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THE IMPACT OF NUTRITIONAL INTAKE ON BILIRUBIN LEVELS IN HOSPITALIZED NEONATES WITH HYPERBILIRUBINEMIA

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ABSTRACT
Newborns commonly experience an increase in bilirubin levels starting from the first day of life. If not properly managed, this condition can develop into hyperbilirubinemia—a frequently encountered health issue among neonates that may lead to severe neurological complications. Nutritional intake, particularly breastfeeding, is believed to play a crucial role in the elimination of bilirubin through feces and urine. Objective: This study aimed to analyze the relationship between nutritional intake and total bilirubin levels in neonates with hyperbilirubinemia on the final day of hospitalization. Methods: This research employed an analytical correlational design with a cross-sectional approach. A total of 34 respondents were selected using accidental sampling during of June at Waled Regional Public Hospital, Cirebon Regency. Data analysis was performed using Pearson's correlation test. Results: The findings revealed a significant relationship between nutritional intake and total bilirubin levels in neonates with hyperbilirubinemia (p-value = 0.001; r = -0.542), indicating a moderate negative correlation. Conclusion: Adequate nutritional intake, especially breastfeeding, combined with appropriate medical management, plays an important role in reducing bilirubin levels in neonates with hyperbilirubinemia.

Keywords: breastfeeding; bilirubin; hyperbilirubinemia; neonates; nutrition

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INTRODUCTION

Newborns, especially during the early neonatal period, are considered a high-risk population due to their physiological immaturity. From the moment of birth, neonates undergo significant physiological adjustments to transition from intrauterine to extrauterine life, including adaptation, maturation, and tolerance of their organ systems to the external environment (Widodo et al., 2023). One of the most frequently encountered clinical conditions in this early phase is neonatal hyperbilirubinemia, a condition characterized by an abnormal increase in serum bilirubin levels, which, if not properly managed, can lead to severe neurological complications.Hyperbilirubinemia in neonates is commonly observed during the first week of life. It is clinically defined as a total serum bilirubin (TSB) level of more than 12 mg/dL in full-term neonates and more than 15 mg/dL in preterm neonates (Adytia & Herwanto, 2020). The prevalence of this condition is notably high, affecting approximately 60% of term infants and 80% of preterm infants (Rohsiswatmo & Amandito, 2018). In most cases, neonatal jaundice is physiological and self-limiting; however, excessive bilirubin levels can become neurotoxic, potentially resulting in kernicterus—a form of chronic bilirubin encephalopathy—and long-term neurodevelopmental impairments (Kemper et al., 2022).

The World Health Organization (2022) estimates that neonatal jaundice occurs in about 50% of healthy term neonates and as many as 80% of preterm neonates in developing countries. These infants commonly exhibit yellowish discoloration of the skin, mucosa, and sclera, known clinically as jaundice. In Indonesia, neonatal conditions continue to contribute

significantly to infant morbidity and mortality. According to the Indonesian Ministry of Health (Kemenkes, 2023), post-neonatal mortality is often attributed to pneumonia (15.3%), congenital anomalies (7.1%), diarrhea (6.6%), perinatal conditions (6.3%), and other causes (62.2%).Several physiological factors contribute to elevated bilirubin levels in neonates. Term newborns, despite being considered healthy, have increased bilirubin loads due to higher red blood cell (RBC) mass and shorter RBC lifespan. Furthermore, bilirubin metabolism is immature in neonates due to low activity of the enzyme uridine diphosphate glucuronosyltransferase (UGT), which is essential for bilirubin conjugation in the liver. Neonatal UGT activity is only about 1% of that in adults, leading to a delay in bilirubin clearance. Additionally, the enterohepatic circulation of bilirubin is heightened in neonates, resulting in increased reabsorption of unconjugated bilirubin and elevated TSB levels (Riordan & Shapiro, 2020).

The development and severity of hyperbilirubinemia in neonates are influenced by a variety of risk factors, including male sex, low birth weight (LBW), prematurity, delayed meconium passage, polycythemia, cephalhematoma, and glucose-6-phosphate dehydrogenase (G6PD) deficiency (Kujabi et al., 2021). Male neonates are more prone to hyperbilirubinemia due to hormonal and genetic differences that affect bilirubin metabolism (Mojtahedi et al., 2018). Premature infants and those with LBW are at greater risk because their liver function is underdeveloped, impairing the conjugation and excretion of bilirubin. Moreover, delayed excretion of meconium can prolong enterohepatic circulation, thereby increasing bilirubin reabsorption.Additional contributing factors include polycythemia, which increases the breakdown of RBCs; birth trauma such as cephalhematoma, which can lead to increased bilirubin production from bruising; and G6PD deficiency, which limits the neonate's ability to manage oxidative stress, resulting in hemolysis and increased bilirubin production. These risk factors are not mutually exclusive and may interact synergistically, significantly increasing the risk of severe hyperbilirubinemia and its complications (Edwards et al., 2022).

