# THIRD YEAR BSC PERFUSION TECHNOLOGY

# APPLIED

# QUESTION BANK

## ESSAY

**1. Anticoagulation and its monitoring during CPB**

**Anticoagulation**

- Anticoagulation is used to prevent blood clotting in veins, arteries and lungs
- Discovered: Jay Mc Lean (1916)
- Source: Liver
- Dosage: 3-4 mg/kg
- Half life: 40-60 minutes
- MOA: inhibits reactions that leads to clotting of blood and formation of fibrin clots both in vitro and in vivo
- Heparin resistance: inability to rise ACT to expected levels despite inadequate dose and plasma conc of heparin.
- Heparin less bypass
- HIT
- Monitoring: ACT
- Heparin alternatives: LMWH, Bivalirudin, Hirudin, Argartroban, Dermatan sulfate, Lepirudin
- Adverse effects of heparin: bleeding, deep vein thrombosis, osteoporosis

**2. Assisted devices**

- Circulatory assisted device: IABP and VAD
- IABP:
- Circulatory assist device used to support LV in LV failure patients
- Working principle: counter pulsation
- IABP Balloon :Filled with helium gas, do not cause harm to patient even if the balloon ruptures

- Access: descending aorta, 1-2cm below the subclavian artery and above renal artery
- Contraindications: irreversible brain damage and aortic dissection
- Advantage: decreased coronary oxygen demand, increased coronary oxygen supply
- Complications: pseudo aneurysm, renal failure
- Timing errors
- VAD
- It is used to partially or completely support a failing heart
- Type: LVAD, RVAD, BIVAD
- Types of mechanical circulatory support: short term and long term
- Indications: failure in weaning, myocarditis, cardiomyopathy, CP arrest
- Advantages: low priming volume, low level of anticoagulation
- Disadvantages: shorter duration, infection
- Complication: hypovolemia, kinking, arrhythmia

**3. Describe the techniques of blood conservation during CPB**

- Aim: to use blood or blood products appropriately and find ways to reduce or avoid the need for blood transfusion
- Techniques:

**Ultrafiltration**

- Used in pediatric patients
- Have low blood volume
- High priming volume

**VAVD**

- To decrease priming volume
- Small cannulas used
- Increase venous drainage

**Microplegia**

- Called miniplegia
- Short term surgeries
- Intermittent warm blood CP

**Autologous blood predination**

- Safe and efficient
- Hct 22-25% in CPB
- Not suitable for neonatal surgery

**Cell salvage technique**

- Scavanges blood loss
- Types: non washed and washed techniques
- Reduce allogenic blood transfusion

**Retrograde autologous priming**

- Hemodynamic stable patient
- Low HCT patient
- Reduce blood transfusion

**Antegrade autologous priming**

- Displacing some of circuit prime at initiation of CPB with patients own circulating blood

**4. Explain systemic inflammatory response syndrome. What are the pathophysiological changes**

- Offers protection to organs from pathological insults
- Activation of immune system occurring in the context of CPB is multifactorial
- Due to activation of immune system
- CPB activates innate and acquired system
- Indicates various infectious and non infectious conditions
- CPB produces whole body inflammatory response
- Clinical manifestations of SIRAB
- Pulmonary, renal, CNS dysfunction
- Coagulopathy
- Sequence which CPB leads to SIRS
- Initiating factors
- Immune system activation
- Cellular injury

- Cellular components of blood
- RBC
- Vascular endithelium
- Leukocytes
- WBC
- Minimise SIRS
- Pharmacological: aprotinin
- Mechanical manipulation: CUFF, MUFF

**5. Discuss and enumerate in detail on ultrafiltration and its types during CPB**

- Filtration using a medium fine enough to retain colloidal particles viruses or large molecules
- Made of fibres
- Indication: patient not responding to dialysis therapy, renal failure
- Principle:hydrostatic pressure forces a liquid against a semipermeable membrane
- Sieving coefficient
- Advantage:remove excess volume in reservoir, decrease lung water
- Types: 4 types
- **Pre-BUFF**: also called prime filtration
- Filtration during priming
- Duration: 10 mins

- **CUFF:** used to concentrate circuit
- Reduce cerebral edema
- Widely used

- **Z-BUFF**
- Done during rewarming
- Decrease pulmonary vascular resistance
- Correct electrolyte imbalance

- **MUFF**
- Used after bypass
- Pediatric and neonate patients

- 2 types: arteriovenous and venovenous

## SHORT NOTES

- Haematological effects on CPB.

