UNDERSTAND OXYGEN TRANSPORT AND YOU WILL UNDERSTAND CONGENITAL HEART DISEASE

Physiologic Disturbances in the infant/Newborn

- Inadequate Pulmonary blood flow

  Tetraology of Fallot or Pulmonary Atresia

- Excessive Pulmonary blood flow

  VSD or any Cyanotic CHD with unrestricted Pulmonary blood flow

- Inadequate systemic blood flow

  Aortic Atresia, Critical ASV

- Abnormal Mixing **TGA**

Concepts of Oxygen Transport

- Definitions: oxygen saturation, oxygen content and oxygen-hemoglobin dissociation curve.
- **Systemic oxygen Transport** . Effect of Hemoglobin, low systemic or pulmonary blood flow, and lung function.
- The effect of Pulmonary blood flow on **Systemic Oxygen transport** in complete admixture CHD

Concepts of Oxygen Transport

- Relationship between VO_2 and oxygen Delivery
- Systemic responses to inadequate oxygen transport.
- Markers of inadequate oxygen Transport
  - Lactic Acid
  - SVO_2

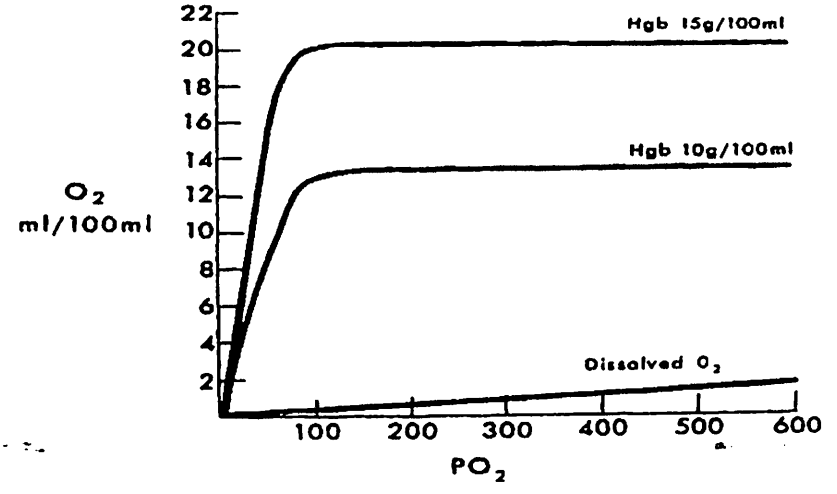
Oxygen Transport and Congenital Heart Disease

