

Neurobehavioral Responses for Neonates under Conventional Phototherapy Modality

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Abstract

Background: Neonatal jaundice is a common condition worldwide that results in substantial morbidity and mortality. Phototherapy is a universal treatment option. However, it has a slew of negative consequences. **Aim:** This study aimed to evaluate the neurobehavioral responses for neonates under conventional phototherapy modality. **Design:** Descriptive exploratory was utilized for this study. **Setting:** The study was done out in the Al-Salam Neonatal Intensive Care Unit and the Women's Specialist Hospital in Port-Said City, Egypt. Non-probability purposive sampling of 50 neonates was included in this study from the previously mentioned settings. **Two tools** were used for gathering the data. Tool one: Neonatal characteristics assessment sheet. Tool II: Neonatal Behavioral Assessment Scale to assess neurobehavioral responses of neonates before and after conventional phototherapy modality. **Results:** revealed that total neonate means score of habituation, social interaction, state organization, and total level of bilirubin before and after conventional phototherapy was statistically significant difference $p \leq 0.05$. **Conclusion:** concluded that, there were statistically significant difference regarding neonate's neurobehavioral responses in domains of habituation, social interactive, state organization, and total bilirubin level **Recommendations:** A neonatal neurobehavioral evaluation educational training program should be scheduled regularly for pediatric nurses in the neonatal intensive care units.

Keywords: Neurobehavioral response; Neonates; Phototherapy; Conventional modality

Introduction

In neonates, jaundice is a leading cause of death and morbidity. It affects 60 to 80 percent of newborn infants (Amos et al., 2017). Early detection and monitoring are significant issues in lowering the frequency of jaundice-related brain impairment around the world. (Outlaw et al., 2020). In neonatal intensive care units (NICUs), where they receive care and therapy throughout the transition period to extrauterine life, neonates are exposed to a variety of environmental stimuli (bright light, loud noise, frequent touching, and so on) as well as stressors such as repetitive painful procedures (Lammertink et al., 2020). Newborns exhibit physical and behavioural stress symptoms in reaction to the obstacles they face during this period, even though they are not developmentally mature. Previous research has shown that there is a relation between neonate behavior and stimulation in addition to the environment. As a result, it's critical to monitor neonates' actions during the period of adapting to life outside the uterus (Guimaraes et al., 2018).

The evaluation of a neonate's neurobehavioral assists a practitioner in developing appropriate treatment and intervention (Barlow et al., 2018). The Neonatal Behavioral Assessment Scale (NBAS) is a one-of-a-kind and extremely valuable tool for assessing an infant's development and capabilities, as well as emotional regulation, Stress indicators, psychomotor and neurological skills, reactivity, irritable, appeasing & consciousness, attention, orientations, and relationship skills are all important factors to consider (Basdas et al., 2018). Sensory aspects (sight, smell, and hearing), motor characteristics (muscular tension and diverted attention), and kinetic characteristics (speed and acceleration) are all indicators of the neonate's participation and ability to model his interactions in the NBAS (Belot et al., 2021). The performance of the infant was divided into seven categories: habituation, orientation, motor behaviour, range of state, state regulation, autonomic stability, and reflexes. (Paul and Gosse, 2018).

On the other hand, significant increases in bilirubin levels are usually cytotoxic and can affect the developing of the central nervous system (CNS) (Bulut et al., 2020). They may also be related to neurological and behavioral abnormalities in both preterm and full-term newborns (Althomali et al., 2018). Conventional phototherapy lights involve non-light-emitting diode (LED) units for examples Unique blue fluorescent , tiny fluorescent , and halogen spotlights. (Gutta et al., 2019). Phototherapy is an effective treatment for neonatal hyperbilirubinemia since it is inexpensive and free of the risks associated with double volume exchange transfusions (Fabrizia et al., 2019). Its effectiveness is determined by the dose and wavelength of light employed, as well as the surface area exposed (Montealegre et al., 2020).

Nursing care has a significant impact on the efficacy of phototherapy treatment, as well as the rate at which total blood bilirubin levels fall and the length of hospital stay. Phototherapy is more effective and so less susceptible to problems with proper nursing care (Montealegre et al., 2020). In NICUs, team members responsible for protecting and promoting health, particularly nurses who are the primary caregivers, must be aware of neonatal responses (Akhil and Damke, 2021). Nursing care that ensures optimal irradiance delivery, optimizes skin exposure, provides eye protection, pays close attention to thermoregulation, maintains enough hydration, promotes elimination, and supports parent-infant connection helps to reduce problems. In addition to preventing and lowering the danger of short and long-term side effects, newborns who are receiving phototherapy require special attention and behavioral evaluation. (Koot and Newton, 2020).

