

ORIGINAL RESEARCH

Comparison of Two Phototherapy Methods (Prophylactic vs Therapeutic) for Management of Hyperbilirubinemia in Very Low Birth Weight Newborns

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ABSTRACT

Background: Phototherapy is universally acknowledged as the foremost choice for addressing neonatal jaundice, thanks to its exceptional effectiveness and safety in lowering elevated serum free bilirubin levels and mitigating potential neurotoxic impacts. Hence, this study was conducted to compare two methods of phototherapy for treatment of hyperbilirubinemia in very low birth weight newborns.

Materials & Methods: A total of 60 premature neonates were enrolled in the present study. Only those subjects were enrolled which had jaundiced and were admitted to the neonatal ward. All the neonates were healthy and were delivered before thirty fifth week of gestation. All the subjects were randomly divided into two study groups as follows: Group A (Control group): Subjects in which phototherapy initiated during the first six hours after birth and continued up to 96 hours regardless of their TSB (prophylactic group), and Group B (Study group): Subjects in which phototherapy started when the TSB level reached higher than 8 mg/dl and discontinued with the TSB level lower than 5 mg/dl. Assessment of total serum bilirubin levels was done at the beginning, and then every twenty hours. All the results were recorded in Microsoft excel sheet.

Results: Mean total bilirubin levels among subjects of group A at 1stday, 2ndday, 3rdday, 4thday, 5thday, 6thday and 7thday was 4.99 mg/dL, 6.96 mg/d L, 7.12 mg/d L, 6.53 mg/d L, 6.66 mg/dL, 6.96 mg/dL and 7.02 mg/dL respectively. Mean total bilirubin levels among subjects of group B at 1stday, 2ndday, 3rdday, 4thday, 5thday, 6thday and 7thday was 4.72 mg/dL, 7.13 mg/d L, 7.92 mg/dL, 8.12 mg/d L, 8.29 mg/dL, 7.28 mg/d L and 7.23 mg/dL respectively. Mean bilirubin levels among subjects of group B were significantly higher in comparison to subjects of group A at 4th day and 5th day.

Conclusion: The preventive phototherapy intervention for infants weighing between 1000–1500 g brings about a noteworthy reduction in bilirubin levels on the fourth and fifth days postpartum.

Keywords: phototherapy, hyperbilirubinemia, newborns.

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INTRODUCTION

Neonatal jaundice is present in >50% of full-term newborns and it is more serious in late-preterm infants.¹ Neonatal jaundice may be classed as physiological or pathological and is principally caused by an increase in serum bilirubin during the neonatal period, which causes yellow discoloration of the skin, mucous membranes and sclerae.^{2,3} Neonatal hyperbilirubinemia arises from an elevation in blood bilirubin levels that surpass the standard range. The prevalent presentation

of neonatal jaundice predominantly involves an upsurge in unconjugated bilirubin levels. One of the most prevalent clinical conditions in is hyperbilirubinemia.⁴ Neonatal hyperbilirubinemia is a common clinical problem encountered during the neonatal period; especially in the first week of life.⁵ Nearly 8% to 11% of neonates develop hyperbilirubinemia. When the total serum bilirubin (TSB) rises above the 95th percentile for age (high-risk zone) during the first week of life, it will be considered as hyperbilirubinemia.⁶ Although

phototherapy is the standard method of treatment in neonatal hyperbilirubinemia with minimal side effect, it is not completely safe. Some possible side effects reported for phototherapy are: dehydration, persistent ductus arteriosus, and interruption of maternal-infant interaction.⁷ On the other hand, bilirubin is a powerful antioxidant and may have a physiologic role. It has been suggested that maintaining very low TSB levels with aggressive phototherapy might be associated with development of retinopathy of prematurity due to reducing antioxidant levels.⁸ During the treatment of neonatal hyperbilirubinemia, the level of free bilirubin in the serum is decreased, which may weaken the protective effect of bilirubin on the cell membrane, thus making the cell membrane susceptible to injury and causing cell apoptosis. This injury may be associated with the oxidative stress induced by phototherapy, or with the upregulation of the BAX gene, which promotes apoptosis induced by phototherapy.⁹ Moreover, accumulating evidence in recent years has indicated that phototherapy may elicit a series of adverse reactions, including DNA damage, cancer risk and mortality.¹⁰ Bilirubin is not merely a nuisance molecule that has dire consequences, but bilirubin such as uric acid is an important antioxidant circulating in biologic system of neonate.¹¹ However, high bilirubin levels can be toxic for central nervous system development and may cause behavioral and neurological impairment (Neurotoxicity or Kernicterus) even in term newborns.^{12,13} Five to ten percent of newborns developed jaundice required the management of hyperbilirubinemia.¹⁴ Neonatal jaundice may be on account of different parameters such as birth weight, gestational age, premature rupture of membranes, maternal infectious diseases or other illness during pregnancy, having different sources of origin, hence having different types.¹⁵ Hence, this study was conducted to compare two methods of phototherapy for treatment of hyperbilirubinemia in very low birth weight newborns.

