SNS COLLEGE OF ALLIED HEALTH SCIENCES

SNS Kalvi Nagar, Coimbatore - 35

Affiliated to Dr MGR Medical University, Chennai

DEPARTMENT OF CARDIO PULMONARY PERFUSION CARE TECHNOLOGY

COURSE NAME : PRINCIPLES OF PERFUSION TECHNOLOGY I

II YEAR

TOPIC : HYPOTHERMIA

HYPOTHERMIA

- Hypothermia is defined as a decrease in a core body temperature below ***37 degree Celsius.***

- The principle reason for hypothermic CPB is to protect the heart and other organs by ***reducing metabolic rate and thus oxygen requirements.***

- In the myocardium, hypothermia sustains intracellular reserves of high – energy phosphates and reserves high intracellular pH and electrochemical neutrality.

HISTORY OF HYPOTHERMIA

- In ***1950, Bigelow*** (Canada) first demonstrated the linear relationship between **falling temperature and falling metabolic rate** when anaesthesia was used to control shivering and the increased muscle tone generated in response to cold.

- In ***1952, Lewis & Taufic*** used surface cooling to 28ºc with 5.5 minutes of inflow occlusion to facilitate successful closure of an atrial septal defect in a 5 year old child.

- Hypothermia equipment, used at the University of ***Colorado Medical Centre*** in 1953, is in the Smithsonian Institution in Washington, D.C., as a medical “landmark”

- ***1953 Swan*** (US) experimented with hypothermia further, and used this knowledge to the success of his first open heart surgery.

HISTORY OF HYPOTHERMIA (Cont)

- ***1955 Cooley*** (US) first use of hypothermia for **cerebral protection** during first **aortic arch aneurysm repair** with a homograft.

- ***1955 Lillehei and Kirklin*** (US) noticed and published that better outcomes occurred when body temperature cooled spontaneously during oxygenation.

- After development of the pump oxygenator by ***Gibbon,*** CPB and hypothermia were combined by ***Sealy in 1958.***

- ***1959 Sealy*** (US) continued Lillehei and Kirklin's development and added a heat exchanger to a Dewall oxygenator to use hypothermia alongside it.

HISTORY OF HYPOTHERMIA (Cont)

- ***1963, Barnard and Schrire*** (South Africa) First used DHCA and CPB at the same time on an ascending and arch aortic aneurysm.
- ***1975 Griepp*** (US) used surface cooling with CPB to resect aortic arch aneurysms in four patients.

USES OF HYPOTHERMIA

- Major vascular diseases (aortic aneurysm)
- Removal of hepatic and renal tumour
- Intracranial surgery
- Multiple cerebral diseases
- Better myocardial protection
- Better organ preservation
- Lower pump flows – less blood trauma
- Safety margin during CPB
- Bloodless and motionless surgical field.

MYOCARDIAL COOLING

Myocardial cooling can be achieved with,

- ***Cold cardioplegia***

- ***Pouring cold tropical solution on the heart***

- ***Cooling jackets as well as by systemic hypothermia***

Q10 EFFECT

- ***For every one degree reduction in temperature there is reduction of 7% of metabolic needs.***
- Systemic O2 consumption is reduced by approximately 50% for every 7 degree Celsius reduction in core temperature below hypothermia.
- ***For 30^0 Celsius = 50%***
- ***For 23^0 Celsius = 25%***
- ***For 16^0 Celsius = 12.5%***

CLASSIFICATION OF HYPOTHERMIA

- ***Mild*** ***36 - 34 º c***
- ***Moderate*** ***33 - 28 º c***
- ***Deep*** ***27 - 18 º c***
- ***Profound*** ***< 18 º c***

METABOLIC LEVEL IN HYPOTHERMIA

HYPOTHERMIA	METABOLIC RATE
• ***Mild***	***80%***
• ***Moderate***	***61%***
• ***Deep***	***41%***
• ***Profound***	***18 – 7 %***

TEMPERATURE MONTORING SITES IN PATIENTS

Temperature should be monitored in multiple sites they are,

- ***Nasopharynx***
- ***Tympanic membrane***
- ***Pulmonary artery***
- ***Bladder***
- ***Rectum***
- ***Distal esophagus***

TEMPERATURE MONTORING SITES IN HEART LUNG MACHINE

In CPB circuit the temperature probes are placed at,

- ***The venous inlet***
- ***The arterial outlet***
- ***The CPDS***

TEMPERATURE MONITORING SITES AND ITS ACCURACY

- ***Nasopharyngeal temperature probes*** underestimate but ***approximate to brain temperature***, with the mixed venous temperature on the CPB circuit being an approximation of average body temperature.

