THIRD YEAR BSC PERFUSION TECHNOLOGY CLINICAL

QUESTION BANK

ESSAY

1. **Discuss the myocardial protection during cardiopulmonary bypass.**

- During cardiopulmonary bypass there are high chances of getting myocardial damage.
- To prevent this there are several strategies to protect myocardium
- They include:
- Pre cpb myocardial protection
- Myocardial protection during cpb
- Post cpb myocardial protection

pre cpb myocaridal protection

- They include:
- Metabolic preparation
- Pharmacological preparation
- Hemodynamic preparation

Myocardial protection during cpb

- They include:
- Cardioplegia
- Hypothermia
- Venting

Cardioplegia

- It is a solution used for the temporary cessation of the heart
- They are of two types
- Blood cardioplegia
- Crystalloid cardioplegia
- Crystalloid cardioplegia includes:
- Intracellular cardioplegia (Custodiol solution)

- Extracellular cardioplegia(Delnido , St Thomas solution)

Routes of administration of cardioplegia

There are two routes:

1. Antegrade (aortic root, coronary ostium , proximal end of bypass graft)
2. Retrograde(coronary sinus)

Hypothermia

- Initiation of hypothermia is to decrease the myocardial energy requirements and to lower the metabolic rate

Classification of hypothermia

- Warm cold induction
- Topical hypothermia

Venting

- It is to prevent the distension of heart
- There are two types of venting

1. left heart venting
- Sites: ascending aorta, direct LV, direct LA, indirect LV, pulmonary artery
2. Right heart venting

Post cpb myocardial protection

They include:

- Hotshot
- Adenosine therapy
- Adenosine lignocaine magnesium
- Buffering
- Anti inflammatory therapy

2. Describe Adequacy of perfusion during CPB.

- Adequacy of perfusion is defined as ultimate ability to ensure full return of preoperative functions to all organ systems of the patient after full operation
- The ultimate aim in cpb is maintenance of adequate tissue perfusion and energy supply demand

- Equality during performance of cardiac surgical procedures at a time when many of the patient's normal physiological mechanism are impaired.

Specific aspects of perfusion

- Perfusate
- Pressure and systemic blood flow
- Pulsatality
- Temperature

Factors to control adequacy of perfusion

- Flow rate
- Arterial pressure
- HCT
- Gas exchange

3. Discuss in detail conduct and monitoring during CPB

- Advances in cardiac surgery have been made possible due to the development of cardiopulmonary bypass .it is a form of ECC whose function is circulatory and respiratory support along with temperature management.
- It includes : Initiation
- Performance and monitoring
- Physiological response
- Weaning

Before Initiation there are fee steps:

- Chart review and selection of equipments
- Assembling
- Priming
- Occlusion setting
- Positioning of pump and arrangement of lines
- Performance and monitoring: Continuous monitoring and intermittent monitoring
- Weaning : it is defined as the gradual withdrawal of extra corporeal support as the heart takes over the circulation.

4. Termination of CPB

- It is defined as the gradual withdrawal of extra corporeal support as the heart takes over the circulation .
- Checklist for termination of CPB:
- Laboratory data
- Anaesthesia machine
- Monitoring
- Patient/pump
- Supports

Seperation from CPB:

- Preparation
- Rewarming
- Metabolic abnormalities
- Anaesthesia, oxygen and ventilation
- Hemodynamic monitoring
- Heart rate and rhythm
- Ventricular function and inotropic support

Seperation from CPB-Technique

Seperation from CPB-problem situations:

- Left ventricular failure
- Right ventricle failure
- Delayed acute Hemodynamic deterioration
- Post bypass hypotension
- Hypoxemia

5. Pharmacokinetics and pharmacodynamics

- Pharmacokinetics: Defined as the process through which a drug is handled once introduced into the body
- What body does to the drug?
- Volume of distribution

- Clearance
- Elimination half time
- What happens to drug in body
- How drug exists in blood
- Drug accumulation
- Termination of drug effect
- Drug cleared by kidney

Changes in drug pharmacokinetics due to CPB:

- Hemodilution
- Hypothermia
- Altered organ perfusion
- Acid base status
- Drug sequestration to lung and cpb circuit
- Altered metabolism and clearance due to activation of SIRS
- Pharmacodynamics: it is how a drug interacts with body to produce its effects .
- Receptors
- Second messengers
- Cpb induced changes

Changes in pharmacodynamics during CPB:

The factors that affect the ability of drugs during CPB

- Protein binding
- Tissue binding
- Age
- Cns penetration
- Temperature
- Acid base and electrolyte changes
- Cardiopulmonary bypass
- Sirs

Specific drugs used: Antibiotics, steroids, inotropic agents, iv anaesthetic agents, opioids, vasodilators, volatile anaesthetic agents.

