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RESEARCH ARTICLE

EVALUATION OF HIGH RISK NEONATES FOR ELECTROLYTE IMBALANCES FOLLOWING PHOTOTHERAPY

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ABSTRACT

Background: Neonatal hyperbilirubinemia is the leading cause of NICU readmission. Excess bilirubin may enter into the brain and causes bilirubin encephalopathy. Therefore appropriate treatment is of paramount important and phototherapy is the mainstay of treatment. Phototherapy has its own adverse effects amongst them electrolytes imbalance is a common complication.
Aims and objectives: To evaluate the high risk neonates for electrolyte imbalances following phototherapy and compare the electrolyte changes between term and preterm neonates.
Methods and materials: A prospective hospital-based observational comparative study conducted on 206 eligible neonates admitted in NICU receiving phototherapy from 1st July 2017 to 31st June 2018. Serum bilirubin and electrolytes were determined before (controls) and after the termination of phototherapy or 48 hours of phototherapy whichever is earlier and analyzed and compared by using SPSS.
Results: In our study, 80 were LBW, 71 were preterm neonates and 8 were post term neonates. LBW (26.25%) had developed hypocalcemia following phototherapy more than normal weight neonates (7.94%) which was statistically significant. 25.34% preterm were having hypocalcemia as compared to 10.24% term neonates which were also statistically significant ($p<0.022$). Incidences of hyponatremia following phototherapy in LBW (18.75%) and preterm (18.31%) were significantly more than normal weight (10.32%), term neonates (11.02%). 10% LBW neonates had developed hypokalemia compare to 4.23% of normal weight neonates. We found no correlation between incidences of hypomagnesemia with gestational age. The mean values of all electrolytes were more declined following phototherapy in LBW and preterm than normal birth weight, term neonates.
Conclusion: Preterm and LBW neonates are in high risk group for developing electrolyte imbalances and they need continuous monitoring.

INTRODUCTION

Neonatal hyperbilirubinemia (NHB) is the most leading cause for NICU readmission during neonatal period. It is also a common concern for parents and pediatricians. NHB can be divided into two types: physiological, pathological jaundice. It develops due to deposition of unconjugated bilirubin and clinically appears as a yellowish discolor of skin. 60% term and 80% preterm will develop jaundice during first week of life.[1] Amongst them only 6.1% term have serum bilirubin level >12.9 mg/dl and 3% have level >15mg/dl.[1] Immature liver, short life span of fetal RBCs, increase enterohepatic circulation are the most important contributing factors for neonatal hyperbilirubinemia.

In most of the cases of NHB no intervention is needed and only 5-10% of them develops significant jaundice and need treatment[2]. Excess unconjugated bilirubin enters to the brain and deposit in the neurons causing bilirubin encephalopathy and subsequently kernicterus (chronic stage), with devastating permanent neurodevelopment handicaps[3,4].

Neonatal jaundice is mainly treated by phototherapy, exchange transfusion and few drugs. Amongst them phototherapy is the mainstay of treatment and it also decreases the incidence of exchange transfusion and bilirubin encephalopathy. Phototherapy is non-invasive, cheap and easy method of treating NHB. As any treatment has its adverse effects, it has also some side effects but they are not harmful or severe. The main side effects are hyperthermia, feed intolerance, loose stools, bronze

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baby syndrome, retinal changes, dehydration, hypocalcemia, electrolyte imbalances[5,6].

