SNS COLLEGE OF ALLIED HEALTH SCIENCES

SNS Kalvi Nagar, Coimbatore - 35

Affiliated to Dr MGR Medical University, Chennai

DEPARTMENT OF CARDIOPULMONARY PERFUSION CARE TECHNOLOGY

COURSE NAME: CPB & Perfusion Technology – II

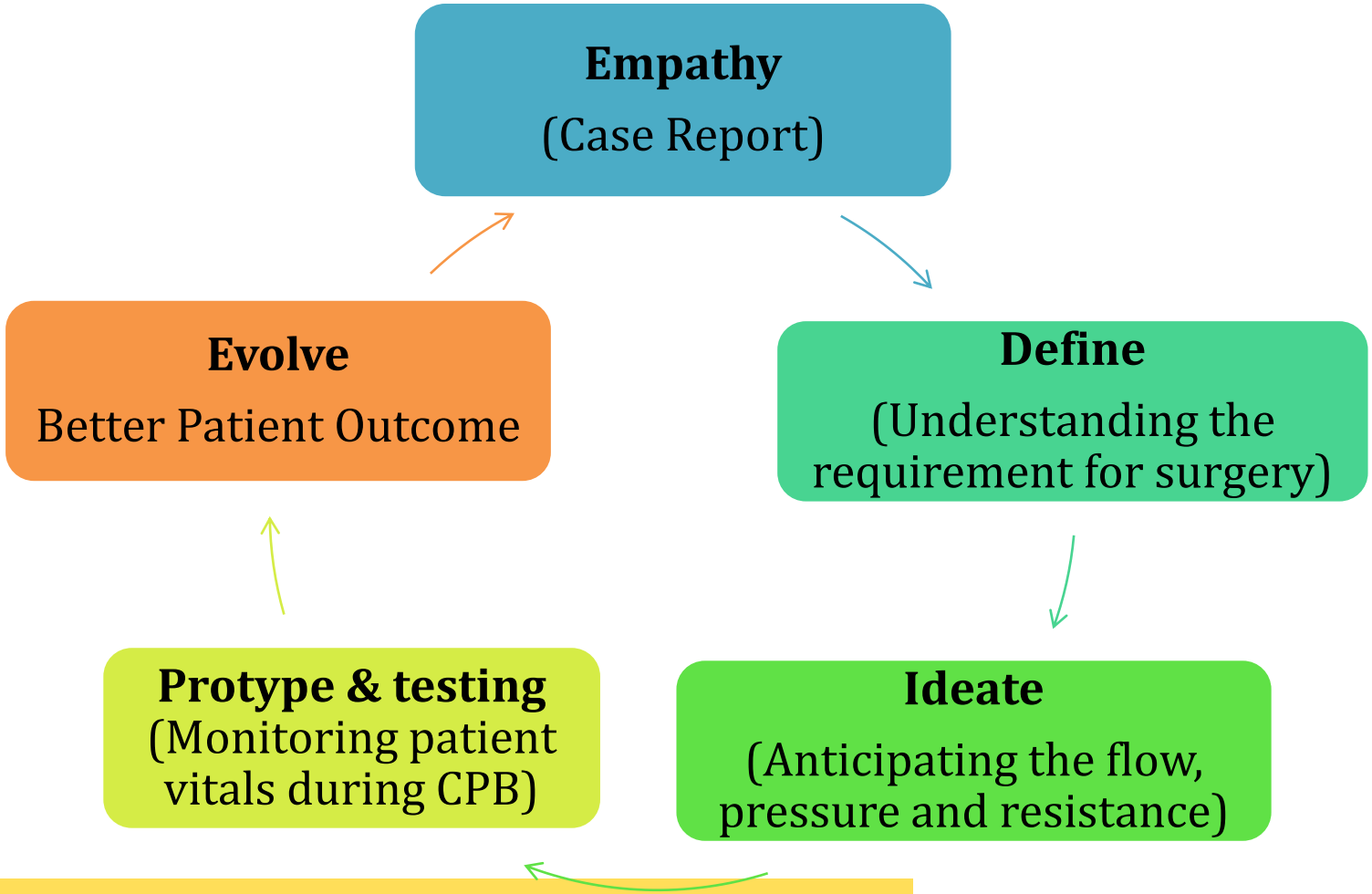
TOPIC : Patient Monitoring during bypass

