complications

Treatment
• Call for help/stop surgery if possible
• Stop trigger/change anaesthetic breathing circuit
• Give 100% oxygen
• Hyperventilate
• Active cooling
• Dantrolene i.v.
• Treat complications as they arise: <ul style="list-style-type: none">- renal failure/hyperkalemia- coagulopathy- cardiovascular complications

1- Change the whole machine because even trace of that inhalational anesthetic will trigger the MH again

2- e.g. a hypothermia blanket(s) (over and under the patient) and a refrigerator containing cold isotonic saline for IV infusion. Ice is much more effective at cooling, though core cooling using iced saline intravenously may be effective

Intraoperative Anesthetic Emergencies

Anaphylaxis

Definition: Acute severe type 1 hypersensitivity reaction when an antigen (trigger) reacts with immunoglobulin IgE bound to histamine rich mast cells and basophils. First exposure they build the antibodies and anaphylaxis will occur at the second exposure but sometimes it happens at the first due to cross-reaction.

Symptoms:

- Anxiety, feeling of impending doom
- Rash, itch
- Wheeze, shortness of breath
- Abdominal pain, diarrhoea, vomiting
- Hypotension
- Chest pain

Signs: Dependant on the histamine release

- Angioedema, e.g. skin, lips, throat.
- Rash, lushing, urticaria.
- Tachycardia, bradycardia, dysrhythmias.
- Hypotension.
- Bronchospasm.

Treatment:

1. Basic resuscitation based on Airway Breathing Circulation (ABC)
2. Remove suspected cause, Call for help
3. Give patient 100% oxygen, tracheal intubation if necessary. Try to intubate as early as possible before the mucosa becomes swollen because then the intubation will be difficult
4. Elevate legs if hypotension (increases venous return) to bring blood from the peripheries to the central compartments
5. Start cardiopulmonary resuscitation (CPR) if needed
6. Give epinephrine 50µg (best antidote) in repeated doses; consider epinephrine infusion when there's a response but it's not maintained
7. Give large volumes of fluid, e.g. normal saline or Hartmann's solution. Sudden vasodilation → fluid leak into extravascular compartments → edema so replace the IV fluid

Secondary treatment:

- Chlorpheniramine 10mg (H1 antagonist)
- Hydrocortisone 200 mg to reduce edema, bronchospasm
- Consider alternative vasopressor if unresponsive to epinephrine
- Consider salbutamol i.v./nebulizer, aminophylline, for persistent bronchospasm. Aminophylline is not available nowadays so forget about it
- High dependency (for observation, if the patient is breathing spontaneously and has recovered) or intensive care transfer (if the patient is intubated, ventilated and hypotensive)

Intraoperative Anesthetic Emergencies

Failed intubation¹: Is when an experienced anesthesiologist tries 3 attempts of intubation and still failed

01

Assess the likelihood and clinical impact of basic management problems²: (history to prepare yourself)

- Difficulty with patient cooperation or consent.
- Difficulty mask ventilation.
- Difficulty supraglottic airway placement³.
- Difficulty laryngoscopy, positioning.
- Difficulty intubation.
- Difficulty surgical airway access. Most important is Difficult oxygenation.

Direct Laryngoscopy

Any problems

Call for help

02

Actively pursue opportunities to deliver supplemental oxygen throughout the process.

03

Consider the relative merits and feasibility of basic management choices:

- Awake intubation vs. intubation after induction of general anesthesia⁴.
- Non-invasive technique vs. invasive techniques for the initial approach to intubation. Examples: Invasive → cricothyrotomy. Non invasive → holding the mask and trying to wake the patient up.
- Video-assisted laryngoscopy as an initial approach to intubation.
- Preservation vs. ablation of spontaneous ventilation⁴.

Plan A: Initial tracheal intubation plan

- Direct laryngoscopy
 - check: neck flexion and head extension.
- Laryngoscope technique and vector.
- External laryngeal manipulation
 - by laryngoscopist.
- Vocal cords open and immobile.
- If poor view:
Introducer (bougie)⁵ seek clicks or hold-up and/or alternative laryngoscope.

Failed Intubation

Plan B: Secondary tracheal intubation plan

- ILMA or LMA
 - Not more than 2 insertions.
 - Oxygenate and ventilate keep the oxygenation above 90% as much as possible

Failed oxygenation (e.g. SpO₂ < 90% with FiO₂ 1.0) Via ILMA or LMA

Plan D: Rescue techniques for 'can't intubate, can't ventilate' situation.

- surgical airway to save the pt's life. (cricothyrotomy or tracheostomy)

Failed ventilation & oxygenation

Plan C: Maintenance of oxygenation ventilation, postponement of surgery and

- Revert to face mask.
- Oxygenate and ventilate.
- Reverse non-depolarizing relaxant to allow spontaneous breathing
- 1 or 2 person mask technique. (with oral ± nasal airway)

1- Before intubation if you did not ventilate the patient probably you may lose the patient by causing brain damage because of hypoxia.

2- All of these should be assessed by the anesthesiologist during the preoperative visit.

3- Pitney will not have adequate mouth opening (1-2 fingers) which means LMA cannot be used. If LMA cannot be used, you will be in trouble.

