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Assessement of Behavioral and Neurological Responses of Neonates with Jaundice undergoing Phototherapy

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Abstract

Background: Phototherapy has been the standard of care for the treatment of hyperbilirubinemia in neonates. It is generally safe procedure, although behavioral and neurological side-effects can occur.

Aim of Study: To assess behavioral and neurological responses of neonates with jaundice undergoing phototherapy.

Subjects and Methods: A descriptive exploratory research design was utilized on a convenient sample of sixty neonates with jaundice, total serum bilirubin level ranged from seven to twenty mg/dl and undergoing phototherapy at the NICU of El-Monera Pediatric Hospital, Cairo University. A neonatal characteristics assessment sheet, and Neonatal Behavioral Assessment Scale (NBAS) were used to collect data from September 2018 to February 2019. After written consent from parents, neonatal characteristics were recorded from the medical sheet and every neonate was assessed individually using (NBAS) two times, before starting and after stopping phototherapy.

Results: The current study revealed that all neonates were full term and their mean weight was 2.86±0.53. Behavioral and neurological responses of neonates with jaundice were differed significantly after than before starting phototherapy on the NBAS.

Conclusion: There were behavioral differences of studied neonates after phototherapy related to their habituation, social interactive, motor response, state organization, state regulation and reflexes.

Recommendation: NBAS must be used as a tool in the routine care for neonates with jaundice undergoing phototherapy and establishment of health educational instruction for all working nurses in NICUs about appropriate nursing care to minimize the potential side effects and complications of phototherapy.

Key Words: *Behavioral – Neurological responses – Neonatal jaundice – Phototherapy.*

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Introduction

NEONATAL period is the time from birth to the first four weeks of life. It is considered one of the most vulnerable times of the human cycle. Neonates have the highest risk of death among all children. The major causes of neonatal death are prematurity, sepsis, low birth weight, asphyxia, pneumonia and congenital abnormalities **[1]**. Within hours after birth, newborn shows significantly preference for their mother's voice and facial features. He can actively perceive, learn, and organize information while constantly striving to control their sensory input **[2]**. The behavior of a healthy, full-term newborn displays a unique organized series of distinct states of consciousness over time. The state is an indicator of the newborn's general level of well-being and is a sensitive measure of the neonate's behavior. Orientation and social interaction are also another important component of newborn's behavior which enables him to interact with his caregiver and environment **[3]**.

Behavioral adaptation is defined as a progression of events triggered by stimuli from the extra uterine environment after birth. Newborn demonstrates several predictable responses when interacting with their environment. How they react to the world around them is termed a neurobehavioral response. It comprises predictable periods that are probably triggered by external stimuli. Expected newborn behaviors include orientation, habituation, motor maturity, self-quieting ability, and social behaviors. Any deviation in behavioral responses requires further assessment, because it may indicate a complex neurobehavioral problem **[4]**. One method of systematically assessing the neonate's behavior is use of the Neonatal Behavioral Assessment Scale **[5]**.

The behavioral state is an indicator of the neonate's general level of well-being and is a sensitive measure of the neonate's behavior. Behavioral state recognized on the basis of three to four essential physiological parameters (respiration, eyes open or closed, eye movements, body movements) that remain stable over time for at least a few minutes [6].

Phototherapy affects neonatal behavior, including visual and auditory orientation and alertness [5,7,8]. Both phototherapy and separations are complex variables. Phototherapy entails more than merely increased exposure to lights: Infants under the lights experience different sensory inputs in that they are blindfolded, undressed and are held and talked to less. Blindfolding has been shown to result in increased abdominal girth, presumably because of increased aerophagy, a result not found when infants' eyes were protected by a screen rather than eye patches and exposure to light itself has been shown to alter behavioral rhythm in non-jaundiced infants [9]. In a comparative study of two groups of full-term infants, [10] found that infants exposed to uncycled 24-hour light, equivalent to that in a nursery, demonstrated poorer regulation of sleep states and decreased total daily sleep during the first two weeks of life. Light has also been shown to produce disorders in hormonal rhythms which last from six tom nine days following its use for hyperbilirubinemia [11].

Appropriate nursing care minimizes the potential side effects and complications of phototherapy. So, nurses' responsibilities include general assessment, providing protection for eyes and genital area, carefully monitoring thermoregulation, assuring effective irradiance delivery, proper positioning, maximizing skin exposure, maintaining adequate hydration, daily weighing, supporting parent- neonate interaction [5]. Neonates under phototherapy need conscious care and behavioral assessment to prevent and reduce the risk of short and long term side effects. Although jaundiced infants undergoing phototherapy are common in newborn nurseries, little has been written about their behavior. So this study aimed to assess the behavioral and neurological response of neonates with jaundice undergoing phototherapy.