CASE STUDY

An adult female patient of 56 years, admitted in the compliance of Left Breast Pain and mild giddiness for the past week and upon further examination the patient was diagnosed with Mitral Stenosis and with pulmonary hypertension. The patient was diabetic and under treatment for the past 1 year. The patient was advised for the elective Mitral Valve Repair.

As a perfusionist what are the parameters you should considered and monitored while on bypass?

DESIGN THINKING FRAMEWORK



IMPORTANCE OF MONITORING DURING CPB

- Monitoring during bypass is one of the most important work of perfusionist to avoid accidental effects during bypass.
- Proper monitoring provides the best outcomes of patient
- Monitoring is done on the Circuit as well as the Patient Side
- The circuit Monitoring is done by the safety devices incorporated in the circuit

THE 'MATRIX' PART FOUR: 'THE RISE OF HIPAA'

MONITORING DURING BYPASS

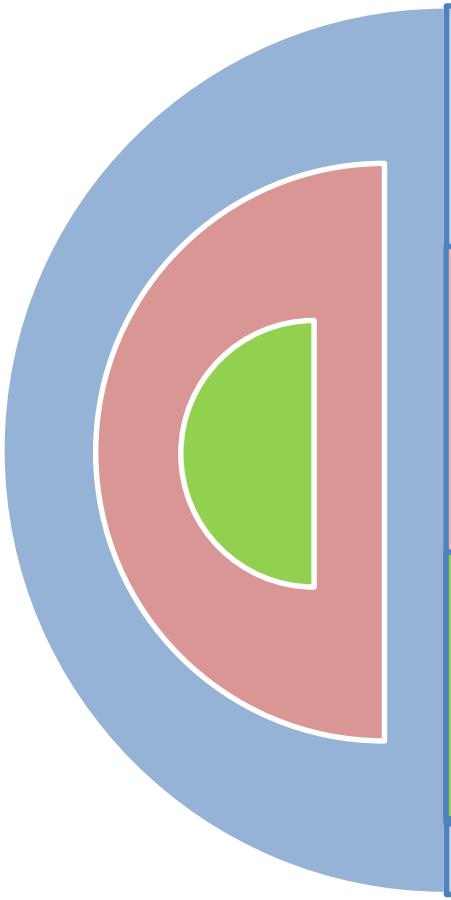
Patient Monitoring

- Physiologic Variables
- Physiologic response
- Cardio vascular monitoring
- Neurologic monitoring
- Temperature monitoring
- Urinary volume and Renal function
- Coagulation status and ABG

Circuit Monitoring

- Drainage
- Reservoir Volume
- Continuous Monitoring of Flows
- Gas Monitoring
- Temperature Monitoring
- Oxygenator color change
- CPDS Monitoring
- Circuit Alarms
- Fluid Management
- Perfusion Chart

PATIENT VARIABLES



Intensity - patient condition ,procedural requirements and expected problems.

monitoring includes- BP,CVP,PA and LV pressures and temperature including myocardium.

