Intermittent Mixed Venous Oxygen Saturation in Pediatric Septic Shock

AMI P SHAH,[1*] PRERNA BATRA[2]

[1]*Department of Emergency Medicine, University of Nevada, Las Vegas School of Medicine, Las Vegas, NV,USA;*
[2]*Department of Pediatrics, University College of Medical Sciences and Guru Teg Bahadur Hospital, Delhi.*
**ami.shah@unlv.edu*

Across the globe, sepsis is the leading cause of morbidity and mortality in the pediatric population. An estimated 1.2 million cases of childhood sepsis are reported worldwide [1]. Given the global burden of disease in 2001, Surviving Sepsis Campaign (SSC) was initiated to collaborate and improve research and education for sepsis survival [2,3]. Shortly after the SSC campaign was initiated, the American College of Critical Care Medicine (ACCM) and Pediatric Advanced Life Support (PALS) guidelines recommended the use of targeted mixed venous oxygen saturation (ScvO2) therapy for Early Goal Directed Therapy (EGDT) in pediatric septic shock. Targeted ScvO2 monitoring is a critical tool for guiding therapy in children with septic shock both in the developed and developing countries [4-6]. Despite extensive use of ScvO2 monitoring in clinical practice, there are not many studies supporting its use. Clinical practice guidelines for management of pediatric septic shock by ACCM (2014) strongly recommended the use of targeted ScvO2 levels, a surrogate for cardiac index, as a marker of therapeutic end point for resuscitation, based on case control and cohort studies [7]. However, these recommendations are based mostly on the adult studies from developed world. Feasibility of continuous ScvO2 monitoring is question-able in resource-constrained settings of low- and middle-income countries (LMICs).

De Oliveira, et al. [8] with their randomized controlled design provided a head on comparison of continuous targeted ScvO2 >70% in children with fluid refractory shock guided monitoring (n=51 in each group). The authors reported a significant reduction in mortality in children with targeted ScvO2 therapy with numbers needed to treat (NNT) of 3.6. The study provided a premise for use of ScvO2 monitoring in clinical practice in advanced pediatric intensive care units (PICU) in the developing world. Subsequently, Sankar, et al. [9] published a prospective cohort study of children with fluid refractory shock admitted to a PICU in India. They used intermittent ScvO2 values obtained at 1, 3 and 6 hours after initiation of therapy to guide treatment against clinical variables and lactate among controls. The catheter was placed in subclavian/internal jugular vein, and the patients in whom catheter could not be placed served as controls. The authors observed a lower mortality in ScvO2 group as against controls (33% vs 54%; NNT=5). The limitation of the study was its design with a possible selection bias but it provided a balanced approach in resource-limited set ups, where continuous monitoring was not feasible.

The 2020 SSC International guidelines support the use of advanced hemodynamic monitoring such as ScvO2, but categorize it under weak low quality evidence [2,10]. Jain, et al. [11] report on a randomized controlled trial targeting intermittent superior vena caval saturation (ScvO2) above 70% for EGDT in patients with pediatric septic shock, in the current issue of *Indian Pediatrics*. The study population included children from 1 month to 12 years of age with fluid refractory shock admitted to the PICU. The authors found a significantly lower 28-day mortality and lower new organ dysfunction in the group with ScvO2 targeted therapy group. There was no difference noted in the time to achieve therapeutic end points, need for organ support and length of PICU or hospital stay. The study protocol is similar to the previous study from India except that fluid refractory shock was defined as shock not responding to 40 mL/kg of fluids as compared to 60 mL/kg used by Sankar, et al. [9]. All these studies support the utility of continuous and intermittent ScvO2 monitoring as a cost-effective tool for improving the survival of children with sepsis.

Dr. Joseph Carcillo, whose work has been instrumental in the field of pediatric septic shock, refers ScvO2 as a poor man's mixed venous oxygen saturation [12]. The author warns us of the limitations of the use of ScvO2 measurements. True ScvO2 requires oxygen saturation measurement of the pulmonary artery and this value can be 2% to 8% lower than catheters placed at SVC-RA and IVC-RA junction. High ScvO2 can indicate improved oxygen delivery but may also be reflective of poor oxygen consumption due to sepsis induced dysfunctional tissue perfusion and mitochondrial dysfunction [12,13]. In 2018,

Goonasekera, et al. [14] studied global oxygen extraction ratio (gO2ER) as a marker of oxygen consumption in fluid refractory pediatric septic shock on a cohort of 62 children admitted to the PICU with fluid refractory shock. They concluded that gO2ER of >0.48 with a blood lactate >4.0 mmol/L and metabolic acidosis are better predictors of death as compared to ScvO2.

Children are not young adults. With the limited evidence available in pediatric population, the study by Jain, et al. [11] continues to support the use of intermittent targeted ScvO2 monitoring for improving survival in pediatric septic shock refractory to 40 mL/kg of fluid resuscitation. However, the results mostly apply to sick children with septic shock having low SvcO2. With the clinical world constantly searching for more non-invasive methods, implementing the principles of EGDT using echocardiography and point of care ultrasound (POCUS) in children with septic shock may give newer insights in future [6,14].

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