4- If you're going to intubate the patient after GA make sure you can ventilate the patient before giving muscle relaxant (by doing a trial)

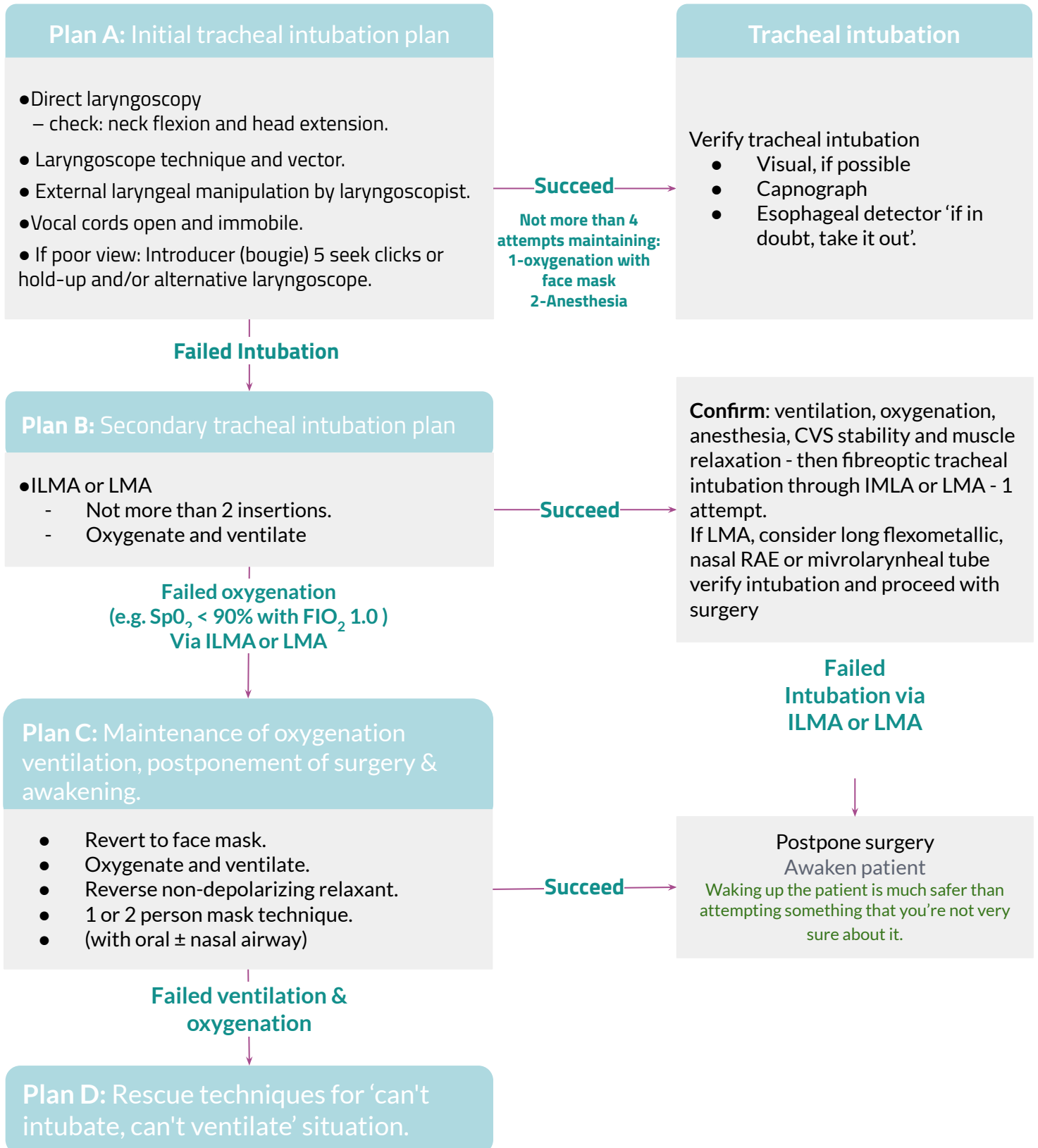
5- The bougie, also called 'introducer', 'gum-elastic bougie' or 'GEB', is a device which allows a Seldinger-like technique of intubating a patient's airway. This means the device is inserted into the airway first, then an endotracheal tube is railroaded over the bougie into the airway, after which the device is removed.

Intraoperative Anesthetic Emergencies

Failed intubation: (reproduced from the difficult Airway Society, with permission)

Unanticipated difficult tracheal intubation - during routine induction of anesthesia in an adult patient

