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The Predictive Value of Mesenteric and Cerebral Tissue Oxygenation Measurements for Feeding Intolerance and Necrotizing Enterocolitis in Preterm

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ABSTRACT

Introduction: Necrotizing enterocolitis (NEC) is a major cause of morbidity and mortality in preterm infants. Early detection of impaired intestinal perfusion may support preventive strategies. Near-infrared spectroscopy (NIRS) is a non-invasive bedside method that continuously measures regional tissue oxygenation. This study aimed to assess whether baseline regional cerebral oxygen saturation ($rcSO_2$), regional mesenteric/splanchnic oxygen saturation ($rsSO_2$), and their ratio (SCOR), measured within the first 24–48 hours of life, could predict the development of NEC.

Methods: This prospective cohort study included preterm infants with gestational age <34 weeks and/or birth weight <1250 g. Infants were classified as NEC or as controls (no NEC and no feeding intolerance). Baseline $rcSO_2$ and $rsSO_2$ values were continuously recorded for one hour between 24 and 48 hours postnatal using NIRS. Demographic, maternal, and clinical data were obtained from hospital records. Appropriate parametric and non-parametric tests were used; $p<0.05$ was considered significant.

Results: Forty infants were included (NEC, n=18; control, n=22). Gestational age (29.27±1.64 vs. 29.50±2.18 weeks; p=0.923) and birth weight (1378.18±275.55 g vs. 1226.67±271.27 g; p=0.187) were similar between groups. Small-for-gestational-age status was observed only in the NEC group (16.7%; p=0.083). Hematocrit levels were significantly higher in the NEC group (mean ± standard deviation: 52.44±7.38% vs. 46.11±5.97%; p=0.006). Baseline $rcSO_2$ was slightly higher and $rsSO_2$ was slightly lower in infants who developed NEC, but these differences were not statistically significant ($p>0.05$). SCOR values were comparable (median= 0.7). Time to reach full enteral feeding was significantly longer in the NEC group (30.5 vs. 18.5 days; p=0.001).

Conclusion: Baseline cerebral and splanchnic NIRS values within the first 48 hours of life did not predict the development of NEC. Elevated hematocrit levels may indicate early circulatory vulnerability by altering microcirculation. Continuous, trend-based NIRS monitoring, in combination with clinical and biochemical parameters, may improve the prediction of NEC.

Keywords: Necrotizing enterocolitis, infant, premature, spectroscopy, near-infrared, splanchnic circulation, intestinal ischemia, microcirculation

Introduction

Necrotizing enterocolitis (NEC) is one of the most devastating gastrointestinal emergencies in neonatal intensive care units (NICUs), predominantly affecting very low birth weight and preterm infants. Despite advances in neonatal care, the incidence of NEC remains between 5% and 10% among infants born before 32 weeks' gestation, with mortality rates rising to 30–50% in severe cases (1-3). Early detection of infants at risk is crucial, as clinical signs often appear only after irreversible intestinal injury has occurred.

The pathophysiology of NEC is multifactorial, including intestinal immaturity, dysbiosis, ischemia–reperfusion injury, and inflammatory responses (4,5). Among these, impaired mesenteric perfusion and oxygenation play central roles in triggering mucosal injury. Near-infrared spectroscopy (NIRS), a non-invasive tool for monitoring regional tissue oxygen saturation (rSO_2), provides real-time information on cerebral and mesenteric/splanchnic perfusion. Since its first clinical application by Jobsis in 1977, NIRS has been widely used in neonatal research to assess cerebral, renal, and intestinal oxygenation and has shown potential for identifying preterm infants at risk of hemodynamic instability and NEC (6-10).

Several studies have demonstrated that lower splanchnic oxygen saturation or a decreased splanchnic–cerebral oxygenation ratio (SCOR) precede NEC onset, reflecting intestinal hypoxia before clinical symptoms develop (7-12). However, findings remain inconsistent, likely

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due to methodological variability, measurement timing, and differences between NIRS devices (INVOS™ vs. NIRO™) (13,14). In particular, whether baseline splanchnic and cerebral oxygenation values obtained within the first two postnatal days can reliably predict NEC remains controversial. Some studies suggest that low regional splanchnic oxygen saturation ($rsSO_2$) or SCOR values in this period indicate vulnerability to intestinal ischemia, whereas others report no significant predictive association (7-12,15).

