Anaesthesia

Edition 8.5

Marrow

MARROW

Instructions

- Notes are to be used in conjunction with Marrow videos.

Please note:

- The information in this book has been printed based on the transcript of the Marrow videos. This book has to be used in conjunction with the Marrow videos and not as a standalone material.
- The information contained in this book is for educational purposes only. The content provided is not intended to substitute for professional medical advice, diagnosis or treatment.
- This book cannot be sold separately. It has been made available to only select eligible users who have an active subscription to Marrow videos.
- The text, images, slides, and other materials used in this book have been contributed by the faculty, who are subject matter experts. We have merely reproduced them as video transcripts in this book.
- The notes have been consciously designed in a way that is concise and revisable. To ensure this, we have intentionally added only the most relevant modules and images that are needed for you.
- Reasonable care has been taken to ensure the accuracy of the information provided in this book. Neither the faculty nor Marrow takes any responsibility for any liability or damages resulting from applying the information provided in this book.

All Rights Reserved

No part of this publication shall be reproduced, copied, transmitted, adapted, modified or stored in any form or by any means, electronic, photocopying, recording or otherwise.

©Marrow

//ME901-MPTL

Contents

Anaesthesia

Pre Anaesthetic Checkup : Part 1 1

Past medical history

Pre Anaesthetic Checkup : Part 2 5

Personal & family history • Allergy history • ASA grading

Pre-Operative Preparation 9

Investigations • Optimization & risk stratification • Pre medication & consent

Monitoring Under Anaesthesia : Part 1 14

Central nervous system monitoring • Cardio vascular system monitoring

Monitoring Under Anaesthesia : Part 2 20

Respiratory system monitoring • Neuromuscular monitoring • Temperature monitoring

Anaesthesia Workstation 26

Anaesthesia work station • High pressure system • Intermediate pressure system • Low pressure system

Breathing Systems 34

Open circuits & mapleson's circuits • Closed circuits

Regional Anaesthesia 40

Spinal anaesthesia

Epidural Anaesthesia 48

Epidural anaesthesia - procedure • Factors affecting epidural anaesthesia • Epidural aanesthesia - advantages & disadvantages • Caudal anaesthesia • Modifications - spinal & epidural anaesthesia

Peripheral Nerve Blocks 52

Head and neck • Upper limb • Thorax & abdomen • Lower limb

Intravenous Anaesthetics 59

Barbiturates • Non barbiturates

Inhalational Anaesthetics : Part 1 65

Classification • Mechanism of action • Factors affecting uptake of IA • Systemic effects of IA (Induction agents) - RS & CVS

Inhalational Anaesthetics : Part 2 69

Systemic effects of IA (Induction agents) - CNS, GIT & renal • Systemic effects of IA - uterus, muscular & ocular

Local Anaesthetics 74

Classification • Mechanism of action • Clinical pharmacology • Local anaesthetics - drugs

Muscle Relaxants : Part 1 81

Physiology of neuromuscular junction (NMJ) • Depolarising muscle relaxants • Non depolarising muscle relaxants (NDMR)

Muscle Relaxants : Part 2 86

Non depolarising muscle relaxants (NDMR)

Anaesthesia For Coexisting Diseases 90

CVS disease • Respiratory diseases • Neurosurgical diseases • Hepatic diseases • Renal diseases • Urological surgeries • Blood disorders • Neuromuscular disorders • Endocrine disorders

Subspecialty Management 101

Anaesthesia for bariatric surgeries • Obstetric anaesthesia • Ocular & ENT surgeries • Paediatric & orthopaedic surgeries • Anaesthesia for laparoscopic surgery • Office based & remote location anaesthesia

Malignant Hyperthermia 107

Etiology • Pathophysiology • Clinical presentation • Management

Day Care Anaesthesia 110

Introduction • Prerequisites for DCA • Anaesthetic agents • Recovery • Complications

Airway Management 116

Upper airway anatomy • Airway assessment • Steps of intubation

Anaesthesia Equipment 125

Anatomical face mask • Guedel's airway • Nasopharyngeal airway • Laryngoscope • Endotracheal tube (ETT) • Miscellaneous anaesthetic equipments • Supraglottic airway devices • Accessory gadgets • Failed intubation algorithm