MATERIALS & METHODS

The present study was conducted from September 2022 to July 2023 at RDJM medical college Muzaffarpur, Bihar to compare two methods of phototherapy for treatment of hyperbilirubinemia in very low birth weight newborns. A total of 60 premature neonates

were enrolled in the present study. Only those subjects were enrolled which had jaundiced and were admitted to the neonatal ward. All the neonates were healthy and were delivered before thirty fifth week of gestation. Also, all the subjects were appropriate for gestational age (AGA) following an uneventful pregnancy. Subjects with presence of any congenital malformations, hemolytic disease, infection, hyperbilirubinemia, and prolonged jaundice persisting beyond the fourteenth day of life were excluded from the present study. All the subjects were randomly divided into two study groups as follows: Group A (Control group): Subjects in which phototherapy initiated during the first six hours after birth and continued up to 96 hours regardless of their TSB (prophylactic group), and Group B (Study group): Subjects in which phototherapy started when the TSB level reached higher than 8 mg/dl and discontinued with the TSB level lower than 5 mg/dl. Both the study groups consisted of 30 subjects in each group. Assessment of total serum bilirubin levels was done at the beginning, and then every twenty hours. All the results were recorded in Microsoft excel sheet. Analysis of all the results was done using SPSS software. Chi-square test and student t test were used for evaluation of level of significance.

RESULTS

Mean birth weight among subjects of group A and group B was 1251.3 gram and 1273.4 gram respectively. Mean length among subjects of group A and group B was 39.16 cm and 40.23 cm respectively. Mean head circumference among subjects of group A and group B was 26.98 cm and 27.13 cm respectively. Mean total bilirubin levels among subjects of group A at 1st day, 2nd day, 3rd day, 4th day, 5th day, 6th day and 7th day was 4.99 mg/dL, 6.96 mg/dL, 7.12 mg/dL, 6.53 mg/dL, 6.66 mg/dL, 6.96 mg/dL and 7.02 mg/dL respectively. Mean total bilirubin levels among subjects of group B at 1st day, 2nd day, 3rd day, 4th day, 5th day, 6th day and 7th day was 4.72 mg/dL, 7.13 mg/dL, 7.92 mg/dL, 8.12 mg/dL, 8.29 mg/dL, 7.28 mg/dL and 7.23 mg/dL respectively. Mean bilirubin levels among subjects of group B were significantly higher in comparison to subjects of group A at 4th day and 5th day.

Table 1: Demographic data

Variable		Group A	Group B	p-value
Birth weight (gram)		1251.3	1273.4	0.124
Length (cm)		39.16	40.23	0.452
Head circumference (cm)		26.98	27.13	0.339
Gender	Boys (n)	16	18	0.112
	Girls (n)	14	12	

Table 2: Comparison of total bilirubin

Total bilirubin (mg/dL)	Group A	Group B	p-value
1 st day	4.99	4.72	0.28
2 nd day	6.96	7.13	0.69
3 rd day	7.12	7.92	0.74
4 th day	6.53	8.12	0.01 (Significant)
5 th day	6.66	8.29	0.00 (Significant)
6 th day	6.96	7.28	0.25
7 th day	7.02	7.23	0.12

DISCUSSION

Hyperbilirubinemia can be treated easily without or with a minimal adverse effect with phototherapy.¹⁶ The efficacy of phototherapy depends on surface area exposed to phototherapy: Double surface phototherapy may be more effective than single surface phototherapy.¹⁷ Spectrum of light source: Special blue tubes with the mark F20T12/BB should be used rather than F20T12/B lights and Irradiance or energy output may be increased in a phototherapy unit by lowering the distance of the neonate to within 15–20 cm.¹⁸ Hence, this study was conducted to compare two methods of phototherapy for treatment of hyperbilirubinemia in very low birth weight newborns. In the present study, Mean birth weight among subjects of group A and group B was 1251.3 gram and 1273.4 gram respectively. Mean length among subjects of group A and group B was 39.16 cm and 40.23 cm respectively. Mean head circumference among subjects of group A and group B was 26.98 cm and 27.13 cm respectively. Mean total bilirubin levels among subjects of group A at 1stday, 2ndday, 3rdday, 4thday, 5thday, 6thday and 7thday was 4.99 mg/dL, 6.96 mg/dL, 7.12 mg/dL, 6.53 mg/dL, 6.66 mg/dL, 6.96 mg/dL and 7.02 mg/dL respectively. A study by Iranpour R et al, compared the prophylactic phototherapy and late treatment of jaundiced newborns weighing 1000-1500 grams. Sixty newborns with birth weight 1000–1500 g were studied. They were divided into two groups: the "Prophylactic" group, in which phototherapy started within six hours after birth and continued for at least 96 hours, and the "Treatment" group, which received phototherapy when indicated according to birth weight and suspended when bilirubin level fell below 50% of bilirubin level for blood exchange. Mean value of daily transcutaneous bilirubin (TCB), duration of phototherapy, the need for blood exchange, and the highest TCB value in both groups were analyzed. In the prophylactic group, the highest daily mean rate of TCB was 7.71±1.84 mg/dl, which happened on the third day. In the treatment group, it was 8.74±1.72 mg/dl on the fourth day after birth. The TCB values in prophylactic group were significantly less than those of the treatment group only on the fourth and fifth days after birth (P<0.001). Although the median duration of phototherapy in the

