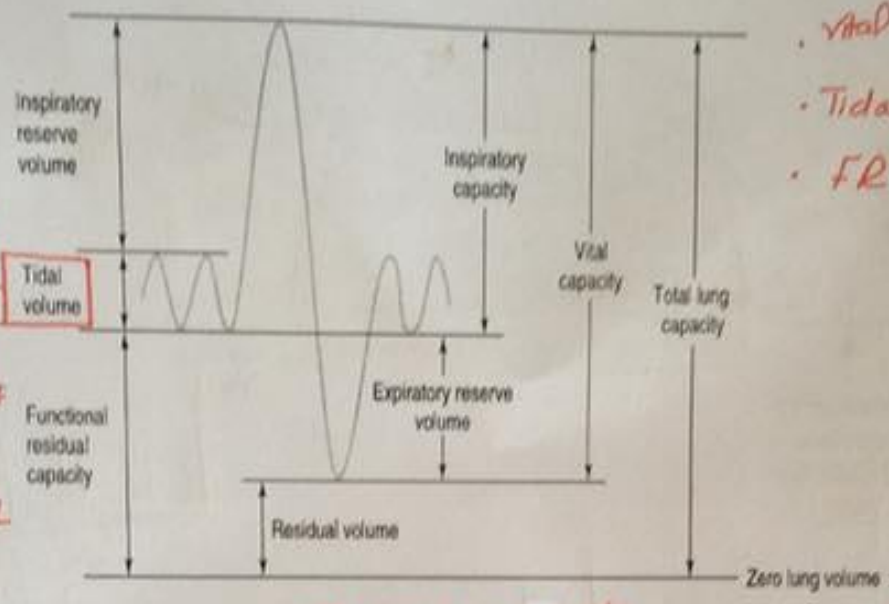
Pulmonary function test.



the volume of air displaced between normal inhalation and exhalation when extra effort is not applied.
↓
normally = 500 mL or 7 mL / Kg

- vital capacity = 70 mL/Kg
- Tidal volume = 7 mL/Kg
- FRC = 30 – 40 mL/Kg
↓
average in adults = 2500 ml.
↓ 21% of them is oxygen
500 mL O_2
↓
we consume 250 mL/min O_2 → so 500 mL O_2 will be enough for only 2 minutes

That's why we make pre-oxygenation or de-nitrogenation to substitute the N_2O with O_2, so all the 2500 mL will be O_2 ⇒ enough for 10 minutes.

- invasive BP measurment is more accurate than the non-invasive.

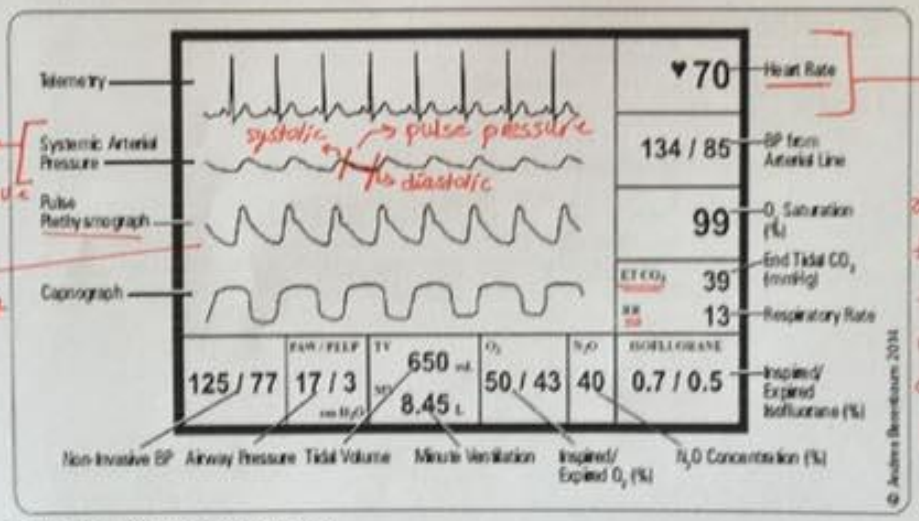


Figure 2. Typical anesthesia monitor

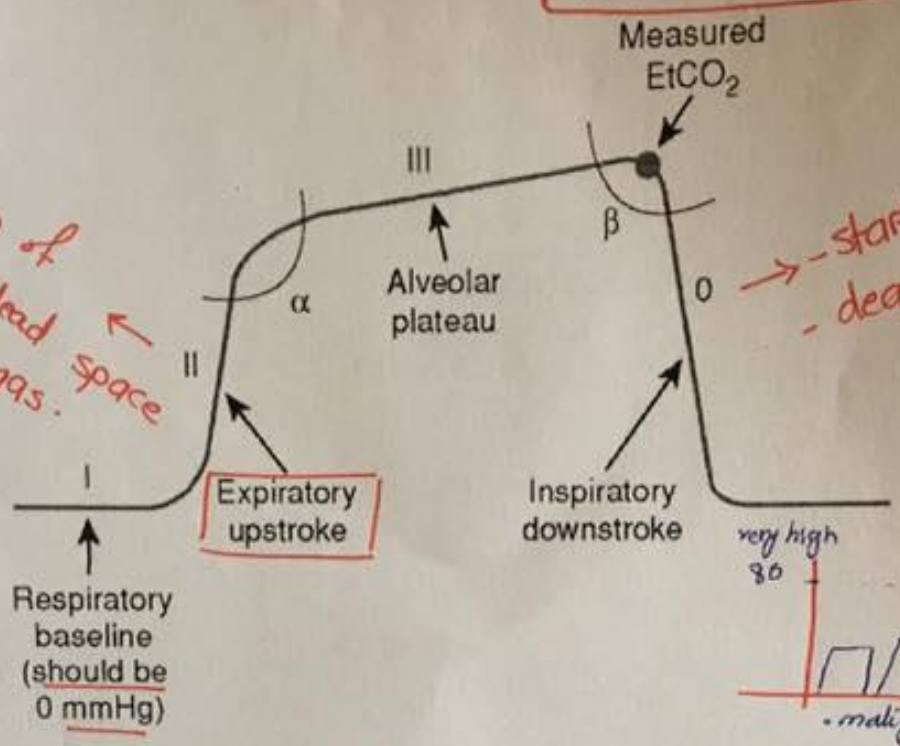
- invasive BP
The wave: invasive BP wave

lower limit of normal O_2 sat = 92%
↓
P_aO_2 = 60

- stardard ECG → Lead II or V_5
- The ECG and HR reflects the electricity of the heart, not the mechanical function that's why there's electromechanical dissociation or pulseless electrial activity.

capnograph
- what it reflects? (ventilation).
- what does it measure? 1. End tidal CO_2 2. respiratory rate.

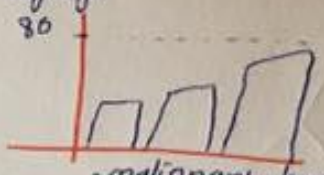
end tidal volume



exhalation of both mixed dead space and alveolar gas.

- start of inspiration.
- decrease the level of CO

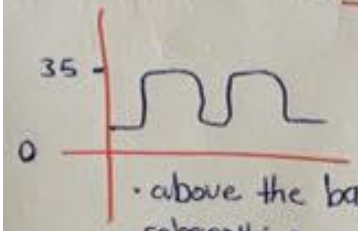
very high
80



- malignant hyperthermia

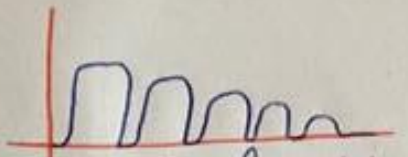
normal CO_2 = 30 – 40

35



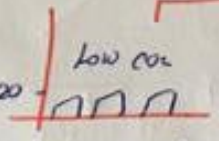
0

- above the baseline.
- rebreathing, causes?
(exhaustion of soda-lime)



- esophageal intubation.

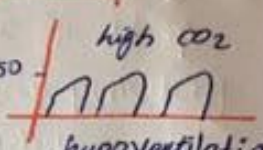
20



low CO_2

hyperventilation

50

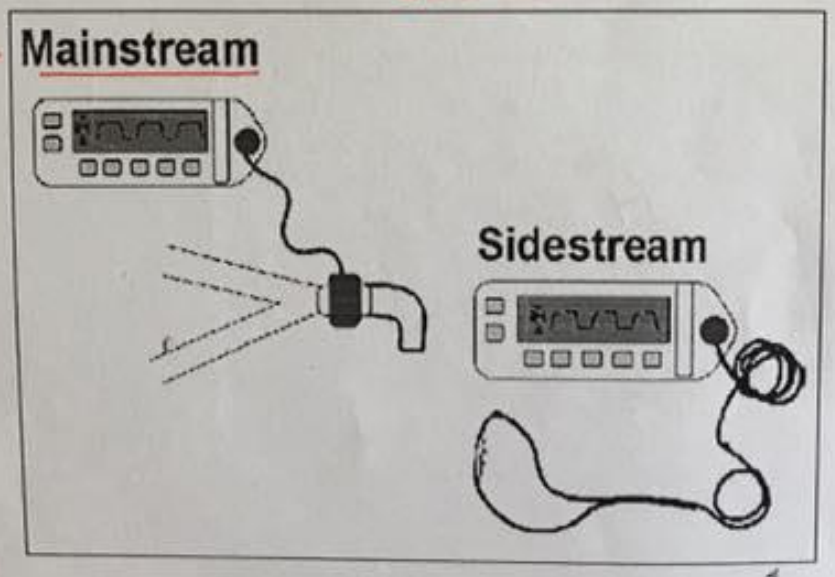


high CO_2

- hypoventilation

These are capnometers

attached to the breathing system.



* The sock has 3 phases : 1. compensatory phase.
2. decompensatory phase.
3. multi-organ dysfunction phase.

• Shock symptoms after :

1 pneumonia ⇒ septic shock

2 Penicillin ⇒ anaphylactic shock

3 central line ⇒ Tension pneumothorax ⇒ obstructive cardiogenic shock.

Shock: Classification

- Hypovolemic shock - due to decreased circulating blood volume in relation to the total vascular capacity and characterized by a reduction of diastolic filling pressures
- Cardiogenic shock - due to cardiac pump failure related to loss of myocardial contractility/functional myocardium or structural/mechanical failure of the cardiac anatomy and characterized by elevations of diastolic filling pressures and volumes
- Extra-cardiac obstructive shock - due to obstruction to flow in the cardiovascular circuit and characterized by either impairment of diastolic filling or excessive afterload
- Distributive shock - caused by loss of vasomotor control resulting in arteriolar/venular dilatation and characterized (after fluid resuscitation) by increased cardiac output and decreased SVR

Society of Critical Care Medicine

difference in → anaphylactic shock, neurogenic sh, septic shock.

* shock ⇒ MAP < 40 ⇒ MAP = CO * SVR

CO ↓ when this decreases (cardiogenic) shock

SVR ↓ when this decreases (vasogenic shock)

* if the CO ↓ → SVR should ↑ ⇒ compensatory phase.

CO = HR * SV → depends on
- preload (LVEDV)
- after load (resistance)
- contractility (ejection fraction)

example :- patient with normal BP, HR = 105, urine output = 25 m/hr ⇓ Class II

Clinical Correlates of Hemorrhage

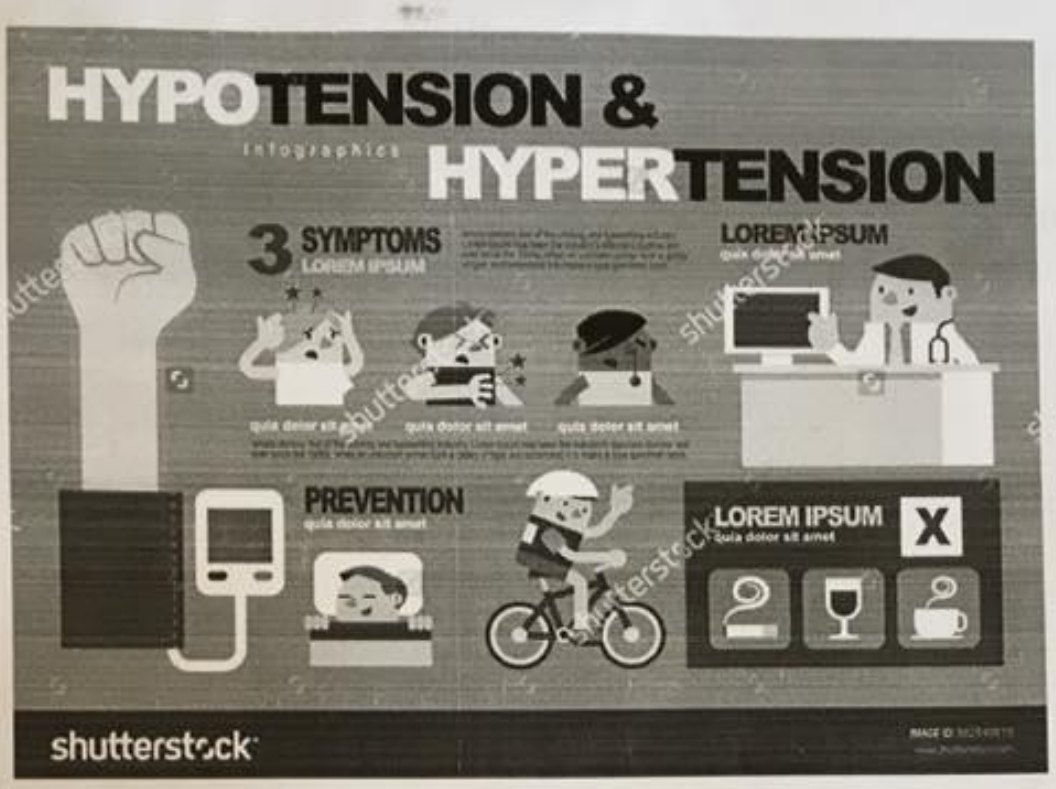
compensatory ..... decompensatory ..... multi. organ dysfunction

	Class I +	Class II	Class III	Class IV
* Blood loss (mL)	> 750	750 - 1500	1500 - 2000	> 2000
Blood loss (% total)	> 15%	15 - 30%	30 - 40%	> 40%
* Pulse rate	< 100	> 100	> 120	> 140
* Blood pressure	Normal	Normal	↓	↓
Pulse pressure	Normal or ↑	↓	↓	↓
Orthostasis	Absent	Minimal	Marked	Marked
Capillary refill	Normal	Delayed	Delayed	Delayed
Resp rate	14 - 20	20 - 30	30 - 40	> 34
* UO (mL/hr)	> 30	20 - 30	5 - 15	< 5
CNS mental status	Slight anxiety	Mild anxiety	Anxious/confused	Confused/lethargic
CI (L/min)	↓ 0-10%	↓ 20-50%	↓ 50-75%	↓ >75%

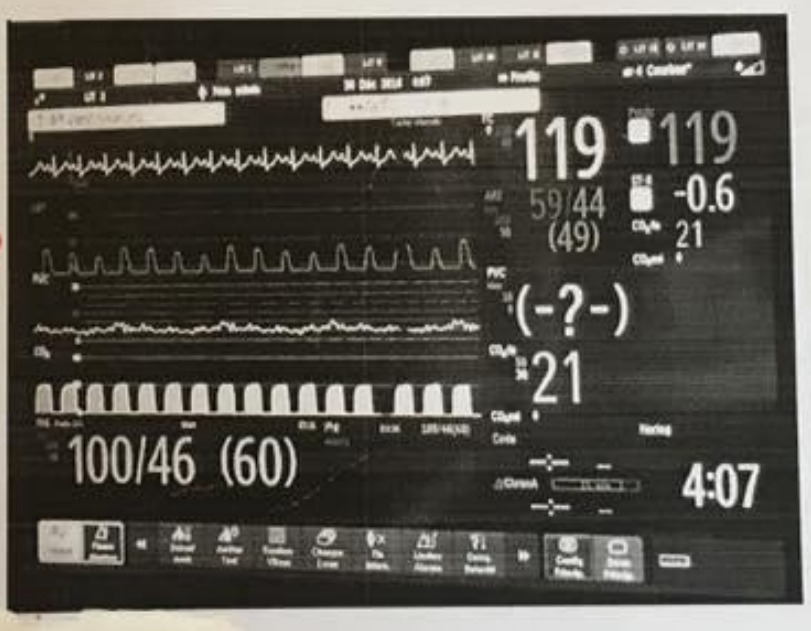
American College of Surgeons, 1989

Society of Critical Care Medicine

- if the preload decreases ⇒ hypovolemic shock (most common)
- if the contractility decreases ⇒ cardiogenic shock (non-obstructive)
- if the preload ↓ and after load ↑ ⇒ obstructive cardiogenic shock (aortic stenosis, HTN, cardiac tamponade, tension pneumothorax)



*Shocked patient, what is the managment if he needs surgery?



Road Traffic accident

- RTA,,,need GA,,,YOUR management,,,,
- THREE MAJOR CONCERN FOR ANESTHESIA THIS PT,,,,

ABCDE
large canula (2)
colloid or blood ↺
arterial line
central line

[1] rapid sequence induction (The patient has full stomch)
[2] we give Ketamine (to increase the circulation) → don't give propofol or Thiopental.
[3] maintenance ⇒ opioid or inhalational agents.

