https://doi.org/10.56871/PED.2025.36.87.003 UDC 616.36-008.5-053.31+615.831+616-06

Control of phototherapy for neonatal jaundice

Galina N. Chumakova, Dmitry O. Ivanov, Elena V. Bem, Sofia T. Posmashnaya, Natalia A. Krivonos, Svetlana E. Pavlova, Alexandra S. Panchenko, Larisa A. Fedorova, Dmitry V. Shakalis

Saint Petersburg State Pediatric Medical University, Saint Petersburg, Russia

ABSTRACT

Background. The main method of neonatal jaundice treatment is phototherapy (PT), which has been successfully used for 65 years. Like any highly effective type of therapy, this treatment method can cause short- and long-term adversere actions in newborns.

Aim of the study: to optimize phototherapy in the conditions of the level 3A perinatal center, to evaluate the clinical and laboratory indications for the appointment of standard (SPT) and intensive phototherapy (IPT), to determine the validity of the duration of PT and the adequacy of monitoring the level of total serum bilirubin (TSB) during and after SPT and IPT.

Materials and methods. 78 infants' histories who received phototherapy due to the presence of hyperbilirubinemia of various etiologies were retrospectively studied.

Results. In 21.7%, the visualization of jaundice was assessed on the Kramer scale. The level of reticulocytes was determined in 12.7% of cases. Indications for SPT were observed in 52.9%, and for IPT — in 40% of cases. Bilirubin levels were monitored after the start of PT at intervals according to clinical recommendations in 70.6% of cases with SPT and in 50.0% with IPT. PT withdrawal according to indications was carried out in 13% of children with SPT and in 21.4% of newborn sreceiving IPT. Post-PT monitoring was performed in 56.36% of cases according to clinical recommendations.

Conclusions. Indications for PT are not observed both in the appointment of SPT and in IPT. PT control according to clinical recommendations is not carried out in one third of children with SPT and in half of children with IPT. In most cases, the transfer from IPT to SPT and the cancellation of SPT is carried out untimely, which increases the risk of PT complications.

Keywords: jaundice of newborns, neonatal hyperbilirubinemia, newborn, term newborn, phototherapy, complications of phototherapy, control of phototherapy

To cite this article

Chumakova G.N., Ivanov D.O., Bem E.V., Posmashnaya S.T., Krivonos N.A., Pavlova S.E., Panchenko A.S., Fedorova L.A., Shakalis D.V. Control of phototherapy for neonatal jaundice. *Pediatrician (St. Petersburg).* 2025;16(4):29–37. https://doi.org/10.56871/PED.2025.36.87.003.

Submitted: 04.08.2025 **Accepted: 08.10.2025** **Published online: 05.12.2025**

ISSN 2587-6252 (Online)

https://doi.org/10.56871/PED.2025.36.87.003 УДК 616.36-008.5-053.31+615.831+616-06

Контроль проведения фототерапии при неонатальной желтухе

Г.Н. Чумакова, Д.О. Иванов, Е.В. Бем, С.Т. Посмашная, Н.А. Кривонос, С.Е. Павлова, А.С. Панченко, Л.А. Федорова, Д.В. Шакалис

Санкт-Петербургский государственный педиатрический медицинский университет, Санкт-Петербург, Россия

АННОТАЦИЯ

Актуальность. Основным методом лечения неонатальных желтух является фототерапия (ФТ), которая успешно применяется уже в течение 65 лет. Как любой высокоэффективный вид терапии, этот метод лечения может вызывать краткосрочные и долгосрочные побочные реакции у новорожденных детей.

Цель исследования: для оптимизации проведения фототерапии в условиях перинатального центра 3А уровня дать оценку клинических и лабораторных показаний к назначению стандартной (СФТ) и интенсивной фототерапии (ИФТ), определить обоснованность длительности ФТ и адекватность выполнения контроля уровня общего билирубина сыворотки (ОБС) при проведении и окончании СФТ и ИФТ.

Материалы и методы. Ретроспективно изучено 78 историй развития детей, получавших фототерапию в связи с наличием гипербилирубинемии различной этиологии.

Результаты. В 21,7% визуализация желтухи оценивалась по шкале Крамера. Уровень ретикулоцитов был определен в 12,7% случаев. Показания к СФТ соблюдены в 52,9%, а к ИФТ — в 40% случаев. Контроль уровня билирубина после начала ФТ осуществлялся в интервалах согласно клиническим рекомендациям в 70,6% случаев при СФТ и в 50,0% при ИФТ. Отмена ФТ по показаниям проводилась у 13% детей при СФТ и у 21,4% новорожденных, получавших ИФТ. Контроль после окончания ФТ проводился в 56,36% случаев согласно клиническим рекомендациям.

Выводы. Показания к ФТ не соблюдаются как при назначении СФТ, так и при ИФТ. Контроль ФТ согласно клиническим рекомендациям не проводится у трети детей при СФТ и у половины детей при ИФТ. В большинстве случаев перевод с ИФТ на СФТ и отмена СФТ проводится несвоевременно, что повышает риск осложнений ФТ.

Ключевые слова: желтухи новорожденных, неонатальная гипербилирубинемия, новорожденный, доношенный новорожденный, фототерапия, осложнения фототерапии, контроль фототерапии

Как цитировать

Чумакова Г.Н., Иванов Д.О., Бем Е.В., Посмашная С.Т., Кривонос Н.А., Павлова С.Е., Панченко А.С., Федорова Л.А., Шакалис Д.В. Контроль проведения фототерапии при неонатальной желтухе. *Педиатр*. 2025;16(4):29–37. https://doi.org/10.56871/PED.2025.36.87.003.