- ***Nasopharyngeal and tympanic membrane*** probes shows ***surface temperature.***

TEMPERATURE MONITORING SITES AND ITS ACCURACY

- ***Bladder and Rectal temperature*** given an ***indication of core body temperature***, but these can be erroneous due to interference from varying **urine production and faecal matter,** respectively.

- These low blood flow sites tend to underestimate temperature so are particularly valuable following deeper levels of hypothermia.

Temperature monitoring

Measuring site	Advantages	Limitations
Nasopharyngeal	easy to introduce	measurement errors due to leakage of air; nosebleeds; the core temperature is not measured
Oesophageal	reliable	dislocation; gastric catheters
Rectal	easy to introduce	not always accurate; the faeces act as insulation; the core temperature is not measured
In the bladder	can be used during both general and locoregional anaesthesia	the urine flow affects the temperature
Tympanic	can be used during both general and locoregional anaesthesia	potentially traumatic; unreliable if not inserted by an expert
Axillary	easy to introduce	only moderately reliable; the core temperature is not measured
Via the blood, tip of a Swan-Ganz catheter or CVC, the pulmonary artery	the core temperature	only during invasive pressure measurement

BLOOD GAS FLOW RATIO

TEMPERATURE	GAS / BLOOD FLOW RATIO	FIO2
37ºC	1:1	80
34ºC	8:1	70
30ºC	7:1	65
28ºC	6:1	60
22ºC	5:1	50

SAFE ARREST PERIOD FOR TEMPERATURE

TEMPERATURE	*ARREST PERIOD*
32ºc	under 10 minute
28ºc	10 to 15 minute
18ºc	16 to 45 minute
< 18ºc	46 to 60 minute

GRADIENT OF TEMPERATURE MANAGEMENT

Temperature gradient between Hemotherm & pt. blood

Adult 10 - 12º c

Paediatric 8 - 10º c

Gradient for temperature management

Cooling 1º c for 1 minute

Rewarming 1º c for 3 minute

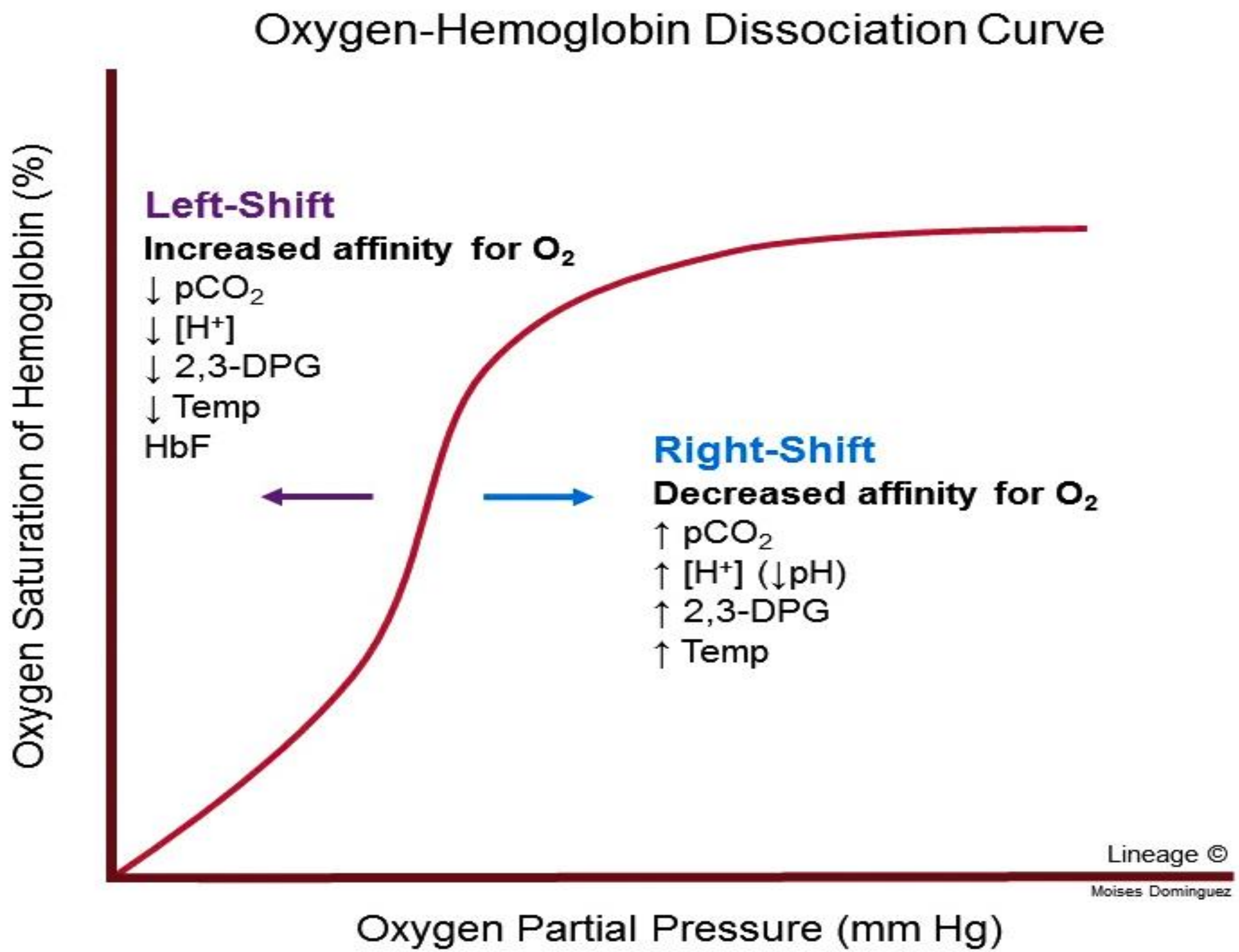
CHANGES IN OXYGEN – HEMOGLOBIN DISSOCIATION CURVE

