

Research Article

Electrolyte Changes (Serum Sodium, Potassium, Calcium) in Neonates Receiving Phototherapy for Neonatal Jaundice - An Analytical Study

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ABSTRACT

Background: Neonatal jaundice nearly affects 60% of term and 80% of preterm neonates during first week of life.

serum bilirubin of more than 12.9 mg% is present in 6.1% of well term newborn. 3% of normal term newborn shows Serum bilirubin over 15 mg% . If not treated, then severe unconjugated jaundice is potentially neurotoxic and conjugated jaundice is a harbinger of underlying serious illness². Neonatal jaundice means it is liver's immaturity to excrete bilirubin and neonatal jaundice is the most common reason for admission of neonates in first week of life after postnatal discharge from hospital³. Neonatal jaundice is a cause of concern for both parents and pediatricians⁴.

Aim & Objective:1 To evaluate electrolyte changes in neonates after receiving phototherapy in neonatal hyperbilirubinaemia.

Methods: Hospital Based Analytical type of study. Study setting: Neonatal intensive care unit of a Department of Pediatrics, DR S.C.G.M.C. Nanded, Maharashtra. Study duration: 2 years (August 2023 to August 2025). Study population: 100 full term neonates

Sample size: 100

Results: 49% neonates were Male and 51% were female neonates. 35% neonates had 37-38 wks gestational age followed by 55% 39- 40 wks gestational age and 10% having gestation age 41 -42 wks. 35 % neonates were SGA followed by 62 % neonates were AGA ,3% neonates were LGA. before giving phototherapy, 1% neonates had Sr. Bilirubin less than or equal to 10 mg/dl, followed by 84 % neonates with Sr. Bilirubin 11-14 mg/dl, and 15% neonates with more than or equal to 15 mg/dl Bilirubin. after giving phototherapy, 4% neonates had Bilirubin level less than 2 mg/dl followed by 54% neonates with Bilirubin level 2 to 4 mg/dl and 42% had bilirubin level between 4-6 mg/dl. When comparing the serum sodium before and after Phototherapy it was found that there was statistical insignificance in the values between them. Results analysed using Paired t test showed a statistically insignificant 'p' value. When comparing the serum potassium before and after Phototherapy it was found that there was statistical insignificance in the values between them. Results analysed using Paired t test showed a statistically insignificant 'p' value. When comparing the serum calcium before and after Phototherapy it was found that there was statistical significant in the values between them. Results analysed using Paired t test showed a statistically significant 'p' value. All Full Term Neonates (100%) admitted for neonatal hyperbilirubinemia after receiving Phototherapy were discharged.

Conclusions: Significant reduction in the levels of serum calcium was seen in full term newborns with icterus which was induced by phototherapy.

Keywords: Hyperbilirubinemia, Serum Calcium, Serum Potassium, Sga, Aga, Lga.

INTRODUCTION

One of the common deranged physical finding during the first 7 days of life is the neonatal jaundice . Over 2/3rd of neonates develop clinical jaundice. Due to accumulation of unconjugated bilirubin there is physical finding like yellowish discoloration of the skin and sclera In newborn. Unconjugated type of jaundice shows a normal physiological phenomenon, in most of the infants,[1]. Neonatal jaundice nearly affects 60% of term

and 80% of preterm neonates during first week of life.

serum bilirubin of more than 12.9 mg% is present in 6.1% of well term newborn. 3% of normal term newborn shows Serum bilirubin over 15 mg% . If not treated, then severe unconjugated jaundice is potentially neurotoxic and conjugated jaundice is a harbinger of underlying serious illness [2]. Neonatal jaundice means it is liver's immaturity to excrete bilirubin and neonatal jaundice is the

most common reason for admission of neonates in first week of life after postnatal discharge from hospital [3].

Neonatal jaundice is a cause of concern for both parents and pediatricians [4]. Premature babies require therapeutic intervention as they have more incidence of developing neonatal jaundice as compared to term neonates. Over a period of 7 years in AIIMS, jaundice was found to be the most common morbidity (65%) among 137 extremely low birth weight neonates born [5]. Increased levels of indirect (unconjugated) bilirubin can lead to bilirubin encephalopathy and after that kernicterus, which can damage brain cells, with life time neurodevelopmental damage [6]. Potentially serious hepatic disorders or systemic illnesses indicated by Conjugated jaundice. Hence appropriate management of neonatal jaundice is of most importance.

