

Effect Of Applying Aluminum Foil Reflector During Phototherapy Combined With Nursing Care On Neonatal Hyperbilirubinemia

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Abstract

Background: Phototherapy has long been recognized as an effective treatment for neonates with neonatal hyperbilirubinemia. **Aim of the study** is to evaluate the effect of applying aluminum foil reflector during phototherapy combined with nursing care on neonatal hyperbilirubinemia. **Subject and method:** A quasi-experimental research design was used in the current study in the neonatal intensive care unit at Minia university hospital for obstetric and pediatrics and Minia general hospital. The sample was 70 neonates and 60 nurses. Two tools were used; Tool I: A self-administered questionnaire and Tool II: The neonatal outcome sheet. **Results:** More than half of the neonatal nurses had satisfactory knowledge related to neonatal hyperbilirubinemia and the majority of them had a competent level in caring of high-risk neonates under phototherapy. The mean score of bilirubin value was decreased in the aluminum foil group compared to the control group before the neonatal discharge from the hospital with statistically significant differences. Most of the studied neonates in the aluminum foil group were discharged after 48 hours compared to three-quarters of the neonates in the control group with statistically significant differences and this finding evidenced the large effect of applying aluminum foil as well as nurses' knowledge and practices on bilirubin value before discharge among the studied sample. **Conclusion:** Applying an aluminum foil reflector during phototherapy combined with nursing care is effective in reducing the bilirubin levels of full-term neonates. **Recommendation:** Prepare written guidelines in the neonatal intensive care unit about phototherapy combined with aluminum foil reflectors to enhance the management of hyperbilirubinemia.

Keywords: Aluminum foil reflector, Eta square test, Neonatal hyperbilirubinemia, Phototherapy.

Introduction:

Neonatal jaundice, characterized by a yellow coloring of the skin, mucous membranes, and sclera, is caused by an elevation in serum bilirubin. The most typical sign of neonatal hyperbilirubinemia is an elevation in unconjugated bilirubin levels. (Mojtahedi et al., 2018). According to Swapna et al., (2017) stated that neonatal hyperbilirubinemia is a prominent cause of mortality and morbidity in many developing nations, making it one of the most significant public health problems worldwide.

The goal of phototherapy is to convert unconjugated bilirubin into water-soluble forms that can be promptly eliminated by the liver and kidneys without glucuronidation, which is a slow and inefficient process. It's the

gold standard for treating and preventing kernicterus, a brain malformation common in neonates, and other forms of hyperbilirubinemia (Pace et al., 2019). Treatment of hyperbilirubinemia in infants with single phototherapy augmented by low-cost reflecting curtains may be preferable to double phototherapy (El-Farrash et al., 2019).

The thinness of aluminum foil makes it simple to fold into any configuration. A sheet of aluminum foil, being the "whitest" metal, will reflect and absorb all light in a direct manner because of this. When used as a reflector, aluminum foil may reflect between 92% and 98% of the incident light, depending on the wavelength and irradiance, and it is also corrosion-resistant. Compared to other materials, aluminum foil is more cost-effective, requires less time and effort to produce, is easier to

maintain, and has no negative side effects (Dachlan et al., 2015).

The nurse should implement several precautions to protect the infant during phototherapy, the vital signs are taken at least every 4 hours to monitor the infant's temperature. An opaque mask shield is used to cover the eyes to prevent damage to the retina, the eye shield is removed during feedings, which provides the opportunity for visual and sensory stimulation. When using phototherapy, the baby should be held at a distance of 45 cm from the light source and should be repositioned every two hours or after each feeding for optimal exposure. As per protocol, phototherapy is discontinued once bilirubin levels return to an acceptable range (Revathy, 2019).

Significance of the study

Globally, hyperbilirubinemia at birth is the leading cause of hospitalization for neonates in the first week of life, there is a risk of serious bilirubin-induced morbidity and mortality if this is not handled adequately (Santhi et al., 2020). Jaundice affects more than 85 percent of neonates within the first week of life (Olusanya et al., 2018). It accounts for half of all births worldwide and 60% of Egyptian births (Ahmed and Hani, 2017).

