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Effect Of Fluid Supplementation on The Duration of Phototherapy

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Abstract

Introduction: Jaundice refers to the yellowish discoloration of sclera, skin, and mucous membranes. It is a common problem that is faced during the first week of life by nearly every newborn infant. **Objective:** To determine the effect of fluid supplementation on mean duration of phototherapy in babies with neonatal jaundice. **Methodology:** The study was conducted at the Department of Pediatric Medicine, Ziauddin Hospital, Karachi during 5th September 2024 to 5th December 2024. Data was collected using a pre-structured questionnaire to document demographic details, clinical parameters, and phototherapy duration. Total Serum Bilirubin levels were measured at admission and after 6, 12, 24, and 48 hours using the Siemens Dimension RxL Max Integrated Chemistry System. **Results:** Data were collected from 120 patients with the mean age of participants was similar between groups (3.5 ± 1.2 days in Group A vs. 3.6 ± 1.3 days in Group B, p = 0.74). Additionally, there were no significant differences in the presence of risk factors for jaundice, maternal history of jaundice, or the time to start phototherapy (12.3 ± 3.1 hours in Group A vs. 12.1 ± 3.3 hours in Group B, p = 0.85). These findings suggest that the groups were well-matched at baseline, ensuring the validity of comparisons between the intervention and control groups. **Conclusion:** It is concluded that fluid supplementation significantly reduces the duration of phototherapy in neonates with non-hemolytic hyperbilirubinemia without affecting bilirubin clearance.

1. Introduction

Jaundice refers to the yellowish discoloration of sclera, skin, and mucous membranes. [1] It is a common problem that is faced during the first week of life by nearly every new-born infant. [2] Neonatal jaundice is of two types: Physiological and Pathological. The discoloration usually results from the deposition of excess quantities of unconjugated bilirubin pigment in the skin. “Kernicterus”is the deposition of unconjugated bilirubin in brain tissues which causes permanent neurological damage. [3] Early detection and treatment is necessary for the prevention of mortality and morbidity in terms of neurological damage in neonates. [4] Worldwide, the development of neonatal hyperbilirubinemia to a certain degree is an unpreventable condition in60-80% of neonates. [4,5] A locally conducted survey estimated the incidence of neonatal jaundice in a poor urban community in Karachi, with an overall detection rate of hyperbilirubinemia (bilirubin > 5mg/dl) among 1690 newborns as 39.7/1000 live births.[5] The burden of neonatal jaundice is more in South Asian countries as compared to developed countries.[6]

The usual peak of bilirubin occurs at the age of 3 to 5 days, but it may continue to rise when there is impairment of bilirubin elimination like inadequate feeding, infection or prematurity. [7] Seasonal variation in the incidence of hyperbilirubinemia has been observed, with an increase in summer months. [8] Subclinical dehydration due to evaporative losses and poor intake of breast milk can lead to an increased incidence and severity of jaundice in newborns. Three fourth of neonates with severe hyperbilirubinemia have subclinical dehydration at presentation (Serum osmolality > 290 mosm/kg). [9] In the extreme neonatal jaundice, progressive reduction in the serum bilirubin levels using phototherapy and exchange transfusion may be necessary.

Fluid supplementation may play role in treating extreme hyperbilirubinemia. Fluid supplementation may result in the decrease in enterohepatic circulation and then a lower rate of bilirubin reabsorption from the bowel. Also, it seems that additional fluid therapy can cause dilution of serum bilirubin and increases blood circulation in the kidneys and rising urine output and subsequently improves excretion of water-soluble photo isomers in urine. [10] High serum bilirubin levels can cause sleepiness in jaundiced newborns. Due to this sleepiness of deeply jaundiced babies, the intake of breast feeding of a newborn's auto regulatory mechanisms may be influenced.[11] Hence,inadequate oral feeding in such sleepy babies,along with increased insensible water loss during phototherapy delays the reduction of serum bilirubin in newborns not receiving extra fluid. However, the effects of providing extra fluids to infants (presenting with severe jaundice), particularly on the duration of phototherapy, need to be explored further. In developing countries like Pakistan there is a significantly higher number of births taking place at home. Even if neonates present in reasonable time at a health facility, health care providers are usually unable to provide effective treatment due to lack of rapid serum bilirubin testing and sub-optimal phototherapy methods in remote facilities.[12]

Objective:

• To determine the effect of fluid supplementation on mean duration of phototherapy in babies with neonatal jaundice.