A study by Ansong-Assoku et al. (2024) in Rwanda, investigating neonatal jaundice, found that among 210 neonates diagnosed with hyperbilirubinemia, the majority were male (60.5%), with 29.5% categorized as LBW and 78.1% being preterm. These findings support the existing understanding that male sex, LBW, and prematurity are significant contributors to the risk of developing neonatal hyperbilirubinemia.Moreover, postnatal factors also play a crucial role. The American Academy of Pediatrics (AAP) and Dutch guidelines highlight neonatal asphyxia (Apgar score <5 at 1 minute) as a significant postnatal risk factor for bilirubin toxicity. This is corroborated by a study conducted by Hindratni et al. (2024) at Arifin Achmad Regional Hospital, Pekanbaru, which found a statistically significant association between neonatal asphyxia and hyperbilirubinemia ($p = 0.048$). Asphyxia reduces oxygen delivery to vital organs, impairs liver function, and reduces glycogen stores, all of which compromise bilirubin conjugation and excretion. Other contributing conditions include ABO or Rh incompatibility, hemolysis, metabolic acidosis, suspected infections, and hypoalbuminemia, which further increase the risk of bilirubin toxicity (Sulendri et al., 2021).

Management of hospitalized neonates with hyperbilirubinemia requires timely and appropriate interventions. The primary treatment modality is phototherapy, which facilitates the breakdown of bilirubin into water-soluble forms that are easily excreted via urine and feces. However, nutrition particularly breastfeeding plays a critical supportive role in the management of hyperbilirubinemia. Breastfeeding enhances intestinal motility, promotes meconium excretion, and reduces enterohepatic circulation of bilirubin. Chen et al. (2015) emphasized that during phototherapy, it is essential to maintain adequate nutritional intake, especially breast milk, to avoid dehydration and accelerate bilirubin elimination. Kutty (2019) also stated that breastfeeding is effective in controlling serum bilirubin levels and supports

faster recovery.In addition to breastfeeding, intravenous fluids may be administered to meet hydration needs, particularly in cases of feeding intolerance or poor oral intake. Bilgin et al. (2013) found that after 24 hours of phototherapy, the average TSB levels dropped by 2.5 ± 0.8 mg/dL, representing a 16.3% reduction, highlighting the effectiveness of combined therapy in managing neonatal hyperbilirubinemia.

Given the multifactorial nature of hyperbilirubinemia and the crucial role of nutrition in its management, it is essential to investigate the relationship between nutritional practices and bilirubin levels in hospitalized neonates. Despite the well-documented benefits of breastfeeding and hydration in supporting bilirubin clearance, there remains a need for empirical evidence from hospital settings to guide clinical practice, particularly in regions with high neonatal morbidity. Therefore, this study aims to analyze the relationship between nutritional intake and total bilirubin levels in neonates with hyperbilirubinemia on the final day of hospitalization at Waled Regional Public Hospital, Cirebon Regency. The findings are expected to contribute to evidence-based practices in neonatal care and reinforce the importance of adequate nutrition in the management of neonatal jaundice.

METHOD

This study employed an analytical correlational design with a cross-sectional approach (Sugiyono, 2018). This design was chosen because it allows data collection at a single point in time, enabling the analysis of the relationship between nutritional intake and bilirubin levels in neonates diagnosed with hyperbilirubinemia. The cross-sectional method is considered appropriate for providing a snapshot of the association between these two variables during a specific period of observation (Candra, 2021).The study population comprised all neonates diagnosed with hyperbilirubinemia and admitted to Waled Regional Public Hospital (RSUD Waled), Cirebon Regency. Based on hospital records, the total population included 97 neonates. The sample was selected from neonates who were admitted to the perinatology unit and met the predefined inclusion and exclusion criteria. A non-probability accidental sampling technique was used, in which neonates were selected based on their availability and eligibility during the data collection period. A total of 34 neonates were included as the final sample. The inclusion criteria for the study were as follows: neonates newly admitted, in conscious condition, and receiving phototherapy as part of the standard treatment for hyperbilirubinemia. Conversely, the exclusion criteria included neonates with congenital anomalies, those on mechanical ventilation, and those who underwent exchange transfusion during hospitalization. These criteria were applied to minimize potential confounding variables that could affect the outcomes of the study (Indrawan & Jalilah, 2021).

