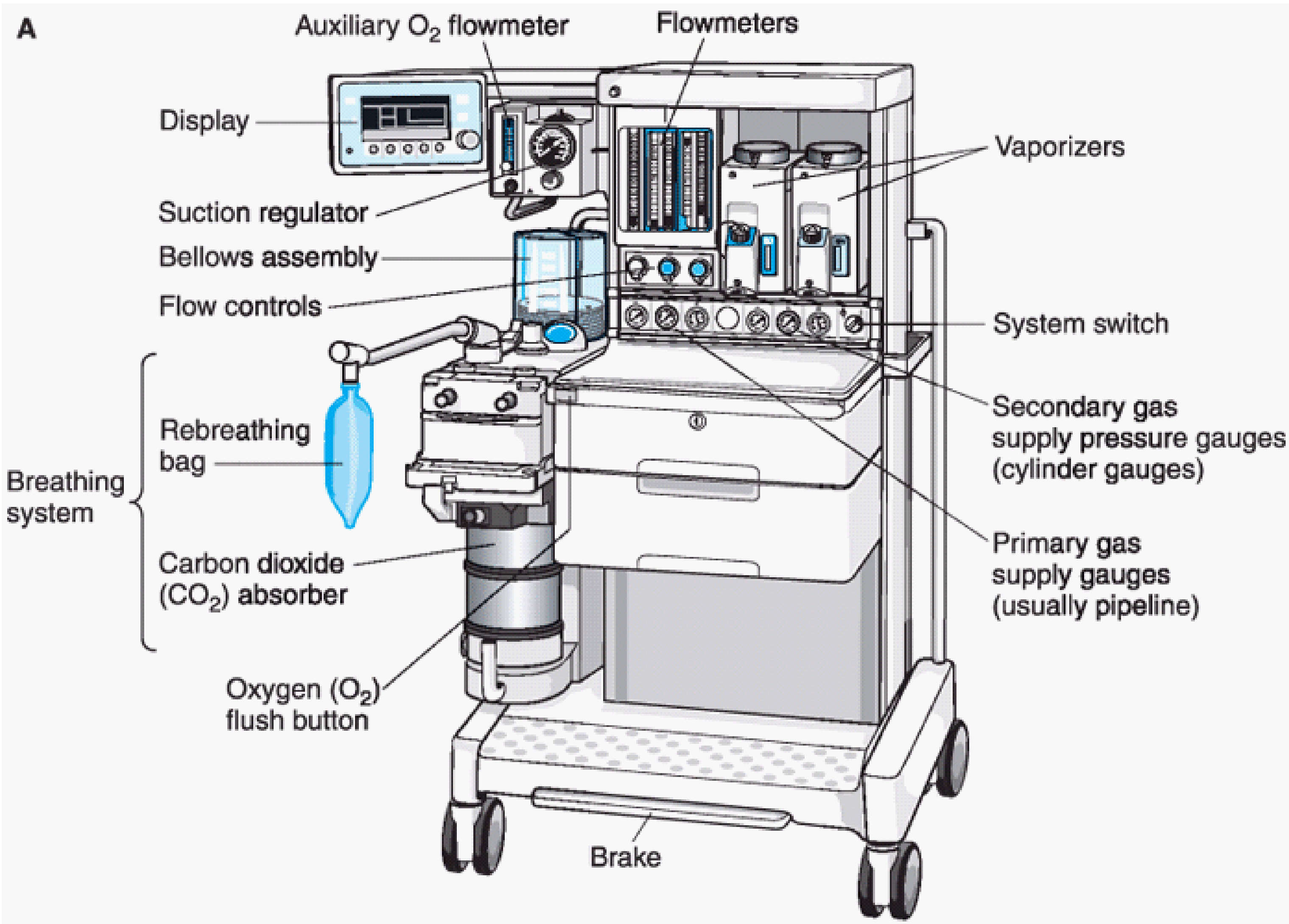
Anaesthetic Equipment

By Dr Subhi Al-GHANEM
Prof. Of Anesthesia
Dept. of Anesthesia
Faculty of Medicine
Jordan University Hospital

The Anesthesia Machine:



The Anesthesia Machine:

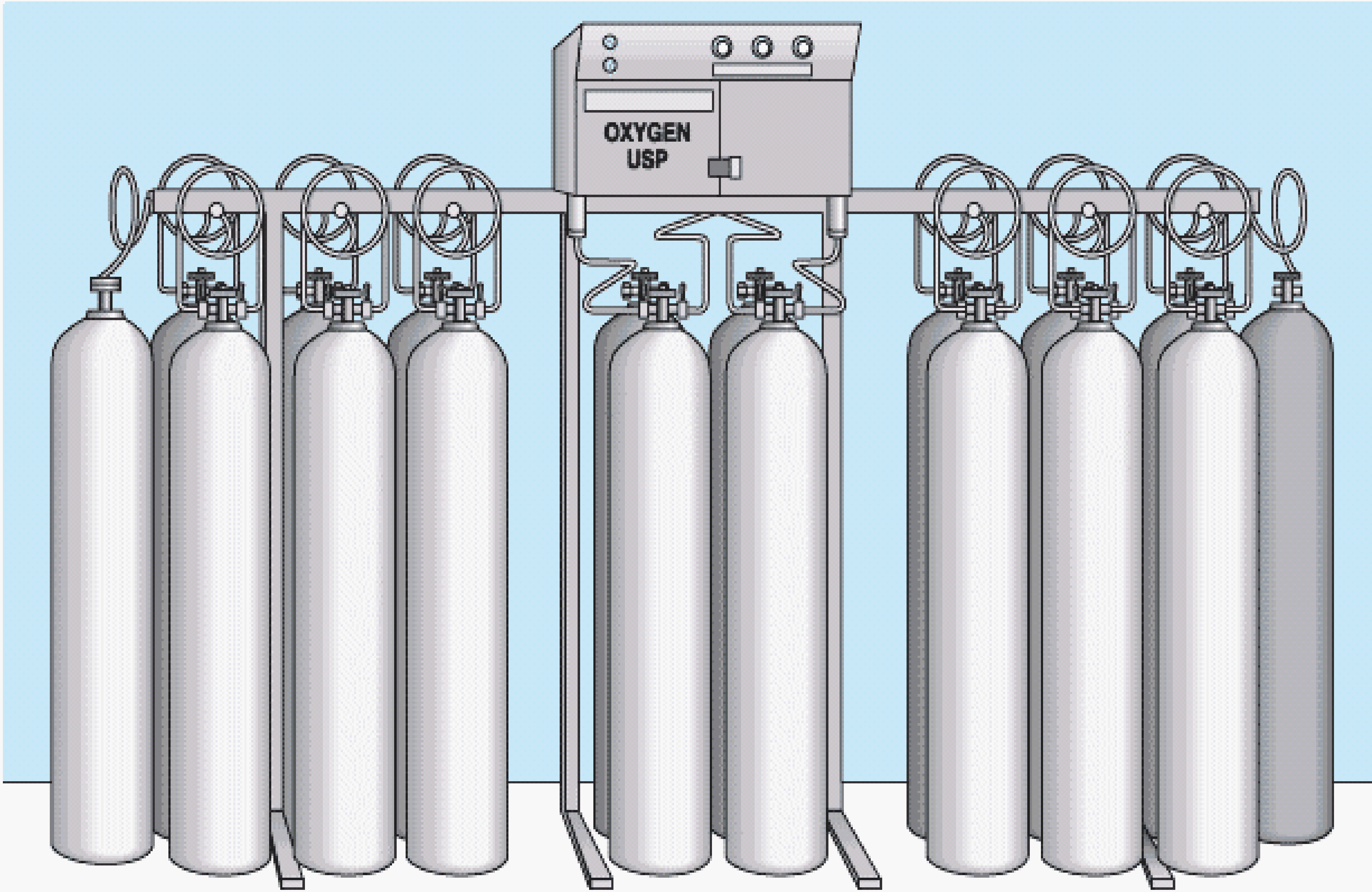
Medical gases

- The medical gases commonly used in operating rooms are oxygen, nitrous oxide, and air .
- Gases used in anaesthesia are usually supplied under high pressure either in cylinders or as a piped gas supply.

