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ЖУРНАЛ ГЕПАТО-ГАСТРОЭНТЕРОЛОГИЧЕСКИХ ИССЛЕДОВАНИЙ

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OPTIMIZING THE DIAGNOSIS AND TREATMENT OF NEONATAL JAUNDICE

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ANNOTATION

Although the etiology and pathogenesis of pathological jaundice in newborns have been studied for many years, and modern principles for preventing bilirubin encephalopathy were developed over half a century ago, differential diagnosis and selection of optimal treatment methods for neonatal jaundice continue to pose challenges even for experienced neonatologists and pediatricians. The aim of this study was to monitor bilirubin levels in newborns using noninvasive methods for the timely detection of these conditions. Materials and methods. We observed 48 full-term newborns from the Neonatal Pathology Department of the Regional Children's Multidisciplinary Hospital who had hyperbilirubinemia for more than 3-4 weeks. To assess bilirubin levels in newborns, we used transcutaneous bilirubinometry, using a special device – a transcutaneous bilirubinometer. Measurements were taken at three different points on the infant's body: the forehead, the upper chest, and the inner leg. In parallel with transcutaneous measurements, a third of the newborns examined (16 infants) underwent bilirubin testing by determining the total bilirubin concentration in the serum using a biochemical assay.

Key words: jaundice, newborns, hyperbilirubinemia, transcutaneous bilirubinometry.

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ОПТИМИЗАЦИЯ ДИАГНОСТИКИ И ЛЕЧЕНИЯ НЕОНАТАЛЬНЫХ ЖЕЛТУХ

АННОТАЦИЯ

Несмотря на то, что этиология и патогенез патологических желтух у новорожденных изучались на протяжении многих лет, а современные принципы предупреждения билирубиновой энцефалопатии были разработаны более полувека назад, дифференциальная диагностика и выбор оптимальных методов терапии неонатальных желтух по-прежнему вызывают трудности дажеу опытных неонатологов и педиатров. Целью работы было проведение мониторинга уровня билирубина у новорожденных при помощи неинвазивных методов исследования для своевременного выявления состояний. Материалы и методы исследования. Нами наблюдались 48 доношенных новорожденных из отделения патологии новорожденных Областной детской многопрофильной больницы, у которых гипербилирубинемия сохранялась более 3-4 недель. Для оценки уровня билирубина у новорожденных мы использовали транскутанную билирубинометрию, применяя специальный прибор – транскутанный билирубинометр. Измерения осуществлялись в трех различных точках на теле младенца: на лобной области, в верхней части грудной клетки и на внутренней стороне голени. Параллельно с транскутанными измерениями, у трети обследованных новорожденных (16 младенцев) проводилась проверка уровня билирубина путем определения концентрации общего билирубина в сыворотке крови посредством биохимического анализа.

Ключевые слова: желтуха, новорожденные, гипербилирубинемия, транскутанная билирубинометрия.

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CHAQALOQLAR SARIQLIGINI DIAGNOSTIKA VA DAVOLASHNI OPTIMALLASHTIRISH

ANNOTATSIYA

Yangi tug'ilgan chaqaloqlarda patologik sariqlikning etiologiyasi va patogenezi ko'p yillar davomida o'rganilgan, bilirubin ensefalopatiyasining oldini olishning zamonaviy tamoyillari yarim asr oldin ishlab chiqilgan bo'lsa-da, neonatal sariqlikni differentsial diagnostika qilish va optimal davolash usullarini tanlash tajribali neonatologlar va pediatrlar uchun ham qiyinchiliklarni keltirib chiqarmoqda. Ushbu tadqiqotning maqsadi yangi tug'ilgan chaqaloqlarda bu holatlarni o'z vaqtida aniqlash uchun noinvaziv usullardan foydalangan holda bilirubin darajasini aniqlash edi. Materiallar va usullar. Viloyat bolalar ko‘p tarmoqli shifoxonasining neonatal bo‘limida 3-4 haftadan ortiq giperbilirubinemiya bilan og‘rigan 48 nafar to‘liq muddatli yangi tug‘ilgan chaqaloqni kuzatdik. Yangi tug'ilgan chaqaloqlarda bilirubin darajasini baholash uchun biz maxsus qurilma - transkutan bilirubinometr yordamida transkutan bilirubinometriyadan foydalandik. O'lchovlar chaqaloq tanasining uch xil nuqtasida amalga oshirildi: peshona, ko'krakning yuqori qismi va oyog'ining ichki qismi. Transkutan o'lchovlarga parallel ravishda, tekshirilgan yangi tug'ilgan

