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ORIGINAL ARTICLE

Frequency of electrolyte imbalance in neonates receiving phototherapy.

Ramsha Mehmood[1], Arit Parkash[2], Sadaf Asim[3]

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ABSTRACT… Objective: To determine the frequency of electrolyte imbalance in neonates receiving phototherapy. **Study Design:** Cross Sectional study. **Setting:** Department of Pediatrics, National Institute of Child Health (NICH), Karachi, Pakistan. **Period:** July 2024 to December 2024. **Methods:** A total of 192 neonates between 2nd and 14th day of life, and presenting with jaundice and hyperbilirubinemia (total serum bilirubin>5 mg/dl) were analyzed. Demographic details were documented. Blood samples were sent for the evaluation of baseline serum bilirubin, and electrolyte levels. Duration of phototherapy was 48 hours. Post-treatment after 48-hours, serum bilirubin, and electrolyte evaluation was performed. **Results:** In a total of 192 neonates, 105 (54.7%) were male. The mean age, and gestational age were 8.24± **2.61 days, and** 38.5±**1.44 weeks**. After 48 hours of phototherapy, a significant reduction was observed in total bilirubin (p<0.001), direct bilirubin (p<0.001), and indirect bilirubin (p<0.001). After 48 hours of phototherapy, decrease in the proportion of neonates with normal levels was observed for sodium (82.3%, p=0.736), chloride (77.6%, p=0.776), calcium (80.7%, p=0.475), potassium (81.8%, p=0.302), and magnesium (87.5%, p=0.195). The proportion of hypocalcemia increased from 14.6% to 18.8%, hypokalemia from 10.9% to 15.6%, and hypomagnesemia from 8.9% to 12.5%. **Conclusion:** This study highlights the effectiveness of phototherapy, and its potential to cause electrolyte disturbances. While the reductions in serum sodium, chloride, calcium, potassium, and magnesium levels were statistically significant, their clinical relevance remains uncertain.

Key words: Calcium, Chloride, Magnesium, Phototherapy, Potassium, Serum Bilirubin, Sodium.

INTRODUCTION

Neonatal hyperbilirubinemia is a frequent condition in the 1st weeks of life.[1] Between 8-11% neonates develop hyperbilirubinemia during first week of life, an estimated 60% term and 80% pre-term newborns exhibit clinical jaundice in the first week of life.[2-4] In newborns, jaundice becomes clinically noticeable when total serum bilirubin levels reach or exceed 5 mg/dL, compared to adults where it becomes evident at levels of 2 mg/dL or higher.[5]

Phototherapy (PT) plays a main role in the treatment of clinical jaundice but has its own side effects.[6] A relatively less known side effect is electrolyte imbalance after PT.[7] Regional data analyzing electrolyte imbalance after PT in neonatal hyperbilirubinemia showed significant decrease in serum sodium and calcium level after 48-72hours of PT.[8,9] A local study conducted at King Abdullah Teaching Hospital Mansehra in 2018 showed significant hypocalcaemia in neonates after 48 hours of PT.[10]

Multiple studies done worldwide and in Pakistan have shown electrolyte imbalances after PT in neonatal jaundice but very few have focused on the frequency of various electrolyte parameters. Keeping in mind the large number neonatal admission in NICH solely for neonatal hyperbilrubinemia and limited data availability on the treatment course and effects of PT on these patients, this study was planned to help in better management of these patients. This study was done to determine the frequency of electrolyte imbalance in neonates receiving PT.

METHODS

This cross sectional study was conducted at the department of pediatrics, National Institute of

1. MBBS, Post-graduate Trainee Pediatric Medicine, National Institute of Child Health, Karachi, Pakistan.
2. MBBS, FCPS (Pediatric Medicine), FCPS (Pediatric Gastroenterology), Professor Pediatric Medicine, National Institute of Child Health, Karachi, Pakistan.
3. MBBS, DCH, MCPS, FCPS (Pediatrics), FCPS (Pediatric Nephrology), Assistant Professor Pediatric Nephrology, National Institute of Child Health, Karachi, Pakistan.

Correspondence Address:
Dr. Ramsha Mehmood
Department of Pediatric Medicine
National Institute of Child Health, Karachi, Pakistan.
ramsha.mehmood333@yahoo.com

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Child Health (NICH), Karachi, Pakistan during July 2024 to December 2024. Using OpenEpi online sample size calculator, a sample size of 192 was calculated taking the proportion hypocalcemia as 14.6%[11], with 95% confidence level, and 5% margin of error. Inclusion criteria were neonates between 2nd and 14th day of life, and presenting with jaundice and hyperbilirubinemia (total serum bilirubin>5 mg/dl). Neonatal jaundice was labeled as the yellow discoloration of the skin, mucous membrane, and sclera.[13] Exclusion criteria were neonates born before 37th week or after 40th week of gestation. Babies with birth weight below 2kg were also excluded. Neonate with history of birth trauma, cephal hematoma, bruises on body, birth asphyxia, sepsis, acute kidney injury, or congenital heart defects were also excluded. Neonates requiring exchange transfusion were also not included. Infants born to diabetic mothers were also excluded.