* what is this maneuver ?

1) In-line stabilization. the patient is suspected to have neck injury after RTA

2) Laryngoscopy.

(air-Fluid Level)

* where you can see it?
in intestinal obstruction.

*what are the cardinal features of intestinal obstruction

1) abdominal distension.
2) constibation 3) vomiting
4) abdominal pain.

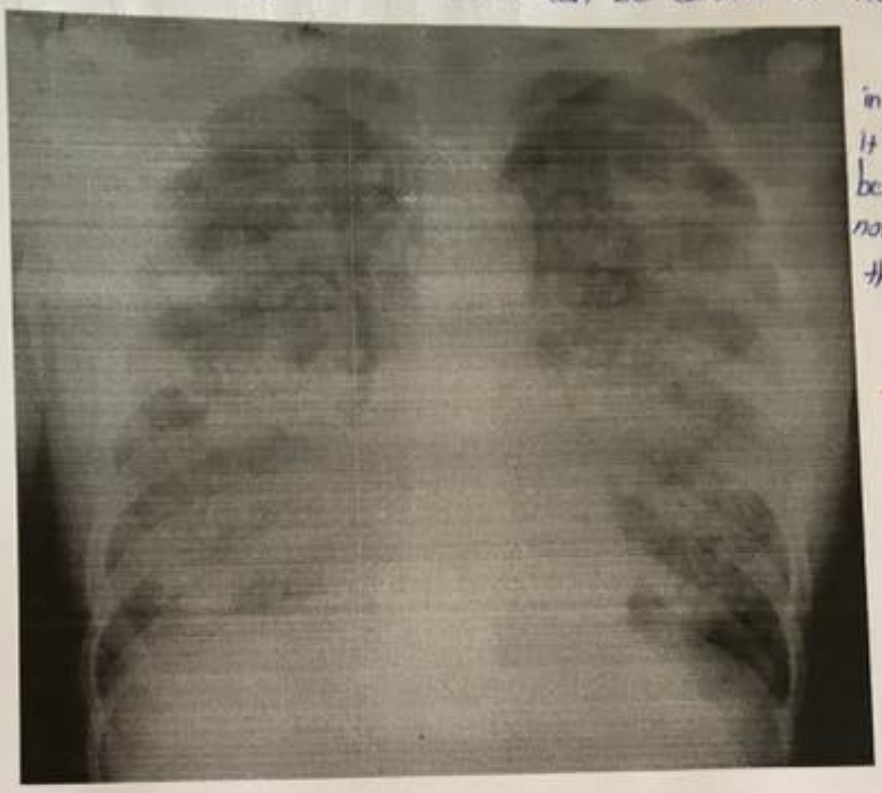
* what's the type of acid-base disturbance in this patient?
metabolic alkalosis
(patient is losing acids by vomiting)

* what's the anesthesia concern in this patient?

1. patient is dehydrated → rehydrate!
2. patient has electrolyte disturbances → correct it
3. risk of aspiration → rapid sequence induction
4. ICU admission and good approach for pain managment.

* What's the cause of this patient x-ray ?

This is pulmonary edema which can be cardiac or non-cardiac



⇓

in this patient it's non-cardiac because of the normal size of the heart

⇓

This is ARDS.

(cardiogenic pulmonary edema)

← cardiomegaly.

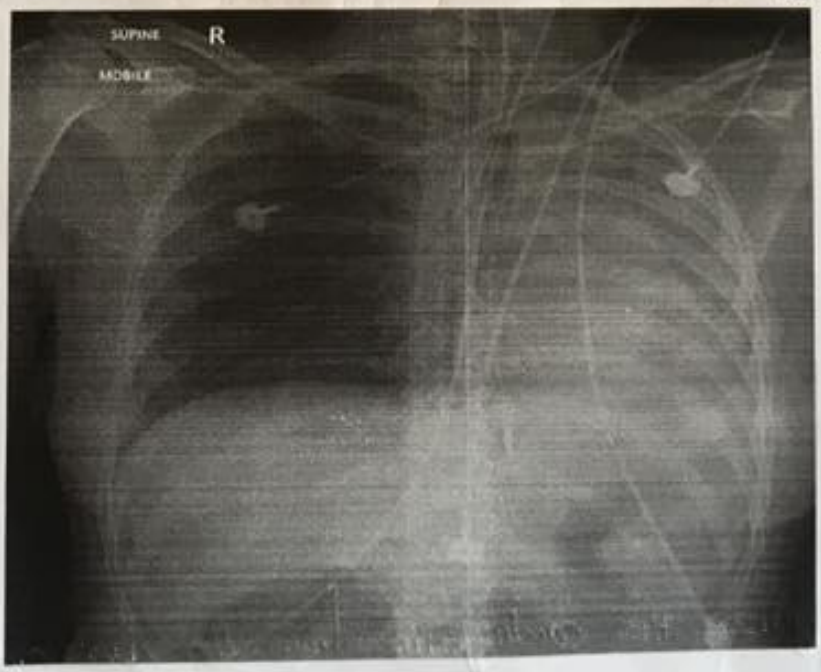
* We can recognize the cardiogenic from the non-cardiogenic pulmonary edema by:

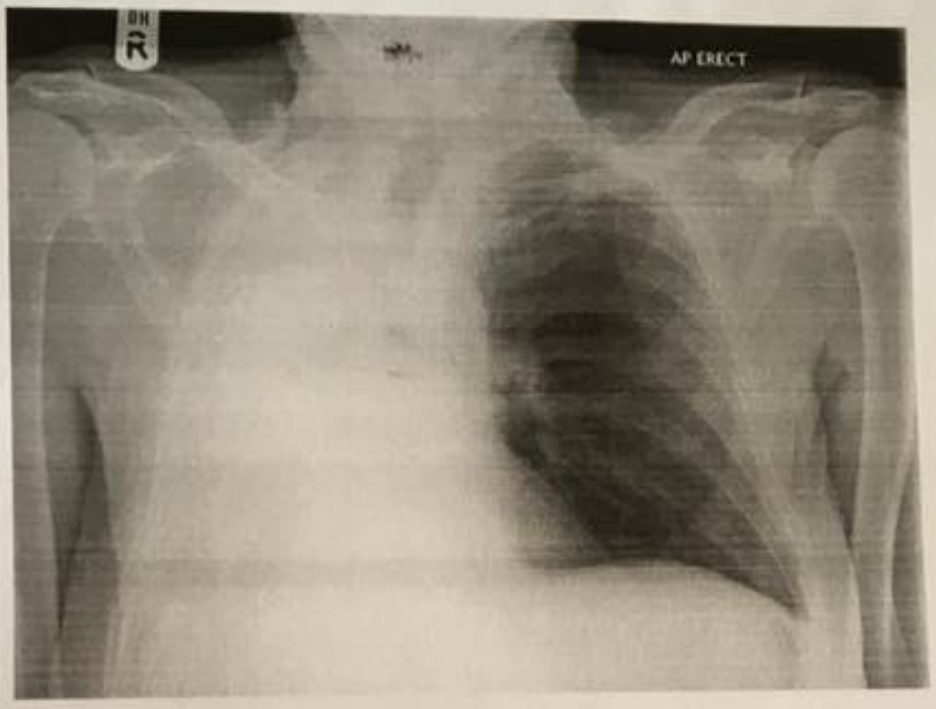
1. the size of the heart ⇒ cardiomegaly in cardiogenic pulmonary edema
2. wedge pressure ⇒ more than 18 mmHg in cardiogenic.

* what's the arrowed structure ? Central line.
* where does it go ? at the junction between the SVC and right atrium.

* Through which vein we introduced it ?(in this pic).
Left internal jagular vein

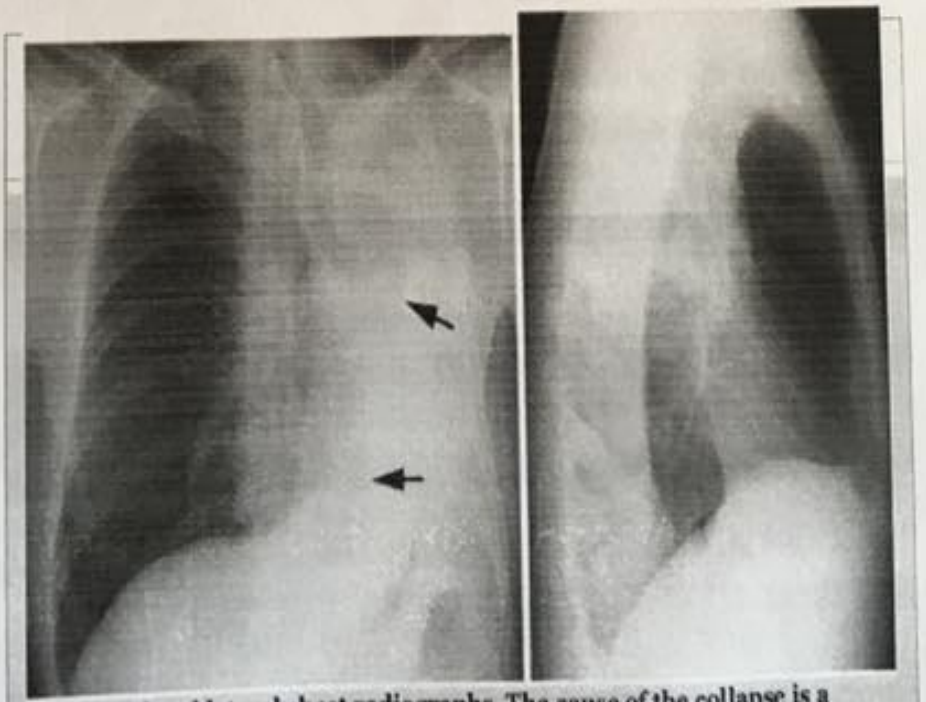
* what is the cause of this patient x-ray ? Lung collapse. (Left)
* mention the causes of Lung collapse ? 1. bronchial obstruction (may by foreign body, Tumor, blood) 2. external obstruction (Lymphoma) 3. tube introduced to one major bronchi, not to the other.





* This is lung collapse with tracheal deviation.
* Possible cause? bronchogenic carcinoma (mostly) or tension pneumothorax.

Lung collapse, causes
1. endobronchial intubation.
2. bronchial obstruction (foreign body)



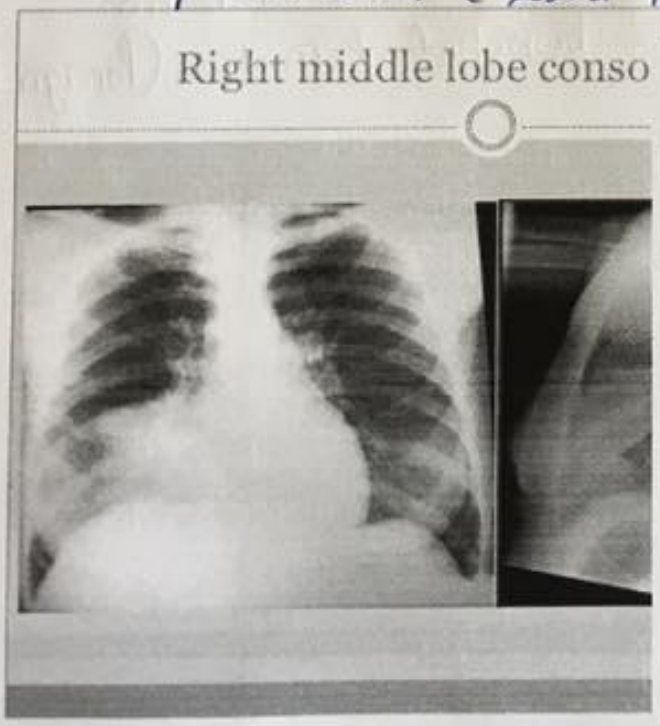
Frontal and lateral chest radiographs. The cause of the collapse is a

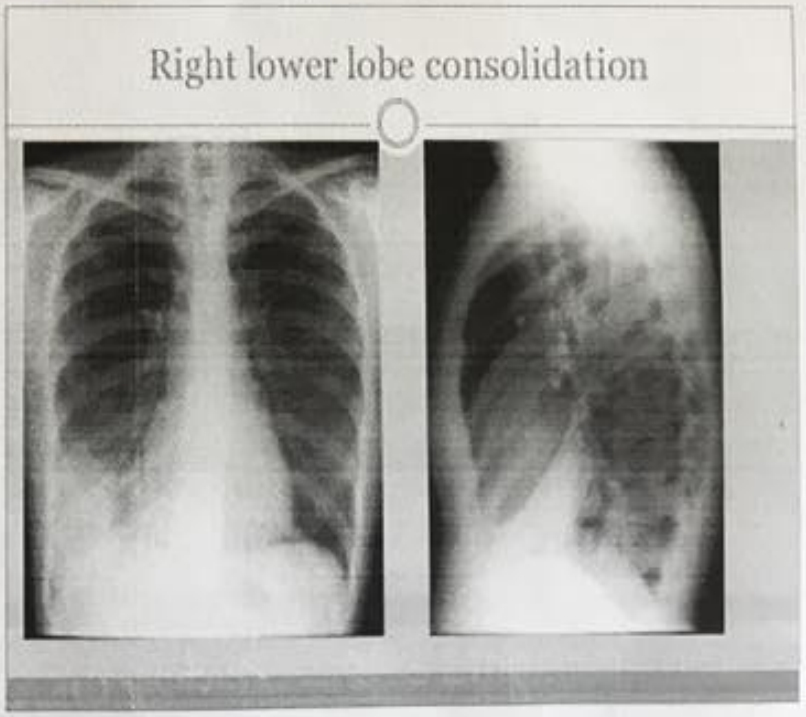
This is a neonate with lung collapse.

The cause? endobronchial intubation.

* This patient presented to the hospital with cough and fever what's the possible cause of these symptoms, with this chest x-ray

- pneumonia (lower lobe)



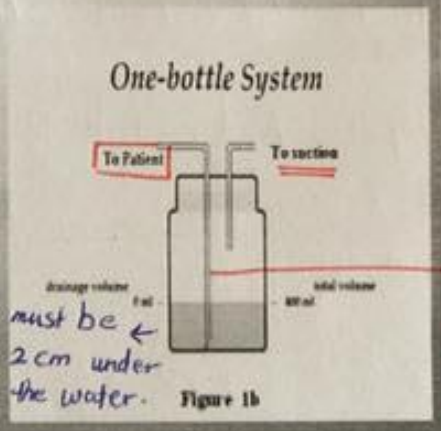


* underwater seal system, attaches the patient's chest tube.
* indications:- 1. pneumothorax | 3. haemothorax | 5. post-op
2. pleural effusion | 4. chylothorax. ⇓ CABEG

MORE ABOUT DRAINAGE CANISTERS

ONE-BOTTLE SYSTEM

- SIMPLEST SET UP
- FIRST TUBE SUBMERGED IN 2 CM WATER CREATES A WATER SEAL
- SECOND TUBE CONNECTED TO WALL SUCTION
- EXCESSIVE ACCUMULATION OF FLUID CAN CAUSE DECREASED FUNCTION OF THE UNIT



complication: if this tube goes out from the water, the air will enter the pleura (pneumothorax) because of the pressure difference.

CLASSIFICATION

HYPOXAEMIC TYPE I	VENTILATORY TYPE II
ABG CHANGES:	**ABG CHANGES:**
• PaO_2 ↓ (< 60 mmHg / 8.0 kPa)	• PaO_2 ↓ (< 60 mmHg / 8.0 kPa)
• $PaCO_2$ normal or ↓ (<50 mmHg /6.7 kPa)	• $PaCO_2$ ↑ (> 50 mmHg /6.7 kPa)
• $PA\text{-}aO_2$ ↑	• $PA\text{-}aO_2$ normal
	• pH↓ (Acidosis)

→ uncompensated respiratory acidosis, Resp. failure Type II

- pH 7.02, CO2 65, HCO3 23 and PaO2 55

acidosis hypercapnia normal. Low.