Significance of Study

Neonatal jaundice is expectable to ascend in sixty percent of term newborns in the first week of life, and less two percent variety total serum bilirubin (TSB) levels of 20 mg/dL. Neonatal hyperbilirubinemia (HB), commonly known as neonatal jaundice can affect a child's neurodevelopment, increasing the chance of serious neurological impairment in the infant.

Even though most of neonatal HB cases are benign, a few cases occur in which bilirubin levels rise substantially and remain high, causing lifetime physical harm and frequently affecting central nervous system developing. Although phototherapy is an effective treatment for newborn hyperbilirubinemia, it has an impact on the neonate's neurobehavioral responses. Although phototherapy for jaundiced infants is prevalent in newborn nurseries, little is known regarding their neurobehavioral outcomes. As a result, the goal of this study was to assess neonatal neurobehavioral responses to conventional phototherapy modality.

Aim of the study:-

The study aims to evaluate neurobehavioral responses for neonates under conventional phototherapy modality.

Specific objectives:

- 1- Evaluate neurobehavioral responses for neonates before conventional phototherapy modality.
- 2- Evaluate neurobehavioral responses for neonates after conventional phototherapy modality.
- 3- Compare between neurobehavioral responses for neonates before & after conventional phototherapy modality.

Research questions:

- 1- What are the neurobehavioral responses alterations for neonates under conventional phototherapy modality?

Subjects and Methods

Research design: Descriptive exploratory design was used .

Study Setting: The study was done out in neonatal intensive care units (NICU) in Al Salam and Women's Specialist Hospital. They are the largest neonatal intensive care units in

Port Said, and they are affiliated with the comprehensive health insurance system.

Subjects: A sample of the present study involved 50 neonates; 20 neonates from Women's Specialist Hospital and 30 neonates from AL Salam Hospital, from both sexes, aged from 1 day to 4 days. Their gestational age extended from 37 weeks to more than 38 weeks, their weight began 2,400 grams. The sample was chosen based on non-probability purposive sampling technique from the previous pointout settings. Neonate with neonatal jaundice the bilirubin level directed for conventional phototherapy. While, infants were receiving any analgesic or sedative medications and Infants with neonatal jaundice bilirubin levels referred for other treatment, modalities like as intensive phototherapy and blood exchange were excluded from the present study.

Tools of Data Collection:

Tool I: Neonatal demographic characteristics assessment sheet for collecting data regarding gestational age, gender, weight, age, and hospital days.

Tool II: The Neonatal Behavioral Assessment Scale was used in the current study to assess neonatal neurobehavioral responses before and after conventional phototherapy. It was developed by **Brazelton et al., (1995)**, the scale was divided into two parts:

The first part (Neonatal behavioral responses assessment): it is consisted of 27 items are cover the six domains : 1) Neonatal orientation response "habituation" (4 items) , 2) Social interactive response (6 items), 3) Motor system (5 items) , 4): State organization (4 items) , 5) State regulation (4 items) and 6) Autonomic system (4 items) .

The second part Reflexes responses assessment : for evaluating neonatal neurological response and encompassed of 20 items.

Score system:

I- Behavioral responses assessment:

There are twenty-seven behavioural items on part one of the score sheet. On the behaviour assessment constructs, each of which is scored on a nine point scale. each item received a score between 1 and 9. The total scores ranged from 27 to 243. As the reader will quickly notice, some goods are best at the

midway of a five-point scale, while others are best at a nine-point scale. There has been no attempt to develop a scale with a sum-of-score that may be construed as optimal neonatal behavior. According to the author of NBAS, there is no such thing as ideal neonatal behavior.

II- Reflexes assessment:

Every item in the reflex evaluation dimension rated on a scale of 0 to 3. The total score ranged 0 to 60 (not done =zero, low= one, moderate= two and high= three)

Validity and reliability

The validity test was performed by five experts in Pediatric department, Faculty of Medicine, Port -Said University, and Pediatric Nursing Department, Faculty of Nursing Menoufia University. The reliability of the Neonatal Behavioral Assessment Scale by **Brazelton et al ., (1995)** was confirmed by Cronbach's alpha coefficient (0.09).