Oxygen Content CaO2

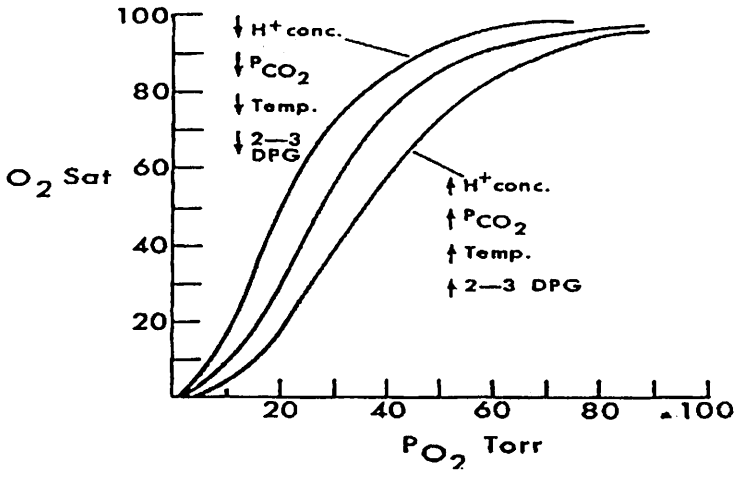
Hemoglobin 1.36ml/100ml x % saturation

Plasma .003ml/100ml/mmHg or
.3 ml/100ml/100mmHG

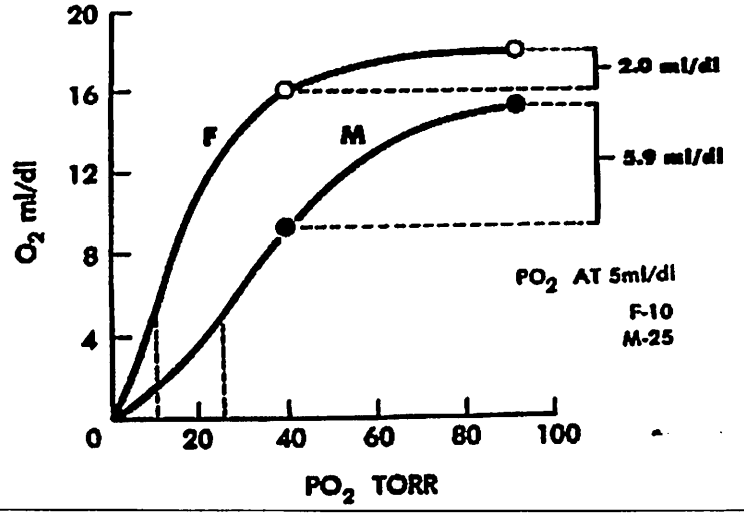
Oxygen Transport



Oxygen Hemoglobin Dissociation curve



Oxygen Hemoglobin Dissociation curve



Oxygen Delivery
Systemic oxygen Transport

Oxygen Delivery (DO_2) ml O2/minute

=

Cardiac Output x Oxygen Content (CaO_2)

L/minute ml O_2/ 100 ml

Oxygen Delivery

Importance of hemoglobin

The single best way to increase oxygen Delivery is to give a blood transfusion.

15gm Hb x 1.36ml x % O2 saturation

20.4 ml/ 100 ml oxygen

10 gm Hb x 1.36ml x % O2 saturation

13.6 ml/100 ml oxygen

33% increase in oxygen Delivery

Importance of Plasma Oxygen content

In the anemic patient dissolved oxygen can be a major component of oxygen content