Phototherapy is a well-established and successful treatment for neonates who have substantial neonatal jaundice, and it has been used for this purpose for many years. Hanging reflecting materials from the sidewalls of phototherapy units is a potential low-cost and simple method for boosting the amount of light that falls on the body of the neonate (Van Rostenberghe et al., 2020). When caring for neonates, nurses play a crucial role in delivering individualized care through providing careful and proper nursing care during the phototherapy process (Santhi et al. 2020).

Aim of the study:

The current study aimed to:

Evaluate the effect of applying aluminum foil reflector during phototherapy combined with nursing care on neonatal hyperbilirubinemia.

Research hypotheses

H 0: No effect of applying an aluminum foil reflector during phototherapy combined with nursing care on neonatal hyperbilirubinemia.

H 1: Applying an aluminum foil reflector during phototherapy combined with nursing care will show a significant decrease in bilirubin levels among neonates.

H 2: Applying an aluminum foil reflector during phototherapy combined with nursing care will show a significant decrease in hospital stay in the NICU.

H 3: There will be statistically significant differences between the nurses' knowledge, practices, and bilirubin level of neonates .

Inclusion criteria

- Full-term neonate
- Neonates diagnosed with physiological jaundice,
- Neonates with normal birth weight.

Exclusion criteria:

- Neonates with congenital anomalies
- Neonates with severe asphyxia
- Neonates with G6PD deficiency
- Neonates with severe infection.

Operational definition:

Phototherapy: Phototherapy involves exposure of a naked baby to blue, cool white, or green light of wavelength 450 - 460 nm. The light waves convert bilirubin to water-soluble nontoxic forms which are excreted.

Aluminum foil reflector: Aluminum foil is a silver, very thin substance and easy to fold into the desired shape. It absorbs and reflect all the light directly, it has a cheap price, the facility in making the reflectors, the simpler maintenance, and the lack of adverse effects.

Subject and Method

Research design

quasi-experimental research design was used in the current study. A quasi-experimental design is one type of experimental design that is very similar to the true-experimental design except that there is no random assignment of the subjects into groups. Quasi-experiments are subjects to concern regarding internal validity because the intervention and control groups may not be comparable at baseline (Grove & Gray, 2018).

Setting:

The current study was conducted in the neonatal intensive care unit at Minia university hospital for obstetric and pediatrics and Minia general hospital.

Subject:

A Purposeful sample consisted of all the available high-risk neonates diagnosed with neonatal jaundice who were admitted to the neonatal intensive care unit. The sample was 70 neonates and 60 nurses who worked with them from the above-mentioned hospitals over three months period. The sample was divided into two equal groups, the Aluminium foil group (35) and the control group (35 neonates).

Tools of data collection

Tool I: A self-administered questionnaire sheet was designed by the researcher in an Arabic language, which consisted of the following parts:

Part 1: Personal and professional characteristics of the studied nurses as age, years of experience in the field of nursing and neonatal intensive care unit, and previous attendance of training courses.

Part 2: Demographic characteristics of the studied neonates as gestational age, sex, and amount of feeding /3 hours.

Part 3: Nurses' knowledge related to neonatal hyperbilirubinemia such as the definition of hyperbilirubinemia, investigation of hyperbilirubinemia, causes of hyperbilirubinemia, manifestations of hyperbilirubinemia, bilirubin level of hyperbilirubinemia, treatment of hyperbilirubinemia, complications of

hyperbilirubinemia, the definition of phototherapy and minor side effect of phototherapy (El-Kurdy et al., 2021; Gani & Ahmad, 2021; Mohanty & Acharya, 2021).

Scoring system:

Scoring system for nurses' knowledge related to neonatal hyperbilirubinemia: Each correct response took one score, and the wrong answer or do not know took zero scores. The total score of < 75% considered unsatisfactory knowledge and $\geq 75\%$ considered satisfactory knowledge.

