Overview of Critical Care - LMICs in Perspective

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Objectives:
To highlight different aspects and components of critical care
To demonstrate better understanding of critical care in the ICU
To appreciate the scope of critical care
To aid focused approach to critically ill patients

Introduction
Critical Care Medicine is an evolving specialty in our environment. Intensive Care Unit is a specially staffed and equipped hospital ward dedicated to the management of critically ill patients with reversible organ dysfunction, life threatening illness, injuries or complications who will benefit from care not available on the general ward. The Care is INTENSIVE!

Case Scenario:
A 62year old known hypertensive, diabetic and asthmatic, a victim of RTA rushed to ER. GCS 5/15, PR 125bpm, BP 80/55mmHg, RR 48cpm, Sat 85% on NRM @15L/min, dyspnoiec. Bleeding from orofacial orifices, # ribs, blunt abdominal injury with guarding, tenderness++, #long bones
Hb 7.2g/dl, WBC 32,000, PLT 80,000
Lactate 8. What is the diagnosis? What is the next line of management?

Who is a critically ill patient?
A critically ill patient describes a patient with a clinical state that may arise from various medical conditions e.g. acute coronary syndrome, stroke, infection, trauma etc or following major surgery leading to one or more organ dysfunction (consciousness, circulation, respiration, renal, endocrine or metabolic etc)

Level of Care
There are different levels of care depending on the clinical state of the patient. The severity of the patient's condition will determine the location where care will be deployed for the patient. The levels of care include:

Levels	Classification
0	Normal ward care
1	At risk of deteriorating, Requires support from Critical Care team
2	Single failing organ

	Post op Care Requires more observation or intervention
3	Two or more organs affected (multi-organ failure) Requires advanced respiratory support

Intensive Care Unit can otherwise be called Intensive Therapy/Treatment Unit (ITU) or Critical Care Unit (CCU) caters for patients with reversible or recoverable illness though could be severe or life threatening! It involves close, constant, intensive attention or care by a team of specially-trained health care providers. It is a Level 3 of care.

There are different types of ICU which include Medical Intensive Care Unit (MICU), Surgical ICU (SICU), Trauma Intensive Care Unit (TICU), Neonatal Intensive Care Unit (NICU), Paediatric intensive Care Unit (PICU), Coronary Care Unit (CCU), Neurological Intensive Care Unit (NeuroICU), Mobile Intensive Care Unit (MICU), Psychiatry Intensive Care Unit (PICU).

High Dependency Unit

A High Dependency Unit (HDU) is a step down unit that caters for patients that have made significant improvement from ICU before transfer to the ward or serves as a step up unit to take care of patients with one organ dysfunction from the Ward, Emergency Department or post operatively who are at risk of deterioration and require close monitoring. It is a Level 2 form of care

Category of ICU

Intensive Care Units can be categorized based on

1. Structure or Location
2. Function or Model

1. There are different categories or levels of ICU based on availability of expertise available at the centre.

Level	Category
1	Located in a district hospital with close nursing observation, basic monitoring, resuscitation and short-term ventilation
2	A regional general hospital ICU, with access to support systems - physio, radiological services, complex life support not provided.
3	Provides ALL aspects of ICU care staffed with Intensivists, trainees, Nurses, Allied healthcare professionals, Supports complex procedures, interventions, invasive monitoring, imaging

2. Models of ICU

Open ICU: One where the specialty teams have full admitting rights and where an Intensivist is merely “consulting”. Also referred to as “Service” ICU. Usually found in our Public Tertiary Institutions.

Closed ICU: One where the Intensivist is the admitting medical personnel and the specialty teams collaborate with ICU staff. Also referred to as “Specialist” ICU. This is

the model usually deployed in Private ICUs in LMICs. Intensivist-led team responsible for making clinical decisions

Advantages of both ICU Models or Structural Organization

Closed ICU	Open ICU
- Decreased mortality - "High Intensity" model - Decreased ICU length of stay - Mandatory daily intensivist involvement - On-site Intensivist coverage is not 24hrs - Better coordination of critical care services - More cohesive treatment strategy with better leadership - More efficient use of resources - Focused critical care skills in a critical care environment	- Primary specialists carry on care after ICU admission - Workload can be outsourced to allied health staff e.g. resp. care technicians, physician assistants - Hand over is compulsory if not, vital information might be lost - There is no need for interfering intensivist, which might be favoured by specialist teams