Alveolar PO2 600Torr

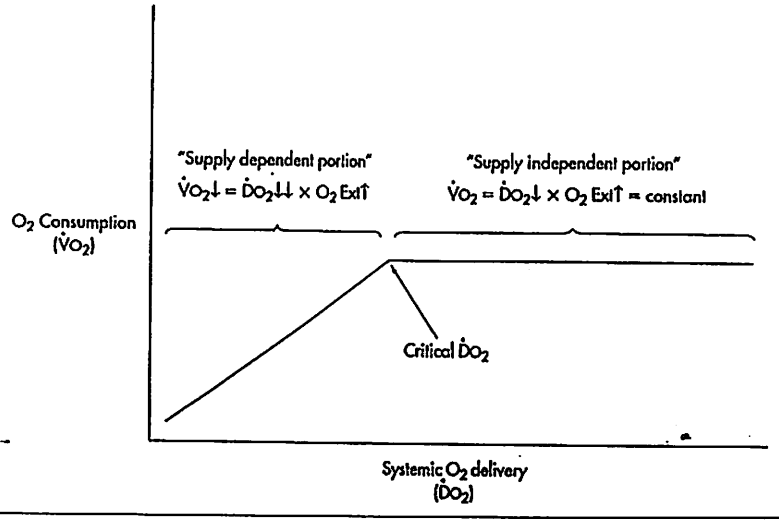
10 gm Hb x 1.36 ml + 1.8 ml/100ml

Dissolved Oxygen 13 %

5 gm Hb x1.36ml + 1.8ml/100ml

Dissolved Oxygen 26%

Relationship Between oxygen Consumption VO_2 and Delivery

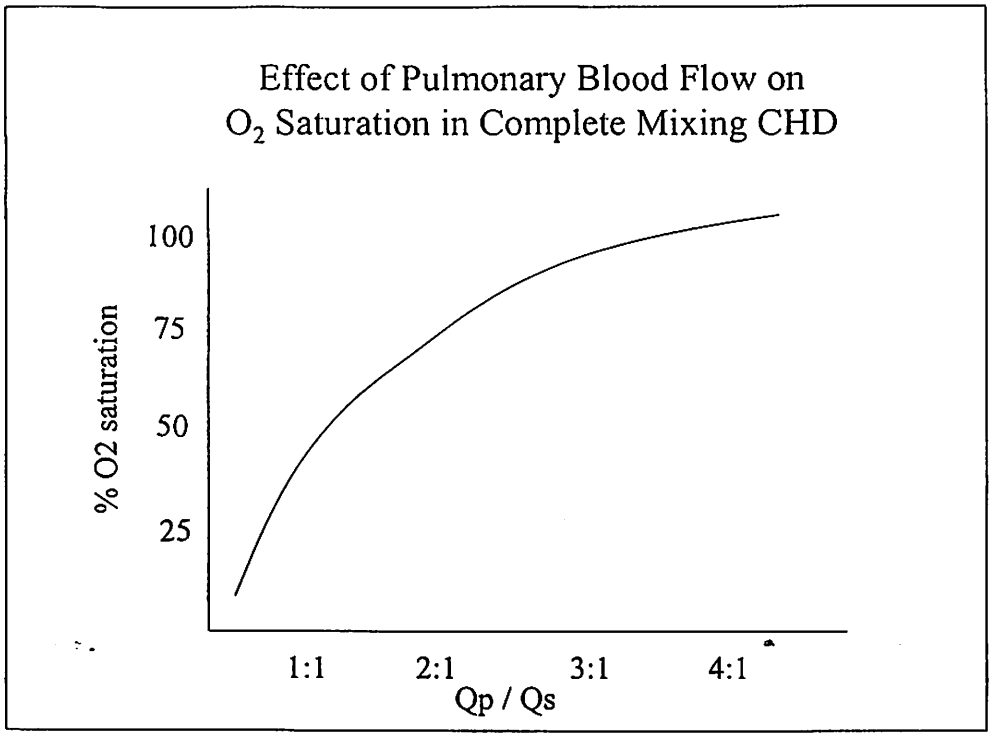


Response to Inadequate Oxygen Delivery

- Activation of Neurohumoral mechanisms mediated by the sympathetic nervous system which leads to differential vasoconstriction depending on the density of sympathetic innervation. (Kidney, skin, GI tract >muscle. In Brain and Heart almost no vasoconstriction.
- Arterial PO_2 direct control-Vasodilation in response to low Arterial PO_2.
- Renin AngiotensinII aldosterone Arginine Vasopressin axis

Markers of Tissue Oxygenation

- Mixed venous PO_2 or SVO_2 is the single most reliable indicator of tissue hypoxia. O2 diffusion from blood to cell is directly related to the difference between capillary PO_2 and the intracellular PO_2. Capillary PO2 reflects:
  - Arterial oxygen content
  - Organ blood flow
  - Organ oxygen consumption
- Lactic Acid


Effect of Pulmonary Blood Flow on
O_2 Saturation in Complete Mixing CHD
% O2 saturation
100
75
50
25
1:1
2:1
3:1
4:1
Qp / Qs

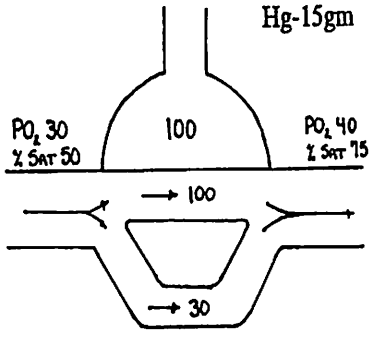
Oxygen Transport and Congenital Heart Disease

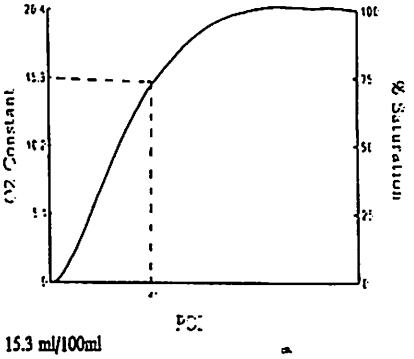
Summary

- Physiological Disturbances are related to abnormalities in Systemic blood flow, pulmonary blood Flow, or mixing.
- Maintaining adequate oxygen capacity (Hemoglobin) is critical.
- Primary response to tissue hypoxia is the sympathetic nervous system.
- Monitoring : Lactic Acid and SVO_2 are useful.

Hyperoxia Test

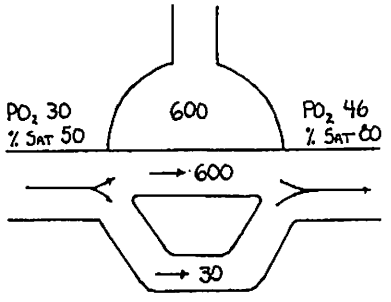
The Hyperoxia Test - Forgotten but still useful for understanding the Physiology of congenital heart disease.

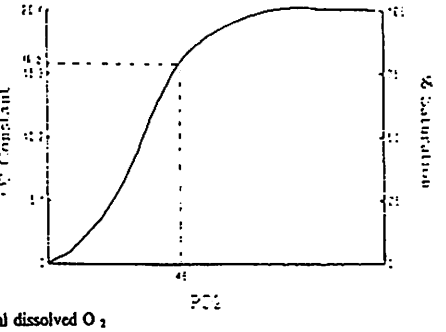




$$\frac{20.4 + 10.2}{2} = 15.3 \text{ ml/100ml}$$

Hyperoxia test
FIO_2 1.0





* Add 1.8 ml/100ml dissolved O_2

$$\frac{22.2 + 10.2}{2} = 16.2 \text{ ml/100ml}$$