E Size Compressed Gas Cylinders IN U.K

Cylinder Characteristics	Oxygen	Nitrous Oxide	Carbon Dioxide	Air
Color-(shoulder)	Black-white (green in us)	Blue	Gray	Gray (Black/White) yellow in us
State	Gas	Liquid and gas	Liquid and gas	Gas
Contents (L)	625	1590	1590	625
Empty Weight (kg)	5.90	5.90	5.90	5.90
Full Weight (kg)	6.76	8.80	8.90	
Pressure Full (psig)	2000	750	838	1800

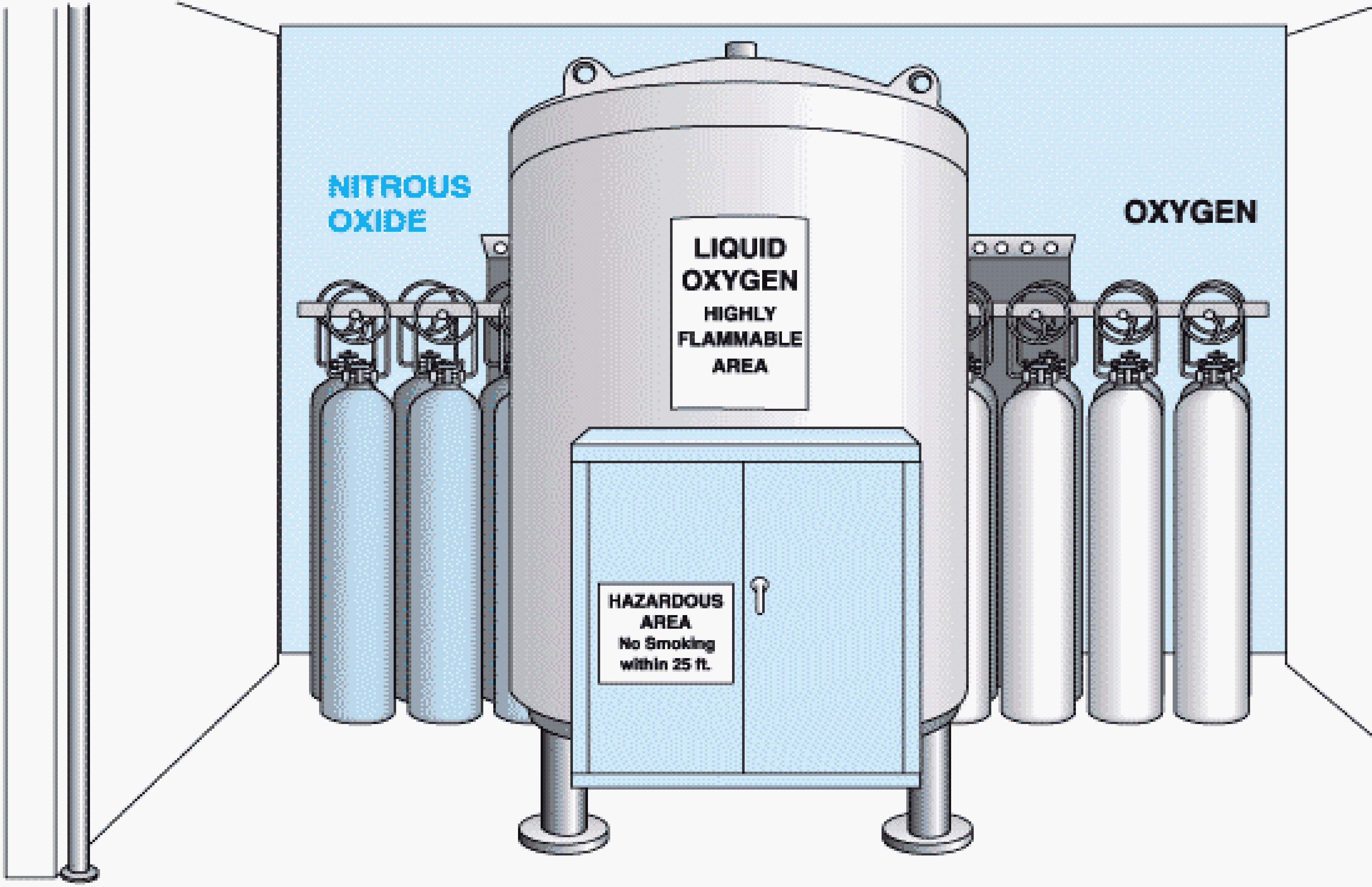
Cylinder Characteristics	Helium	Entonox (o2+n2o)	Heliox(o2+helim)
Color-shoulder	brown	Blue-(white+blue)	Black-(white+brown)
State	Gas	Gas	Gas
Contents (L)	-	-	600
Pressure Full (bar)	137	137	137



A bank of oxygen H-cylinders connected by a manifold.

Pipelines

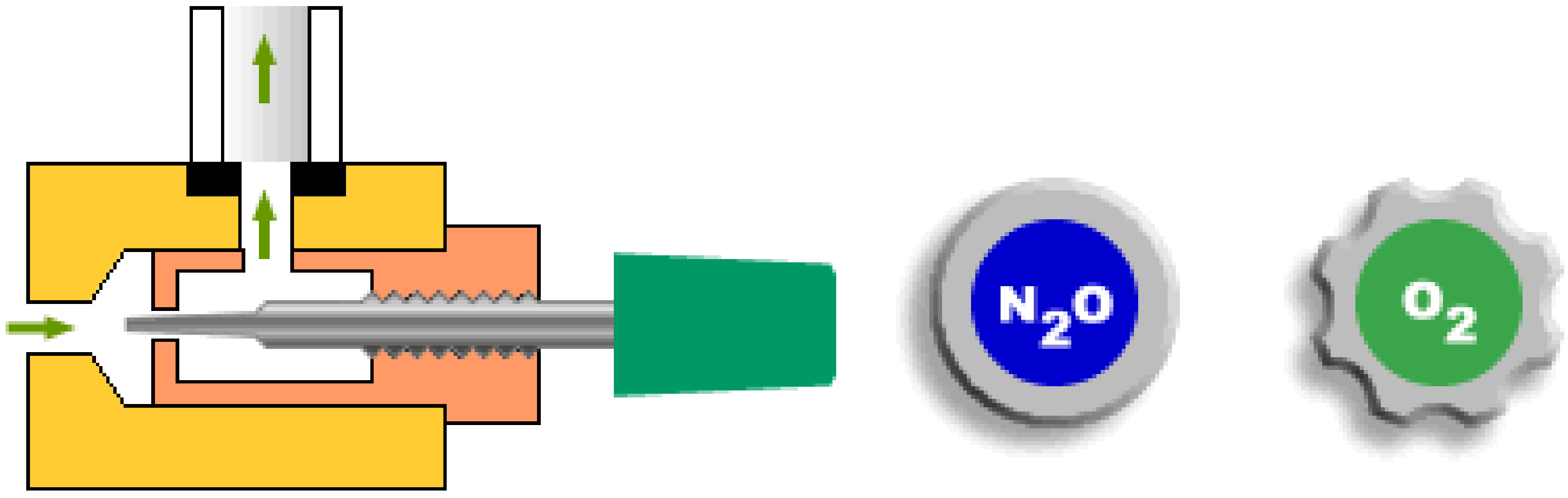
- Medical gases are delivered from their central supply source to the operating room through a piping network
- The tubing is color coded and connects to the anesthesia machine through a noninterchangeable **diameter-index safety system (DISS)** fitting that prevents incorrect hose attachment.
- The anaesthetist should check that the pipeline pressure displayed on the anaesthetic machine should indicate 400 kPa.



A liquid storage tank with reserve oxygen tanks in background.

Flowmeters and gas flow regulation

- **<u>Valves</u>**
  - Needle valves
  - As the valve is opened, the orifice around the needle becomes larger and flow increases.

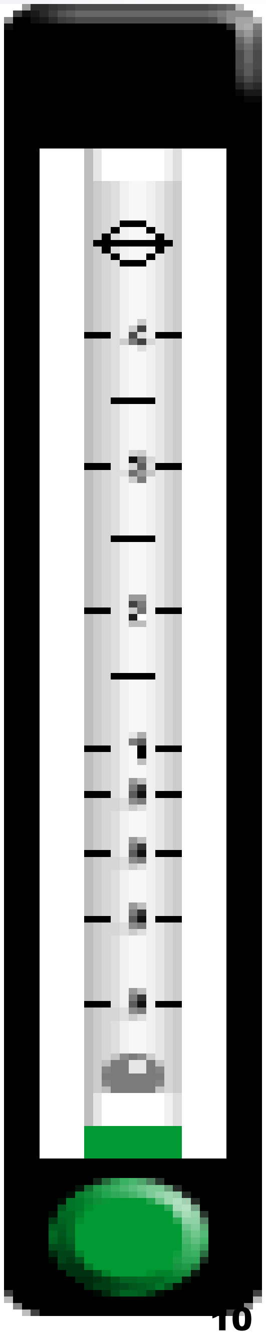


Flowmeters

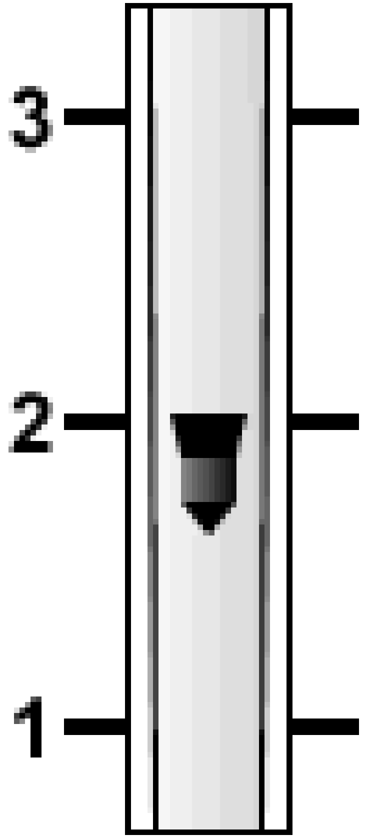
- Tapered glass tube containing a bobbin or ball, which floats on the stream of moving gas.
- Flowmeters are specifically constructed for each gas, since the flow rate depends on both the viscosity and density of the gas.