chaqaloqlarning uchdan bir qismi (16 chaqaloq) biokimyoviy tahlil yordamida umumiy bilirubin kontsentratsiyasini aniqlash orqali bilirubin testi o'tkazildi.

Kalit so'zlar: sariqlik, yangi tug'ilgan chaqaloqlar, giperbilirubinemiya, transkutan bilirubinometriya.

Despite extensive research, the problem of neonatal hyperbilirubinemia remains relevant and urgent. Neonatal jaundice develops in 60% of full-term infants. Almost all newborns experience a temporary increase in serum bilirubin levels after birth. In most cases, jaundice appears within the first three days of life, progresses normally, and is considered a physiological condition, as it is often caused by developmental and metabolic factors during this period [1,4].

Epidemiologically, over the past five years, there has been an increase in the incidence of hyperbilirubinemia in both premature and full-term infants. In approximately half of cases, the cause of hyperbilirubinemia is unclear—known risk factors (Rhesus incompatibility, infectious diseases, occult bleeding, anemia, or polycythemia) are absent [3,12]. However, the role of hyperbilirubinemia in damage to the central nervous system in newborns, particularly the auditory system and subcortical nuclei of the brain, has been reliably established. This makes it possible to carefully and repeatedly monitor bilirubin levels throughout the day in the first days of a child's life [6,7].

A generally accepted objective monitoring method involves measuring the total bilirubin concentration in plasma or serum by direct photometry or biochemical analysis. Frequent blood sampling from newborns, especially premature infants, is technically challenging and can cause hemodynamic instability, vascular spasms, decreased oxygen levels, and can lead to painful shock and infection [2,15]. Given the difficulties of blood collection and the risk of infection in newborns, laboratory bilirubin analysis is typically performed selectively for at-risk individuals [11,14].

Neonatology, more than any other field of medicine, requires atraumatic and highly accurate methods. Therefore, the development and implementation of noninvasive bilirubin analysis methods is crucial. It should be noted, however, that the practice of noninvasive bilirubin assessment is not entirely new [1,5]. An experienced physician can assess the presence and degree of hyperbilirubinemia by observing the yellowing of the skin. However, this assessment is highly subjective: in addition to personal experience, the perception of a child's skin color is influenced by the type of lighting and the presence of skin tones caused by various clinical factors, necessitating laboratory testing [10,13].

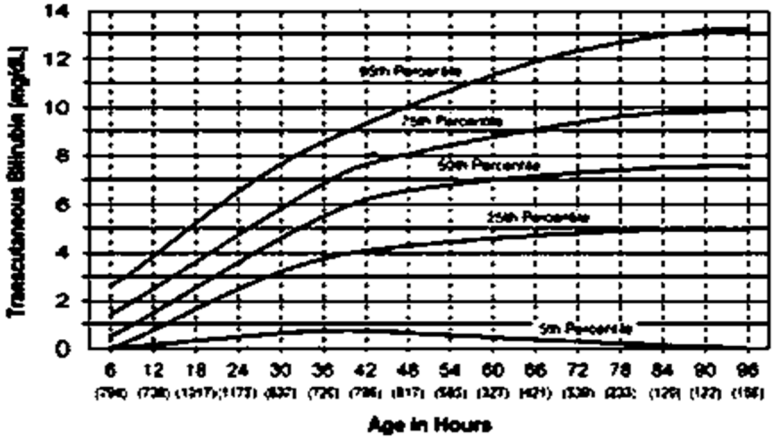
Transcutaneous bilirubinography is based on the phenomenon of reverse diffusion of bilirubin from the blood into the surrounding tissue (dermis) [9,12]. An increase in bilirubin concentration in the blood leads to an increase in bilirubin concentration in the dermis, and conversely, a decrease in bilirubin concentration in the blood (for example, during a blood transfusion) leads to a reverse movement of bilirubin from the dermis into the blood until equilibrium is reached between these two systems. Because bilirubin is a distinct yellow color, skin color varies depending on the bilirubin content in the dermis. Bilirubin's yellow color is due to its absorption band in the blue region of the spectrum, peaking at 460 nm [3,8].

