JOURNAL OF
CONTEMPORARY MEDICINE

DOI:10.16899/jcm.910028
J Contemp Med 2021;11(4):560-564

Orjinal Araştırma / Original Article


# Indirect Neonatal Hyperbilirubinemia and Associated Risk Factors for Long Phototheraphy Duration in A Baby-Friendly Hospital in Konya, Turkey

## Türkiye, Konya'da Bebek Dostu Bir Hastanede İndirekt Neonatal Hiperbilirubinemi ve Uzun Fototerapi Süresi ile İlişkili Risk Faktörleri

**Esma Keleş Alp[1]**

[1]Dr. Ali Kemal Belviranlı Women's Maternity and Children's Hospital Department of Pediatrics, Konya, Turkey

## Abstract

**Aim**: Indirect neonatal hyperbilirubinemia is a common neonatal disorder worldwide which can remain benign if prompt management is available. However there is a higher morbidity and mortality risk in settings with limited access to diagnosis and care. The aim of this study was to evaluate the etiologies of indirect neonatal hyperbilirubinemia, to determine the effectiveness of phototherapy treatment and to specify the associated risk factors for prolonged phototherapy duration.

**Material and Method**: Infants with ≥37 weeks of gestation, postnatal age of ≤14 days, and diagnosis of hyperbilirubinemia at admission, defined as serum bilirubin level at or above the phototherapy treatment threshold were included in the study. All the study participants were treated with intermittent phototherapy. The data were retrospectively analized and duration of phototherapy was classified as ≤24 hours (early discharge) and >24 hours (late discharge).

**Results**: A total of 205 newborns were included in the study. The mean birth weight was 3171.12±436.19 g and mean gestational age was 38.87±1.18 (37–39) weeks. Also, ABO incompatibility and cephalic hematoma were found to be the most common etiologies in our series. On the other hand, male gender (p=0.03) and formula as the first prelacteal feeds (p=0.03) were significantly higher in late discharge group. Additionally; male gender, formula as the first prelacteal feed, ABO incompatibility, Rh isoimmunization, cephalic hematoma and sepsis were risk factors for long phototherapy duration of >24 hours.

**Conclusion**: Determination of possible risk factors for neonatal jaundice can provide early hospital admissions by informing mothers before discharge after birth.

**Keywords**: Neonatal jaundice, indirect hyperbilirubinemia, etiology, phototheraphy treatment, risk factors

## Öz

**Giriş**: İndirekt neonatal hiperbilirubinemi, dünya çapında yaygın bir yenidoğan hastalığıdır ve hızlı tedavi edilirse benign kalabilir. Bununla birlikte, tanı ve sağlık hizmetine sınırlı erişimin olduğu ortamlarda daha yüksek bir morbidite ve mortalite riski vardır. Bu çalışmanın amacı, indirekt neonatal hiperbilirubineminin etiyolojilerini değerlendirmek, fototerapi tedavisinin etkinliğini belirlemek ve uzun süreli fototerapi süresi için ilişkili risk faktörlerini belirlemektir.

**Gereç ve Yöntem**: Çalışmaya, serum bilirubin düzeyi fototerapi tedavi eşiğinde veya üzerinde olarak tanımlanan; 37 gebelik haftasından büyük, postnatal yaşı 14 günden küçük ve başvuru anında hiperbilirübinemi tanısı olan bebekler dahil edildi. Tüm vakalar aralıklı fototerapi ile tedavi edildi. Veriler geriye dönük olarak analiz edildi ve fototerapi süresi 24 saatten kısa (erken taburculuk) ve 24 saatten uzun (geç taburculuk) olarak sınıflandırıldı.

**Bulgular**: Çalışmaya toplam 205 yenidoğan dahil edildi. Ortalama doğum ağırlığı 3171,12±436,19 g ve ortalama gebelik yaşı 38,87±1,18 (37-39) hafta idi. Ayrıca serimizde ABO uyumsuzluğu ve sefal hematom hiperbilirubinemide en sık görülen etiyolojiler olarak bulundu. Diğer taraftan, erkek cinsiyet (p=0.03) ve ilk besin olarak mama kullanılması (p=0.03) geç taburculuk grubunda anlamlı olarak daha yüksekti. Bunlara ek olarak; ABO uyumsuzluğu, Rh izoimmünizasyonu, sefal hematom ve sepsis, >24 saatlik uzun fototerapi süresi için risk faktörleriydi.