Basics of Critical Care 135

Approach in casualty • Approach in ICU • Oxygen therapy • Physiology of O_2 flow & hypoxia • Indications of oxygen therapy • Techniques of O_2 administration • Device selection

Mechanical Ventilation : Part 1 144

Physiology of respiration • Positive pressure ventilation (PPV)

Mechanical Ventilation : Part 2 149

Non invasive ventilation (NIV) • Care of patient on ventilator • Indications & assessments of NIV • Ventilatory settings for obstructive & restrictive lung disease • Weaning from ventilator

BLS and ACLS 153

Basic life support (BLS) • Advanced cardiac life support (ACLS) • Adult tachyarrhythmia with pulse algorithm • Adult bradycardia with pulse algorithm • Adult post cardiac arrest care algorithm • Adult and pediatric durable LVAD algorithm • Cardiac arrest in pregnancy algorithm

PRE ANAESTHETIC CHECKUP : PART 1

----- Active space -----

Identify the problem → Optimise patient's general condition → Safely tolerate → surgery.

Components :

- History taking.
- Physical examination.
- Systemic examination.
- Airway examination.

History taking :

Factors	Components
Identification	Name, age, sex, address, ID no
medical history	Chief complaints, present history, past medical history, personal history, family history, allergy history
Surgical history	Past surgical history
Others	menstrual history, immunization history

Past Medical History

00:05:08

Hypertension :

Significance :

Anaesthesia → Sudden hypotension → Disrupted autoregulation of vital organs → Hypoperfusion of brain, kidney, heart.

Cut-off value :

BP <180/110 mmHg can be taken up for surgery.

Management :

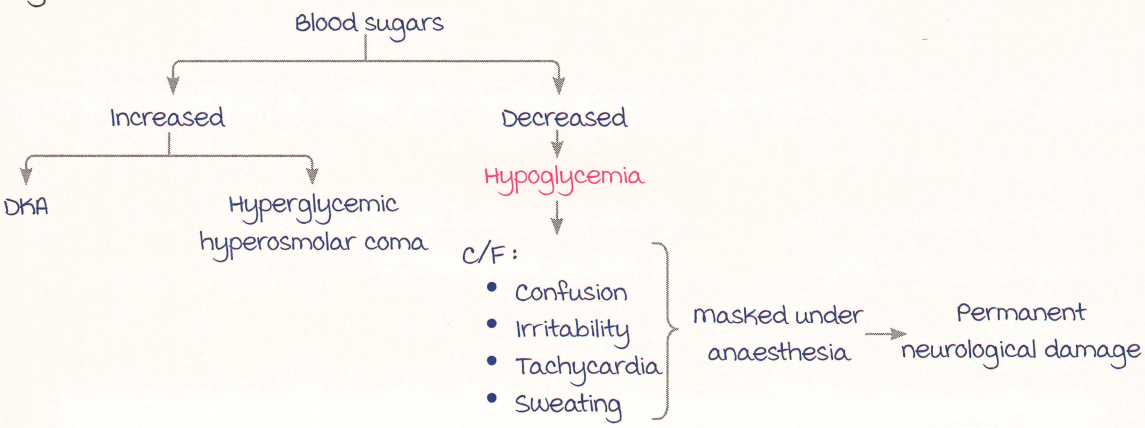
Anti-hypertensives :

- Continued till the day of surgery to prevent rebound hypertension.
- ACE inhibitors, ARBs stopped prior to surgery d/t risk of orthostatic hypotension.
- ACE inhibitors continued in minor surgeries with minimal blood loss (Ex : Cataract).

----- Active space -----

Diabetes :

Significance :



Management :

Oral hypoglycemic agents, insulin.

Drugs stopped	Drugs continued
OHA & insulin skipped on day of Sx Reason : Hypoglycemia	Long acting insulin : Dose reduced (1/3 or 1/2)
SGLT-2 inhibitors : • Stopped 24 hours prior to Sx • Stopped 72 hrs prior to intermediate/high risk Sx Reason : Euglycaemic ketoacidosis	

Intraoperative monitoring :

- Monitor blood sugars every 30 minutes.
- Short acting insulin : If blood sugars ↑.
  a. Target glucose levels : 120-200 mg/dL.
  b. Onset : 7-10 minutes.
  c. Duration : 30 minutes.

