# Safety in anesthesia

Objectives

- Risk of anesthesia
- Complication of anesthesia
- How to implement anesthesia safety in OR
- Error related to complication
- Factors threatening patient safety in the operation rooms
- General safety strategies
- Quality assurance
- Crucial errors to know and avoid
- Postoperative pain management
- Hypothermia sequences

Important - Golden Note - 436 Notes - Notes

# Anesthesiology

Anesthesiology is a high-risk specialty as compared with other specialties in medicine so you should always be prepared for complications and have plan A, plan B, and plan C ready.

# Risk of anesthesia

- Anesthesia may contribute to death in about 1 per 10,000 (in developed countries), to 1 per 200.000 anesthetics (in highly civilized countries).
- Some patients suffer serious and costly nonfatal injuries (affecting quality of life) such as permanent neurologic damage (paraplegia and vegetative state), a major complication is "hypoxic encephalopathy".

## Complications of anesthesia

| Major Complications | Minor complications |
|---|---|
| – **Cardiac arrest** in severe anaphylactic reaction & hypoxia & hx of MI. So we need to keep all alarms on and intervene immediately if anything goes wrong. (if pt has bradycardia check BP and identify source)<br>– **Perioperative MI**<br>– **Aspiration** prevented by fasting for 6-8h for adult. For neonate 6h & for breastfeeding 4h without water & 2h without milk.<br>– **Anaphylaxis** happens with antibiotics. Or prev hx of latex allergy or pt with other types of allergies like asthma. When u have pt with desaturation, bradycardia/tachycardia & hypotension, u have to stop every medication running.<br>– **Drug overdose**. Don't push the medication.<br>– **Convulsion** happens in induction & recovery. So u have to expect it in pt with epilepsy & give them midazolam & mild analgesic agent before they're shifting to recovery room.<br>– **Nerve palsy** during positioning of the pt.<br>– **Organ injury**<br>– **Malignant hyperthermia.** Drug-induced-hypothermia like suxamethonium. Should be avoided in pt of family hx of hypothermia & muscle dystrophy. | **– Airway Obstruction**<br>**-Postop nausea, vomiting f**asting & antiemetic medication. In the preop assessment we ask the pt if he had problems with N/V in prev surgeries and if yes we should give multimodal antiemetic + hydrate pt + and avoid medications causing N/V like morphine.<br>– **Sore throat**, due to intubation so we try to be gentle.<br>– **Hemodynamic instability** in pts w/ comorbidities we have to titrate medications and keep vasopressors ready<br>– **Pneumonia**. Due to aspiration so pt should fast 6 - 8 hours.<br>– **Delirium** advice regional than general anesthesia in cases of eldery.<br>– **Shivering** we need to warm the pt properly using fluid warmers, blankets, etc.<br>**- Organ Dysfunction (kidney, liver)**<br>– **Cognitive defect** pre-existing dementia will be exaggerated. |

## 10 common causes of cardiac arrest under anaesthesia

- Drug overdose/ adverse reaction (so we should check the dose & concentration of the drugs and titrate meds).
- Rhythm disturbances (Arrhythmias) (if the pt has a previous history of arrhythmia we have to continue medication, and maintain electrolytes and avoid hypokalemia).
- Peri-op MI (if a pt had a recent MI we should **postpone** elective surgery for **6 months**!)
- Airway obstruction
- High spinal, you put the epidural catheter, suddenly the pt starts to have **bradycardia & hypotension** & non responding > the catheter migrated intrathecally. Titrating the dose is imp in both epidural or I.V anesthesia. (Exam Q: bradycardia + hypotension = high spinal block. IF tachycardia + hypotension = hypovolemia)
- Lack of vigilance (we need to stay close to the monitors and keep all the alarms on)
- Bleeding you have to prepare early for bleeding and treat it vigorously, ex: if the surgeon tells you during laparoscopic nephrectomy he cut the IVC, you have to expect huge bleeding, ask the surgeon to convert to laparotomy, and you have to call for blood, put an arterial line and be ready for a massive blood transfusion.
- Aspiration in ER cases, in case you anesthetized the pt & about to start the intubation but you found parts of food in his mouth, first put his head down > suction > intubate > suction inside the tube > start ventilating the pt.
- Technical Problem in Anesthesia Machine