Direct Laryngoscopy → Any problems → Call for help



Intraoperative Anesthetic Emergencies

Cardiac arrest

During CPR

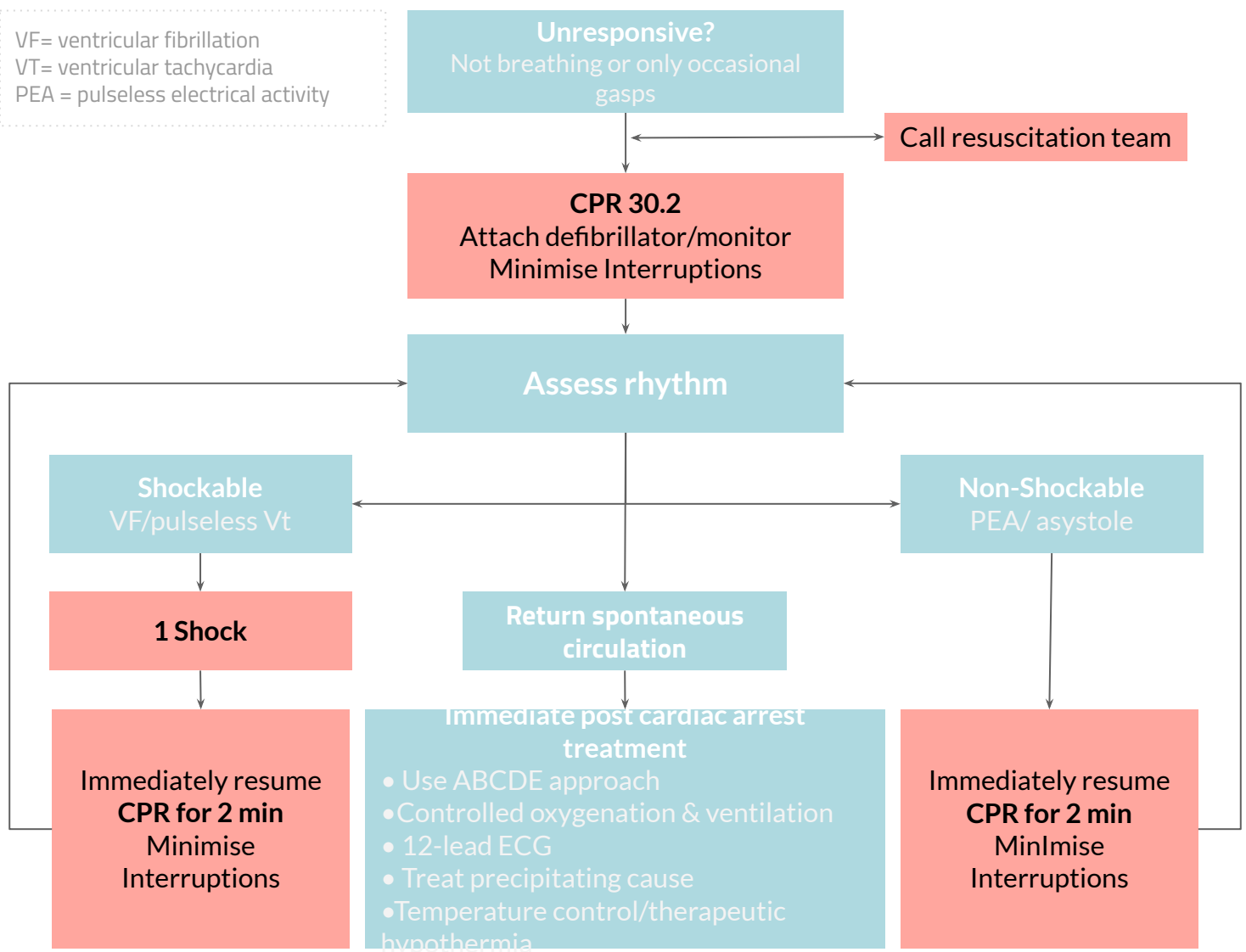
- Ensure high-quality CPR rate, depth, recoil
- Plan actions before interrupting CPR
- Give oxygen
- Consider advanced airway and capnography
- Continuous chest compressions when advanced airway in place
- Vascular access (intravenous, intraosseous)
- Give adrenaline every 3–5 min
- Correct reversible causes

Reversible causes:

- Hypoxia
- Hypovolaemia
- Hypo-/hyperkalemia/metabolic
- Hypothermia
- Thrombosis coronary or pulmonary
- Cardiac tamponade
- Toxins
- Tension pneumothorax.

Cardiac arrest Advanced life support algorithm

VF= ventricular fibrillation
VT= ventricular tachycardia
PEA = pulseless electrical activity



Intraoperative Anesthetic Emergencies

Status Asthmaticus

Definition: is a severe acute exacerbation of asthma refractory to conventional β 2 agonist therapy and is a medical emergency.

Signs:

1. Tachypnoea
2. Use of accessory respiratory muscles (e.g. abdominal, sternocleidomastoid), & intercostal & subcostal recession.
1. Wheeze might be minimal or absent. Sometimes the wheeze can be heard even at a distance from the patient and sometimes there's severe spasm and you won't hear anything (silent chest)
1. Tachycardia & Sweating.
2. Pulsus paradoxus > 10 mmHg (a reduction in blood pressure on inspiration).
3. Tiring & Confusion.
4. Cyanosis

Treatment: Most important thing is to avoid the trigger.

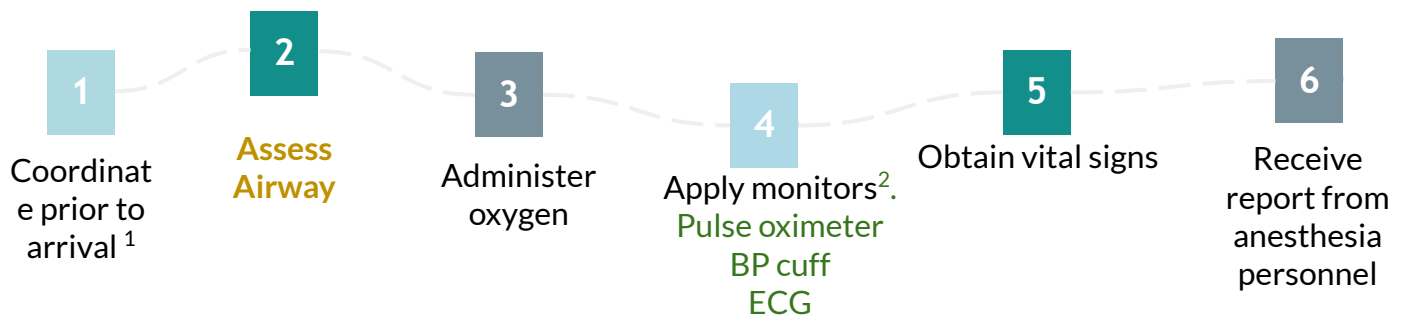
1. Give supplemental oxygen to maintain SaO₂ 94-98%. Do not try to give COPD patients 100% O₂ because these patients depend on the hypoxic drive to breath, without hypoxia they cannot breath.
2. β 2 agonist (either salbutamol or terbutaline) via O₂ driven nebulizer. For bronchoconstriction
3. Continuous nebulization can be used if there is a poor initial response.
4. Intravenous β 2 agonists should only be used when the inhaled route is unreliable.
5. Steroids – either oral prednisolone or i.v. hydrocortisone. To reduce the inflammation in the bronchi
6. Nebulized ipratropium (anticholinergic). Bronchodilator
7. Consider i.v. magnesium sulphate when life-threatening or poor initial response to treatment. Also, ketamine can be used as it is a good bronchodilator.
8. Aminophylline might also be considered in this situation.