Given these uncertainties, further investigation of early NIRS measurements may clarify NIRS's role in NEC prediction and early risk stratification. Therefore, this study aimed to evaluate whether baseline splanchnic and cerebral tissue oxygenation values and their ratio (SCOR), measured within the first 24–48 hours of life using the INVOS 5100C system, were associated with the development of NEC in preterm infants.

Methods

Study Design and Setting

This prospective, single-center cohort study included preterm infants admitted to the tertiary-level NICU between September 2017 and August 2018. The primary objective was to assess whether baseline regional cerebral and splanchnic oxygen saturation levels, measured by NIRS during the first 24–48 hours of life, could predict the development of NEC in preterm infants. The study protocol was approved by the Local Ethics Committee of Harran University Faculty of Medicine (approval number: 08, date: 02.08.2018), and written informed consent was obtained from the parents of all participating infants.

Study Population

Preterm infants admitted to the NICU who were <34 weeks' gestation and/or had a birth weight <1250 g were screened for eligibility. Only those who were within their first 24–48 postnatal hours and who had not yet begun enteral feeding, other than minimal trophic feeds, were considered for inclusion. Newborns were excluded if they had major congenital malformations, chromosomal abnormalities, perinatal asphyxia, hydrops fetalis, grade ≥3 intraventricular hemorrhage (IVH), hemodynamic instability, congenital heart disease affecting systemic perfusion, or were receiving inotrope or caffeine therapy.

NEC was diagnosed and staged according to the modified Bell's criteria, which combine clinical manifestations with radiologic and laboratory findings (16). Stage I included infants who presented with non-specific gastrointestinal or systemic symptoms (such as increased gastric residuals, abdominal distension, or hematochezia) without confirmatory imaging. Stages II and III were categorized as definite or advanced NEC and required radiologic evidence of intestinal involvement (pneumatosis intestinalis, portal venous air, or free intraperitoneal gas), in addition to systemic compromise (acidosis, thrombocytopenia, coagulopathy, or shock) and more pronounced abdominal signs (erythema, tenderness, or a palpable mass).

Feeding intolerance was defined as isolated gastrointestinal symptoms such as increased gastric residuals, vomiting, or abdominal distension without accompanying systemic signs or radiologic findings suggestive of NEC.

In contrast, Bell stage I NEC was diagnosed when gastrointestinal findings were accompanied by systemic signs (such as temperature instability, apnea, or lethargy) consistent with modified Bell's criteria, even in the absence of definitive radiologic findings.

Infants initially classified as having feeding intolerance were closely monitored, and those who subsequently fulfilled Bell's staging criteria were reclassified into the NEC group.

Near-Infrared Spectroscopy Measurements

NIRS is a non-invasive bedside modality that enables continuous assessment of regional tissue oxygenation in organs such as the brain and gastrointestinal tract (6,9,10,17). The method relies on the differential absorption characteristics of oxygenated and deoxygenated hemoglobin when exposed to near-infrared light, allowing clinicians to estimate both oxygen delivery and extraction within the monitored tissue. A NIRS sensor contains a light source and two detectors positioned at different distances from the light source; the device calculates rSO_2 by determining the ratio of oxygenated hemoglobin to total hemoglobin. The derived rSO_2 signal primarily reflects venous blood (approximately 70–75%), with smaller contributions from arterial and capillary compartments (9,18).

NIRS Monitoring Protocol

In this study, cerebral and splanchnic oxygenation values were obtained using the INVOS™ 5100C Cerebral/Somatic Oximeter (Medtronic, Minneapolis, MN, USA), an FDA-approved device widely used in neonatal monitoring (14). The infrared light emitted by the system is considered safe for continuous neonatal use and does not result in skin or tissue injury.

Before sensor placement, the skin was gently cleansed and single-use neonatal electrodes were applied to two predefined anatomical regions:

- Frontal area → regional cerebral oxygen saturation ($rcSO_2$)
- Left paraumbilical abdomen → regional splanchnic oxygen saturation ($rsSO_2$)

Measurements were recorded continuously for 1 hour between 24 and 48 hours of age. For each infant, mean, minimum, and maximum values were calculated from the recorded data. The SCOR was computed as $rsSO_2/rcSO_2$.

During the measurement period, peripheral oxygen saturation (SpO_2) and heart rate were monitored using a Nellcor™ bedside SpO_2 system, and non-invasive blood pressure was measured with a Nihon Kohden BSM-3562 monitor. No changes in respiratory support or feeding practices were made during the NIRS recording period.