➔ Anesthesia event can cause severe results

➔ We should find out factors threatening patient safety in the operation room and search for strategies to deal with them

## How to implement anesthesia safety in OR

- Standardization drug dosage, dosing units, concentration , drugs preparation methods workplace design.
- Technology: drug identification (by color coding or barcode) and delivery system, utilization automated information system
- Safety features of anesthesia machine
- Pharmacy: dedicate pharmacy resource to the OR. (for when we want to use medication not available in the OR like electrolytes or cardiac medication, the pharmacist will check the medication then the nurse then we will check it so less likely for an error to occur)
- Culture: speak out! recognize and report the errors, learn from adverse events www.apsf.org

## Factors threatening patient safety in the operation rooms:

➔ Equipment Causes: Design flaw, User error, Malfunction.

➔ Strategies: pre-use checkout/checkup. (ONLY prepare agents you will use!)

- When to Check resources? Before starting Anaesthesia

➔ Patient :

Causes Underlying diseases:

- Hyperthyroidism-thyroid storm, diabetes-ketoacidosis[1], hyperosmolar coma
- Allergic reaction to some drugs.

Strategies:

- Preoperative evaluations

## Pre-anesthesia Check

- ➔ Check patient risk factor: ASA 1,2,3,4,5, e in case of emergency
- ➔ Airway assessment
- ➔ Aspiration risk
- ➔ Allergies
- ➔ Abnormal investigation
- ➔ Comorbidity
- ➔ Medication
- ➔ Formulate anesthesia plan

**Causes of Accidents: There is rarely a single cause for an accident (multifactorial).**

## Error related to complication

| **System error** Related to hospital setup | **Human** or Personal **error** |
|---|---|
| – Equipment failure<br>– Limitation of therapeutic standard<br>– Limitation of available resources<br><br>**System failures are the main reason for accidents**<br>– check anesthetic machine<br>– oxygen supply<br>– A backup O2 tank mandatory.<br>– Never shut down audible alarms (very important)<br><br>**Emergency ventilation equipment**<br>Ambu bag should be available all the time. | – Limitation of supervision. This error on the consultant when she allows the residents start on their own.<br>– Communication error (most common cause)<br>– Technical accident ex: if you are giving epidural and the catheter enters intrathecal.<br><br>**Human error contributes to 70 – 80 % of anesthetic incidents**<br>**Human error may involve:**<br>– Misjudgments<br>– Failure to check equipment's<br>– Fault with technique<br>– Communication problem |



[1] If a pregnant lady presented w/ fetal distress going for emergency C/S and you put the tube and find she has low end tidal CO2 ⟶ do blood gas you will find that the pt is severely acidotic & was hyperventilating.

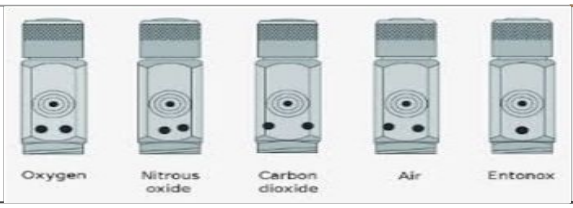
## Human error (anesthesia and surgeon)

- Anesthetist and Surgeon Human factors affecting performance such as :
  - fatigue, noise, boredom, long hours, hunger, tension
- Human error is a strong contributor
  - Deviations from accepted anesthesia practices.
  - A lapse in vigilance and no attention to details.
  - **Vigilance** lets anesthetists find abnormal signs as early as possible.
  - Vigilance allows the anesthetist to remain aware of surrounding events and signals while performing other tasks.
  - Vigilance lets anesthetist find abnormal sign as early as possible.
- Safety anesthesia workstation. https://youtu.be/tFZHiFDtPCY

## Safety feature of anesthesia machine. important, you will see it in every exam

### 1. Pin index safety system.

Each opening is different and will only connect to specific type of cylinder; just like a key and lock so the oxygen cylinder will only connect to oxygen socket and not to nitrous oxide.



