Introduction to ICU

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What is the ICU?

- Definition: The ICU is a specialized department in hospitals providing intensive treatment to critically ill patients.

- Patients often have life-threatening conditions or require constant monitoring and advanced medical interventions.

- Staff: Specialized physicians, nurses, respiratory therapists, and other healthcare professionals.

Cont…

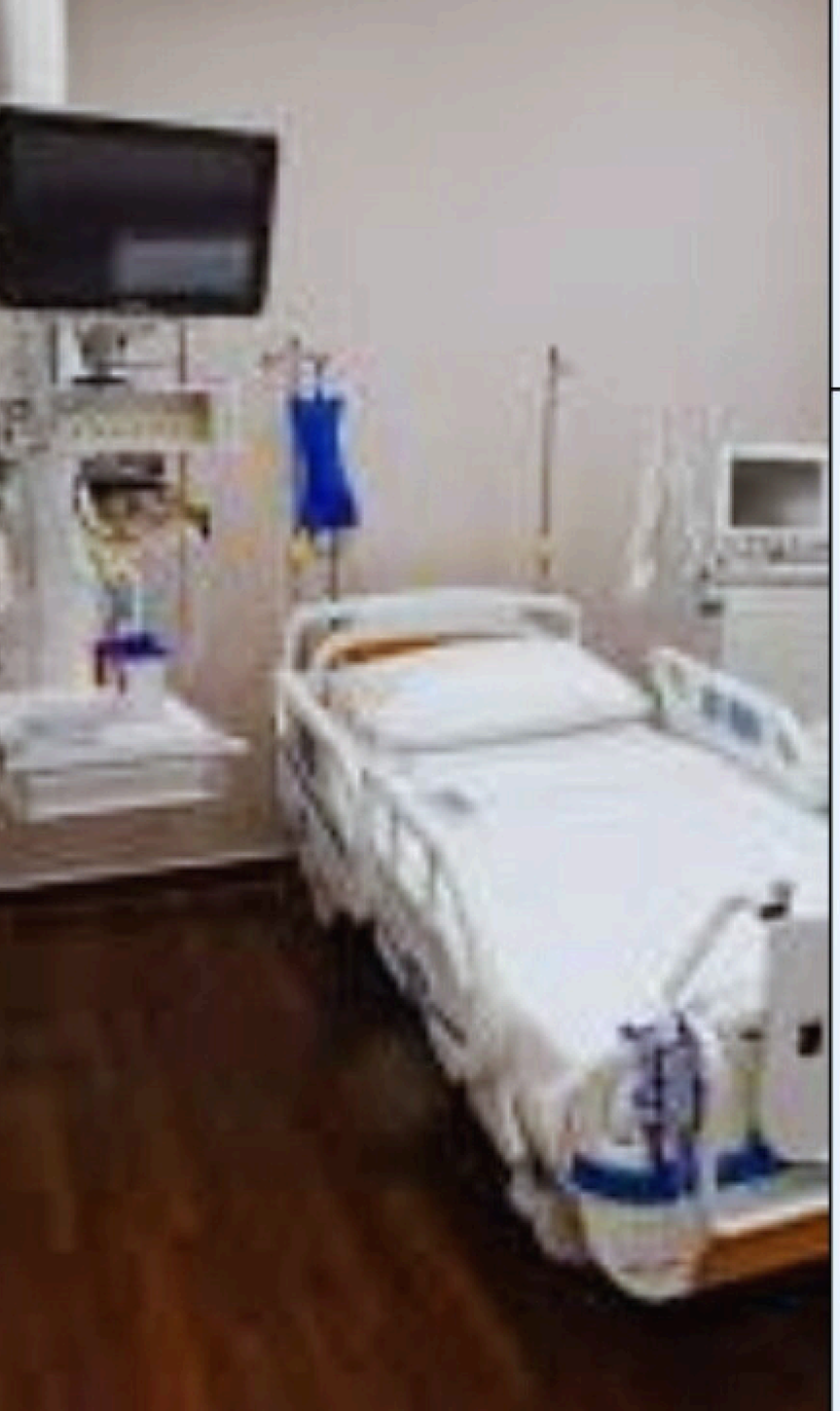
- Highest level of continuous patient (maintenance, care, treatment)
- nurse: patient 1:1
- nurse in change 24 hr .
- resident doctor 24 hr .
- consultant frequent) visit 4-2hr (
- facilities to support organ system failure with full monitor care
- The main functions of any ICU :
- Provide adequate monitoring of vital functions .
- Provide optimum life support

Types of ICUs

- General ICU: Manages a variety of critical conditions.
- Surgical ICU (SICU): Focuses on post-operative patients.
- Cardiac ICU (CICU): Specializes in severe heart conditions.
- Neurological ICU (Neuro ICU): Deals with brain injuries, strokes, and neurological conditions.
- Pediatric ICU (PICU): Cares for critically ill children.

Common Conditions Treated in the ICU

- Sepsis
- Acute Respiratory Distress Syndrome (ARDS)
- Myocardial Infarction (Heart Attack)
- Stroke
- Multi-organ failure
- Severe Trauma



High Dependency Unit (HDU)

- Definition: An intermediate unit providing a level of care between the ICU and general ward.
- It is appropriate for patients who have had major surgery and for thos with single-organ failure.
- Patients may be admitted to an HDU bed because they are at risk of requiring intensive care admission, or as a step-down between intensive care and ward-based care .
- Indications for HDU Admission:

•Patients requiring closer monitoring but not full ICU support.

Cont…

- nurse: patient 1:2
- nurse in change 24 hr .
- resident doctor available immediately
- consultant frequent: per call or shift or round
- appropriate level of monitor, Specialist advice, Supportive care

General Ward

- Definition: Standard inpatient hospital area for patients requiring regular care but not intensive monitoring.

Block forming a division of a hospital (or a suite of rooms) shared by patients who need a similar kind of care .

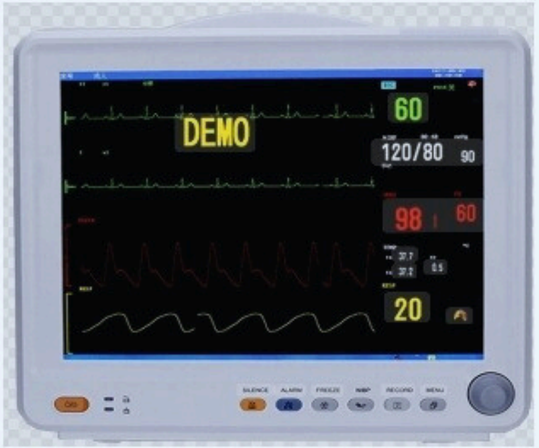
- _nurse: patient: NURSE/shift
- _nurse in change: NURSE/room
- _resident doctor available
- _consultant frequent: per call or round
- _facilities to support organ system failure: not Necessary

Preparation of the unit:

The unit should be kept ready all the time which should include the following:

1. special bed having the following facilities:

- **Head board should be detachable to facilitate intubation**
- **Bed should be firm and non-yielding to facilitate cardiac massage**
- **Should have a tilting mechanism (to keep position of patient)**
- **Should have side rails to prevent falling**
- **There should be a bed side locker an over bed table and a foot stool kept adjacent to the bed**



2. Cardiac monitor system with alarm

3. Oxygen and suction apparatus

4. Resuscitation unit containing the following :

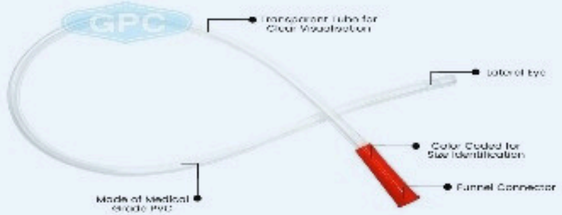
- Syringes, needles, IV Cath, IV fluid, IV administration sets and blood sets