Part four: Nurses' practices regarding the care of high-risk neonates under phototherapy, included the following: Assure the efficiency of phototherapy, provide eye protection, assess and adjust thermoregulation device, proper covering and shielding of the genital area, assess skin exposure, change position every two hours and promoting elimination and skin integrity (El-Kurdy et al., 2021; Gameel et al., 2020).

Scoring system:

Scoring system of the observational checklist: Each done correctly took one score, while the incorrect or not done was taken as zero scores. The total nurses' practices scores were classified into the following: Competent level of performance was achieved by the nurse at a score of 75% or more and incompetent level of performance was at a score less than 75%.

Tool II: The neonatal outcome Sheet: Prepared by the researchers to assess the outcomes of the neonates suffering from hyperbilirubinemia in both pre and post-intervention groups, included the following items: Total serum bilirubin level every 24 hours and hospital duration (length of stay)

Ethical consideration

A Written approval was obtained from the Research Ethics Committee at the Faculty of Nursing, Minia University. And also, the researchers obtained written consent from the director of the previously mentioned hospital as well as from the director of the neonatal intensive care unit. Written formal consent was obtained from nurses who participated in this

study. The researcher explained the study's purpose and nature through direct personal interviews ensuring that the data were confidential and used for the research purpose only. The study adhered to common ethical principles to participate in the research, anonymity, and privacy was present through coding the data, and the nurses have the right to reject participation in the study without any justification.

Validity and Reliability

Five neonatology and pediatric nursing specialists were asked to review the tools for content validity. Based on the panel's evaluation of the text's clarity of sentences, appropriateness of content, and logical progression of items, the content validity index was 0.826, indicating that no changes were made to the text. Cronbach's Alpha, a reliability test, confirmed the instruments' internal consistency at 0.825 and 0.875.

Pilot Study:

In order to test and ensure the feasibility, objectivity, application, clarity, adequacy, and content validity and to identify any issues in the methodological approach or tools, a pilot research was conducted on 10% of babies and the nurses who participated in the study. The proposed statistical and data analysis methods were examined by using the results of the pilot project. In this investigation, we included the pilot study's sample in our overall sample size.

Data collection procedure

For the aluminum foil group

Before starting phototherapy, the total serum bilirubin level was measured as a baseline, the neonates wore only diapers and eye covers, to prevent eye damage, and the distance between the phototherapy and the neonate was adjusted to be 45cm. The reflective materials such as aluminum foil can reflect dispersed phototherapy light was placed around the phototherapy unit and draped on three sides of the incubator while infants are receiving phototherapy, they capture light, by their reflective nature, reflect it back onto the infant. Blue light phototherapy with a wavelength range of 460–490 nm was used. phototherapy was stopped during neonate care, and the neonates' position was changed every 2–3 hours to maximize the surface area of light-exposed skin. Total serum bilirubin was measured every 24 hours and recorded in the neonates' sheet and the

demographic characteristics were obtained from the neonates' sheet. also, the researcher took oral consent from the nurse and explain the purpose and the nature of the study, after that; the researchers distribute the questionnaire sheet for the nurses to fill it (**Tool I**). They collected the data during the morning and evening shifts and still with the nurses to explain any unambiguous questions. And also, they uses an observational checklist to assess nurses' practice during the care of the neonate under phototherapy ,the time for data collection extended from the beginning of december2022 to the end of February 2022.

For the control group

Before starting phototherapy, the total serum bilirubin level was measured as a baseline, the neonates wore only diapers and eye covers, to prevent eye damage, and the distance between the phototherapy and the neonate was adjusted to be 45cm. Ablue light phototherapy with a wavelength range of 460–490 nm was used. photo therapy was stopped during neonate care, and the neonates' position was changed every 2–3 hours to maximize the surface area of light-exposed skin. Total serum bilirubin was measured every 24 hours and recorded in the neonate sheet.