The aim of the study was to monitor bilirubin levels in newborns using non-invasive research methods for the timely detection of conditions that require additional interventions.

Material and methods of research. We observed 48 full-term newborns from the neonatal pathology department of the Regional Children's Multidisciplinary Hospital, in whom hyperbilirubinemia persisted for more than 3-4 weeks. All children received phototherapy around the clock, with feeding intervals of 2-5 days. A bilirubin concentration greater than 250 μmol/L was the indication for phototherapy. The criterion for discontinuing phototherapy was a decrease in the blood level of indirect bilirubin below the level that crosses the blood-brain barrier. Bilirubin was monitored daily, and a complete blood count was performed upon admission to and discharge from the hospital.

We used transcutaneous bilirubinometry using a transcutaneous bilirubinometer for newborns. Measurements were taken at three sites: the forehead, the upper sternum, and the inner surface of the shin. Simultaneously with transcutaneous bilirubinometry, bilirubin levels were monitored in one-third of the newborns (16 newborns) by measuring the total bilirubin concentration in the serum using a biochemical analysis.

A study of bilirubin metabolism using the device, measuring bilirubin concentration in the blood in parallel with the transcutaneous bilirubin index (TBI), revealed an increase in total bilirubin due to the indirect fraction, averaging over 200-300 μmol/L. With adequate therapy, the duration of jaundice syndrome did not exceed two weeks. The small, hand-held, self-powered device is simple and easy to use and is used directly by neonatal staff. This allows for more rapid and frequent bilirubin testing in newborns without the need for laboratory services. The device determines bilirubin concentration in the dermis using direct photometry. It provides information on the total bilirubin concentration in the baby's subcutaneous tissues in units of the transcutaneous bilirubin index (TBI), the values of which are highly correlated with the bilirubin concentration in the blood.



The device is calibrated so that when measured on the newborn's forehead, the total bilirubin concentration in the serum (plasma) (in micromoles per 1 L) approximately corresponds to the TBI value multiplied by 10. The transcutaneous bilirubin measurement technique using device is very simple and consists of placing the end of the device's movable light guide on the selected area of the skin surface and gently pressing it until a beep is heard, lasting 1-3 seconds. The end of the beep indicates the completion of the measurement, the display of the result on the light panel, and the device's readiness for repeat measurements. If a repeat measurement is not performed, then 45-60 s after the indication of the result of the last measurement, the device automatically switches to the standby mode for the next measurement,

in which it remains constantly, without requiring switching on or off during the entire period of its operation.

For prompt control of the correct functioning, the device is specially equipped with two control measures. There are a number of advantages of using a non-invasive method of measuring bilirubin, in comparison with the invasive method, these are the ability to avoid injury, infection, blood loss, development of anemia; a fully automated measurement process, the device does not require calibration and is always ready for work, which does not require preliminary preparation; the optical scheme of the device with simultaneous measurement at wavelengths of 492 and 523 nm allows to compensate for the effect of skin hemoglobin on the device readings; the duration of the measuring cycle does not exceed 1-3 seconds; the measuring cycle starts automatically when you press the movable head of the device towards the child; repeated measurements are possible every 5 seconds without the need to erase the result of the previous measurement; The device does not require switching on and off; it is constantly in standby mode for measurements with minimal power consumption.

