https://menj.journals.ekb.eg
Print ISSN: 2735-3974
Online ISSN: 2735-3982
DOI: 10.21608/MENJ.2024.354776

MNJ
Menoufia Nursing Journal
Faculty of Nursing
Menoufia University

Routine Phototherapy Vs Aluminum Foil Associated Phototherapy : Effect on Neonatal Hyperbilirubinemia

Ragaa Gasim Ahmed Mohmmed

Assistant Professor in Pediatric and Child Health Nursing, Faculty of Applied Medical Sciences, Al-Baha University

Abstract: Background: Using reflective material such as aluminum foil increases light intensity on infants' bodies, which could influence hyperbilirubinemia. **Purpose:** To assess the effect of phototherapy alone versus in combination with reflective aluminum foil on newborns with unconjugated hyperbilirubinemia. **Methods:** A quasi-experimental research design was utilized. **Setting**: It was conducted in El-Khartoum Teaching Hospital at Neonatal Intensive Care Unit (NICU), Sudan. **Sample**: It involved a purposive sample of 60 newborns assigned to the study and control groups (30 newborns in each). **Instruments**: Two instruments were used for data collection (Characteristics of neonates structured questionnaire and neonatal outcomes structured questionnaire). **Results:** On admission, the level of bilirubin was 15.93± 2.97 among neonates in the study group and 15.67± 2.19 among neonates in the control group, while on discharge, the level of bilirubin was 9.03± 1.65 among neonates in the study group and 12.90± 1.79 among neonates in the control group. The mean difference in reduction of bilirubin level was very highly significant (P=0.00). The hospital stay of neonates in the study group was significantly shorter (5.77± .568 versus 11.60± .675, p=0.000) than in the control group. **Conclusion**: Phototherapy with aluminum foil reflectors for newborns with hyperbilirubinemia has a beneficial effect on reducing bilirubin levels and earlier discharge from the hospital. **Recommendations**: Nurses in hospitals should receive training on the use of phototherapy with an aluminum foil reflector as part of their standard care.

***Keywords**: Aluminum foil, Neonatal, Hyperbilirubinemia*

Introduction:

The neonatal period is a period from birth to the first four weeks of life. It is considered one of the most vulnerable times of the human cycle (Kenawi et al., 2020). Physiological immaturity-related jaundice often manifests between 24 and 72 hours of life, peaks by 4-5 days for term neonates and by the 7th day for preterm neonates (Agarwal et al., 2014).

Based on empirical research, newborn jaundice is a primary cause of readmissions for neonates who are discharged from the hospital. When jaundice is seen during a clinical examination, the condition is known as hyperbilirubinemia (Salia et al.,

2021). Approximately 10% of neonates are likely to experience hyperbilirubinemia that is clinically severe and needs to be closely monitored and treated (Zhang et al., 2021).

An increase in serum bilirubin is the cause of neonatal jaundice, which is characterized by a yellowish discoloration of skin, mucous membranes, and sclera. An increase in unconjugated bilirubin levels is the most common symptom of newborn hyperbilirubinemia (Aboelmagd, Tawfiq, and Mohamed, 2022). Neonatal hyperbilirubinemia, which affects over 60% of term neonates and 80% of preterm neonates, is one of the most prevalent conditions in newborns (Dachlan, Yuniati, & Sukadi, 2015). The most obvious clinical sign of hyperbilirubinemia in plasma is jaundice, which can be identified when serum total bilirubin levels are higher than 5-7 mg/dl (Alencar et al., 2021). Due to calorie shortage, breastfeeding exacerbates physiologic jaundice during the first postnatal week, which increases enterohepatic circulation. Other factors include mild dehydration and delayed meconium passing (Lauer & Spector, 2011).