<u>Inaccuracy in flowmeters</u> due to:

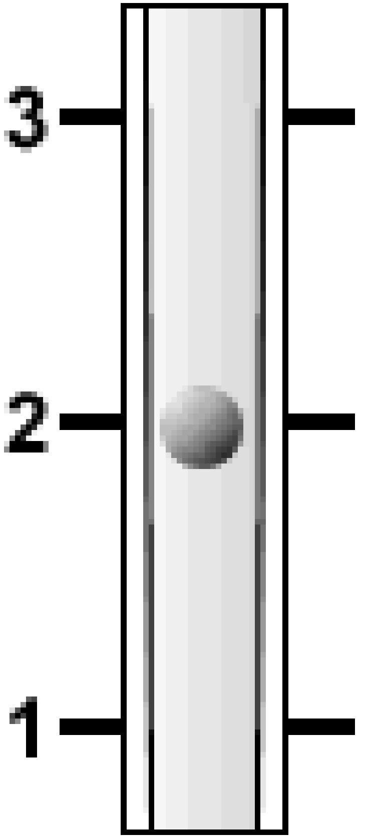
- The tube not being vertical.
- Back-pressure from, for example, a ventilator.
- Static electricity causing the float to stick to the tube.
- Dirt causing the float to stick to the tube.



Bobbins and balls



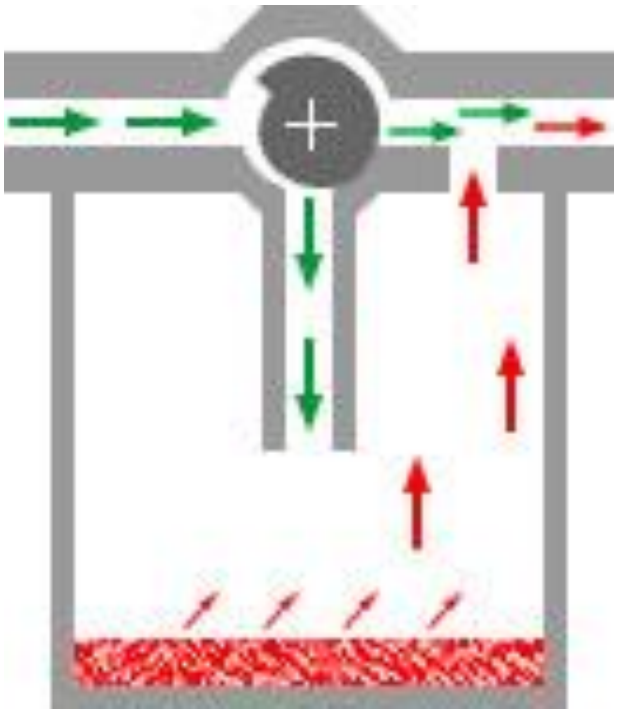
Bobbin flowmeter, reading 2 L/min



Ball-float flowmeter, reading 2 L/min

Vapourisers

- The purpose of an anaesthetic vaporiser is to produce a controlled and predictable concentration of anaesthetic vapour in the carrier gas passing through the vaporiser.
- Most vaporisers are of the plenum type, which consists of a vaporising chamber containing the liquid anaesthetic, and a bypass.
- Gas passing through the vaporising chamber volatilises the anaesthetic and is then mixed with the anaesthetic-free gas bypassing the chamber, the proportion of vapour-containing gas and bypass gas being controlled by a tap.




Tec 7
SEV
ISO
HAL

Factors affecting vaporiser output

- Flow through the vaporising chamber
- Efficiency of vaporisation
- Temperature
- Time
- Gas flow rate
- Carrier gas composition
- Ambient pressure

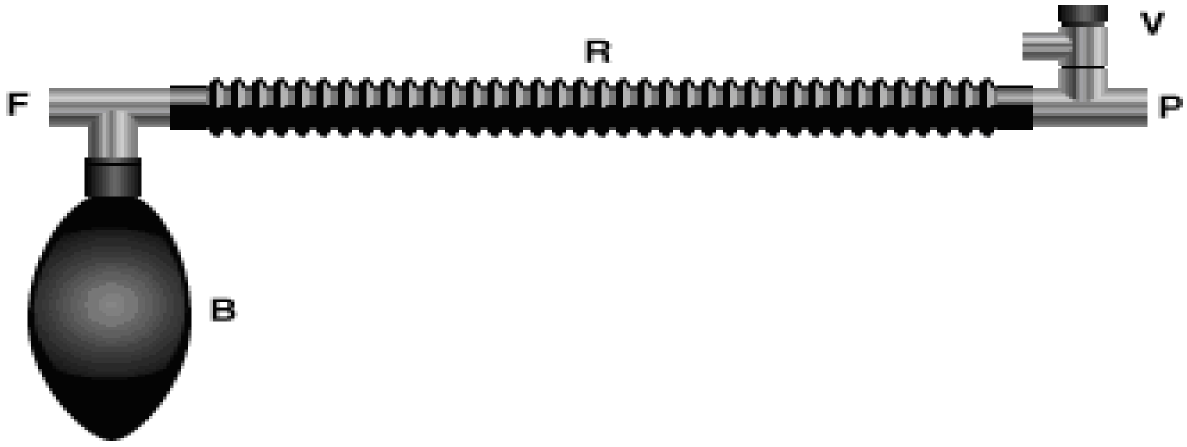
Breathing circuits

- The function of the circuit is to deliver oygen and anaesthetic gases to the patient and to eliminate carbon dioxide.

Mapleson systems

Mapleson described five different arrangements of breathing circuits. He classifed these circuits and they are now known as the Mapleson systems, termed A-E.

Mapleson A (Magill circuit)

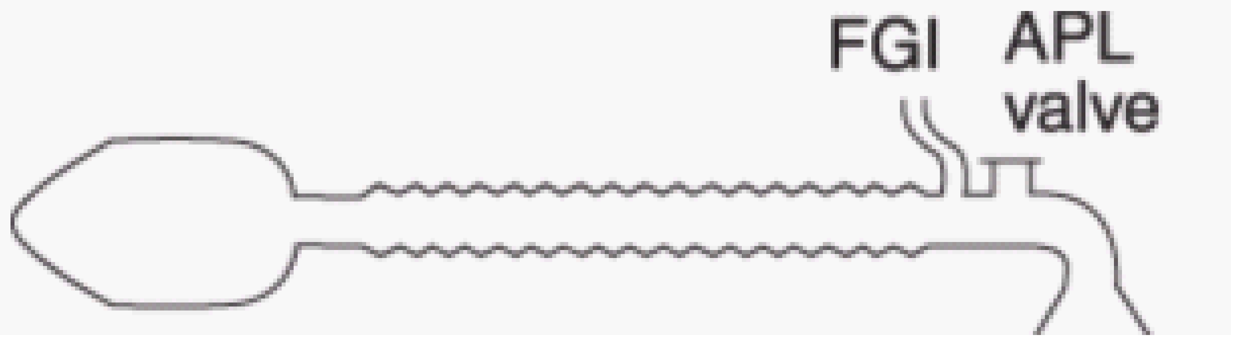


- It consist of a three-way T-tube connected to the fresh gas outlet (F), a breathing bag (B) and a reservoir tube (R). The other end of the reservoir tube is connected to the patient (P) and a spring-loaded expiratory valve (V).

Mapleson A (Magill circuit)

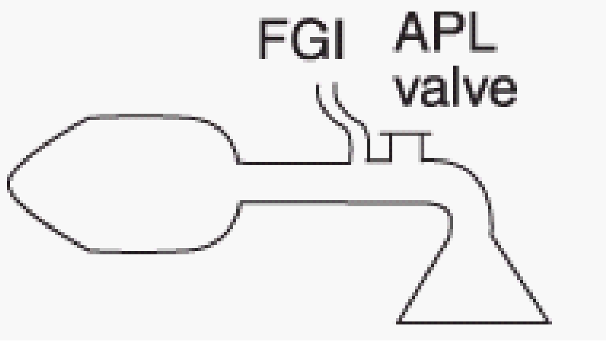
Required Fresh Gas Flows	
Spontaneous	Controlled
Equal to minute ventilation (≈80 mL/kg/min)	Very high and difficult to predict

Mapleson B



Required Fresh Gas Flows	
Spontaneous	Controlled
2 × minute ventilation	2–2½ × minute ventilation

Mapleson C

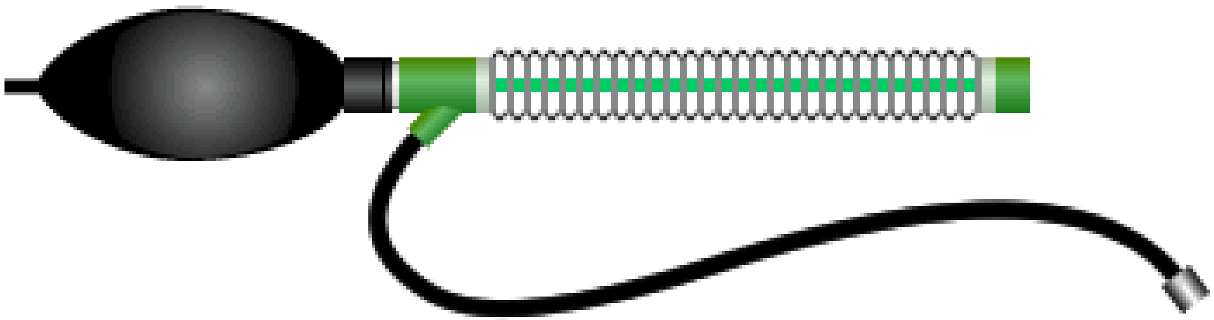


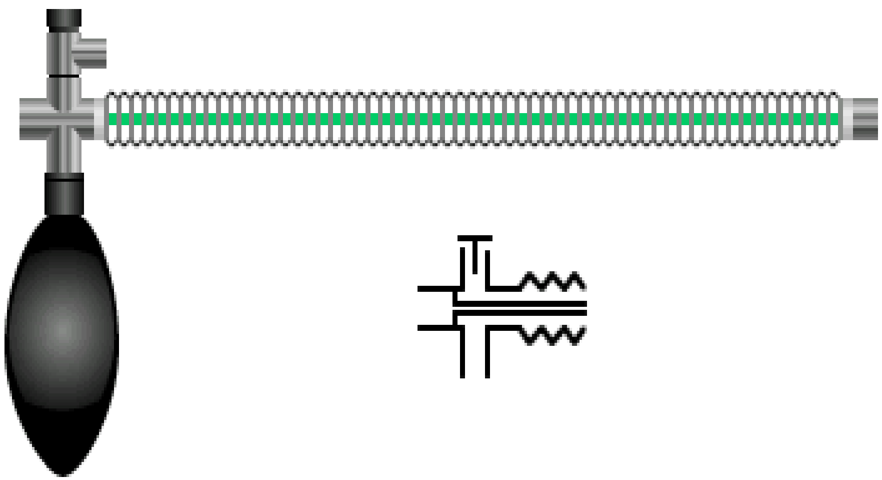
Required Fresh Gas Flows	
Spontaneous	Controlled
2 x minute ventilation	2–2½ x minute ventilation