**Sonuç**: Yenidoğan sarılığı için olası risk faktörlerinin belirlenmesi doğum sonrası taburculuk öncesi anneleri bilgilendirerek erken hastaneye yatışları sağlayabilir.

**Anahtar Kelimeler**: Yenidoğan sarılığı, indirekt hiperbilirubinemi, etyoloji, fototerapi tedavisi, risk faktörleri

**Corresponding *(İletişim)*:** Esma Keleş Alp, Fatih Mah. Yeni İstanbul Cd. No:32 42285 Selçuklu, Konya, Turkey
**E-mail *(E-posta)*:** esmaalp@hotmail.com
**Received *(Geliş Tarihi)*:** 05.04.2021 **Accepted *(Kabul Tarihi)*:** 25.06.2021

## INTRODUCTION

Neonatal jaundice is usually a physiologic condition and is one of the most common causes of hospital admissions in otherwise healthy newborns.[1] Jaundice can affect>60% of late preterm and term infants. High levels of total serum bilirubin can be toxic to the central nervous system leading to acute bilirubin encephalopathy and kernicterus spectrum disorders, with devastating, permanent neurodevelopmental handicaps or exitus.[2] Recommendations have been developed to prevent acute bilirubin encephalopathy and kernicterus spectrum disorders by establishing total serum bilirubin levels signaling risk for neurological damage at which to start phototherapy treatment, the first-line treatment for neonatal hyperbilirubinemia and, eventually, with exchange transfusions.[3-5] Also, national guideline has been published with the aim of standardizing the starting and stopping of phototherapy, and the monitoring of total serum bilirubin levels during phototherapy.[6]

With implementation of standardized and harmonized guidelines for management of hyperbilirubinemia, the incidence of severe hyperbilirubinemia has decreased markedly in high income countries.[1,7-10] However, it is still an important problem resulting in significant disability and mortality in low and middle income countries.[11-14] Also, the incidence of severe neonatal hyperbilirubinemia and acute bilirubin encephalopathy in southeast region of Turkey is reported to be higher than in high income countries and lower than in low and middle income countries.[15]

Risk factors for the development of severe hyperbilirubinemia include cephalhematoma or significant bruising, early gestational age, exclusive breastfeeding (especially unsuccessful breastfeeding and/ or weight loss of 8% to 10%), isoimmune or other hemolytic anemia, and a sibling with a history of neonatal jaundice.[16] In addition to hyperbilirubinemia, earlier gestational age, hemolysis, sepsis, and low birth weight are associated with the development of bilirubin encephalopathy.[16]

The aim of this study was to evaluate the etiological reasons for the development of neonatal hyperbilirubinemia, to determine the effectiveness of phototherapy treatment and to specify the associated risk factors for prolonged phototherapy duration.

## MATERIAL AND METHOD

### Study population

This is a single-center retrospective cohort study which was conducted at a baby friendly hospital between July 2016 and June 2020 in the middle region of Turkey. All medical records of patients were reviewed. Infants with ≥37 weeks of gestation, povwstnatal age of ≤14 days, and diagnosis of hyperbilirubinemia at admission, defined as serum bilirubin level at or above the phototherapy treatment threshold according to the guidelines of the American Academy of Pediatrics[4] and national guideline,[6] were included in the study. Infants born at <37 weeks of gestation, with congenital/ chromosomal anomalies and infants that were performed exchange transfusion were excluded from the study.

Hemolytic jaundice was defined as presence of anemia, hyperbilirubinemia, and hemolysis findings in peripheral smear. Direct Coombs test positivity was accepted as a supportive finding for hemolytic jaundice and intravenous immunoglobulin (IVIG) was used in infants having hemolytic findings with direct Coombs positivity.