Only a few studies are currently available which describes the effect of phototherapy on electrolytes. Most of the studies had shown that phototherapy causes electrolyte imbalances and among them incidence of hypocalcemia is more. The mechanism for this hypocalcemia is that phototherapy inhibits pineal secretion of melatonin which blocks the effect of cortisol on bone calcium. Cortisol exerts a direct hypocalcemic effect and increases bone uptake of calcium as well.[7]

Few studies have described that phototherapy causes hyponatremia and hypomagnesemia. The mechanism of hypomagnesemia following phototherapy has been explained by Mohsen *et al*.[8] Unconjugated bilirubin gets deposited on the outer membrane of the neurons and causes bilirubin toxicity. To prevent the deposition of bilirubin in the outer membrane, intracellular magnesium goes out from the neurons, erythrocytes and cardiocytes and gets deposit in the outer membrane. Cells get damage as intracellular magnesium goes out from the cells and plasma ionized magnesium goes up. So this protective mechanism itself causes neuronal and cardiac damage. Phototherapy reduces bilirubin. As a result of this, the movement of magnesium from intracellular to extracellular is stopped and this leads to decrease in the plasma ionized magnesium and S. magnesium also.[8]

The reason for hyponatremia is not well known but it might be due to prolong phototherapy as Curtis MD *et al*[9] hypothesized that prolong phototherapy causes diarrhea which impair absorption of electrolytes mainly potassium, chloride, sodium.
Only a few studies are currently present which compare the effect of phototherapy on electrolytes in different groups of neonates and evaluate a high risk neonates. Since there are only few studies have published till now, more studies are required to reach a conclusion against the effect of phototherapy on serum electrolytes in term and preterm neonates. So this study is designed to evaluate the high-risk neonates for electrolytes imbalances following phototherapy.

MATERIALS AND METHODS

It is a hospital based prospective observational comparative study. It was conducted amongst 206 eligible neonates who were admitted in Neonatal Intensive Care Unit (NICU), Gauhati Medical College and Hospital (GMCH) from1st July 2017 to 30th June 2018. Our study includes all icteric stable neonates (term or preterm), who were on breastfeeding and standard formula feeding after taking proper informed consent from the parents and it was approved by the Ethical Committee. We excluded the neonates who had developed jaundice in the first 24 hrs, birth asphyxia, congenital malformation, sepsis, hypothyroidism, ABO/Rh incompatibility, G6PD deficiency. We also excluded IUGR, infant of diabetic mother, neonates who were already having electrolyte imbalances and neonates with conjugated hyperbilirubinemia.

We put the eligible neonates under double surface phototherapy (wave length of 425-475nm) and continued the phototherapy till the TSB level came 2-3 mg/dl below the age-specific level on the nomogram.

We sent venous blood sample for serum electrolytes before putting under phototherapy which was considered as control and a second venous blood sample (for serum electrolytes) was sent at 48 hours of phototherapy or at discontinuing the phototherapy, whichever is earlier. TSB was measured at every 24 hours interval. For exclusion of any observational error we also sent all the baseline investigations (G6PD, Blood group to exclude ABO/RH incompatibility).

Total and direct bilirubin was measured by Diazo method, S. calcium, magnesium by reflectance spectrophotometry and formazen dye method, sodium and potassium were measured by potentiometric method (autoanalyzer VITROS 4600 machine). Blood group of the newborn was analyzed by antisera method.
We done a comparative study between these two samples and data were analyzed using the appropriate computer software, Statistical Package for Social Sciences (SPSS) (Version 21.0). To demonstrate the associations and comparisons between different parameters, Chi-square test was used. For all statistical evaluations, a two-tailed probability of value <0.05 was considered significant.

RESULTS

This study was conducted among 206 neonates who were admitted in NICU, GMCH in a study period of 1 years for neonatal jaundice and who met the inclusion criteria.

Incidences of male and female were 102 (49.51%) and 104 (50.49%) respectively with a ration of 0.98:1.

Table 1 Sex distribution of neonates

Sex	No. of neonates (n)	% (Percentage)
Male	102	49.51
Female	104	50.49
Total	206	100

In our present study, 71 were preterm neonates (34.47%) among these, 40 neonates were male and 31 neonates were female. Out of 127 term neonates, 59 were male and 68 were female.

