Background

Near-infrared spectroscopy (NIRS) is a noninvasive technology that can measure the amount of oxygen in tissue beds and is being increasingly utilized to measure Renal Regional Saturation of Oxygen (RrSO₂) in preterm neonates. It is commonly believed that organ tissue oxygen distribution is approximately 75% venous, 20% arterial, and 5% capillary. A properly placed umbilical vein catheter (UVC) may be used to estimate RrSO₂ due to the proximity to the renal vein. Previous adult and pediatric studies have observed a significant correlation between RrSO₂ and oxygen saturation from catheterized renal venous blood gas specimens.¹

Methods

This was a secondary analysis of a prospective RrSO₂ monitoring study in preterm neonates (GA<32 weeks)². INVOS NIRS sensors applied over kidney until day 7 of age. Inclusion criteria: Blood gas obtained during period of RrSO₂ monitoring. Exclusion criteria: Improper UVC placement (UVC not located at inferior vena cava/right atrium junction on x-ray). Average RrSO₂ values calculated for the exact minute at the time of the blood draw. RrSO₂ compared to O₂ saturation of each blood gas specimen using the non-parametric Mann Whitney U-Test and Spearman correlation coefficient.

Objective

To correlate RrSO₂ in preterm neonates to venous oxygen saturation (SvO₂), arterial oxygen saturation (SaO₂) and capillary oxygen saturation (ScO₂) obtained from UVCs, umbilical artery catheters (UACs), and capillary heel stick specimens, respectively.

Results

In this small pilot secondary NIRS study in preterm neonates, renal tissue oxygenation correlates with both arterial and capillary oxygen saturation while no correlation is observed between central venous.

Conclusions

1. This is the first study to examine the correlation between renal tissue oxygenation and blood oxygen saturation in preterm neonates.
2. Renal tissue oxygen saturation values are lower than blood oxygen saturations.
3. Renal tissue oxygen saturation correlates significantly with arterial and capillary oxygen saturation.
4. The findings of this study did not support the hypothesis that renal tissue oxygen saturation is significantly correlated with UVC blood oxygen levels; this finding may be due to the small UVC sample size.

Table 1. Characteristics of the 32 neonates who had blood gas values associated with the period of NIRS monitoring. Median and IQR values reported for gestational age and birth weight. Numbers and associated percentages of participants that were of the male sex and small for gestational age.

<table>
<thead>
<tr>
<th>Demographics</th>
<th>Patients (n=32)</th>
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<tbody>
<tr>
<td>Gestational age, weeks (Median, IQR)</td>
<td>28.7 (26.5-31.3)</td>
</tr>
<tr>
<td>Birth weight, grams (Median, IQR)</td>
<td>1015 (777.5-1396.5)</td>
</tr>
<tr>
<td>Male sex, N (%)</td>
<td>17 (53.1)</td>
</tr>
<tr>
<td>Small for gestational age, N (%)</td>
<td>6 (18.8)</td>
</tr>
</tbody>
</table>

Figure 1. Procedure for data organization and analysis: 35 patients were enrolled in the study, 3 did not have blood gas values associated with the time of NIRS monitoring. The blood gas values of the remaining 32 patients were analyzed. 27 venous blood oxygen values were obtained from proper UVC placement. These 27 venous blood oxygen values were the values analyzed in calculations of summary statistics and tests of correlation.

Figure 2. Categories for distinguishing the placement of the umbilical vein catheter (UVC) into the renal vein. Low refers to a UVC below the level of the diaphragm and into the liver. Proper refers to a UVC at the level of the diaphragm. High refers to a UVC above the level of the diaphragm.

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References