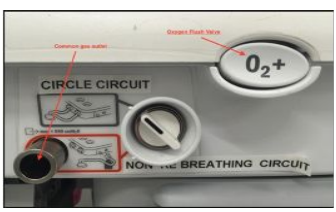

### 2. Diametre index safety system

### 3. Flowmeters

- Flow delivered through the anesthetic machine is displayed by a bobbin within a rotameter to allow accurate gas delivery. It should be rotating, not fixed.
- Hypoxic guard
  The O2 and N2O control knobs are linked, preventing <25% O2 being delivered when N2O is used. If N2o flowmeter is open then O2 flowmeter opens automatically. So N2O cannot be given alone.
- Oxygen is delivered distal to N2O within the rotameter, preventing hypoxic gas delivery if the O2 rotameter is faulty or cracked.

### 4. Emergency oxygen flush

When pressed, oxygen bypasses the back bar and is delivered to the CGO (common gas outlet) at >35 L/min.
Manual outlet for anesthesia circuit, used when anesthesia machine shut down.




### 5. Suction

Adjustable negative-pressure generated suction is used to clear airway secretions/vomit and must be available for all cases

| Ventilator Alarms Memorize it. | | |
|---|---|---|
| **Alarm** | **Definition** | **Potential cause** |
| **1. High pressure** | Pressure required to ventilate exceeds preset pressure. | Pneumothorax[2], excessive secretions, decreased lung compliance. |
| **2. Low pressure** | Resistance to inspiratory flow is less than preset pressure. | Disconnected from ventilator, break in circuit. |
| **3. Low exhaled volume** | Exhaled tidal volume drops below preset amount. | Leak in system, increased airway resistance, decreased lung compliance. |
| **4. Rate /apnea** | Respiratory rate drops below preset level. Apnea period exceeds set time. | Client fatigue, decreased RR due to medication (you give pt medication and keep him breathing spontaneously). |
| **5. FIO2** | Indicates FIO2 drift from preset range. | Change in level of consciousness, disconnected from O2 source, break in circuit. |

# Scavenging System

gas comes out of the pt with anesthesia gases. Everyone's in the OR will fall asleep if these gases weren't transferred out the OR.

- Scavenging of vented anaesthetic gases is active, passive or a combination.
- Scavenged gases are usually vented to the atmosphere.
- Scavenging tubing has a wider bore (30mm), preventing accidental connection to breathing circuits.

# General Safety Strategies

**A. Prepare a preoperative plan**

- Preoperative visit to the patient to let us know the patient's condition in detail
- Make an anesthesia plan to let us know how to perform the anesthesia and how to deal with possible crisis

**B. Develop situational awareness**

➔ Use a systematic approach to scanning the machine, monitors, patient, surgical field, and surroundings

➔ If one vital sign is anomalous, quickly assess the others (urine output, heart rate) while repeating the measurement and observing what is happening on the surgical field.

[2] Trauma pt undergoing surgery, you intubate and find high pressure alarm, O2 saturation will drop, bradycardia, auscultate and no breath sounds so he has pneumothorax. How to treat? (Exam Q) for emergency we put needle (aspirate) in 2nd intercostal space.

**C. Verify observations, Cross-check observations, Assess co varying variables**

Review it with a second person.

**D. Implement compensatory responses If something wrong happens urgently,**

First implementing time-buying measures then look for cause. e.g( increase the fraction of inspired oxygen when oxygen saturation falls; administer intravenous fluids or vasopressors when hypotension occurs).