Sepsis was defined as presence of clinical signs of sepsis associated with a positive blood culture and/or an elevated c-reactive protein level, total leukocyte count of >25,000/mm$^3$ or <5000/mm$^3$, an immature to total neutrophil ratio of >0.2, or a band count of >10%.[17]

### Phototherapy treatment

All the study participants were treated with intermittent phototherapy and blue lights with wavelengths of 460 nm were used for this treatment. Intermittent phototherapy was performed as intermittent blue light: 3–5 hours of blue light of irradiation and a stop of 2–4 hours in between.[18] The course of treatment for babies was 24 hours or more. The perineum of newborns was protected by black cotton diapers, and the eyes were protected by a black eye mask, and children were appropriately constrained. In order to ensure that the skin of children receives light evenly, the light distance was adjusted to 25 cm, and the blue light wavelength was set as 425–475 nm and the power to 160 W. Also, phototherapy treatment was stopped when total serum bilirubin level was <13–14 mg/dL, after two consecutive decreasing values measured 6–12 h after the beginning of treatment, or once serum bilirubin has fallen to a level of at least 2.9 mg/dL, or just below the phototherapy threshold.[4,5,19] The duration of phototherapy was classified as ≤24 hours (early discharge) and >24 hours (late discharge).

### Statistical analysis

Descriptive statistics were calculated using counts, frequencies, medians, and interquartile ranges for patient demographics and sedation procedure characteristics. Categorical data were presented as frequencies (%) and analyzed using Chi-square test. Multivariate binary logistic regression analysis was used to determine the risk factors associated with phototherapy duration. Adjusted odds ratios (OR) and 95% confidence interval (CI) for independent risk factors were determined. Statistical significance was inferred at $p<0.05$. Statistical analyses were done using SPSS for Windows Version 17.0 software (Chicago, IL, USA).

## RESULTS

A total of 205 newborns were included in the study. The demographic and laboratory characteristics of study population were summarized in **Table 1**. The infants' mean birth weight was 3171.12±436.19 g and mean gestational age was 38.87±1.18 (37–39) weeks. In total 90 (43.9%) infants were females and 115 (56.1%) infants were males (female/ male=1.27). Also, the mean maternal age was 29.32±8.21

years and the mean parity of mothers was 3.[1-4] Additionally, 122 (59.5%) infants and 83 (40.5%) infants were delivered by vaginal and caesarean section, respectively. The mean Apgar score at 5 minutes of babies was 8.2[7-10] and 129 (62.9%) infants were breastfeed as the first prelacteal feeds. The mean postnatal age at admission was 4.19±2.69 days. The mean indirect serum bilirubin concentration at admission and at discharge was 16.35±3.94 mg/dL and 9.38±2.07 mg/dl, respectively. On the other hand, positive direct coombs was detected in 17 (8.3%) patients and the mean phototheraphy duration was 33.6±26.88 hours.

The etiologies of indirect hyperbilirubinemia in study population was given in **Table 2**. The etiologies; ABO incompatibility, Rh isoimmunization, lack of proper feeding and dehydration (>%10), cephalic hematoma, sepsis, urinary system infections, hypothyroidism, baby of diabetic mother, and unknown were diagnosed in 89 (43.4%), 17 (8.3%), 19 (9.3%), 34 (16.6%), 2 (0.9%), 1 (0.5%), 3 (1.5%), 5 (2.4%) and 21 (10.2%) infants, respectively.

All patients were divided into two groups according to phototheraphy duration; patients who were received phototheraphy <24 hours (84 patients) and that were >24 hours (121 patients). The comparison of demographic and laboratory characteristics of two groups were given in **Table 3.** No statistical difference was achived for gestational age (p=0.745), birth weight (p=0.851), maternal age (p=0.684), mode of delivery (p=0.791 and p=0.103), postnatal age of admission (p=0.561), indirect bilirubin level on admission (p=0.914), indirect bilirubin level at discharge (p=0.136) and positive direct coombs (p=0.583) between the two gorups. However, male gender (p=0.03) and formula as the first prelacteal feeds (p=0.03) were significantly higher in the group that was received phototheraphy of >24 hours.