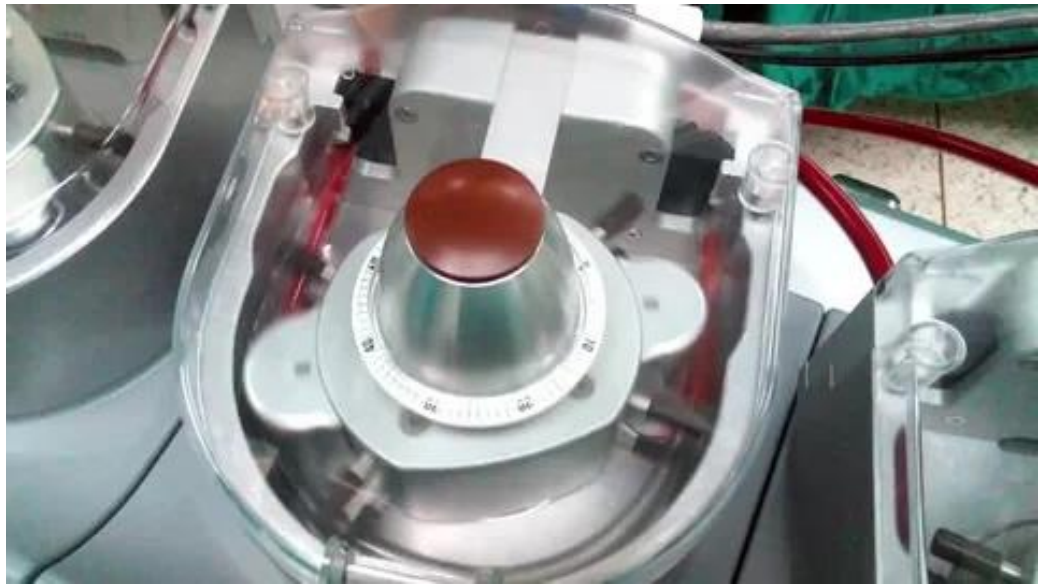
The perfusionist and anesthesiologist must monitor ECG and EEG if used. Both can warn of abnormal or unexpected conditions

PHYSIOLOGIC RESPONSE

Flow	Pressure	Resistance	Oxygen Consumption
Flow calculated according to the Cardiac index Flow should not affect autoregulatory mechanism of organ	Pressure regulation of heart – PA, LA Pressure Perfusion Pressure – Line & CPDS Pressure	systemic vascular resistance are frequently observed at the onset of and during CPB, mainly due to hemodilution	Infant = 10ml/kg/min Adult = 4-5ml/kg/min Total systemic Vo_2 depends on age, BSA & temperature

PERFUSION FLOW

- Selection of perfusion pressure during CPB is based on achieving a balance between the requirements of **surgical access** (bloodless field) and **patient outcome** (adequate oxygen delivery).



Flow Considerations:

- Patients with type one **diabetes mellitus** appear to have impaired metabolism-flow coupling and some loss of pressure-flow autoregulation during cardiopulmonary bypass. So maintain higher perfusion flow and pressure.

- **Hypertensive patients** have pressure-dependent flow pattern.

PERFUSION FLOW

- **Normal Perfusion (CPB) Flow:** it is the amount of blood that must be pumped at most of cardiopulmonary bypass time, **at normal temperature (37° C)**, to deliver the tissues needs of oxygen.

- **Maximum Perfusion (CPB) Flow:** is the largest amount of blood can be pumped if that necessary, for any reason such as **pressure drop** or physio pathological particularities, regardless of the patient's temperature ,which based on patient age\weight, size of aortic cannula ,and size of oxygenator

- **Minimum Perfusion (CPB) Flow:** is a lowest sufficient amount of blood that can be pumped to patient, **at reduced of temperature**, to reduce the amount of back flow and provide a bloodless field when the surgeon need it to work, or to reduce the pump side effects on blood in complex and long cases .

FLOW RECOMMEDATIONS

- It has been noted that progressive acidosis and increased lactate production of total flow less than 1.6L/min/m^2 or 50ml/kg/min.

- So it is necessary to give flow at a cardiac index,

  2.4L/min/m^2– during rewarming and cooling

  2.0L/min/m^2– hypothermia at 28-30'c

  2.5 – children and infants.