→ compensated metabolic acidosis, possible cause → acute or chronic renal injury; aspirin toxication; alcohol toxication

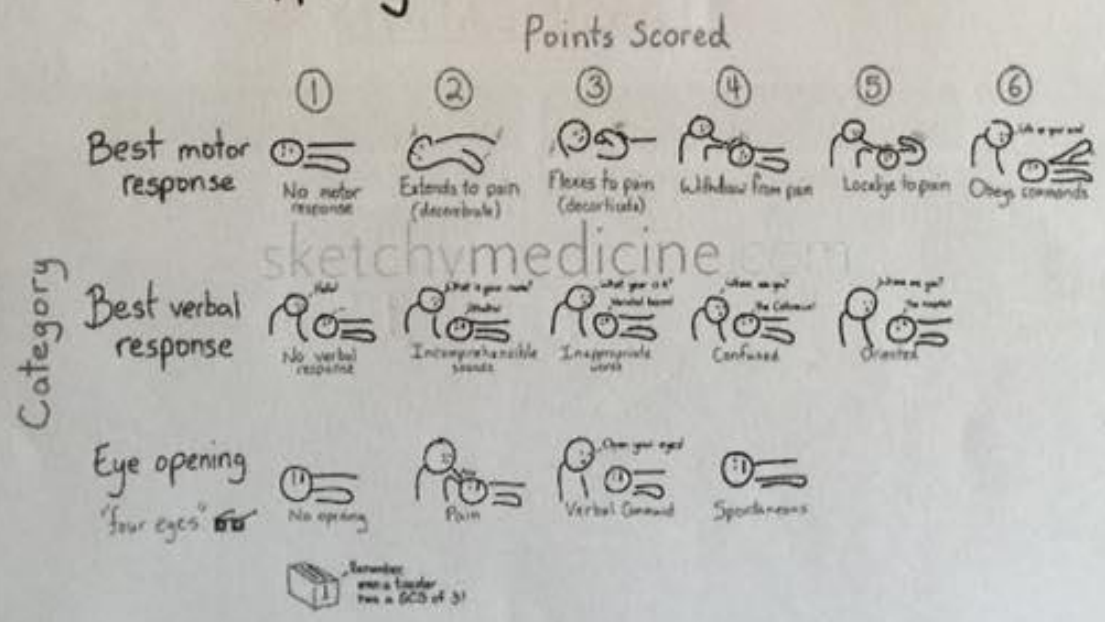
- .pH 7.25, CO2 22, HCO3 19, pO2 60

acidosis Low Low (acidosis)

- pH 7.52, CO2 21, HCO3 23, pO2 45

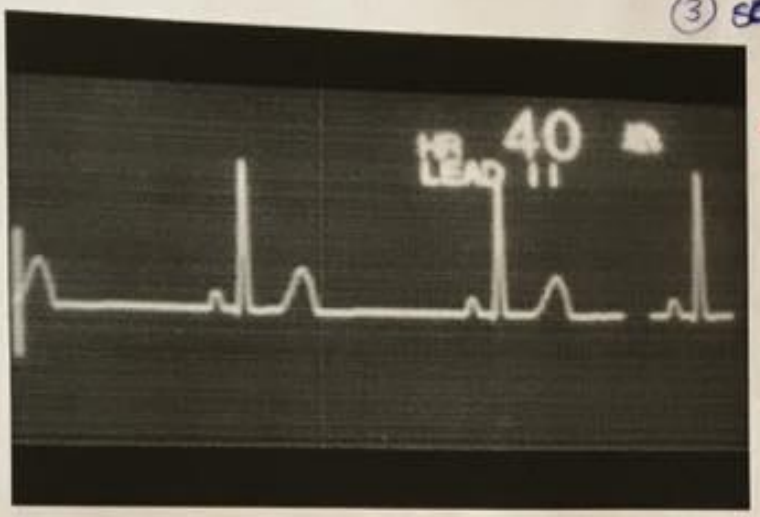
Alkalosis Low normal hypoxia.

→ uncompensated resp. alkalosis, Resp. failure Type I.



You must think about anesthesia related causes =)

* This is bradycardia, possible causes ① propofol ② morphine ③ scoline.



* what's the managment?
Atropine.

* Diagnosis? Sinus Tachycardia.
* causes? 1. pain 2. fever 3. hypovolemic shock 4. Thiopental 5. Ketamine.
* managment? 1. Treat the underling cause 2. β-Block (1st choice) 3. calcium channel blocker (2nd choice)

* what is this device ? Pulse oxymeter
* what does it reflect ? 1. pulse wave.
2. pulse → reflects the circulation.
3. SpO_2 → reflects the oxygenation.

Estimating FiO_2

O_2 Flow rate	FiO_2
Nasal cannula	
1	0.24
2	0.28
3	0.32
4	0.36
5	0.4
6	0.44

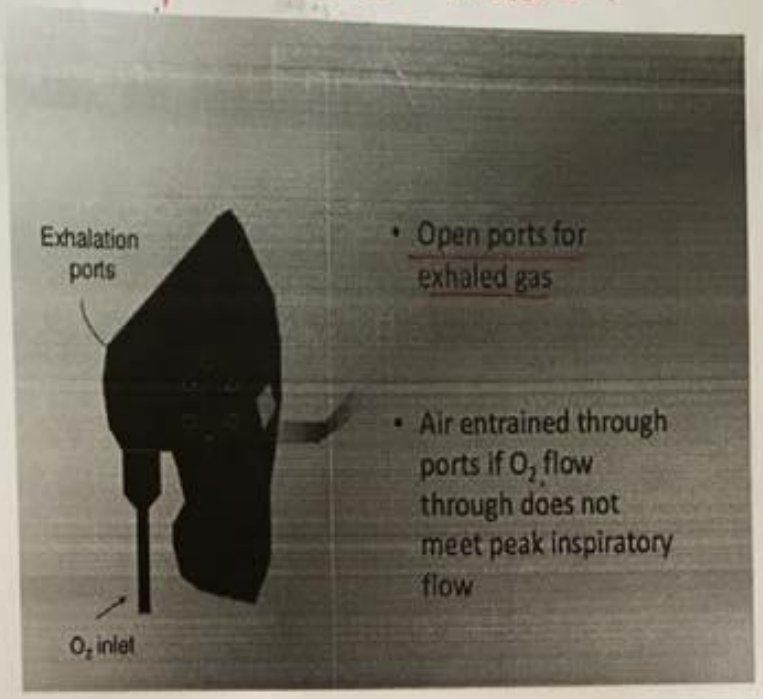
O_2 Flow rate	FiO_2
Oxygen mask	
5-6	0.4
6-7	0.5
7-8	0.6

O_2 Flow rate	FiO_2
Mask with reservoir	
6	0.6
7	0.7
8	0.8
9	0.80+
10	0.80+

every one Litre increases the FiO_2 by 0.04
↓
we can give maximum 6L
→ after that's there will be irritation.

→ here we can make titration, so we can prevent hypoxia.

Simple face mask.



* There's leak, that's why the O_2 saturation does not reach 100 %

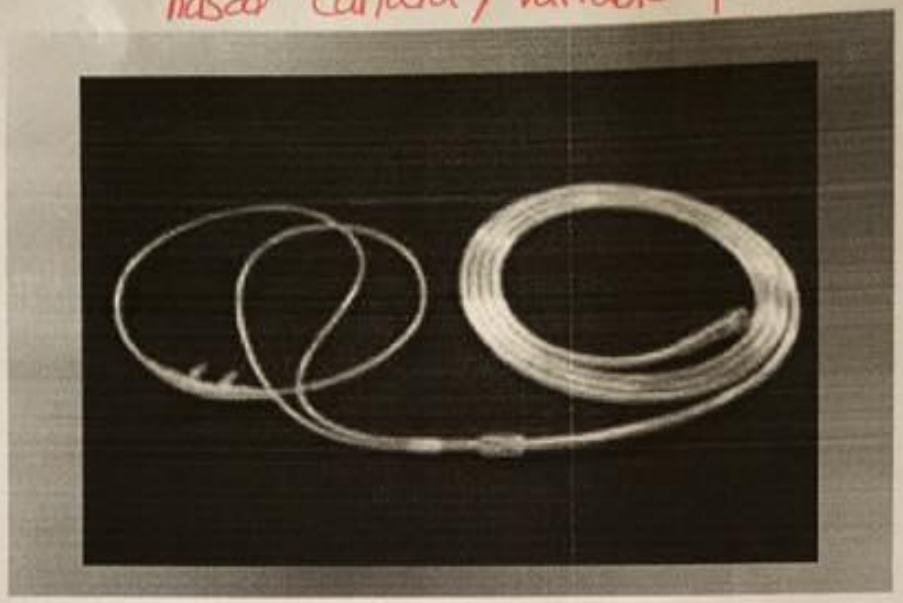
Simple face mask :
Variable performance system , small capacity

Low flow (6 L/min)

⇓

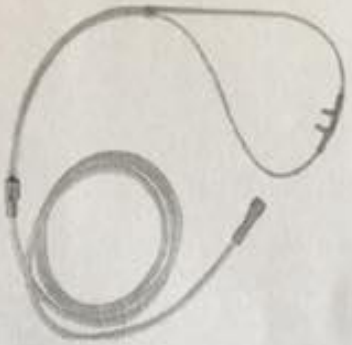
(40 % or 0.4)
FiO_2.

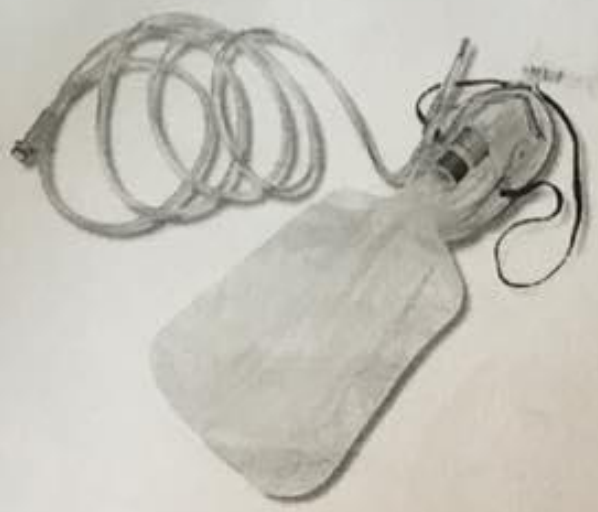
nasal canula / variable performance.



Nasal cannula :
Variable performance system

* what's the minimum FiO_2 does it give? 0.24



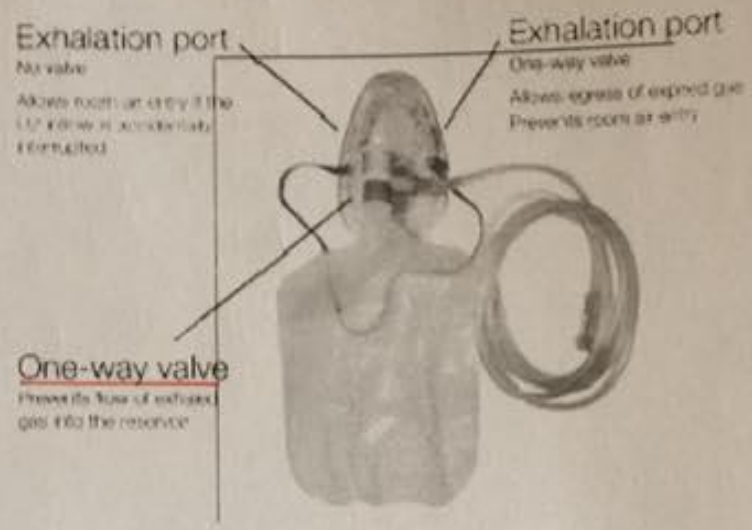


→ There are exhalation ports but there's unidirectional valve
→ the air can go out, but can't go in, so there's no leak, and the O_2 can reach high value (around 80%)

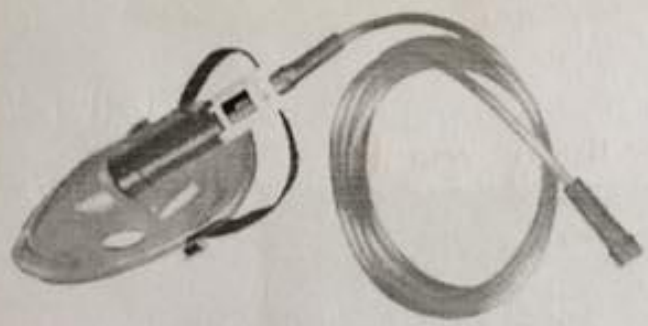
Non-rebreathing mask :
Variable performance system

non-rebreathing mask.

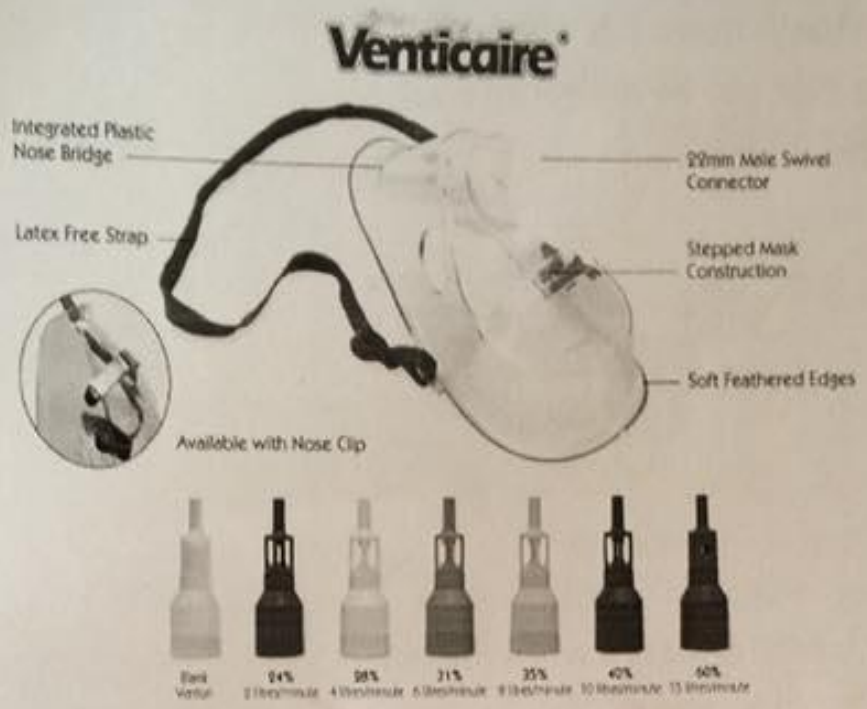
reservoir bag.



* if it presents in both sides ← One-way valve
→ the mask is non-rebreathing completly.
* if just in one side (non-rebreathing mask)
→ partial non-rebreathing



Venturi mask : → it can maximum give 60% O_2.
Fixed performance system
Bernoulli principle



Q14)- based on what principle does this mask work? Bernoulli's

2- what type of mask is this? Fixed performance system

A) What is mask 1 & what is the maximum FiO2 that can be delivered by it?

non-rebreathing mask, maximum 80%.

B) what is FiO2 of mask 2 when the flow is 5 L?

simple face mask, maximum 60%,
when the flow is 5L ⇒ FiO_2 = 40%.

Q15) 1- what is this laryngeal mask.
2- give a contraindication for its use
3- name two conditions where it is used? ① short procedure.
② difficult air way managment

* absolute:
1. pharyngeal pathology.
2. Full stomach.

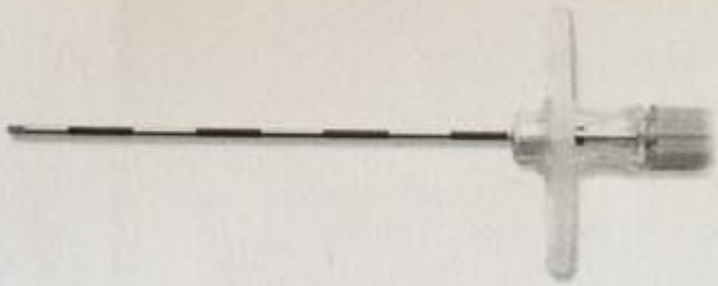
* relative:
1. poor oral opening.
2. poor lung compliance.
3. Long procedure (> 2 hrs)
4. head and neck surgery.

* what is this ?
  pulmonary function test device.

* what does it measure ?
  1. volume (forced vital capacity)
  2. capacity

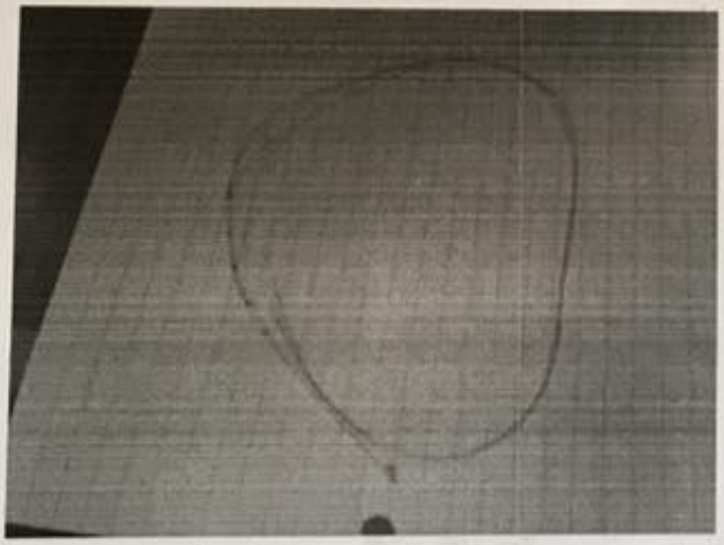
* what is it's use ?
  to prevent atelectasis in post - operative patients

* This is Tuohy needle (epidural needle)
* gauge = 18



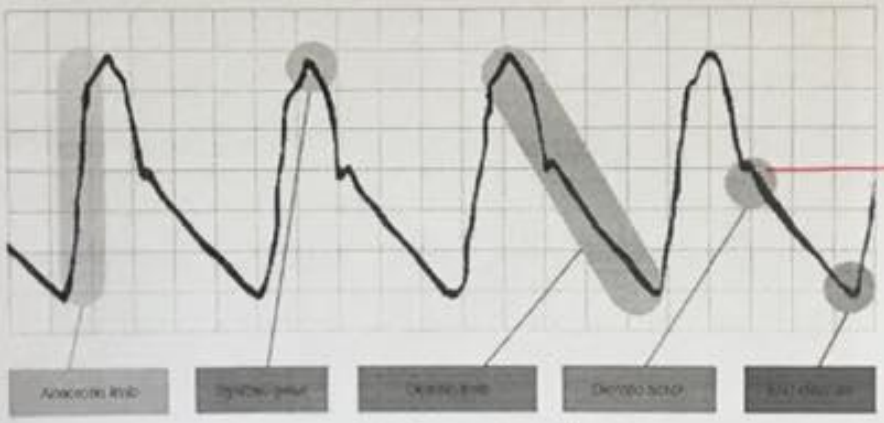
Spinal needle ⇒ Quincke (cutting)

Epidural catheter ⇒ between legamentum flavum and dura matter.