Statistical analysis

Social science statistical software (SPSS 28) was used to tabulate and analyze the data collected to make judgments on the nurses and neonates in the study. Chi-square test, mean, standard deviation, and percentages were all used in the study's statistical analysis (X^2). When looking for a correlation between two qualitative factors, the chi-square test was performed. When the sample size is limited and you need to test for a link between two qualitative variables or find variations between more than two proportions, Fisher's exact test is the way to go. Graphs were done for data visualization using Microsoft Excel. The P - value of ≤ 0.05 indicates a significant result while the P .value of > 0.05 indicates a non-significant result. Spearman correlation was used to test the association between the studied nurse's total knowledge and practices scores with selected demographic characteristics. Also, One- way ANOVA test and the eta square test by the ANOVA test.

Results

It was clear from table (1) that,61.7 of the studied nurses' age ranged between 21- < and 27,

while 65% of them came from an urban area and 78.3% was married>on the other hand,40 % of the studied nurse had 6 - < 11years of experience in the field of nursing and 50% had 1 - < 6 years of experience in NICU. Regarding the training courses about phototherapy, 73.3% of the studied nurses had training courses.

Figure (1): Illustrates that 56.7% of the neonatal nurses had satisfactory knowledge and 43.3% had poor knowledge regarding hyperbilirubinemia.

Figure (2): Illustrates that ;88.3% of the neonatal nurses had a competent level in caring of high-risk neonates under phototherapy and 11.7% were incompetent.

Figure (3): Illustrates that 94.3% of the studied neonates in the aluminum foil group were discharged after 48 hours compared to 77.1% of the high-risk neonates in the control group with statistically significant differences (*P*- Value < 0.04).

Table (1): Percentage Distribution Of The Studied Nurses Regarding Their personal and professional Characteristics (n= 60).

Personal and professional characteristics	No.	%
Age/ years		
21- < 27	37	61.7
27 - < 32	15	25.0
32 – 36	8	13.3
Mean ± SD	25.9 ± 4.5	
Residence		
Urban	21	35.0
Rural	39	65.0
Marital status		
Single	13	21.7
Married	47	78.3
Years of experience in the nursing field		
Less than one year	21	35.0
1 - < 6	24	25.0
6 - < 11	15	40.0
Mean ± SD	4.53 ± 3.8	
Years of experience in NICU		
Less than one year	25	41.7
1 - < 6	30	50.0
6 - < 11	5	8.3
Mean ± SD	4.2 ± 2.6	
Previous training about phototherapy		
No	16	26.7
Yes	44	73.3

Table (4) Clarifies that the total mean score of bilirubin value was decreased in the aluminum foil group compared to the control group before the neonatal discharge from the hospital (9.6 ± 0.8 compared to 10.5 ± 1.5 respectively) with statistically significant differences (*P*-value at < 0.004).

Table (5): Shows a reduction in the mean bilirubin value of the high-risk neonates who were discharged at 48-72 hours in the control group (10.2 ± 1.4 compared to 11.3 ± 1.3 mg/dl) with statistically significant differences (*P* - value at 0.037), but no statistically significant relation between the mean of bilirubin value at discharge time with gender, and type of phototherapy among the aluminum foil group and control group.

Table (6):Clears that; there was a large effect of nurses' knowledge and practices on bilirubin value before discharge among the studied sample ($\eta^2 = 0.466$ & 0.368 respectively).

Figure (1): Distribution Of Nurses' Knowledge Level Regarding Hyperbilirubinemia Among The Studied Nurses (N= 60)

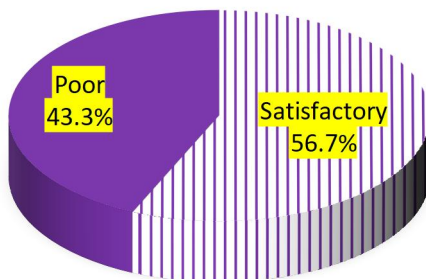


Figure (2): Distribution Of Nurses' Practice Level Regarding Caring Of High-Risk Neonates Under Phototherapy (N= 60)