Epilepsy :

Significance : Epilepsy : Abnormal excitation of brain cells.

Falling back of tongue

↓

Hypoxia, hypercarbia, acidosis

(Precipitation agents)

↓

Subsequent episodes

↓

Status epilepticus

(Permanent neurological defect)

Management :

----- Active space -----

Evaluation :

- After the first episode of seizure :
  a. Radiological investigations.
  b. Start anti - epileptic drugs (AED) - if necessary.
- Known case of seizure on AED :
  a. Complete blood count.
  b. Liver function test.
- S/E of AED : Bone marrow suppression, leucopenia, electrolyte abnormalities, macrocytic anemia.
- AED continued till the day of surgery.

For acute seizure :

In public setting	In hospital setting
• Jaw thrust manoeuvre. • Left lateral position : If pulse (+), breathing (+).	• Call for help. • Medications. Short acting BZD (Midazolam 0.3 mg/kg) ↓ If seizure persists Phenytoin sodium (10-15 mg/kg in 100 ml NS) ↓ If seizure persists Newer AED (levetiracetam, piracetam) ↓ If seizure persists General anaesthesia + muscle relaxants

Thyroid disorders :

	Hypothyroidism	Hyperthyroidism
Significance	Hypothyroid ↓ ↓↓ basal metabolic rate	Hyperthyroidism ↓ Palpitations
Effect of anaesthesia	Delayed metabolism of drug ↓ Delayed recovery	Precipitate supraventricular arrhythmia.
Management	Thyroxine	Antithyroid drugs (Carbimazole, methimazole, propylthiouracil)
Day of surgery	Continue the drug	Continue the drug
Presentation of unprepared patient	Myxedema coma : • Severe bradycardia. • Hypotension. • Hypothermia. • Delayed recovery.	Thyroid storm : • Sudden unexplained tachycardia. • Hypertension. • Hyperthermia. • Atrial fibrillation/supraventricular tachycardia.

----- Active space -----

Psychiatric Disorders :

Continue antipsychotics till the day of surgery.

Exceptions :

- Monoamine oxidase inhibitors (MAO) stopped 2-3 weeks prior to surgery.
  - Reason : Older MAO inhibitors $\xrightarrow{\text{Interact with}}$ meperidine & ephedrine $\rightarrow$ Hypertensive crisis.
- Lithium (used in bipolar disorder)
  - Stop 24 hours prior only if short acting muscle relaxants aren't available.
  - Current guideline : Continue lithium on the day of surgery if short acting muscle relaxants (Atracurium, mivacurium) are available.

Note :

$MgSO_4^{2+}$ used in pre-eclampsia should be continued on the day of surgery (Mg^{2+} same action as lithium).

PRE ANAESTHETIC CHECKUP : PART 2

----- Active space -----

Coronary Heart Disease :

Significance :

1. Blood thinners → Aspirin / Clopidogrel
   - Stopped prior to surgery.
   - Reason : To avoid bleeding in closed cavities (Vertebral column, orbital cavity, cranial cavity) during regional anaesthesia.
   - Complications of stopping blood thinners : Re-infarction.
   - Prophylaxis :
     - Start low dose LMWH (Bridging)
       a. Duration of action : 12 hours.
       b. Stop 12 hours prior to surgery.
2. All other cardiac medications to be continued on the day of surgery.