Clinical Data Collection

Demographic and perinatal variables, including gestational age, birth weight, sex, mode of delivery, small-for-gestational-age (SGA) status, and maternal comorbidities [preeclampsia, chorioamnionitis, placental pathology, and preterm premature rupture of membranes (PPROM)], were obtained from hospital records. Postnatal clinical data included Apgar scores, surfactant administration, ventilatory support (type and duration), umbilical venous catheterization (presence and

duration), hematocrit and lactate levels, history of packed red blood cell transfusion within the first 14 days, presence of hemodynamically significant patent ductus arteriosus (PDA), neonatal sepsis, IVH, timing of meconium passage, timing of initiation of minimal enteral feeding, time to reach enteral feeding volumes of 100 and 150 mL/kg/day, length of hospital stay, and survival status.

Clinical data were compared between the NEC and control groups to identify potential differences associated with NEC in clinical characteristics, risk factors, and baseline tissue oxygenation values.

Statistical Analysis

All statistical analyses were performed using IBM SPSS Statistics for Windows, version 22.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were expressed as mean ± standard deviation for normally distributed variables, and as median (minimum–maximum) for non-normally distributed variables. Categorical variables were presented as numbers (percentages). The Shapiro–Wilk test and graphical methods were used to assess the normality of the distribution.

For group comparisons, the Student's t-test was used for normally distributed variables, while the Mann–Whitney U test was applied for non-normally distributed variables. Pearson's chi-square test or Fisher's exact test were used for categorical data as appropriate. All tests were two-tailed, and a p value <0.05 was considered statistically significant.

A post-hoc power analysis was conducted using G*Power 3.1 (Heinrich-Heine University, Düsseldorf, Germany), based on the observed difference in hematocrit levels between the NEC and control groups. With α: 0.05 and sample sizes of 18 (NEC group) and 22 (control group), the calculated effect size (Cohen's d: 0.92) yielded a statistical power of 0.83 (83%). This indicates that the study had adequate power to detect large effect sizes in key clinical parameters.

Due to the lack of well-established effect size estimates for early baseline splanchnic NIRS measurements in preterm infants, a post-hoc power analysis based on the observed difference in hematocrit levels was performed. Therefore, the calculated power reflects the ability to detect differences in selected clinical parameters rather than in the primary NIRS-related outcomes.

Results

During the study period, 1,704 neonates were admitted to the NICU. Of these, 40 preterm infants who met the inclusion criteria were enrolled in the study. Group 1 (control group, n=22) included infants who had no gastrointestinal symptoms or who had feeding intolerance in the absence of radiologic or systemic signs of NEC. The remaining 18 infants with confirmed Stage I, Stage II, or Stage III NEC were assigned to Group 2 (NEC group). Clinical characteristics of infants with and without NEC are detailed in Table 1.

Demographic and Perinatal Characteristics

There were no statistically significant differences between the two groups with respect to gestational age (29.27±1.64 vs. 29.50±2.18 weeks; p=0.923), birth weight (1378.18±275.55 g vs. 1226.67±271.27 g; p=0.187), sex distribution, mode of delivery, or multiple gestations. Although all SGA infants were in the NEC group, this finding did not reach statistical significance (p=0.083). Regarding maternal characteristics, the rates of preeclampsia, chorioamnionitis, and placental disease were similar between groups. However, PPROM was significantly more common in controls than in the NEC group (27.3% vs. 0%; p=0.024). Demographic and perinatal characteristics are summarized in Table 1.

Postnatal Clinical Findings

Postnatal clinical findings are summarized in Table 2. There were no significant differences between the groups in surfactant use, in the duration or type of mechanical ventilation (invasive or non-invasive), or in umbilical venous catheterization. The incidences of hemodynamically significant PDA, IVH, and sepsis were also similar.

Hematocrit levels at birth were significantly higher in the NEC group compared with controls (52.44±7.38% vs. 46.11±5.97%; p=0.006), whereas lactate levels did not differ significantly between groups. Packed red blood cell transfusions within the first 14 days occurred more frequently in the NEC group (27.8% vs. 4.5%), although this difference was not statistically significant (p=0.073). The median time to initiation of minimal enteral feeding was similar between groups (2 days; p=0.063). However, the time to reach full enteral feeding (150 mL/kg/day) was significantly longer in infants with NEC (median: 30.5 vs. 18.5 days; p=0.001). The median duration of hospitalization tended to be longer in the NEC group (57.5 days vs. 47 days), although the difference was not statistically significant (p=0.248). Mortality was higher in the NEC group (11.1% vs. 4.5%), but this difference was not statistically significant (p=0.579).

