Non-invasive measurement of venous oxygen saturation as early marker of impaired oxygen supply in preterm neonates

Lukas P. Miledler, Berndt Urllesberger, Julia Buchmayer, Nariae Baik-Schneditz, Bernhard Schwabegger, Nina Höller, Gerhard Pichler

Research Unit for Neonatal Micro- and Macrocirculation, Department of Paediatrics and Adolescent Medicine, Medical University of Graz, Graz, Austria
Division of Neonatology, Department of Paediatrics and Adolescent Medicine, Medical University of Graz, Graz, Austria

Background and aims

Venous oxygen saturation (SvO_2) decreases in situations of impaired oxygen supply of tissues, even if there is no reduction in arterial oxygen saturation (SaO_2). Andersen et al. (Pediatrics 2017) suggested that “*measuring oxygen extraction or the venous oxygen reservoir could define a physiologically based definition of adequate oxygen(-ation)*”. Hence, our aim was to assess whether there is a difference in peripheral muscle SvO_2 (pSvO_2) and fractional oxygen extraction (pFOE) measured by near-infrared spectroscopy (NIRS) between preterm neonates with an early infection compared to those without an early infection during the first 36 hours of life.

Methods

We analysed secondary outcome parameters of a randomized controlled trial („Avoiding Hypotension in Preterm Neonates”: Pichler et al. Front Pediatr 2018) and included preterm neonates at risk of early infection, in whom NIRS measurement including peripheral venous occlusion was performed. Infection was diagnosed by clinical signs and a positive blood culture and/or C-reactive protein (CrP) above the cut-off value (10mg/l).

We measured peripheral muscle tissue oxygenation index (pTOI) using NIRO 200-NX (Hamamatsu Photonics, Japan), calculated pFOE from pTOI and SaO_2 and measured pSvO_2 via venous occlusion method. For this, a blood pressure cuff was placed around the upper arm or thigh and inflated to a pressure level above the estimated venous blood pressure, thus interrupting venous outflow but leaving arterial inflow undisturbed (**Figure 1**).

Results

We included 33 preterm neonates with a mean gestational age of 33.2 ± 1.5 weeks (birth weight: $2007 \pm 486\text{g}$; m:w = 20:13). NIRS measurements and venous occlusions were performed at a median of 16.0 hours (1.0-28.0) after birth.

Of the 33 preterm neonates, five (15.2%) developed an infection (mean leucocytes: $17.252 \pm 11.129/\mu\text{l}$, mean CrP: $6.7 \pm 4.4\text{mg/l}$). Peripheral SvO_2 was significantly lower (49.3% versus 59.0%; $p=0.018$) and pFOE significantly higher (47.8 versus 38.8; $p=0.026$) in preterm neonates with an infection (**Figures 2a & 2b**).

Figure 1: NIRS-measurement with venous occlusion (thigh), NIRS sensors (calf) and pulse oximetry (foot).

Figures 2:

a) pSvO_2 in preterm neonates without (left column) and with an infection (right column);

b) pFOE in preterm neonates without (left column) and with an infection (right column).

Conclusions

We found impaired pSvO_2 and increased pFOE in preterm neonates with an early infection. Non-invasive measurement of these parameters is feasible and could be utilized for early detection of impaired peripheral oxygenation and (micro-)circulation in the future.