

## Yenidoğan Yoğun Bakım Ünitesinde Yeni Bir Yaklaşım: Hemşirelik Bakımında Yakın Kızılötesi Spektroskopisi (Near-Infrared Spectroscopy-NIRS) Kullanımı

### A New Approach in Neonatal Intensive Care Unit: Use Of Near-Infrared Spectroscopy (NIRS) in Nursing Care

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#### Özet

Yenidoğan yoğun bakım ünitelerinde (YYBÜ) hemşirelik bakım ve uygulamaları oldukça önemlidir. YYBÜ'lerinde bebekler özellikle ağrı ve strese çok sık maruz kalmaktadır. Ağrının sık tekrarması ve uzun süre olması yenidoğan bebeklerde ilerleyen dönemlerde nörolojik açıdan komplikasyonlar oluşturmaktadır. Ağrının hafifletilmesinde bebeklere sağlanacak bakım ve uygulamalar bu nedenle oldukça önemlidir. Ağrının belirtileri fizyolojik parametreler ile tespit edilip ölçekler ile düzeyi belirlenmektedir. Bu alanda yeni uygulamalardan biri NIRS (Near-Infrared Spectroscopy-NIRS/Yakın Kızılötesi Spektroskopisi) cihazıdır. NIRS, dokudaki oksijenli ve deoksijenli hemoglobinin (HbO<sub>2</sub> ve HbR) konsantrasyonlarını ölçmek ve beyin konsantrasyonlarındaki ince değişiklikleri tespit etmek için kullanılabilen noninvaziv bir tekniktir. NIRS; alın (serebral), karın (mezenter) ve alt sırt (böbrek) gibi vücudun farklı alanlarına probalar yerleştirilerek bölgesel doku oksijenasyonunu (rSO<sub>2</sub>) izler. NIRS, YYBÜ'sinde yatan preterm ve kritik hastalarda ağrı ile uyarılmış serebral aktivasyonu değerlendirme tekniği olarak kullanılabilir. Son zamanlarda NIRS kullanılarak hem term hem de preterm bebeklerde hem stresli hem de ağrılı uyaranlara yanıt olarak serebral hemodinamik değişikliklerin meydana geldiği gösterilmiştir. Ağrılı işlem (invaziv işlemler, toplu bakım vb.) esnasında dokularda kullanılan O<sub>2</sub> değişikliklerini belirlememizi sağlamaktadır. Ağrılı işlem esnasında kanguru bakımı, yuvalama kullanımı, pozisyon değişiklikleri gibi uygulamaların ağrıyı hafiflettiği ve beyin HbO<sub>2</sub> düzeyinde değişiklikler sağladığı belirlenmiştir. NIRS'ın koku, müzik, uyku ve doğumdan sonra oksijen tedavisine başlama gibi başka uygulamalarda da kullanıldığı görülmüştür. Yatak başında kullanılabilmesi ve invaziv olmayan bir işlem olması sebebi ile kullanım kolaylığı sağlamaktadır. NIRS cihazı birçok hemşirelik bakımı ve uygulamaların etkinliğinde kullanılacak bir cihaz olmasından dolayı dikkat çekici bir konumdadır. Son yıllarda NIRS teknolojisi ile dokuların oksijen tüketiminin ölçümü yenidoğan merkezlerinde giderek yaygınlaşmaktadır. YYBÜ'nde çalışan hemşirelerin NIRS cihazını kullanması ve yorumlanmasını öğrenmesi ve hemşirelik çalışmalarına ihtiyaç vardır.

**Anahtar kelimeler:** hemşire, NIRS, yenidoğan yoğun bakım ünitesi

#### Abstract

Nursing care and implementations are very important in neonatal intensive care units (NICU). In NICUs, infants are frequently exposed to pain and stress. Frequent recurrence and prolonged pain may cause neurologic complications in newborn infants. Therefore, nursing the care and implementations to be provided to the babies in relieving the pain are very important. Symptoms of pain are determined by physiological parameters and their level is determined by scales. One of the new applications in this field is the NIRS device (Near-Infrared

Spectroscopy). NIRS is a noninvasive technique that can be used to measure concentrations of oxygenated and deoxygenated hemoglobin (HbO<sub>2</sub> and HbR) in tissue and to detect subtle changes in brain concentrations. NIRS; It monitors regional tissue oxygenation (rSO<sub>2</sub>) by placing probes in different areas of the body such as forehead (cerebral), abdomen (mesentery) and lower back (kidney). NIRS, can be used as a technique to evaluate pain-induced cerebral activation in preterm and critical patients hospitalized in the NICU. Recently, using NIRS, it has been shown that cerebral hemodynamic changes occur in response to both stressful and painful stimuli in both term and preterm infants. It allows us to identify O<sub>2</sub> changes in tissues used during painful process (invasive procedures, collective care, etc.). It has been determined that kangaroo care, nesting, position changes during painful process relieved pain and caused changes in brain HbO<sub>2</sub> level. NIRS has been found to be used in other applications, such as smell, music, sleep, and starting oxygen therapy after birth. It provides ease of use as it can be used at the bedside and is a non-invasive process. NIRS device is a device that can be used in the effectiveness of many nursing care and applications is in a remarkable position. In recent years, the measurement of oxygen consumption of tissues with NIRS technology has become increasingly common in neonatal centers. There is a need for nurses working in the NICU to learn how to use and interpret the NIRS device and nursing studies.