- ***As the temperature decreases, the affinity or strength of binding between O2 and Hemoglobin increases.***

(a lower partial pressure of O2 is required to force a given amount of O2 into hemoglobin molecule)

- The oxygen – hemoglobin dissociation curve is shifted to left. Release of O2 from hemoglobin at the tissue level is less efficient.

CHANGES IN OXYGEN – HEMOGLOBIN DISSOCIATION CURVE



CHANGES IN SOLUBILITY OF O2 AND CO2

- As temperature decreases, gases become more soluble in liquid. For a given amount of O2 and Co2 more gas will be dissolved in the plasma and the partial pressure of the gas will decrease.

- This is much more significant for CO2 because it is more soluble in plasma at any given temperature.

MECHANISM OF ACTION

- Reduction in cerebral metabolism (CMRO2) by approximately 7% per 1º C. This leads to less oxygen and glucose consumption.
- Promotion of cerebral vasoconstriction, which can directly decrease ICP. Also, vascular permeability and therefore edema formation is decreased.
- Prevention of neuronal injury leading to programmed cell death (apoptosis) mainly by inhibition of caspase activation.

MECHANISM OF ACTION

- Decrease the free radical formation

- Suppression of inflammatory cascade and decreased nitric oxide, cytokine and leukotriene production. Leukocyte migration from the damaged endothelium is diminished.

ADVERSE EFFECT

- Mostly thrombocytopenia by reversible sequestration of platelets in portal circulation.
- RBC aggregate and leads to reduced perfusion to capillaries.
- Tissue H_2O content increases due to hemodilution which can cause swelling and edema.
- O_2 availability decrease because of left shift of O_2 Hb curve.

ADVERSE EFFECT

- It can cause coagulopathy disorder (eg) cold agglutination.

- Capillary resistance increases due to increase HCT have low / cerebral circulation. So, hypothermia can be performed slowly with low HCT.

- Importantly rewarming should not result in hyperthermia even 1ºc to 2ºc increase in brain temperature can excerbate ischemic cerebral damage.

SYMPTOMS FOR DECREASED BODY TEMPERATURE

BODY TEMPERATURE	SYMPTOMS
36º C	Normal core temperature
35º C	Vasoconstriction (peripheral), maximal shivering, speech disorders and hyper reflexia
34º C	Still conscious, but movements are difficult
33 - 31º C	Retrograde amnesia, no shivers, hypotension and dilation of pupils
30 - 28º C	Loss of consciousness, muscular rigidity, bradycardia and bradypnea
27 - 25º C	Loss of reflexes, ventricular fibrillation and suspended animation
17º C	Iso – electric ECG

Rewarming

Passive external rewarming | *Active external rewarming* | *Active Internal rewarming*

RATE OF REWARMING

- Maintain a gradient of nasal to water bath of at least 6ºc in adult and 4ºc in paediatrics.
- Warm at a rate of 1ºc for 3 – 5 mins
- Plan accordingly with surgeon, consulting with anaesthetist.
- Consider – Bicarb, Mannitol, ZBUF ,CUF
- Proper gas flow

TOO HIGH FLOW AT REDUCED TEMPERATURE

Too high flow at a reduced temperature may,

- Cause blood damage
- Impede the surgery by flooding the field
- Cause an excessive rise in venous pressure
- Cause rewarming of the heart when cardioplegia has been used.
- Cause underperfusion.

THANK YOU