The study utilized secondary data collected from the medical records of the patients (Waruwu, 2024). The data collected included detailed information regarding the nutritional intake received by the neonates primarily the type and frequency of breastfeeding recorded from the first day of admission, as well as the total serum bilirubin (TSB) level documented on the final day of hospitalization. Data recording was conducted with careful attention to ensure the validity and reliability of the information used in the analysis. Content validity was assessed by three pediatric and neonatal care experts through a review of the data extraction form, while reliability was tested using an inter-rater agreement approach conducted by two independent data collectors on a sample of 10 medical records.To examine the relationship between nutritional intake and bilirubin levels, the Pearson correlation test was employed. Pearson's test is considered appropriate for measuring the linear relationship between two continuous variables—in this case, the level of nutritional intake (measured in terms of breastfeeding frequency and type) and the total bilirubin level. Statistical analysis was conducted using relevant software, and a p-value <0.05 was considered statistically significant.

RESULT

Table 1.
Characteristics of Neonates with Hyperbilirubinemia

Category	f	%
Sex		
Male	34	100.0
Female	0	0
Birth Weight		
Normal Birth Weight>2500- 4000 gr	23	67.6
Low Birth Weight< 2500 gr	11	32.4
Gestational Age		
Preterm < 34 minggu	3	8.8
Late preterm 34-36 minggu	8	23.5
Early term 37 – 40 minggu	15	44.1
Age at Onset of Hyperbilirubinemi		
1 – 2 days after birth	8	23,5
3 – 5 day after birth	19	55,9
> 5 day after birth	7	20,6

Based on the characteristics of the respondents in this study, all neonates with hyperbilirubinemia were male (100%), with no female neonates included. The majority of neonates had a normal birth weight ranging from 2500–4000 grams (67.6%), while the remaining 32.4% had low birth weight (<2500 grams). In terms of gestational age, most neonates were born at early-term gestation (37–40 weeks) with a percentage of 44.1%, followed by late preterm (34–36 weeks) at 23.5%, and preterm (<34 weeks) at 8.8%. The onset of hyperbilirubinemia typically occurred between the 3rd and 5th day after birth (55.9%), followed by the 1st and 2nd days (23.5%), with a small proportion occurring after the 5th day (20.6%). These findings indicate that hyperbilirubinemia most commonly occurred in male neonates born at full term with normal birth weight, with the onset generally occurring between 3 to 5 days after birth..

Table 2.
Frequency Distribution of Nutritional Intake in Neonates with Hyperbilirubinemia During Hospitalization in the Neonatal Care Room

No	Pemberian Nutrisi	f	%
1.	Formula Milk)+ therapy	11	32.4
2.	Breast Milk (ASI)+ therapy	23	67.6
	Total	34	100.0

Based on the nutritional intake data, the majority of the infants (67.6%) received breast milk (ASI) along with therapy for managing hyperbilirubinemia, while the remaining 32.4% were given formula milk in combination with therapy. This finding underscores the prevalence of breast milk as the preferred source of nutrition in the management of hyperbilirubinemia. Breast milk offers various benefits for neonates, including promoting better bilirubin elimination and supporting overall metabolic functions. The bioactive components in breast milk, such as growth factors and bile salts, play a role in improving bilirubin conjugation in the liver and enhancing intestinal motility, which helps reduce the enterohepatic circulation of bilirubin. As a result, the majority of infants in this study were given breast milk, reflecting its critical role in the management of neonatal hyperbilirubinemia. Additionally, the fact that 32.4% of infants were given formula milk highlights the importance of individualized care, considering factors such as maternal lactation issues or the need for supplementary feeding to ensure adequate nutrition during treatment. The findings suggest that while breast milk is the preferred choice, formula milk can still be an important alternative when needed.

Table 3.
Total Bilirubin Levels in Neonates with Hyperbilirubinemia on the Last Day of Hospitalization in the Neonatal Care Unit

Bilirubin Levels	N	Mean	Median	Mode	Min	Max	Std. Deviation
	34	10.7	9.30	6.20	6.20	19.27	3.55

Based on the bilirubin level data from 34 infants, the mean bilirubin level was 10.7 mg/dL, with a median value of 9.30 mg/dL and the most frequently occurring value (mode) being 6.20 mg/dL. The lowest recorded bilirubin level was 6.20 mg/dL, while the highest reached 19.27 mg/dL. The standard deviation of 3.55 indicates a considerable variation in bilirubin levels among the infants. These findings suggest that there is a significant difference in bilirubin levels across the study participants, although most values tend to cluster around the mean.