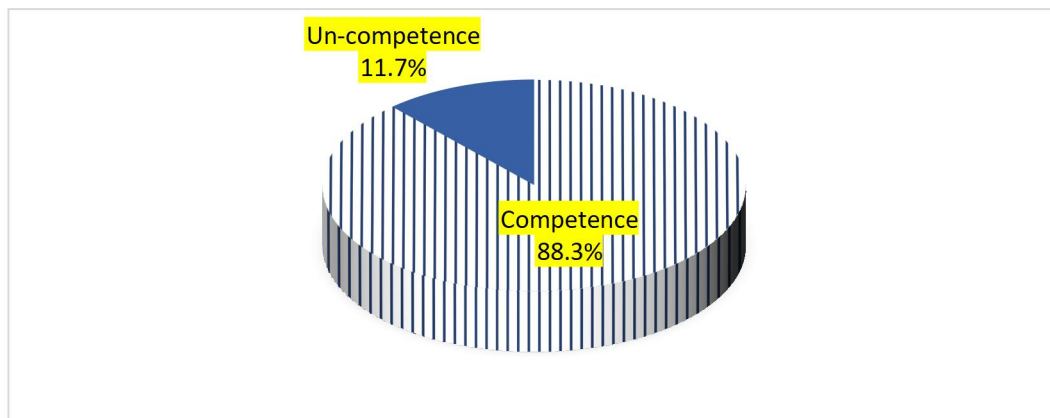
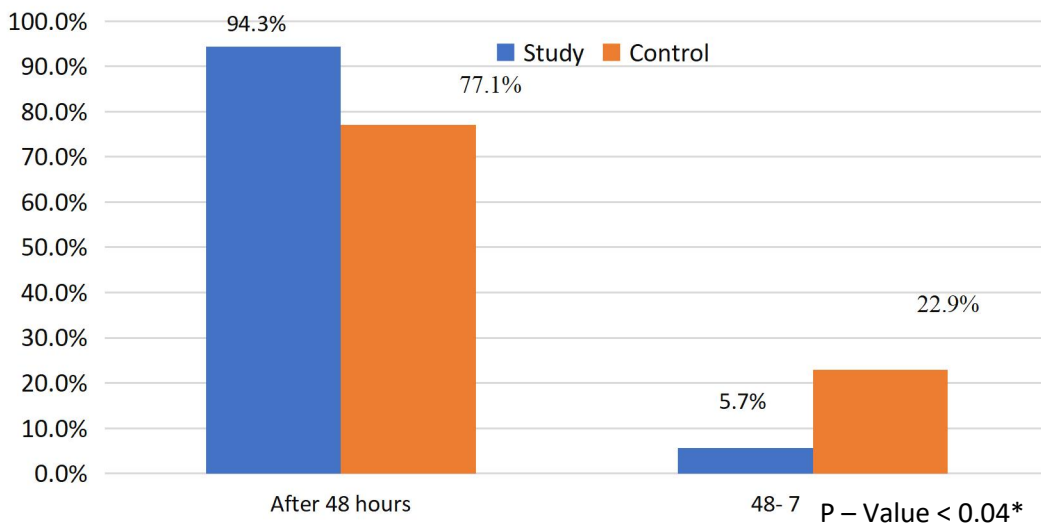


Figure (3): Distribution Of Hospital Stay Per Day Among The Aluminum foil group



And Control Group (N= 70).

Table (4): Comparison Between The Total Mean Scores Of Bilirubin Values Among The Aluminum foil group And Control Group (n = 70)

		Aluminum foil group (35)		Control group (35)		Test of significance	
		Mean	SD	Mean	SD	t	P value
Bilirubin value at	admission	15.5	1.6	15.3	1.5	0.413	0.341
	2 nd day	12.0	1.2	12.6	1.3	1.507	0.068
	before discharge	9.6	0.8	10.5	1.5	2.795	0.004**

*Statistical significance differences at 0.05** highly statistical significance differences at < 0.01

Table (5): Relation Between The Mean Bilirubin Value At Discharge Time Among The Aluminum foil group And Control Groups With Their Gender, Type Of Phototherapy, And Hospital Stay (N = 70).

