LETTER

A Novel Approach to Phototherapy Initiation in Preterm Infants

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Abstract: Therapeutic interventions in preterm infants are determined based on birth weight. Phototherapy (PTx) is the treatment for hyperbilirubinemia, started based on serum bilirubin level. However, weight-based guidelines for PTx in preterm infants are lacking. We present a simple way of calculating the bilirubin to initiate PTx. A percentage body weight, ranging from 0.5%-1%, is used to calculate bilirubin.

Keywords: Phototherapy, Preterm infants, Bilirubin, Jaundice, Hyperbilirubinemia, Therapeutic interventions.

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1. INTRODUCTION

Hyperbilirubinemia is a common problem in neonates. Phototherapy (PTx) is treated to handle hyperbilirubinemia. The initiation of PTx depends upon the serum bilirubin level, clock hours counted from the time of birth and gestational age. Higher bilirubin level at early hours of life with low gestation is a strong indication of starting PTx. The dose of PTx is calculated as irradiance ranging between 15-40 µW/cm²/nm. Established guidelines are available for PTx treatment for neonates older than 35 weeks [1] but data is scarce about the guidelines in preterm infants younger than 35 weeks [2]. In preterm infants, weight rather than gestational age is used for certain calculations and therapeutic interventions. Therefore, there is a need for a weight-based guideline for PTx. We present a simple weight-based approach to the initiation of PTx in preterm infants.

2. METHODS

We used the percent body weight as a factor determining the need for phototherapy. Total body water (TBW) of a preterm neonate is about 80% of the bodyweight (TBW = weight in grams x 0.80); 50% is extracellular and 30% is intracellular. Plasma/serum constitutes about 5% of the TBW. With the change in gestation and weight, body fluid composition changes. A serum bilirubin level of 5 mg/dL in a 500-gram infant is different than a 1500-gram infant. Using the principle of TBW and determining changes in the body fluid composition, we developed a weight-based guide for PTx in preterm infants. For infants < 750 grams, we used 1% of body weight, 0.75% for 751-1500 grams and 0.5% for 1501-2500 grams (Box 1, 2 and 3), respectively.

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The study was a preliminary work depicting a mathematical formula for initiating PTx. No sample size calculation was performed. For comparison with other methods of initiating PTx in preterm infants, we used data published by Maisels et al. [2]. We compared our weight-based approach with their data.

3. RESULTS

Table 1 depicts the findings. For each gestation, we selected the corresponding mean weight using the Fenton chart for boys. We used the boys’ chart for uniformity. As noted in Table 1, for gestational age less than 28 weeks, the phototherapy level of bilirubin level ranges from 5-6 mg/dL. Based on Fenton’s chart, < 28 weeks correspond to 500-1100 grams mean weight. By using percent body weight formula (1% for < 750 and 0.75% for 750-1500 grams), the bilirubin was found to be in the range of 5-8 mg/dL. A similar trend was noted with increasing gestational age.

4. DISCUSSION

Phototherapy could be associated with potential complications in preterm infants including transepidermal water loss, rash and possibly seizures. The approach to the treatment of hyperbilirubinemia with PTx could be conservative or aggressive depending on the ranges of TSB used [3]. When we compared our approach to the Norwegian guidelines [4], we noted our approach to be conservative (Table 2). The mean bilirubin level for all weight ranges matches the calculated bilirubin.

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The tool used in our brief report is available at zero cost. It is a simple mathematical tool based on infant’s birth weight. Based on this study, we planned an IRB follow-up study on real patients comparing the outcomes of reducing serum bilirubin level using the mathematical tool and guidelines described recently [5 - 8].

Table 1. Comparison of gestation and weight-based approach.

<table>
<thead>
<tr>
<th>Gestational age (Weeks)</th>
<th>Initiate Phototherapy Total Serum Bilirubin (mg/dL) (Maisels et al)</th>
<th>Mean Weight for Gestational Age (Grams)</th>
<th>Initiate Phototherapy Total Serum Bilirubin (mg/dL) Weight-based Approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 28 0/7</td>
<td>5-6</td>
<td>500-1100</td>
<td>5-8.2</td>
</tr>
<tr>
<td>28 0/7-29 6/7</td>
<td>6-8</td>
<td>1101-1400</td>
<td>8.2-10</td>
</tr>
<tr>
<td>30 0/7-31 6/7</td>
<td>8-10</td>
<td>1401-1750</td>
<td>8.7-10</td>
</tr>
<tr>
<td>32 0/7-33 6/7</td>
<td>10-12</td>
<td>1751-2200</td>
<td>8.7-11</td>
</tr>
<tr>
<td>34 0/7-34 6/7</td>
<td>12-14</td>
<td>2201-2500</td>
<td>11-12.5</td>
</tr>
</tbody>
</table>

Mean weight for gestational age is taken as the average weight (50% for boys from Fenton growth chart).

