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Electrolyte Imbalances Resulting From Phototherapy in Neonatal Hyperbilirubinemia

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Abstract: Introduction: *Neonatal hyperbilirubinemia is the most common NICU readmission and abnormal physical finding during the first week of life. Hence appropriate management of this is of paramount importance. Phototherapy is an important treatment modality. However, it has some inherent complications; amongst them electrolyte changes is a common complication.*
Aims and objectives: *To evaluate the electrolyte changes in neonates receiving phototherapy with find out the high risk neonates for electrolyte changes and to compare the effect on electrolytes in preterm and term neonates receiving phototherapy.*
Method: *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 termination of phototherapy or 48 hours of phototherapy whichever is earlier and analyzed and compared by using SPSS.*
Results: *Out of 206 neonates, 80 were LBW and 71 were preterm. Incidence of hypocalcemia after phototherapy was 15.04% which was more in LBW (26.25%, p<0.001) and preterm (25.34%, p<0.022) than in normal weight (7.94%) and term neonates (10.24%). Incidence of hyponatremia after phototherapy was 13.59% which was more in LBW (18.75%, p<0.0456) and preterm (18.31%, p<0.032) than in normal weight (10.32%) and term neonates (11.02%). A significant reduction of mean serum potassium and magnesium levels were found after phototherapy but no association were found between incidence with gestational age or birth weight.*
Conclusion: *Phototherapy causes significant electrolyte imbalances in neonates and preterm, LBW neonates are in high-risk group and they need continuous close monitoring.*
Keywords: *NHB- neonatal hyperbilirubinemia*

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I. Introduction

Neonatal hyperbilirubinemia (NHB) is a common physical finding in the first week of life.[1] It is a common cause of concern for parents and the most common cause for hospital readmission during neonatal period.[1] The clinical symptom of jaundice is yellowish discoloration of the skin due to deposition of unconjugated bilirubin. Clinically jaundice appears in the neonates when bilirubin level goes >7mg/dL.[2] 60% term and 80% preterm neonates develop jaundice during the first week of life, amongst them only 6.1% of term neonates are found to have a S. bilirubin >12.9mg/dL and 3% have a S. bilirubin >15mg/dL.[3]

Increase fetal red cell destruction and immature liver to metabolize the excess bilirubin with increase enterohepatic circulation are the main causes for jaundice. Incidence of hyperbilirubinemia is much higher in preterm neonates than term neonates.[2] Only 5-10% of them develops significant jaundice and need treatment.[4] Excess unconjugated bilirubin enters the brain and deposit in the neurons causing bilirubin encephalopathy and subsequently kernicterus (chronic stage), if they are untreated.[5,6]

NHB is treated by phototherapy, exchange transfusion or pharmacological agents. Among these three, phototherapy is the mainstay of treatment for NHB and it also decreases the incidence of exchange transfusion and bilirubin encephalopathy. As any treatment has its adverse effects, phototherapy also has some side effects but they are not harmful or severe. The main side effects are hyperthermia, feed intolerance, loose stools, skin rashes, bronze baby syndrome, retinal changes, dehydration, hypocalcemia, redistribution of blood flow, genotoxicity and electrolyte imbalances.[2,6]

Very few studies are currently available that describe adverse effect of phototherapy on electrolytes. Most of the studies showed that phototherapy causes hypocalcemia, which is more in preterm (90%) than term (75%). 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]

Some studies showed increase chances of hyponatremia and hypomagnesemia following phototherapy. 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]

Since there are only few studies published till now, more studies are required to reach a conclusion about the effect of phototherapy on serum electrolytes. So this study is designed to evaluate the electrolyte changes following phototherapy and to find the high-risk neonates for electrolyte imbalances.

II. Materials and Methods

A prospective hospital based observational comparative study was conducted on 206 eligible neonates admitted in Neonatal Intensive Care Unit (NICU), GMCH from 1st July 2017 to 30th June 2018 after taking proper informed consent from the parents which was approved by the Ethical Committee. Our study includes all icteric stable neonates (term or preterm) who were on breastfeeding and standard formula feeding. We excluded the neonates who had developed jaundice in the first 24 hrs, who had birth asphyxia, congenital malformation, sepsis, hypothyroidism, ABO/Rh incompatibility, G6PD deficiency. IUGR, infant of diabetic mother, those on IV therapy or already with electrolyte imbalances and neonates with conjugated hyperbilirubinemia were also excluded.