Minimum duration for discontinuing drugs prior to regional anaesthesia :

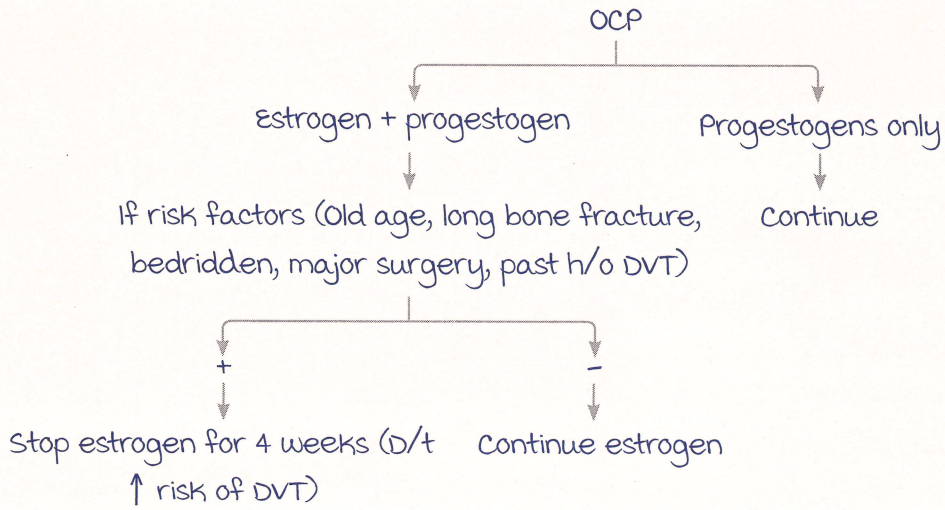
Drugs	Duration of discontinue
Aspirin	• Low dose : Continue. • High dose/risk of bleeding (+) : Stop prior 3 days.
Clopidogrel, warfarin	Prior 5–7 days
Ticagrelor	5–7 days
Prasugrel	7–10 days
Ticlopidine	10 days
Cangrelor	3 hours

Note :

- Duration of high dose LMWH : 24 hours.
- Continue all medication in topical anaesthesia.

----- Active space -----

Oral Contraceptive Pills :



Drugs	Continuation/discontinuation
Antitubercular drugs	• Continue the drug. Stopping drug → multidrug resistance. • Check LFT prior to surgery.
Steroid	• Continue the drug : Sudden stoppage → HPA axis suppression. • Additional steroid supplement. (Inj Hydrocortisone 1–2 mg/kg) Yes: If on high dose of steroid No: If dose <5 mg, duration <3 wks
Herbal medication	Check LFT Normal: Continue procedure Abnormal: Repeat after 1–2 weeks
Antiretroviral therapy	• Continue. • Check LFT, serum electrolytes, CBC. Note : Viral load >10000 CD_4 <200 → ↑ mortality.
NSAIDS	• Paracetamol : Continue. • COX inhibitors : Stop prior 24 hrs. • Stop[a] all other NSAIDS 48 hrs prior d/t ↑ chance of bleeding, renal injury.
Sildenafil (Phosphodiesterase inhibitor)	• Stop 24 hrs prior to surgery d/t severe hypotension. • Used in pulmonary artery hypertension, erectile dysfunction.
Diuretics	Except thiazide diuretics, all others are stopped.
Topical ointments	Stopped prior to surgery.

Personal & Family History

00:23:30 ----- Active space -----

Personal History :

Factors	Interaction with anaesthesia
Smoking	Stop prior 6–8 wks (minimal of 3–4 wks) Chronic smoking ↓ **Bronchospasm** • C/F : Sudden unexplained tachycardia, hypertension. • Capnography ($EtCO_2$) : Shark fin appearance. • Rx : Bronchodilators (Inhaled β_2 agonist). **Laryngospasm** (m/c in extubation) • C/F : Stridor, ↓SpO_2 (D/t sudden forceful contraction of laryngeal muscles). • Rx : 100% O_2 + Larsons manouevre Propofol 10 mg iv during extubation ↓ if uncontrolled Quick acting muscle relaxant (Succinylcholine) ↓ Intubate
Alcohol	• Hepatic microsomal inducers. • Stop prior 24–48 hrs. • Complication in post op : Acute fulminant hepatic necrosis (Rare).
Tobacco	Difficult intubation (D/t restricted mouth opening).
Breast feeding	Major Sx : Drugs secreted in breast milk ↓ Express breast milk for 24 hrs post sx Minor Sx : Short acting drugs not secreted in breast milk ↓ Continue breast feeding after 6–8 hrs
Drug addiction	• Sympathetic stimulants. • Risk of HIV infection/infective endocarditis. • Stop drug after physician consultation.