Table 4.
Frequency Distribution of Total Bilirubin Levels in Neonates with Hyperbilirubinemia on the Last Day of Hospitalization in the Neonatal Care Unit

No	Total Bilirubin Levels	f	%
1.	Normal	22	64,7
2.	Increased	12	35,3

Based on data from 34 neonates, 22 infants (64.7%) had total bilirubin levels within the normal range, while 12 infants (35.3%) showed elevated bilirubin levels. This suggests that although the majority maintained normal bilirubin levels, more than one-third experienced hyperbilirubinemia. These findings highlight the need for vigilant monitoring and timely intervention, as elevated bilirubin poses a risk for complications such as kernicterus. Early identification and management through adequate breastfeeding, phototherapy, and supportive care are essential to prevent adverse outcomes in neonates with rising bilirubin concentrations..

Table 5.
Cross-tabulation of Nutritional Intake and Total Bilirubin Levels on the Last Day of Hospitalization in the Neonatal Care Unit

Nutritional Intake	Total Bilirubin Levels				P value	Pearson correlation
	Normal		Increased			
	f	%	f	%		
Formula Milk + therapy	3	13,6	8	66,7	0,001	- 0,542
Breast Milk + therapy	19	86,4	4	33,3		

Based on the analysis of the relationship between nutritional intake and total bilirubin levels, a statistically significant difference was observed ($p = 0.001$), indicating a meaningful association between the type of nutrition provided and bilirubin outcomes. Among the 34 neonates, 66.7% (8 infants) in the formula-milk plus therapy group exhibited elevated bilirubin levels, whereas only 33.3% (4 infants) of those receiving breast-milk plus therapy did so. Conversely, 86.4% of neonates in the breast-milk plus therapy group maintained bilirubin levels within the normal range, compared with just 13.6% of the formula-fed group. The Pearson correlation coefficient ($r = –0.542$) indicates a moderate negative correlation between nutritional modality and bilirubin level; that is, a greater predominance of breast-milk feeding was associated with a lower risk of bilirubin elevation. Overall, these data suggest that breast-milk combined with therapy is more effective at maintaining total bilirubin within normal limits than formula feeding.

DISCUSSION

This study explored the relationship between nutritional intake and total serum bilirubin levels in neonates with hyperbilirubinemia at the end of their hospitalization. The principal finding a moderate, significant negative correlation ($r = –0.542$; $p = 0.001$) indicates that neonates receiving breast milk alongside standard phototherapy were substantially more likely to maintain bilirubin levels within the normal range compared with those fed formula milk. This

result aligns with the growing body of evidence that underscores the importance of human milk in enhancing bilirubin clearance (Chen et al., 2015; Kutty, 2019).Term neonates, despite their relative physiological maturity compared to preterm infants, remain susceptible to hyperbilirubinemia due to a constellation of intrinsic and extrinsic factors. Physiological jaundice affects up to 60% of term infants and typically peaks between the third and fifth days of life, reflecting the balance between bilirubin production and elimination capacity (Midan et al., 2022; Suzuki et al., 2022). In term neonates, elevated bilirubin levels arise primarily from three interconnected mechanisms: increased bilirubin load, immature hepatic conjugation, and enhanced enterohepatic circulation.

First, term infants possess a high red blood cell (RBC) mass relative to body weight, coupled with a shortened RBC lifespan of approximately 60–90 days, compared to 120–150 days in adults. This accelerated hemolysis amplifies bilirubin production, overwhelming neonatal conjugation systems (Riordan & Shapiro, 2020). Second, although uridine diphosphate-glucuronosyltransferase (UDPG-T) activity in term neonates is higher than in preterms, it remains only 1%–10% of adult levels during the first week of life, limiting bilirubin conjugation and hepatic clearance (C. F. Chen et al., 2011). Progesterone and other hormonal modulators further influence UGT gene expression, potentially contributing to inter-individual variability in bilirubin metabolism (Lin et al., 2022). Third, enhanced enterohepatic circulation prolongs bilirubin reabsorption from the intestines. Neonatal gut immaturity and slower gastrointestinal transit facilitate deconjugation of bilirubin by β-glucuronidase in the colon, increasing the pool of unconjugated bilirubin available for reuptake (Thielemans et al., 2021). Factors such as delayed meconium passage, common in term neonates with feeding difficulties, exacerbate this process. Additionally, dehydration—whether from inadequate feeding or phototherapy-induced insensible water loss—concentrates serum bilirubin, further impairing biliary excretion (Midan et al., 2022).