➔ Then search out any correctable primary cause and treat it appropriately

**E. Prepare for crisis**

In case any critical events happened (cardiac arrest, malignant hyperthermia or difficult intubation), call for help early. 1st

➔ then use accepted protocols for emergencies and resuscitation (e.g., advanced cardiac life support, malignant hyperthermia protocols).

**F. Enhance teamwork;**

➔ Enhance teamwork communication, address surgeons and nurses early in the case by names.

➔ Make requests and delegate tasks clearly and specifically by name (e.g., "Jack, do task X and tell me when task X is completed."). Closed loop communication is mandatory.

**G. Compensate for stressors (Anesthesia is a stressful job).**

If you feel very tired, ask for a relief. Reduce various stressors: noise, fatigue, interpersonal tension, etc. optimize the work environment

**I. Learn from close calls Every mistake is an opportunity to learn and Improve.**

Analysis and feedback of adverse events to identify and assess system problems. Don't be ashamed of your mistakes but learn from them.Document and discuss.

## Quality Assurance

The aim is to improve the quality of care and minimizing the risk of injury from anesthesia.

**A. Documentation** Any adverse events should be reported truthfully, discussed, analyzed to identify causes and assess system problems. So we can learn from them and develop patterns to prevent recurrence.

**B. Standards and guidelines**: Anesthetists should be aware of their institution's safety policies and procedures. These should include those for monitoring, response to an adverse event, handoff checklist, resuscitation protocols, perioperative testing, and any special procedures or practices for the use of drugs, equipment, and supplies.

**C. Safety training Anesthesia providers:**

- Should obtain training in safety to learn and maintain basic skills.
- Simulation based training techniques.

# Crucial Errors to Know and Avoid

| A. Airway errors | B. Medication errors. | C. Procedure errors |
|---|---|---|
| Patients receiving general anesthesia have no spontaneous respiration due to use of muscle relaxants, their respiration is controlled by machine via endo-tracheal tube.<br>- So we must ensure oxygen supply and avoid accidental extubation during surgeries (prone surgery) and transport.<br>- Once it happens, It can cause severe hypoxia and directly threaten the patient's life.<br><br>Exam Q: how to know if there is circuit disconnection? End tidal CO2! | Examples:<br>– Administration of undiluted potassium by rapid intravenous infusion can cause ventricular fibrillation and cardiac arrest.<br>– Neostigmine given without an antimuscarinic drug can cause asystole, severe bradycardia and atrioventricular block and can be fatal.<br>Exam Q: neostigmine should be given with? Atropine or glycopyrrolate<br>– Succinylcholine can cause severe hyperkalemia and dysrhythmias, may trigger malignant hyperthermia.<br>– Medications to which a patient is allergic can cause anaphylaxis[1].<br>– Administering the wrong blood can cause an incompatibility reaction that can be fatal.<br>What are the sign & symptoms of acute hemolytic reaction? Hypotension, tachycardia, oozing in surgical site, flank pain, N/V, dark urine. To avoid we should double check blood products before giving. | • Inadvertent intravascular injection of local anesthetics during a nerve block can cause neurologic and cardiac toxicity.<br>• Avoid epidural hematoma (Hx of coagulopathy)<br>• Air embolism:with insertion or removal of central line. To avoid it we do head down position when you're inserting the central line or removing it. |
| **How to avoid it:**<br>Check the system and guarantee it to function well<br>• Verify the position of endotracheal tube by auscultation for breath sounds bilaterally and detecting ETCO2 with proper fixation<br>• Closely observe the vital signs<br>• Be careful when position the patient in prone position because accidental extubation may occur esp in kids, so what to do to maintain ventilation? LMA. | **How to avoid it:**<br>• Be Familiar with the medication you use<br>• Know clearly its indications and contraindications.<br>• Administer the medication strictly according to instructions & guidelines.<br>• Know the patient's history of allergy<br>• Cross-check blood type.<br>• All electrolyte concentrate should be stored out OR<br>• Label high alert medication and keep it isolated from routinely used medication. | **How to avoid it:**<br>• Adequate preoperative evaluation<br>• Follow standards guidelines<br>• Vigilance |