Table 2 Gestational age distribution of neonates

Gestational	Gender		Total n (%)
	Male	Female	
<37 weeks	40 (39.22%)	31 (29.81%)	71 (34.47%)
37-42 weeks	59 (57.84%)	68 (65.38%)	127 (61.65%)
>42 weeks	3 (2.94%)	5 (4.81%)	8 (3.88%)
Total	102 (100%)	104 (100%)	206 (100%)

80 neonates (38.83%) were low birth weight (LBW) (<2.5 kg. birth weight). Among 126 neonates (61.17%) with normal birth weight (>2.5 kg. birth weight), 57 neonates were male and 69 neonates were female. The mean birth weight was 2.61±0.5141kg.

Table 3 Weight distribution of neonates

Weight (kg)	Gender		Total n (%)
	Male	Female	
LBW (<2.5 kg)	45 (44.12%)	35 (33.65%)	80 (38.83%)
Normal	57 (55.88%)	69 (65.35%)	126 (61.17%)
Total	102 (100%)	104 (100%)	206 (100%)

We found a statistically significant decline of mean value of all the electrolytes following phototherapy along with serum bilirubin. That conclude that phototherapy causes a significant decline of all the electrolytes. Our study also found a significant neonates had developed hyponatremia (13.6%) and hypocalcemia (15.04%) following phototherapy.

Table 4 Comparative evaluation of study variables before and after phototherapy in neonates

	Values before phototherapy (Mean ± Standard deviation)	Values after phototherapy (Mean ± Standard deviation)	Difference	T value	P value
Total S. Bilirubin	18.13±2.414	13.73±1.955	4.404	30.357	<0.0001
S. Calcium	9.02±0.993	8.21±1.084	0.809	17.111	<0.0001
S. Sodium	141.97±2.795	140.66±4.751	1.311	5.234	<0.0001
S. Potassium	5.01±0.683	4.63±0.666	0.379	6.6890	<0.0001
S. Magnesium	2.28±0.290	2.08±0.345	0.197	10.362	<0.0001

Our study found that mean value of all the electrolytes were significantly decreased following phototherapy in both term and preterm neonates. We found that, the decline was significantly more in preterm than term neonates for all of the electrolytes.

Table 5 Comparison of different study variables before and after phototherapy with gestational age

Preterm neonates (n=71)	Values before phototherapy (Mean ± Standard deviation)	Values after phototherapy (Mean ± Standard deviation)	Difference	t value	P value
Total S. Bilirubin	18.59±2.353	13.90±1.995	4.691	18.825	<0.0001
S. Calcium	8.83±0.934	7.84±1.073	0.992	12.766	<0.0001
S. sodium	141.54±2.551	139.20±4.024	2.338	6.685	<0.0001
S. Potassium	4.94±0.746	4.53±0.704	0.410	4.323	<0.0001
S. Magnesium	2.24±0.269	2.06±0.342	0.178	5.114	<0.0001
Term neonates (n=127)					
Total S. Bilirubin	17.95±2.392	13.71±1.929	4.239	23.359	<0.0001
S. Calcium	9.09±0.913	8.37±1.036	0.715	11.691	<0.0001
S. Sodium	142.23±2.920	141.40±4.953	0.827	2.439	0.0161
S. Potassium	5.06±0.653	4.69±0.647	0.369	5.251	<0.0001
S. Magnesium	2.29±0.305	2.09±0.354	0.198	8.414	<0.0001
Post term (n=8)					
Total S. Bilirubin	16.93±2.806	12.44±1.734	4.486	5.061	0.001
S. Calcium	9.66±0.883	8.99±0.985	0.675	5.400	0.001
S. Sodium	141.75±2.659	141.87±4.94	- 0.125	-.104	0.920
S. Potassium	4.95±0.542	4.66±0.578	0.287	1.007	0.348
S. Magnesium	2.34±0.213	1.97±0.219	0.362	5.800	0.001

Incidences of hyponatremia and hypocalcemia were significantly more in preterm (18.31%, 25.34%) than term (11.02%, 10.24%) respectively. Our study had showed more declines in the mean value of serum potassium, magnesium in preterm than term neonates. Our study did not find any correlation between the incidences of hypokalemia and hypomagnesemia with gestational age.

