IMPORTANCE OF NIRS MONITORING FOR THE OPTIMIZATION OF INTENSIVE CARE IN THE POSTOPERATIVE PERIOD FOR CYANOTIC CONGENITAL HEART DEFECTS IN CHILDREN

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ABSTRACT

In children with cyanotic congenital heart defects, the period after cardiac surgery is considered a high-risk stage. During this period, latent hypoperfusion and tissue hypoxia can develop in the brain, kidneys and other vital organs. Traditional monitoring methods (arterial blood pressure, pulse oximetry, central venous pressure) do not provide complete information about the oxygen supply at the organ level. In recent years, it has become possible to continuously and non-invasively monitor regional tissue oxygenation using Near Infrared Spectroscopy (NIRS) technology. This study analyzes the clinical role of NIRS monitoring in pediatric cardiac surgery, its role in improving the effectiveness of intensive care and the prospects for its implementation in Uzbekistan.

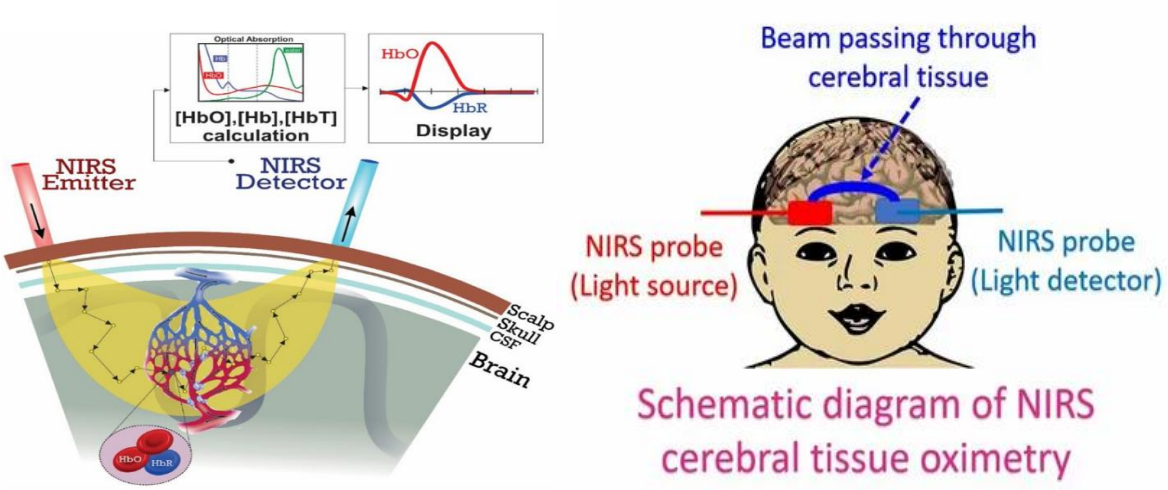
Introduction. Congenital heart defects are among the most common congenital pathologies among children. About 20–25% of them belong to cyanotic forms. In these cases, hypoxia develops in the brain and other organs as a result of a chronic decrease in the level of oxygen in the arterial blood. Even after surgical correction, the risk of developing hemodynamic instability, low cardiac output syndrome (LCOS) (Low Cardiac Output Syndrome) and neurological complications, renal dysfunction and multi-organ failure remains.

NIRS technology allows for real-time assessment of regional oxygen saturation by determining the ratio of oxyhemoglobin to deoxyhemoglobin in tissues. This method allows, in an intensive care unit, to determine the deterioration in the patient's condition before the appearance of clinical signs.

Purpose of the study. Analysis of clinical and economic advantages of NIRS monitoring in improving the effectiveness of intensive postoperative intensive care in children with cyanotic congenital heart defects on the basis of international experience and evaluation of prospects for its implementation in the practice of Uzbekistan.

Materials and Methods. This work was carried out on the basis of a literature review. Scientific articles related to NIRS monitoring were searched and analyzed from the PubMed, Scopus, and Web of Science databases. Based on the analysis, international scientific articles on pediatric cardiac surgery published during 2015–2025 were included. The data obtained were qualitatively summarized and the clinical significance of NIRS monitoring and prospects for implementation in the practice of Uzbekistan were assessed.