**words:** neonatal intensive care unit, NIRS, nurse

## Introduction

Neonatal intensive care units (NICU) are areas where premature and term infants are followed with unstable, continuous nursing care and invasive procedures with medical and surgical problems (1,2). Preterm infants hospitalized in the NICU are exposed to many painful applications and procedures. Since pain has many negative effects especially in neurological aspects, it is very important to notice and comfort the infant in a short time. Frequent and recurrent painful procedures have negative effects in the long term (3,4,5). Pain in newborns is determined by changes in vital signs (SpO<sub>2</sub>, heart rate, respiratory rate) and pain scales. Methods for measuring oxygenation include SpO<sub>2</sub> measurement with pulse oximetry, PaO<sub>2</sub> measurement in blood gas, demonstration of oxygen dissociation curve on arterial and venous sides, and measurement of O<sub>2</sub> consumption in tissue by NIRS (Near-Infrared Spectroscopy) (6). The NIRS device has recently been used in the field of nursing. When the literature is examined, it is seen that the studies are inadequate and not examined in all aspects. This device is similar to monitors, since it is easy to use at the bedside, it does not cause pain and stress in infants. With these devices, it is possible to detect the painful situation and determine the applications that will provide relief to the infants. It is thought that NIRS device will be very useful in determining nursing care and applications in premature infants who constitute high risk patient group in NICU.

Using NIRS (Near-Infrared Spectroscopy)

NIRS is a noninvasive technique that can be used to measure concentrations of oxygenated and deoxygenated hemoglobin (HbO<sub>2</sub> and HbR) in tissue and to detect subtle changes in brain concentrations (7,8,9,10). It is based on the principle that light from 700 nm to 1000 nm can penetrate up to 8 cm of skin and brain tissue (10, 11,12,13). NIRS; It monitors regional tissue oxygenation (rSO<sub>2</sub>) by placing probes in different areas of the body such as forehead (cerebral), abdomen (mesentery) and lower back (kidney). Each probe consists of a light source and 2 photodetectors to measure tissue oxygen levels at different tissue depths (14).

Pulse oximetry alone is insufficient to detect hypoxia at tissue level because only arterial oxygen saturation is measured by pulse oximetry, it does not indicate whether sufficient blood flow or oxygen delivery in a particular tissue actually occurs (15). NIRS cihazının önemi, mevcut yöntemlerle rutin olarak tanımlanamayan doku oksijen alımındaki farklılıkları tespit



edebilmesidir (14). NIRS is needed to see how much O<sub>2</sub> the tissue consumes. The NIRS device shows venous saturation by weight and O<sub>2</sub> saturation from tissue (6). NIRS measures the difference between oxyhemoglobin and deoxyhemoglobin, which reflects oxygen uptake in the tissue. This measurement is reported as regional oxygen saturation (rSO<sub>2</sub>). NIRS shows Hb-O<sub>2</sub> saturation in tissues, especially in the venous compartment (0-100%). NIRS reflects arterial (25%), capillary (5%) and venous (70%) O<sub>2</sub> saturation. The tissue O<sub>2</sub> value indicated by NIRS ranges from 55% to 85%. The difference between arterial (pulse oximetry-SpO<sub>2</sub>) and venous (NIRS) indicates the oxygen consumed by tissues (6,10,15). NIRS can show whether there is sufficient oxygenation in the local tissues of a preterm infant (eg brain) and how much this oxygen can be consumed (6,12,14).

One application of NIRS is to investigate hemodynamic responses to brain activation. Since NIRS can be applied to bedside measurements, it is an attractive method for monitoring infants, being safe, portable and quiet (8). In recent years, the measurement of oxygen consumption of tissues by NIRS technology has become increasingly widespread in NICU. The NIRS used in the NICU allows continuous measurement of tissue oxygenation reflecting the perfusion status and allows healthcare professionals to monitor fluctuations directly in real time (14). Since this technique does not require much physical restriction, it is especially suitable for the study of preterm and term infants (16). NIRS has attracted attention in neonatology because it can simultaneously detect differences in regional tissue oxygen uptake in different organ tissue beds. There are many ways to use NIRS in neonatology. NIRS provides continuous tissue oxygenation monitoring that allows the assessment of perfusion status, with the ability to monitor noninvasively at the bedside without interrupting routine care (14).