Table 6 Correlation of post phototherapy serum electrolytes with gestational age

	Gestational age			Total (n=206)	P value
	< 37 weeks (n=71)	37-42 weeks (n=127)	>42 weeks (n=8)		
Sodium					
<135	13 (18.31%)	14 (11.02%)	1 (12.5%)	28 (13.59%)	0.032
135-145	54 (76.06%)	96 (75.59%)	5 (62.5%)	155 (75.24%)	
>145	4 (5.63%)	17 (13.39%)	2 (25%)	23 (11.17%)	
Potassium					
<3.5	8 (11.27%)	6 (4.73%)	0 (0%)	14 (6.8%)	0.325
3.5-5.5	60 (84.51%)	115 (90.55%)	7 (87.5%)	182 (88.35%)	
>5.5	3 (4.22%)	6 (4.72%)	1 (12.5%)	10 (4.85%)	
Calcium					
<6	1 (1.40%)	0 (0%)	0 (0%)	1 (0.48%)	0.022
6-6.9	17 (23.94%)	13 (10.24%)	0 (0%)	30 (14.56%)	
7-7.9	23 (32.39%)	30 (23.32%)	1 (12.5%)	54 (26.21%)	
8-8.9	19 (26.76%)	50 (39.37%)	3 (37.5%)	72 (34.95%)	
>9	11 (15.49%)	34 (26.77%)	4 (50%)	49 (23.79%)	
Magnesium					
<1.6	3 (4.23%)	4 (3.15%)	0 (0%)	7 (3.40%)	0.453
>1.6	68 (95.77%)	123 (96.85%)	8 (100%)	199 (96.60%)	

Thus it infers that preterm neonates are at high of developing electrolyte changes following phototherapy and they are also high risk groups.

We also found a significant reduction in the mean value of all the serum electrolytes following phototherapy but it was more in LBWs than normal birth weight neonates.

Table7 Comparison of different study variables before and after phototherapy with birth weight

LBW (n=80)	Values before phototherapy (Mean ± Standard deviation)	Values after phototherapy (Mean ± Standard deviation)	Difference	T value	P value
Total S. Bilirubin	18.26±2.317	13.75±1.931	4.509	20.535	<0.0001
S. Calcium	8.77±0.899	7.79±0.988	0.982	13.672	<0.0001
S. Sodium	141.52±2.408	139.26±4.170	2.262	6.459	<0.0001
S. Potassium	4.92±0.714	4.64±0.724	0.280	3.130	<0.002
S. Magnesium	2.25±0.267	2.07±0.335	0.179	5.509	<0.0001
Normal Birth Weight (>2.5kg) (n=126)					
Total S. Bilirubin	18.05±2.480	13.71±1.978	4.336	22.550	<0.0001
S. Calcium	9.18±0.921	8.48±1.060	0.699	11.533	<0.0001
S. Sodium	142.25±2.990	141.55±4.89	0.706	2.117	<0.0363
S. Potassium	5.07±0.659	4.62±0.63	0.442	6.362	<0.0001
S. Magnesium	2.29±0.304	2.08±0.353	0.209	8.943	<0.0001

The incidence of hyponatremia, hypocalcemia and hypokalemia are more in LBW (18.75%, 26.25%, and 10% respectively) than in normal neonates (10.32%, 7.94% and 4.76%). Though LBW had developed more significant decline of mean value of serum magnesium following phototherapy than normal weight neonates but we did not find any correlation between incidences of hypomagnesemia with birth weight.