The principle of operation of NIRS technology. The NIRS device measures the absorption of light passing through biological tissues using infrared rays in the range of 700–1000 nm. Because oxyhemoglobin and deoxyhemoglobin absorb infrared light differently, the device calculates regional oxygen saturation (rSO_2).



Literature review.

1.An analysis by Zaleski and Kussman (2020) shows that NIRS is one of the most commonly used tissue oxygenation monitoring methods in pediatric cardiac surgery. The authors stated that changes in oxygen delivery in brain and somatic tissues can be detected early using NIRS (Zaleski KL, Kussman BD, 2020).

2.Wong and co-authors (2018) found significant improvements in cerebral and somatic oxygenation rates after surgery in children with cyanotic heart defects. According to the study, NIRS can be used as an additional marker in assessing surgical outcomes (Wong, JJM et al., 2018).

3.A systematic review by Hirsch et al. showed that NIRS monitoring may help reduce the risk of neurological injury, but noted that there is a need for large, randomized studies (Hirsch JC et al., 2009).

I4.liopoulos et al. (2025) have shown that NIRS indicators are associated with perfusion markers and adverse outcomes. The authors stated that NIRS is an important monitoring tool in intensive care (Iliopoulos I et al., 2025).

According to the results of the international literature review:

1.Decreased brain oxygenation is associated with an increased risk of developing neurological complications after surgery.

2.With NIRS monitoring, tissue perfusion disorders and low cardiac output syndrome can be detected before clinical signs appear.

3.Based on NIRS indicators, the possibility of individualization of infusion, vasopressor, and inotropic therapy increases.

4.The use of NIRS monitoring improves the quality of dynamic patient assessment in the intensive care unit.

5.Centers that used NIRS monitoring had a higher chance of early detection of postoperative complications, according to international studies.

6.NIRS technology is being evaluated as an important component of modern multimodal monitoring in pediatric cardiac surgery.

Discussion. As pediatric cardiac surgery and cardiac anesthesiology continue to develop in Uzbekistan, the introduction of modern monitoring techniques into intensive care has become increasingly important. At present, NIRS monitoring is not widely available in most pediatric cardiac surgery centers in our country, and there are limited opportunities to detect disorders of perfusion of cerebral and somatic organs before the development of clinical signs. The analysis of international experience shows that with the help of NIRS monitoring it is possible to continuously monitor tissue oxygenation, detect hypoperfusion and hypoxia at an early stage, as well as optimize intensive therapy tactics in a timely manner. In this context, the gradual implementation of NIRS monitoring in the practice of pediatric cardiac surgery in Uzbekistan is a clinically promising and scientifically grounded direction.

Scientific novelty

1.For the first time, a systematic analysis of the clinical significance of NIRS monitoring in the practice of pediatric cardiac surgery in Uzbekistan was conducted based on modern international scientific literature.

2.The importance of NIRS monitoring in improving the effectiveness of postoperative intensive care in children with cyanotic congenital heart defects was summarized.

3.The clinical advantages and prospects of implementing NIRS monitoring in local practice were scientifically substantiated.

4.Potential directions for implementing NIRS monitoring in pediatric cardiac surgery practice in Uzbekistan were identified based on international scientific evidence.

Conclusion

1.NIRS (Near-Infrared Spectroscopy) monitoring is a modern, non-invasive monitoring method that allows for a continuous assessment of brain and somatic organ oxygenation in the postoperative period in children with cyanotic congenital heart defects.

2.The results of international studies demonstrate the importance of NIRS monitoring in the early detection of tissue hypoperfusion and hypoxia, the assessment of low cardiac output syndrome, and the effectiveness of intensive care.

3.The use of NIRS monitoring allows for individualization of intensive care tactics, optimization of hemodynamic support, and effective control of patient status.

4.The introduction of NIRS technology in practice can facilitate the early detection of postoperative complications, improve the quality of intensive care, and improve treatment outcomes.

5.Based on these findings, it is advisable to gradually introduce NIRS monitoring into the practice of pediatric cardiac surgery centers and intensive care units in Uzbekistan.

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