- Spirit, swabs, adhesive plaster and tourniquets

- Airways, endotracheal tubes and laryngoscopes of different sizes

- Ambu bag and suction catheters

- Oxygen cylinders special trays



- Drugs

5. Following equipment should be easily available:

- **Defibrillator** in working mode with electrodes and jell

- **Cardiac pacemaker** with pacing catheters in the sterile tray

- **Mechanical ventilators**

- **Facility for invasive and non invasive procedure**
  like (CVP line, intra arterial pressure monitor)

- **Portable X-Ray machine**

- **ECG machine**

- **Oxygen therapy**

Indications for admission

1. Pre and post-operative patients and who underwent major surgeries.
2. Craniotomy patients.
3. Thoracotomy patients.
4. Ultra major surgeries.
5. Unstable multiple trauma patients.
6. Patients with head or spine trauma requiring mechanical ventilation.
7. Any surgical patient who requires continuous monitoring or continuous life support

ICU patients

- **critical patients** (multiple diagnoses, multi-organ failure, immunocompromised and major trauma and post-surgery)
- **Move less**
- **Malnourished**
- **More obtunded / deaden** (Glasgow coma scale ≤ 12)
- **Organ failure**

TABLE 38-2

Glasgow Coma Scale

BEHAVIOR	RESPONSE	SCORE
Eye opening response	Spontaneously	4
	To speech	3
	To pain	2
	No response	1
Best verbal response	Oriented to time, place, and person	5
	Confused	4
	Inappropriate words	3
	Incomprehensible sounds	2
	No response	1
Best motor response	Obeys commands	6
	Moves to localized pain	5
	Flexion withdrawal from pain	4
	Abnormal flexion (decorticate)	3
	Abnormal extension (decerebrate)	2
	No response	1
Total score:	*Best response*	15
	Comatose client	8 or less
	Totally unresponsive	3

Admitted to ICU criteria in general

- compromised airway
- Glasgow Coma Scale ≤ 12
- Unstable vital sign
- pH ≤ 7.2 or 7.5
- $PaCO_2$ > 45-55
- PaO_2 < 60 HYPOXIA
- FiO_2 > 60% needed

Hypoxia

- Hypoxia classification (PaO2 < 60 mmHg)

1. Hypoxic Hypoxia: in inadequate ventilation and oxygenation . Asthma
2. Anemic Hypoxia: in inadequate hemoglobin content OR function . Anemia
3. Circulatory Hypoxia :in inadequate perfusion . CHF
4. Histotoxic Hypoxia :in inability of the cells to utilize oxygen . Cyanide poisoning
5. Demand Hypoxia :increase O2 requirement . Fever

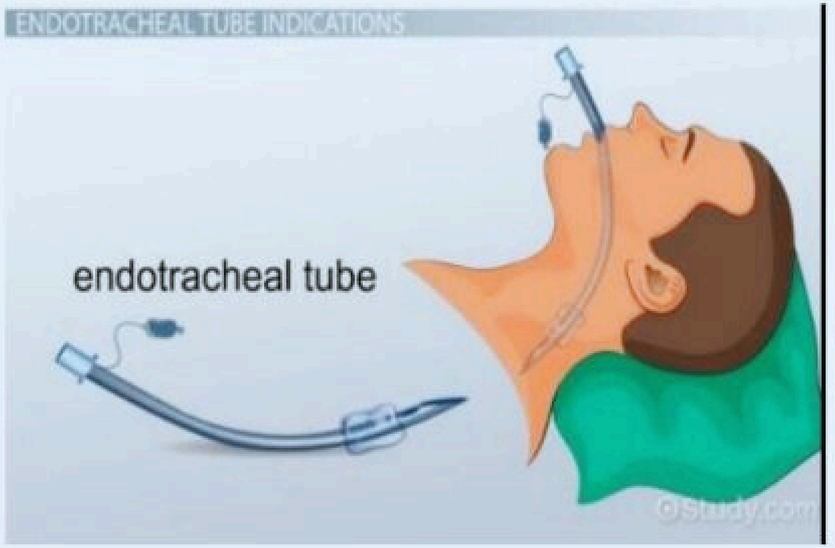
Hypoxemia S&S:

- **restlessness, tachycardia, tachypnea, cyanosis**
- **(Cardiac irritability → Obtundation → Bradycardia → Hypotension and Ischemia → Cardiac arrest)**

Hypovolemia S&S:

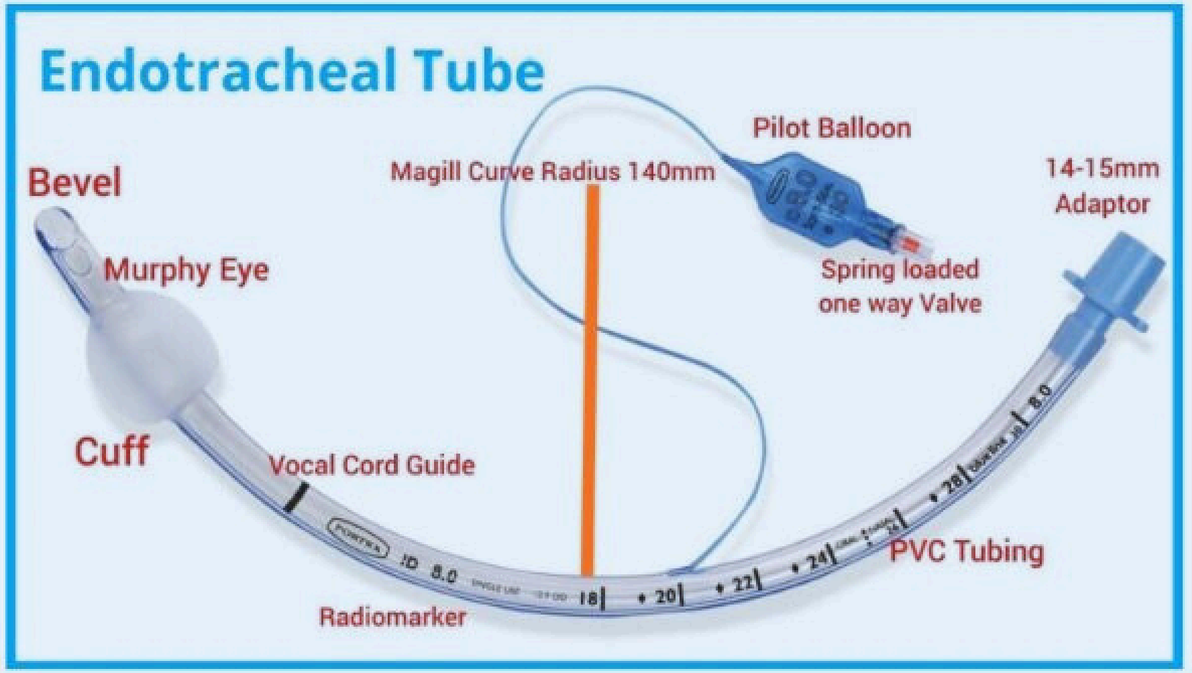
- **Dehydration+ Decrease B.P**
- **Orthostatic hypotension ± decrease Hb level or blood volume**

Intubation:
is the process of inserting a tube, called an endotracheal tube (ETT),
through the mouth and then into the airway.
This is done so that a patient can be placed on a ventilator
to assist with breathing during anesthesia, sedation, or severe illness



- **Intubation indications:**

1. apnea: as in: - central decrease GCS ≤ 8 → absent gag reflex
- induced apnea → General anesthesia
- poisoning
2. Resp. failure: - drugs arrest
- diseases (ARDS, COPD, Asthma, sepsis)
3. Resp. airway protection: - risk of aspiration
- burn patients
4. Resp. obstruction: trauma, tumor, laryngeal edema, epiglottitis
5. hemodynamic instability: shock, cardiac arrest, sever hypothermia