Setting up an ICU

The number of ICU beds should constitute 1-2% of total hospital beds. Subdivision into specialized units e.g. Medical, Surgical, Neuro ICU etc is advised if there are more than 10 beds. The bed space area should be approx $20m^2$ for infection control and gadgets storage. An Isolation bed (1 per 6 ICU beds) should be made available for high risk patients, highly contagious patients or those that require barrier nursing
An ICU is a specialized area hence needs well trained staff that work 24hours a day, 7 days a week. The staffing include Intensivists, Consultants in Anaesthesia, Trainees (Resident Doctors), Medical Officers, Nurses, Nurse Assistants and Cleaners. Ancillary staff include Physiotherapists, Dieticians etc. The Nurse to Patient ratio is 1:1 except in HDU where it can be 1:2 or 1:3. This ratio is difficult to achieve in LMICs because of gross shortage of personnel.
The location of ICU should be in close proximity to theatres, accident and emergency department, radiology department and laboratories.

Setting up an Intensive Care Unit (ICU) involves several critical considerations. These components are essential for establishing a functional and effective ICU that meets the needs of patients and the healthcare facility and include the following:

1. Need Assessment: Evaluate the demand for an ICU by analyzing historical case data, including the number of patients referred to other facilities and incidents that could have been mitigated by having an ICU.

3. Budgeting: Establish a comprehensive budget to ensure that all necessary resources are accounted for before initiating the project.

3. Stakeholder Engagement: Organize a meeting with key stakeholders to discuss the "3M's": management, manpower, and money. This is essential for aligning interests and securing support.

4. Location and Equipment: Determine the optimal location for the ICU and identify the types of equipment, drugs, and consumables needed to operate effectively.

4. Protocols and Guidelines: Develop standard operating procedures (SOPs), protocols, and guidelines to ensure consistent and high-quality care.

5. Training and Retraining: Implement ongoing training programs for staff to maintain high competency levels and adapt to new practices or technologies.

7. Audits: Conduct regular audits to objectively assess the ICU's performance and identify areas for improvement.

8. Research: Encourage research initiatives to foster advancements in ICU practices and improve patient outcomes.

Scoring Systems

These are tools or severity scales utilized in assessing severity of illness in patients admitted in ICU. They are important adjuncts of treatment, an essential part of improvement in clinical decisions with the essential functions. They assist to predict outcome, compare quality of care, explain differences in mortality, stratification for clinical trials, help with decision making at the right time and describe ICU populations. The scoring systems consist of 2 parts - severity score & calculative probability of mortality.

Scoring systems can be subjective or objective and should have the following characteristics:

- validation: ability to predict mortality
- calibration: correlation between estimated & observed mortality
- reliability: inter & intra- observer agreement in scoring

Scoring can be done on the first day - APACHE, SAPS, MPM or Daily (repetitive) - GCS, SOFA, MODS, ODIN, TRIOS

Equipment or devices in the ICU include ICU beds, ventilators, syringe drivers, infusion pumps, ABG analyzer, multiparameter monitors, suction machine / apparatus, gas pipeline supply, body/fluid warmer, intermittent pneumatic compression device, air or water bed / mattress, air blend machine (High Flow Nasal Oxygen), defibrillator, cardiac arrest trolleys, Continuous Renal Replacement Therapy (CRRT).

Various procedures are carried out in ICU hence the need for proficiency. These procedures include endotracheal intubation, arterial sampling and catheterization,

central venous cannulation, peripherally inserted central cannulation (PICC), chest tube insertion, percutaneous tracheostomy, USS (POCUS), ECMO

ABC Approach to a Critically ill Patient

A	Airway	Patency, Endotracheal Tube, Tracheostomy, Obstruction,
B	Breathing	Spontaneous / Laboured / Mechanical Ventilation
C	Circulation	Venous access, CO, CVP, IABP, Shock
D	Drugs Disability (Neurology)	Review of medications Neuro assessment (GCS)
E	Exposure (Temp, Skin) Electrolytes	Hypo/hyperthermia Decubitus Ulcers Serum Na, K, Ca, Mg etc FBC
F	Fluids Feeds	Input / Output monitoring Optimal nutritional status / serum albumin
G	Glucose	Random Blood Sugar
H	Head Up	