Рукопись получена: 04.08.2025 **Рукопись одобрена: 08.10.2025** **Опубликована online: 05.12.2025**

ISSN 2079-7850 (Print)

RELEVANCE

Photobiology research on bilirubin began with Dr. R. Kremer's presentation "Light Sensitivity of Serum Bilirubin" at the 363rd meeting of the Biochemical Society of the Department of Chemistry at Durham University (UK) in 1957 [8]. In 1958, R. Kremer described a device [7] for phototherapy that included eight blue fluorescent lamps. The use of this device significantly reduced the level of total serum bilirubin (TSB) in newborns with jaundice. The year 2023 marked the 65th anniversary of phototherapy (PT) in neonatology. PT is now widely recognized as the standard treatment for neonatal jaundice due to its high effectiveness in reducing indirect bilirubin and preventing the development of bilirubin encephalopathy [12, 13]. At the same time, it has been shown that a moderate increase in indirect bilirubin in newborns is beneficial due to its protective antioxidant role for cell membranes, and extremely low concentrations of indirect bilirubin can even be dangerous [6, 9, 16]. During phototherapy, an excessive decrease in indirect bilirubin weakens its protective effect on cell membranes, making them susceptible to damage and causing apoptosis under conditions of oxidative stress induced by PT. Literature discusses amplification of the BAX gene under phototherapy, which contributes to the development of apoptosis [10]. Thus, both high and low levels of indirect bilirubin are dangerous for newborns. Phototherapy is a routine method in clinical practice, creating a false impression of its safety for children. Over the past decade, more than 20 early and a number of late complications have been described, occurring years after PT treatment [17, 18]. To avoid serious harm to infant health, the use of PT in clinical settings needs to be standardized and rationalized. Increased attention is needed when prescribing and administering PT. Phototherapy should be considered a "medicine" that is dosed carefully and judiciously and has serious side effects [11, 14]. Experts from the American Academy of Pediatrics believe that the benefits of phototherapy outweigh the potential risk of complications when the TSB level is at or above the threshold value at which phototherapy is indicated, taking into account risk factors [19].

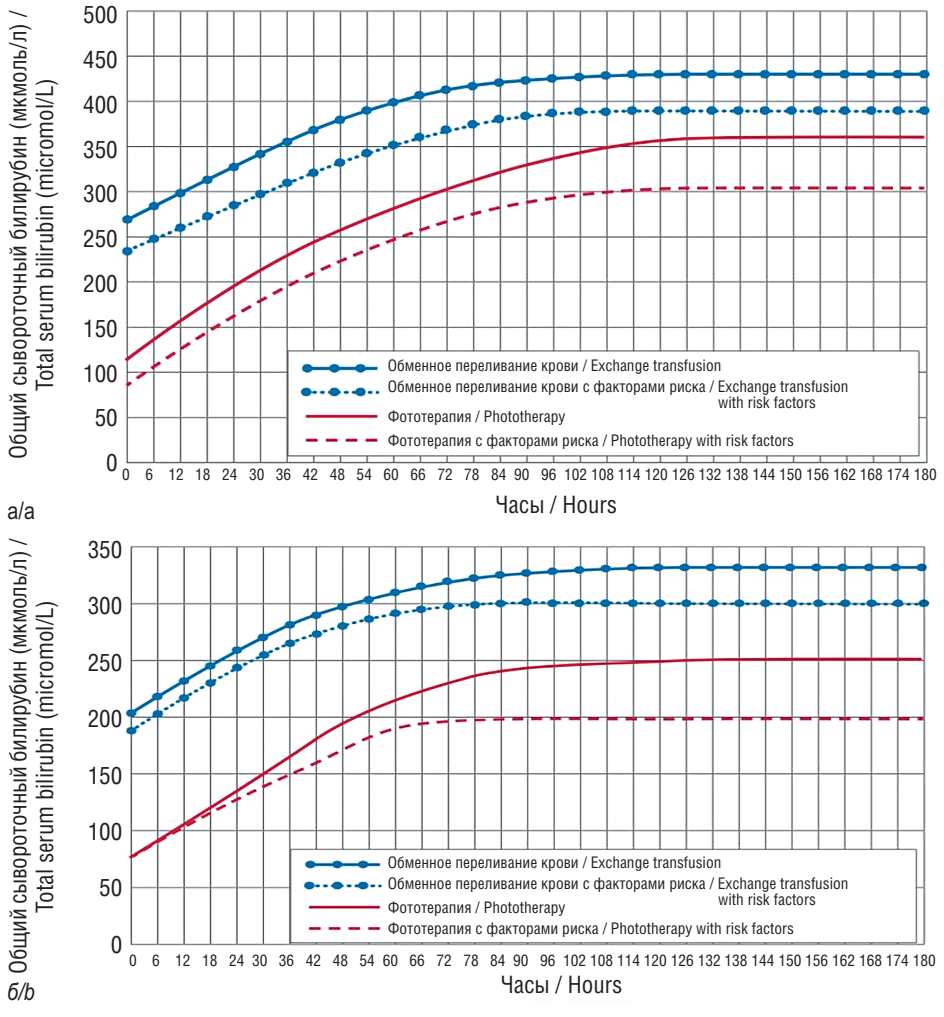

Fig. 1. Checklist of indications for phototherapy in newborns gestational age: *a* — 38 weeks or more; *b* — 35 0/7 — 37 6/7 weeks [15]

Рис. 1. Чек-лист показаний к проведению фототерапии новорожденных детей гестационного возраста: *а* — 38 недель и более; *б* — 35 0/7 — 37 6/7 недель [15]