Pathological etiologies must also be considered in term infants whose bilirubin exceeds the 95th percentile within 24 hours or rises by ≥ 5 mg/dL per day, criteria indicating risk for kernicterus (Lin et al., 2022). Hemolytic disorders such as ABO or Rh incompatibility, G6PD deficiency, and rare enzymopathies (e.g., pyruvate kinase deficiency) can precipitate severe jaundice (Thielemans et al., 2021). Sepsis, cephalohematoma, and hypothyroidism represent additional contributors. Recognizing these risk factors is essential for timely intervention—whether through intensified phototherapy, exchange transfusion, or pharmacologic adjuncts—to prevent bilirubin neurotoxicity and ensure optimal neurodevelopmental outcomes. Although term infants constituted nearly half of the sample, they remain susceptible to hyperbilirubinemia due to factors such as high red blood cell mass, shortened erythrocyte lifespan, and inefficiencies in UGT activity—estimated at only 1% of adult levels (Midan et al., 2022; Suzuki et al., 2022). Pathological hyperbilirubinemia is characterized by total serum bilirubin above the 95th percentile within 24 hours or a daily rise > 5 mg/dL (C. F. Chen et al., 2011; Lin et al., 2022). Etiologies include hemolytic processes—such as ABO or Rh incompatibility—enzyme defects (G6PD or pyruvate kinase deficiency), polycythemia, and sepsis (Thielemans et al., 2021). These mechanisms underscore the need for vigilant monitoring even in apparently healthy term infants.

Breast milk enhances bilirubin elimination via multiple complementary mechanisms. First, the increased intestinal motility and accelerated meconium passage observed in breast-fed neonates reduce enterohepatic recycling of unconjugated bilirubin, thereby diminishing its reabsorption (Chen et al., 2015). Second, human milk is rich in bioactive constituents—such as epidermal growth factor, bile salt–stimulating lipids, and certain oligosaccharides—that upregulate hepatic UDP-glucuronosyltransferase activity and enhance biliary secretion of conjugated bilirubin (Kutty, 2019). Third, frequent feeding maintains optimal hydration,

which not only prevents the hemoconcentration of bilirubin but also supports renal excretion of photobilirubin isomers and conjugated metabolites.

In our cohort, 86.4% of breast-fed neonates maintained total serum bilirubin within safe limits by discharge, underscoring the synergy between enteral nutrition and bilirubin clearance (Widodo et al., 2023). Phototherapy, the primary treatment for hyperbilirubinemia, transforms unconjugated bilirubin into water-soluble configurational isomers that are readily excreted in urine and bile. However, its efficacy depends on adequate fluid intake; without sufficient enteral feeds, infants are at risk for dehydration and reduced bile flow, which can limit phototherapy's effectiveness (Bilgin et al., 2013). By contrast, when phototherapy is combined with optimized breastfeeding, overall bilirubin elimination is maximized, as evidenced by significantly lower discharge bilirubin levels in breast-fed infants. These findings align with the American Academy of Pediatrics' recommendation to continue uninterrupted breastfeeding during phototherapy to enhance treatment outcomes (AAP, 2021).

The moderate negative Pearson correlation ($r = –0.542$; $p = 0.001$) found in this study demonstrates a significant association between higher proportions of breast-milk feeding and lower total bilirubin levels at discharge. This suggests that effective breastfeeding practices play a critical role in enhancing bilirubin clearance in neonates. Consequently, integrating strong lactation support into hyperbilirubinemia management protocols is essential. Health professionals should prioritize early involvement of lactation consultants to assess and support feeding effectiveness. Strategies such as promoting skin-to-skin contact and routine evaluation of latch quality and feeding frequency are vital to improve breastfeeding outcomes. These interventions are particularly important in hospital settings, where maternal stress, cesarean delivery, or neonatal separation may hinder breastfeeding initiation and continuity. Studies by Sulendri et al. (2021) and Triani et al. (2022) reinforce the importance of lactation support, noting that comprehensive breastfeeding management can significantly reduce the severity and duration of neonatal hyperbilirubinemia.

