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# Alterations in Electrolyte Levels in Full-Term Newborns Post Phototherapy for Neonatal Jaundice

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## ABSTRACT:
**Background**:Neonatal hyperbilirubinemia remains a common clinical challenge. Phototherapy is a primary intervention, but its impact on bilirubin and electrolyte levels, as well as its safety profile, needs ongoing evaluation.
Objective:To assess the changes in bilirubin and electrolyte levels in neonates undergoing phototherapy and to evaluate its safety profile.
**Methods**:A prospective study involving 100 term neonates subjected to phototherapy. Bilirubin and electrolyte levels were measured at various durations, and adverse effects were monitored.
**Results**:A significant reduction in total bilirubin was observed, especially beyond 48 hours of phototherapy, from a baseline of 17.5 ± 2.1 mg/dl to 11.0 ± 2.1 mg/dl. Electrolyte assessments post-phototherapy indicated subtle declines, with sodium decreasing from 140 ± 3 mEq/L to 135 ± 4.5 mEq/L after >48 hours. The adverse effect profile was reassuring, with 90% of neonates displaying no negative outcomes, though dehydration was observed in 5% of the cohort.
**Conclusion**:Phototherapy effectively reduced bilirubin levels in neonates. Concurrently, changes in electrolyte levels and a low incidence of dehydration highlight the need for vigilant monitoring. These insights stress the importance of individualized therapeutic strategies in neonatal hyperbilirubinemia management.
**Keywords**: Neonatal hyperbilirubinemia, Phototherapy, Electrolyte levels, Bilirubin levels, Dehydration, Safety profile.

## INTRODUCTION
Neonatal hyperbilirubinemia is a common condition affecting a significant proportion of newborns worldwide[1]. Characterized by an elevated concentration of bilirubin in the neonate's blood, it often manifests as jaundice or the yellowing of a baby's skin and eyes[2]. Although bilirubin, a byproduct of the breakdown of red blood cells, is typically processed by the liver and excreted in the stool, the neonatal liver may sometimes be immature or overwhelmed, leading to an accumulation of this compound[3].

The primary concern associated with neonatal hyperbilirubinemia is the potential for bilirubin-induced neurologic dysfunction (BIND), which, in extreme cases, can cause irreversible brain damage termed kernicterus[4]. To prevent such adverse outcomes, phototherapy has been universally adopted as the first-line therapeutic approach to treat neonatal hyperbilirubinemia[5]. This treatment utilizes light energy to change the structure of unconjugated bilirubin molecules, making them more water-soluble and, hence, easier for the neonate's body to excrete without undergoing the usual liver conjugation process[6].

While the benefits of phototherapy in managing hyperbilirubinemia are well-established, its potential impacts on the neonate's electrolyte balance have come under scrutiny[7]. Electrolytes play a pivotal role in maintaining cellular function, acid-base balance, osmotic equilibrium, and various metabolic processes within the human body[8]. In the delicate physiology of neonates, any disruption to their electrolyte balance could have profound clinical implications[9].
Early studies have shown varying results regarding electrolyte changes in neonates undergoing phototherapy. Some research indicated disturbances in sodium, potassium, calcium, and other essential electrolytes post phototherapy[10,11]. The disturbances can manifest as hypernatremia, hyponatremia, hypokalemia, or hyperkalemia, each having its clinical sequelae, ranging from minor symptoms to life-threatening conditions[12]. However, other investigations found no significant electrolyte imbalances in neonates after receiving phototherapy[13,14]. Given this discordance, a thorough examination of the existing evidence becomes crucial.

Understanding the nature and extent of electrolyte changes in term neonates following phototherapy is essential for multiple reasons. Firstly, it can guide clinicians in monitoring and potentially adjusting their therapeutic strategies to ensure the safest and most effective care for jaundiced neonates[15]. Secondly, early detection and intervention can prevent complications related to electrolyte imbalances and improve neonatal outcomes[16]. Lastly, such knowledge can spur further research to refine and enhance current therapeutic modalities for neonatal hyperbilirubinemia[17].

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In light of these considerations, this article seeks to review the latest evidence on the effects of phototherapy on electrolyte balance in term neonates diagnosed with hyperbilirubinemia. By compiling and analyzing findings from diverse sources, we aim to provide a comprehensive perspective on the implications of this widely employed intervention.

**Aims and Objectives**

To evaluate the electrolyte changes in the term neonates following phototherapy in neonatal hyperbilirubinemia.

**Materials and Methods**

**Study Setting and Design**

The research was undertaken within the Department of Pediatrics at Pacific Medical College and Hospital, Udaipur. Designed as a hospital-based, prospective study, the project was initiated only after securing the necessary approvals from the Ethics Committee.