Neonates with hyperbilirubinemia and immature blood-brain barrier are susceptible to neonatal encephalopathy. This may cause kernicterus, which could lead to inferior neurodevelopmental outcomes, athetoid cerebral palsy, and deafness in an undetermined number of children (Waqar, Arham & Razzaq, 2013). During the first three to five days of life, physiological jaundice begins to manifest. It peaks at 5 to 6 mg/dl (86 to 103 μmol/l) at the end of the first week and returns to normal in 10 to 12 days for term babies. Values beyond this threshold (7–17 mg/dl [104–291 μmol/l]) result in exaggerated physiologic jaundice (Waqar, Arham & Razzaq, 2013).

For neonates with hyperbilirubinemia or at risk of acquiring it, three therapies are utilized to lower total serum bilirubin (TSB) levels: exchange transfusion, phototherapy, and stimulation of enteral feeding (Joel et al., 2020). Bilirubin undergoes a chemical transformation upon exposure to light, facilitating its fast excretion and obviating the necessity for liver conjugation (Bura'a & Younis, 2023). Phototherapy has been acknowledged as a successful non-invasive treatment for newborn jaundice since 1958 (Neghabadi et al., 2015).

According to the American Academy of Pediatrics report, there are still significant differences in the spectrum output, irradiance levels, and irradiated area offered by commercial phototherapy systems, even after a long time of development since the original paper by Cremer et al (Kurniasih et al., 2011). Bilirubin found in the skin's superficial capillaries, interstitial spaces, and subcutaneous tissues is transformed by phototherapy into isomers that are soluble in water and excretable without the need for additional liver metabolism (Stokowski, 2011).

For phototherapy to be an effective first line of treatment, a neonate must have light emission spectra with

bilirubin absorption between 400 and 520 nm, an irradiance of at least 10 µW/cm2/nm, an optimal length of light exposure, and light exposure covering at least 80% of their body surface area (Amadi et al., 2020).

Aluminum foil is easy to fold into any shape because of its thinness. Since aluminum foil is the "whitest" metal, it will directly reflect and absorb all light. Depending on the wavelength and irradiance, aluminum foil can reflect anywhere from 92% to 98% of the incident light when used as a reflector.

Aluminum foil is more affordable than other materials, easier to maintain, takes less time and effort to make, and has no unfavorable side effects (Aboelmagd, Tawfiq, & Mohamed, 2022). Aluminum foil and white fabric are examples of bright surfaces that can reflect scattered phototherapy light.

Because they are reflecting, curtains made of reflective materials are typically put around the baby's cot and attached to the phototherapy unit to collect light that may otherwise be distributed away from neonates and reflect it onto them (Rostenberghe et al., 2020). Using surfaces that reflect light, like aluminum foil, can increase the amount of body surface exposed to sunlight, which lowers total serum bilirubin in phototherapy protocols (Basiri et al., 2020).

Identification of the neonate at risk, parent education and support, and nursing care for newborns receiving hyperbilirubinemia treatment are all crucial tasks performed by the neonatal nurse. The neonatal nurse is responsible for facilitating communication between parents, lab staff, doctors, and other members of the newborn care team (Ibrahim et al, 2019).

During phototherapy, newborns need nursing care that include monitoring room temperature, positioning, body temperature, skincare, hydration, feeding, umbilical stump care, eye care, genital care, and nursing care that is based on evidence (Pandey, 2023).

Purpose of the study:

To assess the effect of phototherapy alone versus in combination with reflective aluminum foil on newborns with unconjugated hyperbilirubinemia

Hypotheses of the study:

- **Hypothesis one:** Neonates who receive phototherapy associated with aluminum foil application (study group) are expected to have lower bilirubin levels than neonates in the control group..
- **Hypothesis two:** Neonates who receive phototherapy associated with aluminum foil application (study group) are expected to have a shorter duration of hospitalization than neonates in the control group.

Methods

Design:

A quasi-experimental research design (study and control groups) was utilized.

Setting:

The study was carried out in El-Khartoum Teaching Hospital, neonatal intensive care unit (NICU), Sudan

Sampling:

A purposive sample of 60 neonates with unconjugated hyperbilirubinemia was selected. A simple random sample was done to assign neonates equally into a study and control groups.

Inclusion criteria:

Full-term neonates diagnosed with unconjugated hyperbilirubinemia. Uncomplicated neonatal hyperbilirubinemia present in the first 7 days of life.