This study was performed after the permission of "Institutional Ethical Review Board" of NICH (IERB-63/2023, dated: 20-02-2023). Non-probability, consecutive sampling technique was employed. Informed and written consents were obtained from parents/caregivers. Neonates fulfilling the eligibility criteria were included from NICU and emergency room (ER) of NICH. Demographic details including gender, age (day of life), gestational age (weeks), weight (kg), height (cm), were noted. Blood sample was obtained under aseptic conditions and sent for the evaluation of serum bilirubin (mg/dl) and electrolyte levels. Normal sodium levels were 135-145mg/dl. Normal chloride levels were 96-106 MEq/L. Normal calcium levels were 7.5-10mg/dl. Normal potassium levels were 3.5-5mEq/L. Normal magnesium levels were 1.7-2.2mg/dl. Duration of PT was 48 hours adopted standard protocols. A special proforma was designed to record all relevant study data.

Data analysis was conducted by using "IBM-SPSS Statistics, version 26.0". Mean and standard deviation were calculated for quantitative variables, while frequency and percentage were calculated for categorical data. Chi-square / fisher's exact test or paired sample t-test were applied for the comparisons, taking $p<0.05$ as significant.

RESULTS

In a total of 192 neonates, 105 (54.7%) were male. The mean gestational age was 38.5± 1.44 weeks, while 114 (59.4%) neonates were born at 37–38 weeks of gestation. The mean age was 8.24± 2.61 days, while 119 (62.0%) neonates were aged between 2 and 7 days (Table-I).

Characteristics		Frequency (%)
Gender	Male	105 (54.7%)
	Female	87 (45.3%)
Age (days)	2-7	119 (62.0%)
	8-14	73 (38.0%)
Gestational age	37-38	114 (59.4%)
	39-40	78 (40.6%)

Table-I. Characteristics of neonates undergoing phototherapy (n=192)

After 48 hours of PT, a significant reduction was observed in total bilirubin ($p<0.001$), direct bilirubin ($p<0.001$), and indirect bilirubin ($p<0.001$), as shown in (Table-II).

Parameters	Baseline (Mean ± SD)	Post-48 Hours (Mean ± SD)	P-Value
Total Bilirubin (mg/dL)	15.2 ± 2.8	9.6 ± 2.3	<0.001
Direct Bilirubin (mg/dL)	1.8 ± 0.7	1.2 ± 0.4	<0.001
Indirect Bilirubin (mg/dL)	13.4 ± 2.6	8.4 ± 2.1	<0.001

Table-II. Serum bilirubin levels at baseline and after 48 hours of phototherapy (N=192)

Baseline serum electrolyte levels revealed mean sodium, chloride, calcium, potassium, and magnesium levels of 137.5±5.5 mEq/L, 97.0±6.5 mEq/L, 8.2±1.1 mg/dL, 4.0±0.8 mEq/L, and 1.9±0.4 mg/dL, respectively. After 48 hours of PT, statistically significant reductions were observed in sodium ($p=0.001$), chloride ($p<0.001$), calcium ($p=0.005$), potassium ($p<0.001$), and magnesium ($p=0.006$) (Table-III).

Parameters	Baseline	After 48-hours of Phototherapy	P-Value
Sodium (mEq/L)	137.5±5.5	136.0±5.7	0.001
Chloride (mEq/L)	97.0±6.5	96.5±6.4	<0.001
Calcium (mEq/L)	8.2±1.1	7.9±1.0	0.005
Potassium (mEq/L)	4.0±0.8	3.7±0.7	<0.001
Magnesium (mEq/L)	1.9±0.4	1.8±0.3	0.006

Table-III. Electrolytes levels at baseline and after 48 hours of phototherapy (N=192)

At baseline, the majority of neonates had normal serum electrolyte levels for sodium (84.4%), chloride (79.7%), calcium (84.4%), potassium (84.9%), and magnesium (90.1%). After 48 hours of PT, decrease in the proportion of neonates with normal levels was observed for sodium (82.3%, p=0.736), chloride (77.6%, p=0.776), calcium (80.7%, p=0.475), potassium (81.8%, p=0.302), and magnesium (87.5%, p=0.195). The proportion of hypocalcemia increased from 14.6% to 18.8%, hypokalemia from 10.9% to 15.6%, and hypomagnesemia from 8.9% to 12.5% (Table-IV).