- Essential management in ICU: (FAST HUG)

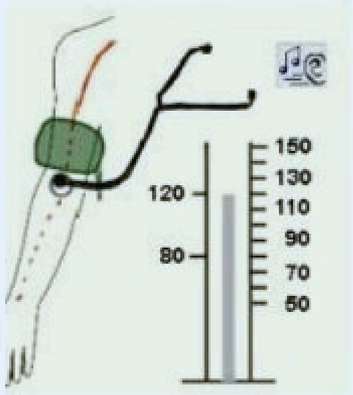
F :feedings
A : analgesia
S : sedation
T : thrombo-embolism prophylaxis
H : head of bed elevation (30 - 45)
U : ulcer prophylaxis (stress ulcer, bed sore)
G : glucose control

Monitoring System

Topics :
1- Non-Invasive BP measurement
2- Central line (central venous catheter)
3- Invasive arterial line
4- Capnography
5- Pulse oximeter
6- Arterial Blood Gas (ABG)
7- Temperature
8- Oxygen analyzer
9- Urine catheter

A. Noninvasive Blood Pressure (NIBP):

- Non-invasive BP measurement provides either intermittent or continuous readings. Most commonly,
an occluding upper arm cuff is used for intermittent non-invasive monitoring. BP values are then
obtained either
manually (by:1- auscultation of Korotkoff
2- palpation)
or automatically (by:oscillometry).
- In ICU we monitor blood pressure every (1-4) hours.



Why do we monitor BP?!

1. It Provides data for therapeutic decisions.
2. Important for determining organ perfusion.
3. One of the vital signs.

B. Invasive blood monitoring (IBP):

- Invasive (intra-arterial) blood pressure (IBP) monitoring is a commonly used technique in the Intensive Care Unit (ICU) and is also often used in the operating theatre.

This technique involves direct measurement of arterial pressure

by inserting a cannula needle in a suitable artery

Arterial cannulation is used:

*** to access arterial blood sample, for checking ABG.**

*** for arterial pressure monitoring**

× But not for intra vascular drug administration.

A saline-filled tube is used to connect the cannula to the transducer, to the display.

It measures IBP on beat to beat basis.

C. CENTRAL VENOUS PRESSURE (CVP)

_ The CVP cannula is inserted in to the internal or external jugular vein or subclavian vein

_ The tip is situated approximately 2cm above the right atrium in the superior vena cava

_ They provide access for intra venous drugs particularly which produce irritation to peripheral veins e.g. strong potassium chloride

Complications of Central Line:

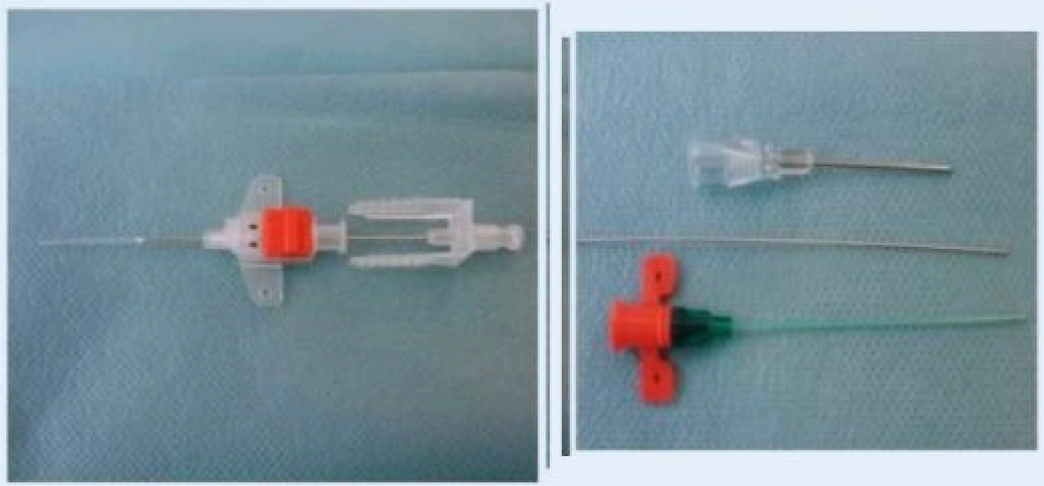
- **Pneumothorax:**

_ 30% of all mechanical adverse events of Central Line insertion (for central lines placed in the chest); the incidence is thought to be higher with subclavian vein catheterization. In catheterization of the internal jugular vein, the risk of pneumothorax is minimized by the use of ultrasound

- Haemothorax
- Arterial puncture
- Air embolism

D. Arterial Line:

Arterial lines are commonly used in critical care. They allow us to draw blood easily without having to stick the patient with a needle. They also allow us to draw blood tests that must be drawn from an artery (such as arterial blood gases). Arterial lines are also used when close blood pressure monitoring is required



Definition: An arterial line or art-line is a thin catheter inserted into an artery.

- Most commonly used in I.C.U and anesthesia to monitor the BP and it's more accurate than measurement of BP by noninvasive means, and to obtain continuous samples for ABGs.

Arterial lines can be placed in multiple arteries, including:

The Radial, Ulnar, Brachial, Axillary, Posterior tibial, Femoral, and Dorsalis pedis.

- **Mostly inserted in Radial artery because its large and more superficial, Low complication**
- **The second Most common is Femoral artery: larger and strong pulsation**

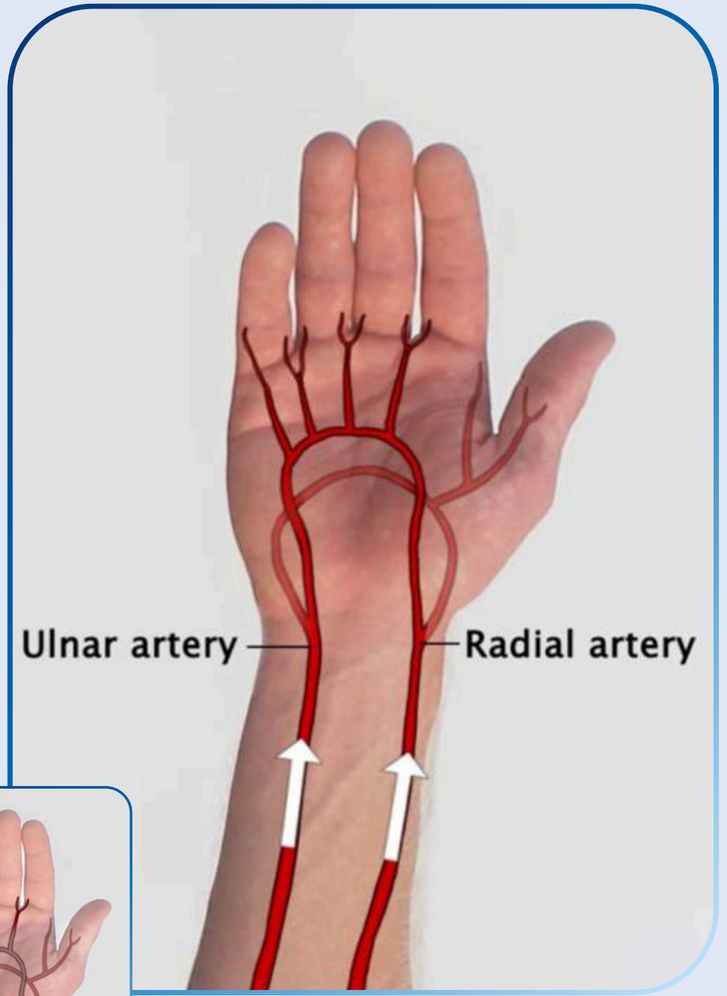
Alen's Test

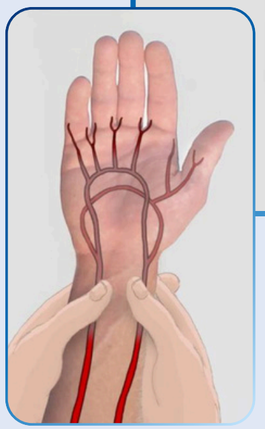
Alen's Test

The hand has a rich vascular network , which is mostly supplied by the radial and ulnar arteries.