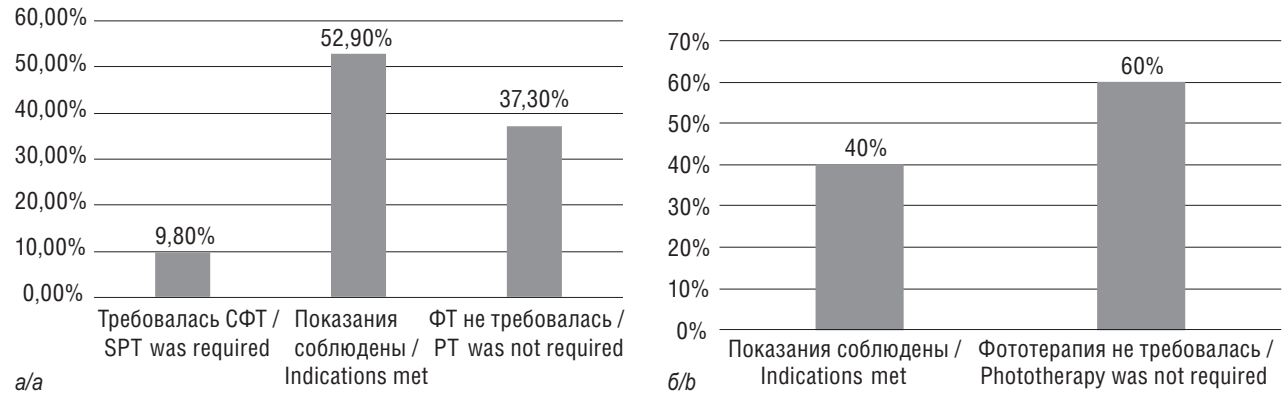

Fig. 2. Compliance with the indications for standard phototherapy (SPT) (*a*) and intensive phototherapy (*b*) in newborn children with hyperbilirubinemia treated in Perinatal Center

Рис. 2. Соблюдение показаний к стандартной фототерапии (СФТ) (*а*) и интенсивной фототерапии (*б*) у новорожденных детей с гипербилирубинемией, получавших лечение в Перинатальном центре

AIM

The aim of the study is to determine the duration of phototherapy, to assess the level of TSB Imonitoring during and at the end of standard and intensive phototherapy in order to optimize phototherapy procedures in a level 3A perinatal center, as well as to evaluate the use of clinical and laboratory indications for prescribing standard and intensive phototherapy.

MATERIALS AND METHODS

A continuous sample of 100 case histories of full-term newborns was conducted. All newborns received phototherapy for neonatal jaundice in the physiology and pathology departments of a level 3A perinatal center in 2022. When studying the development histories, 78 of them were found to be suitable for analysis. However, 22 histories did not specify the duration of phototherapy, which made it impossible to assess timeliness of bilirubin monitoring and the duration of phototherapy. Questionnaires were compiled to collect data on medical history, clinical manifestations, and laboratory indicators (TSB and its fractions, complete blood count, reticulocytes). In order to assess the adequacy of phototherapy, checklists from the Australian guidelines for treating hyperbilirubinemia for practicing physicians were used [15]. These checklists were compiled based on nomograms recommended by the American Academy of Pediatrics [5] and Russian clinical guidelines [1]. The checklists simultaneously include nomograms for indications for PT and exchange transfusion, taking into account the gestational and chronological age of a newborn and the presence of risk factors. The PT checklist, which should be used for full-term infants with a gestational age of 38 weeks or more, is shown in Figure 1, a. For infants born at a gestational age of 35 0/7 to 37 6/7 weeks, the checklist shown in Figure 1, b was used.

All data on the clinical manifestations and laboratory parameters studied in neonatal jaundice were evaluated in accordance with paragraphs 3.16.11. and 3.16.12 of the Order of the Ministry of Health of Russia[1] and the clinical guidelines “Management of full-term and preterm newborns with indirect hyperbilirubinemia” [1] and “Hemolytic Disease of the Fetus and Newborn” [3].

RESULTS AND DISCUSSION

78 medical records of newborns diagnosed with indirect hyperbilirubinemia requiring phototherapy were analyzed. When assessing the clinical manifestations of jaundice, 78.3% of newborns showed subicteric skin, i.e., low intensity of jaundiced skin coloration. This term is not used in full-term newborns with satisfactory subcutaneous fat. Due to the fact that full-term newborns “turn yellow” in stages from the face to the feet and palms, clinical guidelines [1] recommend describing jaundice in medical records, indicating the skin areas on the Kramer scale. In this case, it will be possible to determine the degree of jaundice and assess its dynamics. The degree of skin coloration was assessed using the Kramer scale in only 21.7% of cases.

When diagnosing pathological jaundice, the ICD-10 code “P59.9 — Neonatal jaundice, unspecified” was used in 64.1% of cases. The reticulocyte level was determined in only 12.7% of cases, thus, in the remaining cases, the hemolytic cause of hyperbilirubinemia was not excluded, and hemolysis is one of the main risk factors requiring phototherapy according to a nomogram with risk factors.

None of the neonatal case histories included a “Point-based assessment of the severity of clinical manifestations of bilirubin encephalopathy in newborns in the acute period,” which is provided in the clinical guidelines [1], although three children showed general lethargy and poor suckling. If these symptoms are indeed present in a child

[1] Order of the Ministry of Health of Russia No. 203n of May 10, 2017 “On Approval of Criteria for Assessing the Quality of Medical Care.” Available at: https://www.garant.ru/products/ipo/prime/doc/71575880/ (accessed: July 29, 2025).

with pathological jaundice, this condition is interpreted as acute bilirubin encephalopathy and requires escalation of medical care (in these cases, intensive phototherapy instead of standard phototherapy) [2].

Analysis of compliance with the indications for standard and intensive phototherapy was performed (Fig. 2).

Thus, only in 52.9% of cases standard PT was prescribed according to direct indications, in 37.3% it was administered without risk factors, and in 9.8% of cases, intensive phototherapy (IPT) was required.

IPT is indicated in cases where the rate of bilirubin increase is >8.5 μmol/L per hour or the bilirubin level is 50 μmol/L or less and is approaching the values for replacement blood transfusion. The indications for IPT were met in only 42% of cases, and IPT was not indicated in 58% of cases.