Post Anesthesia Care Unit (PACU)

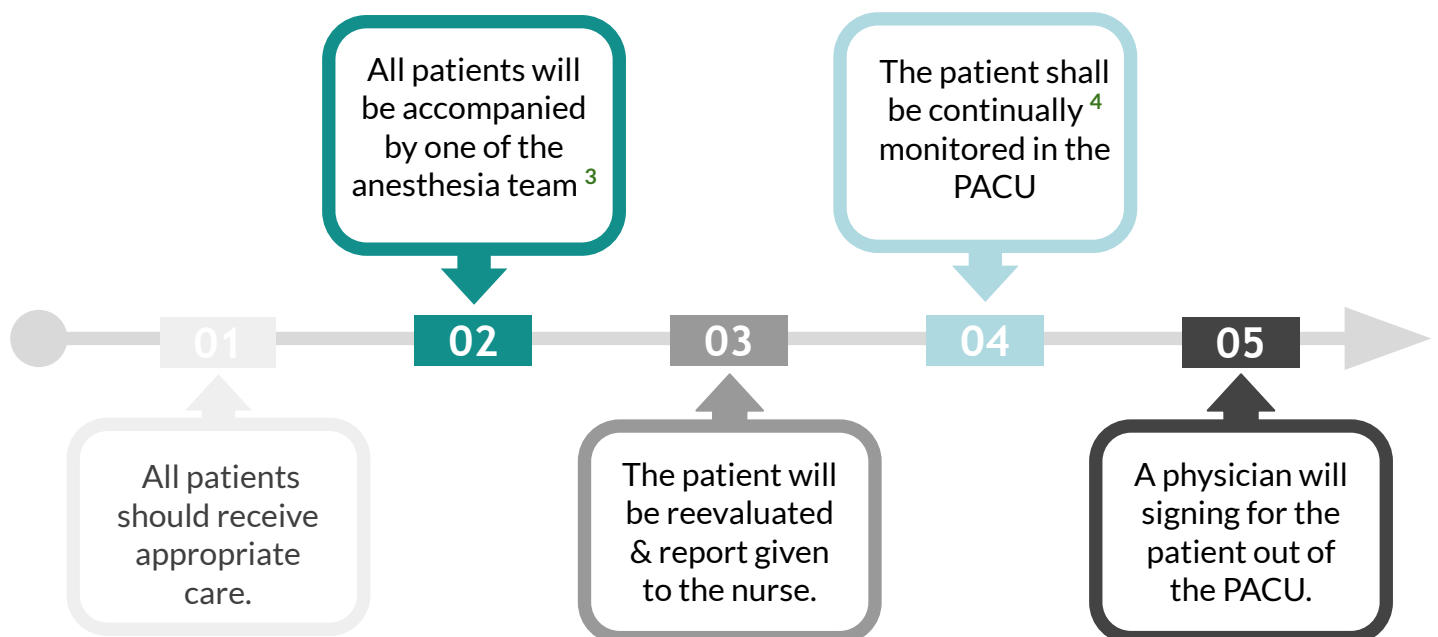
Post Anesthesia Care Unit:

The role of the anaesthetist is not limited to theatres.	Design should match function
After receiving anesthesia for a surgery or procedure a patient is sent to the PACU to recover and wake up .	The PACU is similar to a critical care unit where the patient's vital signs are closely observed, pain management begins , and fluids are given
The nursing staff is skilled in recognizing and managing problems in patients after receiving anesthesia.	The PACU is under the direction of the Department of Anesthesiology.
There may be a number of postoperative responsibilities to undertake, both in the recovery room and on the surgical ward.	<ul style="list-style-type: none"> - Location: Close to the OR, Access to x-ray, blood bank & clinical labs. - Monitoring equipment. - Emergency equipment: ETT, laryngoscope - Well trained personnel.

Admission to PACU (steps) :



PACU ASA Standards:



1- Ensure empty space.
 2- Connect O2 first then apply the monitors to keep good oxygenation.
 3- Till the patient is discharged from the OR
 4- Every 3-5 minutes

Post Anesthesia Care Unit (PACU)

Patient Care in the PACU	
Admission	<ul style="list-style-type: none"> ● Apply oxygen and monitor. ● Receive report
Monitor & Observe & Manage	To Achieve: <ul style="list-style-type: none"> ● Cardiovascular stability. ● Respiratory stability. ● Pain control.
Discharge from PACU	if oxygen saturation is good

Monitoring in the PACU

- Baseline vital signs.
- Respiration: RR/min, Rhythm, Pulse oximetry
- Circulation: PR/min & Blood pressure, ECG
- Level of consciousness.
- Pain scores.
- Urine output

Initial assessment

- Color
- Respiration
- Circulation
- Consciousness
- Activity

Aldrete score: A scoring system to see if the patient is fit for discharge. (>8 you can discharge).