Phototherapy or exchange transfusion or pharmacologic agents are the treatment modalities for the jaundice. In prevention and treatment of jaundice, phototherapy is important, it reduces the need for exchange transfusion. But phototherapy has some adverse effects like skin rashes, loose stools, dehydration, hypocalcemia, hyperthermia, feed intolerance, damage to male genitals, bronze baby syndrome, retinal damage, redistribution of blood flow and genotoxicity [4,5,7]. Few studies show the adverse effects of phototherapy on serum electrolytes. 90% of preterm and 75% of term neonates develop hypocalcemia after giving phototherapy [7,8]. Irritability, jitteriness, convulsion, apnea are the complications of the hypocalcemia. Hence, phototherapy induced hypocalcemia is a significant problem. Therefore, newborn requiring phototherapy, calcium administration may be considered in them. Studies are available related with the changes in the other electrolytes like sodium and potassium. So we intended to study the serum electrolyte changes after receiving phototherapy: whether any significant changes in sodium, potassium, and calcium.

NEED FOR THE STUDY

During first week of life, Jaundice in newborn is affecting nearly 70% of term and 90% of preterm neonates. One of the most common sign encountered in newborn is Hyperbilirubinemia. Jaundice is a benign problem, in most of the cases. If left untreated, conjugated hyperbilirubinemia is a harbinger of underlying serious illness and severe

unconjugated hyperbilirubinemia is potentially neurotoxic.[9] Liver's immature excretory pathway for bilirubin is reflected as Neonatal hyperbilirubinemia.

At a time, non physiological or pathological hyperbilirubinemia is known to occur in 5-10% of healthy term newborn. Neonatal hyperbilirubinemia is the most common reason for readmission of neonates in first week of life [10]. More than term neonates, premature babies have much higher incidence of neonatal jaundice requiring therapeutic intervention. In AIIMS, It was found that hyperbilirubinemia is most common morbidity (65%) among 137 extremely low birth weight neonates born over a period of 7 years [11].

When the serum bilirubin level is more than 7 mg/dl, newborn appears jaundiced. Newborns whose total serum bilirubin (TSB) level falls within the normal range, the term physiologic jaundice generally is applied to them but because of the significant differences in TSB levels in different populations, it is difficult to define what is physiologic or non-physiologic, normal or abnormal.

Due to the accumulation of unconjugated, non polar, lipid soluble bilirubin pigment in the skin, skin appears yellow in colour. It may also be due to deposition of conjugated, water soluble, polar bilirubin pigment. Potentially serious hepatic disorders or systemic illnesses indicated by Conjugated Hyperbilirubinemia. As a result of excessive bilirubin formation and because the neonatal liver cannot clear bilirubin rapidly enough from the blood, Unconjugated (indirect) hyperbilirubinemia occurs.

Excessive levels of indirect (unconjugated) bilirubin can lead to bilirubin encephalopathy, which will lead to kernicterus, with devastating, permanent neurodevelopment handicaps. Most of the newborns with jaundice are otherwise healthy, each jaundiced baby necessitates attention at the earliest to look for signs and symptoms of pathological jaundice because; unconjugated bilirubin is potentially toxic to the central nervous system. And hence importance is given to the appropriate management of Neonatal Hyperbilirubinemia. In three ways, Hyperbilirubinemia [12] can be treated:

- Mechanical removal of bilirubin by Exchange transfusion;
- Conversion of bilirubin to products, by Phototherapy, which bypasses the liver's conjugating system and excreted in the bile or in the urine without further metabolism; and

c. Pharmacologic agents which interferes with degradation of heme and production of bilirubin, which accelerates the normal metabolic pathways for bilirubin clearance, or which inhibits the enterohepatic circulation of bilirubin.

TSB level beyond which baby required intervention (Phototherapy and/or Exchange Transfusion) for neonatal jaundice, defines Significant neonatal jaundice. There are some adverse effects of phototherapy [13] like hyperthermia, feed intolerance, dehydration, electrolyte changes, vomiting, decreased urine output, bronze baby syndrome. Few studies are currently available which shows the adverse effects of phototherapy on serum electrolytes. Those Neonates, who requires phototherapy are at a higher risk of developing hypocalcemia.

Therefore, it is suggested that, administration of calcium may be considered in newborn requiring phototherapy. Very few studies are available regarding the changes in the other electrolytes like sodium, potassium, chloride. Diarrhoea is one of the side effect of phototherapy. As diarrhoea can lead to electrolyte changes, I thereby wanted to study the electrolyte changes due to phototherapy: whether any significant changes in sodium, potassium, calcium occurs.

METHODOLOGY

Study Design: Hospital Based Analytical type of study.

Place of study: Neonatal intensive care unit of a Department of Pediatrics, DR S.C.G.M.C. Nanded, Maharashtra

Duration Of Study: August 2023 to August 2025

Sampling Method: All full-term newborn according to inclusion and exclusion criteria admitted in tertiary care hospital from August 2023 to August 2025 after taking informed consent from mother or father, were enrolled in the study.

