THIRD YEAR BSC PERFUSION TECHNOLOGY
ADVANCE
ANSWER KEY

ESSAY

1. What is ECMO. Describe differences between Adult and pediatric CPB .What are the technologies for neuromonitoring in pediatric CPB.
   - ECMO provides a means of supporting blood gas exchange using a membrane oxygenator.
   - Venous blood is pump through oxygenator where gas exchange occur and is actively rewarmed before being returned to the patient via the venous or arterial cannulation.
   - Types of ECMO
   - Veno venous ECMO
   - Veno arterial ECMO
   - indications
   - types in detail
   - Pediatric CPB and adult CPB differences
   - type of pump used
   - myocardial protection strategies
   - Cardioplegia used
   - Neuromonitoring of pediatric CPB
   - EEG (electroencephalogram)
   - Cerebral oximetry
   - Somato sensory evoked potential

2. Cannulation Strategies in case of minimally invasive Aortic valve replacement .What are the save guards to be taken with regards to safe conduct of CPB in MICS
   - Introduction
   - Hemisternotomy
   - Minithoracotomy
   - Thoracoscopic surgery
   - Robotically assisted heart surgery

Cannulation sites

- Femoral :
- Benefits
- Types surgeries performed
- Types of clamp
- Cannulation
- Hemithoractomy
- Ministernotomy

Direct ascending aorta cannulation

- Aortic occlusion clamps in Ministernotomy:
- transthorasic aortic clamp(advantage)
- end aortic balloon occlusion clamp(advantages)

Specialized CPB circuit

- VAVD
- KAVD

CPB monitoring in MICS

PACS

- Materials used
- Endo arterial reperfusion cannula
- Endo venous drainage cannula
- Endo aortic occlusion clamp
- End coronary sinus retrograde cardioplegic catheter
- Endo pulmonary artery vent.
- Connection of PACS to CPB circuit
- Contradictions of PACS
- Complications of PACS
- Perfusion Management during PACS

3. Discuss the perfusion Accidents
   - The best way to handle an accident is to avoid it However Perfusion accidents occur suddenly and require a thoroughly planned response .The unexpected nature of the

problem may lead to an Improper response unless the perfusionist follows a systematic procedure (battle plan or back up plan) to deal with the exigency.

- Establishing protocols and procedures is required to assure quality perfusion, here in this part we take a detailed insight in to some of the most common perfusion problems, which can occur during cardio-pulmonary bypass, their causes , prevention and treatment .

1. Air embolism
2. Protamine reaction
3. Oxygenator failure
4. Electrical failure
5. Mechanical failure
6. Drug errors
7. Blood clotting within extra corporeal circuit
8. Transfusion errors
9. Gross contamination
10. Heat exchanger failure or leak (heat exchanger leaking water in to extran corporeal circuit)
11. Blender failure
12. Malignant hyperthermia
13. Arterial filter blockage / leakage
14. Rupture of pump head
15. Line separation**.**

4. What is Deep hypothermic circulatory arrest .

Deep hypothermic circulatory arrest (DHCA) is a technique to obtain optimal operating conditions while providing cerebral protection.

- Hypothermia
- Definition
- Classification

Neuroprotection strategies in DHCA-

- Anesthesia
- Perfusion

- Surgical

RCP(retrograde cerebral perfusion)

- Definition
- Aim
- Flow rate
- Benefits

ACP(ante grade cerebral perfusion)-

- Aim
- Definition
- Flow rate

DHCA and MHCA with SACP

Unilateral and bilateral ACP protection during DHCA

Conclusion

5. Non cardiac application of cpb
   - The non-cardiac applications of CPB have been extended and modified, and principally the applications include firstly: the surgical resection of lesions that cannot be managed safely and effectively by conventional techniques, or techniques that carry significant risks to the patient .it includes:

     1. Application in lung surgery
     2. Pulmonary embolectomy
     3. Surgery of trachea and carcina
     4. Lung transplantation
     5. Lung cancer with extension into heart
     6. Severe respiratory dysfunction during lung surgery
     7. Chest trauma
     8. Application in neuro surgery
     9. Application in liver transplant