In multivariate logistic regression analysis; male gender (OR=0.91, 95%CI=0.09-1.1, p=0.02), formula as the first prelacteal feed (OR=7.1, 95%CI=7.3-14.1, p=0.01), ABO incompatibility (OR=2.6, 95%CI=1.3-9.8, p=0.01), Rh isoimmunization (OR=11.5, 95%CI=5.3-22.3, p=0.001), cephalic hematoma (OR=6.2, 95%CI=4.8-10.9, p=0.03) and sepsis (OR=2.1, 95%CI=6.9-10.2, p=0.04) were strongly associated with and risk factors for long phototherapy duration of >24 hours (**Table 4**).

**Table 1.** Demographic and laboratory characteristics of study population

| Variables | N=205 (Mean±SD) | Percentage (%) |
|---|---|---|
| Gestational age (weeks) | 38.87±1.18 | |
| Birth weight (gr) | 3171.12±436.19 | |
| Gender | | |
| Female | 90 | 43.9 |
| Male | 115 | 56.1 |
| Maternal age (years) | 29.32±8.21 | |
| Mode of delivery | | |
| Vaginal | 122 | 59.5 |
| Caesarean section | 83 | 40.5 |
| Parity | 3 (1-4) | |
| Apgar score at 5 minutes | 8.2 (7-10) | |
| First prelacteal feeds | | |
| Breastmilk | 129 | 62.9 |
| Formula | 76 | 37.1 |
| Postnatal age of admission (days) | 4.19±2.69 | |
| Indirect bilirubin level on admission (mg/dl) | 16.35±3.94 | |
| Indirect bilirubin level at discharge (mg/dl) | 9.38±2.07 | |
| Positive direct coombs | 17 | 8.3 |
| Duration of phototheraphy (hours) | 33.6±26.88 | |

**Table 2.** The etiologies of indirect hyperbilirubinemia in study population.

| Variables | N (=205) | Percentage (%) |
|---|---|---|
| ABO incompatibility | 89 | 43.4 |
| Cephalic hematoma | 34 | 16.6 |
| Lack of proper feeding and dehydration (>%10) | 19 | 9.3 |
| Rh isoimmunization | 17 | 8.3 |
| Baby of diabetic mother | 5 | 2.4 |
| Hypothyroidism | 3 | 1.5 |
| Sepsis | 2 | 0.9 |
| Urinary system infections | 1 | 0.5 |
| Unknown | 21 | 10.2 |

**Table 3.** Demographic and laboratory characteristics of patients who were threated with phototheraphy ≤24 hours and >24 hours.

| Variables | Phototherapy duration | | P value |
|---|---|---|---|
| | ≤24 hours | >24 hours | |
| Gestational age (weeks) | 37.17±2.11 | 38.01±2.08 | 0.745 |
| Birth weight (gr) | 3052.10±136.79 | 3101.25±114.21 | 0.851 |
| Gender | | | |
| Female | 50 | 40 | 0.125 |
| Male | 34 | 81 | 0.03 |
| Maternal age (years) | 28.17±6.12 | 29.10±3.51 | 0.684 |
| Mode of delivery | | | |
| Vaginal | 46 | 76 | 0.791 |
| Caesarean section | 38 | 45 | 0.103 |
| First prelacteal feeds | | | |
| Breastmilk | 67 | 62 | 0.06 |
| Formula | 17 | 59 | 0.03 |
| Postnatal age of admission (days) | 4.09±2.11 | 4.29±0.17 | 0.561 |
| Indirect bilirubin level on admission (mg/dl) | 15.31±1.14 | 16.13±3.10 | 0.914 |
| Indirect bilirubin level at discharge (mg/dl) | 9.01±2.14 | 9.03±1.11 | 0.136 |
| Positive direct coombs | 8 | 9 | 0.583 |

**Table 4.** Multivariate logistic regression analysis of risk factors associated with phototherapy duration of >24 hours.

| Variables | OR | 95% CI | P value |
|---|---|---|---|
| Male gender | 0.91 | 0.92–1.1 | 0.02 |
| Formula as the first prelacteal feed | 7.1 | 7.3–14.1 | 0.01 |
| ABO incompatibility | 2.6 | 1.3-9.8 | 0.01 |
| Rh isoimmunization | 11.5 | 5.3–22.3 | 0.001 |
| Cephalic hematoma | 6.2 | 4.8–10.9 | 0.03 |
| Sepsis | 2.1 | 6.9–10.2 | 0.04 |