Near-Infrared Spectroscopy Findings

Continuous cerebral and splanchnic NIRS monitoring was performed during the first 24–48 hours of life. In the NEC group, mean $rcSO_2$ values were calculable for 70–95% (mean 81%) of the one-hour recording period, and mean $rsSO_2$ values for 20–84% (mean 51%). In the control group, $rcSO_2$ values were available for 69–90% (mean 78.5%) and $rsSO_2$ values for 30–87% (mean 54.5%) of the measurement period.

The mean postnatal age at the time of measurement was 32.4±11.3 hours. Mean baseline $rcSO_2$ was slightly higher in the NEC group than in controls (81.83±7.99% vs. 78.55±6.60%; p=0.285), whereas mean baseline $rsSO_2$ was lower (50.11±16.80% vs. 55.60±15.41%; p=0.380). The median SCOR was 0.7 in both groups; however, the mean ratio was lower in the NEC group (0.61±0.18) than in controls (0.71±0.19), reflecting relatively impaired splanchnic oxygenation, although this difference did not reach statistical significance (p=0.143). Detailed NIRS parameters are presented in Table 3 and Figure 1.

Discussion

In this prospective study, we found no significant association between baseline splanchnic and cerebral NIRS values or their ratio (SCOR), measured during the first 24–48 hours of life, and the subsequent development of NEC. Infants who developed NEC had significantly higher hematocrit levels at birth; SGA status and a history of packed red blood cell transfusion within the first 14 days were more frequent

Table 1. Demographic and maternal characteristics of the study groups

Variable		Group 1 (control, n=22)	Group 2 (NEC, n=18)	p value
Gestational age (weeks)	Min–max (median)	27-32 (30)	27-35 (29.5)	0.923[a]
	Mean ± SD	29.27±1.64	29.50±2.18	
Birth weight (g)	Min–max (median)	980-2000 (1345)	640-1550 (1310)	0.187[a]
	Mean ± SD	1378.18±275.55	1226.67±271.27	
Gender, n (%)	Female	16 (72.7)	10 (55.6)	0.257[b]
	Male	6 (27.3)	8 (44.4)	
Mode of delivery, n (%)	Vaginal delivery	4 (18.2)	3 (16.7)	1.000[c]
	Cesarean section	18 (81.8)	15 (83.3)	
Multiple gestation, n (%)	No	12 (54.5)	13 (72.2)	0.251[b]
	Yes	10 (45.5)	5 (27.8)	
SGA, n (%)	No	22 (100)	15 (83.3)	0.083[c]
	Yes	0 (0)	3 (16.7)	
Apgar score, 1 minute	Min–max (median)	3-7 (5)	0-8 (5)	0.534[a]
	Mean ± SD	5.23±1.07	4.89±1.64	
Apgar score, 5 minute	Min–max (median)	6-8 (6.5)	5-9 (7)	0.839[a]
	Mean ± SD	6.64±0.73	6.67±1.08	
Placental pathology, n (%)	No	19 (86.4)	14 (77.8)	0.680[c]
	Yes	3 (13.6)	4 (22.2)	
Preeclampsia, n (%)	No	19 (86.4)	14 (77.8)	0.680[c]
	Yes	3 (13.6)	4 (22.2)	
PPROM, n (%)	No	16 (72.7)	18 (100)	0.024[c]*
	Yes	6 (27.3)	0 (0)	
Chorioamnionitis, n (%)	No	16 (72.7)	17 (94.4)	0.105[c]
	Yes	6 (27.3)	1 (5.6)	

[a]Mann-Whitney U test, [b]Pearson chi-square test, [c]Fisher's exact test
*p<0.05 considered statistically significant
SGA: Small-for-gestational-age, PPROM: Preterm premature rupture of membranes, Min–max: Minimum–maximum, SD: Standard deviation, NEC: Necrotizing enterocolitis

among these infants, although these differences did not reach statistical significance. Conversely, PPROM was significantly more common in the control group, suggesting that perinatal inflammation alone may not directly predispose to NEC in this cohort.