SHORT NOTES

1. ACT
   - Definition
   - Monitoring of ACT

2. Renoplegia
   - Definition
   - Selective renal perfusion
   - Renal perfusion with cold crystalloid
   - Perfusion solution including
   - Solution delivered through
   - Cold renal perfusion

3. Retrograde cerebral perfusion
   - Definition
   - Benefits
   - Temp of perfusate
   - Flow rates of RCP
   - Monitoring during RCP
   - Clinical outcomes
   - Neuropsychological outcomes
   - Drawbacks
   - Post operative complication

4. Selective antegrade cerebral protection
   - Selective hypothermic brain perfusion permit surgery to be conducted at lesser degree of systemic hypothermia .
   - Explanation

5. Mini bypass circuit
   - Miniature extra corporeal circuit are designed to reduce foreign surface area , priming volume and blood air contact . This leads to decreased hemodilution and thus reduced blood transfusion requirements and may reduce the inflammatory response to CPB.
   - Features

- Use
- Unique feature
- Explanation

6. Percutaneous cardiopulmonary bypass systems
   - Percutaneous cardiopulmonary bypass is an emergency cardiopulmonary bypass through the surgical exposure of femoral artery and veins.

   Used for

   - About traditional circulatory system
   - Methods and materials in detail

7. Reservoir less bypass
   - Introduction
   - Components of reservoir less bypass
   - Centrifugal head
   - Oxygenator
   - Air removal devices
   - Arterial filter
   - LV venting
   - Cardioplegia
   - Other related components
   - Benefits of reservoir less bypass
   - Arterial side of the circuit
   - Mini CPB demonstration
   - Anaesthetic management of reservoir less bypass

8. Left heart bypass
   - Introduction
   - Normal CPB
   - usage of Left heart bypass
   - support using LHB
   - Potential complications of TAAA repair
   - Left heart bypass circuit

9. Indications of ECMO
    - Introduction
    - History
    - Types of mechanical support
    - VAECMO
    - VVECMO
    - Indications
    - neonatal indications and contra indications
    - adult indication and contraindications

10. Inline blood gas monitoring
    - In-line blood gas monitoring allows for real-time monitoring of the "adequacy of perfusion**".**
    - Parameters

11. Coated circuits
    - Introduction heparin less bypass
    - Indication
    - Methods of heparin coating
    - Covalent bonding
    - Ionic bonding
    - Mechanism of action
    - Advantages of coated circuit

12. Spinal cord protection
    - Strategies to prevent & treat ischemia
    - Strategies to short intraoperative Duration of spinal cord ischemia
    - Strategies to increase spinal cord tolerance to transient ischemia
    - Strategies to augment spinal cord perfusion
    - Early detection of spinal cord ischemia

13. End aortic balloon clamp
    - **An aortic cross-clamp** is a surgical instrument used in cardiac surgery to clamp the aorta and separate the systemic circulation from the outflow of the heart.

- End aortic occlusion clamp is an aortic occlusion clamp,used in minimally invasive cardiac surgery.
- Procedure :
- Disadv : Expensive
- Used in TEE

  Pressure : 300-350 mmHg

14. Retrograde autologous blood priming
    - The Dearing of CPB circuit is done by priming solutions, consisting of a mixture of crystalloids and colloids.
    - Blood priming.
    - Two types : antegrade & retrograde
    - Advantage
    - Disadvantage
    - Complications
    - Limitation
    - Indication
    - Contraindication

15. CPB Consideration in special cases
    - Sickle cell anemia
    - Thalassemia
    - Pregnancy
    - Cold agglutinin
    - Jehovah's witnesses