Table 2. Comparison of Norwegian guidelines and weight based approach.

<table>
<thead>
<tr>
<th>Weight (grams)</th>
<th>Initiate Phototherapy (Day 1) Total Serum Bilirubin (mg/dL)* Norwegian Guidelines</th>
<th>Initiate Phototherapy (Day 1) Total Serum Bilirubin (mg/dL) Weight-based Approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 1000</td>
<td>5.8 (100 µmol/L)</td>
<td>5-7.5</td>
</tr>
<tr>
<td>1000-1500</td>
<td>7.3 (125 µmol/L)</td>
<td>7.5-11</td>
</tr>
<tr>
<td>1500-2500</td>
<td>8.7 (150 µmol/L)</td>
<td>11-12.5</td>
</tr>
</tbody>
</table>

*To convert µmol/L to mg/dL, multiply by 17.1.

Box 1. Calculation of bilirubin by using percent body weight.

<table>
<thead>
<tr>
<th>Factor = Percent Body Weight (BW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>500-750 grams, 1% of BW</td>
</tr>
<tr>
<td>751-1500 grams, 0.75% of BW</td>
</tr>
<tr>
<td>1501-2500 grams, 0.5% of BW</td>
</tr>
</tbody>
</table>

Box 2. Examples of bilirubin calculation.

Example 1:
Birth weight (BW) = 1300 grams, % birth weight factor = 0.75%
Total Serum Bilirubin (TSB) = 6.2 mg/dL.
Calculated Bili-Photo level (cBili) = Weight x % BW factor
 =1300 x 0.75/100 = 9.7
Interpretation: cBili > TSB
Plan: No Phototherapy (TSB of 6.2 is < 9.7 cBili), Follow bili in 4 hours

Example 2:
Birth weight (BW) = 1800 grams, % birth weight factor = 0.5%
Total Serum Bilirubin (TSB) = 11 mg/dL.
Calculated Bili-Photo level (cBili) = Weight x % BW factor
 =1800 x 0.5/100 = 9
Interpretation: cBili < TSB
Plan: Start Phototherapy (TSB is > cBili), Follow bili in 4 hours

Example 3:
Birth weight (BW) = 600 grams, % birth weight factor = 1%
Total Serum Bilirubin (TSB) of 7 mg/dL.
Calculated Bili-Photo level (cBili) = Weight x % BW factor
 =600 x 1/100 = 6
Interpretation: cBili < TSB
Plan: Initiate PTx with single light, irradiance of 15-20 µW/cm2/nm, Check TSB in 4 hr.
Box 3. Tips for using percent weight-based bilirubin.

<table>
<thead>
<tr>
<th>Box 3. Tips for using percent weight-based bilirubin.</th>
</tr>
</thead>
<tbody>
<tr>
<td>• If TSB is greater than cBili, start Phototherapy (PTx).</td>
</tr>
<tr>
<td>• Start single PTx, irradiance of 15-20 µW/cm²/nm*.</td>
</tr>
<tr>
<td>• If TSB level is 50% above the cBili, start double PTx, irradiance of 20-30 µW/cm²/nm.</td>
</tr>
<tr>
<td>• If TSB is 100% above the cBili, start triple PTx, irradiance of 30-40 µW/cm²/nm.</td>
</tr>
<tr>
<td>• Check in TSB in 4 hr. Expected decline is 0.2-0.5 mg/dL per hour.</td>
</tr>
<tr>
<td>• A decline in TSB indicates adequate PTx.</td>
</tr>
<tr>
<td>• If TSB continues to trend down, start weaning PTx, Double → Single → Discontinue.</td>
</tr>
<tr>
<td>• If TSB is up, add another light. Follow TSB in 4 hrs.</td>
</tr>
<tr>
<td>• If TSB continues to incline up despite intensive PTx, consider Exchange transfusion.</td>
</tr>
<tr>
<td>• Follow gestational-aged based exchange transfusion guidelines, Maisels et al.</td>
</tr>
</tbody>
</table>

*Irradiance range of 15-40 µW/cm²/nm, Morris et al: Calculated Bilirubin, TSB: Total Serum Bilirubin

CONCLUSION
In conclusion, the weight-based approach, by using percent body weight as a factor, to initiate phototherapy in preterm infants is a simple way of managing hyperbilirubinemia. Further studies should be done to investigate the validation of this approach.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE
Not applicable.

HUMAN AND ANIMAL RIGHTS
No animals/humans were used for studies that are the basis of this research.

CONSENT FOR PUBLICATION
Not applicable.

AVAILABILITY OF DATA AND MATERIALS
Not applicable.

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CONFLICT OF INTEREST
The authors declare no conflict of interest, financial or otherwise.

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REFERENCES