Table 8 Correlation of post phototherapy serum electrolytes with birth weight

	Weight (kg)		Total (n=206)	P value
	LBW (n=80)	Normal (n=126)		
Sodium				
<135	15 (18.75%)	13 (10.32%)	28 (13.59%)	0.0456
135-145	59 (73.75%)	96 (76.19%)	155 (75.24%)	
>145	6 (7.5%)	17 (13.49%)	23 (11.17%)	
Potassium				
<3.5	8 (10%)	6 (4.76%)	14 (6.8%)	0.033
3.5-5.5	67 (83.75%)	115 (91.27%)	182 (88.35%)	
>5.5	5 (6.25%)	5 (3.97%)	10 (4.85%)	
Calcium				
<6	1 (1.25%)	0 (0%)	1 (0.48%)	0.001
6-6.9	20 (25%)	10 (7.94%)	30 (14.56%)	
7-7.9	24 (30%)	30 (23.80%)	54 (26.21%)	
8-8.9	25 (37.5%)	47 (37.30%)	72 (34.95%)	
>9	10 (12.5%)	39 (30.95%)	49 (23.79%)	
Magnesium				
<1.6	3 (3.75%)	4 (3.18%)	7 (3.40%)	0.8242
>1.6	77(96.25%)	122 (96.82%)	199 (96.60%)	

Our study has found that LBW neonates are also at more risk of developing electrolytes changes following phototherapy and they are the high risk group.

DISCUSSION

The most important cause for NICU admission in neonates during their first week of gestation is neonatal jaundice. If jaundice is not treated promptly and timely then excess bilirubin will enter to the brain and causes permanent brain damage. It is crucial to categorize the neonates who are at risk for significant jaundice to prevent bilirubin encephalopathy, the gravest complication of hyperbilirubinemia and need continuous monitoring. Phototherapy is the current therapy of choice for treatment of unconjugated hyperbilirubinemia. As any treatment has its own side effects, phototherapy also has its side effects but it is not fatal and has no long-term effects. One of the side effects is electrolytes imbalances after giving phototherapy.

A few studies in the recent past had stressed on the changes of electrolytes following phototherapy. Hence our study was designed to determine the high risk neonates for electrolyte changes after phototherapy and compare between the term and preterm neonates.

Table 9 Comparison of gestational age groups with other studies

Study	Year	Study group	Preterm	Term
Sethi *et al*[10]	1993	40	20	20
Jain *et al*[11]	1998	60	20 cases and 10 controls	20 cases and 10 controls
Karamifar *et al*[12]	2002	153	62	91
Eghbalian F. *et al*[13]	2002	63	-	63
Yadav RK *et al*[14]	2012	30	15	15
Taheri PA *et al*[15]	2013	147	-	147
Arora S *et al*[16]	2014	100	46	54
Reddy *et al*[17]	2015	252	51	201
Kumar S *et al*[18]	2015	252	51	194
Nishant *et al*[19]	2016	84	-	84
Sapkota *et al*[20]	2016	60	-	60
Rozario CI *et al*[21]	2017	100	-	100

In our study, we took 206 neonates and among them 71 neonates were preterm and 127 were term and 8 were post-term neonates. Sethi *et al*[10] and Karamifar *et al*[12] selected preterm >31 weeks whereas Eghbalian *et al*[13], Taheri PA *et al*[15], Nishant *et al*[19], Rozario CI *et al*[21] included only term neonates. In our study all the preterm and term neonates were appropriate for gestational age, same with Romagnoli et at[22], Sethi *et al*[10], Jain *et al*[11], Arora *et al*[16].

Table 10 Comparison of mean birth weight with other studies

Study	Year	Preterm	Term
Jain *et al*[11]	1998	2.150±0.150 kg	2.8±0.220 kg
Karamifar *et al*[12]	2002	2.077±0.316 kg	2.889±0.474 kg
Reddy *et al*[17]	2015	2.224±0.340 kg	2.980±0410 kg
Our study		2.11±0.265kg	2.89±0.396kg

The mean birth weight in our study was 2.61±0.5141kg. In our study mean birth weight of preterm neonates was 2.11±0.265 kg and mean birth weight of term neonates was 2.89±0.396 kg. The mean birth weight of preterm and term neonates were respectively 2.150±0.150 kg and 2.8±0.220kg in Jain *et al*[11], 2.077±0.316kg and 2.889±0.474kg in Karamifar *et al*[12], 2.224±0.340 and 2.980±0.410 kg in Reddy *et al*[17], 2.84±0.51kg in Kumar S *et al*[18]. In Taheri*et al*[15] mean birth weight in term neonates was 3.182±0.430 kg.