FAST HUG BIDS
F Fluids / Feeds
A Analgesia
S Sedation
T Thromboprophylaxis

H Head Up
U Ulcer prophylaxis
G Glucose
S Sedation vacation, SBT, Skin integrity

B Bowel care
I Indwelling catheter
D De-escalation of antibiotics

Mechanical Ventilation: This is a critical intervention in the ICU for patients who experience respiratory dysfunction and cannot maintain adequate oxygenation and ventilation on their own. It provides respiratory support through two main ways. It can be Invasive (through endotracheal tube or via a tracheostomy) or Non Invasive (through the use of tight fitting face masks

Invasive Ventilatory Modes: Controlled Mandatory Ventilation (CMV), Assist Controlled Mandatory Ventilation, Synchronized Intermittent Mandatory Ventilation

(SIMV). These can either be Pressure or Volume controlled. Others include Pressure Support Ventilation (PSV), PRVC SIMV, APRV, PRVC, Adaptive Support Ventilation.
Non Invasive Modes: Continuous Positive Airway Pressure (CPAP), Bilevel Positive Airway Pressure (BiPAP)

Indications for Mechanical Ventilation
- Acute respiratory failure
- Altered conscious level or decreasing conscious level
- Inability to protect airway
- Following cardiac arrest
- For recovery after prolonged surgery or extensive trauma
- Control of intracranial pressure in head injury
- Respiratory rate > 35 or < 8 breaths/minute
- Exhaustion, with laboured pattern of breathing
- Hypoxia – central cyanosis, Sa02 <90% on oxygen or Pa02 < 8kpa
- Hypercarbia – PaC02 > 8kpa
- Significant chest trauma
- Tidal volume < 5ml/kg

Weaning
Weaning from mechanical ventilation is the gradual process of reducing and eventual discontinuation of ventilatory support to allow patient resume full spontaneous breathing. It entails the following:
- Ensure resolution of the underlying clinical or pathological condition
- The patient should be haemodynamically stable or on very minimal vasoactive support
- Ensure adequate oxygenation and ventilation SpO2 ≥ 90% with FiO2 ≤ 40 - 50% and PEEP ≤ 5 - 8cm H2O, PaO2/FiO2 ratio > 200
- Minimal respiratory acidosis with a pH ≥ 7.30
- Ability to initiate spontaneous breathing and maintain adequate ventilation
- Good cough and airway protection
- Rapid Shallow Breathing Index (RSBI) RR/VT(Litres) also known as Tobin Index. An RSBI < 105 suggest a higher likelihood of weaning success.
- Perform Spontaneous Breathing Trials using low levels of pressure support, T-piece, CPAP
- Cuff leak test can be performed
- Closely monitor mental status, cardio respiratory parameters etc.

ABG

	pH	PCO2	pO2
Respiratory Acidosis	low	High	normal
Respiratory Alkalosis	high	low	normal
Metabolic Acidosis	low	normal	low

Metabolic Alkalosis	high	normal	high

Analgosedation

Drug	Type	Sedation	Analgesia	Dose	Advantages	Side Effects
Fentanyl	Opioid	+	+++	20 - 100ug/kg/min	Reversible, rapid onset, short duration	Resp depression, chest wall rigidity, gastric dysmotility, hypotension
Morphine	Opioid	+	+++	1 - 5mg/hr	Reversible	Resp depression, chest wall rigidity, gastric dysmotility, hypotension
Remifentanil	Opioid	+	+++	0.5 - 2ug/kg/min	Reversible, rapid onset, short duration	Resp depression, gastric dysmotility, hypotension, hallucination
Midazolam	Benzodiazepines	+++	-	1 - 5mg/hr	Reversible, shorter duration and titratable	Resp depression, hypotension, confusion, delirium
Diazepam	Benzodiazepines	+++	+	1 - 5mg	Reversible	Resp depression, hypotension, confusion
Lorazepam	Benzodiazepines	+++	-	1 - 5mg/hr	Reversible	Resp depression, hypotension, confusion
Dexmedetomidine	Alpha 2 agonist	++	++	0.2 - 1.5 ug/kg/hr	Maintains cognitive function	Dry mouth, bradycardia, hypotension, atrial fibrillation
Propofol		+++	-	1 - 3 mg/kg/hr	Very short duration, titrable	Hypotension, resp depression, metabolic acidosis, pain on injection