* equipment of arterial line.

Normal arterial waveform



The anacrotic limb marks the waveform's initial upstroke, which occurs as blood is rapidly ejected from the ventricle through the open aortic valve into the aorta.

Arterial pressure then rises sharply, resulting in the systolic peak – the waveform's highest point.

As blood continues into the peripheral vessels, arterial pressure falls and the waveform begins a downward trend, called the dicrotic limb. Arterial pressure usually heads falling until pressure in the ventricle is less than pressure in the aortic root.

When ventricular pressure is lower than aortic root pressure, the aortic valve closes. This event appears as a small notch on the waveform's downslope, called the dicrotic notch.

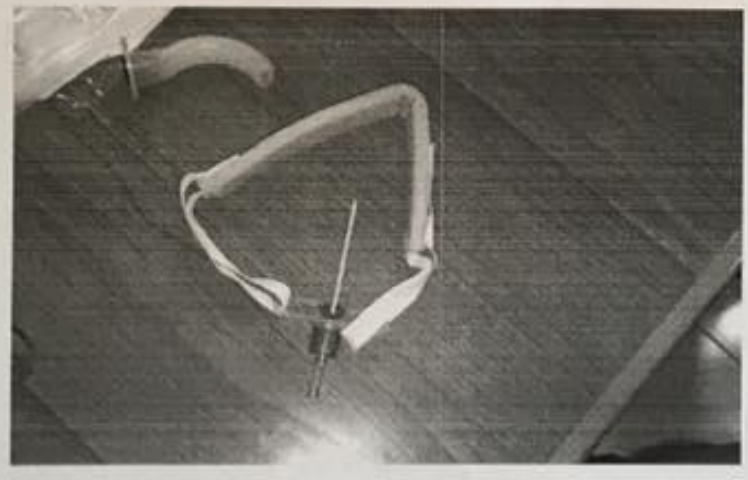
When the aortic valve closes, diastole begins, progressing until aortic root pressure gradually falls to its lowest point. On the waveform, this is known as end diastole.

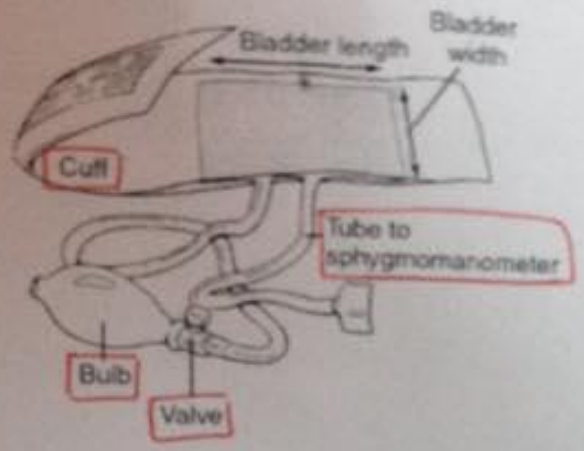
dicrotic notch.
↓
closure of aortic valve.

cricoid pressure (rapid sequence induction)

→ head tilt, chin lift, jaw thrust.

Crichothyrotomy set when we use it? when we can't intubate, can't ventilate.





what is this? device used for non-invasive BP monitoring.

Table 3. Causes of Abnormal CO_2 Levels

Hypocapnia (Decreased CO_2)	Hypercapnia (Increased CO_2)
Hyperventilation	Hypoventilation
Hypothermia (decreased metabolic rate)	Hyperthermia
Decreased pulmonary blood flow (decreased cardiac output)	Improved pulmonary blood flow after resuscitation or hypotension
Technical issues: Incorrect placement of sampling catheter Inadequate sampling volume	Technical issues: Water in capnography device Anesthetic breathing circuit error • Inadequate fresh gas flow • Rebreathing • Exhausted soda lime • Faulty circuit absorber valves
	Low tidal volume
V/Q mismatch • Pulmonary thromboembolism • Incipient pulmonary edema • Air embolism	

	Ventilation	metabolism	circulation	device
hypercapnia	hypoventilation	hypermetabolism	hypordynami	dissociation of valve the device + unidirectional
hypocapnia	hyperventilation	↓	↓	exhausted soda-lime.

→ semi-open circuit.

MAPLESON SYSTEM

The best one for spontaneous ventilation.

The best for controlled ventilation it is called (Bain circuit)

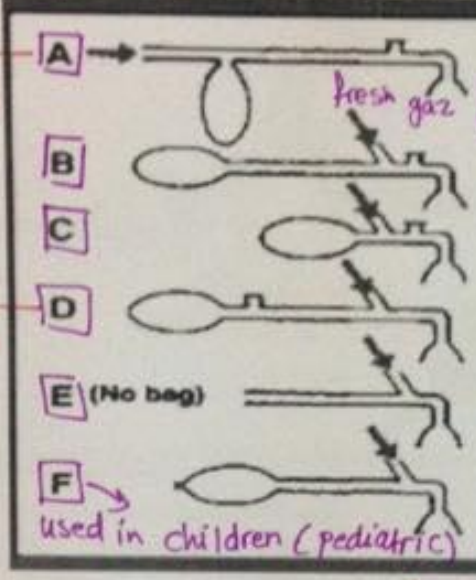
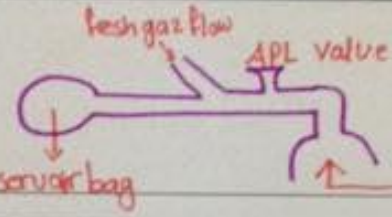


Figure 1

Mapleson classification of anaesthetic breathing systems. The arrow indicates entry of fresh gas to the system.



Mapelson D

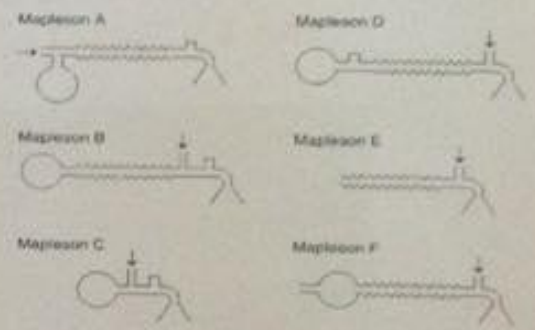


FIGURE 4-3. Mapleson circuits.

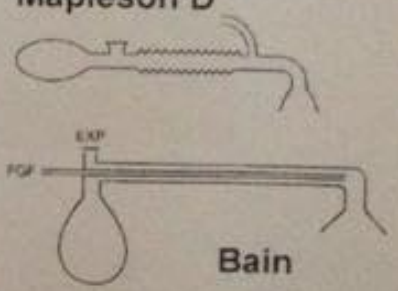
Mapleson F (Jackson Rees Modification)

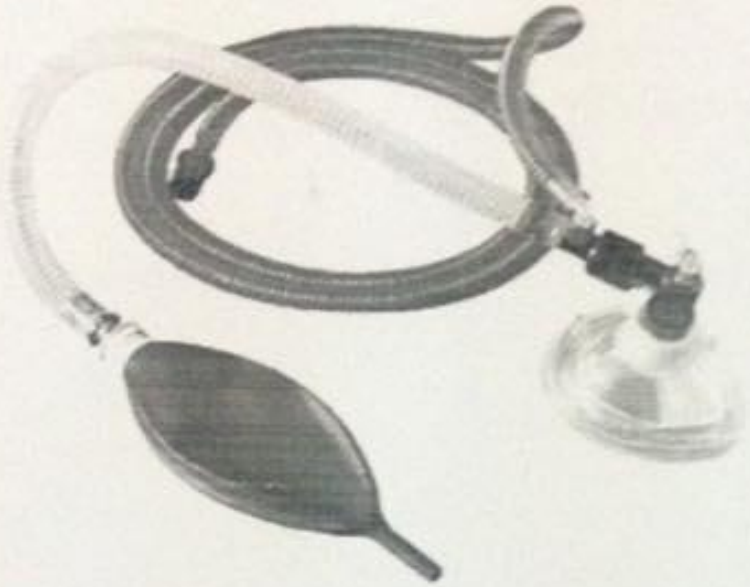
Ayres - 1937

JR - 1950

- The Mapleson F or Jackson Rees modification of the Ayres T Piece is a basic system for use with very small patients.
- It is a big disadvantage that you cannot remove waste gases safely.

Mapleson D

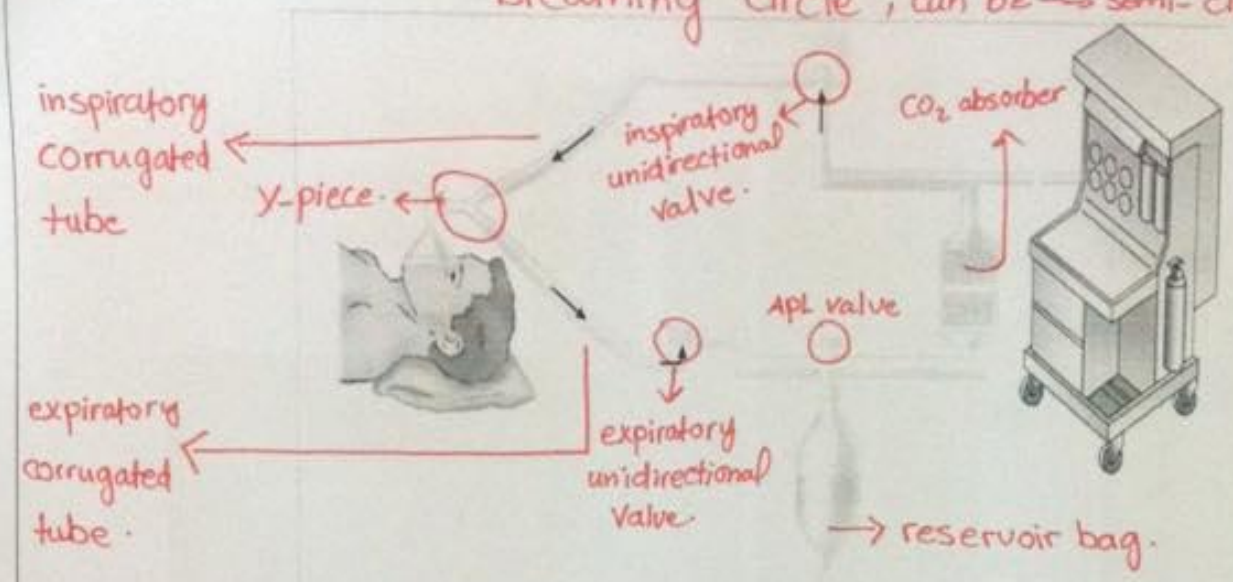




* Mapelson F (Jackson Rees)
* semi - open circuit.

* This is Tracheostomy tool attached to Mapelson E and it's called T- Piece which is a semi- open circuit

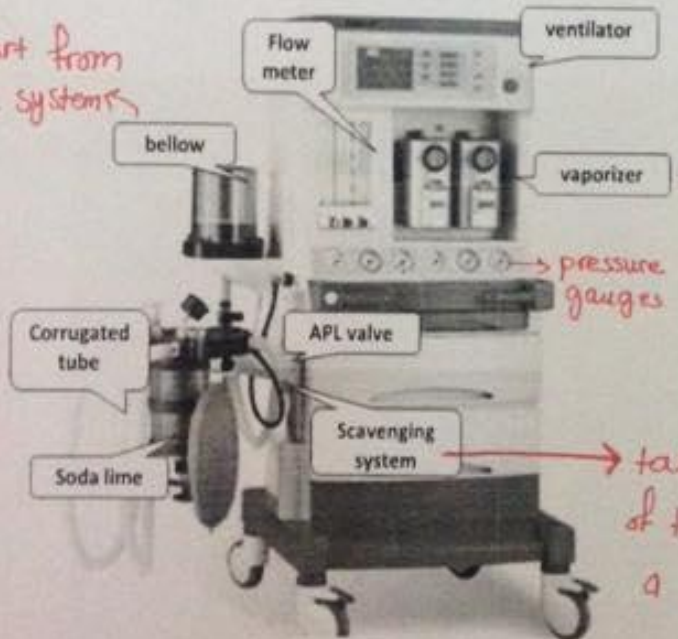
Breathing circle, can be → closed : with scavenging system
→ semi-closed : without scavenging system.



- The APL valve is used only during spontaneous breathing (maneual).
- The function of the APL valve is to control the pressure inside the circle,

⇒ when the APL vavle is closed, the pressure inside the reservoir bag will increase and create pressure gradient with the lung.

It is a part from the circle systems



→ converts the aneshetic drug from liquid to vapor.

yellow ⇒ sevoflurane (MAC = 2)
purple ⇒ isoflurane (MAC = 1.2)

→ take the waste gaz out of the operating theater, has a negative pressure

Q5) picture shows flowmeter and the q was what is the function of it and there is an arrow on CO2 absorbent and the q was identify the structure?

composed of : sodium hydroxide, pottasium hydroxide, calcium chloride, water, silica.

bobbin

→ function of the flow meter is measurment of the flow.

*when we open the N_2O flow, the O_2 will be opened (3 : 1)

N_2O O_2

proportioning system.

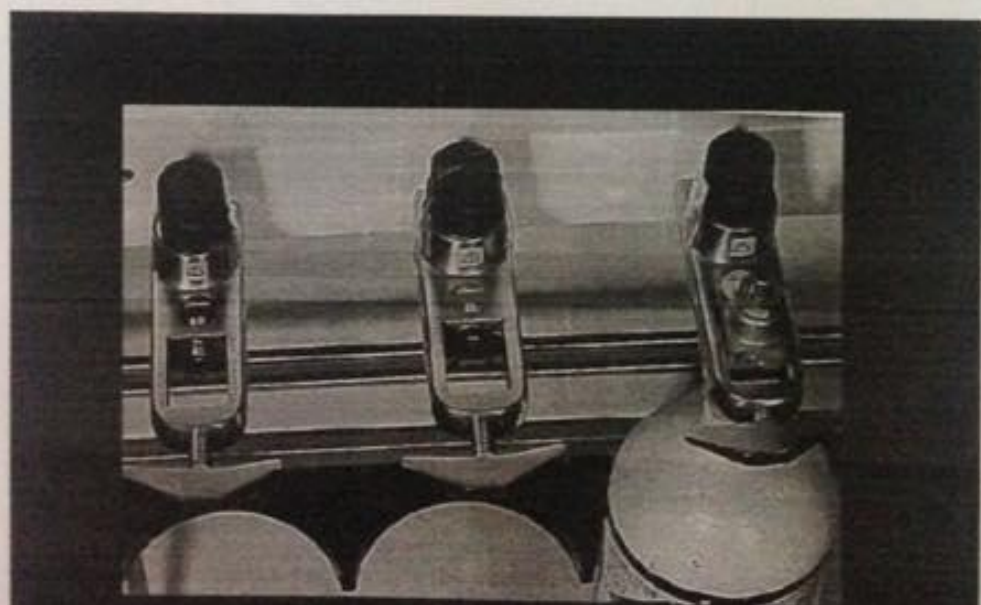
vaporizor

* sevoflurane is better for induction → non-irritant. (pleasant)
* sevo is more expensive than iso.
* sevo is used for pediatrics
* iso is more potent (less MAC value)
* sevo has more risk for emergance (awarness) because it has higher MAC value and less potency
* iso has faster offset

* go and see the colored picture

O_2 N_2O

The small one is E size (behind the anestheia machine)



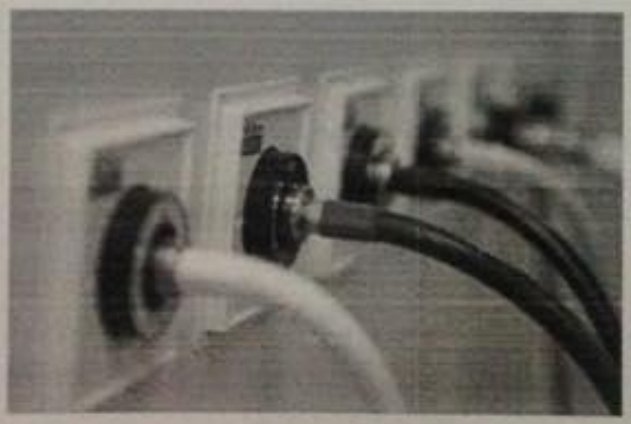
Anesthetic machine cylinder yoke

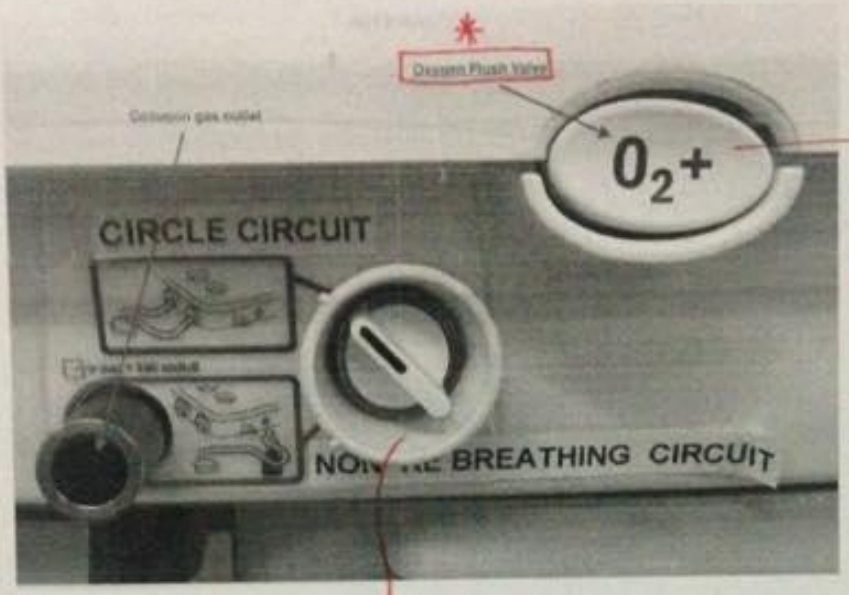
* It has safety system ⇒ every cylinder has it's special yoke

Hanger Yolk

- Hanger Yolk: orients and supports the cylinder, providing a gas-tight seal and ensuring a unidirectional gas flow into the machine
- Index pins: Pin Index Safety System (PISS) is gas specific→prevents accidental rearrangement of cylinders (e.g.. switching O2 and N2O)

Diameter index safety system (DISS)





→ it give O_2 at high pressure around (3 bar) in emergency cases e.g: Laryngeospasm

note : 1 bar = 760 mmHg

switch to transfer the system from circle → circuit
(closed) → (opened)

→ APL valve, it may be either in the circle or circuit system.

gauge pressure, it may be to
- the cylinder
- the pipeline
- the airway pressure.

