Neonates with congenital heart disease (CHD) who require cardiopulmonary bypass may have disease-related and procedure-related disturbances in cerebral oxygen economy, resulting in hypoxic ischemic injuries and abnormal neurodevelopmental outcomes. Advanced neurophysiologic monitoring with near-infrared light may be used to assess cerebral oxygen delivery and consumption. Near-infrared spectroscopy (NIRS), most commonly used as a continuous-wave modality, generates a cerebral tissue oxygen saturation that is highly correlated with jugular venous oxygen saturation. Reduced cerebral tissue oxygen saturation has been linked to states of cerebral oxygen debt and adverse neurodevelopmental outcomes. Frequency domain NIRS represents an alternative methodology with improved accuracy for determination of absolute tissue saturation. Reduced cerebral tissue oxygen saturation has been linked to states of cerebral oxygen debt and adverse neurodevelopmental outcomes. Frequency domain NIRS represents an alternative methodology with improved accuracy for determination of absolute tissue saturation.

Diffuse correlation spectroscopy measures scattering of near-infrared light by red blood cells traveling through an optical field, generating a cerebral blood flow index (CBFi). By using the Fick equation and available clinical data (hemoglobin and arterial oxygen saturation), cerebral tissue oxygen saturation and CBFi measurements enable calculation of the cerebral oxygen extraction fraction (OEF) and the cerebral metabolic rate, providing a quantitative assessment of cerebral oxygen supply and demand.

In the current issue of the Journal, Cheng and colleagues report the results of a prospective observational study in neonates comparing frequency domain NIRS– and diffuse correlation spectroscopy–derived variables of cerebral hemodynamics and oxygen metabolism in healthy control patients and 3 CHD groups (2 ventricle, transposition of the great arteries [TGA], and single-ventricle anatomy [SV]). Comparisons were performed between the control group and the CHD groups preoperatively, and among the CHD groups preoperatively and postoperatively. Relative to control subjects, neonates with CHD exhibited significant differences in cerebral hemodynamics and oxygen metabolism. Notably, neonates with SV had lower preoperative CBFi, whereas neonates with both TGA and SV had increased preoperative OEF. One important finding within the CHD groups revealed a reduction in OEF after TGA repair. Cheng and colleagues hypothesized that increased preoperative OEF in neonates with TGA and SV might be a compensatory mechanism and that reduced calculated ratio of CBFi to cerebral metabolic rate in neonates with SV might be secondary to abnormal prenatal cerebral development.

Limitations of this work include the small sample size and multiple comparisons. More importantly, cerebral frequency domain NIRS and diffuse correlation spectroscopic measurements were performed intermittently, yet the real utility of oximetric technology lies in the ability to perform continuous, noninvasive measurements. No description of patient state during assessments was provided, despite evidence of wide state-dependent variation in cerebral NIRS values. The bypass strategy involved moderate to deep hypothermia with pH-stat blood gas management, all of which have been linked to impaired cerebral autoregulation, potentially affecting postoperative measurements. Finally, there was little discussion of important perioperative ventilatory, vasoactive, or transfusion management strategies, which affect cerebral oxygen delivery and metabolism.

Nevertheless, this thought-provoking study provides a framework for continued exploration of multimodal neurophysiologic monitoring utilizing near infrared light may be used to better understand cerebral oxygen supply and demand relationships in neonatal congenital heart disease.

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neurophysiologic monitoring incorporating near-infrared light to detect abnormalities in cerebral oxygen economy in CHD. Future investigations must focus on ways to incorporate continuous monitoring, which would allow targeted interventions to modify cerebral oxygen debt and associated adverse outcomes in this at-risk population.

References