Pilot study:-

It was done out on five neonates (10 % of the sample) to evaluate the tools' applicability and simplicity, with no changes made. Those neonates were involved in our study subjects.

Field Work: Data was collected from the previous mentioned settings. Before began of the study, an formal letter was occupied from the Dean of the Faculty of Nursing in Port - Said University to the directors of previous stated settings, to obtain their agreement. Permission was obtained from them after an explanation of the study's goal. Data on the demographics of newborns were collected from nursing and medical records. Before initiating and after ending conventional phototherapy treatment, each neonate was examined individually using the (NBAS) method two times. From December 2020 to June 2021, data were collected for seven months. The researchers spent three days a week in NICU, working on the same group of neonates on the morning shift. Items were filled by observation. It took nearly 30 - 40 minutes to complete the assessment for each neonate. Assessment of the neonates' neurobehavioral responses using NBAS was applied as follows:

- **Assessment of Neonates' neurobehavioral responses: habituation and social interactive response** After the neonate has

become habituated to the activity, this is a measure of the neonate's ability to block out external stimuli. This item assesses the capacity to deal with repeated distressing stimuli such as visual, hearing, and tactile stimulus. Responses for Light, rattle, bell, and pin-prick .

Orientation to auditory stimulation was assessed as follows: Orientation response to inanimate visual & auditory, orientation response to animate visual& auditory and alertness. The researchers then scored the neonate's response.

Alertness was assessed by visually stimulating the neonate in the following way: The neonate's ability to fix on a visual item and flow it horizontally was tested using a red ball. The neonate's alertness in response to visual stimulation was then scored by the researchers.

- **Assessment of Neonates' neurobehavioral responses: motor system:** The researchers assessed, recorded and scored the tone of each neonate by the handle. Smooth movements, some head control, and hand-to-mouth or any actions are used to assess coordinating motor activity.
- **Assessment of Neonates' neurobehavioral responses: State organization:** The researchers evaluated and scored the State organization by evaluating each neonate's alertness and ability to blackout complete-body responses to recurrent stimuli when drowsy. Moreover, after crying, the newborn quickly takings to attentiveness and has the ability to quiet self, with few state swings, and low irritability.
- **Assessment of Neonates' neurobehavioral responses: State Regulation:** The researchers evaluated and scored the state regulation by examining each neonate through stressful situations as diaper changing or heel lancing
- **Assessment of Neonates' neurobehavioral responses: Autonomic system:** The researchers assessed, recorded and scored the color of each neonate. The researchers counted the respiratory rate and recorded its characteristics for each neonate.

Ethical Considerations: A verbal agreement was taken from every neonate's parent after a clear and simple explanation of

the purpose of the study and that the information was used for scientific research only and treated as confidential. The head nurses of the NICU and staff nurses were provided a brief explanation of the study and staff nurses encouraged their collaboration.

Statistical analysis:

Data were served to the computer then analyzed using IBM SPSS software package version 20.0. (Armonk, NY: IBM Corp) Qualitative data were labeled using numbers and percentages. Means, standard deviation were used for quantitative data. The significance of the attained results was refereed at the 5% level. **Student t-test** was used for normally distributed quantitative variables, to compare between two studied groups. For normal distributed quantitative variables, and compare between two periods were used **Paired t-test**. To correlate between two normally distributed quantitative variables were used **Pearson coefficient**.

Results:

Table (1) illustrates demographic characteristics of the studied sample, the current study consisted of 50 newborns, 56 % were males and 44 % were females, 80 % were full-term and mean gestational ages was 37.6 ± 1.6 and 96 % were born by cesarean section and mean \pm SD of birth weight was 2.44 ± 0.88 . Their age on admission was 2.1 ± 1.3 and mean \pm SD duration of phototherapy were 3.0 ± 1.23

Table (2): reveals the comparison of total means scores of neonates' neurobehavioral responses before and after conventional phototherapy. Clearly, there was statistical significant difference of total neonate mean score of habituation, social interactive, state organization, and total bilirubin level before & after conventional phototherapy ($p= 0.029, 0.021, 0.002$ and <0.001 respectively).