Score	Activity	Respiration	Circulation	Consciousness	Oxygen Saturation
2	Moves all extremities	Breathes deeply and coughs freely.	BP \pm 20 mm of pre anesth. level	Fully awake	Spo2 > 92% on room air
1	Moves 2 extremities	Dyspneic, or shallow breathing	BP \pm 20-50 mm of pre anesth. level	Arousable on calling	Spo2 >90% With suppl. O2
0	Unable to move	Apneic	BP \pm 50 mm of pre anesth. level	Not responding	Spo2 <92% With suppl. O2

Equipment needed in the PACU for emergencies include but not limited to: Emergency cart, ventilator, intubation trolley, x-ray

Post Anesthesia Care Unit (PACU)

Discharge from Post Anesthesia Care Unit (PACU)

- **Standard Aldrete score:**
 - Simple sum of numerical values assigned to activity, respiration, circulation, consciousness and oxygen saturation.
 - A score of 9 out of 10 shows readiness for discharge.
- **Post-anesthetic Discharge Scoring system:**
 - Modification of the Aldrete score which also include an assessment of pain, N/V and surgical bleeding, in addition to vital signs and activity.
 - Also, a score of 9 out of 10 shows readiness for discharge

Discharge criteria from PACU

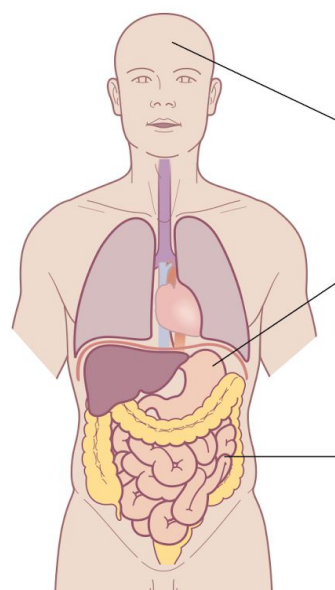
- Easy arousability
- Full orientation
- Ability to maintain & protect airway as well as he can cough
- Stable vital signs for at least 15 - 30 minutes
- The ability to call for help if necessary
- No obvious surgical complication (active bleeding)

Post-operative management

Common PACU Problems: **Dr Notes are in the next slide**

1. Airway obstruction
2. Hypoxemia
3. Hypoventilation
4. Hypotension
5. Hypertension
6. Cardiac dysrhythmias
7. Hypothermia
8. Bleeding
9. Agitation
10. Delayed recovery
11. "PONV"
12. Pain
13. Oliguria

Figure 34.1 Side effects of opioids



Side effect	Potential problems
Respiratory depression, sedation and cough suppression	<ul style="list-style-type: none">• Apnoea,• Gastric aspiration• Respiratory infection
Nausea and vomiting	<ul style="list-style-type: none">• Electrolyte imbalance• Dehydration and malnutrition• Wound dehiscence• Delayed discharge
Reduction in peristalsis	<ul style="list-style-type: none">• Constipation• Ileus and urinary retention• Slow return to GI function after bowel surgery

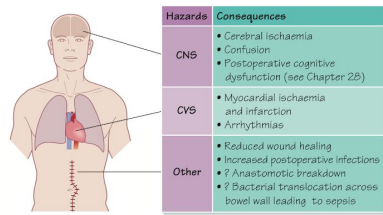
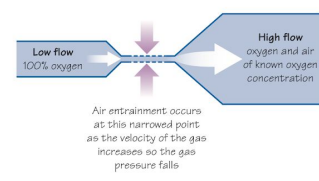
Post Anesthesia Care Unit (PACU)

Post-operative management Cont...

Common PACU Problems:	Dr notes
Airway obstruction	most common, because patient is still not completely awake, so his tongue falls back . If he's unconscious apply an oropharyngeal airway, If he's conscious & trying to push the oropharyngeal airway then try nasopharyngeal. Also suction any secretions + blood. If he's not responding and he's becoming hypoxic he needs Bag mask ventilation to assist him till he can breath on his own
Hypoxemia	Due to airway obstruction or anesthesia drugs that cause respiratory depression like Opioids, Also due to residual muscle relaxant drugs.
Hypoventilation	Treatment? Treat underlying cause/ give antidotes. Opioids → naloxone . Midazolam → Flumazenil
Hypotension	Due to anesthesia drugs, they cause vasodilation/ cardiac depression→ Hypotension. Except midazolam & fentanyl. Can be also due to bleeding or prior hypovolemia
Hypertension	Due to pain/ full urinary bladder causes unexplained HTN/ Previously diagnosed HTN patient missing a dose before the operation. Treatment? Antihypertensive drugs if diagnosed HTN, empty bladder, give analgesia for pain
Cardiac dysrhythmias	Anything that causes cardiac instability (Hypoxia, Hypercarbia, Hypotension). Most common cardiac arrhythmia seen in the PACU is: Premature ventricular contraction. The beat comes during the relative refractory period of the heart.
Hypothermia	Due to room temperature/ cold IV fluids/ gases/ Hypotension→ No circulation in the peripheries/ Rapid cold blood transfusion. To avoid hypothermia: Give warm fluids/ gases/ blood & keep the patient warm
Bleeding	Due to improper occlusion of bleeder (Artery that remains bleeding) → it will continue bleeding in the PACU
Agitation	due to Hypoxia/ pain/ patient on psychiatric drugs/ withdrawal of drugs/ brain injury. Treatment: treat underlying cause
Delayed recovery	Due to having too much drugs/ patients variability. Alcoholics will wake up very fast due to induced liver enzymes that are required for anesthesia drugs metabolism, so it's difficult to put them to sleep & they will wake up early
PONV	Rule out causes. Occur especially in ladies due to cosmetics that contain chemicals that cause the release of histamine→ cross allergy (sensitized to allergens). Also latex allergy can cause anaphylaxis or PONV. Can also happen in patients with full stomach/ diabetes/ Nitrous oxide inside the stomach.
Pain	Best thing is PCA (patient controlled anesthesia) . There's a safety button so he can only take what he needs. E.g. only 6mg of morphine can be given within 1 hour.
Oliguria	Less than 100-200 ml/day. Due to poor perfusion of the kidney which can occur due to stress/ hypovolemia/ underlying renal causes.