Exclusion criteria:

It included: Congenital malformations, cardiac abnormalities recent surgery, serious infection, and all newborns with neonatal hyperbilirubinemia onset at <24 hours of life. They were excluded to avoid their possible influence on physiological functions that may affect hyperbilirubinemia.

Instruments:

The data collection instruments contained two parts:

- **Part one:** It contains characteristics of newborns such as neonatal sex, neonatal age, neonatal gestation age, neonatal weight, neonatal feeding pattern, and number of phototherapy lambs.
- **Part two:** The neonatal outcome sheet was developed by the researcher to evaluate the outcomes of the newborns with hyperbilirubinemia in pre- and post-intervention and also for the control group. It contained the following information: the newborn's total serum bilirubin level and length of hospital stay.

Reliability:

Reliability was estimated among 12 participants by using a test-retest method. Then, the correlation coefficient was calculated between the two scores. The correlation coefficient was 0.83. So, the instrument is reliable in detecting the objectives of the study

Validity:

The instruments were tested for validity by a jury of five experts (assistant professors in the pediatric nursing field) to ascertain relevance and completeness. The relevancy, clarity, fluency, and ease of each component in the questionnaire were examined by the experts and they found that the questionnaire was useful and helpful.

Ethical Consideration:

Formal written consent was obtained from eligible mothers after they received information about the purpose of the study and methods of data collection. Then, they were informed that participation in the study was voluntary. Also, they were ascertained that they were free to withdraw at any time.

Data collection procedure:

The data collection period lasted from the beginning of June 2022 to September 2022 during the morning and afternoon shifts. Data was collected from neonates in the study and control groups about their characteristics of the total serum bilirubin upon admission before the beginning of phototherapy, and it was recorded in the outcome sheet of each neonate. Then, they wore just diapers

and eye covers to minimize ocular injury, and the distance between the phototherapy and the neonate was adjusted to 45 cm before beginning phototherapy. A wavelength range of 460–490 nm was used. White light phototherapy was applied in single, double, and triple configurations.

During neonatal care, phototherapy was discontinued. The newborns' positions were turned every two to three hours to optimize the amount of skin exposed to light. Finally, the total serum bilirubin level was assessed after finishing phototherapy and recorded in the neonatal outcome sheet.

For the study group:

Neonates received phototherapy and routine hospital care. Besides, aluminum foil reflective materials were stretched on three sides of the incubator,

For the control group:

Neonates only received phototherapy accompanied by routine care.

For the study and control groups:

Serum bilirubin level was reassessed at the 12th, 24th, and 48th hours, then every 24 hours.

Statistical analysis

Social science statistical software (SPSS 22) was used to tabulate and analyze the data. Chi-square test, paired and independent sample ttest, mean, standard deviation, and percentages were all used in statistical analysis. A statistically significant difference was considered if P≤.05. A highly statistically significant difference was considered P≤.01. A very highly statistically significant difference was considered if P≤.001.

Results

Table 1 illustrates the characteristics of the newborns. Male newborns were more than females in the study (60% VS 53.3%) and control group (40% VS 46.7%) respectively. Furthermore, more than half of newborns in the study and control groups were less than 3 days old (50% VS 63.3%). The lowest percent of neonates' in both groups was 40 weeks (6.7%). Their means were (38.20±.925 VS 38.03±.890) respectively. Additionally, the mean neonatal weight in grams for the study and control groups was 3039.17±367.009 VS 2928.76±370.352 respectively. Thereafter, more than half neonates in the study and control group were breastfeeding (66.6%).

Table 2 shows that there is no statistically significant difference in neonatal bilirubin level upon hospitalization between the study and control groups (15.93± 2.97 VS 15.67 ±2.19, p-value, .694).

Table 3 shows that there is a statistically significant difference in neonatal bilirubin level on hospital discharge between the study and control groups (9.03 ±1.65 VS 12.90 ±1.79, p-value, .000).

Table 4 declares that neonates in the study group had shorter hospital stays than neonates in the control group, (5.77± .568 versus 11.60± .675). Therefore, there were very highly statistically significant differences (P=0.000).