Since Jobsis first introduced NIRS in 1977, this non-invasive tool has been widely applied to evaluate regional perfusion in neonates, including the cerebral, renal, and splanchnic circulations (6). Several studies have demonstrated decreased intestinal perfusion in conditions such as perinatal asphyxia, symptomatic anemia, hemodynamically significant PDA, and NEC (7-12,17-19). However, results regarding its predictive value for NEC remain inconsistent.

Among INVOS-based studies, Patel et al. (7) reported that $rsSO_2$ ≤56% during the first week predicted NEC, whereas Palleri et al. (11) identified $rsSO_2$ <30% between days 2–6 as strongly predictive of NEC in extremely preterm infants. In contrast, Le Bouhellec et al. (12) and Gan et al. (15) found no consistent early differences in $rcSO_2$, $rsSO_2$, or SCOR within the first 72 hours, which parallels our findings. In Gan's (15) meta-analysis of 14 studies (n=938), pooled $rsSO_2$ values were approximately 12.5% lower in infants who developed NEC; there was moderate heterogeneity, and no significant differences in cerebral oxygenation were observed. These discrepancies likely reflect the physiological nadir of intestinal oxygenation during the first two postnatal days, when mesenteric blood flow is still adapting to extrauterine life and transient decreases in $rsSO_2$ may represent normal developmental changes rather than early ischemia.

Cortez et al. (9), using the same INVOS™ 5100C system as in our study, demonstrated that in infants <30 weeks' gestation, mean mesenteric $rsSO_2$ levels began to decrease significantly after the second postnatal day, with marked drops observed after postnatal day 3 in infants with feeding intolerance and after postnatal day 5 in those who developed NEC. These findings suggest that continuous or serial monitoring beyond the first 48 hours may be more informative for detecting evolving splanchnic hypoxia. In our study, we recorded one-hour continuous baseline measurements between 24 and 48 hours, offering more stable averages than the short 5-minute recordings used in some prior studies (7,10,19). However, no significant predictive thresholds emerged.

Previous studies have identified several risk factors associated with NEC, including low birth weight, SGA status, and high hematocrit levels; these factors may contribute to reduced mesenteric flow and microcirculatory impairment (20,21). Dani et al. (20) reported that SGA infants exhibited lower $rsSO_2$ values than appropriate-for-gestational-age peers regardless of feeding status, likely reflecting chronic intrauterine hypoperfusion.

Table 2. Postnatal clinical characteristics of the study groups

Variable		Control group (n=22)	NEC group (n=18)	p value
Surfactant therapy, n (%)	No	2 (9.1)	2 (11.1)	1.000[c]
	Yes	20 (90.9)	16 (88.9)	
Invasive ventilation, n (%)	No	11 (50.0)	5 (27.8)	0.154[b]
	Yes	11 (50.0)	13 (72.2)	
Duration of invasive ventilation (days)	Min–max (median)	1-18 (4)	2-13 (3)	0.768[a]
	Mean ± SD	6.00±5.93	5.00±3.70	
Non-invasive ventilation, n (%)	No	1 (4.5)	1 (5.6)	1.000[c]
	Yes	21 (95.5)	17 (94.4)	
Duration of non-invasive ventilation (days)	Min–max (median)	1-83 (8.5)	1-39 (16)	0.428[a]
	Mean ± SD	15.22±20.24	14.47±10.79	
Hemodynamically significant PDA, n (%)	No	14 (63.6)	8 (44.4)	0.225[b]
	Yes	8 (36.4)	10 (55.6)	
IVH, n (%)	No	15 (68.2)	13 (72.2)	0.781[b]
	Yes	7 (31.8)	5 (27.8)	
Sepsis, n (%)	No	4 (18.2)	0 (0)	0.114[c]
	Yes	18 (81.8)	18 (100)	
Umbilical venous catheter, n (%)	No	3 (13.6)	2 (11.1)	1.000[c]
	Yes	19 (86.4)	16 (88.9)	
Duration of umbilical venous catheter (days)	Min–max (median)	3-18 (9.5)	3-19 (13)	0.312[a]
	Mean ± SD	9.44±4.76	11.27±5.11	
Hematocrit at birth (%)	Min–max (median)	37-58.1 (45.5)	40.4-67.5 (53.5)	0.006[a]**
	Mean ± SD	46.11±5.97	52.44±7.38	
Lactate (mmoL/L)	Min–max (median)	1.5-9.1 (2.8)	1.3-17 (3)	0.549[a]
	Mean ± SD	3.47±1.94	4.73±4.19	
RBC transfusion within first 14 days, n (%)	No	21 (95.5)	13 (72.2)	0.073[c]
	Yes	1 (4.5)	5 (27.8)	
First meconium passage, n (%)	Within 24 h	11 (50.0)	10 (55.6)	0.726[b]
	After 24 h	11 (50.0)	8 (44.4)	
Time to minimal enteral feeding (days)	Min–max (median)	1-6 (2)	1-5 (2)	0.063[a]
	Mean ± SD	2.79±1.47	2.00±1.03	
Time to enteral feeding (100 mL/kg/day) (days)	Min–max (median)	7-31 (12)	12-47 (26.5)	0.001[a]**
	Mean ± SD	14.83±6.33	26.75±8.99	
Time to full enteral feeding (150 mL/kg/day) (days)	Min–max (median)	10-36 (18.5)	18-50 (30.5)	0.001[a]**
	Mean ± SD	19.67±7.04	32.25±9.29	
Length of hospital stay (days)	Min–max (median)	10-111 (47)	10-206 (57.5)	0.248[a]
	Mean ± SD	50.63±23.55	64.44±43.52	
Outcome, n (%) **Mortality, n (%)**	Survived	21 (95.5)	16 (88.9)	0.579[c]
	Died	1 (4.5)	2 (11.1)	