TEMPERATURE ('C)	CARDIAC INDEX	Fio2 (%)	BLOOD: GAS FLOW RATIO
37	2.4	80	1 : 1
34	2.2	70	1 : 0.8
30	2.0	65	1 : 0.7
28	1.8	60	1 : 0.6
22	1.6	50	1 : 0.5

EFFECTIVE FLOW

- **Effective Flow** is the blood flow from the oxygenator that actually results in tissue perfusion.
- Pressure and Flow have strong relationship and interdependent
- The sufficient amount of perfusion flow without good value of pressure that mean lack of blood supply to the small tissues.
- **Autoregulation -** the ability of organ vasculature via neural and direct smooth muscle effects to regulate local resistance to maintain relatively constant flow though significant change in perfusion Pressure
- Autoregulation depends on **Hemodilution, Continuous flow & Hypothermia**

PERFUSION PRESSURE

- The perfusionist work to maintain the required perfusion pressure.
- To achieve the perfusion pressure goals **modifications of pump flow (or) administration of vasoactive medications** should be done.
- Pressure changes due to effects of **hypothermia, uneven vasodilation with rewarming, mechanical vessel compression or aortic cannula tip malposition.**

- **At Beginning of Bypass -** acute transient state of systemic arterial hypotension, due to the dramatic decreases in viscosity that result from dilution.
- After the initial decrease, systemic arterial pressure often begins to increase spontaneously, maybe by reflecting activation of the renin-angiotensin system or sympathetic nervous system.

PERFUSION PRESSURE

- Flow indices of 1.9—2.3L/min/m^2 and using vasoactive drugs maintains patient MAP at 50—60 mm Hg should be maintained.
- Line pressure of 100 +/- 10 mmHg should be maintained.
- Pressures are monitored using Swan Ganz Catheter through Jugular Vein Insertion and Catheter tip placed on Pulmonary artery.

Perfusion Pressure

Lower Pressure → Reduce cerebral blood flow

Higher Pressure → Impairment of tissue perfusion as well as the risk of intracranial hemorrhage

CENTRAL VENOUS PRESSURE (CVP)

- **Pressure of Right atrium: (0 – 12 mm Hg)**
- Increased CVP indicates impaired venous drainage to the reservoir due to either

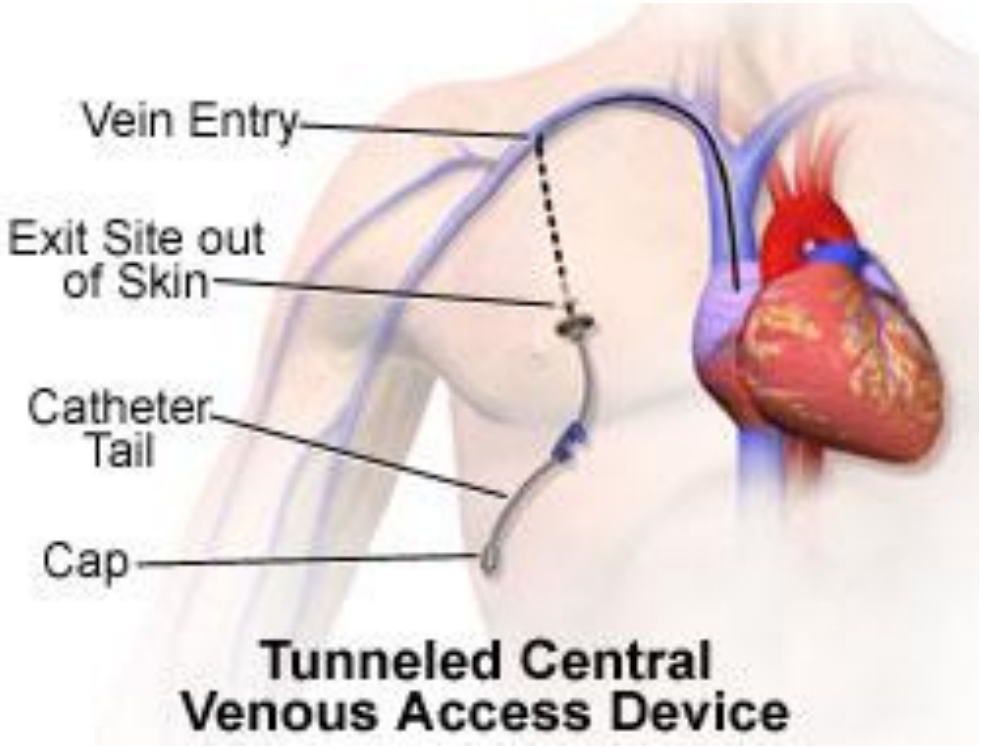
✓ Venous cannula of insufficient size ,

✓Malposition of venous cannula,

✓Venous cannula or drainage line obstruction,

✓Insufficient height difference between heart and venous reservoir which promotes an adequate siphon effect