DISCUSSION

The PT remains the cornerstone of hyperbilirubinemia management. This study demonstrated a statistically significant reduction in serum bilirubin levels following 48 hours of PT. The total bilirubin decreased from 15.2 ± 2.8 mg/dL at baseline to 9.6±2.3 mg/dL (p<0.001), direct bilirubin from 1.8±0.7 mg/dL to 1.2±0.4 mg/dL (p<0.001), and indirect bilirubin from 13.4±2.6 mg/dL to 8.4±2.1 mg/dL (p<0.001). These results affirm the efficacy of PT in mitigating hyperbilirubinemia.[14]

Electrolyte disturbances were notable, with statistically significant declines in serum sodium (p=0.001), chloride (p<0.001), calcium (p=0.005), potassium (p<0.001), and magnesium (p=0.006). The proportions of hypocalcemia, hypokalemia, and hypomagnesemia increased from 14.6% to 18.8%, 10.9% to 15.6%, and 8.9% to 12.5%, respectively, after PT.

Parameters		Baseline (n=192)	After 48-hours (n=192)	P-Value
Sodium (mEq/L)	Normal	162 (84.4%)	158 (82.3%)	0.736
	Hypo	24 (12.5%)	29 (15.1%)	
	Hyper	6 (3.1%)	5 (2.6%)	
Chloride (mEq/L)	Normal	153 (79.7%)	149 (77.6%)	0.776
	Hypo	34 (17.7%)	39 (20.3%)	
	Hyper	5 (2.6%)	4 (2.1%)	
Calcium (mEq/L)	Normal	162 (84.4%)	155 (80.7%)	0.475
	Hypo	28 (14.6%)	36 (18.8%)	
	Hyper	2 (1.0%)	1 (0.5%)	
Potassium (mEq/L)	Normal	163 (84.9%)	157 (81.8%)	0.302
	Hypo	21 (10.9%)	30 (15.6%)	
	Hyper	8 (4.2%)	5 (2.6%)	
Magnesium (mEq/L)	Normal	173 (90.1%)	168 (87.5%)	0.195
	Hypo	17 (8.9%)	24 (12.5%)	
	Hyper	2 (1.0%)	-	

Table-IV. Electrolytes evaluation at baseline and after 48 hours of phototherapy (N=192)

These findings emphasize the risk of dyselectrolytemia associated with PT. Mohamed et al.[15], observed significant reductions in serum bilirubin levels (p<0.001) and notable electrolyte disturbances, particularly hypocalcemia, after PT. Sivastava et al.[16], documented significant declines in serum sodium, potassium, chloride, and calcium levels following PT (p<0.0001), underscoring the universal risk of dyselectrolytemia. Tosson et al. evaluated the effects of different PT types and found that all types significantly reduced serum sodium, potassium, and calcium levels, irrespective of PT type. While Tosson et al.[17], highlighted PT duration as a critical factor influencing dyselectrolytemia, we noted that 48 hours duration of PT correlated with relatively

higher incidences of hypocalcemia, hypokalemia, and hypomagnesemia. In contrast, Singh et al.[18], reported no significant changes in sodium, potassium, or chloride levels after PT, although they observed a significant decline in serum calcium levels ($p<0.005$). Purohit and Verma[19], also observed significant declines in serum sodium, potassium, and calcium levels post-PT ($p<0.01$). This study underscores the importance of monitoring serum electrolytes in neonates undergoing PT. Hypocalcemia, hypokalemia, and hypomagnesemia, if unrecognized, can have serious clinical consequences, including jitteriness, irritability, seizures, and arrhythmias.[20] Strategies such as adequate hydration, calcium supplementation, and periodic monitoring of serum electrolytes can mitigate risks with electrolyte imbalances.

The findings of this study highlight the need for standardized guidelines on electrolyte monitoring during PT. Current practices vary widely, and the lack of uniformity can lead to underdiagnoses or over management of dyselectrolytemia. This study adds to the growing body of evidence advocating for routine electrolyte monitoring, particularly in neonates undergoing prolonged PT. Clinicians should adopt a proactive approach to monitoring and managing electrolyte imbalances during PT, particularly in preterm or low birth weight neonates. By addressing these gaps, we can enhance the safety and efficacy of PT in managing neonatal hyperbilirubinemia.

This study has some imitations. The lack of long-term follow-up precludes conclusions about the persistence of dyselectrolytemia beyond the PT period. While this study observed significant biochemical changes, we did not assess their clinical impact comprehensively, such as monitoring for subtle signs of hypocalcemia or hypokalemia.

CONCLUSION

This study highlights the dual effects of PT as its undeniable efficacy in reducing serum bilirubin levels and its potential to cause electrolyte disturbances. While the reductions in serum sodium, chloride, calcium, potassium, and magnesium levels were statistically significant, their clinical relevance remains uncertain. The increased prevalence of hypocalcemia, hypokalemia, and hypomagnesemia underscores the need for vigilance.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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AUTHORSHIP AND CONTRIBUTION DECLARATION	
1	**Ramsha Mehmood:** Data collection, drafting, responsible for data's integrity, approval for publication.
2	**Arit Parkash:** Study concept, design, methodology, critical revisions, approval for publication.
3	**Sadaf Asim:** Data analysis, methodology, proof reading, approval for publication.