[a]Mann-Whitney U test, [b]Pearson chi-square test, [c]Fisher's exact test
**p<0.01 was considered statistically significant
PDA: Patent ductus arteriosus, IVH: Intraventricular hemorrhage, RBC: Red blood cell, Min–max: Minimum–maximum, SD: Standard deviation, NEC: Necrotizing enterocolitis

Similarly, in our cohort, SGA status and higher hematocrit levels were more frequent in the NEC group, although the differences did not reach statistical significance, supporting the hypothesis that increased blood viscosity and impaired oxygen delivery may contribute to intestinal ischemia in vulnerable preterm infants.

The significantly higher hematocrit levels observed in the NEC group deserve particular consideration when interpreting splanchnic NIRS measurements. Elevated hematocrit may influence regional oxygen saturation readings through two mechanisms: increased blood viscosity leading to true microcirculatory hypoperfusion, and increased optical density affecting near-infrared light absorption. Both mechanisms may artificially lower $rsSO_2$ values, and therefore represent potential confounders in the interpretation of NIRS-derived splanchnic oxygenation.

Table 3. Comparison of baseline NIRS measurements between groups

Variable		Group 1 (control, n=22)	Group 2 (NEC, n=18)	p value
Baseline cerebral $rcSO_2$	Min–max (median)	69-90 (78.5)	70-95 (81)	[a]0.285
	Mean ± SD	78.55±6.60	81.83±7.99	
Baseline splanchnic rSO_2	Min–max (median)	30-87 (54.5)	20-84 (51)	[a]0.380
	Mean ± SD	55.60±15.41	50.11±16.80	
Baseline splanchnic/cerebral oxygenation ratio (SCOR)	Min–max (median)	0.4-1 (0.7)	0.3-0.9 (0.7)	[a]0.143
	Mean ± SD	0.71±0.19	0.61±0.18	

[a]Mann-Whitney U test
NIRS: Near-infrared spectroscopy, Min–max: Minimum–maximum, SD: Standard deviation, $rcSO_2$: Regional cerebral oxygen saturation, rSO_2: Regional oxygen saturation

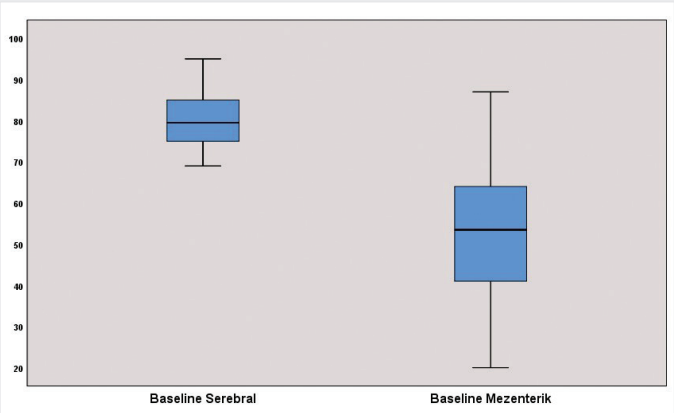

Figure 1. Distribution of baseline cerebral and baseline mesenteric NIRS measurements
NIRS: Near-infrared spectroscopy