#### Pain and NIRS Using

Pain in infants especially in premature infants, it is one of the most common experiences due to trauma, disease or various medical interventions (17). It is almost inevitable that infants hospitalized in the NICU are exposed to painful procedures and stress. Infants are faced with numerous painful interventions such as blood collection and vaccination from birth (18,19,20). Long-term or frequent pain experience has many negative effects such as the development of brain and senses and affect growth on newborns in short and long term (3,4,5,18,20,28,29). If pain is not alleviated or eliminated by effective interventions, it may cause neurological and behavioral disorders over time (30,31,32).

Preterm infants are sensitive to pain and stress (21). Premature and term infants do not have verbal expressions and this makes it difficult to evaluate pain (13,22,23,24,25). Infants show pain with behavioral, physiological, hormonal and metabolic changes (17,26). Behavioral changes include crying, facial expressions, motor movements, and behavior changes. Physiological changes are changes in heart rate, respiratory rate, blood pressure and blood oxygen and carbon dioxide levels (13,27). It is more desirable for healthcare workers to monitor pain in a similar way to vital signs such as heart rate or oxygen saturation in newborn infants who are unable to express verbally pain. NIRS may be a method in this field and can be applied in clinical care (13).

Recently, it has been shown that cerebral hemodynamic changes (possibly due to cortical activation) occur in response to stressful or painful stimuli in both term and preterm infants using NIRS (7,19). It is recommended to use cerebral NIRS technique as an approach that evaluates brain activity in response to pain (35). Non-invasive monitoring techniques, such as NIRS, not only detect pain perception and related cortical sites involved in this experience, but may also provide the most accurate or sensitive observational pain indicators to be identified in certain situations (36,37).

When the literature is examined, it is seen that O<sub>2</sub> changes during painful procedure, especially O<sub>2</sub> changes in brain tissue, can be detected by NIRS device. Bartocci et al. (2006) and Slater et al. (2006) found that NIRS increased the HbO<sub>2</sub> on the contralateral somatosensor cortex after

blood was drawn in a study of tactile and painful stimuli in premature infants (19,33). In a study conducted by Ozawa et al. (2010) to determine whether the previous blood collection experience changed the correlation between prefrontal cortical pain responses and Premature Infant Pain Profile (PIPP) scores when compared with infants without blood collection experience, the NIRS device was included in the measurement instruments used. (38). Orlandi et al (2011), in the study conducted to evaluate the discomfort caused by the decrease in blood oxygenation during crying of preterm infants, NIRS device was used and the recovery period after term crying was found to be more stable and faster than preterm infants (39). Gerull et al (2013), in preterm infants after heel removal procedure to compare the effect of three different non-pharmacological interventions on cortical activation, heart rate and peripheral oxygen saturation (SaO<sub>2</sub>) somatosensory cortex measured by NIRS was analyzed (40).

Decreasing the pain level with the care provided to the infants during the painful procedure are important applications in nursing care. Kangaroo care is the most common practice in this area. Olsson et al. (2016) found that kangaroo care during premature infants to evaluate the relief of pain measured by NIRS was found to be significant increase in oxygenated hemoglobin on the contralateral side of the infants receiving kangaroo care during blood collection and kangaroo care was found to alleviate pain (13).

#### NIRS and other implementations

With the NIRS device, O<sub>2</sub> changes were investigated in other approaches such as smell, sleep, music and oxygen delivery after birth. Bartocci et al (2001) in the study, the use of NIRS monitoring of hemoglobin changes, showed that newborns can be used to evaluate the odor response to colostrum and vanilla (34). Kotilahti et al (2009) used the NIRS device to examine speech and music responses in the auditory cortex of the term newborn during natural sleep (8). Aoyama et al. (2010) used the NIRS device to examine the differences in oxygenation of brain blood flow in breast milk and formula milk. It was found that newborns could distinguish the scents of breast milk from formula milk (41). Taskin et al. (2014) found that the use of cerebral oximetry in the delivery room could be detected more quickly and accurately by using oxygen and thus avoiding unnecessary oxygen use and possible risks (42).

#### Conclusion

The use of NIRS in nursing practice is a new approach. The number of studies conducted in our country is very low, especially in the field of nursing. It provides ease of use with its advantages such as bedside use, very similar to the use of pulse oximetry device, and being non-invasive. Tissue O<sub>2</sub> level with nursing care can be beneficial. Nursing care is especially important in pain procedures. Position change, kangaroo care, use of nesting, use of crib, providing the smell of breast milk, lullaby resting applications such as pain has been found to be beneficial. Increasing the number of NIRS devices in the NICUs will allow O<sub>2</sub> levels to be observed in more infants and studies for nursing applications will be made. Because of these reasons, it is very important for the nurses to know the use and interpretation of NIRS and use it in the field.

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