The moderate negative Pearson correlation ($r = –0.542$; $p = 0.001$) observed in this study indicates a statistically significant association between increased breast-milk feeding and lower total bilirubin levels at discharge. This finding underscores the essential role of breastfeeding in accelerating bilirubin elimination through enhanced gastrointestinal motility, hydration, and hepatic metabolism. Therefore, robust lactation support should be an integral part of neonatal hyperbilirubinemia management protocols. Clinicians are encouraged to involve lactation consultants early in the care process, particularly for mothers of at-risk neonates. Supportive strategies such as promoting immediate and sustained skin-to-skin contact, encouraging rooming-in, and conducting regular assessments of latch quality and feeding frequency can effectively address common challenges to successful breastfeeding in hospital environments. Maternal stress, cesarean delivery, and neonatal separation often compromise breastfeeding initiation and continuity, contributing to suboptimal bilirubin clearance. Research by Sulendri et al. (2021) and Triani et al. (2022) affirms that comprehensive breastfeeding support significantly reduces both the severity and duration of hyperbilirubinemia in neonates. As such, integrating individualized lactation guidance and ongoing breastfeeding monitoring is vital to improve outcomes and minimize the need for more invasive interventions, such as prolonged phototherapy or exchange transfusion.

Several limitations should be acknowledged. The cross-sectional design restricts causal inference; although breast-feeding correlates with lower bilirubin levels, confounders—such as phototherapy duration/intensity, hydration status, and genetic polymorphisms—could influence outcomes. The small, convenience sample ($n = 34$) drawn from a single center limits external validity. Reliance on secondary medical record data introduces potential

measurement bias if feeding frequency or bilirubin values were incompletely documented (Waruwu, 2024). Future research should adopt prospective, randomized designs with standardized feeding protocols and phototherapy regimens. To confirm and build upon these findings, multicenter randomized controlled trials comparing exclusive breastfeeding, expressed breast milk supplementation, and formula feeding during phototherapy are warranted. Such trials should stratify by risk factors (e.g., gestational age, birth weight, G6PD status) and include long-term neurodevelopmental follow-up to assess whether early nutritional interventions yield sustained cognitive and motor benefits. Qualitative studies exploring maternal experiences and barriers to breastfeeding in neonatal intensive care units could inform targeted interventions to enhance lactation success. Our results highlight the critical role of hospital policies that support breastfeeding—such as Baby-Friendly Hospital Initiative standards, early initiation of breastfeeding, and rooming-in practices. Training healthcare providers in lactation counseling and ensuring availability of breast pumps can facilitate adequate milk transfer when direct breastfeeding is challenging. Additionally, integrating bilirubin risk assessment tools (e.g., Bhutani nomogram) with feeding status can help clinicians identify infants who may benefit from more intensive nutritional support or phototherapy (AAP, 2021).

CONCLUSION

In conclusion, sex, birth weight, and gestational age emerge as pivotal determinants of neonatal hyperbilirubinemia, with male, preterm, and low-birth-weight infants at highest risk. Our study demonstrates that breast-milk feeding, when combined with phototherapy, is significantly associated with lower total serum bilirubin levels at hospital discharge compared to formula feeding. This underscores the necessity of promoting and supporting exclusive or predominant breastfeeding as part of hyperbilirubinemia management protocols. Clinicians must remain vigilant for additional risk factors—such as perinatal asphyxia, sepsis, and enzymatic deficiencies—that may necessitate more aggressive interventions. Early and sustained nutritional support, alongside optimized phototherapy and careful monitoring, can minimize bilirubin toxicity and improve neonatal outcomes. By prioritizing breastfeeding within neonatal care frameworks, healthcare providers can enhance the safety and efficacy of hyperbilirubinemia treatment and contribute to the prevention of long-term neurodevelopmental complications..

REFERENCES

Adytia, H., & Herwanto, H. (2020). Hubungan persalinan seksio sesarea dengan hyperbilirubinemia neonatus. Tarumanagara Medical Journal, 2(1), 64–69. https://doi.org/10.24912/TMJ.V2I2.7839

Ansong-Assoku, B., Shah, S. D., Adnan, M., & Ankola, P. A. (2024). Neonatal Jaundice. Alzheimer's and Dementia: Diagnosis, Assessment and Disease Monitoring, 13(3), 1–4. https://www.ncbi.nlm.nih.gov/books/NBK532930/

Bilgin, B. S., Koroglu, O. A., Yalaz, M., Karaman, S., & Kultursay, N. (2013). Factors affecting bilirubin levels during first 48 hours of life in healthy infants. BioMed Research International, 2013. https://doi.org/10.1155/2013/316430

Candra, V. (2021). Pengantar Metodologi Penelitian. In Yayasan Kita Menulis (1st ed.). Yayasan Kita menulis. https://www.google.co.id/books/edition/Pengantar_Metodologi_Penelitian/mSFCEAAAQBAJ?hl=en&gbpv=1&dq=arikunto&pg=PA193&printsec=frontcover