Table 1: Characteristics of Newborns in the Study and Control Groups in El-Khartoum Teaching Hospital, Sudan. (n = 60)

Characteristics	Study	Control	P value
Neonatal sex: Male Female	 18 (60) 12 (40)	 16 (53.3) 14 (46.7)	.610**
Neonatal age in days: <3 days 3-7 days >7 days	 15 (50) 11 (36.6) 4 (13.4)	 19 (63.3) 7 (23.3) 4 (13.4)	.479**
Neonatal gestational age in weeks: 37 weeks 38 weeks 39 weeks 40 weeks	 8 (26.7) 10 (33.3) 10 (33.3) 2 (6.7)	 9 (30) 13 (43.3) 6 (20) 2 (6.7)	.480**
M &SD	38.20±.925	38.03±.890	
Mean neonatal weight in grams	3039.17±367.009	2928.76±370.352	.250*
Neonatal feeding type: Breastfeeding Formula feeding Mixed	 20 (66.6) 6 (20) 4 (13.4)	 20 (66.6) 5 (16.7) 5 (16.7)	.885**

* An independent ttest showed no statistically significant difference

**A chi-square test showed no statistically significant difference

Table 2: Levels of Bilirubin among Neonates in the Study and Control Groups upon Admission

Variable	Study (Mean ± SD)	Control (Mean ± SD)	P value
Neonatal bilirubin level in gm/dl upon hospital admission	15.93± 2.97	15.67± 2.19	.694

* An independent ttest showed no statistical significant difference

Table 3: Levels of Bilirubin among Neonates in the Study and Control Groups upon Discharge

Groups / Variable	Study (Mean ± SD)	Control (Mean ± SD)	P value
Neonatal bilirubin level in gm/dl upon discharge	9.03± 1.65	12.90± 1.79	.000*

* An independent ttest showed a very highly statistically significant difference

Table 4: Mean of Duration of Hospitalization of Neonates in the Study and Control Groups

Groups / Variable	Study (Mean ± SD)	Control (Mean ± SD)	P value
Duration of hospitalization in days	5.77± .568	11.60± .675	.000*

*An independent ttest showed a very highly statistically significant difference

Discussion

Using visible light to treat neonates with hyperbilirubinemia is known as phototherapy. The conversion of bilirubin into water-soluble isomers that may be excreted without liver conjugation decreases serum bilirubin levels (Kurniasih et al., 2011). The light source, light intensity, distance between the phototherapy unit and the newborn, and the ideal amount of skin surface exposed to light all affect how effective phototherapy is (Dachlan, Yuniati, & Sukadi, 2015). The purpose of the study was to assess the effect of phototherapy alone versus phototherapy in combination with reflective aluminum foil on newborns

For the first hypothesis, the results of this study showed that the use of reflective material such as aluminum foil reflector with phototherapy was very effective in reducing the level of total serum bilirubin. These results were supported by GunjanNidh & Sharma (2021) who mentioned that phototherapy accompanied by an aluminum foil reflector was more effective in reducing the level of bilirubin in neonates with hyperbilirubinemia than utilization of phototherapy alone.

Also, this result

agreed with Abo Elmagd, Tawfiq & Mohamed (2022) who studied the effect of phototherapy in association with a reflecting aluminum foil on bilirubin levels in neonates. This could be attributed to the fact that aluminum foil does not absorb the light of phototherapy. Instead, it reflects it and increases its intensity. As a result, the mean bilirubin level for neonates in the study group was less than neonates in the control group (9.03± 1.65 compared to 12.90± 1.79).

On the other hand, the findings of the current study were different from Basiri et al., (2020) who mentioned that serum bilirubin levels decreased gradually in the two groups (phototherapy alone and phototherapy accompanied with foil paper).

For the second hypothesis, the current study pointed out that neonates in the study group were discharged significantly earlier than neonates in the control group. This study was consistent with Abo Elmagd, Tawfiq & Mohamed (2022) who clarified that neonates in the study group were discharged after 48 hours while more than three-quarters of neonates in the control group were discharged very much later.