### 1. Blood cell trauma

- RBC damage occurs due to artificial valve, hear lung machine and other devices which pumps or process blood
- Mechanical stress to RBC
- Analysis of cell damage
- Types: shear stress, blood viscosity, turbulence, cavitation
- Effects on RBC and WBC
- Damages to RBC
- Leukocytes, neutrophils, monocytes
- Uses of analysis of force

### 2. Heparin and its alternatives

- Heparin is used to prevent blood clotting in veins, arteries and lungs
- Discovered: Jay Mc Lean (1916)
- Source: Liver
- Dosage: 3-4 mg/kg
- Half life: 40-60 minutes
- MOA: inhibits reactions that leads to clotting of blood and formation of fibrin clots both in vitro and in vivo
- Alternatives:

LMWH: potent inhibitor of factor Xa

- Dermatan sulfate: inhibition of thrombosis by heparin cofactor lll
- Hirudin: isolated from medicinal leeches
- Bivalirudin: synthetic analogue of hirudin
- Synthetic peptide

### 3. HIT

- Occurs in 3-5% of patients during or after administration of UFH treatment
- Causes: hyperspleenism and hemodilution
- Types: 2 types
- Type 1: non immune mediated
- No antibody mediated
- Type 2: immune and antibody mediated
- Complication: deep vein thrombosis, MI
- Treatment: prompt cessation of heparin and heparin alternatives
- Heparin alternative

**4. Pump lung syndrome**

- Also known as acute respiratory distress syndrome, adult respiratory distress syndrome, shock lung
- Fatal pulmonary parenchymal disorder
- Causes trauma or stress
- Shock lung develops edema, impaired perfusion
- Etiology: pneumonia, trauma, shock
- Management: nitric oxide, 18 PPM reduce mean pulmonary artery pr

**5. Arterial line filters**

- Cardiopulmonary bypass arterial line blood filter is a device used as part of a gas exchange (oxygenator) system to filter non-biologic particles and emboli out of the blood.
- Located: after oxygenator and before patient
- Function: reduce the load of gaseous and particulate emboli
- Advantages: prevention of micro emboli, either being particulate or micro air from reaching the patients circulation
- Working principle: adsorption
- Pore size: 20- 40 micrometre

**6. Massive air embolism and its management**

- Micropore filters are used to prevent the perfusion of microemboli during CPB
- History: Dr RL Swank, Dr RH Patterson, further development in 1970

- Contaminations: particulate and gaseous contamination
- **Massive air embolism:** abnormal collection of gas which forms a bubble creating blockade in circuit
- Causes: rupture of arterial lines and connectors, oxygenator defect, arterial reservoir run dry, sudden acceleration of roller pump
- Management: placing the patient in a deep Trendelenburg position
- Temporary retrograde perfusion through the superior vena cava (SVC) may also be used.
- Stop CPB immediately
- Clamping venous line
- Remove arterial filter
- Induce hypertension
- RCP

**7. Compliment and contact activation**

- Pathway

**8. Z-BUFF**

- Ultrafiltration is the Filtration using a medium fine enough to retain colloidal particles viruses or large molecules
- Made of fibres
- Indication: patient not responding to dialysis therapy, renal failure
- Principle:hydrostatic pressure forces a liquid against a semipermeable membrane
- Z-BUFF is the process by which a solution is infused into CPB circuit and an equal volume of fluid is removed by an ultrafiltration column
- Done during rewarming
- Decrease pulmonary vascular resistance
- Correct electrolyte imbalance
- Used to remove large volume of ultrafiltrate
- Water soluble inflammatory mediators are removed
- Decrease PVR

## 9. Protamine reaction

- Antidote for heparin
- History: John Fredrich (1870)
- MOA: binds with heparin to produce a stable precipitate which has no anticoagulant property and has mild anticoagulant effect independent of heparin
- Source: sperms of salmon fish
- Dosage: 1-1.3 mg of protamine for each 100 units of heparin
- Reactions: 2 types
- Horrow classification and Moorman Zapol Lowenstein classifiaction