Subjects and Methods

Aim of the current study:

To assess behavioral and neurological responses of neonates with jaundice undergoing phototherapy.

Research design:

A descriptive exploratory research design was utilized for the purpose of this study.

Setting:

The study was conducted in NICU that allocated at third floor of El-Monera Pediatric Hospital of Cairo University.

Subjects:

A convenient sample of 60 neonates with jaundice was admitted to NICU within six months from September 2018 to February 2019.

Inclusion criteria:

1- Gestational age more than 35 weeks.
2- With neonatal jaundice.
3- Serum bilirubin level from 7 to 20mg/dl.
4- Neonates undergoing phototherapy.

Exclusion criteria:

1- Neonates with congenital anomalies especially congenital anomalies of Central Nervous System (CNS) such as hydrocephalus and congenital cardiac defects such as tetralogy of Fallot (TGA).
2- Neonates who had any CNS disorder and/or were taking medication that affected on neurological responses such as sedative medications.
3- Neonates with sepsis.
4- Neonates who needed blood exchange or with pathological jaundice.

Study tools:

Data pertinent to the study were collected utilizing the following two tools:

1- Neonatal and maternal assessment sheet, which was developed by the investigators after reviewing of related literature and included the following: Clinical data, gender, date of birth, gestational age, weight, length, head circumference, mode of delivery, Apgar scores, type of feeding, diagnosis on admission, duration undergoing phototherapy, duration of hospitalization .....etc.
2- The Neonatal Behavioral Assessment Scale (NBAS) that is standardized scale and available at neonatal behavioral assessment scale book. It was developed by Berry Brazelton (1973). It included two parts:

• *Part one:* Neonatal behavioral responses, it included sixclusters and measures the following: Neonatal orientation response (habituation), social interactive response, motor system, state organiza-

tion, state regulation and autonomic system and part two reflexes.

• *The first cluster:* Neonatal orientation response (habituation) that is a measure of neonate's ability to block out external stimuli after neonate has become accustomed to the activity. This item measures capacity to decrease responses to repeated disturbing stimuli that are visual, auditory and tactile stimulation. It consists of four sub items: Response decrement to light, response decrement to rattle, response decrement to bell and response decrement to pin-prick.

• *The second cluster:* Social interactive response that is a measure of neonate's ability to focus on visual and auditory stimulation by their movement of head and eyes to focus on stimuli. It consists of six sub items: Orientation response to inanimate visual, orientation response to inanimate auditory, orientation response to animate visual, orientation response to animate auditory and orientation response to animate visual and auditory and alertness.

• *The third cluster:* Motor system that measures motor performance, quality of movement and tone. It consists of five sub items: General tone, motor maturity, pull-to-sit, defensive movement and activity level.

• *The fourth cluster:* State organization that is a measure of neonate arousal and state liability. It consists of four sub items: Peak of excitement, rapidity of buildup, irritability and liability of states.

• *The fifth cluster:* State regulation that is a measure of neonate's ability to regulate his/her state in face of increasing level of stimulation. It consists of four sub items: Cuddliness, consolability, self-quieting and hand to mouth.

• *The sixth cluster:* Autonomic system that records signs of stress related to hemostatic adjustments of central nervous system. It consists of four sub items: Tremulousness, startles, liability of skin color and smiles.

• *Part two:* Neonatal neurological reflexes that includes: Planter grasp, palmer grasp, ankle clonus, babinski, standing, automatic walking, placing, incurvation, crawling, glabella, tonic deviation of head and eyes, nystagmus, tonic neck reflex, moro, rooting, sucking, passive movement for right arm, right leg, left arm and left leg.

Scoring system:

Part one the score sheet includes twenty seven behavioral items, each of which is scored on a nine point scale. As the reader will soon realize some items are optimal at the midpoint a score of five, whereas others are optimal at a score of nine. There has been no attempt to create a scale whose summary score can be interpreted as optimal behavior in the neonate. The author of NBAS believed that there is no such as optimal neonatal behavior. Part two: Twenty elicited responses (reflexes), each of which is scored on a three point scale, are scored as follows: Not done=X=0; low=L=1, medium= M=2; and high=H=3. The items on scale are scored according to the neonate's reactions and responses to these tests.

Validity and reliability:

Neonatal behavioral assessment scale was developed by Berry Brazelton (1973) and its reliability was 0.09.

Procedure:

Neonatal characteristics were recorded from the medical sheet of each neonate using tool one. Every neonate was assessed individually using (NBAS) tool two two times, before starting and after stopping treatment with phototherapy.

