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Advanced understanding of the nor wood physiology and postoperative management

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There have been substantial improvements in surgical survival for infants after the Norwood procedure. The mortality remains the highest (10-25%) in pediatric cardiac surgeries. Postoperative management strategies are suboptimal because they have been based on physiologic data derived from animal and computational models that have inherent limitations. In clinical studies, assessments of O2 transport have commonly used indirect indicators such as arterial and superior vena cava O2 saturation.. Some have derived the values of pulmonary and systemic blood flow and DO2, but assuming VO2 at 160 or 180 ml/min/m2. The paucity of clinical data reflects the difficulties in analyzing their complex circulation. Our group has adapted respiratory mass spectrometry to continuously and precisely measure VO2 in the post-Norwood infants. In combination with blood gas and pressure measurements from aorta, superior vena cava and pulmonary vein, we have been able, for the first time, to determine all of the parameters of systemic hemodynamics and O2 transport, including pulmonary blood flow, systemic blood flow, total cardiac output, pulmonary vascular resistance, DO2, VO2 and O2 extraction ratio. The actual measurements have allowed us to investigate systemic hemodynamics and O2 transport and their determinants in the early post-Norwood period, thereby improving postoperative management in this most challenging group of patients. We have reported that VO2 is highly variable both inter- and intro-individually, ranging from 45 to 155 ml/min/m2 early after the Norwood procedure. VO2 increases immediately after the Norwood procedure, which is a major contributor to the imbalance of systemic O2 transport when cardiac function and DO2 are severely depressed. The most important contributors to DO2 are systemic vascular resistance and systemic blood flow as well as hemoglobin, but not PaO2, SaO2 or pulmonary blood flow and vascular resistance. We have further challenged some of the routine treatments that are used to improve the balance of O2 transport, but actually have adverse effects, such as dopamine and CO2 etc. We also compared resting energy expenditure (measured by respiratory mass spectrometry) to caloric intake in the current feeding protocol, and found caloric intake is substantially inadequate to meet energy expenditure during the first days after surgery.

Conclusions: The advanced techniques using respiratory mass spectrometry to measure VO2 allows precise measurements of each of the parameters of systemic hemodynamics and O2 transport in the Norwood circulation. The actual measurements are fundamental to study the Norwood physiology, based on which treatment strategies are modified and designed aiming to optimize the balance of O2 transport and improve clinical outcomes in this most challenging group of patients in pediatric cardiac intensive care.

Biography

Jia Li, MD PhD obtained her PhD on O2 transport in children after CPB in 2002. She has developed a world-wide reputation for the use of respiratory mass spectrometry as an experimental and clinical research tool, and this technique continues to provide the gold standard of data in the field. She has had 60 publications with focus on systemic and regional O2 transport in patients undergoing cardiac catheterization and after cardiac surgery.