The Efficacy of Phototherapy in the Treatment of Neonatal Jaundice

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Abstract

Phototherapy is safe and effective in the management of neonatal hyperbilirubinemia; its efficacy has been demonstrated in several studies.

A prospective study done on 100 cases of newborns with jaundice admitted to the pediatric ward at Tikrit Teaching Hospital during January to July 2009 were selected randomly, aim to evaluate the efficacy of phototherapy used in the treatment of significant indirect hyperbilirubinemia. The total serum bilirubin determinations were performed on newborns with jaundice. The current study demonstrated a statistically significant positive relation between the rate of TSB decrement and supplementary feeding, B.Wt. and type of light ,and a statistically non-significant negative relation between the rate of TSB decrement and gestational age, type of jaundice and receiving IVF. Conclusion: the efficacy of phototherapy in neonates with mixed feeding more than the bottle feeding and breast feeding, also the response to phototherapy in VLBW newborns was significantly slower than that of NBW and LBW. neonates under blue light phototherapy showed faster response than those under white light.

Keywords: phototherapy; neonatal jaundice; serum bilirubin.

Introduction

Phototherapy is a safe and effective method in the management of neonatal hyperbilirubinemia. Neonatal phototherapy has its origins in the observations of a nurse on the effect of sunlight on jaundiced babies’ skin color. Bilirubin absorbs light maximally in the blue range (420-470 nm). Broad-spectrum white, blue, and special narrow spectrum (super) blue lights have been effective in reducing bilirubin levels.

The use of phototherapy has decreased the need for exchange

Transfusion in term and preterm infants with hemolytic and nonhemolytic jaundice. When indications for exchange transfusion are present, phototherapy should not be used as a substitute; however, phototherapy may reduce the need for repeated exchange transfusions in infants with hemolysis. This effect has been particularly noticeable in infants with very low birth weight, for whom exchange transfusions, is one of the common procedures in the neonatal intensive care unit, are now rare. The factors that affect the dose and efficacy of phototherapy, including type of light source, the infant’s distance from the light, and the surface area exposed, as well as the rate of hemolysis and in vivo metabolism and excretion of bilirubin.

An increased incidence of early-onset jaundice has been reported in breast-fed infants, both full-term and preterm more than those fed formula. Recently hyperbilirubinemia was not found to be correlated with breastfeeding, but rather with an increased weight loss, dehydration, and caloric deprivation which could enhance the enterohepatic circulation of bilirubin.

Aim of Current Study: evaluation of effect of different variables on the efficacy of phototherapy used in pediatric ward in the treatment of neonatal jaundice.

Patients and Methods

Approval & permission to perform the study was obtained from the Dean of College of Medicine- Tikrit University ,the administrator of Tikrit Teaching Hospital
and the family of the neonates. A prospective study done on a 100 cases of newborns with jaundice admitted to the pediatric ward at Tikrit Teaching Hospital during a period from January to July 2009 were selected randomly. The neonates were divided into many groups according to the variables. In relation to the mode of feeding, the neonates were divide into 3 groups: (Group 1: formula-fed neonates; Group 2: breast-fed neonates; Group 3: mixed fed neonates (received formula and breast milk, n=12).

On other hand the sample divide into two main groups according to an IVF intake as (Group 1, receiving IVF; Group 2, not receiving IVF).

Also the sample divided into 3 groups according to B .W.(3) : Group 1, normal B. Wt.(≥2500g); Group 2, LBW(<2500g) and Group 3, VLBW(<1500g) (3).

Exclusion criteria: Newborns above 14 days of age; Newborns who underwent exchange transfusion; Newborns with mainly direct hyperbilirubinemia; Newborns who die during phototherapy, The available Phototherapy (Vickers 80) consist of 3-4 overhead fluorescent lamps blue, white or mixed. Capillary blood was sampled at the start of exposure and at 12-hour intervals; the lights were off and the infants were removed from the cot during the sampling. Phototherapy was used for each patient in regard to the body weight (3).

Statistical analysis: Data were analyzed by using the Windows program for the Statistical Program for the Social Sciences (SPSS 7.5). Analysis of variance (ANOVA) was used to determine whether significant differences occurred among the groups and where they occurred.