- **CVP is zero means good venous drainage will be achieved.**



PA & LA PRESSURE

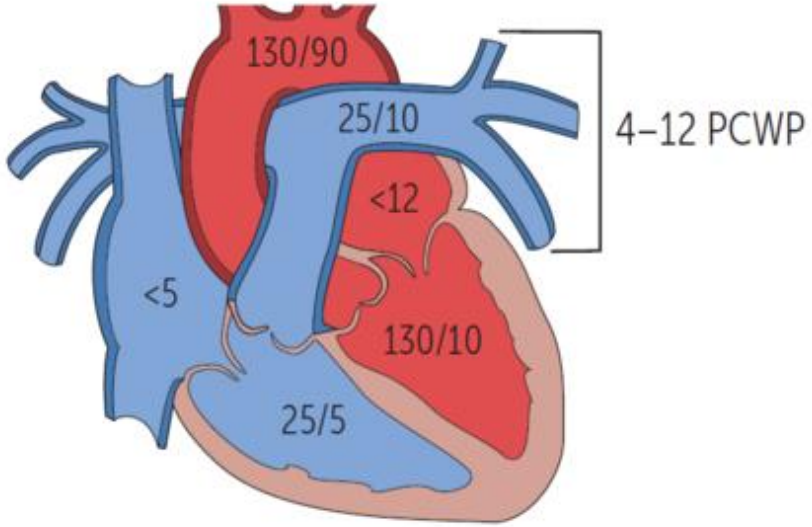
- Used to take decision of **weaning from CPB**.

- **Left ventricular filling during CPB at weaning period and end of CPB**

- During CPB, LA and PA pressure should be **near zero** and monitoring used to prevent over distention of heart.

Ex: Pt with increased bronchial blood flow due to chronic lung disease or cyanotic heart disease can markedly over distend the LV if venting is not adequate.

- Both IVC and SVC pressures should be near at zero during CPB



RESISTANCE

- Hypertension is often treated by **decreasing systemic vascular resistance** with volatile agents or the continuous intravenous administration of **nitroprusside.**

- **Nitroglycerin** has reduced the systemic vascular resistance because of its action in vasodilatation.

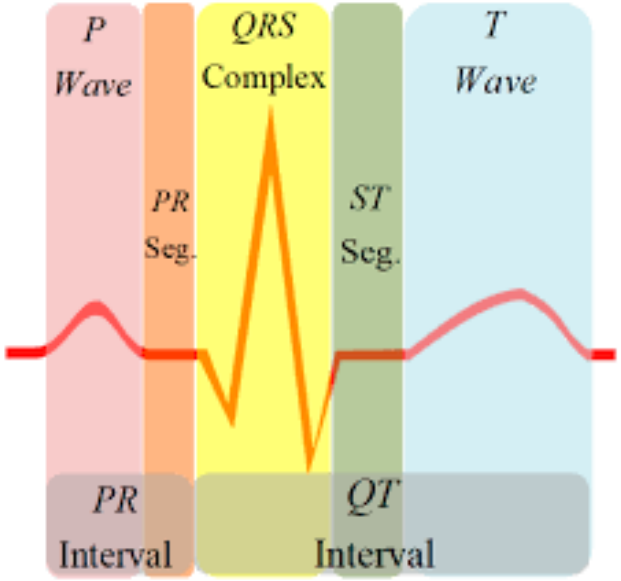
- Reduction in the vasoconstriction and systemic vascular resistance during CPB and increase cardiac index immediately following CPB, due to the decrease in afterload (reduction in post-CPB vascular resistance).