Items	Bilirubin value at discharge			
	Aluminum foil group (35)		Control group (35)	
	Mean	SD	Mean	SD
Gender of high-risk neonates				
Male	9.7	1.103	10.8	1.6
Female	9.6	0.661	10.2	1.4
t-test (P – Value)	0.269 (0.395)		1.135 (0.132)	
Type of phototherapy				
Single	10.0	1.00	9.0	1.4
Double	9.6	0.9	10.6	1.5
t-test (P – Value)	0.739 (0.233)		1.440 (0.080)	
Hospital stay/days				
At 48 hours	9.2	0.9	11.3	1.5
48- 72 hours	9.0	0.1	10.2	1.4
t-test (P – Value)	1.039 (0.153)		2.849 (0.037)*	

*Statistically significant differences

Table (6): Eta Square Test By ANOVA Test For Total Knowledge And Practices Of The Studied Nurses With Study And Control Bilirubin Value At Discharge .

	Bilirubin value before discharge	
	Aluminum foil group (n=35)	Control group (n=35)
Knowledge scores	0.466	0.160
Practice scores	0.368	0.004

Discussion

Unconjugated hyperbilirubinemia is a common occurrence throughout this period of development in most infants. Nonetheless, even in full-term infants, high bilirubin levels can be neurotoxic and lead to neurological damage. Jaundice is typically a harmless illness that does

not necessitate treatment. Although most neonates with jaundice may have no symptoms, 10-15% will have clinically significant jaundice and need phototherapy or another treatment (Begum & Afroze, 2018).

Regarding the nurses' knowledge about neonatal hyperbilirubinemia, the current study

results illustrated that; more than half of the nurses had satisfactory knowledge, and more than two-fifths had poor knowledge regarding hyperbilirubinemia. This result might be due to the mean years of experience in the neonatal intensive care unit of the studied nurses' which was 4.2 ± 2.6 years. This finding was supported by **Verma & Sharma, (2020)** assessed the knowledge regarding care of neonates under phototherapy among staff nurses with the view to developing information pamphlets in Muskan Hospital, Unnao, which showed that; more than half of the staff nurses' moderate knowledge level.

On the other hand, the current study results contradicted **Ibrahim et al. (2019)** and **Gameel et al., (2020)** who cleared that, the studied nurses had poor knowledge about the care provided to neonates undergoing phototherapy.

Concerning the nurses 'practices in the care of high-risk neonates undergoing phototherapy, the current study results proved that the majority had competent levels in caring for high-risk neonates under phototherapy and the minority were incompetent. This result might be due to nearly three-quarters of the studied nurses attending training in phototherapy.

The findings of the study was inconsistent with **Ibrahim et al. (2019)** who found that more than three-quarters of the studied nurses had a poor level of actual practice, while the minority had a good level of actual practice regarding care provided to neonates suffering from jaundice and undergoing phototherapy, In addition, the study results were supported by **El-Shahat, (2014)** who assess nurses' knowledge and practice about the care needed for neonate under phototherapy in a neonatal intensive care unit (NICU) in Ismailia city" and reported that the majority of nurses had very good total practice scores about nursing care for neonates under phototherapy.

Also , the study results was in the same line with **Mohamed et al., (2016)** who studied establishing basic standards for nursing management of neonates with hyperbilirubinemia and proved that; most nurses

have a competent level of performance in regard to providing nursing care for neonates under phototherapy.

Regarding hospital stay in the study and control group of high-risk neonates, the current study results illustrated that most of the studied high-risk neonates in the aluminum foil group were discharged after 48 hours compared to more than three-quarters of the high-risk neonates in the control group with statistically significant differences. Using reflected 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 duration of stay in the hospital. *This finding accepted the second study hypothesis.*

The current study results were supported by the results of **Wongcheeree and Prasarnphanich, (2015)** who studied the effect of phototherapy with reflecting aluminum foil tray on bilirubin level in neonatal jaundice and cleared that after phototherapy for one day, the mean serum bilirubin levels and length of hospital stay in aluminum foil group decreased than the control group with a statistically significant difference.