In table (3) Total neonates' neurobehavioral responses were positive correlatation with gestational age, birth weight and negative correlation with duration of phototherapy before conventional phototherapy (0.060 and 0.112 respectively). Correlated negatively gestational age, birth weight, and duration of phototherapy after conventional treatment ($-0.010, -0.092, \text{ and } -0.013$ respectively). These correlations were not statistically significant.

Table (4): represents the relation between total neonates' neurobehavioral responses before & after conventional phototherapy and gender. The results showed that no statistically significant relationship between total mean scores of neonates' neurobehavioral responses

before conventional phototherapy and gender $p > 0.05$. While, after conventional phototherapy there was statistically significant relation $p < .05$ between total mean scores of neonates' behavior and gender.

Table (1): Frequency & percentage distribution of studied neonates' according their characteristics in (n = 50)

Neonatal characteristics	NO	%
Full term	40	80
Preterm	10	20
Gestational age (week) Mean \pm SD	37.6 \pm 1.6	
Gender:		
Male	28	56.0
Female	22	44.0
Mode of delivery		
Normal Vaginal Delivery	2	4
Cesarean Section	48	96
Birth weight (kg) Mean \pm SD	2.44 \pm 0.88	
Age on admission (days) Mean \pm SD	2.1 \pm 1.3	
Duration of phototherapy Mean \pm SD	3.0 \pm 1.23	

Table (2): Comparison of total means scores of neonates' neurobehavioral responses before and after conventional phototherapy

neonates' neurobehavioral responses	Before conventional phototherapy n = 50	After conventional phototherapy n = 50	T	P
	Mean \pm SD.	Mean \pm SD.		
Habituation Total Score	9.68 \pm 2.38	8.70 \pm 2.35	2.254*	0.029*
Social interactive Total Score	14.48 \pm 3.37	13.0 \pm 2.96	2.384*	0.021*
Motor system Total Score	12.10 \pm 2.77	12.84 \pm 3.30	1.297	0.201
State organization Total Score	9.32 \pm 2.05	7.72 \pm 2.74	3.329*	0.002*
State regulation Total Score	9.10 \pm 2.79	8.70 \pm 2.18	0.800	0.427
Autonomic system Total Score	8.28 \pm 2.34	7.54 \pm 2.05	1.910	0.062
Reflexes Total Score	37.28 \pm 7.30	35.82 \pm 6.06	1.182	0.243
Overall neonates' behavioral response Total Score	98.78 \pm 7.91	95.78 \pm 12.91	1.600	0.116
Total bilirubin level (gm/dl)	19.02 \pm 5.08	8.60 \pm 2.12	12.942**	<0.001**

SD: Standard deviation

t: Paired t-test

Nonsignificant at $p > 0.05$

* Statistically significant at $p \leq 0.05$

** highly significant at $p \leq 0.001$

Table (3): Correlations between total neonates' neurobehavioral responses and neonates' demographic characteristics before and after conventional phototherapy (n = 50)

Neonatal characteristics	Total neonates' neurobehavioral responses			
	Before		After	
	R	P	R	P
Gestational age (weeks)	0.060	0.681	-0.010	0.946
Birth weight	0.112	0.439	-0.092	0.527
Duration of phototherapy	-0.026	0.859	-0.013	0.931

r: Pearson coefficient Non significant at $p > 0.05$

Table (4): Relation between total neonates' neurobehavioral responses before and after conventional phototherapy and gender (n = 50)

	Total neonates' neurobehavioral responses (Total Score)	
	Before	After
Gender:		
Male	97.18 ± 14.27	100.71 ± 7.14
Female	94.0 ± 11.0	96.32 ± 8.32
t(p)	0.862(0.393)	2.010*(0.050*)

SD: Standard deviation t: Student t-test *: Statistically significant at $p \leq 0.05$

Discussion :

The neurobehavioral score examines the newborn's ability to maintain physiological homeostasis, arrange their states of consciousness, and protect themselves from external stimuli. The scoring also considers the newborn's ability to engage with the surroundings, as well as the impact that engagement has on the environment. A clinician can better understand a neonate's needs by assessing its neurobehavioral demands. As a result, implement a suitable intervention as soon as possible. A standardised component of a neonatal clinical observation should be assessment. (Malak et al., 2021).

