Original Article

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Comparison of Light Emitting Diode Phototherapy vs Conventional Phototherapy for Neonatal Hyperbilirubinemia: A Quasi-experimental Study

Paediatrics Section

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ABSTRACT

Introduction: Neonatal hyperbilirubinemia is one of the most common problem encountered during the neonatal period. Phototherapy is a widely accepted, cheap, non-invasive relatively safe and effective method of treatment for neonatal hyperbilirubinemia.

Aim: To compare the efficacy of Light Emitting Diode (LED) phototherapy vs Conventional Phototherapy for treatment of neonatal hyperbilirubinemia in healthy term neonates.

Materials and Methods: A quasi experimental study was conducted in Neonatal Intensive Care Unit and Post-natal wards in a tertiary care hospital affiliated to Medical College and Hospital, Ahmedabad, Gujarat from July 2018 to April 2019 with a sample size of 135 in each group. They were assessed clinically by Kramers method just before initiation of phototherapy, then using Transcutaneous Bilirubinometer (TCB) Total Serum Bilirubin (TSB) level was measured. Bilirubin assessment by these methods were done for every neonate before initiation of phototherapy and then again repeated after 24 and 48 hours of phototherapy. Data was collected and analysed in Microsoft (MS) excel Statistical Package for the Social Sciences (SPSS) 0.26. Chi-square test was used for comparison.

Results: In the present study, 158 (58.51%) babies were male and 112 (41.48%) babies were female. Initially, LED was found to be better than Compact Fluorescent (CFL) conventional phototherapy on comparing the average fall in the serum bilirubin level from baseline during the first 24 hours however no such difference in the efficacy between the two light sources was seen after a period of 48 hours. Total 9 (6.66%) patients developed rebound hyperbilirubinemia after completion of conventional phototherapy whereas 14 (10.37%) developed rebound hyperbilirubinemia after completion of 48 hours of LED phototherapy.

Conclusion: LED and conventional phototherapy were equally efficacious in managing non haemolytic hyperbilirubinemia in healthy term neonates.

Keywords: Kramers staging, Transcutaneous bilirubinometer, Total serum bilirubin

INTRODUCTION

Neonatal hyperbilirubinemia is one of the most common problem encountered during the neonatal period, statistically it affects approximately 60% of term and 80% of preterm neonates during the first week of life. Hyperbilirubinemia is often attributed to an increase in the bilirubin synthesis, ineffective binding and transportation, less efficient hepatic conjugation, excretion and enhanced absorption of bilirubin via entero-hepatic circulation [1-3].

Most of the cases of hyperbilirubinemia are physiological and does not require any specific treatment, but 10 to 20% cases of hyperbilirubinemia are pathological requiring immediate interventions more often. Although the outcome in majority of the cases is benign, infants with untreated, severe hyperbilirubinemia (defined as serum total bilirubin >20 mg/dL) can develop signs of Acute Bilirubin Encephalopathy (ABE), which if not treated immediately might cause kernicterus [4].

Phototherapy is a widely accepted, cheap, non-invasive relatively safe and effective method of treatment for neonatal hyperbilirubinemia. The goal of the therapy is to lower the concentration of circulating bilirubin. With the invention of phototherapy there was less need to resort to invasive modality like exchange transfusion and as an added advantage it was easily available even in the remote areas. Conventional phototherapies were used since many years. Recently, the introduction of LED phototherapy machines in the field of neonatology and it was projected to be more efficacious as compared to conventional [2,3]. CFL uses compact fluorescent (CFL) or halogen lamps. LED is being used as light sources for phototherapy with unique characteristics of portability, power efficiency, lesser heat production, and durability. This study was conducted with aim to compare the efficacy of LED phototherapy vs CFL for treatment of neonatal hyperbilirubinemia in healthy term neonates.