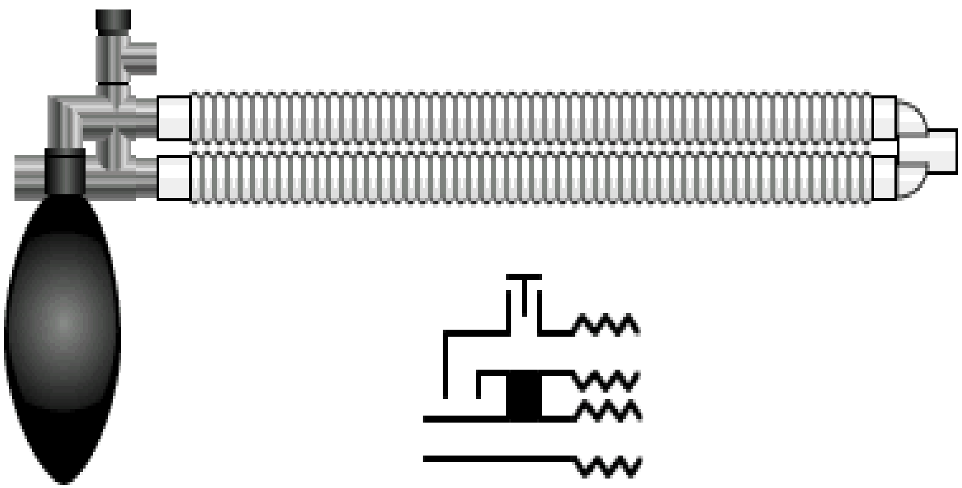
Mapleson D

Required Fresh Gas Flows	
Spontaneous	Controlled
2–3 x minute ventilation	1–2 x minute ventilation

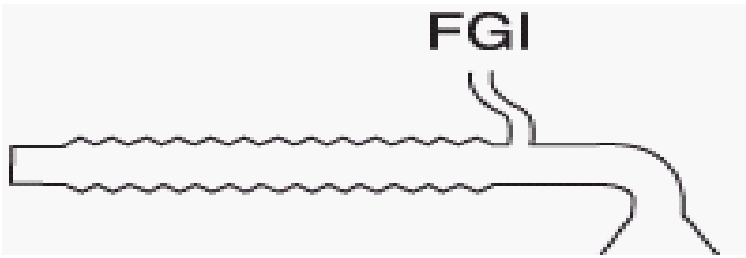
Modifications

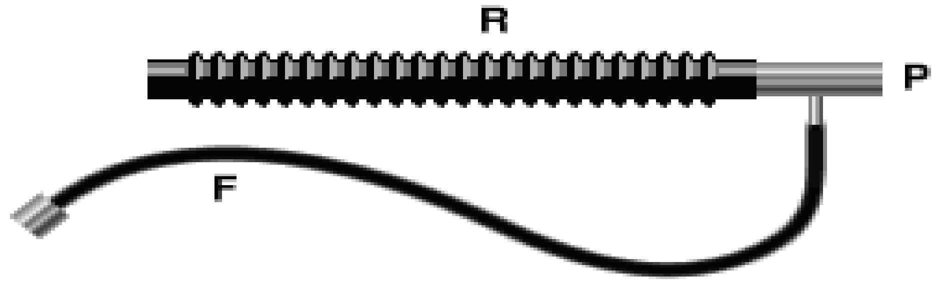




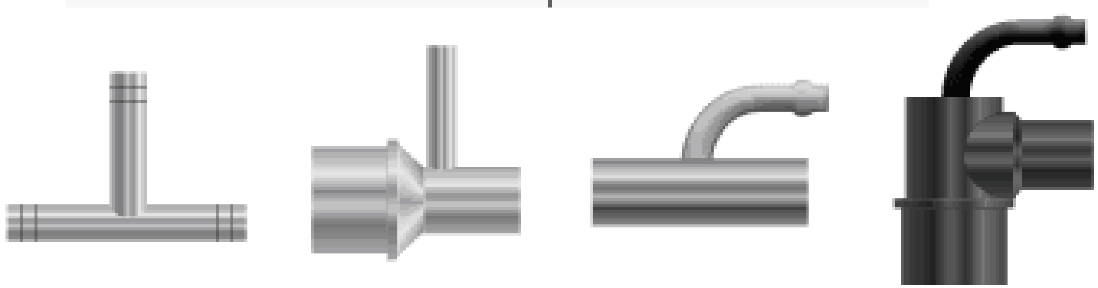


Mapleson E (Ayre's T-Piece)

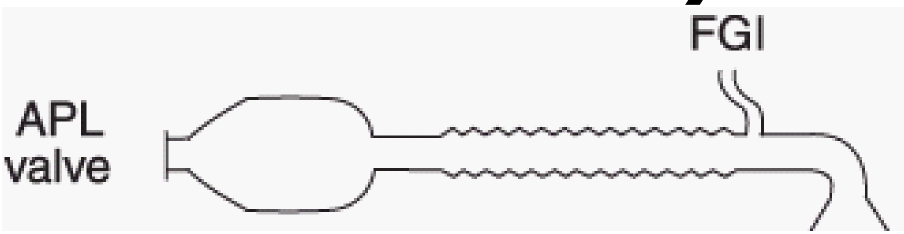


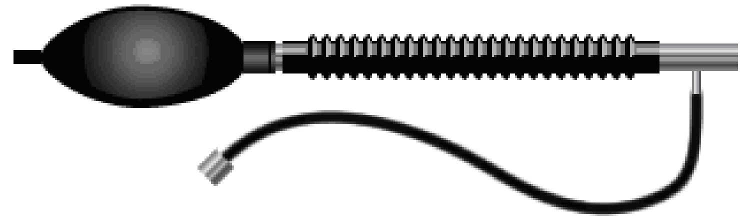


Required Fresh Gas Flows	
Spontaneous	Controlled
2-3 x minute ventilation	3 x minute ventilation



Mapleson F (Jackson-Rees' modification)



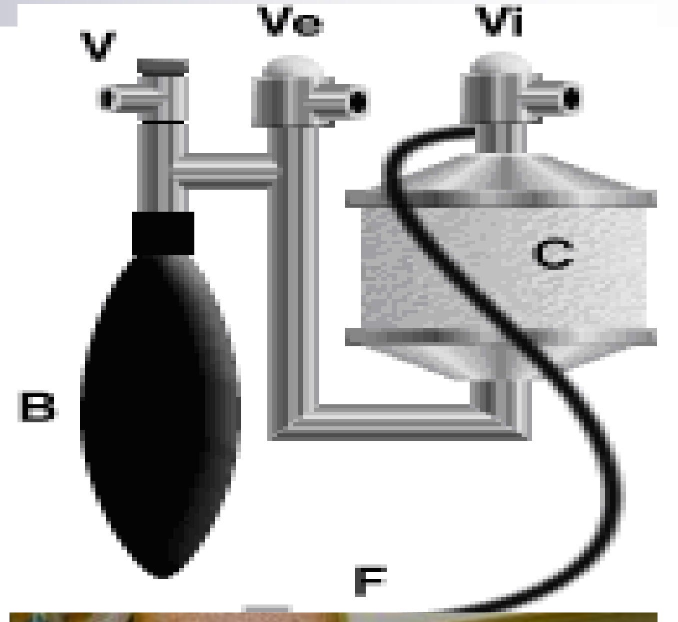


Required Fresh Gas Flows	
Spontaneous	Controlled
2–3 x minute ventilation	2 x minute ventilation

Circle system

The essential features of the circle absorber are:

- A carbon dioxide absorber canister (C)
- Breathing bag (B)
- Unidirectional inspiratory (Vi) valve
- Unidirectional expiratory (Ve) valve
- Fresh gas supply (F)
- Pressure-relief valve (V)



TYPES OF MECHANICAL VENTILATION

- **Positive pressure Ventilators**

The lungs are intermittently inflated by positive pressure generated by a ventilator, and gas flow is delivered through an endotracheal or tracheostomy tube.

- **Negative Pressure Ventilators**

Applied negative pressure around the body or thoracic cavity ,(the body of the patient enclose in an iron box or cylinder and the patient's head protruded out of the end.