It should be remembered that the highest number of early and late complications occurs during IPT, so particular care should be taken when prescribing this type of phototherapy. The duration of phototherapy in standard and intensive modes in the examined children is shown in Figure 3.

Only in 7.8% of newborns did the duration of standard phototherapy (SPT) last less than a day, and in 58.8% the duration of SPT ranged from 24 to 72 hours (Fig. 3). The duration of IPT lasted 24–72 hours in 64.3% of cases, and in one case, the duration of IPT (without indications) lasted 97 hours.

The optimal duration of PT is determined by proper monitoring. PT monitoring is defined by the clinical guidelines “Management of full-term and preterm newborns with indirect hyperbilirubinemia” [1]. When performing standard PT, the level of TSB should be determined every 24 hours, and when performing intensive PT — every 6–12 hours [4]. The time of the first bilirubin monitoring for SPT and IPT is shown in Figure 4.

The first TSB check was performed within the first day of phototherapy in 82.3% of cases, but in 13.7% of cases, no TSB check was performed at all. The first IPT check was performed within the first 12 hours of phototherapy in

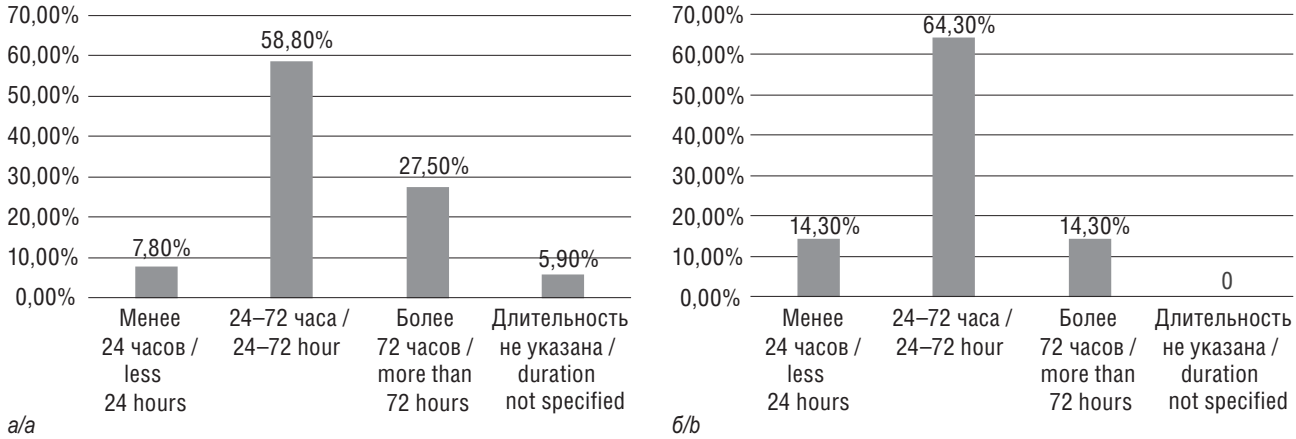

Fig. 3. Duration of standard (*a*) and intensive phototherapy (*b*) in newborn children with hyperbilirubinemia treated in Perinatal Center

Рис. 3. Продолжительность стандартной (*а*) и интенсивной фототерапии (*б*) у новорожденных детей с гипербилирубинемией, получавших лечение в Перинатальном центре

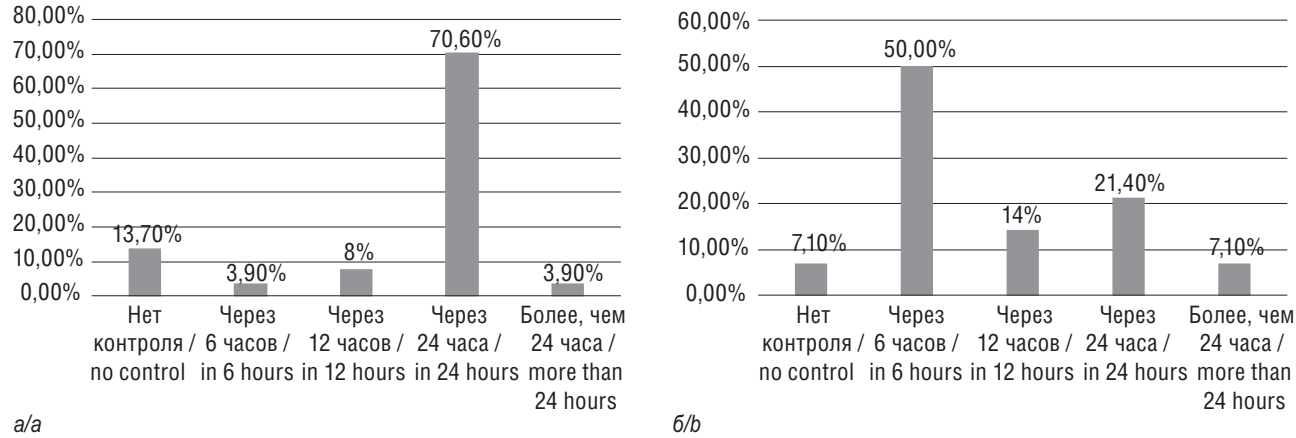

Fig. 4. Time to complete the first control during standard (*a*) and intensive phototherapy (*b*) in newborn children with hyperbilirubinemia treated in Perinatal Center

Рис 4. Время выполнения первого контроля при проведении стандартной (*а*) и интенсивной фототерапии (*б*) у новорожденных детей с гипербилирубинемией, получавших лечение в Перинатальном центре

64.3% of cases, and in 7.1% of cases, no IPT check was performed.