Both artries form anastomosis (palmar arches) .

The Allen is non-invasive technique which is a first-line standard test used to assess the arterial blood supply of the hand .





Indication :

- **before taking a sample for an arterial blood gas and arterial line.**
- **find the best location of the artery for the dialysis**
- **check for a blood flow problem**

Alen's Mechanism :

01

Elevate the hand and Apply digital compression of both ulnar and radial arteries at the level of the wrist, ask pationt to clench and unclench the hand 10 times , causes palmar blanching.

02

Release of compression on either artery, which causes hand flushing and hyperthermia .

Positive Test

If the return of color to the hand within 5-15 seconds it indicates Adequate collateral circulation .

Alternatives :

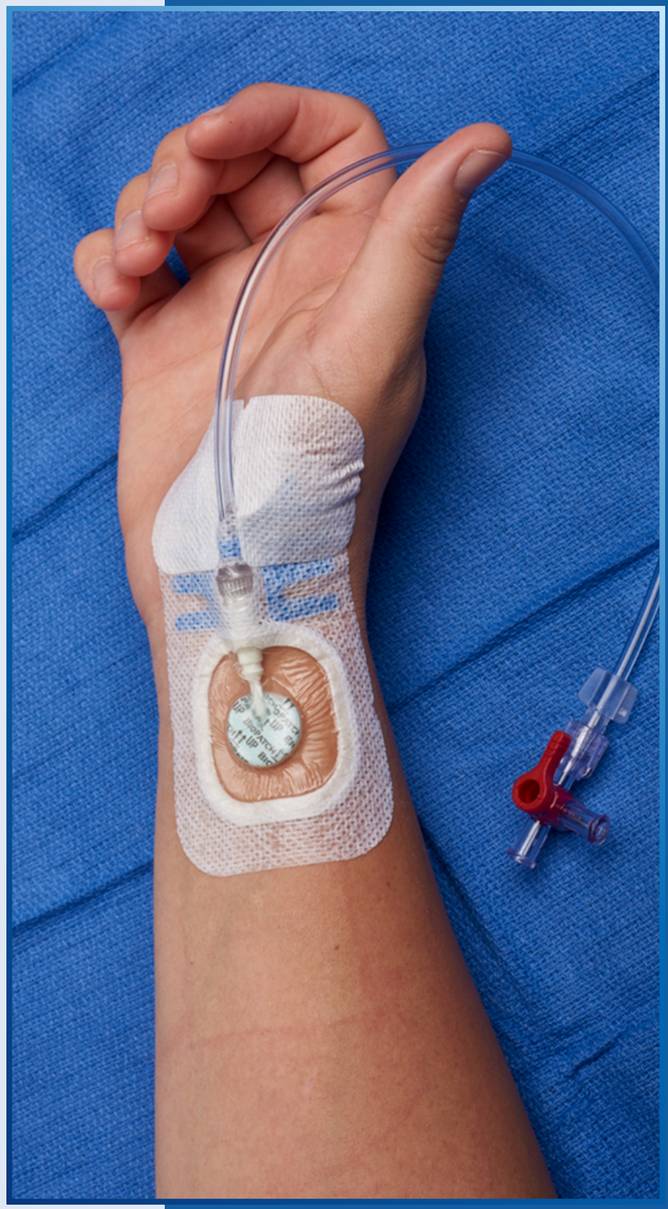
- Doppler probe
- Puls Oximeter
- Plethysmography

Disadv. :

- Need cooperation with patient.

Arterial Catheterization :

Inserting a catheter into a peripheral artery, enabling hemodynamic monitoring and arterial blood sampling.



Indications :

Patient Related :

1- need for continuous BP measurement in patients who are morbidly obese and severely burned.
2- severe sepsis or shock
3- Cardiac diseases.
4- Respiratory Failure.
5- Hemodynamic instability.

Surgical Related:

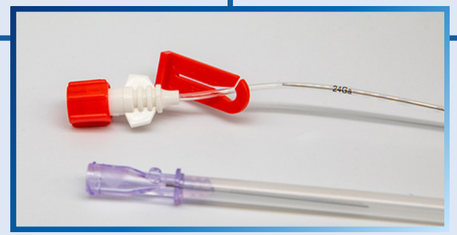
1- Cardiac Surgery.
2- Major surgery on aorta or carotid artery.
3-Neurosurgeryas craniotomy or aneurysm clipping.

Anesthetic Related :

1- Controlled hypotensive technique.
2- Inability to measure blood pressure non-invasively.

Contraindications

Absolute Contraindications	Relative Contraindications
Absent Puls	Hemorrhage
Thromboangitis Obliteration	Angiopathy
Full thickness burns over the cannulation	Coagulopathy
Raynaud Syndrome	Atherosclerosis



Common complications of arterial line placement are :

- **Temporary radial artery occlusion (19.7%)**
- **Hematoma /Bleeding (14.4%)**

Less common and rare complications :

- **Localized catheter site infection**
- **Hemorrhage**
- **Permanent ischemic damage**
- **Others**

OxygenSaturation
SpO2

Is the amount of oxygen you have circulating in your blood.
is usually 95% or higher

The Puls Oximeter (Pulse Ox)

Is an electronic device that provid early and immediate measures the saturation of oxygen.
It is noninvasive and risk-free when used properly, it should be used in all clinical facilitaties .
Pulse oximeters can be attached to your fingers or other sites on face and foot .