Negative Pressure Ventilators

Negative Pressure Ventilators

Positive pressure Ventilators

- **Volume-cycled ventilation**

The ventilator delivers a preset tidal volume regardless of the pressure generated.

- **Pressure-preset ventilation**

The ventilator delivers a preset target pressure to the airway during inspiration. The resulting tidal volume delivered is therefore determined by the lung compliance and the airway resistance.


200
400
600
800
1000
1200
mL
ADULT BELLOWS

Humidity

- Prevention of cilial damage and reduced drying of secretions
- Prolonged severe dehydration of the bronchial tree leads to encrustation of mucus and bronchial or endotracheal obstruction, particularly in neonates and patients with respiratory infection.

DISADVANTAGES

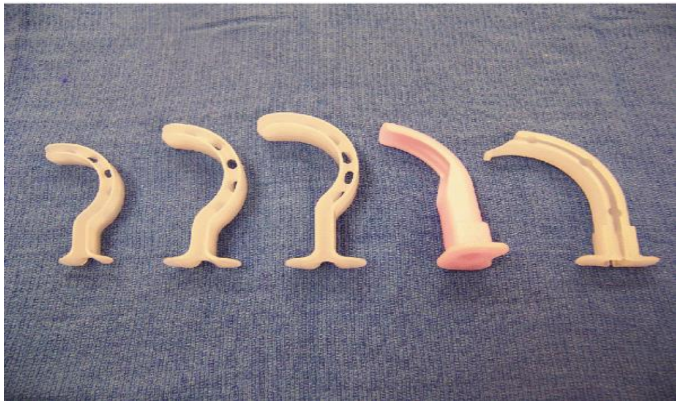
- Disconnection
- Overheating
- Overhydration
- Infection
- Circuit resistance
- Interference with other devices

Anesthetic Face Masks

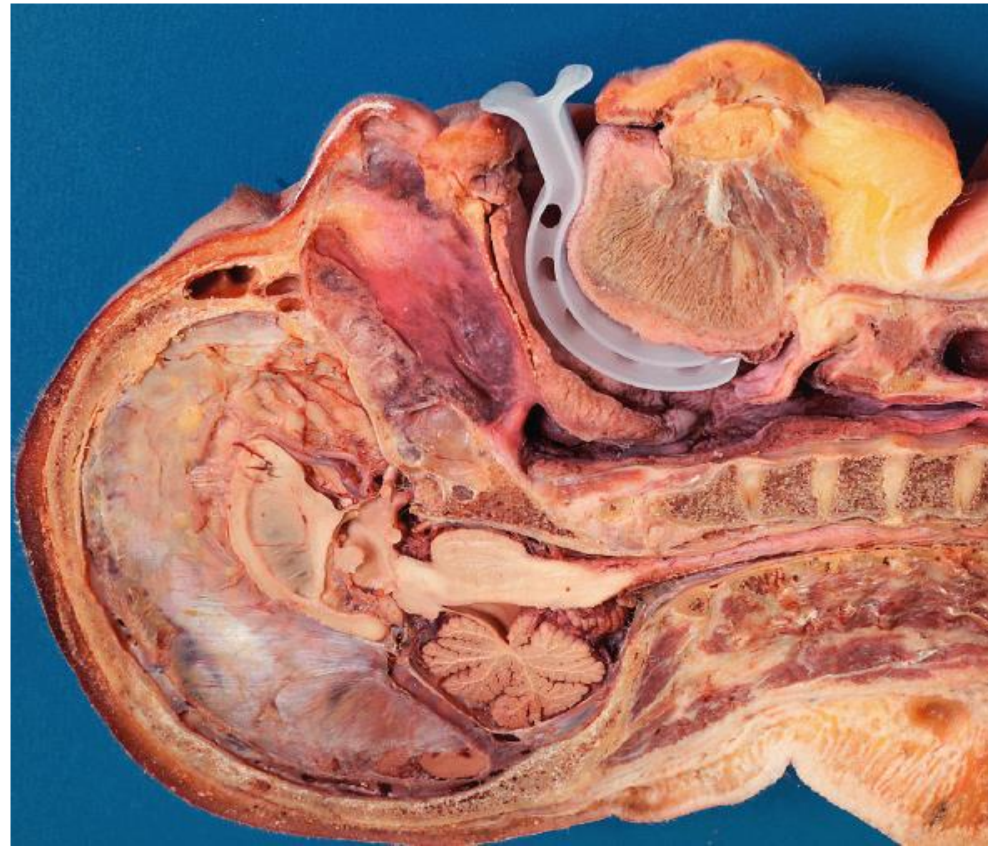
An effective, noninvasive means of providing ventilation and oxygenation in the decompensated or unconscious patient.

Airway devices

Oropharyngeal airways



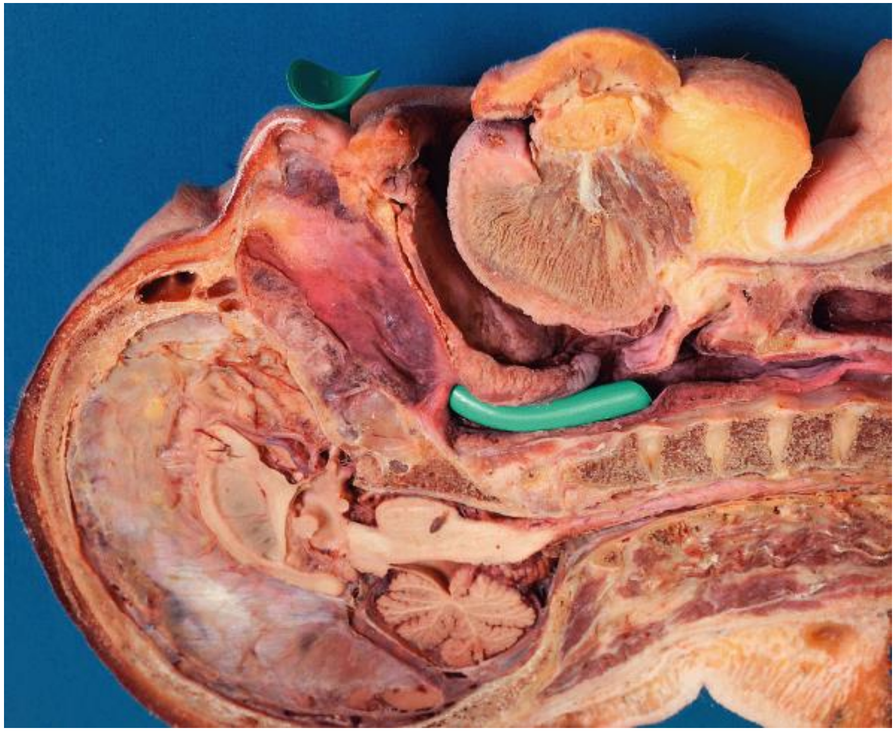
An array of oropharyngeal airways to assist with bag-mask ventilation



Proper placement of an oropharyngeal airway, showing effective separation of dorsal tongue from posterior oropharyngeal wall.

Nasopharyngeal airways

An array of nasopharyngeal airways to assist with bag-mask ventilation



Proper placement of a nasopharyngeal airway, showing effective separation of soft palate from posterior wall of nasopharynx