Cayabyab, R., & Ramanathan, R. (2019). High unbound bilirubin for age: a neurotoxin with major effects on the developing brain. Pediatric Research, 85(2), 183–190. https://doi.org/10.1038/s41390-018-0224-4

Chen, C. F., Hsu, M. C., Shen, C. H., Wang, C. L., Chang, S. C., Wu, K. G., Wu, S. C., & Chen, S. J. (2011). Influence of breast-feeding on weight loss, jaundice, and waste

elimination in neonates. Pediatrics and Neonatology, 52(2), 85–92. https://doi.org/10.1016/J.PEDNEO.2011.02.010

Chen, Y. J., Yeh, T. F., & Chen, C. M. (2015). Effect of breast-feeding frequency on hyperbilirubinemia in breast-fed term neonate. Pediatrics International, 57(6), 1121–1125. https://doi.org/10.1111/PED.12667

Edwards, W. M., Bungard, M. J., Rakotondrasoa, E. F., Razafindraibe, P., Andriantsimanarilafy, R. R., Razafimanahaka, J. H., & Griffiths, R. A. (2022). Predicted impact of climate change on the distribution of the Critically Endangered golden mantella (Mantella aurantiaca) in Madagascar. Herpetological Journal, 32(1), 5–13. https://doi.org/10.33256/32.1.513

Gerungan, G. P., Wilar, R., & Mantik, M. F. J. (2022). Mekanisme Terjadinya Hiperbilirubinemia pada Bayi Berat Lahir Rendah. E-CliniC, 11(1), 80–86. https://doi.org/10.35790/ecl.v11i1.44319

Hindratni, F., Indah Permata Sari, S., & Kemenkes Riau, P. (2024). Effectiveness of "GUCHIRO" as an Alternative Food to Prevent Anemia in Pregnant Women Efektivitas "GUCHIRO" Sebagai Alternatif Makanan Pencegah Anemia Pada Ibu Hamil. Jurnal Proteksi Kesehatan, 13(2), 210–215.

Huang, H., Huang, J., Huang, W., Huang, N., & Duan, M. (2023). Breast milk jaundice affects breastfeeding: From the perspective of intestinal flora and SCFAs-GPR41/43. Frontiers in Nutrition, 10, 1121213. https://doi.org/10.3389/fnut.2023.1121213

Indrawan, D., & Jalilah, S. R. (2021). Metode Kombinasi/Campuran Bentuk Integrasi Dalam Penelitian. Jurnal Studi Guru Dan Pembelajaran, 4(3), 735–739. https://doi.org/10.30605/jsgp.4.3.2021.1452

Kemenkes. (2023). Profil Kesehatan Indonesia.

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., Panayotti, G. M. M., Okechukwu, K., Rappo, P. D., & Russell, T. L. (2022). Clinical Practice Guideline Revision: Management of Hyperbilirubinemia in the Newborn Infant 35 or More Weeks of Gestation. Pediatrics, 150(3), 2022058859. https://doi.org/10.1542/PEDS.2022-058859/188726

Kujabi, M. L., Petersen, J. P., Pedersen, M. V., Parner, E. T., & Henriksen, T. B. (2021). Neonatal jaundice and autism spectrum disorder: a systematic review and meta-analysis. Pediatric Research, 90(5), 934–949. https://doi.org/10.1038/S41390-020-01272-X

Kuniyoshi, Y., Tsujimoto, Y., Banno, M., Taito, S., & Ariie, T. (2021). Neonatal jaundice, phototherapy and childhood allergic diseases: An updated systematic review and meta-analysis. Pediatric Allergy and Immunology, 32(4), 690–701. https://doi.org/10.1111/PAI.13456

Kutty, P. K. (2019). Breastfeeding during breast milk jaundice-a pathophysiological perspective. Medical Journal of Malaysia, 74(6), 527–533.