Table 11 Comparison of Serum calcium before and after phototherapy in neonates with other studies

Study	Year	S. calcium before phototherapy (Mean ± Standard deviation)	S. calcium after phototherapy (Mean ± Standard deviation)	P value
Karamifar *et al*[12]	2002	9.53±0.92	9.3±1.11	0.043
Eghbalian F. *et al*[13]	2002	9.85±1.23	9.09±0.93	<0.001
Taheri PA *et al*[15]	2013	9.8±0.80	9.5±0.90	<0.05
Reddy *et al*[17]	2015	9.16±1.00	8.53±1.17	<0.0001
Rozario CI *et al*[21]	2017	9.27± 0.73	8.88±0.70	<0.001
Suneja *et al*[23]	2018	9.34±1.21	8.38±1.05	<0.001
Our study		9.02±0.993	8.21±1.084	<0.0001

In our study, we found that following phototherapy there was a significant decline in the mean S. calcium level which was statistically significant (p<0.0001) similar to other studies.

Table 12 Comparison of Serum sodium before and after phototherapy in neonates with other studies

Study	Year	S. sodium before phototherapy (Mean ± Standard deviation)	S. sodium after phototherapy (Mean ± Standard deviation)	P value
Kumar S *et al*[18]	2015	139.01± 3.119	138.15± 3.35	<0.0001
Reddy *et al*[17]	2015	139.02±3.12	138.16±3.36	<0.0001
Suneja *et al*[23]	2018	159.38±22.7	148.80±10.9	0.001
Our study		141.97±2.795	140.66±4.751	<0.0001

There are very few studies present till now which had stressed and concerned over the changes of other electrolytes following phototherapy. Curtis MD *et al*[9] (1981) study stated that, absorption of water, sodium, potassium and chloride was significantly impaired in the neonates receiving phototherapy. In our study, we found that there was a decline in the mean S. sodium level following phototherapy which was similar to other studies.

Table 13 Comparison of Serum potassium before and after phototherapy in neonates with other studies

Study	Year	S. potassium before phototherapy (Mean ± Standard deviation)	S. potassium after phototherapy (Mean ± Standard deviation)	P value
Reddy *et al*[17]	2015	4.59±0.51	4.69±0.53	0.23
Suneja *et al*[23]	2018	6.095±1.4	5.28±1.08	0.001
Our study		5.01±0.683	4.63±0.666	<0.0001

In our study we found a significant decline in the mean S. potassium level following phototherapy similar to Suneja *et al*[23].

Table 14 Comparison of mean S. calcium value before and after phototherapy in preterm neonates with other studies

Study	Mean ±SD S. calcium level		P value
	Before phototherapy (mg/dL)	After phototherapy (mg/dL)	
Karamifar *et al*[12]	8.73±1.38	8.40±1.71	0.039
Reddy *et al*[17]	9.10±1.13	7.96±1.34	<0.001
Our study	8.83±0.934	7.84±1.073	<0.0001

In our study, mean S. calcium level before and after phototherapy in preterm neonates was 8.83±0.934 and 7.84±1.703 respectively. Similar to other studies, there was a significant decline in the mean S. calcium level following phototherapy.