SHORT NOTES:

1. Differentiate between Pulsatile and non pulsatile perfusion.

- Introduction
- Theories if pulsatile flow
- Concept of energy equivalent pressure
- Critical capillary closing pressure and microcirculatory patency
- neuroendocrine reflex mechanism triggered by baroreceptor discharge
- Hemodynamic effects of pulsatile perfusion:
  - Renin angiotensin activation mechanism
  - Peripheral vascular resistance during CPB
- Hemodynamic benefits of pulsatile perfusion
- Hematological effects of pulsatile perfusion
- Metabolic effects of pulsatile perfusion
  - Brain function
- Kidney function
- Pancreatic and liver function
- Pulsatile perfusion system
- Benefits of pulsatile perfusion
- Conclusion

2. Aortic cannulation and it's sites

- Arterial cannulation
- Purpose of arterial cannulation is to return Oxygenated blood from the CPB machine into the circulation.
- Types of cannulas used
- Sites of arterial cannulation
- Ascending aorta
- femoral artery
- axillary artery
- abdominal aorta
- Innominate artery
- left common carotid artery

3. Bubble oxygenator v/s Membrane oxygenator

Bubble oxygenator

- Definition
- Principle-Direct blood gas interphase
- Compartments
- mixing chamber
- Reservoir
- Advantages and disadvantages

Membrane oxygenator

- Definition
- Principle-Diffusion
- parts
- membrane oxygenator
- cardiotomy reservoir
- Types
- True membrane
- Microporus polypropylene membrane oxygenator
- Advantages and disadvantages.

4. Priming fluids

- It is used to replace the air in the circuit with fluid or blood.
- Basic definition
- Classification of priming fluids
- crystalloids :
- Definition
- Examples: ringer lactate , dextrose
- colloids:
- Definition
- Examples:
- Albumin
- Gelatin

- Perflurocarbons
- Hydroxyethylated starch
- Conclusion

5. Cardioplegia solution and route of administration.

- Definition
- Types
- Blood cardioplegia
- Crystalloid cardioplegia:
  - Intracellular(custodial)
  - Extracellular(del nido, St Thomas)
- Delnido
- St Thomas
- Custodial/ HTK
- Advantages and disadvantages of blood cardioplegia and crystalloid cardioplegia
- Route of administration
- Antegrade
- Retrograde

6. Hypothermia

- Definition
- Classification of hypothermia
- Warm cold induction
- Topical hypothermia
- Core temperature
- Advantages and disadvantages

7. Venous cannulation.

- Definition
- Principle
- Sites of cannulation:
- svc
- Ivc

- RA
- femoral or iliac artery
- persistent lsvc
- Types of cannulation used:
- bicaval
- cavoatrial
- types of cannulas used:
- single staged
- double staged
- Complications associated with venous Drainage
- Causes of low venous return

8. Augmented venous Drainage

- Principle
- Characteristics
- Purpose
- Types
- kinetic assisted venous Drainage
- vaccum assisted venous Drainage
- Advantages and disadvantages of KAVD And VAVD.
- Precautions
- Problems associated with augmented venous Drainage.
- Complications
- Causes of low venous return

9. Pre CPB checklist

- Check the Calibration of all pump
- Check occlusion of all pump
- Act should be above 480secs
- Ensure no clamps in arterial line
- Snp online and ready
- Central o2 and compressor is functioning
- Stand by o2 available

- Check direction of suction
- Reservoir vent should be open
- Level sensor connected and on
- Pressure sensor connected and on
- Cp solution cooled and ready
- Shunt line closed
- Tell the anaesthetics to put off the warmer
- Handcrank available
- Blood available

10. Cannulation strategies in aortic arch repair.

- Various cannulation techniques include femoral, right axillary, innominate, carotid, central aortic, direct true lumen, transapical, and trans-atrial left ventricle cannulation. The ideal cannulation should be easy, quick, and suitable for all clinical scenarios.

11. Hemodynamic monitoring

Monitoring has a major part initiation, maintenance as well as termination of CPB.