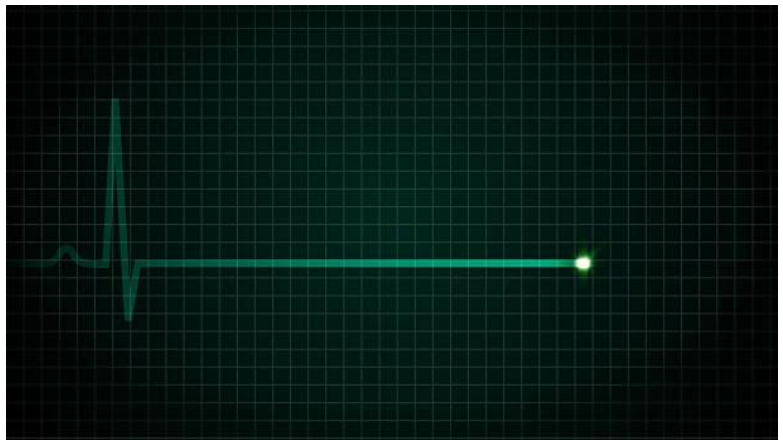
$$Resistance = \frac{Change\ in\ pressure}{Flow}$$

$$Flow = \frac{Pressure\ Difference}{Resistance}$$

CARDIOVASCULAR MONITORING

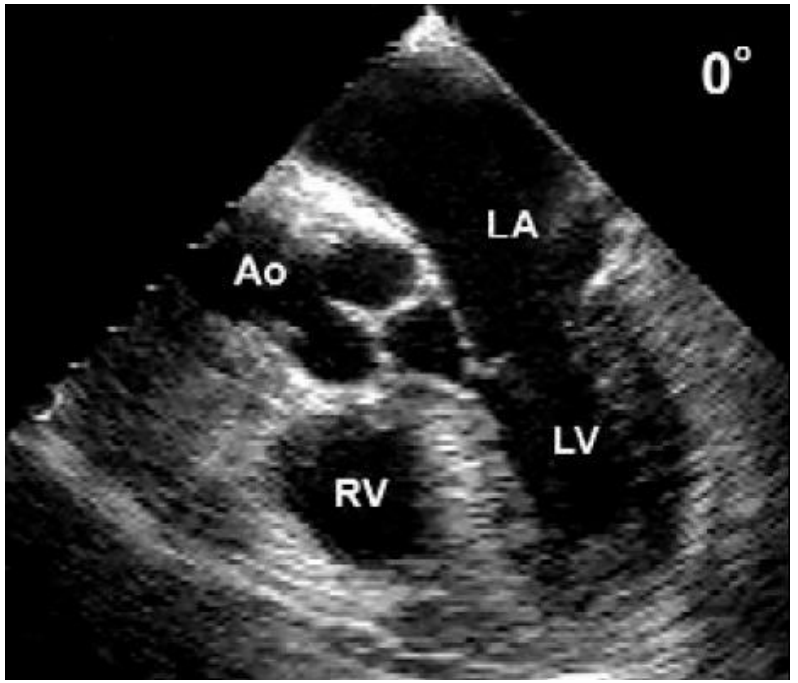
- Must be continuously monitored during CPB.
- During periods of CP arrest, it is important to verify that ECG is isoelectric.
- After surgical repair the should return to normal before weaning from CPB.
- Abrupt changes in ST segment deviation from isoelectric should raise the immediate question of **intracoronary embolization of air**(II, III, aVf= RCA).
- Persistent ST segment deviation should raise the question of ongoing ischemia that should be investigated and corrected before terminating CPB.