[1] Some pts are more prone: hx of allergy, asthma, allergic rhinitis, etc. they may develop allergy to latex, so we should perform latex free procedure. Also to minimize anaphylactic reactions we should titrate medication and give it slowly so that we can recognise the symptoms and act quickly, but if we give a medication fast there will be faster release of histamine

# Medications

- ➔ Human error: most common
- ➔ All drugs should be clearly labelled; cross check before administering.

## Basic medication safety


- ➔ Label all syringes
- ➔ Eliminate look like ampoules
- ➔ Read label before administration
- ➔ Distinctive drug labels
- ➔ Color coding
- ➔ Barcoding

# Standards and protocols

- ➔ Standards for basic anesthetic monitoring:

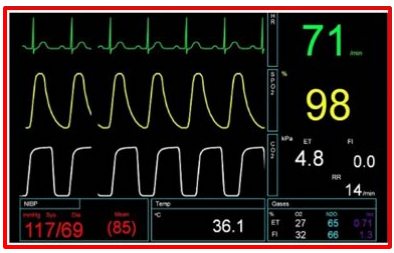
1- Qualified anesthesia personnel should be present in the room throughout the course of all general anesthetics, regional anesthetics, and monitored anesthesia care

2-Continually evaluate the patient's respiration, circulation and temperature.

## Standard monitoring recommended by ASA

ASA standard monitor (**IMPORTANT**):

1. ECG
2. Oxygen saturation
3. End tidal CO2
4. Blood pressure
5. Temperature




# Guidelines for action after an adverse anesthesia event

The anesthesiologist involved in an adverse event **should do the following:**

1. Provide for continuing care of the patient.
2. Notify the anesthesia operating room administrator as soon as possible If a resident or certified registered nurse anesthetist was involved in the event. she/he should notify the attending staff.
3. Don't discard supplies or tamper with equipment so we can determine cause.
4. Document events in the patient record (including the serial number of the anesthesia machine).
5. Stay involved with the follow-up care.
6. Contact Consultants
7. Submit a follow-up report to the department quality assurance committee.
8. Document continuing care in the patient's record.

## Post-operative pain

try to give analgesics without opioids.

• Multimodal analgesia (we give paracetamol, NSAIDs, anti inflammatory medication, neuraxial block, regional block, and opioids)
• Preemptive analgesia (reduce sensitization of pain receptors to neurotransmitters).
• Greater use of regional anesthesia technique than general to maintain opioid free analgesia.
• Regular analgesia technique not PRN. PRN=when necessary, in total hip replacement u give analgesia in regular basis even though he's not complaining cause if u administer it after complaining of pain the drugs won't do any better.
• Identify problematic patient and formulate a management plan.

## Why opioid free analgesia? Because opioids lead to

• Addiction
• PONV, delay of start feeding
• Bladder bowel function (constipation, paralytic ileus)
• Sedation delay mobilization, patient discharge.
• Pulmonary complication.
• Immuno-suppressive effects infection cancer recurrent /mets
• Inadequate analgesia persistence post-op pain into chronic pain. So giving operatively analgesia/ multimodal/ peripheral plexus block are more advisable than opioids.

## Hypothermia: perioperative morbidity/mortality

**Consequences of hypothermia**

- Shivering/oxygen requirement increased: myocardial oxygen supply / demand
- Infection: Directly depress immune function, Vasoconstriction reduced tissue oxygen- predispose to infection
- Delay wound healing
- Bleeding / transfusion: Depressed platelet and coagulation
- Depressed Cardiac function and risk for arrhythmias
- Delay recovery from anesthesia & extubation should be delayed till the pt is fully awake.