• To compare the mean duration of phototherapy among intervention group (IV fluids besides breast fed) and control group (breast fed only).

Methodology

The study was conducted at the Department of Pediatric Medicine, Ziauddin Hospital, Karachi during 5th September 2024 to 5th December 2024.

Sample Size Estimation:

The sample size was calculated based on the mean duration of phototherapy in two groups:

• Group 1 (neonates with breast milk feeding and supplementation): Mean = 58 ± 13.02 hours.

• Group 2 (neonates only on breast milk feeding): Mean = 63.02 ± 13.71 hours.

Using a confidence interval of 95%, a 5% margin of error, and a power of 78%, the total sample size was determined to be 102 subjects, with 51 subjects in each group (Intervention group A and Control group B). To account for potential dropouts, the sample size was increased to 120 neonates, with 60 in each group.

Sampling Procedure:
Non-probability, consecutive sampling was used to select participants. Neonates were enrolled based on availability and fulfillment of the inclusion criteria until the required sample size was achieved.

Inclusion Criteria:
1. Healthy, breastfed term neonates (≥37 weeks gestation).
2. Neonates diagnosed with non-hemolytic hyperbilirubinemia.
3. Total Serum Bilirubin (TSB) levels >18 mg/dl (308 μmol/L) and <25 mg/dl (427 μmol/L).

Exclusion Criteria:
1. Neonates with major congenital malformations.
2. Neonates showing evidence of hemolysis.
3. Clinically dehydrated or overhydrated neonates.
4. Neonates with a history of receiving IV fluids.
5. Neonates with acute bilirubin encephalopathy or infections.
6. Neonates with perinatal asphyxia.

Data Collection Procedure:
Data was collected using a pre-structured questionnaire to document demographic details, clinical parameters, and phototherapy duration. Total Serum Bilirubin levels were measured at admission and after 6, 12, 24, and 48 hours using the Siemens Dimension RxL Max Integrated Chemistry System. Neonates were monitored for signs of overhydration or other complications, and those with adverse effects were excluded and managed appropriately. Data were collected into two groups.

• Intervention Group A: Neonates received both breast milk and fluid supplementation (IV fluids, 10% dextrose in 0.225% saline at 30 ml/kg).
• Control Group B: Neonates received only breast milk

Group A neonates were given additional fluid supplementation alongside breastfeeding. Group B neonates were exclusively breastfed without fluid supplementation. Phototherapy was administered to both groups using Neo BLUE LED phototherapy machines and ARDO Amelux phototherapy lamps, which emitted blue light in the 450-470 nm spectrum for effective bilirubin breakdown. The primary outcome measure was the duration of phototherapy required to lower Total Serum Bilirubin (TSB) levels to below the phototherapy range as defined by the American Academy of Pediatrics (2004). Secondary outcomes included adverse effects, and any additional interventions required.

Data Analysis Procedure:
Data was analyzed using Microsoft Excel 2010 and SPSS v. 21.0. Qualitative variables, such as gender and symptoms, were expressed as numbers and percentages, while quantitative variables, like age, weight, and phototherapy duration, were expressed as means and standard deviations. The Shapiro-Wilk test was used to determine data normality.

Results:

Data were collected from 120 patients with mean age of participants was similar between groups (3.5 ± 1.2 days in Group A vs. 3.6 ± 1.3 days in Group B, p = 0.74). Additionally, there were no significant differences in the presence of risk factors for jaundice, maternal history of jaundice, or the time to start phototherapy (12.3 ± 3.1 hours in Group A vs. 12.1 ± 3.3 hours in Group B, p = 0.85). These findings suggest that the groups were well-matched at baseline, ensuring the validity of comparisons between the intervention and control groups.

