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## **NIRS Values Following Phlebotomy Support the Safety of Foregoing Volume Replacement**

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### **NIRS Values Following Phlebotomy Support the Safety of Foregoing Volume Replacement**

#### **Introduction:**

Many risks are associated with allogenic blood products, including infectious diseases, autoimmune reactions, prolonged hospital stays and increased costs. To this end, various techniques have been developed to limit the need for allogenic blood products.<sup>1</sup> At Nationwide Children's Hospital, we utilize phlebotomy prior to surgical incision, with volume replacement guided by end-organ perfusion as reflected in blood pressure changes, EKG tracings and near-infrared spectroscopy (NIRS) values.

Investigators have demonstrated that changes in underlying cerebral blood flow closely track changes in (NIRS) values.<sup>2</sup> Furthermore, NIRS data and cerebral blood flow has been determined to track more closely with changes in arterial carbon dioxide than with changes in mean arterial pressure. Our data illustrate that phlebotomy prior to incision in the absence of volume replacement results in no significant changes in cerebral perfusion as measured by NIRS values. Perhaps even more intriguing, for patients older than 1 year of age, changes in NIRS values in the setting of acute blood loss are further minimized when arterial carbon dioxide values are greater than 45.

#### **Method:**

Our technique involves removal of blood from the patient after anesthetic induction, with a target amount calculated based on the patient's weight and starting hemoglobin value. As the blood is removed, fluid replacement is guided by changes in end-organ perfusion. A reduction of greater than 20% from baseline in either NIRS data or blood pressure is remedied by volume resuscitation using crystalloid, cessation of phlebotomy or both.

#### **Results:**

The data was collected following institutional IRB review and includes 21 patients undergoing cardiac surgery, ranging in age from 2 months to 50 years. An average of 9.5 ml/Kg of blood was removed per patient, with total crystalloids replacement averaging 7.1 ml/kg. This was associated with a decline in mean arterial pressure, (MAP) from 69.6 to 59.4, (10.2 points). At 15 minutes following phlebotomy the MAP was a mean of 59 and at 30 minutes the MAP was 60.

The NIRS data declined on average from 76.7 to 69.6, (7.1 points). At 15 minutes following phlebotomy the average NIRS was 6.9 and at 30 minutes, 7.7. Patients greater than 1 year of age with an arterial carbon dioxide concentration >45, the decline in NIRS value was on average only 5.2 points. It should be noted that no patient had any documented changes in neurological, cognitive or developmental function following surgery.

#### **Conclusions:**

Isovolemic hemodilution is an accepted technique for reducing the need for blood product transfusions. The replacement of this blood volume with crystalloid may be greatly attenuated when guided by the recent development of monitors such as the NIRS.

In our experience, phlebotomy prior to surgery may be safely undertaken when guided by end-organ perfusion, and in this manner, volume replacement may be individualized. This practice is both an effective and safe method for reducing transfusions and unnecessary crystalloid administration. Further evaluation is needed to determine the impact of arterial carbon dioxide concentration in the interest of further minimizing declines in NIRS values during periods of acute blood loss.

**Summary:**

Pre-surgical hemodilution is employed in the interest of reducing the need for blood product transfusions. Utilizing a NIRS monitor as a proxy for cerebral perfusion, we routinely phlebotomize prior to incision, and replace with crystalloid only with evidence of declining end-organ perfusion.

## Footnotes

<sup>1</sup> Lavoie J. Blood transfusion risks and alternative strategies in pediatric patients. *Paediatr Anaesth*. 2011 Jan;21(1):14-24.

<sup>2</sup> Cooper JA, et al. Continuous Monitoring of Absolute Cerebral Blood Flow by Near-Infrared Spectroscopy During Global and Focal Temporary Vessel Occlusion. *J Appl Physiol*. 2011 Mar 31.

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