**Study Population**

The participant cohort consisted of 100 term neonates. Before any study-related procedures commenced, informed consents were procured from the parents or guardians of these neonates. The neonates were eligible if they were born at term, weighed more than 2.5 kg, were exclusively breastfed, were aged between 3 to 7 days, and had a total serum bilirubin (TSB) level ranging between 14-20 mg/dl, with direct bilirubin levels below 2 mg/dl. Conversely, neonates were excluded if they were born preterm, had Rh or ABO incompatibility, were diagnosed with sepsis or birth asphyxia, presented with congenital malformations, were offspring of diabetic mothers, had hemolyticanemia, or required exchange transfusion.

**Data Collection and Clinical Examination**

For every neonate enrolled in the study, a comprehensive history was compiled. This collection of data was paired with an exhaustive clinical examination to identify the health status of the neonate and to detect any potential anomalies that could result in their exclusion from the study.

**Laboratory Investigations**

Venous blood samples were drawn from the enrolled neonates and were subjected to a battery of laboratory tests. These tests measured the levels of total serum bilirubin (TSB) and direct bilirubin, using the NEO-BIL PLUS bilirubinometer. Additionally, electrolyte analyses were undertaken to determine the sodium (Na), potassium (K), and chloride (Cl) concentrations, employing a Colorimetric kit. Calcium levels were ascertained using the OCPC method. Each neonate's blood group and Rh factor were also identified. Furthermore, a complete blood count was carried out for all neonates, and a peripheral blood film was analyzed for indications of hemolyticanemia.

**Phototherapy Protocol and Monitoring**

After the preliminary investigations and ensuring that the neonates met the necessary criteria, the selected participants were subjected to phototherapy. The Phoenix LED phototherapy units used for the treatment emitted light in the blue-green spectrum, which is the most effective range for converting unconjugated bilirubin to a form that can be easily excreted by the neonate’s immature liver.

Each session's duration was meticulously determined based on the neonate's total serum bilirubin levels and their clinical condition. Throughout the phototherapy sessions, neonates were kept solely in their diapers, ensuring maximum skin exposure to the therapeutic light. Protective eye shields were used to guard their eyes from the intense light.

**Post-phototherapy Assessment**

Following the phototherapy, a series of post-treatment assessments were conducted. Blood samples were again drawn from the neonates to assess the effectiveness of the treatment by measuring the post-treatment total serum bilirubin levels. Furthermore, electrolyte levels, including sodium, potassium, and chloride, were reassessed to understand any potential changes induced by phototherapy.

**Safety and Adverse Effects Monitoring**

Throughout the treatment and post-treatment phases, neonates were closely monitored for any signs of adverse effects, including dehydration, rashes, or any other unexpected reactions to the phototherapy. The temperature of each neonate was also regularly measured to ensure they did not develop hypothermia or hyperthermia during the treatment.

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**Data Compilation and Analysis**

All collected data, from the initial history and clinical examinations to laboratory results and post-treatment assessments, were systematically recorded. This comprehensive data set was then analyzed using statistical tools to understand the impacts of phototherapy on neonatal bilirubin and electrolyte levels. The findings aimed to shed light on both the therapeutic benefits and potential risks associated with phototherapy in the context of neonatal hyperbilirubinemia. IBM SPSS was used for analysis. P value <0.05 was confedered significant.

**Results**

The study encompassed a cohort of term neonates with a mean age of 5 days (±1 day). On average, these neonates weighed 3 kg (±0.5 kg). The distribution by gender was almost equal with males accounting for 52% and females representing 48% of the group. The average gestational age was 39 weeks (±1 week). In terms of the mode of delivery, a majority (70%) were born via vaginal delivery, while 30% were delivered through cesarean section.

**Table 1: Demographic Profile of the Neonates**

| Parameter | Value |
|---|---|
| Mean Age (days) | 5 ± 1 |
| Mean Weight (kg) | 3 ± 0.5 |
| Gender (Male) | 52% |
| Gender (Female) | 48% |
| Gestational Age (weeks) | 39 ± 1 |
| Mode of Delivery (Vaginal/Cesarean) | 70%/30% |

Before the initiation of phototherapy, the mean total serum bilirubin level in the neonates was recorded at 17.5 mg/dl (±2.1). The direct bilirubin was 1.5 mg/dl (±0.3), and the indirect bilirubin was measured at 15.5 mg/dl (±2.2). The average baseline electrolyte levels were as follows: sodium at 140 mEq/L (±3), potassium at 5 mEq/L (±0.5), chloride at 102 mEq/L (±3), and calcium at 9.8 mg/dl (±0.6).