Table 15 Comparison of mean S. calcium value before and after phototherapy in term neonates with other studies

Study	Mean ±SD S. calcium level		P value
	Before phototherapy (mg/dL)	After phototherapy (mg/dL)	
Karamifar *et al*[12]	9.53±0.92	9.30±1.11	0.043
Eghbalian F. *et al*[13]	9.85±1.23	9.09±0.93	<0.001
Taheri *et al*[15]	9.8±0.80	9.5±0.90	<0.05
Reddy *et al*[17]	9.32±0.97	8.82±1.04	<0.0001
Our study	9.09±0.913	8.37±1.036	<0.0001

In our study, we also found a significant decline in the mean S. calcium level following phototherapy in term neonates similar to other studies.

Table 16 Correlation of hypocalcemia following phototherapy with gestational age and compare with different studies

Study	Year	Cases	Hypocalcemia after phototherapy		P value
			Preterm (n)	Term (n)	
Sethi *et al*[10]	1993	40	90% (18)	75% (15)	<0.05
Jain *et al*[11]	1998	40	55% (11)	30% (6)	<0.05
Karamifar *et al*[12]	2002	153	22.6% (14)	8.7% (8)	<0.018
Yadav RK *et al*[14]	2011	30	80% (12)	66.6% (10)	<0.05
AroraS *et al*[16]	2014	100	43% (20)	56% (30)	<0.05
Reddy *et al*[17]	2015	252	41.2% (21)	6.2% (12)	<0.001
Our study		206	25.34% (18)	10.24% (13)	<0.0001

In our study, we found that 25.34% of preterm became hypocalcemic following phototherapy as compared with term neonates, in which only 10.24% became hypocalcemic. Other studies have also shown that preterm neonates are at more risk of having hypocalcemic following phototherapy except for AroraS *et al*[16]. So with this data, it infers that preterm neonates are at a high risk of having calcium derangement following phototherapy. So monitoring has to be needed.

Table 17 Comparison of mean S. sodium value before and after phototherapy in preterm neonates with other studies

Study	Mean ±SD S. sodium level		P value
	Before phototherapy (mmol/dL)	After phototherapy (mmol/dL)	
Our study	141.54±2.551	139.20±4.024	<0.0001
Kumar S *et al*[18]	138.35±3.03	136.37±3.40	<0.0001

In our study, we found that the mean value of S. sodium in preterm before and after phototherapy was 141.54±2.551 mmol/dL and 139.20±4.024 mmol/dL which is similar to other studies. There was a significant decline in the mean S. sodium level following phototherapy.

Table 18 Comparison of mean S. sodium value before and after phototherapy in term neonates with other studies

Study	Mean ±SD S. sodium level		P value
	Before phototherapy (mmol/dL)	After phototherapy (mmol/dL)	
Our study	142.23±2.920	141.40±4.953	<0.0001
Kumar S *et al*[18]	139.26±3.14	136.56±3.18	0.003

There was a significant decline in the mean S. sodium level following phototherapy also seen in the term neonates but the decline was more in preterm neonates than in term neonates. So it infers that preterm neonates are at a risk of having sodium imbalances following phototherapy.

Table 19 Correlation of hyponatremia following phototherapy with gestational age and compare with different studies

Study	Year	Cases	Hyponatremia after phototherapy		P value
			Preterm (n)	Term (n)	
Reddy *et al*[17]	2015	252	17.6% (9)	3.1% (6)	<0.001
Kumar S *et al*[18]	2015	252	17.5% (9)	3.1% (6)	<0.001
Our study		206	18.31% (13)	11.02% (14)	<0.0001

We found 18.31% of preterm neonates had developed hyponatremia following phototherapy and only 11.02% of term had developed hyponatremia. Other studies have also shown that incidence of hyponatremia following phototherapy were more in preterm neonates than term and post-term neonates. So it infers that preterm neonates are at more risk of having dyselectrolytemia.