Results: A total of 100 cases were involved in the study who aged less than 2 week, 67(67%) were full term, 33(33%) were preterm, 66 cases were hemolytic, 36 cases were coombs test positive, 64 cases were coombs test negative, 27 cases undergone exchange transfusion and 2 cases die during admission so that these 31 cases excluded from the study. Phototherapy was started with bilirubin concentration more than 139.4 μmol/L (8.2 mg/dL). In table (1) shows that higher value of TSB at admission was for the normal weight group as the mean ±SD was (14.7±4) as compared with other groups, however rate of decrement in TSB through 12hr.s and 24hr.s in LBW was more than in normal birth weight and VLBW which reflect the efficacy of phototherapy in this group. The difference was significant between the three groups of readings (ANOVA, p<0.05).

<table>
<thead>
<tr>
<th>Body weight</th>
<th>Cases</th>
<th>TSB at admission (mean ±SD)</th>
<th>TSB decrease at 12hr.s (mean ±SD)</th>
<th>TSB ++ decrease at 24hr.s (mean ±SD)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>37</td>
<td>14.7±4</td>
<td>2±1</td>
<td>3.6±1</td>
<td>0.002</td>
</tr>
<tr>
<td>LBW</td>
<td>26</td>
<td>14±2.4</td>
<td>2.3±1</td>
<td>3.8±1.2</td>
<td>0.01</td>
</tr>
<tr>
<td>VLBW</td>
<td>8</td>
<td>9.2±1.6</td>
<td>1±0.9</td>
<td>2±1.8</td>
<td>0.003</td>
</tr>
<tr>
<td>Total</td>
<td>71</td>
<td>13.8±3.7</td>
<td>2±1</td>
<td>3.7±1.7</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Gestational age</th>
<th>TSB at admission (mean ±SD)</th>
<th>TSB decrease at 12hr.s (mean ±SD)</th>
<th>TSB ++ decrease at 24hr.s (mean ±SD)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full term</td>
<td>49</td>
<td>14.8±3.7</td>
<td>2±1</td>
<td>4±1.7</td>
</tr>
<tr>
<td>Preterm</td>
<td>22</td>
<td>11.7±2.8</td>
<td>1.8±1</td>
<td>3.3±1.8</td>
</tr>
<tr>
<td>Total</td>
<td>71</td>
<td>13.8±3.7</td>
<td>2±1</td>
<td>3.7±1.7</td>
</tr>
</tbody>
</table>

†P=0.03 < 0.05 significant; ††P=0.001 < 0.05 significant.
Concerning the rate of decrement of TSB in relation to gestational age, it was more obvious in full term than preterm at both 12hr.s (2 ± 1) and 24hr.s (4 ± 1.7) as shown in table (1). TSB at admission was also higher in full term newborns than preterm’s, but the difference were not significant (ANOVA, P>0.05).

According to type of jaundice, the rate of decrement was more in non hemolytic jaundice (2 ± 1.2) (3.7 ± 1.6) than hemolytic jaundice (1.4±1)(2.3 ±1.8) both 12hr.s and 24hr.s respectively with respect to the TSB reading at admission which was higher in hemolytic than non hemolytic jaundice as shown in table (2). The differences were not significant (ANOVA, P>0.05)

Table(2): The Efficiency of Phototherapy in Relation to Type of Jaundice.

<table>
<thead>
<tr>
<th>Type of Jaundice</th>
<th>Cases</th>
<th>TSB at admission (mean ±SD)</th>
<th>TSB ‡ decrease at 12hr.s (mean ±SD)</th>
<th>TSB ‡‡ decrease at 24hr.s (mean ±SD)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hemolytic</td>
<td>16</td>
<td>16.7±4</td>
<td>1.4 ±1</td>
<td>2.3 ±1.8</td>
<td>0.6</td>
</tr>
<tr>
<td>Non hemolytic</td>
<td>55</td>
<td>14.0± 3.2</td>
<td>2 ± 1.2</td>
<td>3.7 ±1.6</td>
<td>0.3</td>
</tr>
<tr>
<td>Total</td>
<td>71</td>
<td>13.8±3.7</td>
<td>2±1</td>
<td>3.7±1.7</td>
<td></td>
</tr>
</tbody>
</table>

†P=0.9 > 0.05 non-significant; ‡P=0.7 > 0.05 non significant

Regarding the rate of decrement in relation to the type of feeding, those newborn with mixed feeding showed more decrement of TSB at 12hr.s (2.3±.896) and 24hr.s (4.75±1.4) than other groups as shown in table (3). The differences between the readings were significant (ANOVA, P<0.05).