Sedation tools

Richmond Agitation Sedation Score

RASS Scale			CAM ICU
Score	Description		
+4	Combative	Violent, Immediate danger to staff	RASS ≥ -2 Proceed to CAM-ICU assessment
+3	Very agitated	Pulls at or removes tubes/catheters, aggressive	
+2	Agitated	Frequent non purposeful movement, fights ventilator	
+1	Restless	Anxious, apprehensive but not aggressive	
0	Alert & Calm		
-1	Drowsy	Awakens to voice (eye opening/contact) > 10 seconds	
-2	Light sedation	Briefly awakens to voice (eye opening/contact) < 10 seconds	
-3	Moderate sedation	Movement or eye opening to voice (no eye contact)	RASS < -2 STOP Recheck later
-4	Deep sedation	No response to voice but movement or eye opening to physical stimulation	
-5	Unrousable	No response to voice or physical stimulation	

*CAM-ICU: Confusion Assessment Method for the Intensive Care Unit

Ramsay Sedation Scale

Sedation Level	Score
Anxious and agitated or restless or both	1
Cooperative, Oriented and Tranquil	2
Responds to commands only	3
Exhibits brisk response to light glabellar tap or loud auditory stimulus	4
Exhibits brisk response to sluggish glabellar tap or loud auditory stimulus	5
Exhibits No response	6

Haemodynamic Monitoring

Indications for arterial monitoring

- Hypotension
- Complex fluid management e.g. post major surgery with fluid shifts, burns, significant trauma)
- Vasoactive support
- Frequent arterial blood sampling

Requirements for setting up an arterial monitoring system (Picture)

- Arterial catheter: Typically 20-gauge for adults. Common sites include the radial, femoral, or brachial arteries (cautious because it's an end artery)

- Multiparameter monitor with port / facility for invasive monitoring
- Pressure Transducer kit: Includes a transducer which is a device that converts pressure wave to electrical signal. It must be compatible with the cable of the monito. Other components of the kit include flush solution, tubing and a pressure bag.
- Pressure infusor/bag: Inflated to 300mmHg to prevent back flow of blood and maintain line patency.
- Saline bag

Setting up an arterial monitoring system
- Prepare the Pressure Transducer System
* Prime the tubing with saline to remove air bubbles
* Connect the pressure bag to saline and inflate to 300mmHg to provide continuous flush (typically 3-5 ml/hr) to keep the line patent.
* Attach the transducer to the monitor
- Patient is positioned supine head up or flat
- Perform Allen's test for radial artery to confirm adequate ulnar collateral blood flow.
- Positioning the transducer - Place the transducer at the level of the patients phlebostatic axis (mid-axillary line at the level of the 4^{th} intercostal space) for accurate readings
- Zeroing the transducer: turn the stop cock nearest to the transducer to "off" or "close" to patient and "open" to air. Press the "zero" button on the monitor to calibrate to atmospheric pressure. Once zeroed, turn the stopcock off to air and reconnect to the patient.
- Confirm waveform and readings.

Problems with arterial monitoring
- Air emboli
- Haemorrhage
- Distal limb ischaemia
- Inadvertent drug injection
- Thrombosis formation
- Damping

Central Venous Pressure Monitoring. Normal CVP values 2 - 8 mmHg
Indications (Central venous catheter and CVP)
- Assessing volume status
- Guidance with complex fluid requirements
- Monitoring response to fluid therapy
- Guidance with drug and vasoactive substances
- Parenteral Nutrition
- Mixed venous oxygen saturation
Sites: Internal Jugular, Subclavian and Femoral. The catheter tip should ideally be positioned in the lower third of the SVC just above the right atrium. A chest Xray is required for position verification post insertion.
Complications