A pilot study:

A pilot study was conducted on six neonates to test feasibility and applicability of the study tools. The sample of pilot was included in the study.

Administrative design:

An official permission was obtained from the director of El-Monera Pediatric Hospital of Cairo University as well as the head of Neonatal Department and head nurse of NICU after explaining protocol of the study.

Protection of human rights:

A primary approval was attained from the Research Ethical Committee in the Faculty of Nursing, Cairo University. Training of NBAS application was done under supervision neonatologist. All neonates' parents who participated in the study were informed about the aim, procedure, benefits, and nature of the study and the written consent was obtained by the researcher from parents. The researchers emphasized that participation in the study was voluntary, and parents can refuse to participate in the study without any reason and obtained data was only used for the research purpose. The confidentiality of information was assured and the parents had the right to withdraw from the study at any time during the study without any effect on the care provided to their neonates.

Statistical design:

Data were statistically described in terms of mean ± Standard Deviation (± SD), frequencies and percentages when appropriate. Comparison between before and after values was done using paired *t*-test for matched samples. For comparing categorical data, McNemar test was performed. *p*-value less than 0.05 was considered statistically significant. All statistical calculations were done using computer program IBM SPSS (Statistical Package for the Social Science; IBM Corp, Armonk, NY, USA) release 22 for Microsoft Windows.

Results

Table (1) illustrated that 51.7% were male and 48.3% females; mean of gestational age was 37.98 ± 1.157 and their birth weight 2.86 ±0.53. Majority of neonates (88.3% & 90%) on artificial milk before and after phototherapy respectively.

Table (1): Neonatal characteristics in percentage distribution (n=60).

Neonatal characteristics	No.	%
Gender:		
Male	31	51.7
Female	29	48.3
Gestational age/week:		
<37	3	5
≥3	57	95
Mean ± SD	37.98± 1.157	
Birth weight:		
≤2500	18	30
≥2501	42	70
Mean ± SD	2.86±0.53	
Type of milk:		
• *Before phototherapy:*		
Artificial	53	88.3
Breast	7	11.7
• *After phototherapy:*		
Artificial	54	90.0
Breast	6	10.0

Table (2) illustrates that mean total bilirubin level of neonates was 16.59±2.72gm/dl on starting phototherapy and 7.88±1.43gm/dl after. Their mean age was 5.5±3.83 days on starting phototherapy and 7.75±4.04 on ending and mean of duration under phototherapy was 2.45±1.199.

Table (2): Neonates clinical data in percentage distribution (n=60).

Clinical data	N	%
TBL (gm/dl) before phototherapy:		
10-<15	13	21.7
15-20	47	78.3
Mean ± SD	16.59±2.72	
TBL (gm/dl) after phototherapy:		
5-<9	48	80.0
9-11	12	20.0
Mean ± SD	7.88±1.43	
Age on starting phototherapy day:		
1-3	16	26.7
4-6	31	51.7
7-9	9	15.0
10-12	1	1.7
≥13	3	5.0
Mean ± SD	5.50±3.83	
Age on ending phototherapy/day:		
2-4	4	6.7
5-7	33	55.0
8-10	19	31.7
10-12	0	0.0
13-15	0	0.0
≥16	4	6.7
Mean ± SD	7.75±4.04	
Duration (day):		
1-2	39	65.0
3-4	18	30.0
>4	3	5.0
Mean ± SD	2.45± 1.199	

Table (3) illustrates that there are highly statistically significant differences of neonates mean of habitation, social interactive, motor system, state regulation, reflexes and total bilirubin level before and after phototherapy (*p*=0.000, 0.000, 0.000, 0.000, 0.000 & 0.04 respectively).

Table (3): Comparison of total means scoresof neonates' behavior clustersbefore and after phototherapy.

Neonatal behavioral response	Before phototherapy Mean ± SD	After phototherapy Mean ± SD	*p*-value
Habituation	30.30±2.56	25.92±3.63	0.000***
Social interactive	36.72±5.72	27.42±7.55	0.000***
Motor system	27.08±4.74	24.35±4.19	0.000***
State organization	17.95±4.24	16.73±4.63	0.079
State regulation	20.42±3.59	16.27±3.89	0.000***
Autonomic system	10.40±2.44	10.43±2.32	0.926
Reflexes	32.27±2.74	29.97±3.87	0.000***
Total bilirubin level (gm/dl)	16.59±2.72	7.88±1.43	0.04*

Table (4) shows that there is no significance correlation between mean values of total scores differences of studied neonates' behavioral response before and after phototherapy and gender, gestational age, age before phototherapy, and weight before phototherapy. A significance negative correlation was detected between mean values of total scores differences of state organization and devise of phototherapy (p=.050), and a significance positive correlation between habitation, social interactive, reflexes difference and duration of phototherapy (p=0.040, 0.048 & 0.035 respectively).