MATERIALS AND METHODS

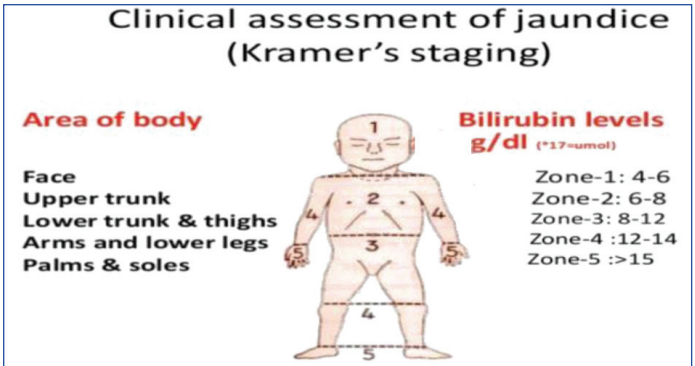
This study was a quasi experimental study done in tertiary care centre affiliated with Medical College and Hospital Ahmedabad, Gujarat, India from July 2018 to April 2019 after clearance from Ethical Committee. Detail history of all the enrolled neonates were taken after obtaining informed consent from the parents for enrolment in the study.

Inclusion criteria: A total of 270 neonates born at 37 or more completed weeks of gestational age and postnatal age ≥2 to ≤14 days of life were eligible for enrolment regardless of their place of delivery.

Exclusion criteria: Neonates with isoimmune haemolytic disease or admitted with duration of jaundice (due to any cause) more than 14 days of life and critically ill neonates were excluded from the study.

They were assessed first clinically by Kramer's method [Table/Fig-1] just before initiation of phototherapy, then using TCB, TSB level was measured [2]. Bilirubin assessment by these methods were done for every neonate before initiation of phototherapy and then again repeated after 24 and 48 hours of phototherapy. Bhutani's nomograms were used as reference charts for management of these neonates [5]. If TCB or TSB values fell into the range for initiation of phototherapy according to the chronological and postnatal age of the new born as per bhutani's nomogram given by American Academy of Paediatrics then the patients were subjected to CFL conventional phototherapy and LED phototherapy respectively by simple randomisation method [3].

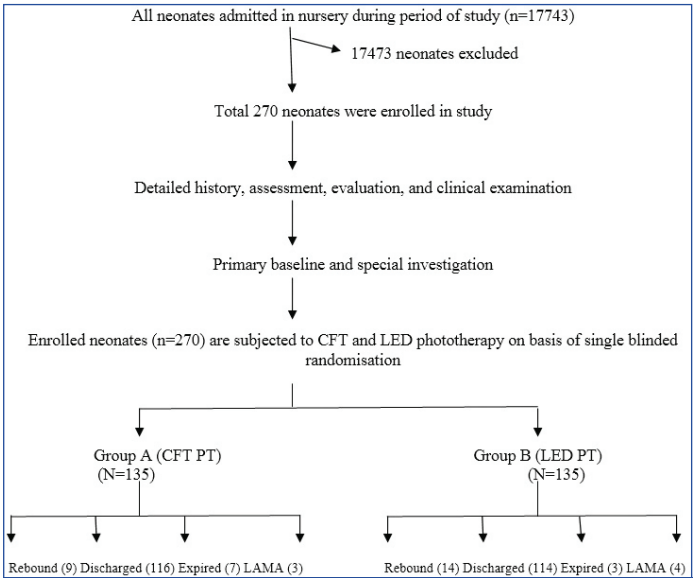
The neonates were completely exposed except for the genitalia and the eyes, which were covered with a diaper and bilib and eyepads, respectively [3]. CFL phototherapy unit consisted of 6 CFL bulbs delivering spectral irradiance of 8-10 µw per square centimetre per nanometre. LED phototherapy unit consisted of special blue



[Table/Fig-1]: Dermal staining in newborn progresses in cephalocaudal direction. Serum levels of total bilirubin are approximately (4-6 mg/dL) (zone1), (6-8 mg/dL) (zone2), (8-12 mg/dL) (zone3), (12-14 mg/dL) (zone4) and >15 mg/dL (zone 5) [2].

fluorescent lamps delivering 30-40 µw square centimetres per nanometre at a waveband between 425 and 475 nm neonate was kept for 48 hours under phototherapy [4,6-9]. The flux of phototherapy was checked each time using commercially available radiometer recommended by the manufacturer of the light source, by a qualified biomedical engineer dedicated to our neonatal intensive care unit.