The current study showed that there was a highly statistically significant reduction in serum bilirubin level after conventional phototherapy than before. In the same line Khatab et al., (2021) reported that there was a significant decrease in serum bilirubin level after phototherapy than before starting the treatment. The duration of phototherapy in this study was mean 3.0 ± 1.23 days on average. This finding is in line with the fact that phototherapy was most effective in the first 42 to 48 hours of treatment. Faulhaber et al., (2019) stated that the medical effect of phototherapy should be visible within four to six hours of commencement, by a serum bilirubin level reduction of greater than 2 mg/dl expected.

The present study found that the total mean scores of neonates' neurobehavioral responses decreased in neonates after conventional phototherapy than before with no statistical significant difference was found. This could be linked to phototherapy's continual experience to light, causes over stimulus in newborns, consequential in irritation and tension, which has a negative impact on the neonates' behavioral. Kenawi et al., (2020) confirmed these findings, showing that phototherapy causes more behavior problems in neonates. Furthermore, this may be associated with separation of the neonate from their mothers, side effects of phototherapy, jaundice disease, and the nursery environment on the neonate' behavioral and neurological responses. In this respect, Abedi et al., (2018) indicated that mothers' holding their children is a significant component in their psychosomatic development. Current treatments for infant jaundice frequently necessitate isolating the baby from his or her mother. Except in cases of severe jaundice, phototherapy can be done on an as-needed basis to allow for breastfeeding or parent visits , allowing skin contact and mother-infant connection while reducing parental concern.

The ability of a newborn infant to reduce or eliminate a sensory reaction is evaluated whether he or she will be exposed to it for an extended period of time or repeatedly in a short

period of time; When a new stimulus is provided, however, the infant's attention turns to it. This response pattern demonstrates the ability to process information. If the habituation response to external signals is delayed, there is a concentrated capability to handle the behavioral reaction to a stress experience (**Bueno et al., 2019**). Therefore, the current study found a statistically significant difference between the mean score of habituation of neonates before and after conventional phototherapy. This could lead to habituation. Following visual, auditory, or tactile stimulation, cluster scores the behavioral described by the cessation of body movements, the reduction of blinks, and variations in respiration. Also, may be Due to covering the eyes during phototherapy, noise in the nursery and phototherapy can affect hearing. This result score is in line with **Kenawi et al., (2020)** who found a statistically significantly difference in the mean habituation of newborns before and after phototherapy.

The social interactive response assesses a neonate's capacity to focus on visual and auditory stimulation by moving their head and eyes to focus on stimuli. (**Basdas et al., 2018**). The current study discovered a statistically significant difference in neonatal visual and auditory orientation responses (Social interactive) before and after conventional phototherapy. may be Increased bilirubin levels have been linked to severe impairments in orientation and state range clusters. Also, it may be due to treatment of phototherapy which play a role in reducing maternal-neonatal interaction during the management, as well as preventing skin-to-skin contact and breastfeeding, which may result in a poorer orientation response to visual and auditory animates in cluster interactive processes. Hyperbilirubinemia and its sensory implications are still a major issue. According to **Dwarakanath, (2018)** phototherapy and hyperbilirubinemia have temporary impacts on cochlea outer hair cell (OHC) function. Another issue connected with phototherapy for neonatal jaundice is retinal damage. The light-sensitive retinas absorb photons more quickly when exposed to blue light, which is the most effective for dissolving bilirubin. Also, **Chen et al., (2019)** reported that the retinal function

degenerates as a result of a large rise in retinal cell death rate following continuous or greater blue light irradiation. Furthermore, phototherapy separates the child from the mother and disrupts the mother-child relationship. It can affect the neonate's hearing and visual attentiveness, as well as cause anxiety in the parents' (**Taksande and Selvam, 2018**).

The motor system of a neonate allows them to express their preferences for the type and amount of handling they need to stay in a healthy state. (**Hamerman and Bhutant, 2015**). In this regard, the current study found no statistically significantly difference between the mean motor system response of neonates before and after conventional phototherapy. This contradicts the findings of **Kenawi et al., (2020)** who found Before and after phototherapy, there were statistically significant variations in the neonates' mean motor system response. The state organization is in control of consciousness from sleep to waking, as well as the ability to maintain the state and smooth transitions between states. The ability of neonates to interact with caregivers is also governed by state control and the attention/interaction subsystem of behavior development. Both are influenced by the maturation of the CNS and neurosensory development in neonates, which improves their attention and interaction with the environment in NICUs (**Halder et al., 2015**). According to the current study's findings, there was statistically significantly differences in the total mean score of state organization before and after conventional phototherapy. **Cremer et al., (2016)** noted that phototherapy has no effect on neonates' sleep.