Table (4): Correlation between mean values of total scores differences of studied neonates' behavioral response before and after phototherapy andtheir clinical data.

Behavioral cluster	Gender P	GA P	Age P	WT P	Device of PH P	TSB P	Duration of phototherapy P
Habituation diff	0.820	0.940	0.28	0.717	0.164	0.138	0.040*
Social interactive diff	0.799	0.274	0.80	0.504	0.243	0.564	0.048*
Motor system diff	0.709	0.380	0.33	0.459	0.190	0.048*	0.419
State organization diff	0.798	0.194	0.71	0.296	0.050*	0.051 *	0.234
State regulation diff	0.723	0.404	0.13	0.909	0.125	0.474	0.840
Autonomic system diff	0.998	0.297	0.85	0.152	0.078	0.168	0.997
Reflexes diff	0.182	0.529	0.32	0.064	0.781	0.700	0.035*

Discussion

The findings of the present study revealed that that about more than half of the neonates were males while the rest were females. This finding is in agreement with **[12]** who found that more than half were males while the rest were females. On the same context, in Egypt **[13]** found that majority of neonates. The findings of this study showed that there was no significance correlation between the behavior of neonates and their gender; boys and girls showed the same behavioral changing after phototherapy.

The present study revealed that the gestational age of studied neonates ranged from 35 to 40 weeks with a mean of 37.98 ± 1.157 weeks. This in agreement with **[13]** who reported that mean gestational age in weeks was 37.23 ± 1.01. This is comparable to **[14]** who observed that newborns of 35 to 37 weeks gestation were 2.4 times more likely to develop significant hyperbilirubinemia than those of 38 to 42 weeks gestation, and thus they should be considered a high-risk group. This also in agreement with the result of another study which reported that the incidence of hyperbilirubinemia increased with decreasing gestational age **[15]**.

The result of this study demonstrated that, the birth weight of studied neonates ranged between 1.5kg and more than 2.5kg with a mean of 2.86 ± 0.53. This finding issupported by **[16]** who concluded that the threshold levels for defining significant hyperbilirubinemia and starting phototherapy treatment in full term neonates increased with decreasing the birth weight. Similar findings were reported by **[17]** in his study stated that birth weight is a significant risk factor for hyperbilirubinemiaand is known to be a basis for increased biologic vulnerability to risk of bilirubininduced neurotoxicity. Also **[18,19]** found that mean birth weight was 3.40 ±0.46 and 3.01 ±0.27 respectively.

The findings of this research showed that the total bilirubin level of studied neonates who their mean age on starting phototherapy was 5.50 ±3.83 days was ranged from 10-20mg/dl with mean of 16.59+2.72mg/dl. This attributed to **[20]** who found that TSB level at 2-3 days of age was 17mg/dl. This results also in agreement with **[21]** who stated that the maximum value of TBL which indicated for phototherapy ranged from 12 to 14mg/dl in the first 72 hours of life this could be due to physiological jaundice and this rang of TBL can be classified as moderate jaundice. Phototherapy is highly effective in the treatment of neonatal jaundice and decline the rate of serum bilirubin levels. The light waves convert the bilirubin to water soluble nontoxic forms which are then easily excreted. In this study the duration of phototherapy was ranged from 2 to 5 days with a mean of 2.45 ± 1.19 days. This finding is in congruent with the fact that that phototherapy had its greatest effect during the first 42 to 48 hours of treatment. This finding is in agreement with) **[22]**, who reported a similar result. This also in agreement with **[23]** who reported that the clinical impact of phototherapy should be evident within 4 to 6 hours of initiation with an anticipated decrease of more than 2mg/dl in serum bilirubin level. The present study revealed that there was significant correlation between change of behavioral responses "habituation, social interactive and reflexes" and duration of phototherapy. It was found that in long duration of phototherapy showed more changes in neonate's behavior than

short duration. These results were confirmed by [24] who found that the longer duration of treatment with phototherapy leading to more behavioral affected in neonates. This might be related to continuous exposure to light of phototherapy which produces over stimulation in neonates resulting in irritability and stress which lead to worse effect on the behavior of the neonates.