## 10. Complication of blood transfusion

- A blood transfusion is a routine medical procedure in which donated blood is provided to you through a narrow tube placed within a vein in your arm.
- Types: packed red blood cells (PRBCs), individual factor concentrates, fresh frozen plasma (FFP), platelet concentrates, and cryoprecipitate.
- Indications: Anaemia.
- Major Surgical Operation.
- Accidents resulting in considerable blood loss.
- Cancer patients requiring therapy.
- Women in childbirth and newborn babies in certain cases.
- Patients of hereditary disorders like Haemophilia and Thalassaemia.
- Severe burn victims.
- Complications: Early Complications:
- Hemolytic reactions (immediate and delayed)
- Non-hemolytic febrile reactions.
- Allergic reactions to proteins, IgA.
- Transfusion-related acute lung injury.
- Reactions secondary to bacterial contamination
- Circulatory overload.
- Air embolism.

## 11. Effects of CPB on kidney

- Function of kidney

- Osmolarity
- Ionic composition
- Vital role: organ of endocrine function
- Regulating RBC mass by production
- Prevention of renal ischemia :increasing oxygen delivery reducing oxygen demand
- Risk factors: preop, operative, perioperative
- Pharmacological therapy: frusemide, dopamine, mannitol, nifedipine
- Treatment: renal replacement therapy( dialysis/hemofiltration)

**12. Autologous blood priming**

- Means to effectively and safely restrict the hemodilution caused by the direct homologous blood transfusion and reduce the blood transfusion requirements during cardiac surgery.
- Types: retrograde autologous priming
- Blood is taken through arterial side
- Reduces blood transfusion
- Reduce homologus blood transfusion
- Reduce priming volume
- Antegrade Autologus priming :
- Blood is taken through venous side.
- Displacing some of circuit prime at initiation of CPB with patients own circulating
- Lower blood transfusion rate perioperatively
- Shorter hospital stays

**13. Screen filters**

- Micropore filters are used to prevent the perfusion of microemboli during CPB
- History: Dr RL Swank, Dr RH Patterson, further development in 1970
- Contaminations: particulate and gaseous contamination
- Composition : polymer threads woven into fibres of definied porosity
- Function : partical removal
- Mechanism: direct interception
- It will not allow particles larger than their pore size
- Small wetted surface area

- Large open surface area

## 14. Major transfusion reaction

- A blood transfusion is a routine medical procedure in which donated blood is provided to you through a narrow tube placed within a vein in your arm.
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- Indications: Anaemia.
- Major Surgical Operation.
- Accidents resulting in considerable blood loss.
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- Women in childbirth and newborn babies in certain cases.
- Patients of hereditary disorders like Haemophilia and Thalassaemia.
- Severe burn victims.
- Transfusion reactions are adverse events associated with the transfusion of whole blood or one of its components.
- Types of transfusion reactions include the following: acute hemolytic, delayed hemolytic, febrile non-hemolytic, anaphylactic, simple allergic, septic (bacterial contamination), transfusion-related acute lung injury (TRALI), and transfusion-associated circulatory overload (TACO).

## 15. Hemodialysis and hemofiltration

- Filtration using a medium fine enough to retain colloidal particles viruses or large molecules
- Made of fibres
- Indication: patient not responding to dialysis therapy, renal failure
- Principle:hydrostatic pressure forces a liquid against a semipermeable membrane
- Sieving coefficient
- Advantage:remove excess volume in reservoir, decrease lung water
- Types: 4 types
- Hemodialysis: 0-9% normal saline used
- Indication: end stage renal disease, renal insufficiency
- Effective in removal of pottasium, urea and electrolyte

- Hemofilter can more effectively remove the middle molecule solutes compared with hemodialysis by convection

## ANSWER BRIEFLY

**1. Thromboelsatography**

- Quantitatively measures the ability of whole blood to form a clot.
- Principle: to detect and quantify dynamic changes of the viscoelastic properties of a blood sample during clotting under low shear stress.
- Types: Standard (kaolin), RapidTEG, heparinase, Functional Fibrinogen and Platelet Mapping.
- Phases: the acceleration phase, strengthening, retraction, and clot lysis.