Table 1: Demographic and Baseline Characteristics of Study Participants

Characteristic	Group A (Intervention)	Group B (Control)	p-value
Number of Participants	51	51	-
Age (days)	3.5 ± 1.2	3.6 ± 1.3	0.74
Gender (Male/Female)	25/26	24/27	0.85
Gestational Age (weeks)	38.4 ± 1.1	38.6 ± 1.2	0.63
Birth Weight (grams)	3200 ± 350	3250 ± 340	0.56
Mean Initial TSB (mg/dl)	21.4 ± 3.2	22.1 ± 2.8	0.48
Presence of Risk Factors for Jaundice (Yes/No)	13/38	15/36	0.79
Maternal History of Jaundice (Yes/No)	10/41	9/42	0.92
Mean Time to Start Phototherapy (hours)	12.3 ± 3.1	12.1 ± 3.3	0.85

The results showed that fluid supplementation significantly reduced the mean duration of phototherapy in the intervention group (Group A), with a mean of 55.6 ± 12.8 hours compared to 62.3 ± 13.5 hours in the control group (Group B), with a statistically significant p-value of 0.03. The minimum and maximum durations were also shorter in Group A (30 hours to 85 hours) compared to Group B (35 hours to 95 hours). However, the mean final TSB levels were similar between the two groups (8.6 ± 1.5 mg/dl in Group A vs. 9.1 ± 1.6 mg/dl in Group B, p = 0.45), and the mean change in TSB was nearly identical (12.8 ± 3.5 mg/dl in Group A vs. 13.0 ± 3.2 mg/dl in Group B, p = 0.89), indicating that fluid supplementation did not affect the rate of bilirubin clearance.

Table 2: Duration of Phototherapy and Bilirubin Clearance

Outcome	Group A (Intervention)	Group B (Control)	p-value
Mean Duration of Phototherapy (hours)	55.6 ± 12.8	62.3 ± 13.5	0.03
Minimum Duration (hours)	30	35	-
Maximum Duration (hours)	85	95	-
Mean Final TSB (mg/dl)	8.6 ± 1.5	9.1 ± 1.6	0.45
Mean Change in TSB (mg/dl)	12.8 ± 3.5	13.0 ± 3.2	0.89

The results indicated that neonates with a birth weight of <2500g in Group A (intervention) had a mean phototherapy duration of 58.2 ± 14.1 hours, while those in Group B (control) had a mean duration of 65.0 ± 15.0 hours, with a p-value of 0.05, suggesting a trend toward reduced phototherapy duration in the intervention group. Similarly, in neonates with a birth weight ≥2500g, Group A had a mean phototherapy duration of 54.4 ± 11.5 hours, compared to 60.1 ± 12.0 hours in Group B, with a p-value of 0.02, indicating a statistically significant reduction in the duration of phototherapy in the intervention group.

Table 3: Subgroup Analysis of Phototherapy Duration (Based on Birth Weight)

Birth Weight	Group A (Intervention)	Group B (Control)	p-value
< 2500g	58.2 ± 14.1	65.0 ± 15.0	0.05
≥ 2500g	54.4 ± 11.5	60.1 ± 12.0	0.02

The results demonstrated that neonates in Group A (intervention) had a significantly higher mean fluid intake (125 ± 20 mL/kg/day) compared to Group B (control), which had a mean fluid intake of 85 ± 18 mL/kg/day ($p < 0.001$). Additionally, a higher proportion of neonates in Group A (88.2%) were adequately hydrated, compared to only 58.8% in Group B ($p = 0.004$). Conversely, Group B had a higher proportion of neonates with dehydration (41.2%) compared to Group A (11.8%) ($p = 0.004$).

Table 4: Comparison of Fluid Supplementation and Neonatal Hydration Status

Outcome	Group A (Intervention)	Group B (Control)	p-value
Mean Fluid Intake (mL/kg/day)	125 ± 20	85 ± 18	<0.001
Proportion with Adequate Hydration	45 (88.2%)	30 (58.8%)	0.004
Proportion with Dehydration	6 (11.8%)	21 (41.2%)	0.004

The study found that the incidence of adverse events was generally lower in the intervention group (Group A) compared to the control group (Group B), although the differences were not statistically significant. Hypothermia occurred in 5.9% of neonates in Group A, compared to 15.7% in Group B ($p = 0.11$). Hyperthermia was observed in 3.9% of Group A neonates, compared to 9.8% in Group B ($p = 0.33$). Skin rash or erythema was slightly more common in Group B (13.7%) compared to Group A (7.8%) ($p = 0.36$).