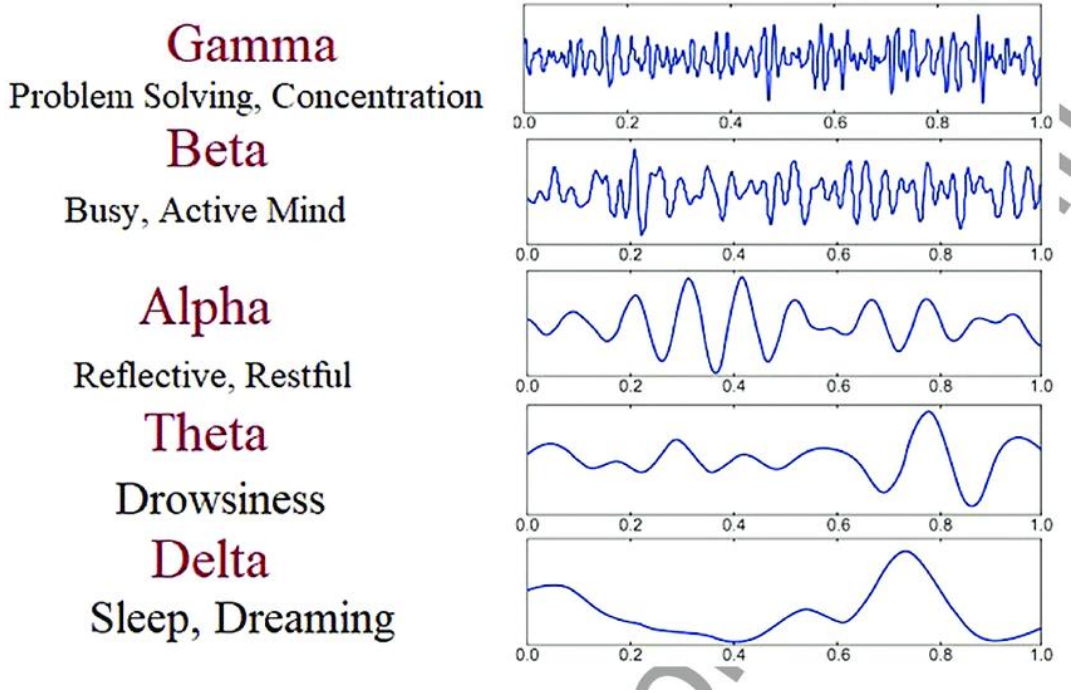
TRANSESOPHAGEAL ECHOCARDIOGRAPHY

- Trans esophageal echocardiogram used to visualize **Cardiac structures by ultra sound definition.**
- But its utility is lost during CPB with Cardioplegia.
- However the heart is filled near the concluding of CPB , TEE regains its ability to visually display intra cardiac structures, wall motion and blood flow direction and velocity can be useful to guide to effective air evacuation from cardiac chambers.



NEUROLOGICAL MONITORING

- Myoneural junction– To confirm adequacy of muscle paralysis.
- CNS – To detect functional abnormalities during CPB.
- **Electroencephalogram Monitoring** for assessing the electrical activities of brain is done.
- The primary changes in the EEG indicating hypo-perfusion or hypoxia are slowing of the dominant frequency and loss of electrical activity .
- Similar changes can produce in EEG by **hemodilution, hypothermia, anesthetics, CPB systemic flow changes , pulsatile changes.**