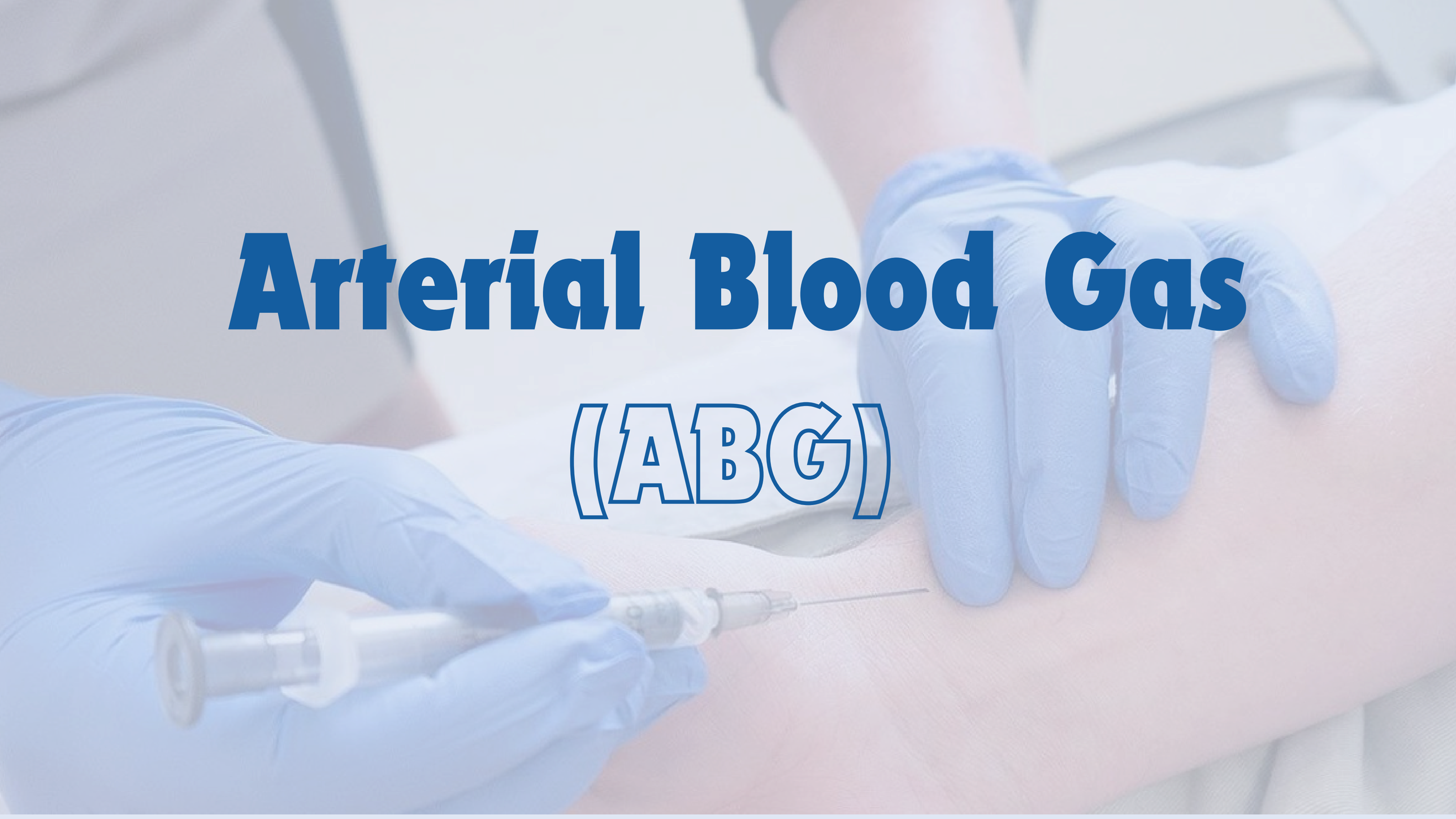
- **If SpO2 is below 95%,**

(it means the O2 delivering is inadequate or poor cardiac output)

- **Start O2 if SPO2 less than 95%**

Arterial Blood Gas

(ABG)



• ABG analysis measures it helps assess the lung's fuction ability to oxygenate the blood and remove carbon dioxide, as well as the body's acid-base balance..

Indications:

• Evaluating respiratory failure, metabolic disturbances, and acid-base imbalances.
• Monitoring critically ill patients, especially those on mechanical ventilation.

Radial Artery: (Preferred Site)

• Superficial and easy to access.
• Collateral circulation via the ulnar artery (confirmed with Allen's test).
• Easy compression to stop bleeding .
• Femoral Artery: Used in emergencies when the radial artery is inaccessible, higher risk of infection .
• Brachial Artery: Easier to access than femoral but lacks collateral circulation .

Contraindications:

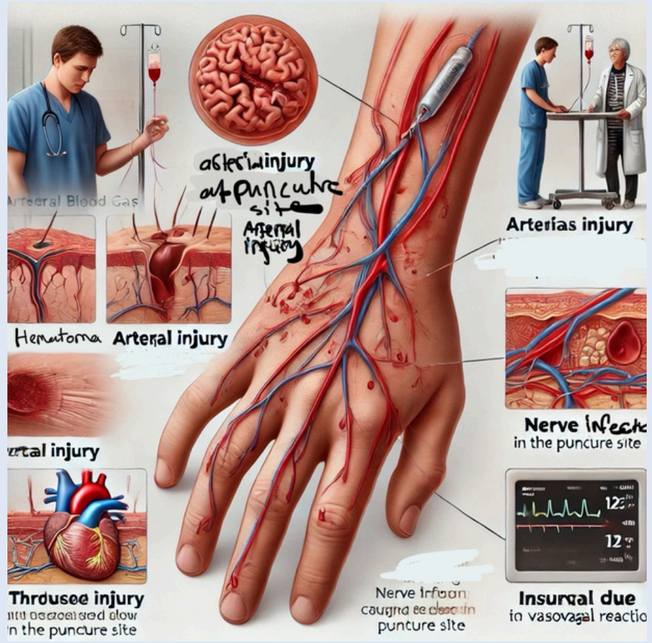
- Failed Allen's test (lack of collateral circulation).
- Infection or trauma at the puncture site.
- Patients with severe coagulopathy (risk of bleeding)

Normal ABG Values:

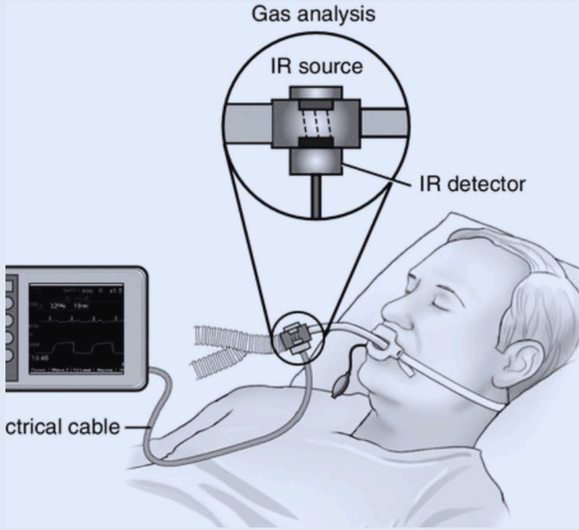
- pH: 7.35 – 7.45
- PaO2: 75 – 100 mmHg
- PaCO2: 35 – 45 mmHg
- HCO3-: 22 – 26 mEq/L
- O2 Saturation (SpO2): 95% – 100%

Complication of ABG:

1. Bleeding and pastiche
2. Infection at puncture sit
3. Local pain
4. Thrombus in artery
5. Feeling faint and Numbness



Carbon Dioxide Monitoring (Capnography) in the ICU



Purpose of Capnography:

- Continuous monitoring of ventilation in critically ill patients.
- Early detection of respiratory failure or complications.
- Helps optimize mechanical ventilation settings.
- Confirms proper airway device placement (e.g., endotracheal tube).

How it Works:

- Measures End-tidal CO_2 ($EtCO_2$): Normal range 35-45 mmHg.
- Utilizes infrared spectroscopy to detect CO_2 in exhaled air.
- Generates a capnogram (CO_2 waveform), which provides real-time data on respiratory cycles.

Key Applications:

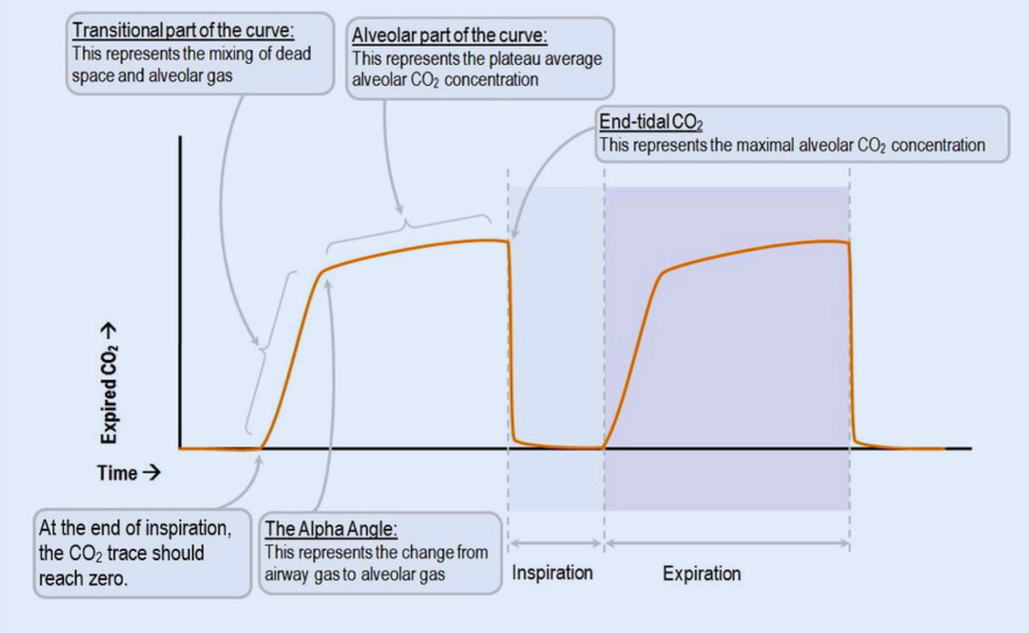
- Validation of proper endotracheal tube placement
- Detection and Monitoring of Respiratory depression
- Hypoventilation
- Obstructive sleep apnea
- Procedural sedation
- Adjustment of parameter settings in mechanically ventilated patients