According to the recommendations, SPT should be discontinued when TSB level falls 50 μmol/L below the hourly phototherapy threshold. IPT should be discontinued when TSB level falls more than 50 μmol/L below the threshold for replacement blood transfusion. If it is necessary to continue phototherapy, it is switched to a standard mode. Only 13% of infants receiving standard therapy were discontinued from phototherapy based on clinical indications. In 21.4% of newborns receiving IPT, it was discontinued based on clinical indications.

It should be remembered that when PT lasts more than 72 hours, the risk of early and late complications of PT increases. After discontinuation of PT, bilirubin should be monitored; it is recommended to perform monitoring 24 hours after the end of PT. If a day has passed since the end of PT, transcutaneous bilirubin (TcB) can be monitored. In the study group, 43.64% of children did not have their bilirubin levels monitored before discharge from the neonatal unit, and there were no recommendations in the discharge summary to measure TcB or TSB on an outpatient basis.

According to a foreign study, the average duration of PT in children with a gestational age of more than 37 weeks is 21.0±17 hours, i.e., less than a day [11, 14]. In our study, in most cases, the transfer from IPT to SPT and the discontinuation of SPT were performed untimely, which increased the risk of PT complications.

FINDINGS

1. Clinical assessment of jaundice severity using the Kramer scale was performed in only 21.7% of children; in the remaining cases, subicteric or icteric skin was indicated. Clinical manifestations of neurotoxicity are ignored, and the bilirubin-induced neurological dysfunction scale, which identifies symptoms of bilirubin neurotoxicity, is not used.

2. Adequate assessment of laboratory parameters (bilirubin level) for prescribing standard phototherapy was observed in 52.9% of cases. Indications for intensive phototherapy were observed in 40% of cases. The reticulocyte level was determined in 12.7% of cases, which did not allow correcting indications for prescribing phototherapy in reticulocytosis, indicating hemolysis.

3. Bilirubin levels during phototherapy were monitored according to the relevant clinical recommendations in 70.6% of cases with standard phototherapy and in 50.0% with intensive phototherapy.

4. Timely discontinuation of phototherapy was performed in 13% of children receiving standard phototherapy and in 21.4% of newborns receiving intensive phototherapy, indicating excessive duration of phototherapy courses.

5. Bilirubin levels were not monitored 12–24 hours after the end of phototherapy in 43.64% of cases.

CONCLUSION

Phototherapy is a “medicine” that requires strict control over its prescription and use. To increase the effectiveness and safety of treating newborns with pathological hyperbilirubinemia, it is necessary to strictly adhere to the indications for prescription and monitor serum bilirubin levels during phototherapy.

ADDITIONAL INFORMATION

Author contribution. All authors made a substantial contribution to the conception of the study, acquisition, analysis, interpretation of data for the work, drafting and revising the article, final approval of the version to be published and agree to be accountable for all aspects of the study.

Competing interests. The authors declare that they have no competing interests.

Funding source. This study was not supported by any external sources of funding.

ДОПОЛНИТЕЛЬНАЯ ИНФОРМАЦИЯ

Вклад авторов. Все авторы внесли существенный вклад в разработку концепции, проведение исследования и подготовку статьи, прочли и одобрили финальную версию перед публикацией.

Конфликт интересов. Авторы декларируют отсутствие явных и потенциальных конфликтов интересов, связанных с публикацией настоящей статьи.

Источник финансирования. Авторы заявляют об отсутствии внешнего финансирования при проведении исследования.

REFERENCES

1. Volodin N.N., Degtyarev D.N., Degtyareva A.N., Karpova A.L.,Mebelova I.I., Prutkin M.E., Senkevich O.A., Harlamova N.V. Tactics of management of full-term and premature newborns with indirect hyperbilirubinemia (clinical recommendations). *Neonatology: news, opinions, training*. 2017;(2):113–126. (In Russian). https://doi.org/10.24411/2308-2402-2017-00035.
2. Ivanov D.O., Chumakova G.N., Panchenko A.S., Fedorova L.A., Sofronova L.N., Bem E.V., Pavlova S.E. Jaundice of newborns: clinical and laboratory screening of hyperbilirubinemia; indications for the appointment and control of phototherapy. Saint Petersburg: SPbSPMU; 2023. (In Russian).
3. Clinical recommendations. Rh isoimmunization. Hemolytic disease of the fetus. Prepared by the professional association LLC “Russian Society of Obstetricians and Gynecologists” (ROAG), approved by the Ministry of Health of the Russian Federation. Moscow; 2024. (In Russian).