## DISCUSSION

This retrospective study confirmed that, most of the term livebirths were treated for indirect neonatal hyperbilirubinemia due to the certain etiologies such as ABO incompatibility, Rh isoimmunization, lack of proper feeding and dehydration (>%10), cephalic hematoma, sepsis, urinary system infections, hypothyroidism and baby of diabetic mother. In addition, male gender, formula as the first prelacteal feed, ABO incompatibility, Rh isoimmunization, cephalic hematoma and sepsis were found to be strongly associated with long phototherapy duration of >24 hours in our study.

Jaundice caused by indirect neonatal hyperbilirubinemia is a common condition and a frequent cause for admission in health care facilities all around the world.[3] Without timely admission and appropriate management, indirect neonatal hyperbilirubinemia can lead to devastating neurologic disorders.[2,10] Cerebral palsy, auditory disturbances and gaze abnormalities are classical sequelae of indirect neonatal hyperbilirubinemia.[20,21] Worldwide, 80% of severe indirect neonatal hyperbilirubinemia occurs in resource-limited settings with an estimated mortality rate of 25% and with a 13% risk of developing neurological sequelae.[1,2,20,21] Also, risk factors for indirect neonatal hyperbilirubinemia and acute bilirubin encephalopathy has been widely researched.[1-3,8-11]

The Turkish Neonatal Jaundice Registry revealed that the most common risk factors for development of severe neonatal jaundice and indirect neonatal hyperbilirubinemia were hemolytic reasons, improper feeding, and dehydration.[15] Also, the most common hemolytic etiology was ABO blood group incompatibility in this registry and related literature.[11,13,15,16] Similar to these results, our study showed ABO blood group incompatibility was the most common etiology and also a risk factor for long phototheraphy duration. Additionally, Rh isoimmunization also caused indirect neonatal hyperbilirubinemia, as seen in our results. In a previous research, hemolytic disease or direct Coombs test positivity was found to be associated with higher risk of acute bilirubine encephalopaty and permanent neurological abnormalities.[22] Although, we found the direct coombs test rate as 8.3% in our study, we did not find any association with long duration of phototherapy.

Male gender is also another risk factors for neonatal indirect hyperbilirubinemia. The studies showed that male/female ratio ranges between 1.2-1.6 in newborns with indirect hyperbilirubinemia.[1,3,5,15] In our study, we determined the female/male ratio as 1.27 in accordance with the literature. Also, our study showed that male gender is a risk factor for long duration of phototherapy.

Although the gold standard for infant nutrition, exclusive breastfeeding has traditionally been considered a risk factor for the development of neonatal indirect hyperbilirubinemia.[23] Current guidelines for the management of neonatal hyperbilirubinemia include the recommendation that hospitals promote and support successful breastfeeding, acknowledging that inadequate milk intake during breastfeeding may contribute to the development of hyperbilirubinemia.[4-6] Also, in a study of Hudson et al. they found that implementation of baby-friendly hospital initiative for breastfeeding in a single hospital center was significantly associated with reduced rates of neonatal hyperbilirubinemia and phototherapy treatment among newborns, without increased rates of 30-day hospital readmissions for the treatment of hyperbilirubinemia.[24] In our study, we found that the formula was the first prelacteal feed in babies who received phototheraphy treatment >24 hours period. Also, statistical significance was achived between the two groups for first prelacteal feed. Additionally, our study revealed that formula as the first prelacteal feed was a risk factor for long phototheraphy treatment >24 hours period.