- Arrhythmias
- Infection
- Air embolus
- Thrombus formation

Inotropes and Vasopressors

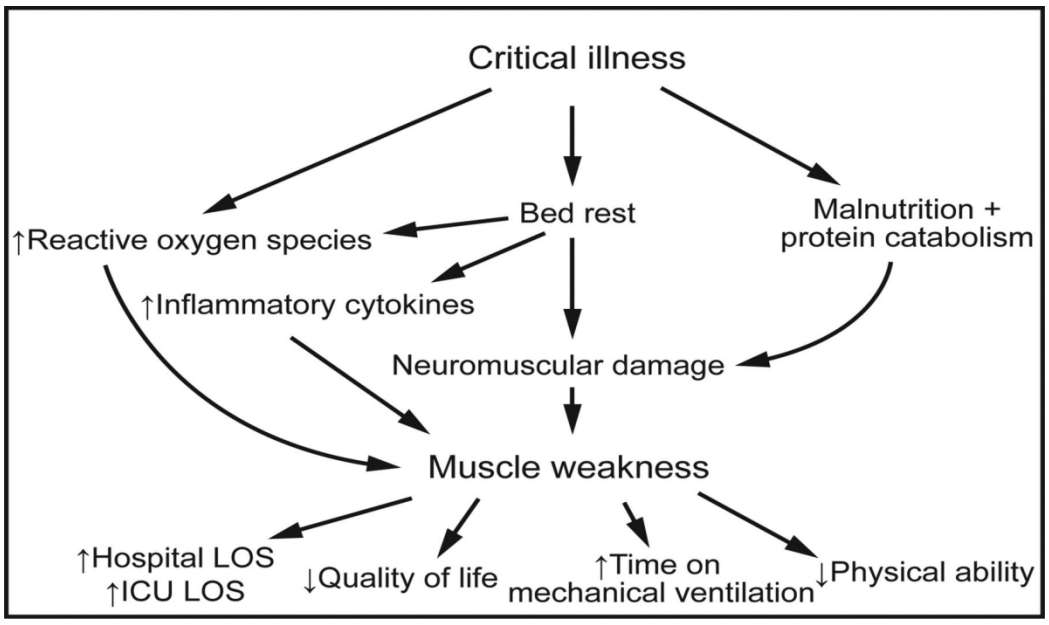
Drug	Indication	Dose
Norepinephrine	Shock (most types)	0 - 40 ug/min
Dobutamine	Cardiogenic shock	2 - 20 ug/kg/min
Adrenaline	Bradycardia, Cardiogenic shock, Sepsis, Anaphylaxis	0 - 20 ug/min
Vasopressin	Distributive Shock / Pulm HTN	0.01 - 0.06 U/min
Milrinone	Cardiogenic shock	0.375 - 0.75 ug/kg/min
Dopamine		1 - 20 ug/kg/min

Nutrition

Critical illness is associated with Malnutrition. Catabolism is more than anabolism.
Routes of administration include oral, enteral and parenteral.
Nutrients: Protein (4KCal/kg). Carbohydrates (4Kcal/kg), Lipids (9Kcal/kg), Vitamins, Minerals Electrolytes & trace elements), Water.

	Healthy 70kg man	ICU Patient
Caloric Intake	25 - 30 KCal/kg/day	
Mild Stress		25 - 30 KCal/kg/day
Moderate Stress		30 - 35 KCal/kg/day
Severe Stress		35 - 40 KCal/kg/day
Protein	0.8 - 1g/kg/day	1 - 2g/kg/day
Fluids	30mls/kg/day	Individualized

Immobility



Sepsis

Sepsis is a life threatening condition which involves organ dysfunction that arises from dysregulated host response to infection leading to widespread inflammation, tissue damage, organ failure and potentially death. Early recognition and prompt intervention are critical as delays in treatment will significantly increase mortality rates.

Chain of Infection: Infectious agent, reservoir, portal of exit, means of transmission, portal of entry, susceptible host

Infection requires three main elements: source of the infectious agent, mode of transmission and a susceptible host.

Types of Infection in ICU

- Catheter Associated Urinary Tract Infection (CAUTI)
- Central Line Associated Blood Stream Infection (CLABSI)
- Surgical Site Infection (SSI)
- Ventilator Associated Pneumonia (VAP)

Infection Prevention and Control:

Standard Precautions to be observed include

- Hand hygiene, before and after every episode of patient contact (i.e. 5 Moments for Hand Hygiene)
- Use of PPE
- Aseptic non-touch technique for procedures
- Safe use and proper disposal of sharps
- Routine thorough environmental and surface cleaning
- Respiratory hygiene and cough etiquette
- Waste management
- Appropriate handling of linen.
- Safe handling of specimen

Antimicrobial Stewardship (AMS)

Antimicrobial resistance is a growing global health concern where microbes evolve to withstand the effects of drugs that were once effective against them. It results from overuse or misuse of antibiotics.