The eligible neonates were put under double surface phototherapy with a wavelength of 425-475nm at a distance of 25-30 cm away from the skin and continued the phototherapy till the TSB level came 2-3 mg/dl below the age-specific level on the nomogram.

Before starting phototherapy we sent venous blood sample for serum electrolytes (first sample) and it was considered as control. 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. We sent all the baseline investigations (G6PD, Blood group to exclude ABO/RH incompatibility) to exclude any observational error.

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.

Comparative study was done between these two samples and the data were analyzed using the appropriate computer software, Statistical Package for Social Sciences (SPSS) (Version 21.0). Data were expressed in frequency and percentage as well as mean and standard deviation. To demonstrate the associations and comparisons between different parameters, Chi-square test was used.

III. Results

In our study, the incidence of male and female were 102 (49.51%) and 104 (50.49%) respectively. Male and female ratio was 0.98: 1.

Table-1: Gender distribution of neonates:

Gender	Number of neonates	Percentage (%)
Male	102	49.51
Female	104	50.49
Total	206	100

80 neonates (38.83%) were low birth weight (LBW). Among them 45 neonates were male and 35 neonates were female. Among 126 neonates with normal birth weight, 57 neonates were male and 69 neonates were female. The mean birth weight was 2.61±0.5141kg.

Table-2: Weight distribution of neonates:

Weight	Gender		Total (%)
	Male	Female	
LBW (<2.5kg)	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%)

In our study, 71 were preterm neonates (34.47%), 127 were term neonates (61.65%) and 8 were post-term neonates (3.88%).

Table-3: Gestational age distribution of neonates:

Gestation	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%)

In our study we found that, following phototherapy a statistically significant (<0.05) decline has been seen in all the electrolytes along with bilirubin.

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

	Values before phototherapy (Mean ± Standard deviation)	Values after phototherapy (Mean ±Standarddeviation)	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

Following phototherapy the mean values of all the electrolytes were significantly decreased.

Table-5: Frequency table showing comparison of distribution of S. Sodium before and after phototherapy:

S. Sodium:before phototherapy	S. Sodium: After phototherapy			Total
	<135 mmol/dl	135-145 mmol/dl	>145 mmol/dl	
135-145	25 (100%)	137 (88.4%)	14 (60.9%)	179 (86.9%)
>145	0 (0%)	18 (11.6%)	9 (39.1%)	27 (13.1%)
Total	28 (13.6% of total)	155 (75.2% of total)	23 (11.2% of total)	206
Chi-square: 18.204: P <0.0001				

In our study we found that statistically significant neonates (13.6% of total) had developed hyponatremia following phototherapy.

Table-6: Frequency table showing comparison of distribution of S. calcium before and after phototherapy:

S. Calcium: before phototherapy	S. Calcium: After phototherapy					Total
	<6 mg/dl	6-6.9 mg/dl	7-7.9 mg/dl	8-8.9 mg/dl	>9 mg/dl	
7-7.9 mg/dl	25 (100%)	23(76.7%)	3 (5.6%)	0 (0%)	0 (0%)	27 (13.1%)
8-8.9 mg/dl	0 (0%)	7(23.3%)	43 (79.6%)	27 (37.5%)	2 (4.1%)	79 (38.3%)
> 9 mg/dl	0 (0%)	0 (0%)	8 (14.8%)	45 (62.5%)	47 (95.9%)	100 (48.5%)
Total	1 (0.48% of total)	30 (14.56% of total)	54 (26.2% of total)	72 (35% of total)	49 (23.8% of total)	206 (100%)
Chi-square: 210.884: P <0.0001						

We found that, 15.04% neonates had developed hypocalcemia following phototherapy which was statistically significant (p <0.0001).

Table-7: Frequency table showing comparison of distribution of S. potassium before and after phototherapy:

S. Potassium: Before phototherapy	S. Potassium: After phototherapy			Total
	<3.5 mmol/dl	3.5-5.5 mmol/dl	>5.5 mmol/dl	
3.5-5.5	12 (85.7%)	140 (76.9%)	9 (90%)	161 (78.2%)
>5.5	2 (14.3%)	42 (23.1%)	1 (10%)	45 (21.8%)
Total	14 (6.80% of total)	182 (88.3% of total)	10 (4.9% of total)	206 (100%)
Chi-square: 1.452: P <0.484				

We found a significant reduction of S. potassium and S. magnesium following phototherapy but the incidence of hypokalemia and hypomagnesemia is not statistically significant. The incidence of hypokalemia following phototherapy was 6.80% of total which was not significant.