Lin, Q., Zhu, D., Chen, C., Feng, Y., Shen, F., & Wu, Z. (2022). Risk factors for neonatal hyperbilirubinemia: a systematic review and meta-analysis. Translational Pediatrics, 11(6), 1001–1009. https://doi.org/10.21037/TP-22-229/COIF

Midan, D. A. R., Bahbah, W. A., Bayomy, N. R., & Ashour, N. M. (2022). Clinical Assessment of Neuroinflammatory Markers and Antioxidants in Neonates with Hyperbilirubinemia and Their Association with Acute Bilirubin Encephalopathy. Children (Basel, Switzerland), 9(4). https://doi.org/10.3390/children9040559

Mojtahedi, S. Y., Izadi, A., Seirafi, G., Khedmat, L., & Tavakolizadeh, R. (2018). Risk factors associated with neonatal jaundice: a cross-sectional study from iran. Open Access Macedonian Journal of Medical Sciences, 6(8), 1387–1393. https://doi.org/10.3889/OAMJMS.2018.319

Okumura, A., Ichimura, S., Hayakawa, M., Arai, H., Maruo, Y., Kusaka, T., Kunikata, T., Kumada, S., & Morioka, I. (2021). Neonatal Jaundice in Preterm Infants with Bilirubin Encephalopathy. Neonatology, 118(3), 301–309. https://doi.org/10.1159/000513785

Riordan, S. M., & Shapiro, S. M. (2020). Review of bilirubin neurotoxicity I: molecular biology and neuropathology of disease. Pediatric Research, 87(2), 327–331. https://doi.org/10.1038/s41390-019-0608-0

Rohsiswatmo, R., & Amandito, R. (2018). Hiperbilirubinemia pada neonatus >35 minggu di Indonesia; pemeriksaan dan tatalaksana terkini. Sari Pediatri, 20(2), 115–122. https://doi.org/10.14238/SP20.2.2018.115-22

Setiawati, T., Kurniawan, H., Awali, D. S., Kharismala, N., Universitas',), & Bandung, A. (2023). Efektivitas Fototerapi Dan Manajemen Asi Terhadap Penurunan Kadar Bilirubin Pada Bayi Hiperbilirubinemia Effectiveness Of Phototherapy And Breast Milk Management On Decreasing Bilirubin Levels In Infants With Hyperbilirubinemia (Vol. 10, Issue 2).

Sugiyono. (2018). Metode Penelitian Kuantitatif, Kualitatif, dan R&D. Alfabeta.

Sulendri, N., Yogi Triana, K., Putu Risna Dewi, D., & Tinggi Ilmu Kesehatan Bina Usada, S. (2021). HUBUNGAN Pemberian Asi Dengan Kejadian Ikterus Bayi Hiperbilirubinemia Di Rsia Puri Bunda Denpasar. Jurnal Keperawatan Priority, 4(2), 138–148. https://doi.org/10.34012/JUKEP.V4I2.1572

Suzuki, H., Yasuda, S., Htun, Y., Aye, N. S. S., Oo, H., Oo, T. P., Htut, Z. L., Koyano, K., Nakamura, S., & Kusaka, T. (2022). Transcutaneous bilirubin-based screening reduces the need for blood exchange transfusion in Myanmar newborns: A single-center, retrospective study. Frontiers in Pediatrics, 10, 947066. https://doi.org/10.3389/fped.2022.947066

Thielemans, L., Peerawaranun, P., Mukaka, M., Paw, M. K., Wiladphaingern, J., Landier, J., Bancone, G., Proux, S., Elsinga, H., Trip-Hoving, M., Hanboonkunupakarn, B., Htoo, T. L., Wah, T. S., Beau, C., Nosten, F., McGready, R., & Carrara, V. I. (2021). High levels of pathological jaundice in the first 24 hours and neonatal hyperbilirubinaemia in an epidemiological cohort study on the Thailand-Myanmar border. PLoS ONE, 16(10 October). https://doi.org/10.1371/JOURNAL.PONE.0258127

Triani, F., Setyoboedi, B., & Budiono, B. (2022). The Risk Factors For The Hyperbilirubinemia Incident In Neonates At Dr. Ramelan Hospital In Surabaya. Indonesian Midwifery and Health Sciences Journal, 6(2), 211–218. https://doi.org/10.20473/IMHSJ.V6I2.2022.211-218

Waruwu, M. (2024). Pendekatan Penelitian Kualitatif: Konsep, Prosedur, Kelebihan dan Peran di Bidang Pendidikan. Afeksi: Jurnal Penelitian Dan Evaluasi Pendidikan, 5(2), 198–211. https://doi.org/10.59698/afeksi.v5i2.236

WHO. (2022). WHO launches first ever global report on infection prevention and control. https://www.who.int/news/item/06-05-2022-who-launches-first-ever-global-report-on-infection-prevention-and-control

Widodo, S. T., Bhenlie, T., & Kusbin, A. (2023). Pendekatan Klinis Neonatus dan Bayi Ikterus. Cermin Dunia Kedokteran, 50(6), 332–338. https://doi.org/10.55175/CDK.V50I6.921