Research results. All infants admitted to hospital were 10.2 ± 0.5 days old and were discharged at 24 ± 0.95 days. During the examination, parenchymal and mechanical jaundice were excluded. Of all the newborns examined, 58% were boys and 42% were girls. Jaundice was observed within the first week of life in 46% of infants (22), while it occurred after 7 days in 54% (26). Concomitant diseases were diagnosed in 33% of infants (16), while isolated jaundice syndrome occurred in 67% (32). Among all the newborns examined, the condition of 29 infants at birth was assessed as satisfactory, 16 as moderate, and 3 children were transferred from the intensive care unit.

The highest risk of developing jaundice was found in mothers with a history of gestosis (54.4%), endocrine pathology such as hyper- or hypothyroidism (43.1%), and blood type O (58.3%). Less significant (risk < 50%) were the baby's gender, low Apgar score, high bilirubin levels in cord blood, maternal hypertension, and low birth weight. Complications during childbirth occurred in 12% of cases. These included primary weakness of labor, drug-induced labor, including oxytocin stimulation, tight umbilical cord entanglement, and forceps.

Total bilirubin and its fractions were significantly elevated upon admission. During treatment, bilirubin levels decreased at varying rates. The rate of bilirubin decline in children was 25 μmol/L or more per day. This rate of bilirubin decline allowed phototherapy to be discontinued in all children within 48–56 hours of its initiation. Phototherapy is now often combined with infusion therapy. The indication for its use is when the child is not receiving the required daily fluid intake, including through nutrition. Adverse effects of phototherapy may include: erythematous rash, development of "bronze baby" syndrome, dehydration, and hyperthermia.

Serum bilirubin levels in newborns (M ± m)

Indicator	Results
On admission: direct bilirubin, μmol/L indirect bilirubin, μmol/L	 7,6 ± 0,3 278,0 ± 17
One day after phototherapy: direct bilirubin, μmol/L indirect bilirubin, μmol/L	 6,2 ± 0,5 257,0 ± 8,6
After 2 days: direct bilirubin, μmol/L indirect bilirubin, μmol/L	 5,8 ± 0,4 221,0 ± 8,8
Ten days after completion of phototherapy: indirect bilirubin, μmol/L	 63,2 ± 4,5

All newborns examined received combination therapy aimed at reducing bilirubin levels. A separate group of newborns (44%) received Cholosas daily in age-appropriate doses alongside the main therapy. The rationale for this medication's use is its drainage, choleretic, and antioxidant effects, which contribute to the resolution of jaundice and a reduction in indirect bilirubin levels in these conditions 1-2 weeks earlier than in the main group (56%). Cholosas (120 ml oral solution) was administered 0.3-0.5 ml (5-10 drops) orally three times daily before feeding.

An analysis of the presented data revealed that the correlation coefficient between blood bilirubin concentration and the TBI value measured on the forehead was 0.87, 0.74 for measurements on the upper sternum, and 0.48 for measurements on the inner surface of the lower leg. It should be noted that the examinations revealed no influence of various factors (hematocrit, body weight, day of life, and gestational age) on individual TBI variations. At the same time, measuring the TBI in different areas of the body allows one to assess the dynamics of jaundice, that is, its increase or decrease during therapy. The study determined that the TBI on the forehead most closely corresponds to the bilirubin concentration in the blood. The maximum TBI value on the upper sternum and lower leg appears later than the peak value in the blood.

This indicates that skin staining in these areas occurs more slowly than on the forehead, just as the skin clears bilirubin more slowly. By measuring the TBI at these points daily, one can assess not only the severity but also the prevalence of jaundice. Thus, the greatest correlation between the TBI and blood concentration is observed in the forehead and, to a lesser extent, in the upper sternum. This is likely due to the distribution of the fat layer in this area and the characteristics of the vascular bed. At the same time, it also determines the ease of examination without the need for any additional manipulation of the child (swaddling, undressing).

Conclusions. Transcutaneous bilirubinometry is a screening method used to identify patients at risk for developing severe hyperbilirubinemia. Determining transcutaneous bilirubin levels is informative and non-invasive, allowing for assessment of the dynamics of jaundice and bilirubin, including their increase or decrease during treatment. Phototherapy increases the rate of reduction of indirect bilirubin levels and can be recommended for newborns, especially those at risk for developing severe and prolonged jaundice.

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