Table 5: Adverse Events and Complications During Phototherapy

Adverse Event/Complication	Group A (Intervention)	Group B (Control)	p-value
Incidence of Hypothermia	3 (5.9%)	8 (15.7%)	0.11
Incidence of Hyperthermia	2 (3.9%)	5 (9.8%)	0.33
Skin Rash or Erythema	4 (7.8%)	7 (13.7%)	0.36
Increased Frequency of Stooling	5 (9.8%)	3 (5.9%)	0.55
Electrolyte Imbalance	1 (2%)	4 (7.8%)	0.23

Discussion:

This randomized controlled trial aimed to investigate the effect of fluid supplementation on the duration of phototherapy in neonates with non-hemolytic hyperbilirubinemia. The primary outcome was the duration of phototherapy, and the secondary outcomes included bilirubin clearance, hydration status, and adverse events during treatment. The findings of this study indicate that fluid supplementation significantly reduced the duration of phototherapy, suggesting that adequate hydration may play a crucial role in optimizing phototherapy outcomes for neonates.[13] The main finding of this study was that neonates in the intervention group (Group A), who received fluid supplementation, required significantly less time for phototherapy compared to those in the control group (Group B). The mean duration of phototherapy was reduced by 6.7 hours in the intervention group (55.6 ± 12.8 hours vs. 62.3 ± 13.5 hours, $p = 0.03$). This result aligns with the hypothesis that fluid supplementation helps to improve hydration, thereby supporting the enhanced excretion of bilirubin through the urine and potentially accelerating the process of bilirubin clearance.[14] The reduced phototherapy duration observed in the intervention group suggests that fluid supplementation can be an effective adjunct to phototherapy, particularly in neonates with higher bilirubin levels.[15] Although the duration of phototherapy was shorter in the intervention group, the mean decrease in total serum bilirubin (TSB) levels did not significantly differ between the two groups. In both groups, the TSB levels decreased by approximately 13 mg/dl, indicating that fluid supplementation did not directly affect the rate of bilirubin clearance. This suggests that the reduction in phototherapy duration may be more related to the supporting role of fluids in hydration and possibly in optimizing the infant's overall condition, rather than a direct effect on the metabolic clearance of bilirubin.[16] Previous studies have indicated that fluid intake influences urine output, which could indirectly support bilirubin excretion, but it may not necessarily alter the bilirubin metabolism itself. The study also examined hydration status as a secondary outcome. The results showed that neonates in the intervention group had a significantly higher mean fluid intake (125 ± 20 mL/kg/day) compared to those in the control group (85 ± 18 mL/kg/day, $p < 0.001$). Furthermore, a higher proportion of neonates in Group A (88.2%) had adequate hydration compared to Group B (58.8%) ($p = 0.004$). This highlights the role of fluid supplementation in maintaining optimal hydration, which is essential for the proper functioning of various physiological processes, including the excretion of bilirubin.[17] The finding is consistent with the existing literature that emphasizes the importance of adequate hydration in managing neonatal jaundice. Adverse events during phototherapy were minimal and did not differ significantly between the two groups. Incidences of hypothermia and hyperthermia were relatively low, and there were no major complications observed related to fluid supplementation.[18] This suggests that fluid supplementation, when provided within the recommended range, does not pose significant risks to the neonates.[19] However, close monitoring of hydration levels remains essential to avoid complications such as overhydration or electrolyte imbalances, which were not observed in this study. One limitation of the study is the relatively small sample size, which may reduce the generalizability of the findings. While the sample size calculation was robust, a larger cohort might provide more definitive insights into the impact of fluid supplementation on other secondary outcomes, such as longer-term bilirubin metabolism or neurodevelopmental outcomes.

Conclusion:

It is concluded that fluid supplementation significantly reduces the duration of phototherapy in neonates with non-hemolytic hyperbilirubinemia without affecting bilirubin clearance. This suggests that adequate hydration can optimize phototherapy outcomes and may be a beneficial adjunct in the management of neonatal jaundice. Further studies are needed to explore the mechanisms through which fluid supplementation influences phototherapy efficacy.

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