4. Moiseeva K.E. The state of and ways to improve the organization of medical care for newborns in obstetrics organizations. MD Dissertation. Saint Petersburg; 2021. (In Russian).
5. American Academy of Pediatrics Subcommittee on Hyperbilirubinemia. Management of hyperbilirubinemia in the newborn infant 35 or more weeks of gestation. *Pediatrics*. 2004;114(1):297–316. Erratum in *Pediatrics*. 2004;114(4):1138.
6. Arnold C., Tyson J.E., Pedroza C., Carlo W.A., Stevenson D.K., Wong R., Dempsey A., Khan A., Fonseca R., Wyckoff M., Moreira A., Lasky R. Cycled phototherapy dose-finding study for extremely low-birth-weight infants: a randomized clinical trial. *JAMA Pediatr*. 2020;174(7):649–656. https://doi.org/10.1001/jamapediatrics.2020.0559.
7. Cremer R.J., Perryman P.W., Richards D.H. Influence of light on the hyperbilirubinaemia of infants. *Lancet*. 1958;2711(7030):1094–1097. https://doi.org/10.1016/s0140-6736(58)91849-x.
8. Cremer R.J., Perryman P.W., Richards D.H., Holbrook B. Photosensitivity of serum bilirubin. *Biochem J*. 1957;66:60.
9. Ebbesen F., Hansen T.W.R., Maisels M.J. Update on Phototherapy in Jaundiced Neonates. *Curr Pediatr Rev*. 2017;13(3):176–180. https://doi.org/10.2174/1573396313666170718150056.
10. El-Abdin M.Y.Z., El-Salam M.A., Ibrhim M.Y., Soheir S.M., Mahmoud K.E. Phototherapy and DNA changes in full term neonates with hyperbilirubinemia. *Egyptian Journal of Medical Human Genetics*. 2012;13(1):29–35. https://doi.org/10.1016/j.ejmhg.2011.11.003.
11. Hansen T.W.R, Maisels M.J., Ebbesen F., Vreman H.J., Stevenson D.K., Wong R.J., Bhutani V.K. Sixty years of phototherapy for neonatal jaundice — from serendipitous observation to standardized treatment and rescue for millions. *J Perinatol*. 2020;40(2):180–193. https://doi.org/10.1038/s41372-019-0439-1.
12. Itoh S., Okada H., Kuboi T., Kusaka T. Phototherapy for neonatal hyperbilirubinemia. *Pediatr Int*. 2017;59(9):959–966. https://doi.org/10.1111/ped.13332.
13. Jiao Y., Jin Y., Meng H., Wen M. An analysis on treatment effect of blue light phototherapy combined with Bifico in treating neonatal hemolytic jaundice. *Exp Ther Med*. 2018;16(2):1360–1364. https://doi.org/10.3892/etm.2018.6340.
14. Mreihil K., Benth J.Š., Stensvold H.J., Nakstad B., Hansen T.W.R. Norwegian NICU Phototherapy Study Group; Norwegian Neonatal Network. Phototherapy is commonly used for neonatal jaundice but greater control is needed to avoid toxicity in the most vulnerable infants. *Acta Paediatr*. 2018;107(4):611–619. https://doi.org/10.1111/apa.14141.
15. Queensland Clinical Guidelines. Nomograms for jaundice, phototherapy and exchange transfusion. Guideline No. V2. [Internet]. Queensland Health. 2022. [cited 2022 July 11]. Available at: https://www.health.qld.gov.au/qcg (accessed: 29.07.2025).
16. Roll E.B., Christensen T., Gederaas O.A. Effects of bilirubin and phototherapy on osmotic fragility and haematoporphyrin-induced photohaemolysis of normal erythrocytes and spherocytes. *Acta Paediatr*. 2005;94(10):1443–1447. https://doi.org/10.1111/j.1651-2227.2005.tb01818.x.
17. Slaughter J.L., Kemper A.R., Newman T.B. Technical report: diagnosis and management of hyperbilirubinemia in the newborn infant 35 or more weeks of gestation. *Pediatrics*. 2022;150(3):e2022058865. https://doi.org/10.1542/peds.2022-058865.
18. Wang J., Guo G., Li A., Cai W.Q., Wang X. Challenges of phototherapy for neonatal hyperbilirubinemia (Review). *Exp Ther Med*. 2021;21(3):231. https://doi.org/10.3892/etm.2021.9662.
19. Kemper A.R., Newman T.B., Slaughter J.L., Maisels M.J., Watchko J.F., Downs S.M., Grout R.W., Bundy D.G., Stark A.R., Bogen D.L., Holmes A.V., Feldman-Winter L.B., Bhutani V.K., Brown S.R., Maradiaga Panayotti G.M., Okechukwu K., Rappo P.D., Russell T.L. Clinical Practice Guideline Revision: Management of Hyperbilirubinemia in the Newborn Infant 35 or More Weeks of Gestation. *Pediatrics.* 2022;150(3):e2022058859. https://doi.org/10.1542/peds.2022-058859.

ЛИТЕРАТУРА

1. Володин Н.Н., Дегтярев Д.Н., Дегтярева А.Н., Карпова А.Л., Мебелова И.И., Пруткин М.Е., Сенькевич О.А., Харламова Н.В. Тактика ведения доношенных и недоношенных новорожденных детей с непрямой гипербилирубинемией (клинические рекомендации). *Неонатология: новости, мнения, обучение*. 2017;(2):113–126. https://doi.org/10.24411/2308-2402-2017-00035.
2. Иванов Д.О., Чумакова Г.Н., Панченко А.С., Федорова Л.А., Софронова Л.Н., Бем Е.В., Павлова С.Е. Желтухи новорожденных: клинико-лабораторный скрининг гипербилирубинемий; показания к назначению и проведению контроля фототерапии. СПб.: СПбГПМУ; 2023.
3. Клинические рекомендации. Резус-изоиммунизация. Гемолитическая болезнь плода. Подготовлены профессиональной ассоциацией ООО «Российское общество акушеров-гинекологов» (РОАГ), утверждены Минздравом РФ. М.; 2024.
4. Моисеева К.Е. Состояние и пути совершенствования организации медицинской помощи новорожденным в организациях родовспоможения. Дис. … д-ра мед. наук. СПб.; 2021.
5. American Academy of Pediatrics Subcommittee on Hyperbilirubinemia. Management of hyperbilirubinemia in the newborn infant 35 or more weeks of gestation. *Pediatrics*. 2004;114(1):297–316. Erratum in *Pediatrics*. 2004;114(4):1138.
6. Arnold C., Tyson J.E., Pedroza C., Carlo W.A., Stevenson D.K., Wong R., Dempsey A., Khan A., Fonseca R., Wyckoff M., Moreira A., Lasky R. Cycled phototherapy dose-finding study for extremely low-birth-weight infants: a randomized clinical trial. *JAMA Pediatr*. 2020;174(7):649–656. https://doi.org/10.1001/jamapediatrics.2020.0559.
7. Cremer R.J., Perryman P.W., Richards D.H. Influence of light on the hyperbilirubinaemia of infants. *Lancet*. 1958;2711(7030):1094–1097. https://doi.org/10.1016/s0140-6736(58)91849-x.
8. Cremer R.J., Perryman P.W., Richards D.H., Holbrook B. Photosensitivity of serum bilirubin. *Biochem J*. 1957;66:60.