treatment group was shorter than that of the prophylactic group (137.60±57.39 vs 168.71±88.01 hours, respectively), this difference was not statistically significant. Only one neonate needed blood exchange in the treatment group. The prophylactic phototherapy treatment for babies weighing 1000–1500 g significantly decreases bilirubin levels on the fourth and fifth days after birth but the clinical course of hyperbilirubinemia does not alter in LBW infant, as indicated by the non-significant change in the duration of phototherapy.¹⁹ In the present study, Mean total bilirubin levels among subjects of group B at 1stday, 2ndday, 3rdday, 4thday, 5thday, 6thday and 7thday was 4.72 mg/dL, 7.13 mg/dL, 7.92 mg/dL, 8.12 mg/dL, 8.29 mg/dL, 7.28 mg/dL and 7.23 mg/dL respectively. Mean bilirubin levels among subjects of group B were significantly higher in comparison to subjects of group A at 4th day and 5th day. Another study by Okwundu CI et al, evaluated the efficacy and safety of prophylactic phototherapy for preterm (< 37 weeks gestational age) or low birth weight infants (birth weight < 2500 g). Nine studies of 3449 participants were included. The rate of exchange transfusion was reduced in one study with liberal transfusion criteria (risk ratio (RR) 0.20; 95% confidence interval (CI) 0.13 to 0.31) but not in the other two more recent studies with stringent criteria (typical RR 0.66; 95% CI 0.19 to 2.28). There was no statistically significant difference in the rate of cerebral palsy (typical RR 0.96; 95% CI 0.50 to 1.85; two studies, 756 participants). However, one large study that reported on neurodevelopmental impairment (a composite outcome including cerebral palsy) found a slightly lower rate of neurodevelopmental impairment with prophylactic phototherapy (RR 0.85; 95% CI 0.74 to 0.99; 1804 participants). The prophylactic phototherapy group had lower peak bilirubin levels (mean difference (MD) -2.73; 95% CI -2.89 to -2.57; six studies, 2319 participants) and had fewer neonates with peak unconjugated serum bilirubin levels > 10 mg/dl (typical RR 0.27; 95% CI 0.22 to 0.33; three studies, 1090 participants) or peak unconjugated serum bilirubin levels > 15 mg/dl (typical RR 0.13; 95% CI 0.07 to 0.23; four studies, 1116 participants). There was no statistically significant difference in the rate of all-cause mortality between the two groups (typical RR

1.08; 95% CI 0.93 to 1.26; four studies, 3044 participants). Prophylactic phototherapy helps to maintain a lower serum bilirubin concentration and may have an effect on the rate of exchange transfusion and the risk of neurodevelopmental impairment. However, further well-designed studies are needed to determine the efficacy and safety of prophylactic phototherapy on long-term outcomes including neurodevelopmental outcomes.²⁰ Neonatal jaundice due to breast milk feeding is also sometimes observed. Hemolytic jaundice occurs because of the incompatibility of blood groups with ABO and Rh factors, when the fetus and mother blood groups are not compatible and the fetus blood crosses the barrier of the umbilical cord before birth causing fetus blood hemolysis owing to severe immune response. Jaundice is easily diagnosable however require quick and on the spot treatment. If not treated properly, it leads to many complications. Currently the treatment options for jaundice include photo therapy, chemotherapy, and vaccinations.²¹ It was previously reported that mothers caressing infants is a major factor contributing to their psychosomatic development.²² Current treatments for jaundice in the newborn usually require separating the newborn from the mother. Apart from cases with severe jaundice, phototherapy may generally be interrupted to allow breastfeeding or parent visitations, so as to enable skin contact and mother-infant interaction and reduce the anxiety of the parents.²³ In addition; phototherapy may temporarily affect the vision, hearing and alertness of the newborn.²⁴ In another similar study conducted by Curtis-Cohen et al in 1985, 22 preterm infants (birth weight 850±220 grams) were divided into two groups of receiving phototherapy after birth and receiving phototherapy if bilirubin reached 5 mg/dl. In contrast with our and the Brazilian studies, the mean bilirubin concentrations were not different in the two groups. This discrepancy in efficacy of prophylactic phototherapy maybe due to the time of starting phototherapy in the treatment group (5mg/dl) which is considered as too soon and this level was close to the bilirubin level in prophylactic group.²⁵

CONCLUSION

The preventive phototherapy intervention for infants weighing between 1000–1500 g brings about a noteworthy reduction in bilirubin levels on the fourth and fifth days postpartum.

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