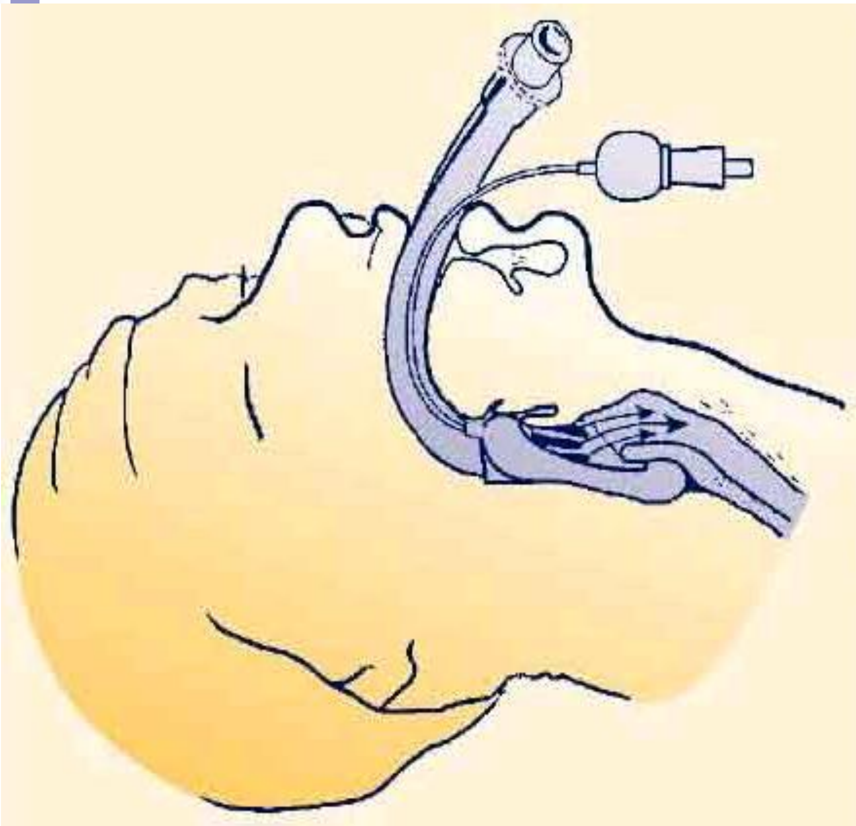
The laryngeal mask

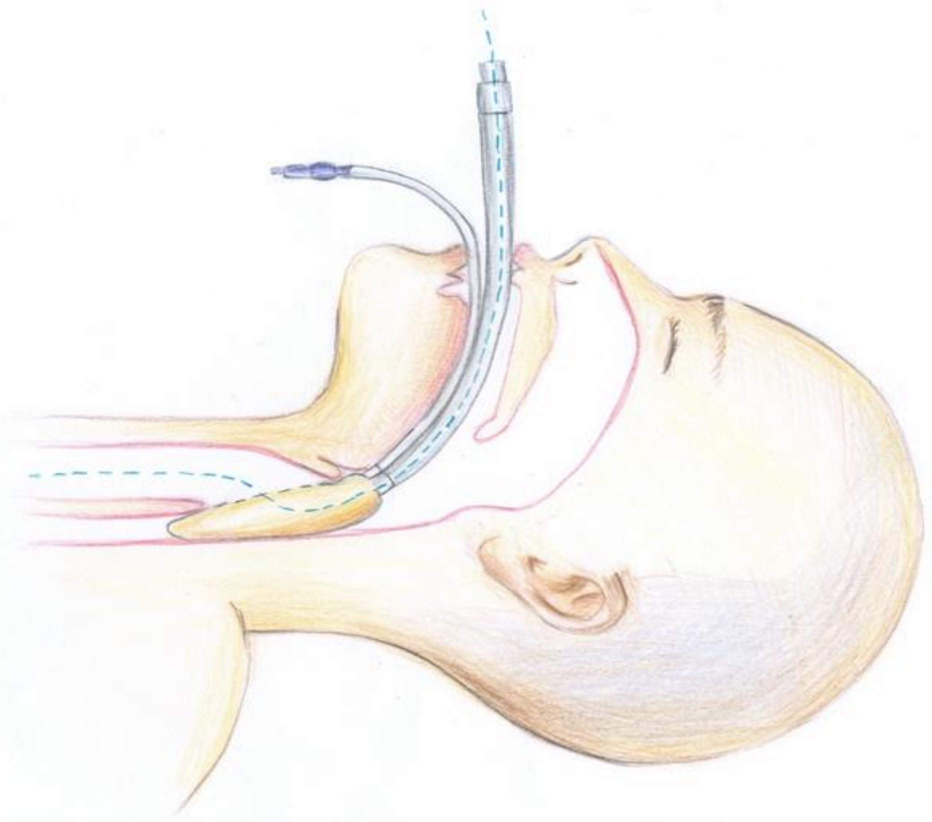
The laryngeal mask

Is a device for supporting and maintaining the airway without tracheal intubation.

<u>Uses of the laryngeal mask</u>

1. Inhalational anaesthesia
2. Maintaining airway during difficult intubation
3. Emergency management of airway in failed intubation





Proper placement of the laryngeal mask airway

Absolute Contraindications

1. Full stomach / significant aspiration risk (including hiatus hernia)
2. Morbidly obese patients
3. Untrained in LMA use
4. Oropharyngeal pathology very likely to result in a poor mask fit (e.g., radiotherapy for hypopharynx/larynx)
5. Glottic surgery

Relative Contraindications

1. PPV with AWP > 20 cm H_2O (stiff lungs, Trendelenburg position, laparoscopy)
2. Very long cases
3. Prone position

The Laryngoscope

This is an instrument used to perform laryngoscopy.

Components of the laryngoscope

Handle

1. Contains battery power source.
2. Fibreoptic scopes contain a fibreoptic bundle in the blade.

Blade

1. Base: attaches to handle
2. Tongue: usually perpendicular to the handle, can be either straight (for placement posterior to the epiglottis) or curved (for anterior placement); most are interchangeable.
3. Web: contains electrical connections and bulb
4. Flange: forms proximal third of the blade.

Macintosh blade

Polio Macintosh blade

Magill blade

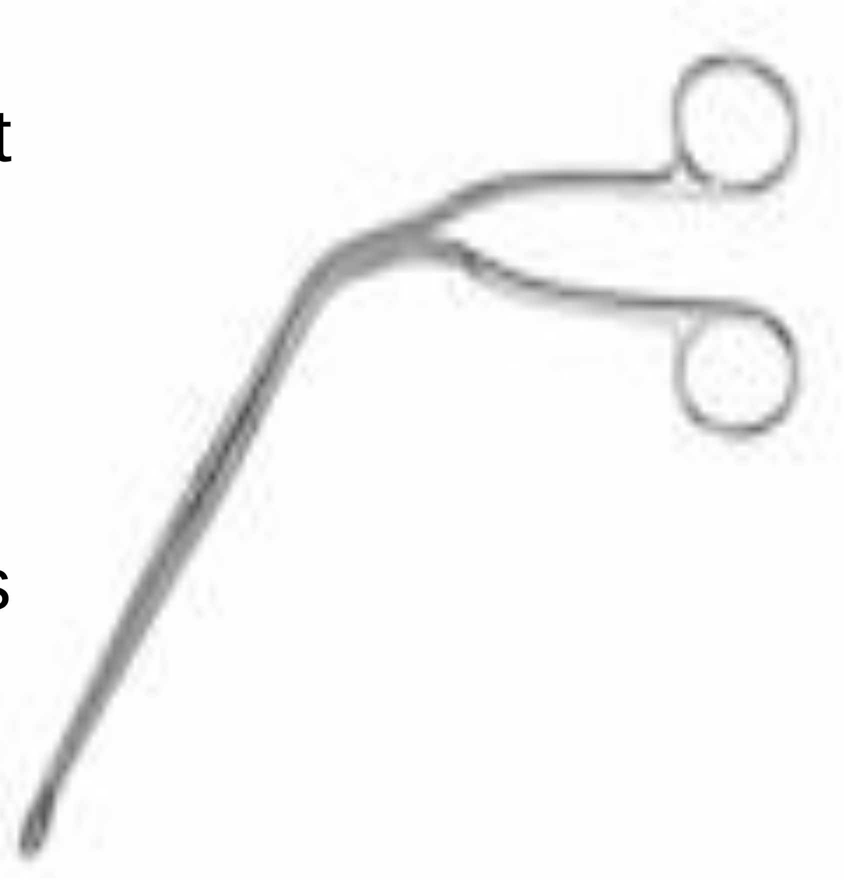
Miller blade

Wisconsin blade

Flexible tip blade (McCoy style)

Magills forceps

Introduced in 1920 to assist placement of gum-elastic bougies for insufflation anaesthesia. Used to guide tracheal tubes into the larynx, or nasogastric tubes into the oesophagus under direct vision. Also used to place pharyngeal packs or to remove foreign bodies.



The Gum Elastic Bougie

The bougie is an adjunct for difficult endotracheal intubations

<u>**Precautions**</u>

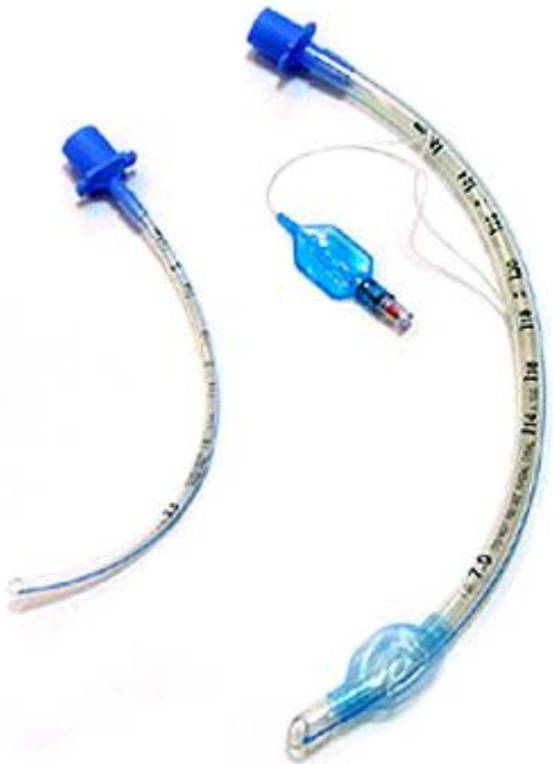
Excessive force, passage beyond the carina, or blind introduction may result in soft tissue damage or may cause rupture of the bronchus.
The endotracheal tube should not be threaded over the introducer without the laryngoscope in place.