Family History :

Malignant hyperthermia.

Allergy History

00:33:53

Causes anaphylactic shock.

m/c drugs : Antibiotics > latex > muscle relaxants > local anaesthetics.

Note : Pholcodine (Cough syrup) : ↑ allergic reactions to muscle relaxants.

----- Active space -----

Pathophysiology :

Antigen + antibody
↓
Degranulation of mast cells
↓
Release of histamine

Clinical Presentation :

- Sudden unexplained tachycardia.
- Hypotension.
- Wheeze (D/t ↑ airway resistance).
- Edema of face, lips, airways.

Management :

- Adrenaline (DOC) :
  - Dosage based on route (1 ampoule = 1 mg = 1 : 1000).
  - IV = 1 ml of 1:10,000.
  - S/c or IM = 0.5 mL of 1 : 1000.

ASA Grading

00:39:39

(American Society of Anaesthesiologists Grading) :

Grade	Characteristics	Examples
I	Healthy patient	Normal BMI, non-smoker, non-alcoholic
II	Mild disease with no functional limitation	• Medical disease under control (HTN, DM, Epilepsy). • Smoker, BMI = 30–40. • Pregnancy
III	Severe disease with functional limitation	• Medical diseases with poor control (HTN, DM, Epilepsy). • CKD, CLD, COPD. • morbid obesity (BMI >40). • Chronic alcoholic, Drug abusers, Active hepatitis. • Implantable cardiac device.
IV	Severe disease with threat to life	Recent MI, CVA, unstable angina
V	Moribund patient	Ruptured aneurysm, death <24 hours
VI	Brain dead patient	-

"E" along with a grade : Emergency surgery.

Disadvantage : No information regarding :

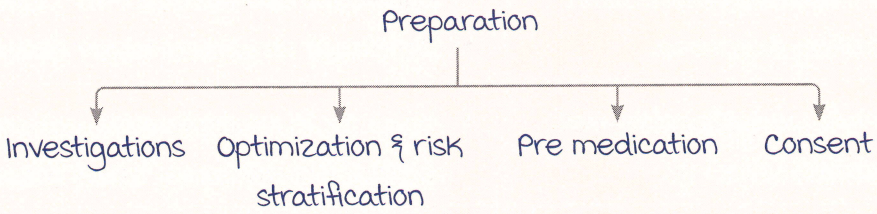
- Mortality.
- Blood loss.
- Days of hospital stay.
- Type of anaesthesia.

Note : Other gradings

- EuroSCORE.
- John Hopkin's score.

PRE-OPERATIVE PREPARATION

----- Active space -----



Investigations

00:01:12

Investigation	Parameters/ Indications
CBC	• Hemoglobin cut off : a. Minimum : 8 g/dl → Risk of post operative complications. b. Systemic disease (Epilepsy, seizures, IHD, major Sx) : 10 g/ dl (D/t loss of blood). c. Severe disease (On ventilator, in ICU) : 12 g/dl.
	• Platelet count cut off : – Regional anaesthesia : a. In closed cavity spaces : 1,00,000/µL. b. Non closed cavity : 80,000/µL. – Biopsy (Eg : Liver, renal) : 80,000/µL. – Invasive procedure (Central venous catheter) : 50,000/µL. Note : Indications of platelet transfusions : • < 20,000/µL. • H/o bleeding.
RFT	Indications : • Chronic kidney disease. • H/o reduced urine output. • H/o nephrotoxic drugs.
LFT	Indications : • H/o herbal medications intake. • H/o antiepileptic drugs. • H/o antitubercular therapy. • H/o chemotherapy.
Coagulation studies	Indications : • H/o bleeding disorders. • On warfarin therapy. • Massive blood transfusion.
Urine examination for casts	• Hyaline cast, proteinuria (Risk of kidney injury).
UPT	• Reproductive age group females.
CXR	Indications : • COPD, bullous lung disorders, mediastinal tumors, pneumonia, pulmonary edema, positive clinical examination for RS pathology.