Rebound hyperbilirubinemia was documented if there was reappearance of icterus after 24 hours of stoppage of phototherapy with value of TSB in mg/dL more than or equal to concentration before initiation of phototherapy [6,7]. All the neonates were monitored for possible side-effects during the phototherapy. After the discontinuation of phototherapy the neonates were discharged from the hospital and followed-up after 48 hours of discharge. The caretakers were taught to recognise the warning signs of severe hyperbilirubinemia at the time of discharge. Those neonates who developed rebound hyperbilirubinemia were re-exposed to phototherapy using the same criteria and protocol. The neonates were either fed using Nasogastric tube feeding or katori spoon feeding under the phototherapy light so that time spent off phototherapy could be minimised. Flow chart of the participants is in [Table/Fig-2].



[Table/Fig-2]: Flowchart of the participants.
CFT PT: Compact fluorescent phototherapy; LED PT: Light diode phototherapy

The rate of fall of the TSB was considered as the primary outcome variable where as the duration of phototherapy was considered as the secondary outcome variable.

STATISTICAL ANALYSIS

Data was collected and analysed in Microsoft (MS) excel Statistical Package for the Social Sciences (SPSS) 0.26. Chi-square test was used for comparison.

RESULTS

In the present study, 158 (58.51%) babies were male and 112 (41.49%) babies were female. Out of 135 patients 84 achieved TSB <7.5 mg/dL after 48 hours of LED phototherapy [Table/Fig-3]. Out of total 135 patients, 2 (1.48%) patients still had TSB 25 mg/dL after completion of 48 hours of phototherapy whereas almost half of the patient 65 (48.14%) achieved TSB <7.5 mg/dL and almost one third 45 (33.33%) achieved TSB between 7.5-10 mg/dL after 48 hours of conventional phototherapy [Table/Fig-4].

TSB (mg/dL) before initiation of LED phototherapy	0 hour of phototherapy	48 hours of phototherapy	p-value
<7.5	-	84 (62.22%)	
7.5-10	7 (5.18%)	35 (25.92%)	<0.001
10.1-15	56 (41.48%)	10 (7.40%)	<0.001
15.1-20	45 (33.33%)	4 (2.96%)	<0.001
20.1-25	20 (14.81%)	2 (1.48%)	<0.05
>25	7 (5.18%)	0	<0.05
Total	135	135	

[Table/Fig-3]: Range of TSB in Patients at 0 hour and 48 hour after LED phototherapy. Chi-square test used

TSB (mg/dL) before initiation of CFL phototherapy	0 hour of phototherapy	48 hours of phototherapy	p-value
<7.5	-	65 (48.14%)	
7.5-10	7 (5.18%)	45 (33.33%)	<0.001
10.1-15	59 (43.70%)	12 (8.88%)	<0.001
15.1-20	49 (36.29%)	6 (4.44%)	<0.001
20.1-25	15 (11.11%)	5 (3.70%)	<0.05
>25	5 (3.70%)	2 (1.48%)	>0.05
Total	135	135	

[Table/Fig-4]: Range of TSB in patients at 0 hour and 48 hours after CFL phototherapy. Chi-square test used

Almost two third of patient 92 (68.14%) had average fall in TSB level more than or equal to 5.1 mg/dL after completion of 24 hours of LED phototherapy. There was a statistical significant difference between CFL and LED phototherapy when considering average fall in TSB below 7 mg/dL over 24 hours but there was no such statistical difference between the two when considering average fall in TSB more than 7 mg/dL over 24 hours [Table/Fig-5].