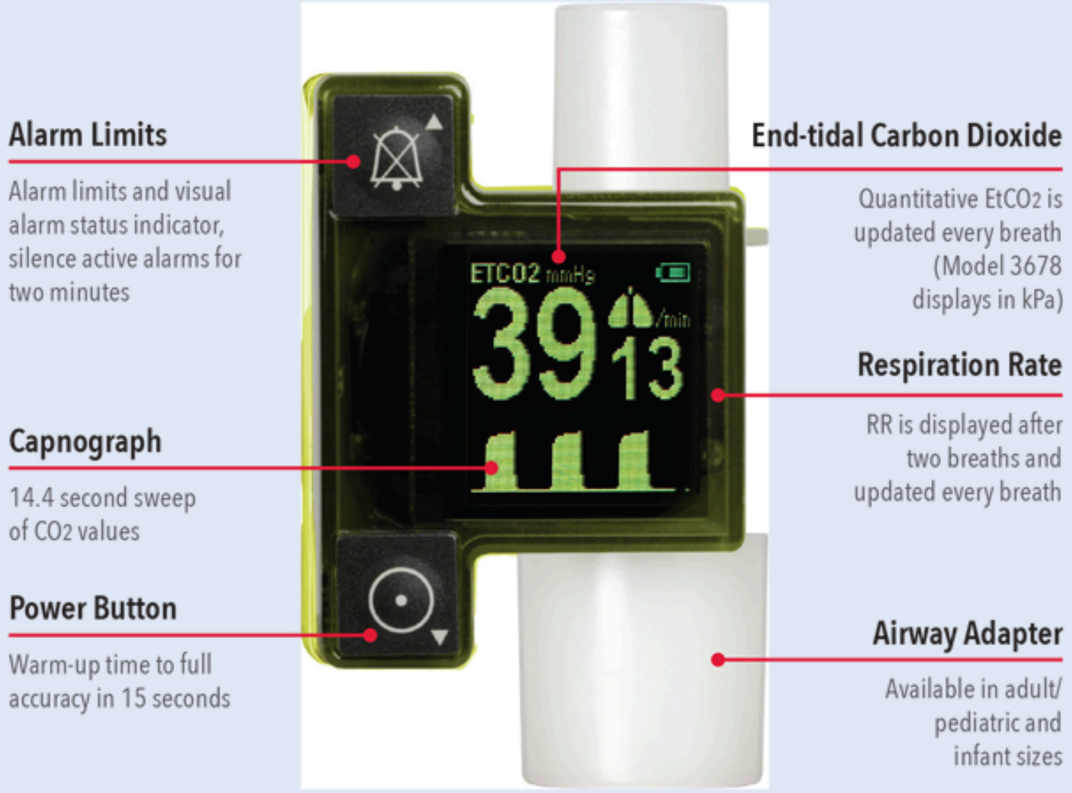
Interpretation:

- **Hypoventilation (High $EtCO_2$): CO_2 retention due to inadequate ventilation.**
- **Hyperventilation (Low $EtCO_2$): Excessive ventilation or poor perfusion.**
- **Obstructive Pattern: "Shark fin" waveform indicates airway obstruction.**

Advantages:

- **Continuous, non-invasive monitoring for early intervention.**
- **Real-time feedback compared to intermittent blood gases.**
- **Useful in detecting complications like airway obstruction, pulmonary embolism, and shock states.**





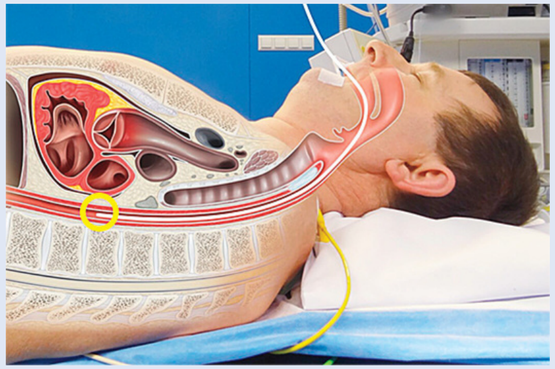
Patient temperature

Temperature regulation is important to the survival of the patient, Although it occurs infrequently, hypothermia with a temperature below 32°C is a serious concern, Ventricular irritability increases, and if the temperature decreases to 28° C cardiac arrest is likely.

shivering can increase oxygen demand 135% to 468%,when respiratory and cardiovascular systems may be unable to respond normally to the increased demand.

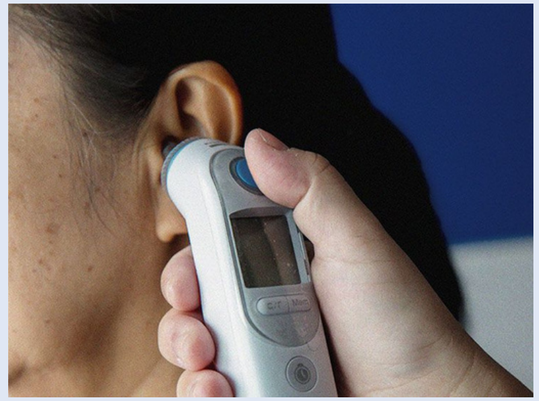
Site for monitoring body temperature:

Oral, Tympanic membrane, Esophageal, Nasopharyngeal, Pulmonary arterial blood, Rectal, Bladder, Axillary, Forehead.



Esophageal temperature

Oral temperature



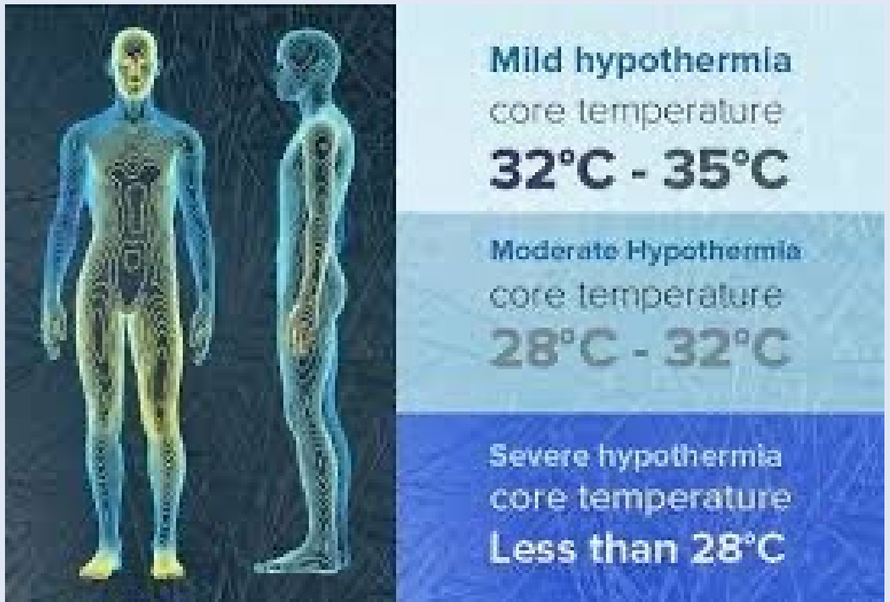
Tympanic membrane temperature

Hypothermia :

- Hypothermia is defined as a potentially dangerous drop in body temperature below 35°C (95°F), and can be the result of environmental forces (accidental hypothermia), a metabolic disorder (secondary hypothermia), or a therapeutic intervention (induced hypothermia).
- Usually caused by prolonged exposure to cold temperatures.