Table-8: 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 ±Standarddeviation)	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

In our study, there were significant reductions in the mean value of all the serum electrolytes following phototherapy but it was more in LBWs than normal birth weight neonates.

Table-9: Correlation of post phototherapy serum electrolytes with birth weight:

	Weight (kg)		Total (n=206)	P value
	LBW (n=80)	Normal (n=126)		
	Sodium			0.0456
<135	15 (18.75%)	13 (10.32%)	28 (13.59%)	
135-145	59 (73.75%)	96 (76.19%)	155 (75.24%)	
>145	6 (7.5%)	17 (13.49%)	23 (11.17%)	
Potassium				0.033
<3.5	8 (10%)	6 (4.76%)	14 (6.8%)	
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				0.001
<6	1 (1.25%)	0 (0%)	1 (0.48%)	
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				0.8242
<1.6	3 (3.75%)	4 (3.18%)	7 (3.40%)	
>1.6	77(96.25%)	122 (96.82%)	199 (96.60%)	

The incidence of hyponatremia was more in LBW neonates (18.75%) than normal neonates (10.32%), which infer that LBW neonates are at high risk for developing hyponatremia following phototherapy. The incidences of hypocalcemia and hypokalemia are also more in LBW (26.25%, 10% respectively) than in normal neonates (7.94%, 4.76%). In our study, we did not find any correlation between incidences of hypomagnesemia with birth weight. Our study has found that LBW neonates are at more risk of developing electrolytes changes and they are the high risk group.

Table-10: 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				0.032
<135	13 (18.31%)	14 (11.02%)	1 (12.5%)	28 (13.59%)	
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					0.325
<3.5	8 (11.27%)	6 (4.73%)	0 (0%)	14 (6.8%)	
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					0.022
<6	1 (1.40%)	0 (0%)	0 (0%)	1 (0.48%)	
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					0.453
<1.6	3 (4.23%)	4 (3.15%)	0 (0%)	7 (3.40%)	
>1.6	68 (95.77%)	123 (96.85%)	8 (100%)	199 (96.60%)	

We found that incidences of hyponatremia and hypocalcemia following phototherapy were more in preterm neonates (18.31%, 25.34%) than term (11.02%, 10.24%) and post term (12.5%, 0%) neonates respectively. Our study did not find any correlation between the incidences of hypokalemia and hypomagnesemia with gestational age but reduction of the mean value of them had been seen following phototherapy. Thus it infers that preterm neonates are at high of developing electrolyte changes following phototherapy and they are also high risk groups.

IV. 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 are at a significantly greater risk for readmission for jaundice than those whose stay is >72 hours in the hospital for jaundice. Bilirubin encephalopathy is the gravest complication of jaundice and 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 known long-term effects, however one of the side effects is electrolyte imbalances after giving phototherapy. Few studies have only focused in the calcium changes following phototherapy. Hence our study was designed to see change of most of the electrolytes following phototherapy.

In our study, we took 206 neonates who met the inclusion criteria and among them 71 neonates were preterm and 127 were term and 8 were post term neonates. Sethi et al[9] and Karamifar et al[10] selected preterm >31 weeks whereas Eghbalian et al[11], Taheri PA et al[12], Nishant et al[13], Rozario CI et al[14] included only term neonates.

Table-11: Comparison of gestational age groups with other studies:

Study	Year	Study group	Preterm	Term
Sethi et al[9]	1993	40	20	20
Karamifar et al[10]	2002	153	62	91
Eghbalian F. et al[11]	2002	63	-	63
Taheri PA et al[12]	2013	147	-	147
Arora S et al[15]	2014	100	46	54
Kumar S et al[16]	2015	252	51	194
Nishant et al[13]	2016	84	-	84
Rozario CI et al[14]	2017	100	-	100
Our study	2018	206	71	127

The mean birth weight in our study was 2.61±0.5141kg. The 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 was respectively 2.150±0.150 kg and 2.8±0.220kg in Jain et al[17], 2.077±0.316kg and 2.889±0.474kg in Karamifar et al[10], 2.224±0.340 and 2.980±0.410 kg in Reddy et al[18], 2.84±0.51kg in Kumar S et al[16] which is comparable to our study.

Table-12: 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
Eghbalian F. et al[11]	2002	9.85±1.23	9.09±0.93	<0.001
Reddy et al[18]	2015	9.16±1.00	8.53±1.17	<0.0001
Rozario CI et al[14]	2017	9.27± 0.73	8.88±0.70	<0.001
Suneja et al[19]	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 of the mean s. calcium which was statistically significant (p<0.0001). The other studies had also shown a decline in the s. calcium following phototherapy.