Average fall in total serum bilirubin level from baseline over 24 hour in mg/dL	CFL phototherapy group (n=135)	LED phototherapy group (n=135)	p-value
>10	1 (0.74%)	5 (3.70%)	0.2135
7.1-10	25 (18.51%)	38 (28.14%)	0.0837
5.1-7	15 (11.11%)	49 (36.29%)	0.0001
3.1-5	58 (42.96%)	31 (22.96%)	0.0007
≤3	36 (26.66%)	12 (8.88%)	0.0002

[Table/Fig-5]: Comparison of rate of fall in Total Serum Bilirubin (TSB) level (mg/dL/24 hour) between conventional and LED phototherapy.
Chi-square test was used; p-value less than 0.05 was considered stastically significant

It was also seen further that, there was no statistical significant difference between conventional and LED phototherapy with p-value >0.05 when considering average fall in TSB over 48 hours and hence there was no difference in effectiveness between conventional and LED phototherapy.

Total 9 (6.66%) patients developed rebound hyperbilirubinemia after completion of conventional phototherapy whereas 14 (10.37%) developed rebound hyperbilirubinemia after completion of 48 hours of LED phototherapy. There was no statistical difference between LED and conventional phototherapy as far as rebound hyperbilirubinemia

was concerned as p-value was 0.3836 [Table/Fig-6]. Total ten babies expired during the study. Out of ten, six babies expired due to sepsis and four babies expired due to ABO Rh incompatibility.

Variables	Total	Rebound hyperbilirubinemia, N (%)	p-value
Total number of patients undergoing phototherapy	270		
Number of patients undergoing conventional phototherapy	135	9 (6.66%)	0.3836
Number of patients undergoing LED phototherapy	135	14 (10.37%)	

[Table/Fig-6]: Comparison of rebound hyperbilirubinemia between conventional and led phototherapy.
Chi-square test was used

DISCUSSION

This study observed that there was no significant difference in the rate of decrease in the serum bilirubin levels between LED and CFL phototherapy, though initially the average fall in the serum bilirubin in the first 24 hours was more with LED phototherapy. This observation is in line with the studies by Mohammadizadeh M et al., (blue fluorescent phototherapy vs LED phototherapy), Takci S et al., (Intensive conventional vs intensive LED phototherapy) Colindres VJ et al., (LED vs CFT phototherapy for in neonatal jaundice) and Kumar P et al., [10-13]. All had compared between different intensive phototherapy units with matched irradiances as per criteria of American Academy of Paediatrics and had concluded that the rate of decrease of serum total bilirubin are equally efficacious both by LED and CFT light sources of phototherapy [3].

The results of present study were not in agreement with the studies done by Purkait R and Mondal M, Swain N et al., Reddy TR et al., and Gutta S et al., [14-17] because they used phototherapy units with irradiances different from our study. Their results showed that LED phototherapy units are more efficacious in terms of higher rate of fall of bilirubin levels and lesser duration of phototherapy compared to CFL units.

According to Mohammedizadeh M et al., study which had compared LEDs with fluorescent phototherapy unit in the treatment of preterm infants with neonatal jaundice, the duration of phototherapy required was found to be the same on using both light sources for phototherapy, and there was no significant difference in the rate of fall of bilirubin. No association was found between the type of treatment and outcome [10]. These results were similar to this study indicating that LEDs units are as effective as CFL units.

The incidence of rebound hyperbilirubinemia also was found to be the same with both the conventional and LED phototherapy in the present study. However, on the contrary studies by Karagol BS et al., Ekisariyaphorn R et al., documented high intensity LED phototherapy to be better in comparison to CFT phototherapy as the duration of phototherapy required was found to be decreased and there was lesser incidence of rebound hyperbilirubinemia [6,7].

Limitation(s)

It was restricted to a single centre. A large multicentric study is required to establish the small differences between LEDs and fluorescent phototherapy methods with regards to rate of fall of bilirubin and duration of therapy.

CONCLUSION(S)

Conventional and LED phototherapy are both equally efficacious in initial decline in TSB level at 24 hours and 48 hours of phototherapy. There is no significant difference between conventional and LED phototherapy as far as rebound hyperbilirubinemia is considered.

Author contributions: CM- Conceptualised and guided throughout manuscript preparation. GK, BP and JP- manuscript preparation. SB and DGC- data collection and analysis.

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