AMS refers to a set of strategies which are well coordinated to ensure the following

(i) improve patient care, and outcomes by optimal therapy;

(ii) reduce collateral damage by reducing antimicrobial use (less resistance), and

(iii) reduce the cost for antibiotics.

Consequences of lack of effective AMS include treatment failures, prolonged hospital stay, increased mortality rates, increased healthcare costs and an overburdened public health system.

The rational use of antimicrobial agents is improved on by careful selection of appropriate agents imbibing the 5 ”D”s of antimicrobial therapy which include

1. right **Drug**,
2. correct **Dose**,
3. right **Drug-route**,
4. right **Duration**,
5. timely **De-escalation** to pathogen-directed therapy (targeted therapy).

Care Bundles

These are structured groups of evidence-based practices aimed at improving patient outcomes, standardizing care and reducing complications. They are typically focused on key areas where ICU patients are at high risk of developing complications.These include: Ventilator Care Bundle, Sepsis Care Bundle, Central Line Care Bundle, Pressure Area Care Bundle, Catheter Associated UTI Care Bundle, Vascular Catheter (Central & Peripheral) Care Bundle.

Ingredients for effective performance in ICU

For effective operation in an Intensive Care Unit (ICU), several key ingredients or requirements are essential: These elements collectively contribute to a well-functioning ICU that can provide high-quality care to critically ill patients.

1. Teamwork (Multidisciplinary Team - MDT): Collaboration among various healthcare professionals, including doctors (physicians, surgeons), nurses, respiratory therapists, physiotherapists, dietitians and pharmacists, is crucial for comprehensive patient care.

2. Good Interpersonal Relationships: Fostering positive relationships among team members is vital for creating a conducive environment where team members can effectively discharge their duties, with enhanced communication and teamwork, leading to better patient outcomes and ultimately overall functioning of the ICU.

3. Hard Work: Commitment and diligence from all staff are necessary to manage the demanding nature of ICU work.

4. Training: Continuous medical education and regular training programs are vital to ensure that staff are up to date with the latest practices and technologies in critical care.

5. Skill Acquisition: Ongoing skill development is important for healthcare providers to perform complex procedures and handle advanced equipment effectively.

6. Resilience: The ability to cope with the emotional and physical challenges of working in an ICU is important for staff well-being and maintaining high-quality care.

7. Communication: Clear, effective and closed loop communication among team members and with patients' families is essential for coordinated care and understanding. Daily update on patient's clinical state is necessary. Be empathetic, avoid ambiguity and don't give false hope.

8. Documentation: Regular documentation of communication or discussions, clinical updates, procedures and other activities in the ICU are essential. Whatever is not documented is assumed not to have been done.

9. Collaboration: Working together across disciplines and departments (e.g., nursing, pharmacy, respiratory therapy) to provide integrated care.

10. Support: Strong backing from hospital management and other departments (such as laboratories and radiology) is necessary to ensure that the ICU has the resources it needs to function effectively.

Challenges of Critical Care especially in resource poor settings

- Inadequate number of functional ICU facilities
- Problem of under-staffing as a result of brain drain and other factors
- Lack of certified training options (accessible & affordable)
- Lack of funding
- Lack of equipment
- Poor working conditions
- Burn out syndrome
- Ineffective Insurance scheme
- High cost

Conclusion:

Critical Care involves holistic approach to patients that have severe illness which is reversible. It has a wide scope and each aspect is crucial and intertwined for favourable outcome. The care of ICU patients though highly demanding, it's rewarding.

References

1. Horner DL, Bellamy MC Care bundles in Intensive Care Continuing Education in Anaesthesia Critical Care & Pain BJA 2012;12:199 - 202
2. Rapsang AG, Shyam DC Scoring systems in the intensive care unit: A compedium Indian J Crit Care Med 2014; 18: 220 - 228
3.Steven MK, Jonathon DT Ventilator-Associated Pneumonia: Diagnosis, Treatment and Prevention Clin Microbiol Rev 2006; 19: 637 - 657 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1592694/
4.https://nursekey.com/haemodynamic-monitoring/ accessed online on 11th Feb. 2023
5. Tobi KU Questions and Answers in Anaesthesia and Critical Care Mindex Pub. Ltd 2018 288 - 295