This study's results indicated that the use of reflective material such as aluminum foil reflector with phototherapy is very effective in reducing the level of total serum bilirubin combined with nursing care. The aluminum foil doesn't absorb fluorescent light but it reflects the phototherapy light, they are inexpensive, and they are found to increase the intensity, and efficiency of phototherapy while shortening the duration of treatment with little or no extra cost (**El-Farrash et al, 2019**).

The current study results were consistent with the the study done by **Dachlan et al., (2015)** who studied the effect of phototherapy with aluminum foil reflectors on neonatal hyperbilirubinemia, and found that; all serum bilirubin in the intervention group decreased to off phototherapy level within three days compared to that of the control group which needs 4 days to reach off phototherapy level.

The current study results disagreed with the study done by **Basiri, Sabzehei, and Shokouhi, (2015)** about the effect of aluminum foil installation on the efficacy of phototherapy in healthy term neonates with non-hemolytic jaundice, cleared that, the installation of aluminum foil in neonates with hyperbilirubinemia under phototherapy can produce a reduction in duration of phototherapy, but does not increase in irradiance leading to decrease in total serum bilirubin.

About mean bilirubin value at discharge time among the study and control groups with their gender, type of phototherapy, and hospital stay, a reduction in the mean bilirubin value of the high-risk neonates who were discharged at 48-72 hours in the control group (10.2 ± 1.4 compared to 11.3 ± 1.3 mg/dl) with statistically significant differences. Furthermore, no statistically significant relation between the mean bilirubin value at discharge time with gender, and type of phototherapy among the study and control groups. The current study results indicated that in the neonates who didn't receive an aluminum foil reflector with phototherapy their bilirubin takes a long time to be reduced than in the Aluminum foil group which assured the efficiency of aluminum foil for reducing bilirubin level.

This finding is in the same line with **Gunjan, and Sharma (2021)** assessed the effect of phototherapy with an aluminum foil reflector on the level of bilirubin among neonates with hyperbilirubinemia in a selected hospital in Panipat, Haryana concluded that; phototherapy with aluminum foil reflector was effective on the level of bilirubin among neonates.

The current study results evidenced the large effect of nurses' knowledge and practices on bilirubin value before discharge among the studied sample ($\eta^2 = 0.466$ & 0.368 respectively). *This finding accepted the third study hypothesis.* Nurses' knowledge and practice play an important role to achieve optimal outcomes for neonates who receive phototherapy. The current study results were attributed to increased knowledge of the nurses as well as their performance regarding nursing care for neonates with hyperbilirubinemia.

This finding evidenced by the study done by **Abdel-Gafour, et al., (2020)** about the effect of nursing intervention on the care of neonates suffering from hyperbilirubinemia, illustrated a significant difference of the studied neonates regarding bilirubin level, and duration of phototherapy after receiving nursing care for hyperbilirubinemia.

Conclusion:

Based on the result of the present study the total mean score of bilirubin value was decreased in the aluminum foil group compared to the control group before the high-risk neonate's discharge with statistically significant differences with statistically significant differences.

Also, most of the studied neonates in the aluminum foil group were discharged after 48 hours compared to more than three-quarters of the neonates in the control group with statistically significant differences. Furthermore, the current study results evidenced the large effect of nurses' knowledge and practices on bilirubin value before discharge among the studied neonates.

Recommendations:

1. The study can be replicated with large samples in various other settings for reinforcement
2. Training about the use of Phototherapy with aluminum foil reflector should be conducted to be practiced by the nurses in hospitals as part of their routine care
3. There should be written guidelines in the neonatal unit about phototherapy combined with aluminum foil reflectors to enhance the management of hyperbilirubinemia.
4. The study should be conducted in different hospital settings.

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