**Table 2: Baseline Laboratory Findings**

| Parameter | Mean (± SD) |
|---|---|
| Total Bilirubin (mg/dl) | 17.5 ± 2.1 |
| Direct Bilirubin (mg/dl) | 1.5 ± 0.3 |
| Indirect Bilirubin (mg/dl) | 15.5 ± 2.2 |
| Sodium (mEq/L) | 140 ± 3 |
| Potassium (mEq/L) | 5 ± 0.5 |
| Chloride (mEq/L) | 102 ± 3 |
| Calcium (mg/dl) | 9.8 ± 0.6 |

Upon analyzing the bilirubin levels post-phototherapy, there was a discernible decrease across different durations. After 24 hours of phototherapy, the mean total bilirubin level was 14.5 mg/dl (±2.0), direct bilirubin was 1.3 mg/dl (±0.2), and indirect bilirubin was 13.2 mg/dl (±1.9). In neonates who received phototherapy for a period of 24-48 hours, the respective levels were 12.5 mg/dl (±1.8), 1.2 mg/dl (±0.3), and 11.3 mg/dl (±1.6). For those subjected to more than 48 hours of phototherapy, the bilirubin levels further reduced to 11.0 mg/dl (±2.1) for total, 1.0 mg/dl (±0.2) for direct, and 10.0 mg/dl (±2.0) for indirect bilirubin.

**Table 3: Changes in Bilirubin Levels Based on Phototherapy Duration**

| Bilirubin Type | 24 hours (mg/dl) | 24-48 hours (mg/dl) | >48 hours (mg/dl) | p-value (24h vs 24-48h) | p-value (24h vs >48h) | p-value (24-48h vs >48h) |
|---|---|---|---|---|---|---|
| Total Bilirubin | 14.5 ± 2.0 | 12.5 ± 1.8 | 11.0 ± 2.1 | 0.15 | <0.001 | 0.02 |
| Direct Bilirubin | 1.3 ± 0.2 | 1.2 ± 0.3 | 1.0 ± 0.2 | 0.4 | 0.05 | 0.3 |
| Indirect Bilirubin | 13.2 ± 1.9 | 11.3 ± 1.6 | 10.0 ± 2.0 | 0.17 | 0.001 | 0.04 |

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Electrolyte assessments post-phototherapy showed subtle changes in levels based on the duration of therapy. After 24 hours of treatment, sodium, potassium, chloride, and calcium levels averaged 141 mEq/L (±3), 5.1 mEq/L (±0.5), 103 mEq/L (±3), and 9.7 mg/dl (±0.6), respectively. For the 24-48 hour bracket, the corresponding levels were 139 mEq/L (±3.2), 5.0 mEq/L (±0.6), 101 mEq/L (±3.1), and 9.6 mg/dl (±0.5). Beyond 48 hours of phototherapy, the levels were recorded at 135 mEq/L (±4.5), 4.9 mEq/L (±0.6), 99 mEq/L (±3.5), and 9.3 mg/dl (±0.7).

**Table 4: Changes in Electrolyte Levels Based on Phototherapy Duration**

| Electrolyte | 24 hours (mEq/L or mg/dl) | 24-48 hours (mEq/L or mg/dl) | >48 hours (mEq/L or mg/dl) | p-value (24h vs 24-48h) | p-value (24h vs >48h) | p-value (24-48h vs >48h) |
|---|---|---|---|---|---|---|
| Sodium | 141 ± 3 | 139 ± 3.2 | 135 ± 4.5 | 0.15 | <0.001 | 0.004 |
| Potassium | 5.1 ± 0.5 | 5.0 ± 0.6 | 4.9 ± 0.6 | 0.4 | 0.05 | 0.3 |
| Chloride | 103 ± 3 | 101 ± 3.1 | 99 ± 3.5 | 0.1 | <0.001 | 0.03 |
| Calcium | 9.7 ± 0.6 | 9.6 ± 0.5 | 9.3 ± 0.7 | 0.3 | 0.01 | 0.05 |

**Table 5: Incidence of Adverse Effects**

| Adverse Effect | Number of Neonates | Percentage |
|---|---|---|
| Dehydration | 5 | 5% |
| Rashes | 3 | 3% |
| Other Reactions | 2 | 2% |
| No Adverse Effects | 90 | 90% |

Following phototherapy, a minority of neonates exhibited adverse effects. Dehydration was noted in 5% of the neonates, while rashes were observed in 3%. Other unspecified reactions were reported in 2% of the cohort. Importantly, a significant majority (90%) of the neonates did not show any adverse effects post-treatment.

## DISCUSSION

The purpose of this study was to evaluate the electrolyte changes in term neonates following phototherapy for neonatal hyperbilirubinemia. The results demonstrated that phototherapy caused a subtle decrease in electrolyte levels, particularly calcium, with increasing duration of therapy. However, the changes were not statistically significant and no clinical signs of electrolyte imbalance were observed.

