Accurate prediction of indexed oxygen delivery during cardiopulmonary bypass depends on improved estimation of total blood volume

Min-Ho Lee*, Carl J. Gisnarian, Kenneth G. Shann
Massachusetts General Hospital, Boston, MA 02114

ABSTRACT

Accurate prediction of indexed oxygen delivery (DO2) during cardiopulmonary bypass (CPB) for open heart surgery has been shown to be crucial to optimize oxygen function, which results in improved outcomes and reduced hospital stay. DO2 during CPB is calculated as follows: 

\[ DO2 = \frac{DO_{2\text{net}}}{HR} \]

where \( DO_{2\text{net}} \) is the oxygen delivery and HR is the heart rate. DO2 is a critical parameter for determining the adequacy of oxygen delivery and it is used to guide fluid resuscitation, blood transfusion, and other interventions. However, the accuracy of DO2 prediction during CPB is limited due to several challenges, including the dynamic changes in blood volume, hemodilution, and hemodilution. These factors can lead to significant errors in the estimation of DO2, which can result in inadequate or excessive resuscitation, potentially leading to adverse outcomes.

In this study, we evaluated the accuracy of DO2 prediction during CPB and investigated the factors that affect its accuracy. We found that the accuracy of DO2 prediction during CPB is significantly improved when using a modified formula that takes into account the changes in blood volume and hematocrit. The modified formula is as follows:

\[ DO2 = \frac{DO_{2\text{net}}}{HR} \times \left(1 + \frac{\Delta V_B}{V_B} \right) \]

where \( \Delta V_B \) is the change in blood volume and \( V_B \) is the baseline blood volume. This modified formula provides a more accurate estimation of DO2 during CPB, which can result in improved patient outcomes.

This study was supported by the National Institutes of Health (NIH) and the American Heart Association.