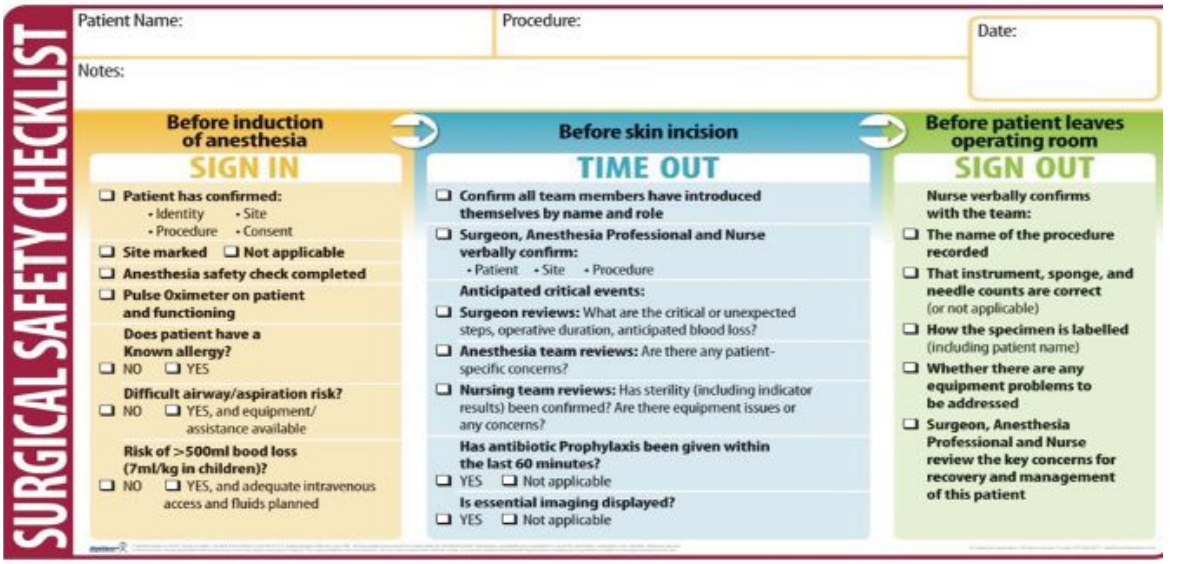
## Postoperative Infection-Anesthetic role

• Antibiotic prophylaxis before one hour of skin incision.
• Avoid hypothermia warm the pt.
• Hand hygiene
• Aseptic precautions for invasive procedures
• Fluid balance (don't overload the pt ⟶ may cause tissue edema and delay healing and predispose to infection), blood transfusion
• Oxygen –avoiding hypoxia/hyperoxia cuz hypoxia induce lactic acidosis> anaerobic metabolism> enhance the infection.

The goal is to provide highest standard of care and safety any setting

International Task Force on Anaesthesia Safety

Approved by: In World Federation of Societies of Anaesthesiologists (WFSA)




# Practice Questions:

**Q1)** A 25 year old patient, intraoperatively, the patient became tachycardic, decreased O2, temperature increased to 113F. The anesthesiologist identified it as Malignant Hyperthermia. Which of the following was given to the pt to *trigger* it?

A) Sevoflurane
B) Amiodarone
C) Dantrolene
D) Lidocaine

**Q2)** Which is the most common human/personal error that causes accidents in anesthesia ?

A) Technical accident
B) Communication error
C) Limitation of supervision
D) Equipment failure

**Q3)**You're operating on a trauma patient, once you intubated him the high pressure alarm goes off, which is the most likely cause in this case?

A) The preset pressure is too low
B) Pneumothorax
C) Ventilator malfunction
D) Circuit problems

**Q4)** In safety features of anesthesia machine, the pin index system is used to prevent which of the following?

A) Incorrect connection of gas pipeline to the machine inlet
B) The incorrect cylinder connection
C) Barotrauma
D) Mixing of two inhalational anesthesia agents

Q1 : A | Q2 : B | Q3 : B | Q4 :B

# Thank You

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Special thank you to 436
team