Sample Size:

This is an analytical study done at Neonatal intensive care unit of a Department of Pediatrics, DR S.C.G.M.C. Nanded, Maharashtra, from August 2023 to August 2025. Total 100 full term neonates, according to inclusion and exclusion criteria and after taking informed consent from parents, were enrolled in our study.

Inclusion Criteria

Already diagnosed Full Term (>37 to <42 weeks) Neonate with Neonatal Hyperbilirubinaemia, Receiving phototherapy, which are without any co-morbidities like birth asphyxia, septicemia, renal failure.

Exclusion Criteria

1. Neonates with Conjugated Hyperbilirubinemia.
2. Neonates with co-morbidities like Birth asphyxia, Renal failure, Septicemia, Congenital malformations.
3. Neonates with abnormal electrolyte findings before phototherapy.
4. Neonates undergone exchange transfusion.
5. Preterm neonates (<37 weeks) and post term neonates (>42 weeks)
6. Respiratory distress

DETAIL STUDY PROCEDURE

▪ Selection:

All full term neonate, according to inclusion & exclusion criteria, admitted in Neonatal intensive care unit of a Department of Pediatrics, DR S.C.G.M.C. Nanded, Maharashtra were enrolled into our study during the study period of August 2023 to August 2025, after taking informed consent from the parents/relatives.

▪ Technique & Tool:

With the approval of Institutional ethical committee, the study was initiated and was carried out after explaining the procedures in detail and getting written informed consent from the subject's mother.

Total 100 full term neonates were selected from Neonatal intensive care unit of a Department of Pediatrics, DR S.C.G.M.C. Nanded, Maharashtra fulfilling the above-mentioned inclusion and exclusion criteria in a given time period. For our study we have considered full term neonate without other major risk factor or comorbidities to avoid interference in results. This was done to increase chances of correctly estimating serum electrolyte changes in neonates after receiving

phototherapy. All full term neonates (defined by last menstrual period - LMP and estimated delivery date (EDD) and confirmed by new modified Ballard's scheme) admitted to NICU with hyperbilirubinemia were selected for the study after detailed history and clinical examination has been carried out along with specific investigations to rule out acute bilirubin encephalopathy, evidence of hemolysis, signs

of dehydration, major congenital malformations and septicemia.

RESULTS AND OBSERVATIONS

Table No: 1 Sex Wise Distribution of Babies Admitted for Phototherapy

SEX	Frequency	percentage
male	49	49%
female	51	51%

In present study we observed 49% neonates were Male and 51% were female neonates.

Table No: 2 Distribution of Babies Admitted for Phototherapy According to Gestational Age

Gestation Age	Frequency	percentage
37-38 weeks	35	35%
39-40 weeks	55	55%
41-42 weeks	10	10%
Total	100	100%

In present study 35% neonates had 37-38 wks gestational age followed by 55% 39-40 wks gestational age and 10% having gestation age 41 -42 wks.

Table No 3: Distribution of Babies According to (SGA) / (AGA) / (LGA)

	Frequency	percentage
SGA	35	35%
AGA	62	62%
LGA	3	3%
Total	100	100%

In our study, 35 % neonates were SGA followed by 62 % neonates were AGA ,3% neonates were LGA

Table No 4: Analytical Statistics of Total Serum Bilirubin Before and After Phototherapy (N=100)

	TOTAL SERUM BILLIRUBIN LEVELS (mg/dl)		P VALUE
	BEFORE PHOTOTHERAPY	AFTER PHOTOTHERAPY	P < 0.001 (significant)
MEAN	13.96	3.46	
STANDARD DEVIATION	1.35	1.16	

When comparing the Total serum bilirubin before and after Phototherapy it was found that there was statistical significance in the values between them. Results analysed using Paired t test showed a statistically significant 'p' value.

Table No 5: Analytical Statistics of Serum Potassium Before and After Phototherapy(N=100)

	TOTAL SERUM POTTASIUM LEVELS (meq/l)		P VALUE
	BEFORE PHOTOTHERAPY	AFTER PHOTOTHERAPY	0.3 (not significant)
MEAN	4.085	4.024	
STANDARD DEVIATION	0.42	0.42	

When comparing the serum pottasium before and after Phototherapy it was found that there was statistical insignificance in the values between them. Results analysed using Paired t test showed a statistically insignificant 'p' value.

Table No 6: Analytical Statistics of Serum Calcium Before and After Phototherapy(N=100)

	TOTAL SERUM CALCIUM LEVELS (mg/dl)		P VALUE
	BEFORE PHOTOTHERAPY	AFTER PHOTOTHERAPY	<0.0001(significant)
MEAN	9.513	8.38	
STANDARD DEVIATION	0.25	0.33	

When comparing the serum calcium before and after Phototherapy it was found that there was statistical significant in the values between them. Results analysed using Paired t test showed a statistically significant 'p' value.

