Predictive Oxygenation: Keeping tight control over your PaO_2's during CPB

We are coming into an era in which CPB parameters are based on goal directed values. One of these parameters is the paO_2 value: What is the best paO_2 for my patient and how can I achieve this. First of all we have to define what is the optimal range of paO_2.

How much oxygen is needed?

Our goal, during CPB, is to prevent tissue hypoxia. However, tissue perfusion depends more on delivery of oxygen (DaO_2) than the paO_2. If your DaO_2 is met, do you need higher paO_2s above the normal range? We should not assume that high levels of oxygen are harmless. Also, there is no established definition of hyperoxia ($FiO_2>0.21$) nor of hyperoxemia ($paO_2>100$mmHg): This is mainly author defined.

In the published literature, there is certainly a long list of adverse effects regarding hyperoxemia such as those mean little oxygen free radicals and alterations in blood flow causing microcirculatory shunting. However, outcome studies are not consistent making this subject an area of much needed future research.

Way back when...Kirklin 1957 States: „There are theoretical considerations suggesting that very high arterial oxygen tension could be disadvantageous during whole-body perfusion. These two lines of thought have made us believe that flow rates of 2.2 to 2.5 litres per minute per square metre, with arterial oxygen tension of approximately 115 mm. of mercury, offer a better way of transporting the oxygen required by the subject than does a somewhat lower rate of flow of arterial blood of higher oxygen tension."

Tim Willcox (Australia) gave a presentation last year at the Montreal meeting on their randomized trial of Avoidance of Hyperoxemia during Cardiopulmonary Bypass. The group with the range of paO_2s between 90 to 110 mmHg exhibited no difference, to the group of modest hyperoxemia (mean, 178 mmHg). He also stated that they would have liked to continue their study to compare patients with extremely higher paO_2s but they could not justify going against their normal protocol.

So it seems that a near normal paO_2 is the most accepted strategy-

Keeping tight control over your paO_2s in order to prevent Hyperoxemia.

The *Predictive Oxygenation* strategy is being able to "predict" your paO_2 and therefore keep a tight control over your paO_2 values during CPB for each individual patient.

This depends on: How your oxygenator performs and the oxygen demands of the patient.

Oxygenator Performance:

In my publication regarding measuring Oxygen Transfer Performance in the Medtronic Fusion (A new method to measure oxygenator oxygen transfer performance during cardiopulmonary bypass: Clinical testing using the Medtronic Fusion oxygenator. Perfusion 32(2) · September 2016) provides now a clinical method to set your FiO_2 to achieve a paO_2 of approx. 150 mmHg depending on the **patient's theoretical Oxygen Consumption (VO_2)**.

This is how you do it:

Make a graph: VO_2 (mlO_2/min) on the Y-axis; FiO_2 on the X-Axis. Draw a line between 2 points; 54:21 and 420:100 which is your O_2T line for a paO_2 of 150 mmHg.

Patient Parameters: Take the BSA and multiply by 80 and 100 $mlO_2/min/m^2$. This is the VO_2 to be expected during CPB at 34 and 37 degrees respectively. If the patient is muscular and young a higher value of 130 $mlO_2/min/m^2$ may be used.

Draw a line from the theoretical VO_2 to the O_2T line (paO_2 150 mmHg) and down to the FiO_2. For initiation of CPB I use the FiO_2 value at 100 $mlO_2/min/m^2$.

During CPB the VO_2 is calculated and the $cFiO_2$ gives an indication on how your oxygenator is performing.

Conclusion:

Start thinking in terms of "goal directed" Oxygen Delivery (DaO_2 and DaO_2/m^2); Oxygen Consumption ($VO_2$and VO_2/m^2)

In this way, a lot more information about our systems and our patients can be gained because we understand how our oxygenators function and how the patient reacts to CPB which aids in keeping tight control over our paO_2s.