Causes:

- Cold exposure.
- Certain medical conditions such as diabetes and thyroid conditions, some medications, severe trauma, or using drugs or alcohol all increase the risk of hypothermia.



What Is the Management for Hypothermia ?

Hypothermia is a potentially life-threatening condition that needs emergency medical attention:

Management of Hypothermia	Details
External Rewarming	Hypothermia is a potentially life-threatening condition that requires immediate action.
a) Remove Wet Clothes	Take off any wet clothing, hats, gloves, shoes, and socks to prevent further heat loss.
b) Protect from Wind & Heat Loss	Shield the person from wind, drafts, and additional heat loss by using warm, dry clothes and blankets.
c) Move to Warm Shelter	Gently move the person to a warm, dry environment as soon as possible.
d) Begin Rewarming	Rewarm the person with extra clothing and warm blankets.
e) Monitor Temperature	If possible, check the person's temperature using a thermometer.
f) Offer Warm Liquids	Provide warm liquids, but avoid alcohol and caffeine, which can speed up heat loss. Do not give fluids to an unconscious person.
g) Perform CPR	If the person is unconscious and shows no signs of breathing or pulse, continue CPR.

Methods of Internal Rewarming	May involve:
- Warmed IV Fluids	Administering warmed intravenous fluids to help reheat the body internally.
- Heated and Humidified Oxygen	Providing heated and humidified oxygen to assist with internal rewarming.
- Peritoneal Lavage	Internal "washing" of the abdominal cavity with warm fluids to raise core temperature.
- Other Medical Interventions	Additional measures may be required based on the severity of hypothermia.

Monitoring the Urine Output

- **Urine output is the best indicator of the state of the patient's kidneys.**

<u>Physical Characteristics</u> of urine examination:

- Volume
- Color
- Odor
- PH
- Specific gravity

1) Volume:

- **Normal** ➡ 1 - 2.5 L/day

- **Oliguria** ➡ < 400 ml/day

Seen in (Dehydration – Shock – Acute glomerulonephritis – Renal Failure)

- **Polyuria** ➡ > 2.5 L/day

Seen in (Increased water ingestion - Diabetes mellitus – insipidus – excessive use of diuretics - excess caffeine or alcohol)

- **Anuria** ➡ < 100 ml/day

Seen in (renal shut down Volume – obstruction such as kidney stone or tumor)

2) Color:

- **Normal** pale yellow in color due to pigments urochrome, urobilin and uroerythrin.
- **Cloudiness** may be caused by excessive cellular material or protein, crystallization or precipitation of non-pathological salts upon standing at room temperature or in the refrigerator, also can be caused by urinary tract infections or obstructions.
- **Color of urine depending upon its constituents.**

Abnormal colors:

- **Colorless** – diabetes, diuretics
- **Deep Yellow** – concentrated urine, excess bile pigments, jaundice Color
- **Red urine** – indicates red blood cells within the urine, sign of kidney damage and disease.

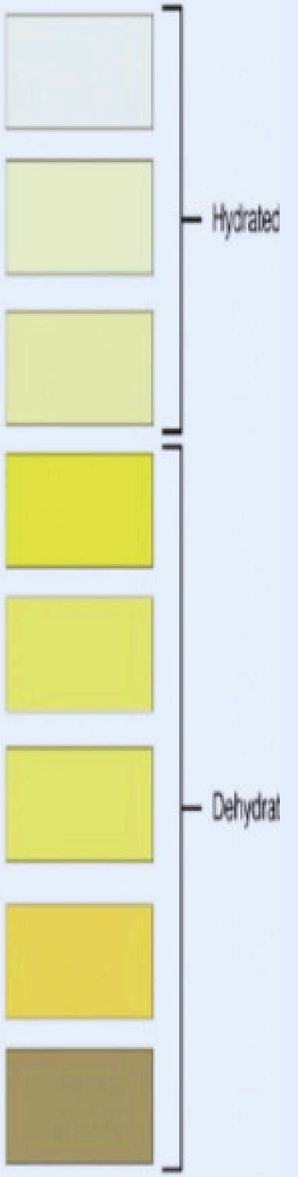


Figure 1. Urine Color

3) Odor:

- **Normal** aromatic due to the volatile fatty acids ,on long standing (aged urine) ammonical decomposition of urea forming ammonia which gives a strong ammonical smell

- **Foul** offensive → pus or inflammation
- **Sweet** → Diabetes
- **Fruity** → Ketonuria

4) PH

- Reflects ability of kidney to maintain normal hydrogen ion concentration in plasma & ECF

- Normally it is slightly acidic lying between (6 – 6.5)

- Acidic Urine ➡ Ketosis (diabetes) , UTI - E.coli

- Much of the variation occurs due to diet

  high protein diets ⟹ more acidic urine

  vegetarian diets ⟹ more alkaline urine

Chronically high or low pH can lead to disorders,
such as the development of kidney stones or osteomalacia.

5) Specific gravity:

➢ **The ability of the kidney to concentrate the urine relative to the plasma from which it is filtered.**

Normal 1.001 - 1.040

- **Increase in Specific Gravity:**

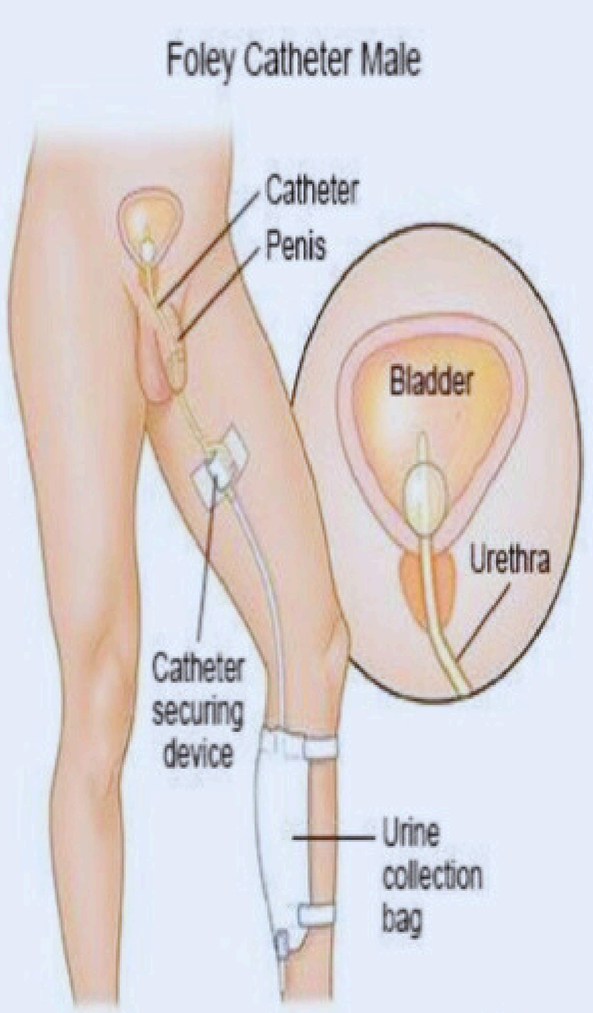
- Low water intake, Diabetes mellitus, Albuminuruia, Acute nephritis.