**2. Timing errors in IABP**

- Early inflation
- Late inflation
- Early deflation
- Late deflation

**3. Tranexamic acid**

- Tranexamic acid (TA) reduces blood loss and blood transfusion during heart surgery with cardiopulmonary bypass (CPB).
- Method:TXA reduced perioperative blood loss and transfusion requirements in a variety of surgical disciplines without increasing the risk of thromboembolic events.
- MOA: This decreases the conversion of plasminogen to plasmin, preventing fibrin degradation and preserving the framework of fibrin's matrix structure.
- ADR: abdominal pain, vomiting, diarrhoea, pulmonary embolism
- Indication: haemophilia
- Contraindication: subarachnoid haemorrhage

**4. Aprotinin**

- reduce the risk for perioperative blood loss and the need for blood transfusion in high-risk patients during cardiopulmonary bypass for coronary artery bypass graft surgery.

- Use :reducing bleeding and the need for blood transfusions after cardiac surgery with cardiopulmonary bypass.
- ADR:atrial fibrillation, fever, nausea, low blood pressure, lung problems

**5. Cell salvage technique**

- Scavenges blood loss
- Two techniques: non washed and washed technique
- Limitations and benefits

**6. Heparin resistance**

- inability to rise ACT to expected levels despite inadequate dose and plasma conc of heparin.
- Clinical conditions:Antithrombin lll deficiency
- On going heparin therapy
- ADR: bleeding, deep vein thrombosis
- Treatment: heparin alternatives, administration of additional heparin
- ATlll suplementation with FFP

**7. Contraindications of IABP**

- Absolute: irreversible brain damage, aortic dissection
- Relative: mild PVD, infection

**8. Heparin less bypass**

- Binding to internal surface of CPB circuit to reduce need for systemic heparinisation
- Indication: routine cardiac surgery and ECMO
- Methods:covalent and ionic bonding
- MOA: inhibits reactions that leads to clotting of blood and formation of fibrin clots both in vitro and in vivo
- Advantages: reduce blood loss and transfusion requirements

**9. Cold agglutinin**

- Antibodies that work on antigens found on surface of RBC

- Cause auto immune reaction
- IgM antibodies in case where agglutination is significant
- Damages
- Techniques to perfuse

**10. CPB in sickle cell anemia**

- Abnormal RBC that is crescent shaped
- Strategy
- Diagnosis
- Management

**11. Alternatives of protamine**

- Antidote for heparin
- Hexamethridine
- PF4
- Methylene blue
- Omit neutralisation
- Heparinase

**12. Activated clotting time**

- Monitor the adequacy of perfusion
- 480 seconds on pump
- Normal: 90-120 sec
- Procedure
- Troubleshoot for ACT
- Indications

**13. Bivalirudin**

- Synthetic analogue of hirudin
- MOA
- Half life 25 min
- Dosage: bolus 0.75 mg/kg, infusion 1.75 mg/kg/hr

## 14. Albumin

- Colloid non blood prime
- Albumin can coat the circuit and decrease the contact between the blood and nonbiological materials
- MOA: increases the oncotic pressure of the intravascular system, moving fluids from the interstitial space, thereby decreasing edema and increasing the circulating blood volume.
- ADR: Blurred vision, chest discomfort, chills, confusion.
- Uses:serious injury, bleeding, surgery, or burns by increasing the volume of blood plasma.

## 15. Component therapy

- Blood component transfusions are therapeutic treatments for patients with a variety of conditions. Blood components are obtained by whole blood donation or by apheresis collection.
- Uses: to treat a specific deficiency, avoid volume overload and minimize reactions to blood products that are not needed
- Indications:Anaemia. Major Surgical Operation. Accidents resulting in considerable blood loss. Cancer patients requiring therapy.
- Complications: transmission of infectious diseases, hemolytic and nonhemolytic transfusion reactions, immunosuppression

***Prepared By –***

**AKHIL JOSE**

KMCT COLLEGE OF ALLIED HEALTH SCIENCE

MUTHALAM, MANASSERY P.O MUKKAM

KOZHIKODE 673602