① Face mask is rigid unlike the simple face mask which is rubber ② Face mask gives maximum FiO_2 around 100% but the simple face mask around 60%,

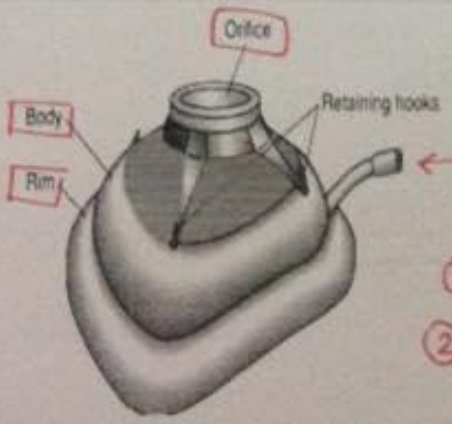
③ Face mask doesn't have ports but simple face mask does.

ambu bag
↓
self - inflating unlike the resivor bag.

PARTS OF FACEMASK

Body (Shell or Dome)

- Constitutes the main part of the mask
- Transparent facemask allows observation for vomitus, secretions , blood, lip color, and exhaled moisture and is better accepted by a conscious patient .

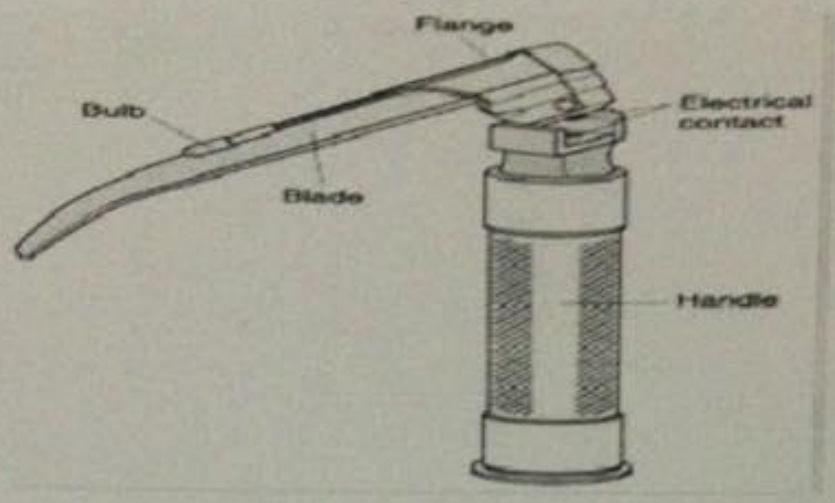


← important for inflating the cuff to:
① fit the patients face
② prevent any leak.

we can Know by it's color (blue) what does it contain (N_2O)

Nitrous cylinder valve and pin index

PRESSURE GAUGE



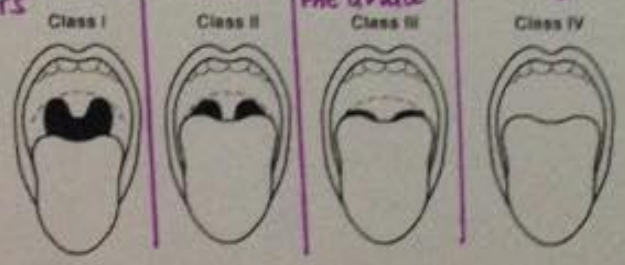
1

1. soft palate
2. hard palate.
3. uvula.
4. pillars

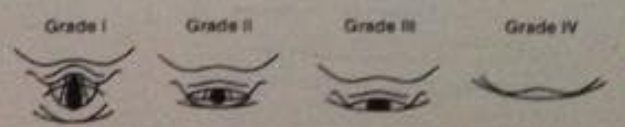
1. soft palate
2. uvula

1. soft palate
2. base of the uvula

hard palate only.



2



Source: Lalwani AK: Current Diagnosis & Treatment in Otolaryngology—Head & Neck Surgery, 2nd Edition: http://www.accessmedicine.com
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⇒ grade I : full view of glottis and epiglottis
grade II : epiglottis and posterior extrem of glottis
grade III : epiglottis only
grade IV : neither glottis nor epiglottis

1. (Mallampati classification)

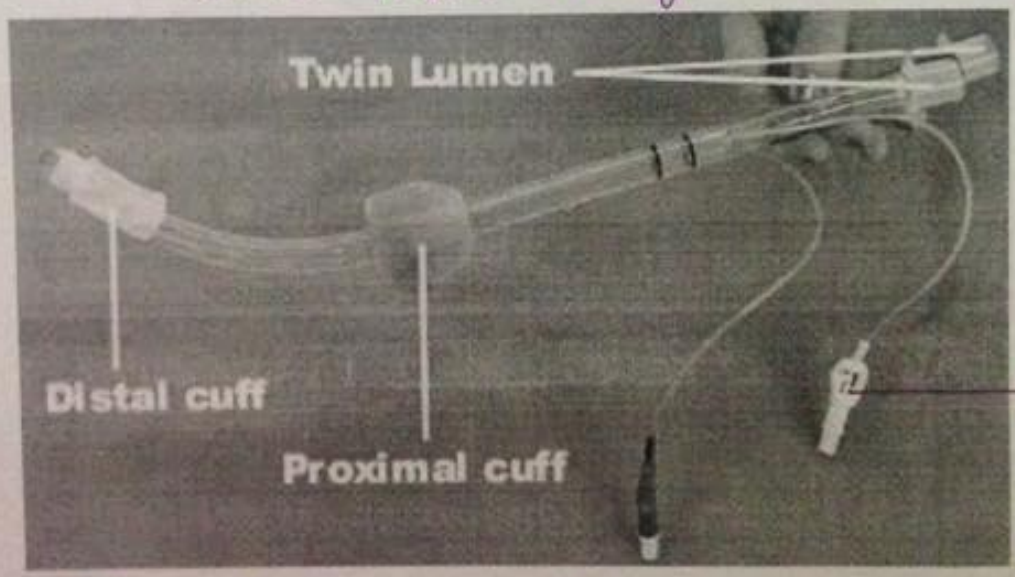
2. Cormack _lehane classification

This attaches to the mainstream analyzer (slide #4) to take CO_2 sample to the capnograph.

* This is HME (heat moisture exchanger)
* Function ? ① humidification : storge of the warm exhaled gaz from the patient and mixing it with the cold inhaled gaz from the machine.

② filtering (antibacterial)

Combi-tube airway



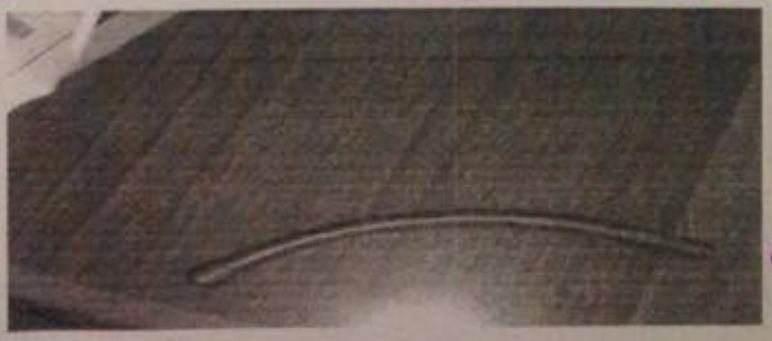
- blind induction airway device.
- The distal cuff is smaller in size than the proximal one.

· nasal airway

⇒ it is flexible , unlike the oral airway.

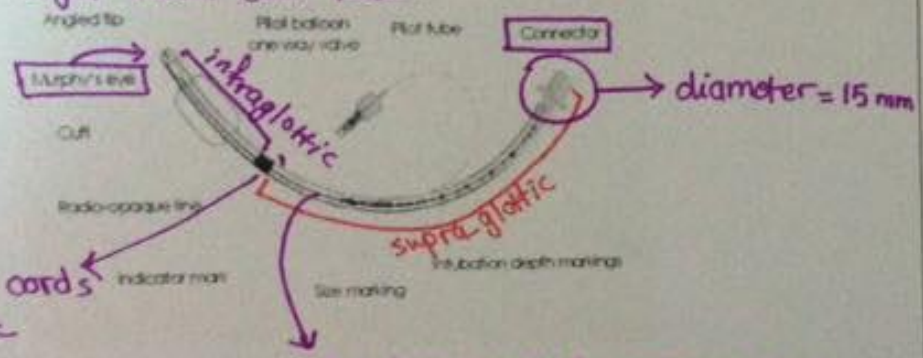
gag reflex ← Oral airway ⇒ To hold the tongue away from the posterior pharynx.

no gag reflex ← Nasal airway → contraindications :-



① nasal polyp
② basal skull fracture.
③ bleeding tendency

* in long term procedures we use low pressure high volum cuff tube.



this line is radiopaque, so that we can see the tube under the chest X-ray.

* (pre-formed endotracheal tube)

6- Child 6 years old:

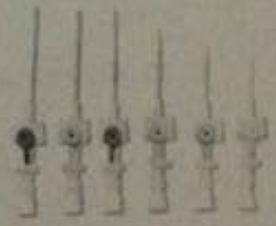
What is the suitable size of an endotracheal intubation?

- internal diameter $= 4 + \frac{Age}{4} = 5.5$ mm
- Length $= 12 + \frac{Age}{2} = 15$ mm

What is the depth of insertion?

* patient with RTA and hypovolemic shock ? green or gray.
* neonate ⇒ yellow.
* child ⇒ blue.

IV Cannula



important →

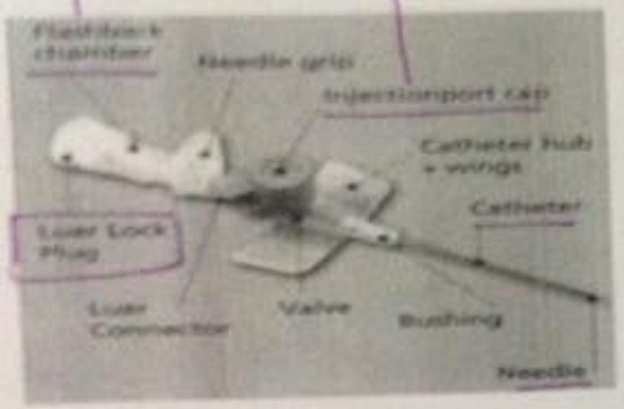
Gauge	14	16	18	20	22
Ext Dia (mm)	2.1	1.7	1.3	1.1	0.9
Length (mm)	45	45	45	25	25
Flow Rate (ml/min)	270	180	80	54	31

www.nurselk.com

you must memorize each canula with it color, gauge and flow rate !!

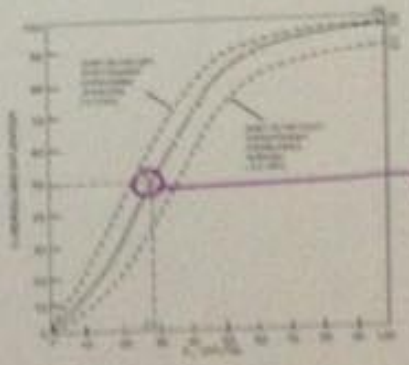
(in and out) flush

In flush only.



Tuohy needle (10 cm)

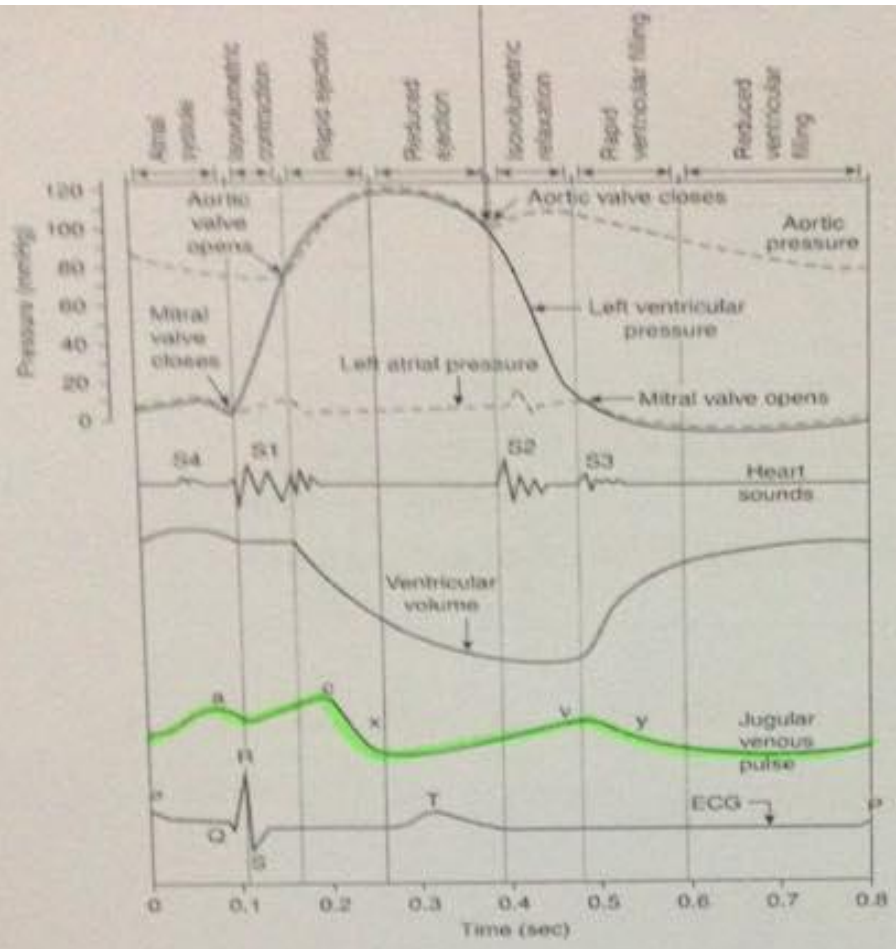
spinal needle.



This point is P_{50} = the O_2 tension at which haemoglobin is 50% saturated

→ normally 26 ± mmHg.

* The importance of P_{50} is to specify the position of O_2 dissociation curve.



e cardiac cycle.