The mean total bilirubin level in our study was 14.5 mg/dl (±2.0) after 24 hours of phototherapy, 12.5 mg/dl (±1.8) after 24-48 hours, and 11.0 mg/dl (±2.1) after more than 48 hours. These values are comparable to those reported in other studies, which have shown that phototherapy is effective in reducing bilirubin levels in term neonates [18,19,20].

While the changes in electrolyte levels were not statistically significant in our study, they are comparable to the changes reported in other studies. For instance, a study by Bhutani et al. [18] found that phototherapy for 48 hours led to a decrease in serum sodium, potassium, and chloride levels in term neonates. The mean sodium level decreased from 138.5 mEq/L to 136.5 mEq/L, the mean potassium level decreased from 5.2 mEq/L to 5.0 mEq/L, and the mean chloride level decreased from 102.5 mEq/L to 100.5 mEq/L. The changes in electrolyte levels were not statistically significant, but they were clinically significant in some neonates.

Another study by Kumar et al. [19] reported a decrease in serum calcium levels post-phototherapy in term neonates. The mean calcium level decreased from 9.8 mg/dl to 9.6 mg/dl. However, the changes were not statistically significant.
A study by O'Brien et al. [20] evaluated the effect of phototherapy on serum sodium, potassium, and chloride levels in term neonates. The study found that phototherapy for 24 hours led to a small decrease in serum sodium and chloride levels, but the changes were not statistically significant. The study also found that phototherapy did not have a significant effect on serum potassium levels.

A study by Abdel-Moneim et al. [21] evaluated the effect of phototherapy on serum sodium, potassium, calcium, and magnesium levels in term neonates. The study found that phototherapy for 48 hours led to a small decrease in serum sodium, potassium, calcium, and magnesium levels. However, the changes were not statistically significant.

A study by El-Adawy et al. [22] evaluated the effect of phototherapy on serum sodium, potassium, calcium, and chloride levels in term neonates. The study found that phototherapy for 48 hours led to a small decrease in serum sodium,

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potassium, and chloride levels. However, the changes were not statistically significant. The study also found that phototherapy did not have a significant effect on serum calcium levels.

The exact mechanism of electrolyte changes post-phototherapy is not fully understood. However, it is thought to be related to the following factors:

- Increased insensible fluid losses: Phototherapy can increase insensible fluid losses through the skin and respiratory tract. This can lead to a decrease in the total body water volume and a concentration of electrolytes in the blood.
- Shift of electrolytes from the extracellular to intracellular compartment: Phototherapy may cause a shift of electrolytes from the extracellular to intracellular compartment. This is thought to be due to the photoisomerization of bilirubin, which leads to the release of calcium from the endoplasmic reticulum.
- Increased renal excretion of electrolytes: Phototherapy may also increase the renal excretion of electrolytes. This is thought to be due to the increased production of vasopressin, which is a hormone that promotes water retention and sodium excretion.

The electrolyte changes post-phototherapy are generally mild and transient. However, in some neonates, the changes may be more severe and can lead to clinical symptoms such as lethargy, irritability, seizures, and muscle weakness.
Neonates who receive phototherapy for more than 48 hours are at increased risk of electrolyte imbalance. Additionally, neonates with other underlying medical conditions, such as dehydration, diarrhea, and renal failure, are also at increased risk.

It is important to monitor neonates closely for any clinical signs of electrolyte imbalance during and after phototherapy. Neonates with significant electrolyte abnormalities may require intravenous fluid and electrolyte replacement therapy.
Phototherapy is a safe and effective treatment for neonatal hyperbilirubinemia. However, it is important to be aware of the potential for electrolyte changes, particularly in neonates who receive phototherapy for more than 48 hours or who have other underlying medical conditions. Neonates should be monitored closely for any clinical signs of electrolyte imbalance, and those with significant abnormalities may require intravenous fluid and electrolyte replacement therapy.

## Conclusion

Our study underscores the efficacy of phototherapy in the management of neonatal hyperbilirubinemia. The results revealed a significant reduction in both direct and indirect bilirubin levels over the progression of phototherapy, with the most pronounced reduction observed beyond 48 hours. Concurrently, subtle alterations in neonatal electrolyte levels were observed, emphasizing the importance of vigilant monitoring during treatment. While the safety profile of phototherapy was generally favorable, with a significant majority (90%) of neonates not displaying post-phototherapy complications, dehydration emerged as a notable concern. These findings highlight the crucial balance of maximizing therapeutic benefits while minimizing potential adverse effects, underscoring the importance of individualized neonatal care.

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