Post Anesthesia Care Unit (PACU)

Common PACU problems

	Causes	Treatment								
Airway Obstruction	<ul style="list-style-type: none"> • Most common: tongue fall back to posterior pharynx. • foreign body. • Inadequate relaxant reversal. • Residual anesthesia 	<ul style="list-style-type: none"> • Patient's stimulation wake him up. • Suction. • Oral Airway. if he is completely unconscious because if he was conscious he will gag • Nasal Airway. if he's awake <p>Others: If saturation is not improving go for invasive:</p> <ul style="list-style-type: none"> • Tracheal intubation. • Cricothyroidotomy • Tracheotomy 								
Hypoventilation	<p>Residual anesthesia:</p> <ul style="list-style-type: none"> • Narcotics. • Inhalation agent. • Muscle Relaxant <p>Post-op Analgesia :</p> <ul style="list-style-type: none"> • Intravenous • Epidural. 	<ul style="list-style-type: none"> • Close observation. • Assess the problem. <p>Treatment of the cause: Reverse (or Antidote):</p> <ul style="list-style-type: none"> • Muscle relaxant → Neostigmine <small>Nowadays we have sugammadex for rocuronium .</small> • Opioids → Naloxone <p><small>You have to remember that when you reverse the opioid the pain will come back, so you have to take care.</small></p> <ul style="list-style-type: none"> • Midazolam → Anexate 								
	<p>Figure 34.2 Hazards of postoperative hypoxaemia</p>  <table border="1"> <thead> <tr> <th>Hazards</th> <th>Consequences</th> </tr> </thead> <tbody> <tr> <td>CNS</td> <td> <ul style="list-style-type: none"> • Cerebral ischaemia • Confusion • Postoperative cognitive dysfunction (see Chapter 28) </td> </tr> <tr> <td>CVS</td> <td> <ul style="list-style-type: none"> • Myocardial ischaemia and infarction • Arrhythmias </td> </tr> <tr> <td>Other</td> <td> <ul style="list-style-type: none"> • Reduced wound healing • Increased postoperative infections • ? Anastomotic breakdown • ? Bacterial translocation across bowel wall leading to sepsis </td> </tr> </tbody> </table>	Hazards	Consequences	CNS	<ul style="list-style-type: none"> • Cerebral ischaemia • Confusion • Postoperative cognitive dysfunction (see Chapter 28) 	CVS	<ul style="list-style-type: none"> • Myocardial ischaemia and infarction • Arrhythmias 	Other	<ul style="list-style-type: none"> • Reduced wound healing • Increased postoperative infections • ? Anastomotic breakdown • ? Bacterial translocation across bowel wall leading to sepsis 	<p>Figure 34.3 Venturi effect</p>  <p>Air entrainment occurs at this narrowed point as the velocity of the gas increases so the gas pressure falls</p>
Hazards	Consequences									
CNS	<ul style="list-style-type: none"> • Cerebral ischaemia • Confusion • Postoperative cognitive dysfunction (see Chapter 28) 									
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Other	<ul style="list-style-type: none"> • Reduced wound healing • Increased postoperative infections • ? Anastomotic breakdown • ? Bacterial translocation across bowel wall leading to sepsis 									
Hypertension	<ul style="list-style-type: none"> • Common causes: Pain <small>If you relieve the pain, the BP will be normal,</small> • Full Bladder. • Hypertensive patients. • Fluid overload. • Excessive use of vasopressors. 	<ul style="list-style-type: none"> • Effective pain control. • Sedation • Anti-hypertensives: Beta blockers, Alpha blockers, Hydralazine (Apresoline), Calcium channel blockers. 								
Hypotension	<ul style="list-style-type: none"> • Decreased venous return • Hypovolemia : ↓ fluid intake / ↑ losses / Bleeding. • Sympathectomy. • 3rd space loss. In major laparotomy surgery • Left ventricular dysfunction. 	<p>Patients will require i.v. fluids until they are able to drink normally</p> <ul style="list-style-type: none"> - maintenance and intraoperative fluid losses; - replacement of pre-existing losses (e.g. dehydration preoperatively); - replacement of postoperative losses (e.g. nasogastric losses, bleeding). <p>types of fluid:</p> <ul style="list-style-type: none"> - isotonic crystalloid (most often used); - colloids (for maintaining intravascular volume, early bleeding); - blood and blood products (for significant haemorrhage, coagulopathy). 								

