Is Bilateral Monitoring of Cerebral Oxygen Saturation Always Necessary?

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Introduction: Cerebral ischemia during deep hypothermic circulatory arrest (DHCA) or low-flow bypass (LF) remains an important cause of cerebral injury in children undergoing cardiac surgery (1). Near-infrared spectroscopy (NIRS) is a non-invasive optical technique to assess tissue oxygenation, and is being used to monitor cerebral oxygenation during pediatric cardiac surgery (2). The INVOS 5100 (Somanetics, Troy, MI) has been approved by the FDA for use as a trend monitor of cerebral oxygenation, but validation studies have not been performed and the sensors are costly (approx. $80). Bihemispheric measurement is recommended by Somanetics, but unilateral monitoring may be adequate and the economic benefit might encourage more widespread use of cerebral oximetry. This study evaluated differences in bihemispheric measurement of regional cerebral oxygen saturation index (rSO_2) during infant cardiac surgery and hypothermic cardiopulmonary bypass (CPB).

Methods: After IRB approval and parental informed consent, 62 neonates and infants undergoing CPB were prospectively studied. Patients with anomalies requiring aortic arch reconstruction or those undergoing selective cerebral low flow perfusion were excluded. A standardized perfusion protocol was used, including non-pulsatile perfusion with a membrane oxygenator, blood prime, pH-stat blood gas strategy, and flow rates of 150-200 ml/kg/min full flow and 50 ml/kg/min low flow. Diagnosis and surgeon preference determined whether LF or DHCA was used. Pediatric SomaSensors® were placed on the right and left forehead following induction, and the rSO_2 was recorded continuously. Data were analyzed by paired t-tests and linear regression, and are presented as mean ± SD.

Results: Demographic and intraoperative data are shown in Table 1. Thirty-six patients had LF and 26 had DHCA. Left and right rSO_2 before, during or after CPB were similar (Table 2). The mean (range) rSO_2 after induction of anesthesia was 62 (39-94) and 65 (38-93) on the left and right respectively. Hematocrit was 34.9 ± 6.4 post induction, 29.3 ± 5.5 after 10 minutes of cooling on CPB, 32.7 ± 3.5 at the start of rewarming, and 34.5 ± 2.8 at the end of CPB. No early major adverse clinical outcomes were noted.

Discussion: Left and right hemisphere rSO_2 measurements were similar, and unilateral monitoring may be sufficient for patients undergoing biventricular repair who do not have aortic arch obstruction. We observed changes in rSO_2 similar to those in previous reports (3). The range in rSO_2 at each time point is consistent with the wide range in rSO_2 values shown for neonates without heart disease breathing room air (4), as well as the cerebral oxygen saturation (Sc_{o2}) in neonates, infants and children with congenital heart disease before surgery (5). This variation raises the question whether normative values can be defined. Although the INVOS 5100 holds promise as a monitor of pediatric cerebral oxygenation, future research should define critical values that are associated with cerebral hypoxic-ischemic damage.

Table 1. Demographic and Intraoperative Data

Age (days) median (range)	51.5 (2 – 263)
Gender (M/F)	36 / 26
Weight (kg)	4.6 ± 1.2
Diagnostic Group (n) TGA Conotruncal abnormalities VSD	 25 20 17
Total CPB time (min)	103.5 ± 34.3
Lowest tymp. temp (°C)	21.0 ± 4.8
Minutes of DHCA median (range)	27 (1-59)

Table 2. Saturation Data (rSO_2)

Perfusion Phase	Left	Right	*P*
Post induction	65 ± 13	66 ± 13	0.14
On CPB	62 ± 13	64 ± 13	0.02
10 min after cooling	84 ± 11	84 ± 10	0.66
Onset of LF	84 ± 11	83 ± 11	0.94
Onset of DHCA	89 ± 10	88 ± 11	0.80
Resume LF	64 ± 17	64 ± 14	0.90
Start rewarming (SW)	81 ± 12	82 ± 13	0.65
10 min after SW	78 ± 16	78 ± 16	0.97
Warm flow (35˚C)	74 ± 14	74 ± 14	0.62
Off CPB	72 ± 14	72 ± 14	0.44
60 min post CPB	72 ± 12	73 ± 13	0.28
6 h post CPB	63 ± 8	63 ± 9	0.76

Refs:

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