9. Ebbesen F., Hansen T.W.R., Maisels M.J. Update on Phototherapy in Jaundiced Neonates. *Curr Pediatr Rev*. 2017;13(3):176–180. https://doi.org/10.2174/1573396313666170718150056.
10. El-Abdin M.Y.Z., El-Salam M.A., Ibrhim M.Y., Soheir S.M., Mahmoud K.E. Phototherapy and DNA changes in full term neonates with hyperbilirubinemia. *Egyptian Journal of Medical Human Genetics*. 2012;13(1):29–35. https://doi.org/10.1016/j.ejmhg.2011.11.003.
11. Hansen T.W.R, Maisels M.J., Ebbesen F., Vreman H.J., Stevenson D.K., Wong R.J., Bhutani V.K. Sixty years of phototherapy for neonatal jaundice — from serendipitous observation to standardized treatment and rescue for millions. *J Perinatol*. 2020;40(2):180–193. https://doi.org/10.1038/s41372-019-0439-1.
12. Itoh S., Okada H., Kuboi T., Kusaka T. Phototherapy for neonatal hyperbilirubinemia. *Pediatr Int*. 2017;59(9):959–966. https://doi.org/10.1111/ped.13332.
13. Jiao Y., Jin Y., Meng H., Wen M. An analysis on treatment effect of blue light phototherapy combined with Bifico in treating neonatal hemolytic jaundice. *Exp Ther Med*. 2018;16(2):1360–1364. https://doi.org/10.3892/etm.2018.6340.
14. Mreihil K., Benth J.Š., Stensvold H.J., Nakstad B., Hansen T.W.R. Norwegian NICU Phototherapy Study Group; Norwegian Neonatal Network. Phototherapy is commonly used for neonatal jaundice but greater control is needed to avoid toxicity in the most vulnerable infants. *Acta Paediatr*. 2018;107(4):611–619. https://doi.org/10.1111/apa.14141.
15. Queensland Clinical Guidelines. Nomograms for jaundice, phototherapy and exchange transfusion. Guideline No. V2. [Internet]. Queensland Health. 2022. [cited 2022 July 11]. Available at: https://www.health.qld.gov.au/qcg (accessed: 29.07.2025).
16. Roll E.B., Christensen T., Gederaas O.A. Effects of bilirubin and phototherapy on osmotic fragility and haematoporphyrin-induced photohaemolysis of normal erythrocytes and spherocytes. *Acta Paediatr*. 2005;94(10):1443–1447. https://doi.org/10.1111/j.1651-2227.2005.tb01818.x.
17. Slaughter J.L., Kemper A.R., Newman T.B. Technical report: diagnosis and management of hyperbilirubinemia in the newborn infant 35 or more weeks of gestation. *Pediatrics*. 2022;150(3):e2022058865. https://doi.org/10.1542/peds.2022-058865.
18. Wang J., Guo G., Li A., Cai W.Q., Wang X. Challenges of phototherapy for neonatal hyperbilirubinemia (Review). *Exp Ther Med*. 2021;21(3):231. https://doi.org/10.3892/etm.2021.9662.
19. Kemper A.R., Newman T.B., Slaughter J.L., Maisels M.J., Watchko J.F., Downs S.M., Grout R.W., Bundy D.G., Stark A.R., Bogen D.L., Holmes A.V., Feldman-Winter L.B., Bhutani V.K., Brown S.R., Maradiaga Panayotti G.M., Okechukwu K., Rappo P.D., Russell T.L. Clinical Practice Guideline Revision: Management of Hyperbilirubinemia in the Newborn Infant 35 or More Weeks of Gestation. *Pediatrics.* 2022;150(3):e2022058859. https://doi.org/10.1542/peds.2022-058859.

AUTHORS' INFO

Galina N. Chumakova, MD, PhD, Dr. Sci. (Medicine), Professor, Department of Neonatology with Courses in Neurology and Obstetric-Gynecology FP and APE, Saint Petersburg State Pediatric Medical University Ministry of Health of the Russian Federation, Saint Petersburg, Russia;
ORCID: 0000-0001-5353-4610; e-Library SPIN: 1821-0198;
e-mail: zelchum-neo@yandex.ru

Dmitry O. Ivanov, MD, PhD, Dr. Sci. (Medicine), Professor, Chief neonatologist of the Ministry of Health of the Russian Federation, Rector, Head of the Department of Neonatology with courses of Neurology and Obstetrics and Gynecology of the FP and APE, Saint Petersburg State Pediatric Medical University, Ministry of Health of the Russian Federation, Saint Petersburg, Russia;
ORCID: 0000-0002-0060-4168; eLibrary SPIN: 4437-9626;
e-mail: delopro@gpmu.org.ru

* **Elena V. Bem**, MD, PhD, Associate Professor Department of Neonatology with Courses in Neurology and Obstetric-Gynecology FP and APE, Saint Petersburg State Pediatric Medical University Ministry of Health of the Russian Federation;
address: 2 Litovskaya str., Saint Petersburg, 194100, Russia;
ORCID: 0009-0008-9337-5667; e-Library SPIN: 2811-5938;
e-mail: e.bohm@inbox.ru

ОБ АВТОРАХ

Галина Николаевна Чумакова, д-р мед. наук, профессор, кафедра неонатологии с курсами неврологии и акушерства-гинекологии ФП и ДПО, ФГБОУВО «Санкт-Петербургский государственный педиатрический медицинский университет» Минздрава России, Санкт-Петербург, Россия;
ORCID: 0000-0001-5353- 4610; e-Library SPIN: 1821-0198;
e-mail: zelchum-neo@yandex.ru