----- Active space -----

Indications of ECG & ECHO :

	ECHO	ECG
Mandatory	• Dyspnoea of unknown origin. • Heart failure patients with worsening dyspnoea.	• K/C/O IHD. • Significant arrhythmia PAD*, CVD*. • Significant structural heart disease.
May be done	• Past h/o LV dysfunction not evaluated since 1 yr.	• Major Sx in asymptomatic patients without h/o coronary heart disease.
Not performed	• As routine investigation.	• Asymptomatic patients. – Low risk surgical procedures.

PAD : Peripheral arterial disease.

CVD : Cerebrovascular disease.

Note :

Validity of investigation → 2 months.

Optimization & Risk Stratification

00:14:45

Cardiac Diseases :

ACC/ AHA guidelines in cardiac patients :

Step 1 :

- High risk Sx :
  - Emergency Sx (< 6 hrs). Eg : Fetal distress
  - Urgent Sx (< 24 hrs). Eg : Laparotomy
  - Time sensitive Sx (within 3 months). Eg : Ortho, onco Sx

→ Proceed for Sx with high risk

Step 2 :

- Elective Sx :
  - Presence of active cardiac disease :
    i. Acute coronary syndrome (ACS).
    ii. Decompensated heart failure.
    iii. Significant arrhythmia.
    iv. Severe valvular heart disease.

→ Do not proceed d/t risk of mortality

Step 3 :

- Assess risk of perioperative MI/death.

----- Active space -----

- Interpretation :

Parameter	Score
High risk Sx (Suprainguinal Sx, emergency Sx, thoracotomies)	1
H/o IHD	1
H/o congestive cardiac failure	1
H/o cerebrovascular accident	1
H/o diabetes mellitus requiring insulin	1
Serum creatinine > 2.0	1

Score	Risk of cardiac complication
0	0.4 %
1	1.0 %
2	2.4 %
≥ 3	5.4 %

- Proceed to Sx if risk < 1 %.

Step 4 :

- Assess functional capacity → > 4 METs : Proceed with Sx.
  - METs : metabolic equivalents.
  - Amount of oxygen consumed by 70 Kg person at rest.
  - 1 MET = 3.5 ml/ Kg/ min.

Step 5 :

- Stress testing.
- Low METs → Dobutamine stress test (or) stress test using treadmills.

Step 6 :

- Proceed with Sx or alternative plan of Rx.

Canadian society guidelines :

Step 1-3 : same as ACC/ AHA guidelines.

Step 4 : Check BNP < 92 or pro BNP < 300 ng/L.

Step 5 : Proceed to Sx.

- measure troponin daily for 48-72 hr after Sx.
- Obtain ECG post operatively.

ACC/ AHA guidelines for patients with coronary stenting :

	Drug eluting stent	Bare metal stent
Elective Sx	Wait for 6 months	Wait for 1 month
Time sensitive Sx	Plan Sx b/w 3 - 6 months	

----- Active space -----

Indications for IE prophylaxis :

- H/o infective endocarditis (IE).
- Prosthetic valves.
- Unrepaired cyanotic congenital heart disease.
- Repaired CHD with residual defect.
- Cardiac transplant.

Respiratory Diseases :

1. URTI/ LRTI :
   - Postpone Sx by 2 – 3 wks (Airway hyper reactive).
2. Obstructive lung diseases : Eg. Asthma, COPD.
   - CXR.
   - ABG (In case of acute exacerbation).
3. Restrictive lung diseases : Eg. Silicosis, asbestosis.
4. Lung Surgeries : Eg. Lobectomy, pneumonectomy.

} Pulmonary function tests

Note : ECHO is done to rule out cor pulmonale.

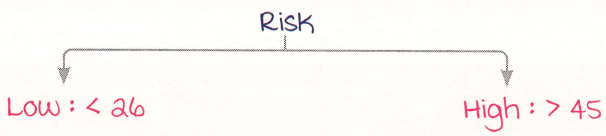
Risk factors for post operative pulmonary complications :

Patient related	Procedure related	Laboratory test
• Old age. • Cigarette smoker. • Abnormal findings on CXR.	• Aortic aneurysm repair. • Upper abdominal Sx. • Emergency Sx.	• Albumin concentration < 3.5 g/ dl. • Chest radiograph abnormalities.