Currently, phototherapy treatment is a widely used method for treating neonatal jaundice. Phototherapy decreases the progression to severe hyperbilirubinemia in infants with moderate hyperbilirubinemia. The effect of phototherapy depends on the intensity of radiation (which in turn depends on the characteristics of radiation, number of radiation sources, and exposed body area) and the distance between the body and the source of radiation.[25] Phototherapy causes minor increases in transepidermal skin water loss in full-term infants. Side effects include temperature instability, intestinal hypermotility, interference with maternal-infant interaction and, rarely, bronze discolouration of the skin. Also, eye patches should be used to protect the developing retina.[26] Current guidelines suggest continuous or intermittent phototheraphy treatment for neonatal jaundice.[4-6] Intensity can be increased by using multiple phototherapy units or moving the unit closer to the infant.[25,27] Recent studies suggested that in term and late preterm infants with non-hemolytic moderate hyperbilirubinemia, intermittent phototherapy with 12 hours on and 12 hours off cycles is as efficacious as continuous phototherapy.[28,29] In the recent study, we used intermittent phototheraphy treatment for indirect neonatal hyperbilirubinemia.

Limitations of the study were; firstly, the babies that were required exchange transfusion were not included in the study. However, during the study period no exchange transfusion was required in our hospital. Secondly, the side effects of phototheraphy treatment were not evaluated. Another limitation was that the incidence of kernicterus and permanent neurologic sequelae due to bilirubin induced neurotoxicity were not known.

## CONCLUSION

Our study showed that ABO incompatibility and cephalic hematoma were the most common etiologies in indirect neonatal hyperbilirubinemia. Additionally, male gender, formula as the first prelacteal feed, ABO incompatibility, Rh isoimmunization, cephalic hematoma and sepsis were the risk factors for phototherapy treatment >24 hours period. Also, determination of possible risk factors for neonatal jaundice can provide early hospital admissions by informing mothers before discharge after birth.

## ETHICAL DECLARATIONS

**Ethics Committee Approval:** Ethical clearance was sought and obtained from T.C. Sağlık Bakanlığı, Konya İl Sağlık Müdürlüğü Ethical Committee (IRB Number: 86737044-806.01.03).

**Informed Consent:** Parents of study participants were asked to provide informed voluntary written consent. Assent was also signed by parents for participants to be included in the study.

**Referee Evaluation Process:** Externally peer-reviewed.

**Conflict of Interest Statement:** The authors have no conflicts of interest to declare.

**Financial Disclosure:** The authors declared that this study has received no financial support.

**Author Contributions:** Concept: E.K.A. Design: E.K.A. Data Collection or Processing: E.K.A. Analysis or Interpretation: E.A.K. Literature Search: E.K.A. Writing: E.K.A.