Table (3): The Efficiency of Phototherapy in Relation to Type of Feeding; type of Light and IVF

<table>
<thead>
<tr>
<th>Feeding</th>
<th>Cases</th>
<th>TSB at admission (mean ±SD)</th>
<th>TSB † decrease at 12hr.s (mean ±SD)</th>
<th>TSB †† decrease at 24hr.s (mean ±SD)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breast feed</td>
<td>33</td>
<td>14.6±4</td>
<td>2.2±1</td>
<td>4±1.3</td>
<td>0.001</td>
</tr>
<tr>
<td>Bottle feed</td>
<td>26</td>
<td>12.6±3.3</td>
<td>1.5±1.00</td>
<td>3 ± 1.7</td>
<td>0.006</td>
</tr>
<tr>
<td>Mixed</td>
<td>12</td>
<td>14.2±3.19</td>
<td>2.3±0.8</td>
<td>4.7±1.4</td>
<td>0.007</td>
</tr>
<tr>
<td>Total</td>
<td>71</td>
<td>13.8±3.7</td>
<td>2±1</td>
<td>3.7±1.7</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Light</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Blue</td>
<td>31</td>
<td>16±3.4</td>
<td>2.2 ±0.8</td>
<td>4 ± 1.4</td>
<td>0.004</td>
</tr>
<tr>
<td>White</td>
<td>24</td>
<td>12±2.6</td>
<td>1.8±1.3</td>
<td>3.3 ±2.0</td>
<td>0.02</td>
</tr>
<tr>
<td>Mixed</td>
<td>16</td>
<td>12.3±3.4</td>
<td>1.5±1</td>
<td>3.1±1.7</td>
<td>0.007</td>
</tr>
<tr>
<td>Total</td>
<td>71</td>
<td>13.8±3.7</td>
<td>2±1</td>
<td>3.7±1.7</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>IVF</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>YES</td>
<td>63</td>
<td>13.5±3.7</td>
<td>2 ±1</td>
<td>3.8 ±1.6</td>
<td>0.004</td>
</tr>
<tr>
<td>NO</td>
<td>8</td>
<td>16.2±3</td>
<td>1.3 ±0.5</td>
<td>3.4±1.5</td>
<td>0.003</td>
</tr>
<tr>
<td>TOTAL</td>
<td>71</td>
<td>13.8±3.7</td>
<td>2±1</td>
<td>3.7±1.7</td>
<td></td>
</tr>
</tbody>
</table>

†P=0.04 < 0.05 significant; ††P=0.02 < 0.05 significant
So, table (3) revealed that the blue light had the biggest role in the TSB decrement both at 12hr.s (2.2 ±0.8) and 24hr.s(4 ± 1.4) than other types of lights. On other hand, TSB at admission was also higher for those who received the blue light. The differences were significant between the three readings (ANOVA, P<0.05).

**Discussion**

The current study showed that the rate of TSB decrement was more in LBW newborn than in normal BW and VLBW which was disagree with study by Joan (45) and Tan(46) in which phototherapy was equally effective in lowering bilirubin levels in all weight categories. This result are also disagree with K. L. TAN(23) who reported an increased effectiveness of phototherapy in extremely preterm infants with very low birth weight. Despite the fact that the increased effectiveness of phototherapy in very low birth weight than in other birth weight categories due to their relatively greater surface area, but it was not in the current study as it included smaller numbers of patients with much smaller differences in size which may give a different interpretation .In addition the bad exposure of VLBW newborns due to unfit diaper and eye protection cover both of which cover most of the body lead to decrease the exposed surface to light , all these factors and may be other factors have a negative effect on the response to phototherapy.