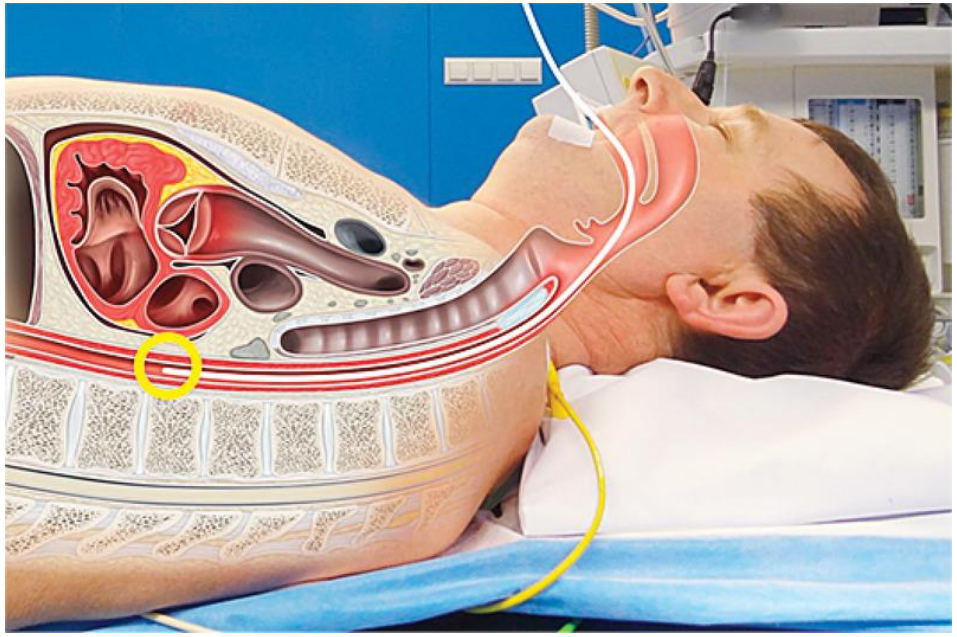
TEMPERATURE MONITORING

- **Temperature measurement is the core physiologic monitor during CPB.**

- Patient Monitoring - Nasopharyngeal, esophagus, tracheal, mixed venous blood, arterial blood, bladder urine, rectal, tympanic membrane and even great toe temperature are readily available for clinical use.

- Temperatures are measured during cooling that the organs believed most vulnerable to potential hypoperfusion actually receive the benefit of the desired degree of hypothermia.

- **Brain is usually target** and the temperature gradient of difference in **10 degree Celsius** is maintained to prevent significant microbubble formation.



MONITORING OF URINE OUTPUT

- **Good urine output is the indication of good renal function is the indicator of the adequacy perfusion.**
- The kidneys receive about 27% of the cardiac output
- **If cardiac output or blood flow on bypass is decreased the kidneys are the 1st organ deprived of blood**
- In general , a physiologic urine volume of 0.5—1.0 ml/kg/hour, a 1ml per minute in average adult
- Oliguric or anuric patients may not benefit to diuretic therapy – so no urine output in CPB in this patients

- **GOOD URINE OUTPUT WILL PREVENT – hyperkalemia, volume overload**
- The urine output should be checked after 15min on bypass to ensure renal function.
- No urine output for 30min is usually treated.

CAUSES OF NO URINE OUTPUT

CAUSES OF NO URINE PRODUCTION	CORRECTIVE ACTION
Kinked or disconnected Foley catheter	Straighten or connect tubing
Catheter with tip obstructed by gel	Push the bladder
Decreased blood pressure	Give vasopressors
Low pump flows	Increase the flows
Fluid moving to intestinal space(EDEMA)	Use mannitol 25%-- 25mg is often given. Next LASIX– 0.25mg/kg.

COAGULATION STATUS

- The heparin is an anticoagulant discovered in 1916

- **Adult Heparin dose = 3× weight in Kg.**
- **Pediatric Heparin dose = 4× weight in Kg**

- Extracorporeal circuit Heparin doses usually from 2000 to 3000 IU per Liter of priming fluid, or **1 mg per kilogram. (1mg Heparin = 100 IU)**

- The half-life of IV heparin is relatively short from **60 to 90 min**

- During CPB – ACT will be **480 seconds**

COAGULATION STATUS

- **Protamine administration -** 1.0 to 1.2 mg of protamine for each 100 U of heparin

- **Maintenance of proper coagulation status is more important to prevent clotting or excessive bleeding.**

Normal Coagulation Values

Table 24 : Normal Coagulation Values	
Activated clotting time(ACT)	110-120 seconds
Prothrombin time (PT)	10-14 seconds
Partial thromboplastin time (PTT)	25 - 35 seconds
Thrombin time (TT)	less than 15 seconds
Bleeding Time	1 - 9 minutes
International Normalized Ratio (INR)	0.8 - 1.2
Fibrinogen Level	200 to 400 mg/dL

ASSESSMENT – I

- What should be the Cardiac Index for adult?
- Which is the appt area for monitoring the patient temperature?
- What should be the ACT during bypass?
- What should be the urine output during bypass?
- The flow should be adjusted according to what parameters?

THANK YOU

Reference:

- https://www.perfusion.com/
- Cardiopulmonary bypass – Principles and Techniques – Mohammed Barham