Post Anesthesia Care Unit (PACU)

Common PACU problems:

	Causes	Treatment
Dysrhythmia	Secondary to: Hypoxemia., Hypercarbia ,Hypothermia, Acidosis, Catecholamines, Electrolyte abnormalities (K+, Ca++)	<ul style="list-style-type: none"> ● Identify and treat the cause. ● Assure oxygenation. ● Pharmacological (stable) ● Electrical cardioversion (unstable)
Oliguria	<ul style="list-style-type: none"> ● Hypovolemia. ● Surgical trauma. ● Impaired renal function. ● Mechanical blocking of catheter. ● Stress will result in increase release of ADH 	<ul style="list-style-type: none"> ● Assess catheter patency ● Fluid bolus. ● Diuretics e.g. Lasix
	<ul style="list-style-type: none"> ● Usually Surgical Problem ● Coagulopathy ● Drug induced 	<ul style="list-style-type: none"> ● Start i.v. lines push fluids ● Blood sample: CBC, Cross matching, Coagulopathy ● Notify the surgeon ● Correction of the cause
Hypothermia	<ul style="list-style-type: none"> ● It's a Minor complication ● Most of patients will arrive cold ● Age ● Cold room & Duration of surgery 	<ul style="list-style-type: none"> ● Get baseline temperature ● Actively rewarm ● Administer oxygen if shivering ● Because O2 consumption will increase and the patient will become hypoxic ● Take care for: Pediatric, Geriatric.
	<ul style="list-style-type: none"> ● Reaction to drugs: (Drugs e.g. sedatives, anticholinergics) Intoxication / Drug abusers ● Pain ● Full bladder ● Hypoventilation ● Low COP ● CVA 	<ul style="list-style-type: none"> ● Reassurances, ● Always protect the patient From injuring himself ● Evaluate the cause ● Treatment of symptoms ● Sedatives / Opioids if necessary.
Delayed Recovery	<ul style="list-style-type: none"> ● The most common cause: Residual anesthesia, Consider reversal ● Hypothermia ● Metabolic e.g. diabetic coma, ● Underlying psychiatric problem ● CVA 	Systematic evaluation <ul style="list-style-type: none"> ● Pre-op status ● Intraoperative events ● Ventilation ● Response to Stimulation ● Cardiovascular status

Post Anesthesia Care Unit (PACU)

Common PACU problems:

Postoperative Nausea & Vomiting "PONV"

Risk factors

- Type & duration of surgery
- Type of anesthesia (morphine)
- Drugs
- Hormone levels
- Medical problems
- Autonomic involvement

Prevention

- NPO status
- Dexamethasone
- Droperidol
- Metoclopramide
- H2 blockers
- Ondansetron
- Acupuncture

Postoperative Pain

Causes

- Incisional: Skin and subcutaneous tissue
- Laparoscopy: Insufflation of Co2
- Others:
 - Deep: cutting, coagulation, trauma
 - Positional: nerve compression, traction & bed sore.
 - IV site: needle trauma, extravasation, venous irritation
 - Tubes: drains, nasogastric tube, ETT
 - Surgical: complication of surgery
 - Others: cast, dressing too tight, urinary retention

Common methods of administering analgesics

Analgesic	Method
Opioids	i.m., i.v. (PCA), epidural/spinal, oral, intra-articular
Paracetamol	i.v. and oral (rarely p.r.)
NSAIDs	Oral, p.r., i.v.
Local anaesthetic	Wound, epidural/spinal, various nerve blocks. Intra-articular

Drugs used for multimodal analgesia

Drug	Side effects
Opioids	See Figure 34.1
NSAIDs	<ul style="list-style-type: none"> • Bleeding, especially gastrointestinal • Gastrointestinal perforation • Asthma, renal failure • Myocardial and cerebral thrombosis
Paracetamol	• Liver dysfunction in overdose
Local anaesthetics	• Cardiac and CNS toxicity

Referral to high dependency unit/intensive care unit

Level of care	
0 (ward)	Patients needs met on normal ward
1 (HDU)	Patients at risk of their condition deteriorating, or who require advice from the ICU team
2 (ICU)	Patients with a single failing organ system or requiring detailed observation/intervention
3 (ICU)	Patients requiring ventilation (alone), advanced respiratory support alone or support of at least two organ systems

439 Lecture Quiz

Question 1: A young ASA1 patient underwent an elective abdominal hysterectomy under general anaesthesia with endotracheal intubation. She had no history of acid reflux. Soon after extubation, the patient developed severe laryngospasm which responded to intravenous propofol and CPAP via a face mask. Despite having a clear upper airway, she remained breathless with an oxygen saturation of 90% whilst breathing 100% oxygen via a face mask. The oxygenation improved over a period of 2 hours following the use of CPAP and diuretic treatment. The most likely diagnosis in this patient is:

- A. Aspiration pneumonia.
- B. Negative pressure pulmonary oedema.
- C. Bronchial asthma.
- D. Fluid overload.
- E. Congestive cardiac failure.

Question 2: A 2-year-old child is brought to the emergency department with acute onset of respiratory distress, cough and stridor. The chest appears hyperinflated on the right side with reduced movements and breath sounds. The child is irritable with an oxygen saturation of 90% on air and a heart rate of 120/minute. What is the most likely diagnosis?

- A. Acute severe asthma.
- B. Acute epiglottitis.
- C. Aspiration pneumonia.
- D. Foreign body aspiration.
- E. Anaphylaxis.

Question 3: An anaesthetist administers 10 ml of 0.5% bupivacaine as part of an epidural top-up for a Caesarean section. One minute after completing the injection, the patient complains of dizziness, difficulty in breathing and then starts to convulse. She then suffers a VF cardiac arrest. The most appropriate management in the first 4 minutes would be:

- A. Defibrillation, CPR, adrenaline, amiodarone.
- B. Defibrillation, CPR, adrenaline, Caesarean section.
- C. CPR, adrenaline, 20% Intralipid, Caesarean section.
- D. CPR, defibrillation, 20% Intralipid, Caesarean section.
- E. CPR, defibrillation, adrenaline, 20% Intralipid.

Question 4: A 67-year-old patient has had a total knee replacement. He is on morphine PCA for the management of postoperative pain. He has received a total of 40 mg morphine in the recovery area and you are worried that he may develop an opioid overdose. Which of the following is the earliest sign of opioid overdose?