It includes:

- pulse oximeter
- Pressure transducer
- Mean arterial pressure
- Mean line pressure
- Central venous pressure
- Urine output
- Transoesophageal echo cardiography

12. Principal of heat exchanger

Heat exchanger: Is used to transfer kinetic energy from molecules of high energy to molecules of lower energy.

- Principles:
- Conduction

- Convection
- Radiation
- Materials made of
- Factors affecting
- Types -Disposible
  - Permanent
- Complications

13. Drugs used in CPB

- Definition
- Classification including dosage, mechanism of action, Adr ,and uses of each
- Anticoagulants :Heparin
- cardioplegia solution: St Thomas ,del nido
- diuretics :Mannitol ,Lasix
- vasodilators: Glyceryl trinitrate , SNP
- Antiarrhythmics: ligocaine, Adenosine
- Anaesthetic agents Fentanyl, pavlon, midazolam, thiopental sodium, propafol, isoflurane
- Agents for acidosis: sodium bicarbonate, THAM
- Drugs for hypo and hyperglycemia: insulin ,glucagon
- corticosteroids:Solumedrol , dexamethasone
- inotropes: epinephrine, norepinephrine, phenylephrine, dopamine,dobutamine,amrinone
- other drugs :atropine

14. Benefits and Pitfalls of hemodilution

- Hemodilution definition
- Benefits :
- decrease the blood viscosity
- Improve regional blood flow
- Improved oxygen delivery of tissues
- Decrease exposure to blood products
- Decrease bypass related complications

- Pitfalls:
- Extreme hemodilution can cause decrease in oxygen carrying capacity
- Tissue edema in various organs
- Reduce neuro cognitive outcomes
- Increase distance between capillaries and tissues causing tissue necrosis and cell damage
- Cause mortality and morbidity

15. Neurological monitoring strategies

- Definition
- They include
    1. EEG electroencephalogram
    2. SSEP somatosensory evoked potential
    3. Cerebral oximetry

Answer briefly

1. Cavitation and spallation

Cavitation :

- The formation of gas bubbles in the venous line when the blood is exposed to negative pressure
- Spallation:
- Release of tubing particles in to the blood due to pump compression.

2. Hemodilution

Use of priming fluids cause hemodilution

Advantages:

- decrease the blood viscosity
- Improve regional blood flow
- Improved oxygen delivery of tissues
- Decrease exposure to blood products
- Decrease bypass related complications

Disadvantages:

- Extreme hemodilution can cause decrease in oxygen carrying capacity
- Tissue edema in various organs
- Reduce neuro cognitive outcomes
- Increase distance between capillaries and tissues causing tissue necrosis and cell damage
- Cause mortality and morbidity

Effects of hemodilution:

- Change in viscosity
- Effect on oxygen transport
- Effect on hematocrit

3. Heat exchanger

- Heat exchanger: Is used to transfer kinetic energy from molecules of high energy to molecules of lower energy.
- Principles:
- Conduction
- Convection
- Radiation
- Materials made of
- Factors affecting
- Types -Disposible
  - Permanent
- Complications

4. Mannitol

- It is an osmotic diuretic
- Indication : to maintain GFR and urine output
- Prevents cerebral edema and helps to decrease intracranial and intra occular tension
- M.O.A : expand of volume
  - Increase GFR and inhibit renin release
  - Corticomedullary osmotic gradient is reduced
- Dose: 1 - 1.5 g/kg

- ADR:
- Excessive amount can cause cellular dehydration
- Can cause chills
- Confusion
- Polydyspia

5. NTG

- Nitroglycerin is a vasodilatory drug used primarily to provide relief from anginal chest pain.
- MOA:
- Converts to nitric oxide (NO) in the body.NO then activates the enzyme guanylyl cyclase, which converts guanosine triphosphate (GTP) to guanosine 3',5'-monophosphate (cGMP) in vascular smooth muscle and other tissues.
- ADR:
- Bloating or swelling of the face, arms, hands, lower legs, or feet.
- Burning, crawling, itching, numbness, prickling, "pins and needles", or tingling feelings.
- Difficult or labored breathing.

6. Isoflurane

- Used to cause general anesthesia (loss of consciousness) before and during surgery. It belongs to the group of medicines known as general anesthetics.
- M.O.A:
- Acts as a positive allosteric modulator of the GABAA receptor in electrophysiology studies of neurons and recombinant receptors.
- ADR:
- Anxiety.
- Chest tightness.
- Confusion as to time, place, or person.
- Cough.
- Dry mouth.
- Irregular heartbeat.
- Irritability.