Дмитрий Олегович Иванов, д-р мед. наук, профессор, главный внештатный специалист-неонатолог Минздрава России, ректор, заведующий кафедрой неонатологии с курсами неврологии и акушерства-гинекологии ФП и ДПО, ФГБОУ ВО «Санкт-Петербургский государственный педиатрический медицинский университет» Минздрава России, Санкт-Петербург, Россия;
ORCID: 0000-0002-0060-4168; eLibrary SPIN: 4437-9626;
e-mail: delopro@gpmu.org.ru

* **Елена Венедиктовна Бем**, канд. мед. наук, доцент кафедры неонатологии с курсами неврологии и акушерства-гинекологии ФП и ДПО, ФГБОУ ВО «Санкт-Петербургский государственный педиатрический медицинский университет» Минздрава России; адрес: Россия, 194100, Санкт-Петербург, ул. Литовская, д. 2; ORCID: 0009-0008-9337-5667;
e-Library SPIN: 2811-5938; e-mail: e.bohm@inbox.ru

AUTHORS' INFO

Sofia T. Posmashnaya, Resident doctor, Department of Neonatology with Courses in Neurology and Obstetric-Gynecology FP and APE, Saint Petersburg State Pediatric Medical University Ministry of Health of the Russian Federation, Saint Petersburg, Russia; ORCID: 0009-0001-4348-8830; e-mail: sofya43137@gmail.com

Natalia A. Krivonos, Resident doctor, Department of Neonatology with Courses in Neurology and Obstetric-Gynecology PGE, Saint Petersburg State Pediatric Medical University Ministry of Health of the Russian Federation, Saint Petersburg, Russia; ORCID: 0009-0008-0462-241X; e-Library SPIN: 7715-3415; e-mail: krivonosnn@mail.ru

Svetlana E. Pavlova, Assistant Professor, Department of Neonatology with Courses in Neurology and Obstetric-Gynecology FP and APE, Saint Petersburg State Pediatric Medical University Ministry of Health of the Russian Federation, Saint Petersburg, Russia; ORCID: 0000-0001-5423-0950; e-Library SPIN: 1761-4768; e-mail: svetlanapav.spb@mail.ru

Alexandra S. Panchenko, MD, PhD, Dr. Sci. (Medicine), Professor Department of Neonatology with Courses in Neurology and Obstetric-Gynecology FP and APE, Saint Petersburg State Pediatric Medical University Ministry of Health of the Russian Federation, Saint Petersburg, Russia; ORCID: 0000-0003-2313-3941; e-Library SPIN: 9552-2350; e-mail: sashawomen18@mail.ru

Larisa A. Fedorova, MD, PhD, Associate Professor Department of Neonatology with Courses in Neurology and Obstetric-Gynecology PGE, Saint Petersburg State Pediatric Medical University Ministry of Health of the Russian Federation, Saint Petersburg, Russia; ORCID: 0000-0001-9747-762X; e-Library SPIN: 5474-0902; e-mail: arslarissa@rambler.ru

Dmitry V. Shakalis, Assistant Professor, Department of Neonatology with Courses in Neurology and Obstetric-Gynecology FP and APE, Saint Petersburg State Pediatric Medical University Ministry of Health of the Russian Federation, Saint Petersburg, Russia; ORCID: 0009-0002-7876-365X; e-Library SPIN: 2886-1420; e-mail: shakalisdoc@gmail.com

ОБ АВТОРАХ

Софья Тарасовна Посмашная, ординатор, кафедра неонатологии с курсами неврологии и акушерства-гинекологии ФП и ДПО, ФГБОУ ВО «Санкт-Петербургский государственный педиатрический медицинский университет» Минздрава России, Санкт-Петербург, Россия; ORCID: 0009-0001-4348-8830; e-mail: sofya43137@gmail.com

Наталья Алексеевна Кривонос, ординатор, кафедра неонатологии с курсами неврологии и акушерства-гинекологии ФП и ДПО, ФГБОУ ВО «Санкт-Петербургский государственный педиатрический медицинский университет» Минздрава России, Санкт-Петербург, Россия; ORCID: 0009-0008-0462-241X; e-Library SPIN: 7715-3415; e-mail: krivonosnn@mail.ru

Светлана Евгеньевна Павлова, ассистент, кафедра неонатологии с курсами неврологии и акушерства-гинекологии ФП и ДПО, ФГБОУ ВО «Санкт-Петербургский государственный педиатрический медицинский университет» Минздрава России, Санкт-Петербург, Россия; ORCID: 0000-0001-5423-0950; e-Library SPIN: 1761-4768; e-mail: svetlanapav.spb@mail.ru

Александра Сергеевна Панченко, д-р мед. наук, профессор, кафедра неонатологии с курсами неврологии и акушерства-гинекологии ФП и ДПО, ФГБОУ ВО «Санкт-Петербургский государственный педиатрический медицинский университет» Минздрава России, Санкт-Петербург, Россия; ORCID: 0000-0003-2313-3941; e-Library SPIN: 9552-2350; e-mail: sashawomen18@mail.ru

Лариса Арзумановна Федорова, канд. мед. наук, доцент, кафедра неонатологии с курсами неврологии и акушерства-гинекологии ФП и ДПО, ФГБОУ ВО «Санкт-Петербургский государственный педиатрический медицинский университет» Минздрава России, Санкт-Петербург, Россия; ORCID: 0000-0001-9747-762X; e-Library SPIN: 5474-0902; e-mail: arslarissa@rambler.ru

Дмитрий Валерьевич Шакалис, ассистент, кафедра неонатологии с курсами неврологии и акушерства-гинекологии ФП и ДПО ФГБОУ ВО «Санкт-Петербургский государственный педиатрический медицинский университет» Минздрава России, Санкт-Петербург, Россия; ORCID: 0009-0002-7876-365X; e-Library SPIN: 2886-1420; e-mail: shakalisdoc@gmail.com

* Автор, ответственный за переписку / Corresponding author.