ARISCAT scoring :

- Assess respiratory risk in surgical patients in catalonia.
- Parameters :
  a. Age.
  b. Preop saturation.
  c. Preop Hb.
  d. Incision.
  e. Recent respiratory tract infection (< 1 month).
  f. Duration of Sx.
  g. Emergency Sx.

Interpretation :



CNS Diseases :

- Recent h/o CVA :
  a. Avoid elective Sx upto 9 months.
  b. Continue aspirin.

Pre Medication & Consent

00:32:58 ----- Active space -----

Pre Medication :

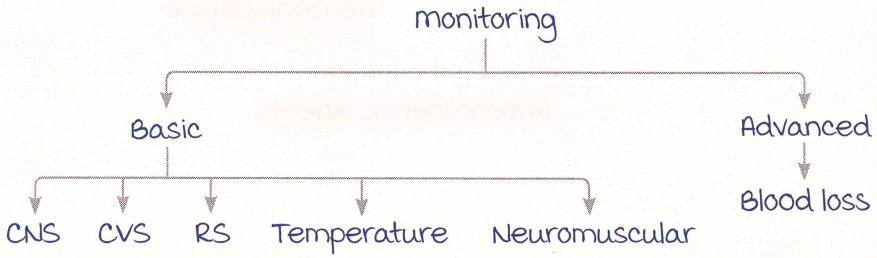
Goal	Premedication
1. Relieve anxiety & induce sedation	• Short acting benzodiazepine (Eg : Midazolam).
2. Reduction of secretions	• Anticholinergic agents (To prevent aspiration) : Eg. Atropine, glycopyrrolate. • Indication : In children, mentally retarded patient, head & neck Sx.
3. Decrease aspiration	a. Prior elective Sx : • Adult : 6 – 8 hrs (Nothing by mouth). • Children : – Clear liquid : 2 hrs – Non human milk : 6 hrs. – Breast milk : 4 hrs. – Heavy fatty meal : 8 hrs. – Solids : 6 hrs. b. Emergency Sx : ↑risk of aspiration. 1. NG tube/ ryles tube aspiration. 2. Prokinetic agent (↑ gastric motility). – Eg : metoclopramide.. 3. To reduce gastric acidity : – PPI/ H_2 receptor blockers. – Gastric acid neutralized by antacid : Eg. Sodium citrate (0.3M, 30ml, 30 min prior).
4. Reduction of infections	• Antibiotics 30 minutes prior to Sx.
5. Reduction of nausea & vomiting	• Antiemetic agents : – Ondansetron : $5HT_3$ blocker. – S/E : Arrhythmia d/t prolonged QT. • APFEL score : – Female. – Non smoker. – H/o postoperative nausea & vomiting. – H/o opioids. } High risk
6. Analgesia	• Pre emptive analgesia (Providing analgesia before surgical incision). • Use : – Decrease post operative pain. – Drug : Short acting opioids (Eg : Fentanyl).

Consent :

Last step → Consent taken & prepared for Sx.

----- Active space -----

MONITORING UNDER ANAESTHESIA : PART 1



Central Nervous System Monitoring

00:01:23

Components of balanced anaesthesia :

- Amnesia (Indicative of deeper planes).
- Analgesia.
- Abolition of reflexes.
- Adequate muscle relaxation.

Depth Of Anaesthesia :

Maintained by :

- Inhalational anaesthetics / benzodiazepines.

Inadequate depth :

- Can lead to laryngospasm while extubating.
- Signs of inadequate depth (Lighter planes).
  1. Tachycardia.
  2. ↑ Blood Pressure (BP).
  3. Reflex movement.
  4. Lacrimation.
  5. Sweating.

Objective measures :

Bispectral index (BIS).