Patel et al. (7) showed that preterm infants who later developed NEC had lower $rsSO_2$ both during the first 48 hours and throughout the first week of life. Their $rsSO_2$ levels were lowest on day 1 (73.8±1.8%) and increased by day 3 to 80.0±1.4% (7). In our cohort, the proportion of infants with $rsSO_2$ <56% was 61.1% in the NEC group and 50% in controls, suggesting a similar trend that was not statistically significant, possibly due to the small sample size and a narrower measurement window. Notably, Patel et al. (7) NEC infants had lower gestational ages and birth weights, whereas our groups were matched for both parameters; this matching may have reduced confounding related to maturity.

Schat et al. (19) demonstrated that differences between mesenteric and cerebral oxygenation (SCOR) were associated with intestinal perforation and mortality, highlighting the value of combined indices. Fortune et al. (8) reported lower SCOR ratios in NEC, and SCOR <0.75 showing the highest predictive accuracy for splanchnic ischemia. Although our mean SCOR values were numerically lower in the NEC group (0.61±0.18 vs. 0.71±0.19), this difference did not reach statistical significance, which likely reflects the very early timing of measurement—before the onset of substantial regional perfusion imbalance.

While some authors have reported that low baseline mesenteric oxygenation predicts NEC (8,22), others—consistent with our results—have found no clear predictive relationship, suggesting that static baseline measurements may be less informative than dynamic trends. Serial or continuous NIRS monitoring, rather than a single early measurement, may better capture the evolving hemodynamic changes preceding NEC onset (17).

Nutritional and circulatory factors also play critical roles in NEC pathogenesis. Inadequate fetal and early postnatal nutrition is associated with long-term adverse outcomes such as cardiovascular and metabolic diseases and neurodevelopmental impairment (1,4,5). Early initiation of enteral nutrition and balanced advancement of feeds reduce the risk of infection, catheter-related complications, and length of hospital stay (1,14). The prolonged time required to achieve full enteral feeding in infants with NEC should be interpreted as an outcome of the disease and its management, as enteral feeding is routinely interrupted during NEC episodes, rather than as a predictive or predisposing factor.

Study Limitations

This study has several limitations. The sample size was relatively small, and the study was conducted at a single center, which may limit generalizability and reduce statistical power to detect subtle differences. The one-hour baseline monitoring period, although longer than in some previous studies, may still have missed transient perfusion fluctuations. Additionally, hemodynamically unstable infants were excluded, potentially underrepresenting those at greatest risk for NEC. Device- and operator-related artifacts may also have influenced NIRS measurements.

An additional limitation was the relatively low signal availability of splanchnic NIRS measurements, with approximately 50% of the recording period yielding usable $rsSO_2$ data. This reflects known technical challenges of abdominal NIRS monitoring in preterm infants, including motion artifacts, bowel gas, and probe displacement, which may have affected the reliability of mean splanchnic oxygenation values.

Conclusion

Baseline splanchnic and cerebral tissue oxygenation values and SCOR ratios, measured during the first 24–48 hours of life using the INVOS™ 5100C system, did not predict the development of NEC in preterm infants. Although early static measurements appear insufficient for reliable risk prediction, combining continuous, trend-based NIRS monitoring with clinical indicators and biochemical markers may improve early identification of splanchnic hypoxia and guide preventive strategies. Future research should focus on continuous, trend-based monitoring and integration of NIRS data with clinical and biochemical markers to refine NEC risk prediction and improve neonatal outcomes.

Ethics

Ethics Committee Approval: The study protocol was approved by the Local Ethics Committee of Harran University Faculty of Medicine (approval number: 08, date: 02.08.2018).

Informed Consent: The written informed consent was obtained from the parents of all participating infants.

Footnotes

Authorship Contributions: Surgical and Medical Practices - M.B., Ö.İ.; Concept - M.B., Ö.İ.; Design - M.B., Ö.İ.; Data Collection or Processing - M.B., Ö.İ.; Analysis or Interpretation - M.B.; Literature Search - M.B.; Writing - M.B.

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