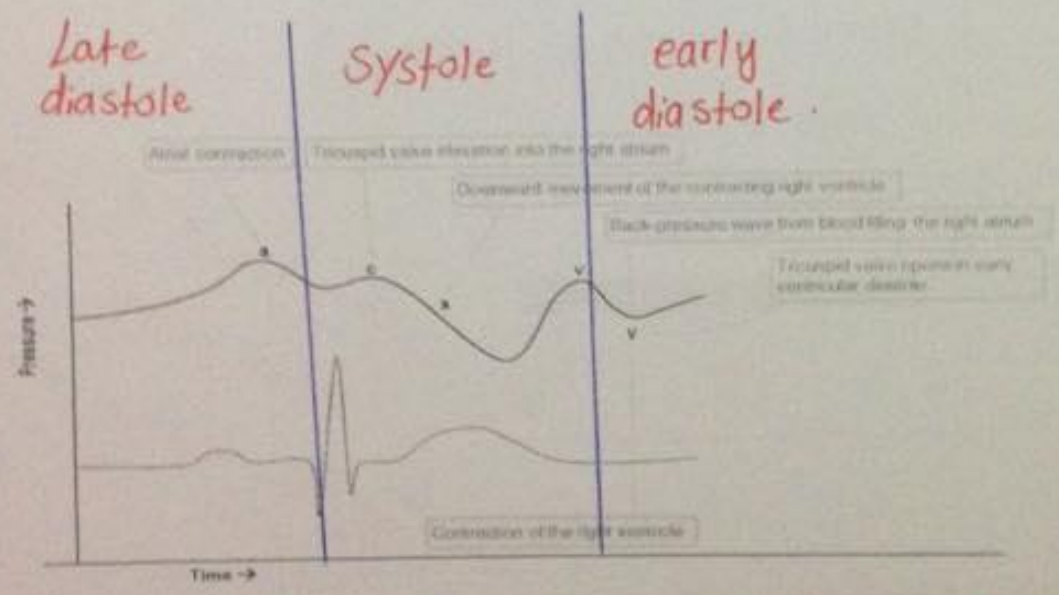
a: atrial contraction.

c: ventricular contraction and closure of the tricuspid valve (early systole)

x: continue ventricular contraction and atrial relaxation.

v: atrial filling.

y: opening of tricuspid valve (ventricular filling)



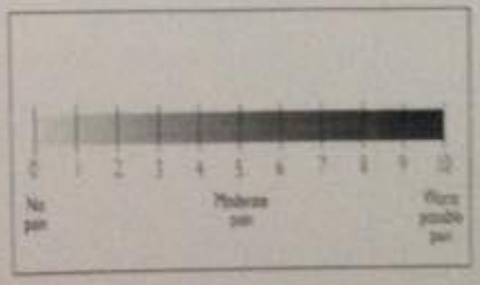
* wave a ⇒ The atrial contraction is active filling to the ventricle.

* wave y ⇒ passive filling, because of the pressure difference.

Table 4. Assessment of Hemorrhagic Shock

	Class I	Class II	Class III	Class IV
Percentage Blood Loss	0-15%	15-30%	30-40%	>40%
Percentage TBW Loss	0-2%	3-4%	6-8%	>8%
Heart Rate	<100	>100	>120	>140
Blood Pressure	Normal	Normal	Decreased	Decreased
Treatment	Rapid infusion of 1-2 L of crystalloid (e.g. Ringer's lactate), maintenance fluids	Rapid infusion of 2 L of crystalloid and re-evaluate	Rapid infusion of 2 L of crystalloid, replace losses with crystalloid (1:3) or pRBCs, colloid (1:1)	Rapid infusion of 2 L of crystalloid, replace losses with crystalloid (1:3) or pRBCs, colloid (1:1)
Note			Goal is to maintain urine output at >0.5 mL/kg/h	Goal is to maintain urine output at >0.5 mL/kg/h

(pain scoring system)



معظم الشعب الأردني
ال pain score
عندهم يساوي 10 :)

1-3 → mild pain → give (NSAID)

4-7 → moderat pain → give weak opioid (tramal, codiene)

8-10 → severe pain → give strong opioid (morphine).

CO_2 ABSORBERS

- Soda lyme composition: 80% calcium chloride, 15% water, 4% sodium hydroxide, and 1% potassium hydroxide.
  - Small amounts of silica added for hardness (and minimize alkaline dust).

* CO_2 absorber is whitish in color because most of it's content is calcium chloride (80%)

exhaustion of soda lime

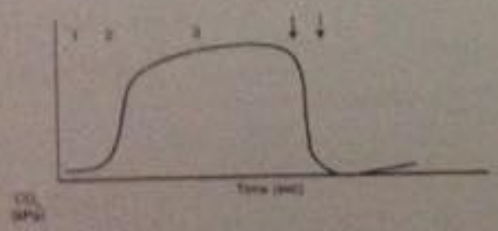


FIGURE 5-1. Capnography tracings.

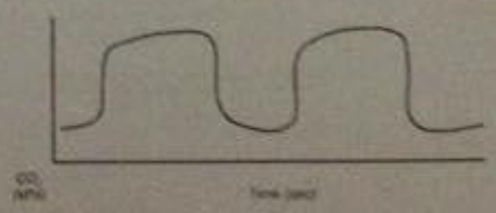


FIGURE 5-2. Capnograph (rebreathing).

* patient with brain edema → giving him glucose will increase his edema.

Q7) picture shows D5W (dextran 5water) and the q was what is the content of dextran mg/ml in this solution and if this solution hypo/iso/hyper tonic?

Table 6. IV Fluid Solutions

		ECF	Ringer's Lactate	0.9% NS	0.45% NS in D5W	D5W	2/3 D5W + 1/3 NS	Plasmalyte
mEq/L	Na^+	142	130	154	77	-	51	140
	K^+	4	4	-	-	-	-	5
	Ca^{2+}	4	3	-	-	-	-	-
	Mg^{2+}	3	-	-	-	-	-	3
	Cl^-	103	109	154	77	-	51	98
	HCO_3^-	27	28*	-	-	-	-	27
mOsm/L		280-310	273	308	154	252	201	294
pH		7.4	6.5	5.0	4.5	4.0	4.3	7.4

*Conversion to lactate

* any percentage when you multiply it by 10, the unit will be converted to mg/mL.

① D5W contains 5% glucose, which equals to 50 mg/mL.

② The solution is hypotonic (252 mOsm/L)

note: isotonic solution osmolarity is 290 ±10 mOsm/L

* what are the layers you go through when you introduce the needle in epidural anashesia?

skin
↓
subcutaneous fat
↓
supraspinatus ligament
↓
intraspinatus
↓
ligamentum flavum
↓
epidural space

Epidural and Spinal Anesthesia

- most useful for surgeries performed below level of umbilicus

Anatomy of Spinal/Epidural Area

- spinal cord extends to L2, dural sac to S2 in adults
- nerve roots (cauda equina) from L2 to S2
- needle inserted below L2 should not encounter cord, thus L3-L4, L4-L5 interspace commonly used
- structures penetrated
  - skin
  - subcutaneous fat
  - supraspinous ligament
  - interspinous ligament
  - ligamentum flavum (last layer before epidural space)
  - dura + arachnoid for spinal anesthesia

Table 9. Epidural vs. Spinal Anesthesia

	Epidural	Spinal
Injection Site	LA injected in epidural space (space between ligamentum flavum and dura) Initial blockade is of the spinal roots followed by some degree of spinal cord anesthesia as LA diffuses into the subarachnoid space through the dura	LA injected into subarachnoid space in the dural sac surrounding the spinal cord and nerve roots
Onset	Sensory and blockade in approx 10-15 min Slower onset of side effects	Rapid blockade (onset in 2-5 min)
Effectiveness	Effectiveness of blockade can be variable	Very effective blockade
Difficulty	Technically more difficult, greater failure rate	Easier to perform due to visual confirmation of CSF flow
Patient Positioning	Position of patient not as important; specific gravity not as issue	Hyperbaric LA solution – position of patient important

spinal anashesia

① rapid and more effective than the epidural.

② more risk of epidural puncture.

* epidural anasthesia → needs more titration.

Table 9. Epidural vs. Spinal Anesthesia (continued)

	Epidural	Spinal
Specific Gravity/Spread	Epidural injections spread throughout the potential space; specific gravity of solution does not affect spread	LA solution may be made hyperbaric (of greater specific gravity than the cerebrospinal fluid) by mixing with 10% dextrose, thus increasing spread of LA to the dependent (low) areas of the subarachnoid space
Dosage	Larger volume/dose of LA (usually > toxic IV dose)	Smaller dose of LA required (usually < toxic IV dose)
Continuous Infusion	Use of catheter allows for continuous infusion or repeat injections	None
Complications	Failure of technique Hypotension Bradycardia (cardiac sympathetics blocked (only if ~ T2-4 block), e.g. "high spinal" Epidural or subarachnoid hematoma Accidental subarachnoid injection can produce spinal anesthesia (and any of the above complications) Systemic toxicity of LA (accidental intravenous) Catheter complications (kinking, looping, vascular or subarachnoid placement) Infection Dural puncture	Failure of technique Hypotension Bradycardia (cardiac sympathetics blocked (only if ~ T2-4 block), e.g. "high spinal" Epidural or subarachnoid hematoma Post-spinal headache (CSF leak) Transient paresthesias Spinal cord trauma, infection
Combined Spinal-Epidural	Combines the benefits of rapid, reliable, intense blockade of spinal anesthesia together with the flexibility of an epidural catheter	

Contraindications to Spinal/Epidural Anesthesia

- absolute contraindications
  - lack of trained personnel
  - lack of resuscitative drugs/equipment
  - patient refusal
  - allergy to local anesthetic
  - infection at puncture site or underlying tissues
  - coagulopathies/bleeding diathesis
  - raised ICP
  - sepsis/bacteremia
  - severe hypovolemia
  - cardiac lesion with fixed output states (e.g. severe mitral/aortic stenosis)
  - lack of IV access
- relative contraindications
  - pre-existing neurological disease (demyelinating lesions)
  - previous spinal surgery, severe spinal deformity
  - prolonged surgery
  - major blood loss or maneuvers that can compromise reaction

Pharmacological family	phenol	Barbiturate	phencyclidine	Benzodiazepines.

Table 4. Intravenous Induction Agents

	Propofol (Diprivan®)	Thiopental (sodium thiopental, sodium thiopentone)	Ketamine (Ketalar®, Ketaject®)	Benzodiazepines (midazolam [Versed®], diazepam [Valium®], lorazepam [Ativan®])
Class	• Alkylphenol – hypnotic	• Ultra short-acting thiobarbiturate – hypnotic	• Phencyclidine (PCP) derivative – dissociative	• Benzodiazepines – anxiolytic
Action	• Inhibitory at GABA synapse • Decreased cerebral metabolic rate and blood flow, decreased ICP, decreased SVR, decreased BP, and decreased SV	• Decreased Ca2+ channels open, facilitating GABA and suppressing glutamic acid • Decreased cerebral metabolism and blood flow, decreased CPP, decreased CO, decreased BP, decreased reflex tachycardia, decreased respiration	• May act on NMDA, opioid, and other receptors • Increased HR, increased BP, increased SVR, increased coronary flow, increased myocardial O_2 uptake • CNS and respiratory depression, bronchial smooth muscle relaxation	• Causes increased glycine inhibitory neurotransmitter, facilitates GABA • Produces anxiolytic and skeletal muscle relaxant effects • Minimal cardiac depression
Indications	• Induction • Maintenance • Total intravenous anesthesia (TIVA)	• Induction • Control of convulsive status	• Major trauma, hypovolemia, severe asthma because sympathomimetic	• Used for sedation, amnesia, and anxiolysis
Caution	• Allergy (egg, soy) • Patients who cannot tolerate sudden decreased BP (e.g. fixed cardiac output or shock)	• Allergy to barbiturates • Uncontrolled hypotension, shock, cardiac failure • Porphyria, liver disease, status asthmaticus, myxedema	• Ketamine allergy • TCA medication (prolonged action causes HTN and dysphoria) • History of psychosis • Patients who cannot tolerate HTN (e.g. CHD, increased ICP, aneurysm)	• Marked respiratory depression
Dosing	• IV induction: 2.5-3.0 mg/kg (less with opioids) • Unconscious: <1 min • Lasts 4-6 min • $t_{1/2}$ = 55 min • Decreased post-operative sedation, recovery time, N/V	• IV induction: 3-5 mg/kg • Unconscious effect 30 s • Lasts 5 min • Accumulation with repeat dosing – not for maintenance • $t_{1/2}$ = 5-10 h • Post-operative sedation lasts hours	• IV induction 1-2 mg/kg • Dissociation in 15 s, analgesia, amnesia, and unconsciousness in 45-60 s • Unconscious for 10-15 min, analgesia for 40 min, amnesia for 1-2 h • $t_{1/2}$ = ~2 h	• Onset less than 5 min if given IV • Duration of action long but variable/unpredictable
Additional Notes	• 0-30% decreased BP due to vasodilation • Reduce burning at IV site by mixing with lidocaine	• Combining with neuromuscular causes prolongation to form	• High incidence of emergence reactions (vivid dreaming, out-of-body sensation, illusions) • Pretreat with glycopyrrolate to decrease salivation	• Antagonist: flumazenil (Romazicon®) competitive inhibitor, 0.2 mg IV over 15 s, repeat with 0.1 mg/min (max of 2 mg), $t_{1/2}$ of 60 min • Midazolam also has amnestic (retrograde) effect and increased risk of thrombophlebitis

* The uses of these drugs → ① induction of anesthesia
② maintenance of anesthesia
③ anxiolytic (diazepam)
④ sedation.
⑤ anti-epileptic.

* The doctor mentiond these SEs ....

	CV	Pulmonary	Cerebral	Other
Barbiturates	Depression of central vasomotor center in the brain stem: vasodilation and ↑ HR	V_T and MV ↓. Normal response to hypoxia and hypercapnia is blunted.	Vasoconstriction, ↓ CBF and ICP, $CMRO_2$ ↓: protection to global ischemia	Known to induce aminolevulinic acid synthetase, may precipitate acute intermittent porphyria
Benzodiazepines	Minimal change in BP, HR, and CO. However, with combination of opioids, SVR and BP can ↓.	Normal response to CO_2 is minimally affected.	$CMRO_2$ is mildly depressed along with CBF and ICP, much less than barbiturates. Not known to be significantly neuroprotective.	
Opioids	Do not tend to be myocardial depressants. Histamine release associated with morphine and meperidine.	Depress ventilation. Normal response to CO_2 is blunted, ↑ resting pCO_2. Associated with chest wall rigidity.	Cause ↓ in $CMRO_2$, CBF and ICP activation of chemoreceptor trigger zone induces nausea and vomiting.	Gastrointestinal: slower gastric emptying and peristalsis, ileus and constipation.
Ketamine	BP, HR, and CO are all ↑ due to CNS sympathetic stimulation.	Normal ventilation and airway reflexes are maintained. Potent bronchodilation.	$CMRO_2$, CBF, and ICP are all ↑, unlike other nonvolatile agents.	Shares similar structure as phencyclidine, therefore similar psychomimetic effects including ↑ in ICP and hallucinations.
Etomidate	No significant effects on myocardial contractility, BP, and CO.	Ventilation is maintained; induction typically does not cause apnea.	Like barbiturates, CBF, ICP, and $CMRO_2$ are all ↓.	Inhibition of 11-β hydroxylase and adrenocortical suppression are seen.
Propofol	Direct myocardial depressant, vasodilation.	Normal response to hypoxia and hypercapnia are blunted.	CBF and ICP are ↓.	Antipruritic and antiemetic properties, effective in terminating status epilepticus.

BP, blood pressure; CBF, cerebral blood flow; $CMRO_2$, cerebral metabolic rate of O_2; CO, cardiac output; HR, heart rate; ICP, intracranial pressure; MV, minute ventilation; pCO_2, partial pressure of carbon dioxide; V_T, tidal volume.

* propofol:
1. hypotension.
2. bradycardia.
3. pain on injection

* Thiopental:
1. hypotension.
2. Tachycardia
3. bronchospasm

* Ketamine:
1. hypertension.
2. Tachycardia

* Benzodiazepines
respiratory depression.

* All of them cause nausea and vomiting except Propofol (anti emetic)

* Ketamine is the most one to cause bronchodilation

Table 12. Opioids

Agent	Relative Dose to 10 mg Morphine IV	Moderate Dose	Onset	Duration	Special Considerations
Codeine	200 mg PO	15-30 mg PO	Late (30-60 min)	Moderate (4-6 h)	Primarily post-operative use, not for IV use
Meperidine (Demerol®)	75 mg IV	2-3 mg/kg IV	Moderate (10 min)	Moderate (2-4 h)	Anticholinergic, hallucinations, less pupillary constriction than morphine, metabolite build up may cause seizures
Morphine	10 mg IV 20 mg PO	0.2-0.3 mg/kg IV 0.4-0.6 mg/kg PO	Moderate (5-10 min)	Moderate (4-5 h)	Histamine release leading to decrease in BP
Oxycodone Controlled Release	15 mg PO	10-20 mg PO (no IV)	Late (30-45 min)	Long (8-12 h)	Do not split, crush, or chew tablet
Oxycodone Regular Tablet	15 mg PO (no IV)	5-15 mg PO	Moderate (15 min)	Moderate (3-6 h)	Percocet® = oxycodone 5 mg + acetaminophen 325 mg
Hydromorphone (Dilaudid®)	2 mg IV 10 mg PO	40-60 µg/kg IV 2-4 mg PO	Moderate (15 min)	Moderate (4-5 h)	
Fentanyl	100 µg IV	2-3 µg/kg IV	Rapid (<5 min)	Short (0.5-1 h)	Transient muscle rigidity in very high doses
Remifentanil	100 µg IV	0.5-1.5 µg/kg IV	Rapid (1-2 min)	Ultra short (<10 min)	Only use during induction and maintenance of anesthesia

In general, parenteral route is 2-3 times potent than oral

* opioids side effects :-

1. respiratory depression
2. addiction, euphoria
3. ileus (constipation)
4. miosis

Table 14. Volatile Inhalational Agents

	Sevoflurane	Desflurane	Isoflurane	Enflurane	Halothane	Nitrous oxide (N_2O)*
MAC (% gas in O_2)	2.0	6.0	1.2	1.7	0.8	104
CNS	Increased ICP	Increased ICP	Decreased cerebral metabolic rate Increased ICP	ECG seizure-like activity Increased ICP	Increased ICP and cerebral blood flow	—
Resp	Respiratory depression (severely decreased TV, increased RR), decreased response to respiratory CO_2 reflexes, bronchodilation					—
CVS	Less decrease of contractility, stable HR	Tachycardia with rapid increase in concentration	Decreased BP and CO, increased HR, theoretical choice of coronary steal**	Stable HR, decreased contractility	Decreased BP, CO, HR, and conduction Sensitizes myocardium to epinephrine-induced arrhythmias	Can cause decreased HR in pediatric cases in those with existing heart disease
MSK	Muscle relaxation, potentiation of other muscle relaxants, uterine relaxation					

*Properties and Adverse Effects of N_2O

Due to its high MAC, nitrous oxide is combined with other anesthetic gases to obtain surgical anesthesia. A MAC of 104% is possible in a pressurized chamber only.