Bispectral index

Bispectral index system value	Depth of sedation
0	Flatline EEG
0–40	Deep hypnotic state, memory function lost, increasing burst suppression
40–60	Recommended range for general anesthesia
60–90	Recommended range for sedation
100	Awake, memory intact

BIS monitoring

Cardio Vascular System Monitoring

00:11:22 ----- Active space -----

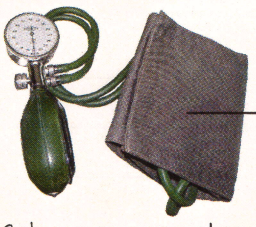
1. Pulse Rate/Heart Rate :

		Bradycardia	Tachycardia
	Rate	<60bpm	>100bpm
Causes	Physiological	Deep sleep Old age	Children Pregnancy
	Pathological	• Sick sinus syndrome. • Heart blocks. • Obstructive jaundice. • Hypothyroidism.	• Fever. • Anxiety. • Stress. • Pain.

2. Blood Pressure :

Methods :

- Non invasive devices
  - Sphygmomanometer
    - Methods :
      - Palpation.
      - Auscultatory.
      - Oscillatory.
  - Automatic NIBP
    - Methods :
      - Oscillatory.
- Invasive

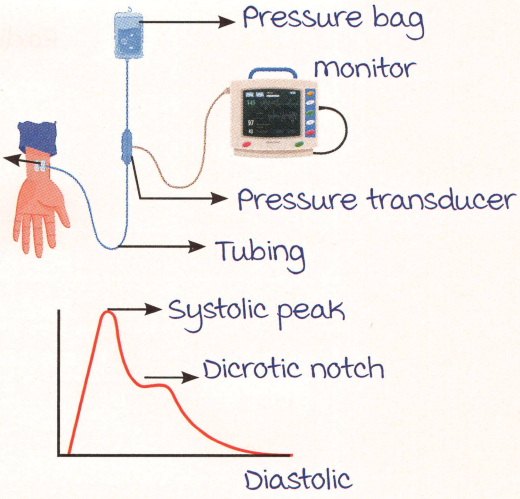


Sphygmomanometer

Size of cuff:
- 1.5 times arm size.
- Should cover 2/3 of arm.



NIBP machine



Monitoring : Every 5 minutes.

C/I : A-V fistula.

Invasive blood pressure :

Indications : Major Sx.

Prerequisite : modified Allen's test positive (To ensure adequate collateral circulation).

Allen's test	modified Allen's test
• Clench the fist. • Apply pressure on radial artery with 2 hands. • Release the pressure.	• Elevate the limb. • Clench the fist. • Apply pressure on both radial and ulnar arteries.

----- Active space -----

Allen's test	Modified Allen's test
• Hand turned to pink : Negative = normal. • Positive : No adequate collateral.	• Release the pressure on one side. • Positive : No pallor = normal. • Negative : No adequate circulation.
The average time required for change in the color should be less than 7 seconds.	

Complications :

- Artery injury.
- Vessel spasm.
- Ischemia.
- Thrombosis.
- Fistula formation.
  - Prevention : Continuous flushing of cannula with normal saline/heparin.

Sites for monitoring :

Population	Artery	Features
Adults	Radial	m/c used
	Ulnar	–
	Brachial	Adv : Less chance of ischaemia (D/t collaterals) Disadv : Uncomfortable
	Femoral	Mimics central pulsation
Children	Axillary	Mimics central pulsation
	Dorsalis pedis	–
	Posterior tibial A.	–
	Superficial temporal A.	–

3. ECG

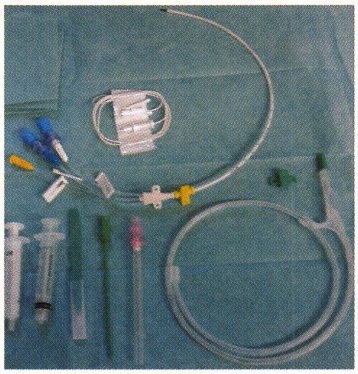
To detect :

- Arrhythmia : Lead II (In line with normal cardiac axis).
- Ischemia/Infarction : Lateral leads (V_4, V_5, V_6)

4. Central Venous Pressure :

Techniques :

- Seldinger's technique :
  a. Guide wire inserted first (monitor for arrhythmias).
  b. Catheter is inserted following guide wire.



Central venous (CV) set

- m/c size used in adult : 7Fr/(20 cm).
- Normal CVP : 0–5 cm of H_2O.