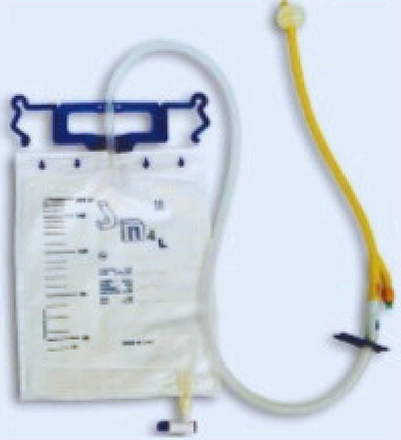
- **Decrease in Specific Gravity:**

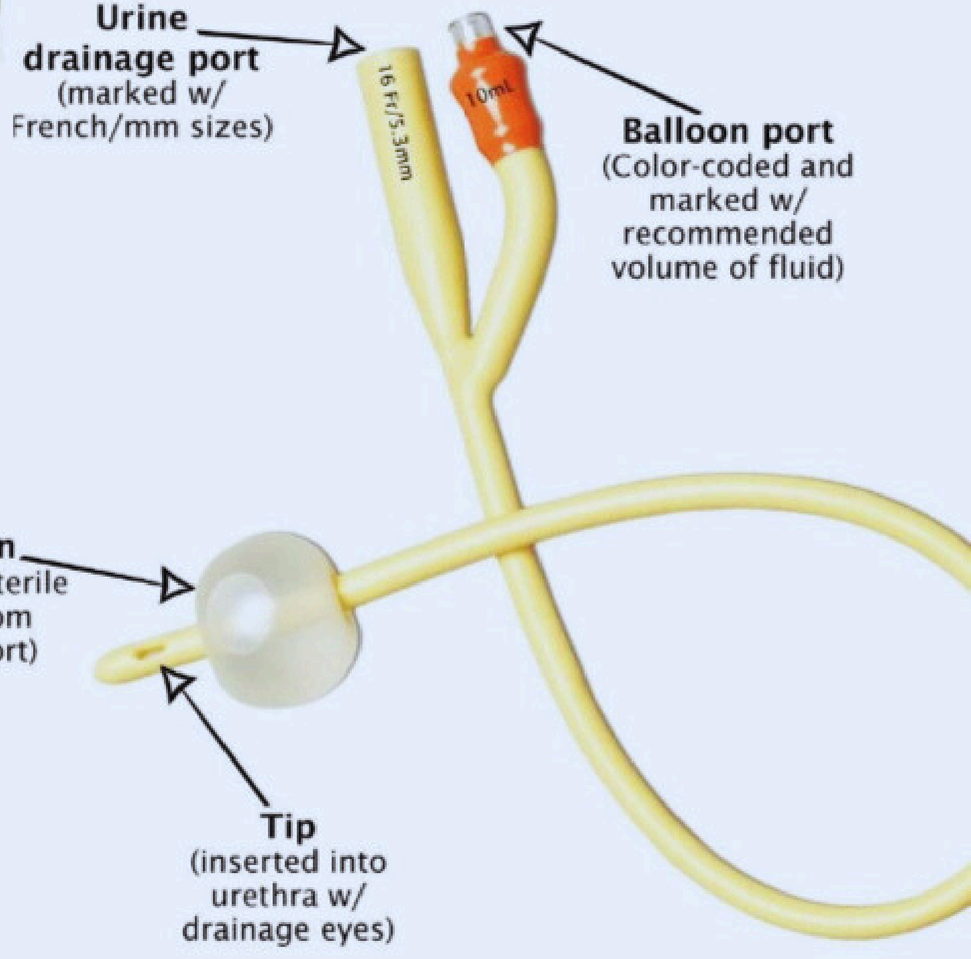
- Absence of ADH, Renal Tubular damage.

Foley catheter

To **measure urine output** in critical care units, a **Foley catheter** is introduced through the patient's urethra until it reaches his/her bladder. The other end of the catheter is connected to a graduated container that collects the urine.
Periodically the nursing staff manually records the reading of the container of every patient, and operates a valve which releases the urine into a larger container.

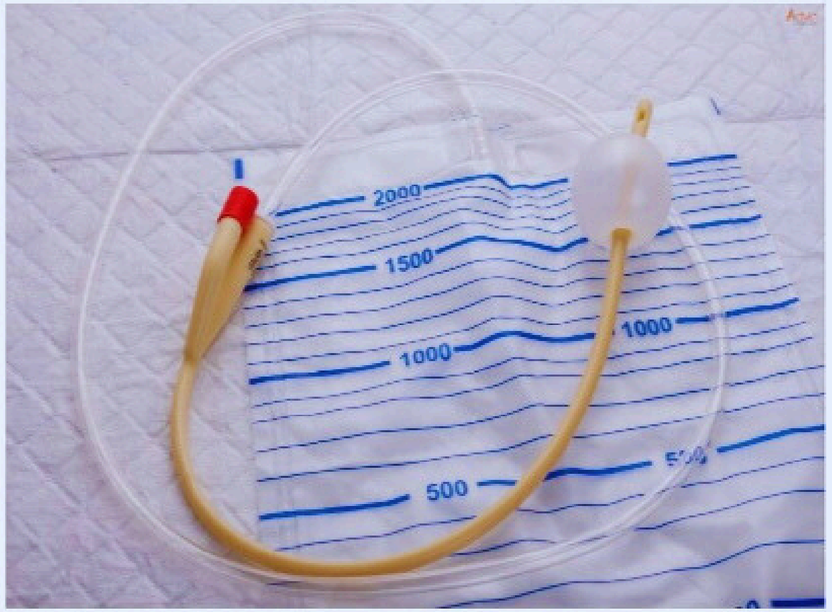






• only burn patients have this parameter recorded every hour,

while the remaining critical patients have it recorded every 2 or 3 hours.

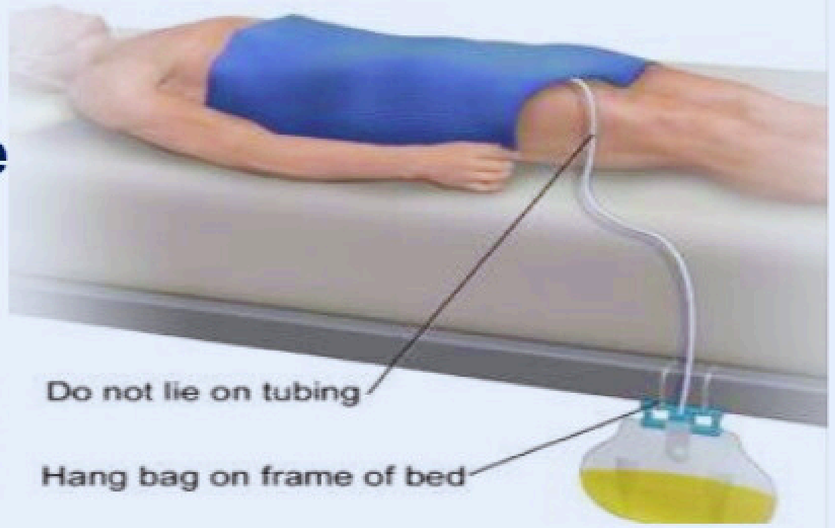


• We can monitor bladder temperature by include a thermistor in the catheter tip.

As long as urinary output is high, bladder temperatue accurately reflects core temperature.

•Complications of catheterization urethral trauma & UTI.

Rapid decompression of a distended bladder can cause hypotension



• To avoid urine reflux and minimize the risk of infection the chamber should remain at a level below the bladder.


تذكّر ، أنّك لا زلت تسير ، ومن سارَ على الدّرب وصل
The End