Second Gas Effect: see Determinants of Speed of Onset of Volatile Anesthetics solubility, A17

Expansion of closed spaces: closed spaces such as pneumothorax, the middle ear, bowel lumen, and ETT cuff will markedly enlarge if N_2O is administered.

Diffusion hypoxia: during anesthesia, the washout of N_2O from body stores into alveoli can dilute the alveolar (O_2), creating a hypoxic mixture if the original (O_2) is low.

**Coronary steal: isoflurane causes small vessel dilation which may compromise blood flow to areas of the heart with fixed perfusion (e.g. stenosis, atherosclerosis)

Table 14. Depolarizing Muscle Relaxants (Non-Competitive): Succinylcholine (SCh)

Mechanism of Action	Mimics ACh and binds to AChr receptors causing prolonged depolarization, initial fasciculation may be seen, followed by temporary paralysis secondary to desensitized AChr receptors by SCh.
Induction Dose	1.1-1.5 mg/kg
Onset	30-60 s - RAPID (Recall of all muscle relaxants)
Duration	3-5 min - SHORT (only depolarizing agent for SCh)
Metabolism	SCh is hydrolyzed by plasma cholinesterase (pseudocholinesterase), found only in plasma and not on the NMJ
Indications	• Rapid intubation • Increased risk of aspiration (based regard paralysis and airway control) • Short procedures (e.g. full abdominal, fracture healing, cleaning, pregnancy, trauma) • Neuromuscular disorders (SCh ↑) • Laryngospasm
Side Effects	1. SCh also stimulates nicotinic cholinergic autonomic receptors (in addition to neuromuscular receptors) • May cause bradycardia, dysrhythmias, sinus arrest, increased secretions of salivary glands (especially in children) 2. Hyperkalemia: • Disruption of motor nerve activity causes proliferation of extrajunctional (outside NMJ) cholinergic receptors • Depolarization of an increased number of receptors by SCh may lead to massive release of potassium out of muscle cells • Patients at risk: • 3rd degree burns 24 h to 6 mos after injury • Traumatic paralysis or neuromuscular diseases (e.g. muscular dystrophy) • Severe intracranial infection • Severe closed head injury • Upper motor neuron lesions 3. Can trigger MH 4. Increased IOP/intracranial pressure/intragastric pressure (no increased risk of aspiration if compressed lower esophageal sphincter) 5. Pseudocholinesterase, prolonged paralysis (myalgia) – may be minimized if small dose of non-depolarizing agent given before SCh administration
Contraindications: Absolute	Known hypersensitivity or allergy, positive history of malignant hyperthermia, myopathy (in congenital, inc. myotonia), pseudocholinesterase congenital, high risk for hyperkalemia complication
Relative	Known history of plasma cholinesterase deficiency, myasthenia gravis, myasthenic syndrome, familial periodic paralysis, open eye injury

Table 15. Non-Depolarizing Muscle Relaxants (Competitive)

Mechanism of Action	Competitive blockade of postsynaptic AChr receptors preventing depolarization				
Classification	Short	Intermediate			Long
	Mivacurium	Rocuronium	Vecuronium	Cisatracurium	Pancuronium
Induction Dose (mg/kg)	0.2	0.6-1.0	0.1	0.2	0.1
Onset (min)	2-3	1.5	2-3	3	3-5
Duration (min)	15-25	30-45	45-60	40-60	90-120
Metabolism	Plasma cholinesterase	Liver (biliary) Renal (trace)	Liver	Hofmann Elimination	Renal (major) Liver (minor)
Indications	A wide indication, except in patients at risk for histamine release, such as those with severe renal failure, severe bronchospasm, or severe hypotension, and patients sensitive to SCh				
Side Effects:					
Histamine Release	Yes	No	No	No	No
Other	—	—	—	—	Tachycardia
Contraindications	Increased duration of action in renal or liver failure	Quick onset of neuromuscular blocks, do use in rapid sequence intubation Cisatracurium is good for patients with renal or hepatic insufficiency			Pancuronium at increased HR and BP desired

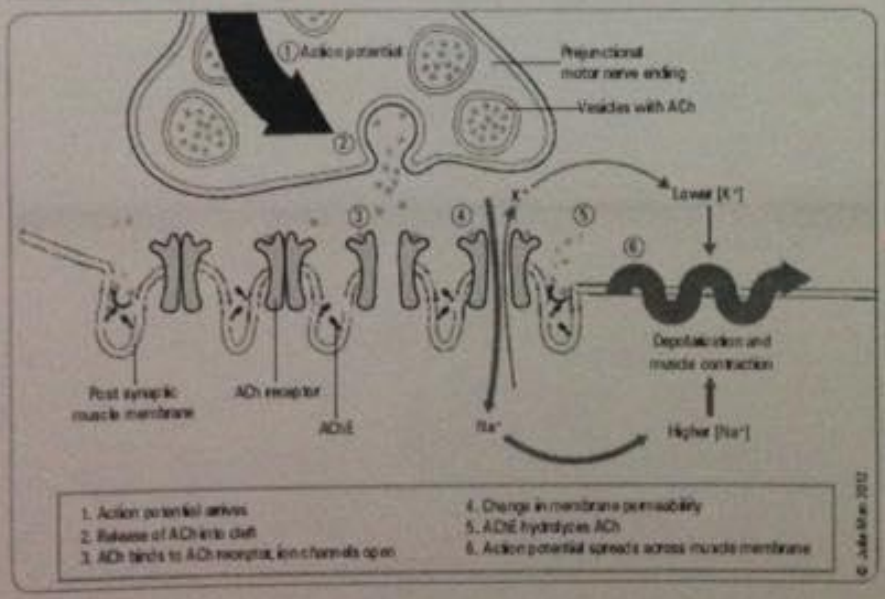
* contraindications of succinylcholine :

1. hyperKalemia
2. malignant hyperthermia.

* mention diseases affect this region :- (neuromuscular junction)

① myasthenia gravis ② Tetany

③ Lambert - eaton.



* note that gullian barre disease does not affect the junction, it affects the nerve it self

* side effects of these drugs: (increase the parasympathatic effect)

1. bradycardia. 2. salivation 3. Lacrimation
4. urination 5. diarrhe 6. meiosis.

Table 17 (Reversal Agents for Non-Depolarizing Relaxants)

Cholinesterase Inhibitor	Neostigmine	Pyridostigmine	Edrophonium
Onset and Duration	Intermediate	Longest	Shortest
Mechanism of Action	Inhibits enzymatic degradation of ACh, increases ACh at nicotinic and muscarinic receptors, displaces non-depolarizing muscle relaxants Muscarinic effects of reversing agents include unwanted bradycardia, salivation, and increased bowel peristalsis*		
Dose	0.04-0.08 mg/kg	0.1-0.4 mg/kg	0.5-1 mg/kg
Recommended Anticholinergic	Glycopyrolate	Glycopyrolate	Atropine
Dose of Anticholinergic per mg	0.2 mg	0.05 mg	0.014 mg

*Atropine and glycopyrolate are anticholinergic agents administered during the administration of reversal agents to minimize muscarinic effects

we give epinephrine to make vasoconstriction and increase the duration of action

Table 18. Local Anesthetic Agents

	Maximum Dose	Maximum Dose with Epinephrine	Potency	Duration
chloroprocaine	11 mg/kg	14 mg/kg	Low	15-30 min
lidocaine	5 mg/kg	7 mg/kg	Medium	1-2 h
bupivacaine	2.5 mg/kg	3 mg/kg	High	3-8 h
ropivacaine	2.5 mg/kg	3 mg/kg	High	2-8 h

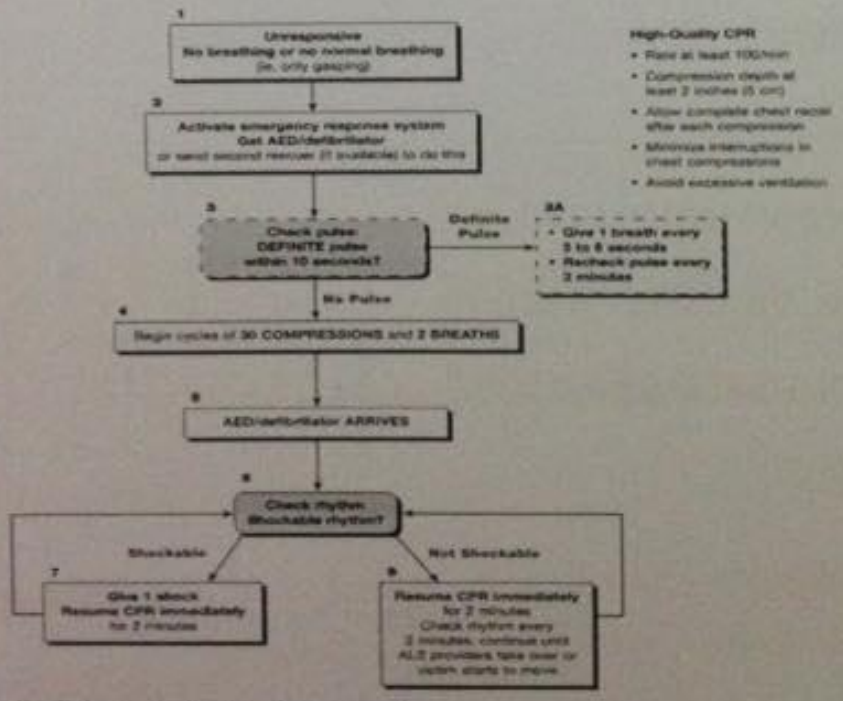
works on Na channel

* do not give IV bupivacaine ⇒ highly cardiotoxic

* Glycopyrolate is recommended with < neostigmine. / pyridostigmine.

* Atropine is recommended with Edrophonium.

Adult BLS Healthcare Providers



Note: The boxes bordered with dashed lines are performed by healthcare providers and not by lay rescuers.

Advanced Cardiac Life Support (ACLS) Guidelines

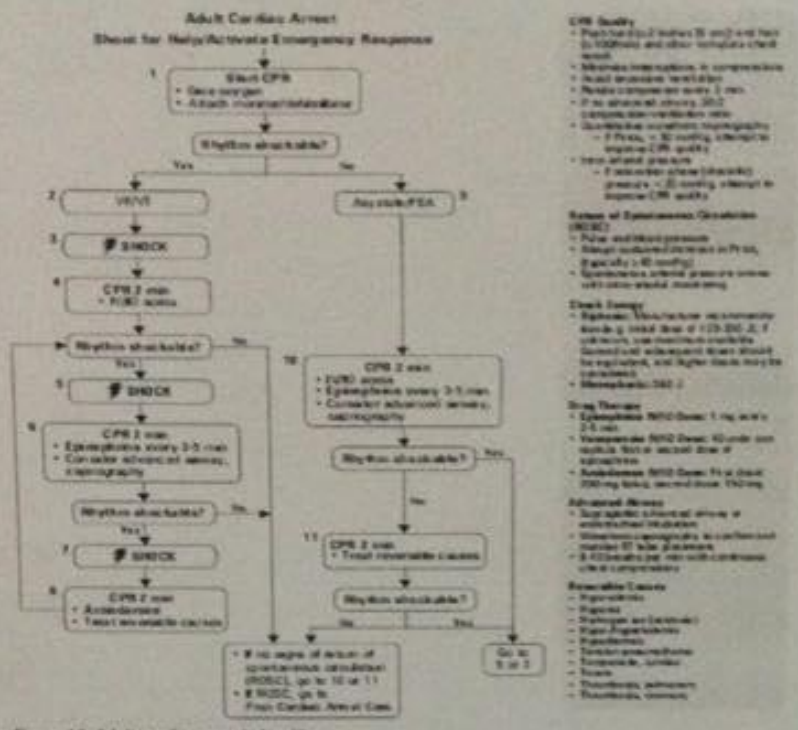
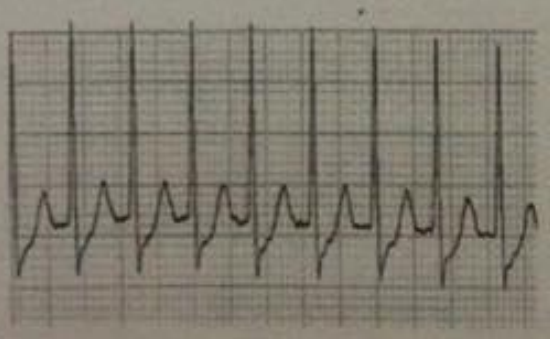
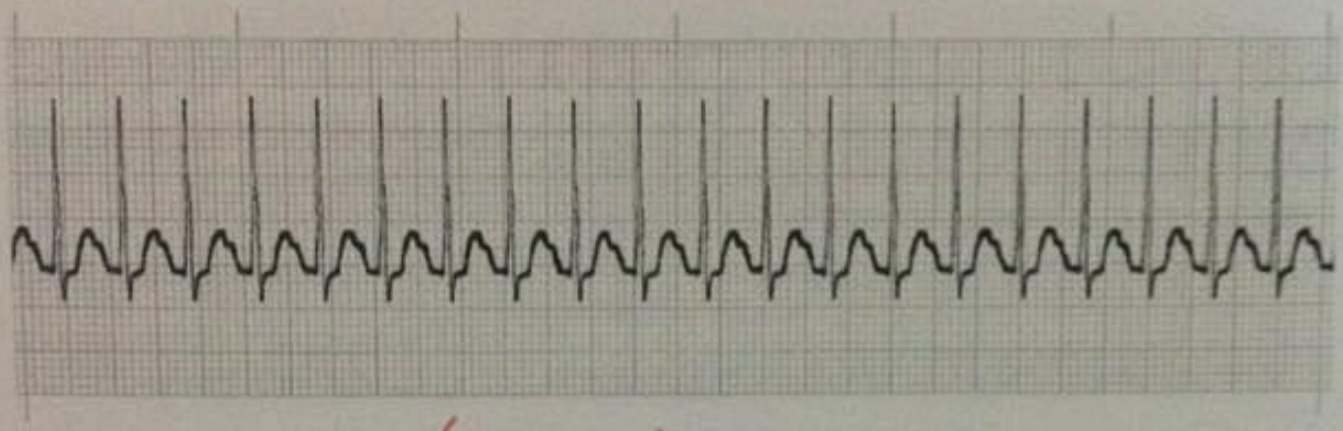


Figure 16. Adult cardiac arrest algorithm

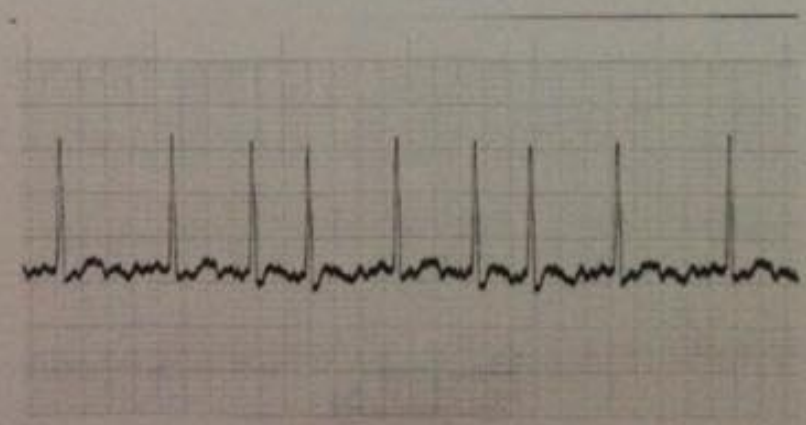
3- a patient presented to you with this ECG, the patient was fully conscious, not in pain, normal vital signs.



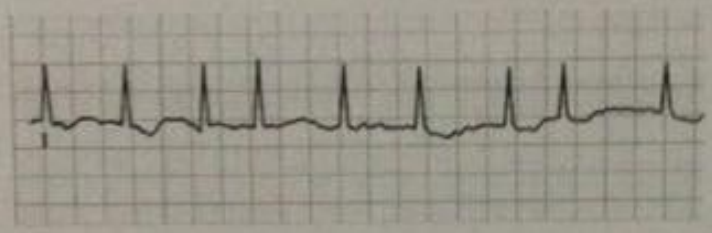
- This represents SVT
- patient is stable, the managment will be < vagal maneuvers / adenosine.
- if he is unstable, the managment will be (DC shock).