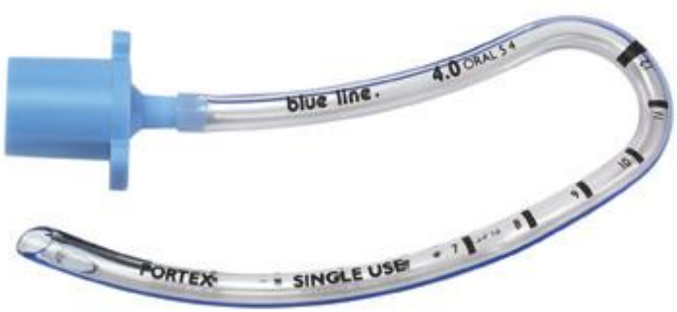
Endotracheal tubes

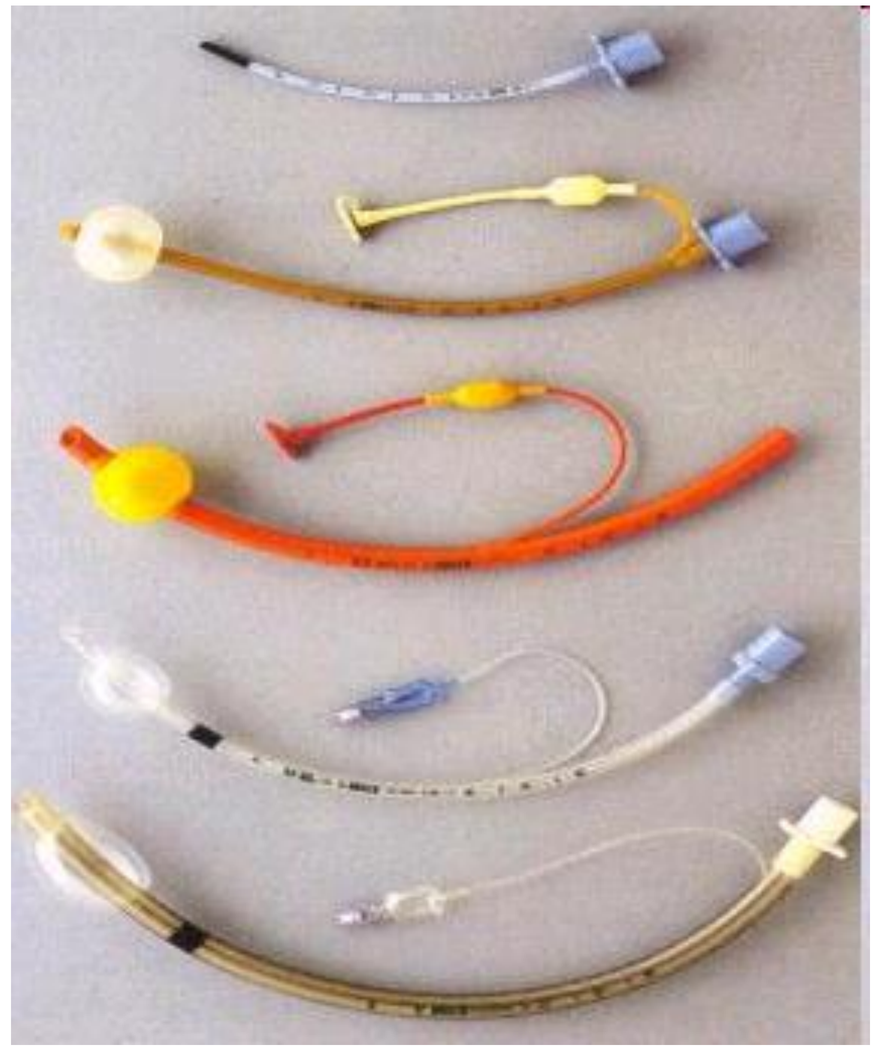
The modern ETT carries the following information:

1. Internal diameter (mm)
2. IT or Z79-IT indicates that the tube has been implant tested in rabbit muscle for tissue compatibility.
3. Distance from the tip of the tube is marked along its length
4. Radio-opaque line (for X-ray detection)
5. Murphy eye, allows ventilation in the event of obstruction of the end of the tube
6. Cuff with a pilot balloon. This cuff seals the trachea to avoid gas leaks or contamination.

Prolonged pressure from the cuff may cause mucosal ischaemia. Uncuffed tubes should be used in Paediatric anaesthesia.



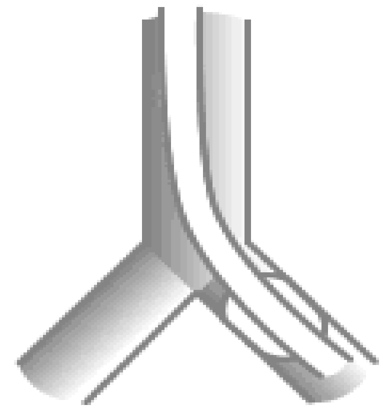

blue line.
4.0 ORAL 5.4
PORTEX
SINGLE USE



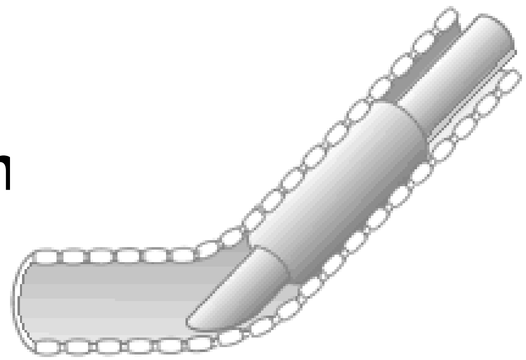
Complications of endotracheal intubation

1. Oesophageal intubation

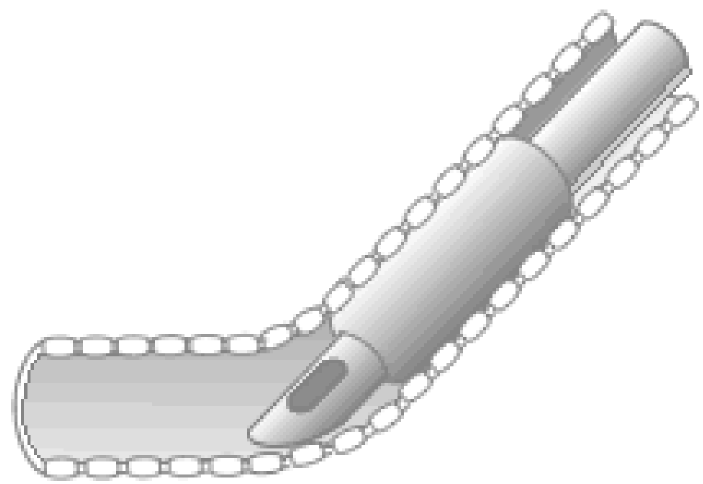
2. Endobronchial intubation



3. Impaction

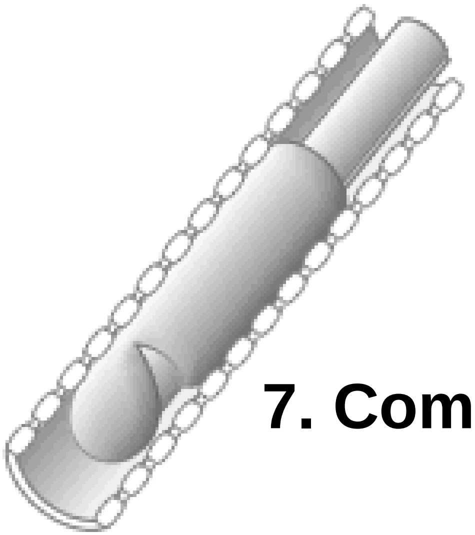


4. The Murphy eye, incorporated into many modern tubes, permits airflow to take place, even if this has occurred.

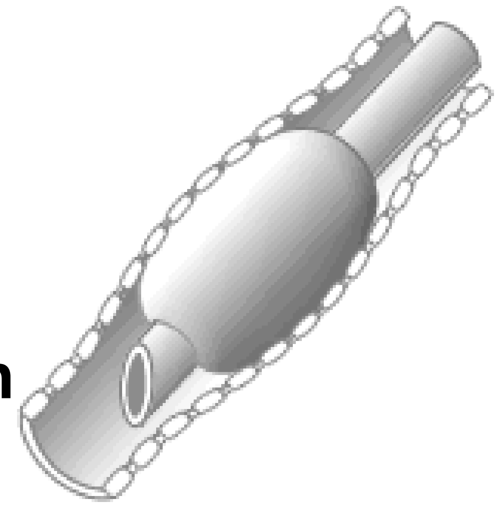


Complications of endotracheal intubation

5. Herniation of the cuff



6. Stretching of the tracheal wall



7. Compression of the lumen

Measurement

Blood pressure

Non-invasive measurement

Auscultatory methods

1. Uses a stethoscope
2. Cuff placed around the upper arm
3. inflated manually by repeatedly squeezing a rubber bulb until the artery is completely occluded
4. Listening with the stethoscope to the brachial artery at the elbow
5. Slowly releases the pressure in the cuff
6. When blood just starts to flow in the artery, the turbulent flow creates a "whooshing" or pounding (first Korotkoff sound).
7. The cuff pressure is further released until no sound can be heard (fifth Korotkoff sound),

Oscillometric methods

Similar to that of the auscultatory method, but with an electronic pressure sensor (transducer) fitted in to detect blood flow, instead of using the stethoscope and the expert's ear. In practice, the pressure sensor is a calibrated electronic device with a numerical readout of blood pressure.