7. Amiodarone

- Amiodarone is used to treat life-threatening heart rhythm problems called ventricular arrhythmias.
- M.O.A:
- It blocks potassium currents that cause repolarization of the heart muscle during the third phase of the cardiac action potential.
- ADR:
- Cough.
- Dizziness, lightheadedness, or fainting.
- fever (slight)
- Numbness or tingling in the fingers or toes.
- Painful breathing.
- Sensitivity of the skin to sunlight.
- Trembling or shaking of the hands.

8. HTK Solution, Custodial solution, del nido solution

- HTK solution:
- Also know as custodial solution.
- Components
- Duration
- Advantages and disadvantages
- Del nido :
- Components
- Duration
- Advantages
- St Thomas :
- Components
- Duration

9. Venous chattering

- Chatter occurring soon after cannulation also called "postcannulation syndrome" may be due to vasodilation as a part of systemic inflammatory response syndrome(SIRS) response upon exposure of blood to the extracorporeal circuit. Other causes being undersized cannula, malposition, and vascular injury.
- Drainage insufficiency can be due to increased cardiac output states, sepsis, agitation due to inadequate sedation, and volume depletion.
- Clinicians should first confirm that chatter is occurring in the prepump drainage tubing. Isolated postpump chatter may be due to blood flow at higher velocities within the tubing. If available, monitoring pressure in the venous drainage cannula (less than −100 mm Hg) may help in the early prediction of chatter.
- A crude indicator of drainage insufficiency is failure to appreciably increase the blood flow in response to increasing the pump speed.

10. Difference between hypertonic , hypotonic , Isotonic solution

- A hypertonic solution is any external solution that has a high solute concentration and low water concentration compared to body fluids. In a hypertonic solution, the net movement of water will be out of the body and into the solution.
- A hypotonic tonic solution is any external solution that has a low solute concentration and high water concentration compared to body fluids. In hypotonic solutions, there is a net movement of water from the solution into the body.
- An isotonic solution is any external solution that has the same solute concentration and water concentration compared to body fluids. In an isotonic solution, no net movement of water will take place.

11. Sandblasting effect

- Sandblasting, where an abrasive is fed into a high air flow directed to a surface at a pressure of a few bars, is a common method to clean or increase the surface roughness in many industrial applications.
- Sandblasting involves impacting the required surface with hard particles at high velocities thereby eroding the material and leaving a roughened surface with expected higher wettability.

12. **Blood cardioplegia.**
    - Definition
    - Advantage
    - Disadvantage

- **Calcium influx**
    - Sudden influx of calcium after a period of profound hypocalcemia.
    - Ischemia sensitised myocardium to calcium levels in cardioplegia solution that are otherwise tolerated by normal myocardium.
    - The systemic release of catecholamines in response to CPB alter the influx of calcium and increase oxygen consumption and hence increase the vulnerability of myocardium to ischemic reperfusion injury

- **Heat exchanger leak and it's management**
    - Heat exchanger leak on CPB is rare and very serious.
    - The exact incidence is not known.
    - It is an emergency associated with potential risk of blood contamination, air embolism and hemolysis. Difficult with rewarming, acidosis, subsequent septic shock, multiorgan failure and death.
    - There is need for safety devices that detect leak and technique to reduce bacterial load.
    - Water is circulated throughout the heat exchanger for priming and visible check is made of the oxygenator bundle to check for leak.
    - Effect of failure :
    - Unexplained increase in circuit volume
    - Increased pottasium
    - Unexplained decrease in HCT
    - Acidosis due to water dilution of HCO3 in blood
    - Hematuria
    - Blood visualised in water lines
    - Multisystem organ failure
    - Management:
    - Immediately turn off the heater cooler and disconnect the water lines
    - Replacement of oxygenator.

- Bubble transgression:
  - Vacuum-assisted venous drainage (VAVD) is widely used to enhance venous blood return from patients undergoing cardiopulmonary bypass (CPB). This vacuum can accidentally reach the oxygenator of the heart-lung machine and draw gas bubbles into the blood. This is known as bubble transgression (BT) and may cause air emboli in the arterial blood line. In order to avoid bubble transgression and minimize the risk of patient injury, knowledge of oxygenator tolerance to vacuum load is critical.

Prepared By –

AKHIL JOSE

KMCT College of Allied Health Science

Muthalam, Manassery P.O, Mukkam

Kozhikode 673602