ANSWER BRIEFLY

1. Perfusion strategies for oncological indications

HIPEC

- Using a cardiopulmonary bypass machine, The HIPEC circuit is completed. Hyperthermia chemotherapy applies thermal energy to both abdominal wall as well as the intra-abdominal viscera.
- **Method** :HIPEC is an aggressive, targeted surgical technique that attacks abdominal cancer with fewer side effects than traditional chemotherapy. At the end of surgery to remove tumors, the patient's abdominal cavity is bathed in a heated, highly concentrated chemotherapy solution to eliminate any residual cancer.
- **Parameters**: Eight parameters potentially have an impact on the efficacy of HIPEC: the type of drug, drug concentrations, carrier solution, volume of the perfusate, temperature of the perfusate, duration of the treatment, the technique of delivery, and patient selection
- **Drugs used** : Background Mitomycin-C (MMC) is the most commonly used chemotherapeutic agent for hypothermic intraperitoneal chemotherapy (HIPEC) after cytoreductive surgery (CRS).
- **Risk factors** : The most common complications are intestinal leaks, kidney failure, inflammation of the pancreas, sepsis, and a drop in bone marrow and blood cells**.**

2. Safety Devices used in CPB
   - It is used to prevent the accidents during CPB

They are:

- Level sensor
- Bubble detector
- Pressure alarms
- Temperature alarms
- Gas alarms
- Electrical flow alarms
- Pressure monitoring
- Oxygen sensor

- Inline blood gas filter
- Bubble traps.

3. Recent advances in Perfusion techniques:
   - VAD
   - IABP
   - RCP
   - SACP
   - ECMO
   - Angioplasty in CPB
   - Advanced Cannulation technique

4. Cerebral oximeters
   - Cerebral oximeters measure tissue oxygen saturation, which reflects hemoglobin saturation in arterial, venous and capillary blood
   - Procedure
   - Working principle
   - Cases used
   - Benefits
   - Types
   - Positioning
   - Indications
   - Normal values

5. Mixed venous saturation
   - **Mixed venous oxygen saturation (SvO2)** refers to the oxygen content of the blood that returns to the heart after meeting tissue needs.
   - Components
   - Normal value
   - Indications
   - Procedure
   - When it is done
   - Goals
   - Factors effecting
   - O2 dissociation curve

6. Malignant hyperthermia
   - **Malignant hyperthermia** is a genetic disease that causes a life-threatening reaction to certain anesthesia medications.
   - History
   - Incidence
   - Pathophysiology
   - Signs
   - Investigations
   - Complications
   - Treatment

7. Oxygenator failure
   - Definition
   - What is oxygenator
   - Function
   - Working principle
   - Types
   - Causes of oxygenator failure
   - Outcomes
   - Risk factors
   - How to overcome

8. 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

9. Blood priming and it's Advantage
   - Types
   - Blood priming
   - Procedure
   - Indications
   - Types

- Benefits
- Disadvantages
- Uses

10. Cell salvage is one of the method of blood transfusion .Cell salvage is the process by which blood from the surgical field or wound drainages is collected, filtered, and washed to produce autologous blood for re-transfusion to the patient.
    - Indications
    - Contraindications
    - Specific cases
    - Procedure
    - Steps
    - Different systems available

11. Run away pump head
    - A condition where a fluid pump operates with no fluid entering the fluid inlet or very little backpressure at the fluid outlet. The lack of fluid or backpressure causes the pump to cycle very rapidly and can damage the fluid pump or air motor.
    - Causes
    - Management

12. Occlusion setting
    - Compression between tubing and back plate of the pump
    - Methods of occlusion setting

13. Rebound hypothermia
    - Rebound hyperthermia is a marker for increased mortality and worsened neurologic morbidity in cardiac arrest patients who have underwent therapeutic hypothermia.
    - Type
    - Stages
    - Symptoms
    - Sign
    - Diagnosis
    - Treatment

14. Coagulopathies
    - Coagulopathy (also called a bleeding disorder) is a condition in which the blood's ability to coagulate (form clots) is impaired. This condition can cause a tendency toward prolonged or excessive bleeding (bleeding diathesis), which may occur spontaneously or following an injury or medical and dental procedures.
    - Causes
    - Classification
    - Symptoms
    - Signs
    - Diagnosis
    - Treatment

15. Experimental perfusion
    - Jarwik heart
    - Ivox
    - Perfluorocarbon
    - Novo lung

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