Table-13: 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)**	
Jain et al[17]	1998	40	55% (11)	30% (6)	<0.05
Karamifar et al[10]	2002	153	22.6% (14)	8.7% (8)	<0.018
Arora S et al[15]	2014	100	43% (20)	56% (30)	<0.05
Reddy et al[18]	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 similar to Karamifar et al[10]. Peterm neonates are at more risk of having hypocalcemic following phototherapy which is seen all other studies except for AroraS et al[15].

Table-14: 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[18]	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-15: 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[16]	2015	139.01± 3.119	138.15± 3.35	<0.0001
Reddy et al[18]	2015	139.02±3.12	138.16±3.36	<0.0001
Suneja et al[19]	2018	159.38±22.7	148.80±10.9	0.001
Our study		141.97±2.795	140.66±4.751	<0.0001

Curtis MD et al[20] (1981) study stated that, absorption of water, sodium, potassium and chloride were significantly impaired in the neonates receiving phototherapy. The mean value of S. sodium before and after phototherapy was 141.97±2.795mmol/dL and 140.66±4.751 mmol/dL respectively which was in consonance to Kumar S et al[16] (139.01± 3.119 and 138.15± 3.35) and Reddy et al[18] (139.02±3.12 and 138.16±3.36).

Table-16: 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[18]	2015	252	17.6% (9)	3.1% (6)	<0.001
Kumar S et al[16]	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 which similar to other studies. So it infers that preterm neonates are at more risk of having hyponatremia.

Table-17: 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[8]	2015	252	17.2% (10)	2.6% (5)	<0.001
Kumar S et al[16]	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.

Table-18: 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[18]	2015	4.59±0.51	4.69±0.53	0.23
Suneja et al[19]	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. In Reddy et al[18], Krishna et al[21] there was no decline in the mean S. potassium level following phototherapy but Suneja et al[19] had shown a significant decline in the mean S. potassium level which was in consonance with our study. The actual relationship between S. potassium following phototherapy has to be evaluated with a larger sample.

Table-19: Incidences and comparison of hypokalemia caused by phototherapy in different studies:

Study	Year	Percentage of neonates having hypokalemia
Reddy et al[18]	2015	0.4% neonates
Suneja et al[19]	2018	3.7% neonates
Our study		11.27% of preterm and 4.73% of term neonates and overall 6.8% of total study neonates

In our study, 64.08% of neonates having a decline of S. potassium from the initial value following phototherapy and 11.27% of preterm neonates and only 4.73% of term neonates had developed hypokalemia. But the incidence of hypokalemia was not statistically significant ($p<0.484$). Other studies like Suneja et al[19] also found a decline of S. potassium level which is in consonance to our study but in Reddy et al[18], found an increment of S. potassium and only 0.4% neonates had developed hypokalemia which differs from our study. The reason for this is not well known but it might be due to prolong phototherapy as Curtis MD et al[20] hypothesized that prolong phototherapy causes diarrhea which impair absorption of electrolytes mainly potassium, chloride, sodium.

Our study also found 10% of LBW neonates 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.

We found 77.18% of neonates had a decline of S. magnesium value following phototherapy but only 3.40% neonates had developed hypomagnesemia. Our study showed 4.23% of preterm and 3.15% of term neonates and 3.75% of LBW and 3.18% of normal birth weight neonates had hypomagnesemia. Though the incidence of hypomagnesemia following phototherapy was not statistically significant, but the decline of mean value of S. magnesium was statistically significant. Sapkota et al[22] had a similar result like what we had but to evaluate a strong relationship between S. magnesium and phototherapy the sample size has to be more.

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

V. Conclusion

In our study, the incidence of hypocalcemia following phototherapy was 15.04% and it was higher in LBW (26.25%) and preterm neonates (25.34%) than in normal birth weight (7.94%) and term neonates (10.24%). It was also observed that following phototherapy there was a significant decrease in the level of serum calcium values in most of the neonates. The incidence of hyponatremia following phototherapy was 13.59% and was higher in preterm (18.31%) and LBW (18.75%) than term (11.02%) and normal birth weight neonates (10.32%). Serum sodium levels were also significantly decreased following phototherapy in most of the neonates. 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%). 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 phototherapy causes significant electrolyte imbalances and preterm and LBW neonates are in high-risk group. Therefore these neonates require continuous close monitoring.

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