Table No 6: Outcome of the Babies Admitted for Phototherapy

	Frequency	percentage
Discharge	100	100%
Death	0	%
Total	100	100%

All Full Term Neonates (100%)admitted for neonatal hyperbilirubinemia after receiving Phototherapy were discharged.

DISCUSSION

Nowadays early discharge of a healthy term neonate after delivery has become a common practice for medical, social and economic reasons. But it has been shown that neonates with postdelivery stay of 72 hours in the hospital for jaundice The general atypical physical finding in the initial week of life is neonatal hyperbilirubinemia.

There is concern regarding early discharge of healthy term newborns due to reports of bilirubin induced brain damage resulting in sequelae like kernicterus (Maisals, 2006) [14]. Bilirubin encephalopathy is the gravest complication of jaundice and phototherapy is the current therapy of choice for treatment of unconjugated hyperbilirubinemia. The need for early detection of hyperbilirubinemia in the early

discharged newborns from the hospital is therefore important. Phototherapy has emerged as the most widely used form of treatment (Stokowski, 2006) [15]. In order to diminish the rigorousness of neonatal unconjugated hyperbilirubinemia this is the recent therapy of preference (Bell et al., 2006). Phototherapy has its side effects(Ehsanipour et al., 2008)[16]. Unlike other side effects a very few studies are currently available that depicts the adverse effects of phototherapy on serum electrolytes. Hence our study was designed to

see changes in the electrolytes – sodium ,potassium and calcium following phototherapy.

In present study, we observed 49% neonates were Male and 51% were female neonates . 35% neonates had 37-38 wks of gestational age followed by 55% neonates of 39-40 wks gestational age and 10% having gestational age of 41 -42 wks (Table 6). Similar finding observed in the study by Karamifar et al [17] and Taheriet al[18],

The mean $\pm$ SD of total serum bilirubin before phototherapy was 13.96 ± 1.35 mg/ dl and after phototherapy was 3.46 ± 1.16 mg/ dl. Results analysed using paired t test shows a statistically significant p value.similar finding observed in the study byEghbalian F. et al[19] Curtis MD et al (1981) study stated that, absorption of water, sodium, potassium and chloride were significantly impaired in the neonates receiving phototherapy. In our study ,the mean value of S. sodium before and after phototherapy was 141.5 ± 1.73 mmol/dL and 141.22 ± 1.43 mmol/dL respectively which was contradictory to Kumar S et al [20] (139.01 ± 3.119 and 138.15 ± 3.35) , Reddy et al[21](139.02 ± 3.12 and 138.16 ± 3.36) and Suneja et al [22] (159.38 ± 22.7 and 148.80 ± 10.9).

In our study , the changes in the levels of mean serum sodium , after giving phototherapy , was insignificant ; which was contradictory to Kumar S et al [20] Reddy et al [21] and Suneja et al [22] .

In our study, there was no significant decline in the mean S. potassium level following phototherapy. In Reddy et al [22] Krishna et al [23] there was no decline in the mean S. potassium level following phototherapy which was in consonance with our study, but Suneja et al [22] had shown a significant decline in the mean S. potassium level which is contradictory with our study. The actual relationship between S.potassium following phototherapy has to be evaluated with a larger sample.

In our study we found that following phototherapy there was a significant decline of the mean s. calcium which was statistically significant ($p < 0.0001$). The other studies like Eghbalian F. et al [19], Reddy et al [21], Suneja et al [22] had also shown a decline in the s. calcium following phototherapy.

Eghbalian et al (2008) [19] in his study found that serum calcium levels declined considerably after neonates with hyperbilirubinemia treated with phototherapy.

CONCLUSIONS

The observations of current study, Significant reduction in the levels of serum calcium was seen in full term newborns with icterus which was induced by phototherapy. the

observations of current study. There was no signs and symptoms suggestive of hypocalcemia which may present like convulsions, cyanosis and apnea due to diminished calcium in the neonates who received phototherapy. There were no significant changes in sodium and potassium levels following phototherapy. Proper monitoring of electrolytes after phototherapy in the neonates can prevent dyselectrolytemia and its associated complications. In the newborns who were treated with phototherapy, level of calcium need to be measured and should be treated accordingly.

Phototherapy induced hypocalcemia was well evident in our study and although the signs were not remarkable the reduction might proceed to the formation of threshold needed for producing hypocalcemia. Hence we suggest assessment of serum calcium, sodium and potassium along with routine measurement of serum bilirubin in neonates before and after phototherapy. Thus by regular monitoring and maintaining normal serum electrolyte levels we can avoid the development of complications in icteric neonates receiving phototherapy.

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