The ability of a neonate to regulate his or her state in the face of increased stimuli is called state regulation. In this study, there were no statistically significant differences in the total mean score of state regulation before and after conventional phototherapy. This could be attributed to the fact that that neonates' regulating behaviours such as sucking hands, which help them cope with stress and regain self-control, are not facilitated with phototherapy. In agreement with **Babu et al., (2013)** Jaundice had a significant impact on the control of the state cluster, which monitors

infants' self-quieting activity, hand-to-mouth ability, and smile..

According to the findings of the current study, there were no statistically significant differences in the total mean score of the autonomic system before and after conventional phototherapy. May be attributed to phototherapy causes sensory overload, which is out of line with the neonates' nervous system development. As a result, these neonates react to the stressors in their environment with a variety of neurophysiological reactions and behavioural stress indicators. They may exhibit stress-related behavior such as jerking, grimacing, staring, and irritability. Also, bilirubin's primary effect on the basal ganglia and mesencephalic structures. In this context, **Uhríkova et al., (2015)** found a removed autonomic balance in jaundice neonates matched to controls, as well as changes in the autonomic balance during phototherapy. Also, according to **Taksande et al., (2020)** phototherapy causes an increase in heart rate as well as a drop in systolic blood pressure, which is linked to a decrease in respiratory rate.

Newborn reflex responses are involuntary neuromuscular actions that provide primordial protection from harm. Because reflexes directly represent adaptive functioning of the very young nervous system, they can be used to assess the location of nervous system anomalies and the integrity of peripheral nerves. Reflexes also serve as a foundation for the development of mature, purposeful actions and postural alterations. As a result, measuring reflexes can be particularly useful in defining the movements and postures of infants as they develop. (**Volpe et al., 2018**). There was no statistically significant difference between the neonates' mean reflex reaction before and after conventional phototherapy, according to the current study. It is supported by **Babu et al., (2013)** who indicated that reflex scores in neonates with jaundice were no statistically significant differences before and after phototherapy. As a result, assessing reflexes can be particularly useful in continuing to describe infants' movements and postures as they mature.

The current study found that total neonatal neurobehavioral responses were

positive correlation with gestational age, birth weight, and negative correlation with duration of phototherapy before conventional phototherapy. After conventional phototherapy, there was a negative correlation between gestational age, birth weight, and phototherapy duration. As well as, no statistical significance to these correlations before and after conventional phototherapy. This could be attributed to phototherapy treatment, which could be a substantial confounding factor impacting neonatal neurobehavior. This finding is similar to **EL Sayed et al., (2013)** who a positively correlation between mean values of total scores differences of examined neonates' behaviors to habituation, social interaction, motor system, state organization, and phototherapy duration.

According to the current findings, there was no statistically significant relationship between overall mean scores of neonate's neurobehavioral responses before conventional phototherapy and gender. While there was a statistically significant relationship between total mean scores of neonates' behavior and gender after conventional phototherapy, males had higher total mean scores of behavior than females. May be the fact the more than half of studied sample were male. The same was reported by **Ahmed et al., (2019)** in a study of Egypt that revealed that there was no significant link between neonates behavior and gender; both boys and girls changed their behavior following phototherapy. It's possible that this is due to the fact that over half of the neonates were males and the rest were females.

Conclusion:

In the light of the present study results, it concluded that after phototherapy, there were statistically significant difference regarding neonate's neurobehavioral responses in domains of habituation, social interactive, state organization, and total bilirubin level.

Recommendations:

- A neonatal behavioral evaluation educational training program should be conducted for pediatric nurses in the NICU for neonates under conventional phototherapy.

- Periodical evaluation of neonatal behavioral assessment in NICU is recommended to determine behavioral changes for neonate undergoing phototherapy.
- Further research is needed to investigate the neurobehavioral responses of neonates who underwent phototherapy for a long time throughout their infancy.

Acknowledgements

The authors would like to thank all nurses and neonates who participated in the study from the NICU in AL Salam and the Women's Specialist Hospital in the Port City for their kindness, and wonderful collaboration.

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