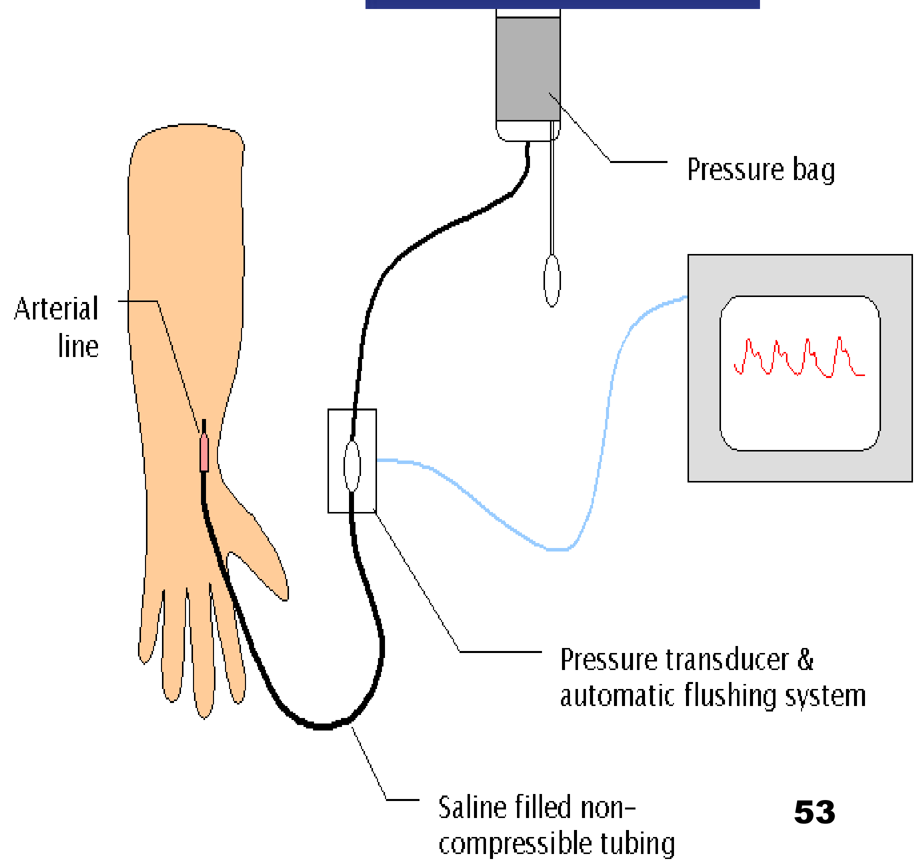

UT4000A
ECG II X1 25.0mm/s 01/07/27 13:52:45
SPO2
HR/Min SpO2(%)
60
98
3:00
NIBP Adult Manual
mmHg
120/080

Invasive measurement

The advantage of this system is that pressure is constantly monitored beat-by-beat, and a waveform (a graph of pressure against time) can be displayed.

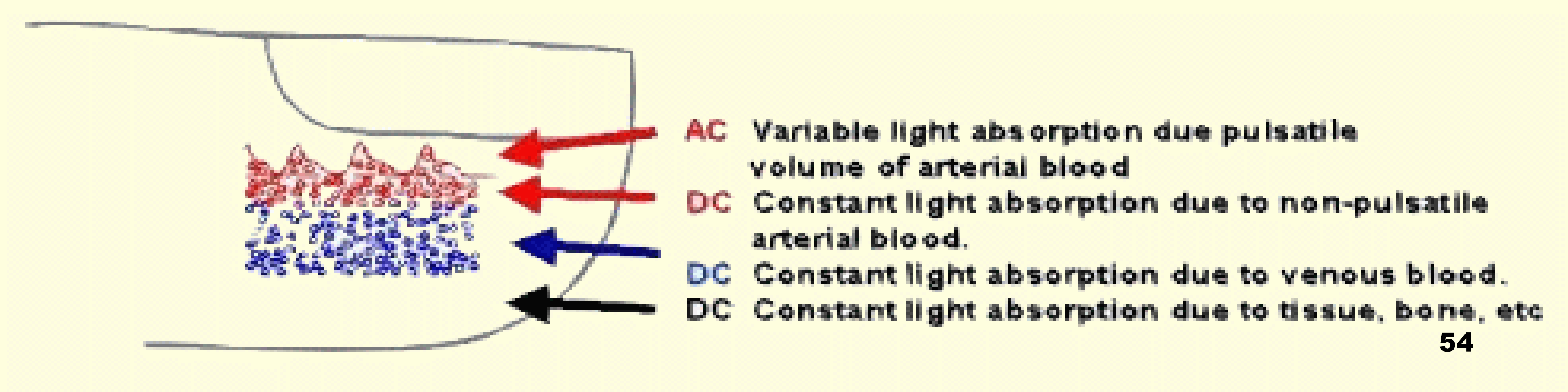
Associated with complications such as thrombosis, infection, and bleeding

Placing a cannula needle in an artery (usually radial, femoral, dorsalis pedis or brachial).



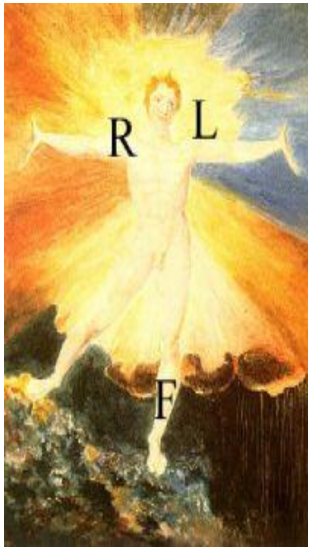
Pulse Oximetry

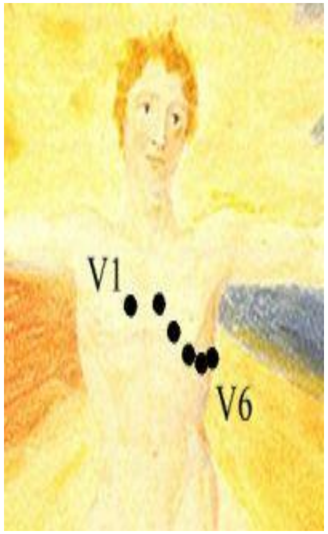
- The principle is based on the red and infrared light absorption characteristics of oxygenated and deoxygenated hemoglobin.
- Oxygenated hemoglobin absorbs more infrared light and allows more red light to pass through.
- Deoxygenated hemoglobin absorbs more red light and allows more infrared light to pass through.

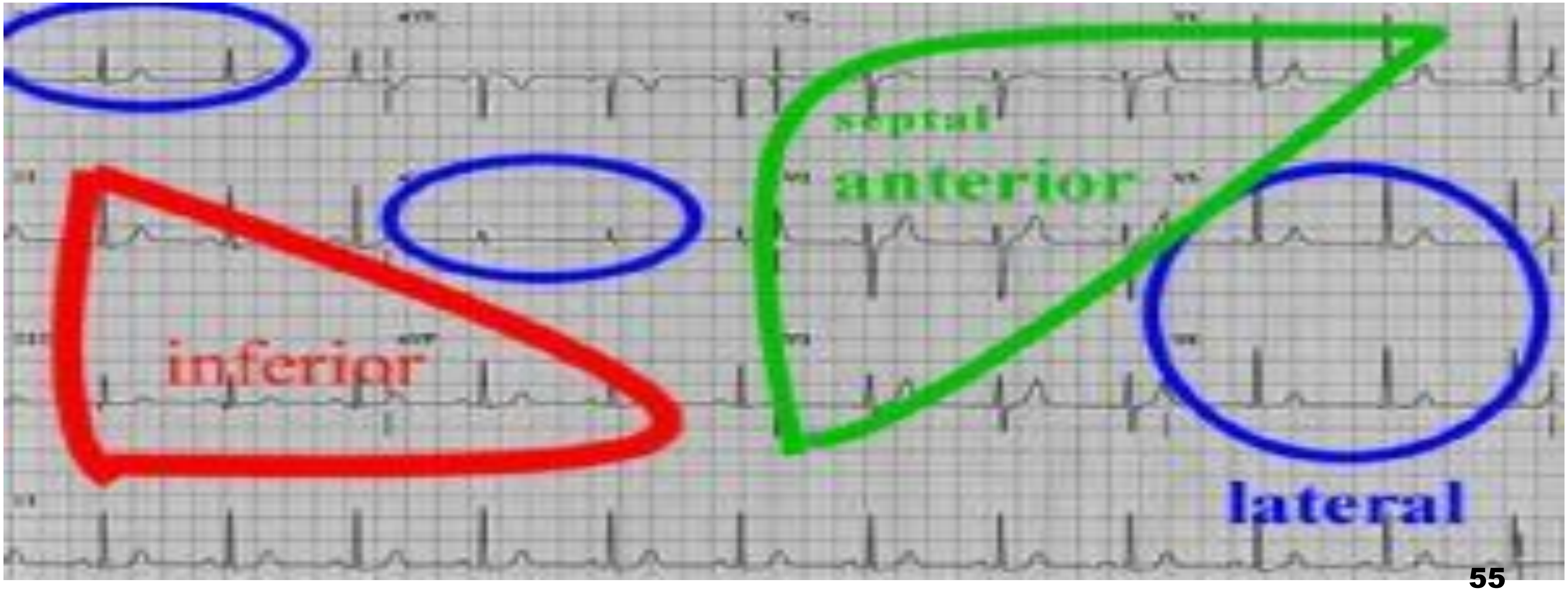


ECG

- When cell membranes in the heart depolarise, voltages change and currents flow







Capnography

- The measurement of carbon dioxide (CO_2) in each breath of the respiratory cycle. The capnograph displays a waveform of CO_2 and it displays the value of the CO_2 at the end of exhalation, which is known as the end-tidal CO_2.
- To assess the adequacy of ventilation, to detect oesophageal intubation, to indicate disconnection of the breathing system or ventilator, and to diagnose circulatory problems and malignant hyperthermia.


UT4000A
ECG II X1 25.0mm/s 01/07/27 13:52:45
SPO2
HR/Min SpO2(%)
98
60
3:00
NIBP Adult Manual
mmHg
120/080