One of the most impressive mechanisms in the neonate is his capacity to decrease responses to repeated disturbing stimuli that is called habituation response. In this cluster, an attempt is made to measure the decrement which occurs in a quiet state, after the infant has responded with an aversive reaction to a flashlight shone briefly in his eyes (closed or open) as a visual stimulus, rattle and bell as auditory stimulus. Thecurrent study demonstrated a statistically significant decrease difference of neonate's mean of habitation before and after phototherapy. This result is congruent with the findings of the study had done by [25] that founded that there was statistically significant decrease differences of neonates mean of habitation before and after phototherapy.

Regarding the orientation response, the studied neonates showed significant differences before and after phototherapy for orientation response in visual and auditory response to object and human. This results agreed with [26] who found that significantly poorer performances in visual and auditory orientation response for newborn who had terminated phototherapy. In consistence with these results [27] who found similar finding. This is may be due to phototherapy; it is the primary choice for treatments of neonatal jaundice, neonates under phototherapy undressed are held and his eyes were covered by eye patches. Blind folding is stressful for newborns. Blind folding is stressful for newborns. Concerning the social interaction response of studied neonates, the results revealed that there were decreased in visual response to human face and visual & auditory response to human face and voice after phototherapy. This finding was supported by the finding of [28] who found that newborns who terminated phototherapy had significant low scores in social interaction response. These can be attributed to maternal separation which includes more than simple maternal absence: The newborn is also deprived of the normal visual, verbal and tactile experience that non separated neonates receive [29]. Stated that the maternal regulators of newborn physiology and behavior, and classified them into nutrient-interceptive and behavioral-sensorimotor which regulated the neonate's activity level. From this perspective, newborn's responses to maternal separation were viewed as a release from maternal regulation.

Concerning to motor maturity response of neonates the current study represented that there were statistically significant decrease differences in the neonates mean of motor system response before and after phototherapy this result in accordance with the study of [30] that demonstrated that there was a decrease in neonates' motor response after they treated by phototherapy.

The findings of the current study demonstrated that highly statistically significant decrease differences were detected between the mean state regulation response of neonates before and after phototherapy. This result is in accordance with the study carried out by [25] that found that there was highly statistically significant difference of neonate's mean of state regulation before and after phototherapy.

Concerning to reflexes the results of the current study reported that there were statistically significant decrease differences between the neonate's mean of reflexes response before and after phototherapy. This result of the current study is contradicted with the study of [25] that found that there was no statistically significant differences of neonates mean of reflexes response before and after phototherapy.

On starting phototherapy there was a negative significant correlation between mean values of total scores differences of studied neonates' behavioral response before and after phototherapy and cluster of state organization and phototherapy device. This disagrees with [26] who demonstrated that there was no difference in stress experienced by neonates in double surface and single surface phototherapy.

The result of the current study indicated that there was a positive significance correlation between mean values of totals scores differences of studied neonates' behavioral response in clusters of habituation, social interactive and reflexes and duration of phototherapy. This result is in the same line with [25] that found there was positive correlation between mean values of totals scores differences of studied neonates' behavioral response of habitation, social interactive, motor system and state organization and duration of phototherapy.

Conclusion:

There were behavioral differences of studied neonates after phototherapy related to their habit-

uation, social interactive, motor response, state organization, state regulation and reflexes.

Recommendation:

NBAS must be used as a tool in the routine care for neonates with jaundice undergoing phototherapy and establishment of health educational instruction for all working nurses in NICUs about appropriate nursing care to minimize the potential side effects and complications of phototherapy. Further researches needed to be done in order to examine the behavioral and neurological responses of neonates who received phototherapy on later outcomes in infancy period.

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التقييم السلوكى والعصبى لإستجابات حديثى الولادة المصابين باليرقان الخاضعين للعلاج الضوئى

الخلفية: تهدف الرسالة إلى التقييم السلوكى والعصبى لإستجابات حديثى الولادة المصابين باليرقان الخاضعين للعلاج الضوئى. تم تطبيق دراسة وصفية إستكشافية على عينة متاحة من ٦٠ طفل حديثى الولادة المصابين باليرقان الوليدى وذلك من خلال إستمارة لجمع البيانات الشخصية الخاصة بالأم والطفل صممت بواسطة الباحثين ومقياس برازيلتون (١٩٧٣) لتقييم سلوك حديثى الولادة قبل وبعد الخضوع للعلاج الضوئى. وقد أظهرت نتائج الدراسة إلى وجود فروق ذات دلالة إحصائية فى إستجابات حديثى الولادة السلوكية والعصبية بعد الخضوع للعلاج الضوئى. وقد أوصت الدراسة بإستخدام مقياس برازيلتون لتقييم سلوك حديثى الولادة الخاضعين للعلاج الضوئى ضمن الرعاية الروتينية المقدمة لهم.