Also, this study was in line with Dachlan, Yuniati, & Sukadi (2015) who illustrated that the duration of phototherapy in the intervention group was significantly less by 24 hours compared to that of the control group. This was attributed to using reflective material such as aluminum foil with phototherapy leads to increased light intensity on the infant body and its efficiency, which leads to better prognosis such as the reduction of bilirubin level in a short time which in turn leads to decreased length of hospital stay

Conclusion

Neonates who received phototherapy associated with aluminum foil application (study group) had lower

bilirubin levels and shorter duration of hospitalization than those in the control group.

Recommendations

1) Nurses in hospitals should receive training on the use of phototherapy accompanied by aluminum foil reflectors as part of their standard care.

2) This study needs to be replicated on a larger number of neonates having hyperbilirubinemia to ensure the generalizability of the result.

References

Aboelmagd, A; Tawfiq, A; and Mohamed, S. (2022) . Effect Of Applying Aluminum Foil Reflector During Phototherapy Combined With Nursing Care On Neonatal Hyperbilirubinemia. Egyptian Journal of Health Care, 13(3), pp. 1335-1345. https://ejhc.journals.ekb.eg/article_260290_421cdb71c0170f8dc6f25e336b6c15cf.pdf

Agarwal, R; Aggarwal, R; Deorari, A; and Paul, V. (2014). Jaundice in the Newborn. The Indian Journal of Pediatrics, DOI: 10.1007/BF02722600 · Source: PubMed.

Alencar, H; Padilla, E; Rolim, K; Albuquerque, F; Albuquerque, C; and Magalhães, F. (2021). Nursing care with the eye protector of newborns submitted to phototherapy. Revista Nursing, phototherapy, 24(276), 5637-5641. DOI: https://doi.org/10.36489/nursing.2021v24i276p5632-564.

Amadi, H; Abdullahi, R; Mokuolu, O; Ezeanosike, O; Adesinae, C; Mohammed, I; Olatejue, E; Abubakar, A; Bellog, M;Eneh, A; Ogahd, E; Eziechilai, B; ChappJumbo, A; Jimoh, A; and Udo, J. (2020). Comparative outcome of overhead and total body phototherapy for the treatment of severe neonatal jaundice in Nigeria. Pediatrics and International Child Health, 40(1), 16–24. https://doi.org/10.1080/20469047.2019.1610607.

Basiri, B; Sabzehei, M; and Shokouhi, M. (2020). Effect of aluminum foil installation on the efficacy of phototherapy in healthy term neonates with non-hemolytic jaundice: a randomized controlled trial. Archive of SID. file:///C:/Users/LENOVO/Downloads/517e20150101%20(1).pdf.

Bura'a, L; and Younis, N. (2023). Nurses' knowledge regarding phototherapy at neonatal care units in Mosul City, Iraq. Rawal Medical Journal, 48(2), 379-381. https://www.rmj.org.pk/fulltext/27-1675710424.pdf.

Dachlan, T; Yuniati, T; and Sukadi,A. (2015). Effect of phototherapy with aluminum foil reflectors on neonatal hyperbilirubinemia. Paediatr Indones, 55(1), pp. 13-17.

https://paediatricaindonesiana.org/index.php/paediatricaindonesiana/article/view/99

Gunjan; and Sharma, N. (2021). A Quasi-Experimental Study to assess the effect of phototherapy with aluminum foil reflector on the level of bilirubin among neonates with hyperbilirubinemia in a selected hospital in Panipat, Haryana. international journal on nursing education. 13(3). https://doi.org/10.37506/ijone.v13i3.16299

Ibrahim, M; Ouda, W; Ismail, S; and Elewa, A. (2019). Assessment of Nursing Care Provided to Neonates Undergoing Phototherapy. Egyptian Journal of Health Care, 10(1), 1-12. https://ejhc.journals.ekb.eg/article_26740.html.