In our study, only 11.27% of preterm and 4.73% of term neonates had developed hypokalemia but no correlation was found between the gestational age and incidence of hypokalemia. Other studies Reddy *et al*[17] (p 0.876), Suneja *et al*[23] also did not found any correlation. Similarly, 4.23% of preterm and 3.15% of term neonates were developed hypomagnesemia following phototherapy but no correlation was found between gestational age and incidence of hypomagnesemia following phototherapy. Sapkota *et al*[24] and our study have shown that, there was a decline in the mean S. magnesium value from the initial mean value following phototherapy which was statistically significant. However the actual relationship between incidence of hypokalemia and hypomagnesemia following phototherapy has to be evaluated with a larger sample study.

Our study infers that preterm neonates are the high risk group for developing electrolyte imbalances following phototherapy and preterm had developed more electrolytes changes than term neonates. The incidence of hypocalcemia and hyponatremia is also more in preterm than term neonates.

Table 20 Correlation of hypocalcemia following phototherapy with birth weight and compare with different studies

Study	Year	Cases	Hypocalcemia after phototherapy		P value
			LBW (n)	Normal birth weight (n)	
Reddy *et al*[17]	2015	252	36.2% (21)	6.2% (12)	<0.001
Our study		206	26.25% (21)	7.94% (10)	<0.0001

In our study, we found that incidence of hypocalcemia was more in LBW babies (26.25%) than normal weight neonates (7.94%) similar to other studies (Reddy *et al*[18]).

Table 21 Correlation of hyponatremia following phototherapy with birth weight and compare with different studies:

Study	Year	Cases	Hyponatremia after phototherapy		P value
			LBW (n)	Normal birth weight (n)	
Reddy *et al1*[17]	2015	252	17.2% (10)	2.6% (5)	<0.001
Kumar S *et al*[18]	2015	252	17.2% (10)	2.6% (5)	<0.001
Our study		206	18.75% (15)	10.32% (13)	<0.0001

Our study showed 18.75% of LBW had developed hyponatremia following phototherapy which was much higher than the normal birth weight neonates. This was statistically significant and similar to other studies. So it infers that LBW neonates are at risk for dyselectrolytemia and therefore continuous monitoring is necessary for them.

Our study also found a decline in the mean S. potassium level following phototherapy and 10% of LBW neonates had developed hypokalemia and only 4.76% of normal weight neonates had developed hypokalemia. This was statistically significant ($p<0.033$). This infers that LBW are at risk of having hypokalemia than normal birth weight neonates. The reason for this is not well known but it might be due to prolong phototherapy as Curtis MD *et al*[9] hypothesized that prolong phototherapy causes diarrhea which impair absorption of electrolytes mainly potassium, chloride, sodium.

In our study, we found that following phototherapy there was a reduction of S. magnesium value from the initial level and only 3.75% of LBW and 3.18% of normal birth weight neonates had developed hypomagnesemia. From our study, we found that LBW neonates were not at risk of having hypomagnesemia.

From our study and other studies, it is evident that preterm and LBW neonates are the high-risk neonates for electrolytes imbalance following phototherapy. And also it is evident that preterm neonates are developing more electrolyte changes than term neonates.

CONCLUSION

In our study we found that following phototherapy all the electrolytes were significantly decline. Therefore it is conclude that phototherapy causing electrolyte imbalances. The incidence of hypocalcemia following phototherapy was higher in LBW (26.25%) and preterm neonates (25.34%) than in normal birth weight (7.94%) and term neonates (10.24%). The incidence of hyponatremia following phototherapy was higher in preterm (18.31%) and LBW (18.75%) than term (11.02%) and normal birth weight neonates (10.32%). We found a significant reduction in the mean S. potassium value following phototherapy and incidence of hypokalemia was more in LBW (10%) than normal birth weight (4.76%). But there was no correlation between the incidences of hypokalemia with the gestational age. Our study found only a significant reduction of mean S. magnesium value following phototherapy but no association was found between the incidences of hypomagnesemia with gestational age and birth weight. Therefore we have concluded that preterm and LBW neonates are in high-risk group. Therefore these neonates require continuous monitoring.

Competing interest: None

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