- A. Respiratory rate less than 8 per minute.
- B. A fall in oxygen saturation.
- C. Rapid shallow breathing.
- D. Progressive rise in sedation level.
- E. Uncontrolled vomiting.

441 Notes:

In anesthetic emergencies, the ABCDs guide us to action. Any abnormalities in the ABCDs demand immediate investigation.

Aspiration

- **Pathophysiology:**
 - When the patient becomes unconscious, all reflexes are lost, and sphincters will loosen, allowing stomach contents to regurgitate.
 - What happens after aspiration? Bronchospasm, wheezing, hypoxia, and compensatory tachycardia.
 - High airway pressure means that you need to ventilate at a higher pressure (positive end-expiratory pressure “PEEP”).
 - Aspiration is usually in the right side because the right bronchus is short and more straight.
- **Patients at risk:**
 - **Patient not fasting properly: must give clear instructions on when to fast and what to avoid,** particularly mothers who are breastfeeding, you should instruct the mother to not feed the baby any milk whether breast milk or formula for at least 4-6 hours before the operation. If patient is not fasting, you may try to empty the stomach using different maneuvers or postpone the operation.
 - Delayed gastric emptying (e.g. due to anxiety, diabetic autonomic neuropathy)
- **X-ray:** will show ground-glass appearance of the lungs
- **Management:**
 - 100% oxygen
 - 30° Head-down tilt (so that gravity brings out the secretions)
 - Suction

Air embolism

- It is introduction of air into the circulating system, which could be venous or arterial.
- In arterial air embolism, air can go to the brain or heart.
- Air embolism usually happens when the head is up and the venous pressure is zero relative to the lower limbs, so when you put a needle air will pass into the circulation. That’s why we favor to position the patient with the head down during central line insertion.
- Some surgeries have higher chance of air embolism, such as neurosurgery, c-section, and procedures performed in the sitting position.
- **S&S: CO₂ will drop** because blood will not go to the lungs and no gas exchange will happen.
- **Dx: best is echocardiography**, where you will see the bubbles inside the heart.
- **Tx:** place pt in lateral position, insert a central line, go to the right atrium and try to suck air, supportive Tx (for hypotension, hypoxia)

Laryngospasm

- Can happen when the airway is manipulated while the patient is not appropriately anesthetized.
- **Tx of partial laryngospasm** → 100% oxygen and CPAP.
- **Tx of complete laryngospasm** → put patient in deep anesthesia or give muscle relaxant.

Anaphylaxis

- A hypersensitivity reaction that happens with the second exposure to an antigen (after Ab formation).
- **Tx:** stop the triggering drug, definitive Tx is epinephrine.

441 Notes:

Malignant hyperthermia

- Malignant hyperthermia is a condition that occurs exclusively during anesthesia, often triggered by the use of succinylcholine (a muscle relaxant).
- It is caused by impaired reuptake of Ca, which leads to accumulation of Ca → muscle spasm → high metabolic rate → high O₂ consumption and high CO₂.
- **What is the earliest sign of malignant hyperthermia? Hypercapnia (the most important)**, shows up even before tachycardia and muscle rigidity.
- **S&S are important to remember.**
- What is the definitive treatment? Dantrolene (↓ Ca release) give as an infusion not only a single dose.
- Patient must be transferred to the ICU.

Failed intubation

A systemic approach is used to manage difficult airway:

- **Plan A:** senior residents skilled in intubation should make **3 attempts**. If unsuccessful, consider making slight adjustments, such as changing position or using a laryngoscope with smaller or larger blades, or using a bougie, which aids in the passage of the ET tube. It is important to stop after 3 attempts and ensure that oxygen saturation remains above 90%.
- **Plan B: LMA (a life saver).**
- **Plan C:** awaken the patient, postpone the surgery, and develop a plan on how to manage (e.g. awake intubation with the assist of fiberoptic laryngoscope or bronchoscope)
- **Plan D:** surgical options (cricothyrotomy or tracheostomy)
- In cases where difficult intubation is anticipated, we may perform **awake intubation**, where the patient remains awake during the procedure, and local anesthesia is administered to numb the airway. The ET tube is then carefully placed under direct visualization with the assistance of a fiberoptic laryngoscope.

Common problems in the PACU

1. **Airway obstruction: the most common problem.** It occurs when the tongue falls back. Tx is chin lift and instruct the patient to stay awake and keep breathing on lateral decubitus position. In cases where the patient is semiconscious, consider using nasopharyngeal airway to maintain an open airway. Oropharyngeal airways should only be used in a deeply unresponsive patient who is unable to maintain his or her airway.
2. **Hypoxemia & hypoventilation:** check for proper reversal of muscle relaxants, including correct dosing and timing. Look for signs of overdose (e.g. pinpoint pupils in opioid overdose) and give antidotes (e.g. naloxone for opioids).
3. **Hypotension:** evaluate the amount of fluid administered and the drugs given. Most drugs cause vasodilation, except for ketamine.
4. **Dysrhythmias**
5. **Hypothermia:** a common problem. Temperature must be monitored in any surgery lasting 2 hours or longer, and IV fluids are warmed before they are sent
6. **Bleeding:** signs of bleeding include hypotension, tachycardia, paleness due to hemoglobin loss, and filling up of drains. Look out for collections or hematomas.
7. **Agitation**
8. **Delayed recovery:** can be due to incomplete cessation of anesthesia or other reasons, such as post-neurosurgery stroke. Consider transferring the patient to the ICU for further management.
9. **Post-OP NV:** especially in women. Minimize the use of opioids and consider other drugs like ketamine.
10. **Oliguria:** usually due to a prerenal problem caused by inadequate fluid administration.



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