Joel, H; Mchaile, D;, Philemon, R; Mbwasi, R; Msuya, L. (2020). Effectiveness of Fiberoptic Phototherapy Compared to Conventional Phototherapy in Treating Hyperbilirubinemia Amongst Term Neonates: a Randomized Control Trial. Research square, https://doi.org/10.21203/rs.3.rs-36655/v1, 1-17. DOI: https://doi.org/10.21203/rs.3.rs-36655/v1.

Kenawi, R; Dabash, S; Rashad, H; and Elhoshy, S. (2020). Assessment of Behavioral and Neurological Responses of Neonates with Jaundice undergoing Phototherapy. Med. J. Cairo Univ, 88(1), 63-70. https://www.medicaljournalofcairouniversity.net/.

Kurniasih, A; Tjipta, G; Ali, M; Azlin, E; and Sianturi, P. (2011). Effectiveness of phototherapy with reflecting curtains on neonatal jaundice. Paediatr Indones, 51(5), 256-261. https://www.scribd.com/document/366379837/706-1460-1-SM.

Lauer, B; and Spector, N. (2011). Hyperbilirubinemia in the Newborn. Pediatrics in Review, 32(8), 341-349. https://www.researchgate.net/publication/51539080_Hyperbilirubinemia_in_the_Newborn.

Murat, Y. (2015). Phototherapy in the newborn: what's new? Journal of Pediatric and Neonatal Individualized Medicine;4(2):e040255 doi: 10.7363/040255

Neghabadi, F; Nourian, M; Farahani, A; Pourhoseingholi, M; Shoorideh, F. (2015). Auditing phototherapy-related nursing care in neonatal general and intensive care units. Iran J Crit Care Nurs, 8(3), 167-172. https://www.researchgate.net/publication/299368956_Auditing_phototherapyrelated_nursing_care_in_neonatal_general_and_intensive_care_units

Pandey, P. (2023). Role and Responsibility of Nurse During Care of Neonates Undergoing Phototherapy.

Journal of Pediatric Disorders and Neonatal Care, 6(1), 1-15. www.scholarena.com

Rostenberghe, V; Ho, J; Lim, C; and Abd Hamid, J. (2020). Use of reflective materials during phototherapy for newborn infants with unconjugated hyperbilirubinemia (Review). Cochrane Database of Systematic Reviews, Art. No.: CD012011.(7), p. DOI:10.1002/14651858.CD012011.pub2.

Salia, S; Afaya, A; Wuni, A; Ayanore, M; Salia, E; Kporvi, D; Adatara, P; Yakong, V; Quansah, S; Quarshie, S;, Dey, E; Akolga, D; and, Alhassan, R. (2021). Knowledge, attitudes, and practices regarding neonatal jaundice among caregivers in a tertiary health facility in Ghana. PLoS ONE 16(6): e0251846. https://doi.org/10.1371/journal.pone.0251846.

Sreesravya, G; Janardhan, S; Sowmini, P; Prasanna, M; Shantharam, B; Muralikeshava, S; and Mukund, S. (2019). Light Emitting Diode (LED) Phototherapy versus Conventional Phototherapy in Neonatal Hyperbilirubinemia: A Single Blinded Randomized Control Trial from Coastal India. BioMed Research International, Volume 2019, Article ID 6274719, 6 pages. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6487143/

Stokowski, L. (2011). Fundamentals of Phototherapy for Neonatal jaundice. Advances in Neonatal Care, 11(5), pp. 10-21. DOI: 10.1097/ANC.0b013e31822ee62c.

Waqar, T; Arham, Q; and Razzaq, A . (2013). Neonatal Jaundice: A Review and Guidelines for its Management in Resource Limited Countries. https://www.researchgate.net/publication/259309673, pp. 1-28.

Zhang, M; Tang, J; He, Y; Li, W; Chen, Z; Xiong, T; Qu, Y; Li, Y; Mu, D. (2021). A systematic review of global clinical practice guidelines for neonatal hyperbilirubinemia. BMJ Open, 11:e040182.doi:10.1136/bmjopen-2020-040182. https://bmjopen.bmj.com/content/11/1/e040182