The current study showed that the rate of TSB decrement was more in full term than preterm at both 12hr.s and 24hr.s which was disagree with study by Tan (47) and Romagnoli et al.,(48), in which response to exposure phototherapy in the preterm infants was significantly better than that in the term infants .This result are also disagree with Joan (45),and Tan (46), in which phototherapy was equally effective in lowering bilirubin levels in all gestational age categories, the bad exposure of premature neonates due to unfit diaper which cover most of the body lead to decrease the exposed surface to light, has a negative effect on the response to phototherapy.

In the current study the rate of decrement was more in non hemolytic type of jaundice than hemolytic type of jaundice at both 12hr.s and 24hr but non significant so had different opinion with study of Thaithumyanon et al.(49), in which efficacy of conventional phototherapy in term infants with severe hemolytic jaundice was slower than in non hemolytic jaundice. The current study be in a disagreement with (28) in which Phototherapy cannot be considered a reliable substitute for exchange transfusion, particularly in the presence of severe hemolysis. The current study disagree with (8) who suggested that phototherapy exerts lesser effect on the more severe forms of hemolytic jaundice than mild forms. The interpretation of such result could be due to continuous hemolytic process which explain the high TSB level of hemolytic jaundice at admission.

In this study the rate of decrement of TSB was more in newborn with mixed feeding than other groups at both 12hr.s and 24hr.s, which agree with Tan (1) phototherapy was highly effective in reducing the bilirubin concentrations in mixed feeding, while it was disagree with current result in which efficacy of phototherapy or the rate of decrease in TSB was poorer in breast fed than formula fed which was converse to this study. This study also come in line with Yoshitada Yamauchi et al. (50), More frequent feedings in the immediate neonatal period probably stimulate gut motility, thereby decreasing the reabsorption of bilirubin through the small bowel and reducing serum bilirubin levels in breast-fed neonates. The increased intake of milk also provides more calories. Caloric deprivation is known to impair bilirubin clearance by the liver (50). The formula fed group response poorer than breast fed group may be due to small number of sample in this group or may be due to inadequate or infrequent feeding of the daily requirement of milk.

In the current study the blue light had the biggest role in the TSB decrement both at 12hr.s (2.2 ±0.8) and 24hr.s(4 ± 1.4) than other types of lights, the same results were obtained by S. Sarıcı etal., (51), American Academy of Pediatrics(24) Conventional phototherapy consisting of special blue fluorescent lamps with approximately two fold higher irradiance and an emission spectrum than daylight and green wave lengths in the standard treatment of term newborns with hyperbilirubinemia. The efficacy of phototherapy depends on the irradiance (energy output) of the light source. Irradiance is measured with a radiometer or spectroradiometer in units of watts per square centimeter or in microwatts per square centimeter per nanometer over a given wavelength band. When positioned 20 cm above the infant, conventional
or standard daylight phototherapy units should deliver a spectral irradiance (measured at the level of the infant) of 8 to 10 μW per square centimeter per nanometer in the 430-to-490-nm band, whereas special blue fluorescent lamps will deliver 30 to 40 μW per square centimeter per nanometer.

The American Academy of Pediatrics defines intensive phototherapy as a spectral irradiance of at least 30 μW per square centimeter per nanometer over the same bandwidth delivered to as much of the infant’s body-surface area as possible this mean blue light more effective than the other type.

According to current study the decrement of TSB in relation to intravenous fluid administration, the rate of decrement at 12hr.s and 24hr.s was more in those who receive an IV fluid (2±1) (3.8 ±1.6), than those who did not receive it (1.3±0.5 ) (3.4 ±1.5), a study done by Boo et al. revealed that the rates of decrease in TSB levels during phototherapy, was irrespective of whether they received oral or intravenous fluid supplementation. In the current study 27(27%) cases from 100cases undergo exchange transfusion 18cases hemolytic jaundice and 9 cases non hemolytic but disagree with Audrey et al.,

**Conclusion**

Phototherapy was more effective in decrease serum bilirubin in LBW infants than the other infant, also Type of feeding affect the efficacy of phototherapy thus in mixed feeding the rate of TSB decrement was more than the other type of feeding so blue light phototherapy was more effective in decreasing serum bilirubin than the white light.

**Ethical Clearance:** None

**Source of funding:** None

**Conflict of Interest:** None

**References**