**Acknowledgement:** We thanks to Ahmet Midhat Elmacı, Assoc. Prof. for the statistical analysis.

## REFERENCES

1. Battersby C, Michaelides S, Upton M, Rennie JM; Jaundice Working Group of the Atain. Term admissions to neonatal units in England: a role for transitional care? a retrospective cohort study. Br Med J Open 2017;7(5):e016050.
2. Shapiro SM. Bilirubin toxicity in the developing nervous system. Pediatr Neurol 2003;29:410–21.
3. Dennery PA, Seidman DS, Stevenson DK. Neonatal hyperbilirubinemia. N Engl J Med 2001;344:581–90.
4. American Academy of Pediatrics, Subcommittee on hyperbilirubinemia, management of hyperbilirubinemia in the newborn infant 35 or more weeks of gestation. Pediatrics 2004;114:297–316.
5. Guidelines for detection, management and prevention of hyperbilirubinemia in term and late preterm newborn infants (35 or more weeks' gestation) - Summary. Paediatr Child Health 2007;12(5):401-18.
6. Çoban A, Kaynak Türkmen M, Gürsoy T. Turkish Neonatal Society guideline to the approach, follow-up, and treatment of neonatal jaundice. Turk Arch Pediatr 2018;53:172-9.
7. Bhutani VK, Vilms RJ, Hamerman-Johnson L. Universal bilirubin screening for severe neonatal hyperbilirubinemia. J Perinatol 2010;30:6-15.
8. Johnson L, Bhutani VK, Karp K, Sivieri EM, Shapiro SM. Clinical report from the pilot USA Kernicterus Registry (1992 to 2004). J Perinatol 2009;29:25-45.
9. Manning D, Todd P, Maxwell M, Jane Platt M. Prospective surveillance study of severe hyperbilirubinaemia in the newborn in the UK and Ireland. Arch Dis Child Fetal Neonatal Ed 2007;92(5):342-6.
10. Sgro M, Campbell D, Shah V. Incidence and causes of severe neonatal hyperbilirubinemia in Canada. CMAJ 2006;175(6):587-90.
11. Gamaleldin R, Iskander I, Seoud I, et al. Risk factors for neurotoxicity in newborns with severe neonatal hyperbilirubinemia. Pediatrics 2011;128(4):925-31.
12. Hameed NN, Na' Ma AM, Vilms R, Bhutani VK. Severe neonatal hyperbilirubinemia and adverse short-term consequences in Baghdad, Iraq. Neonatology 2011;100(1):57-63.
13. Iskander I, Gamaleldin R, El Houchi S, et al. Serum bilirubin and bilirubin/albumin ratio as predictors of bilirubin encephalopathy. Pediatrics 2014;134(5):1330-9.
14. Greco C, Arnolda G, Boo NY, et al. Neonatal jaundice in low- and middle-income countries: lessons and future directions from the 2015 Don Ostrow Trieste Yellow Retreat. Neonatology 2016;110(3):172-80.
15. Erdeve O, Okulu E, Olukman O, et al. The Turkish Neonatal Jaundice Online Registry: a national root cause analysis. PLoS One 2018;13(2):0193108.
16. Maisels MJ, Bhutani VK, Bogen D, Newman TB, Stark AR, Watchko JF. Hyperbilirubinemia in the newborn infant > or = 35 weeks' gestation: an update with clarifications. Pediatrics 2009;124(4):1193-8.
17. Wynn JL. Defining neonatal sepsis. Curr Opin Pediatr. 2016;28(2):135-40.
18. Sachdeva M, Murki S, Oleti TP, Kandraju H. Intermittent versus continuous phototherapy for the treatment of neonatal non-hemolytic moderate hyperbilirubinemia in infants more than 34 weeks of gestational age: a randomized controlled trial. Eur J Pediatr 2015;174(2):177-81.
19. Bratild D, Nakstad B, Hansen TW. National guidelines for treatment of jaundice in the newborn, Acta Paediatr 2011;100:499–555.
20. Shapiro SM. Chronic bilirubin encephalopathy: diagnosis and outcome. Semin Fetal Neonatal Med 2010;15:157–63.
21. Radmacher PG, Groves FD, Owa JA, et al. A modified bilirubin-induced neurologic dysfunction (BIND-M) algorithm is useful in evaluating severity of jaundice in a resource-limited setting. BMC Pediatr 2015;15:1–7.
22. Bhutani VK, Zipursky A, Blencowe H, et al. Neonatal hyperbilirubinemia and Rhesus disease of the newborn: incidence and impairment estimates for 2010 at regional and global levels. Pediatr Res 2013;74(Suppl.1):86-100.
23. Gartner LM. Breast feeding and jaundice. J Perinatol 2001;21(S1):25–9.
24. Hudson JA, Charron E, Maple B, et al. Baby-Friendly Hospital Initiative Is Associated with Lower Rates of Neonatal Hyperbilirubinemia. Breastfeed Med 2020;15(3):176-82.
25. Seidman DS, Moise J, Ergaz Z, et al. A new blue light-emitting phototherapy device: A prospective randomized controlled study. J Pediatr 2000;136:771-4.
26. Messner KH, Maisels MJ, Leure-DuPree AE. Phototoxicity to the newborn primate retina. Invest Ophthalmol Vis Sci 1978;17:178-82.
27. Sisson TR, Kendall N, Shaw E, Kechavarz-Oliai L. Phototherapy of jaundice in the newborn infant. II. Effect of various light intensities. J Pediatr 1972:81:35-8.
28. Sachdeva M, Murki S, Oleti TP, Kandraju H. Intermittent versus continuous phototherapy for the treatment of neonatal non-hemolytic moderate hyperbilirubinemia in infants more than 34 weeks of gestational age: a randomized controlled trial. Eur J Pediatr 2015;174(2):177-81.
29. Zhou S, Wu X, Ma A, Zhang M, Liu Y. Analysis of therapeutic effect of intermittent and continuous phototherapy on neonatal hemolytic jaundice. Exp Ther Med 2019;17(5):4007-12.