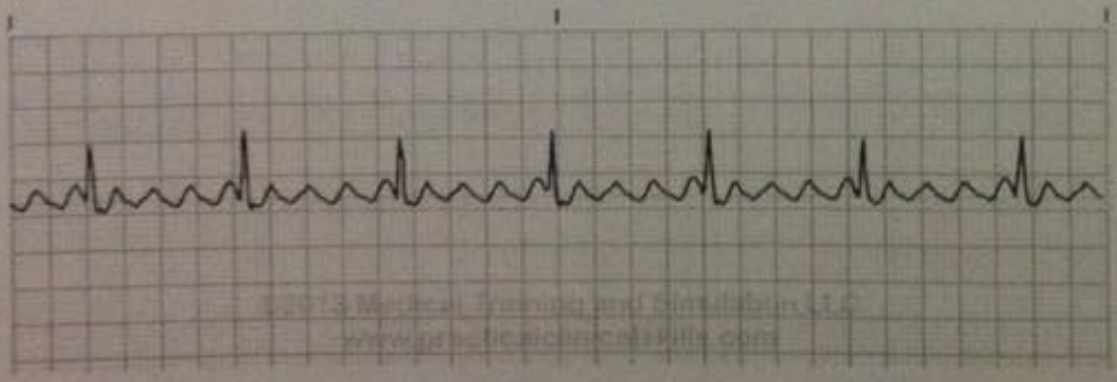
(SVT)



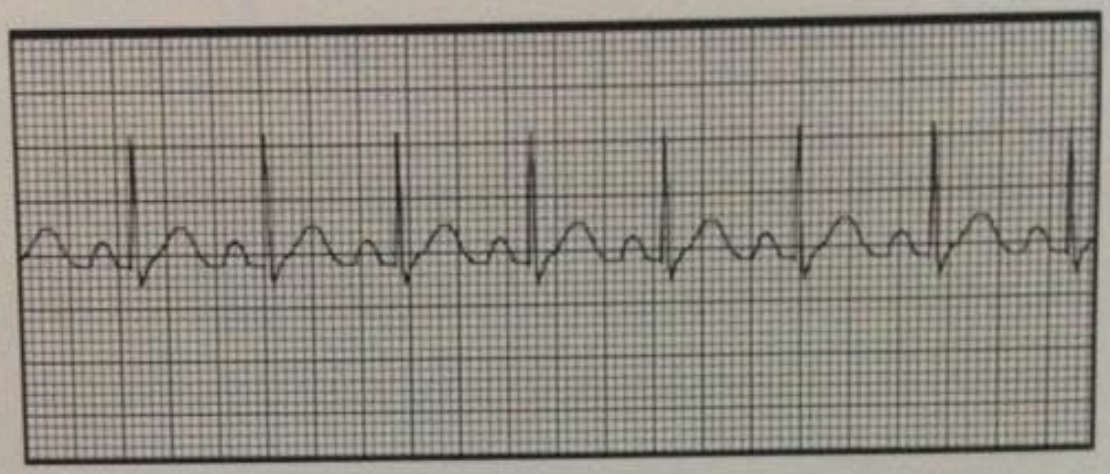
(AFib)



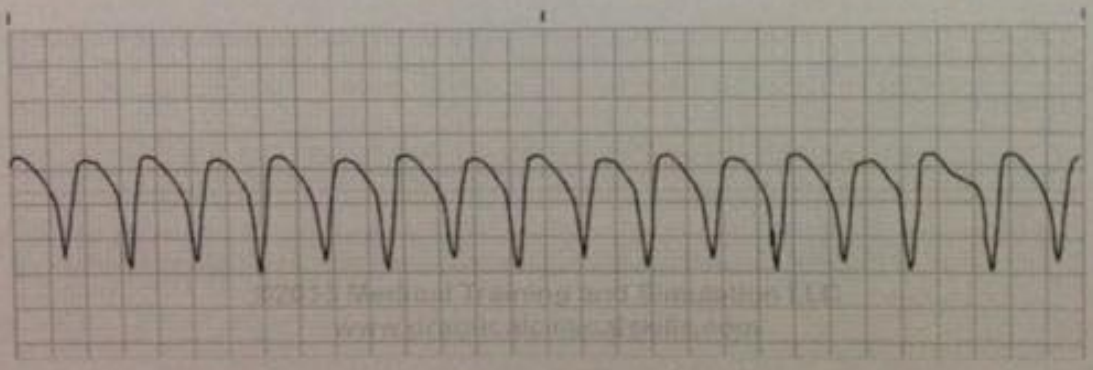
(AFib)



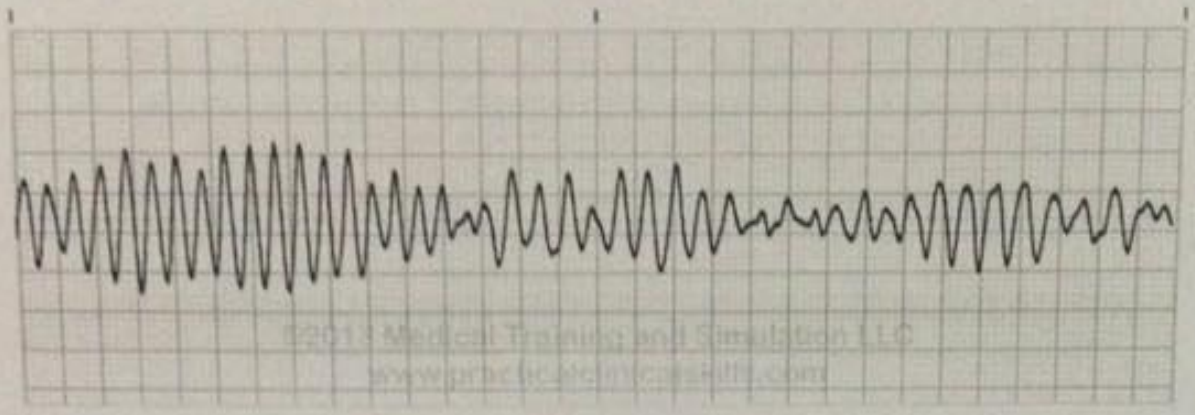
(Atrial Flutter)



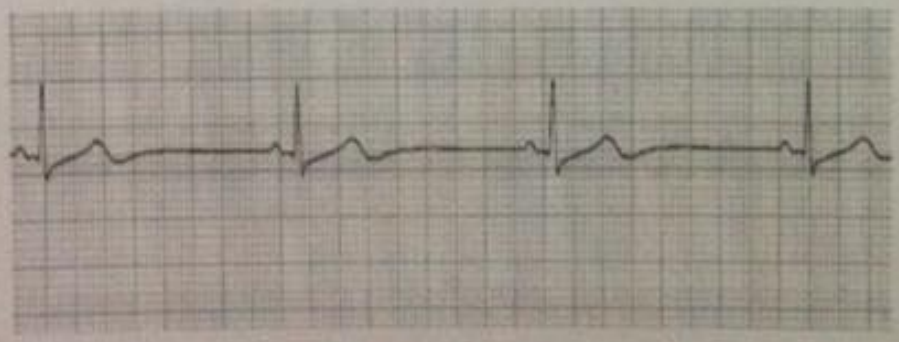
Sinus tachycardia



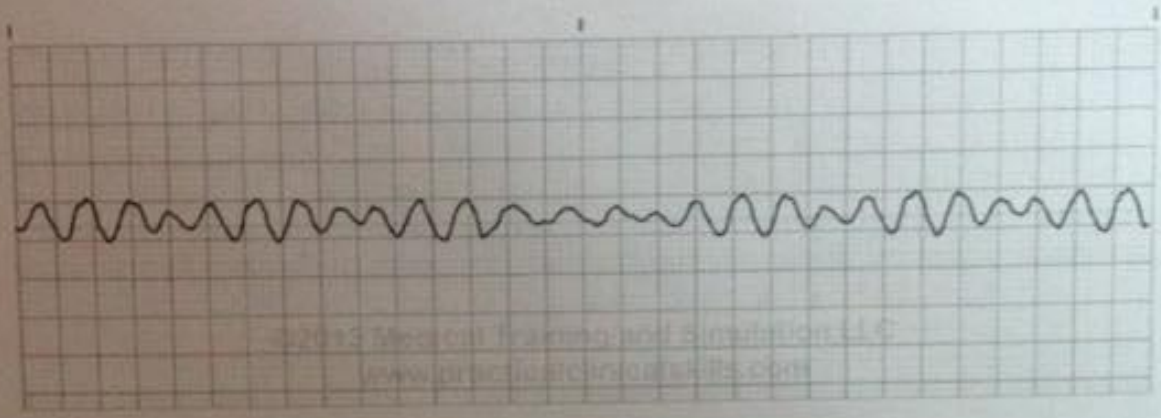
Ventricular tachycardia
(monomorphic)



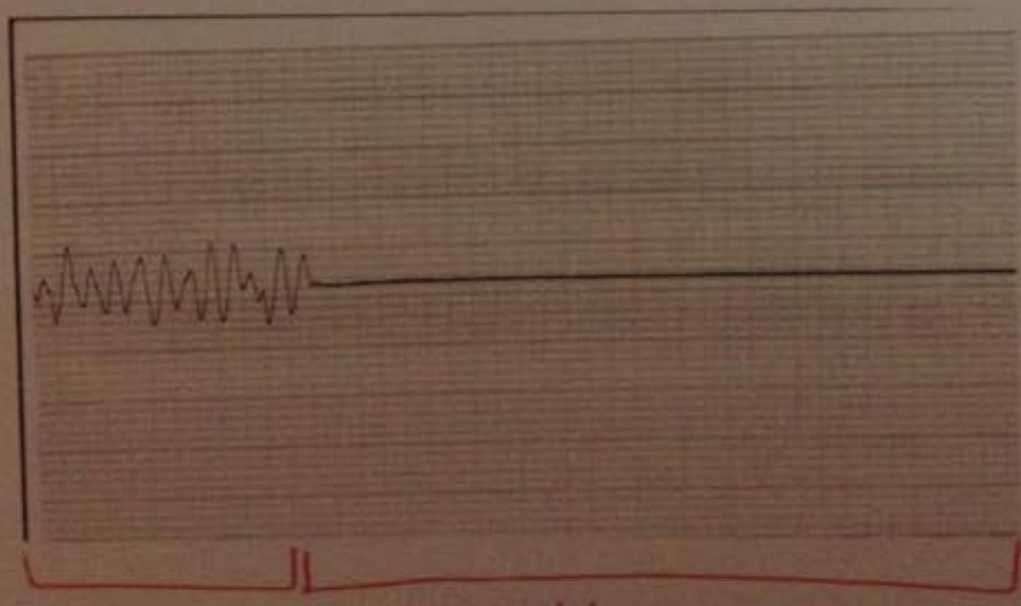
polymorphic ventricular tachycardia
(Torsade de pointes)



- sinus brady cardia.
- Drug of choice : Atropine



- ventricular fibrillation. (coarse)
- managment: asynchronized Dc shock.



VFib (shockable) ⟶ asystole. (nonshockable)

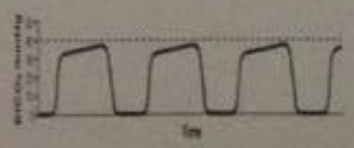
* where should you put the pedals of the defibrillator?
- one is apical → left anterior axillary line between the 4th and 5th rib.
- the other one is sternal → right lateral border of the sternum, 2nd intercostal space.

Q10) mention two types of this device and two indications for its usage

* Types : ① monophasic
② biphasic → الدكتور ما جاوب هذا السؤال، بس بتوقع هيك يكون

* indications : ① VFib
② pulsless VTac.

Q12) give two measurements that can be taken from this graph: ① end tidal CO_2
② Resp. rate.

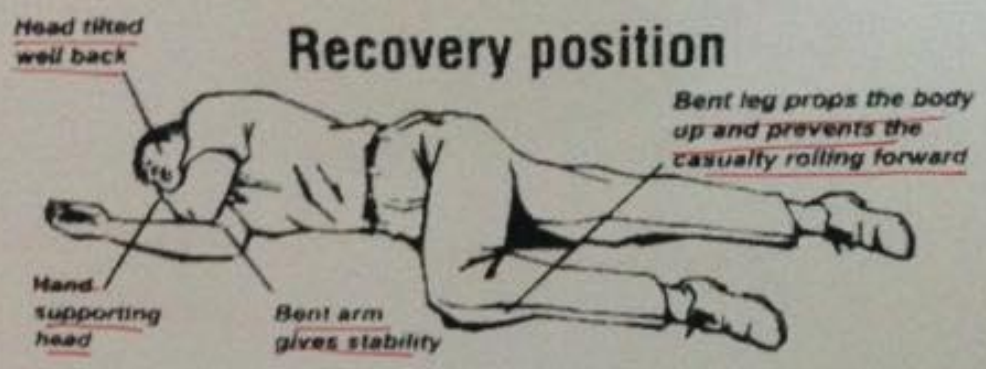


pulse wave

* pulse oxymeter
- 98 represent O_2 sat.
- 64 represent the pulse.

Q9) identify four events in this picture? head tilt, chin lift, look, listen, feel

Breathing monitoring.



* The importance of this position e-
① Keep the airway opened.
② prevent the gastric content aspiration.

* she's checking for responsiveness of patient, which is part from the BLS.

* chest compression, part of both BLS and ALS

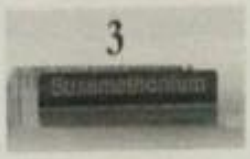
11-A) what is

B) mention two ways to counteract it?

① neostigmine

② pyridostigmine.

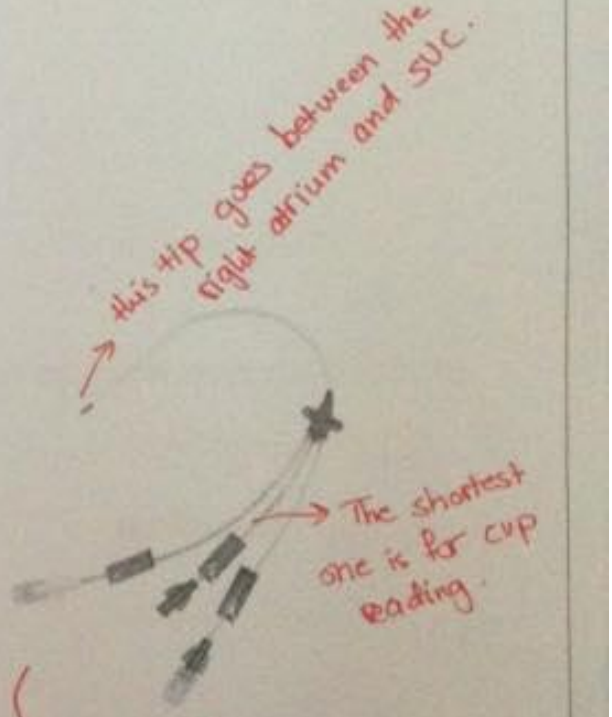
- 12- match:
- -Long acting analgesic..4
- -most potent analgesic..2
- -depolarizing muscle relaxant..3
- -short acting muscle relaxant 3



13- A) What is this? central line used for CVP measurment

B) Mention two complications of its use

1. pneumothorax.
2. Bleeding and hematoma
3. arterial puncture.
4. infection.
5. arrhythmias.



This is IV set.

14- In ALS, if the rhythm is shockable, explain the doses and administration of the drugs.

Adrenaline 1 mg
amiodarone 300 mg } IV or intraosseous

* he Is doing flushing.
why? to insure no bulging, no resistance.

1) pictures about endotracheal tubes and the is match between images and it indicati

a) abdominal hernia surgery ..... cuffed endotracheal tube a

b) child abdominal surgery ..... non cuffed endotracheal tube b

c) mandibular surgery ..... preformed endotracheal tube c

d) maxillary sinus surgery ..... preformed endotracheal tube d.

Lung collapse (left), causes
- → right endobronchial intubation
- → blug in the left
- → endobronchial carcinoma in the left.

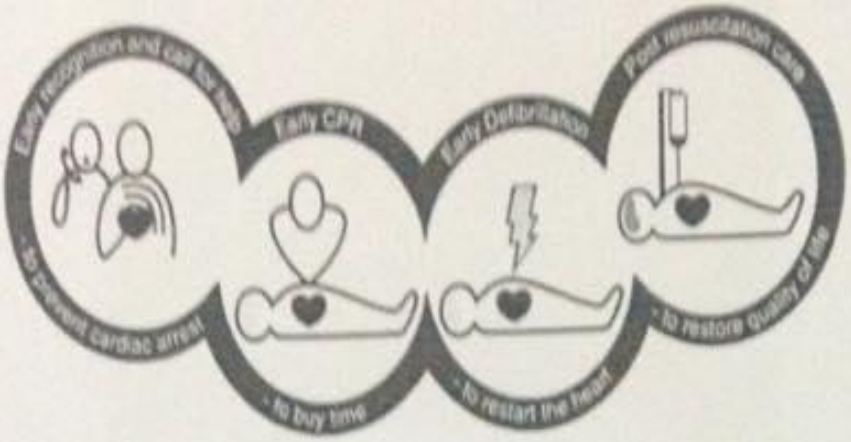
Which drug is more potent? propofol

- Which one is contraindicated in porphyria? Thiopental

Thiopental ←

propofol. ←

* The most stable one is Etomidate.
* The most one to cause hyperdynamic circulation is Ketamine
* The most one to cause instability is propofol.



Collapsed lung

Pneumothorax

Displaced diaphragm

Mediastinal shift

The heart is shifted