

Original Research Article

Comparison of light emitting diode and compact fluorescent lamp phototherapy in treatment of neonatal hyperbilirubinemia

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ABSTRACT

Background: High levels of total serum bilirubin can cause life threatening complications in neonates requiring management either with phototherapy or exchange blood transfusion. Most commonly used modality of phototherapy is with blue light. There are many bulbs like fluorescent tubes, halogen spotlights etc. Due to disadvantages of the available bulbs, newer method like light-emitting diodes (LEDs) has been investigated as possible alternatives as they produce low heat, has a longer life span with lower energy consumption and rapid reduction of serum bilirubin level. The aim was to compare the efficacy between phototherapy equipped with light emitting diode (LED) to compact fluorescent lamp (CFL) in the treatment of neonatal hyperbilirubinemia among neonates.

Methods: A hospital-based intervention study was conducted among 50 neonates born in the hospital during the study period, with gestational age more than equal to 35 weeks, being breastfed and healthy in a private medical college teaching hospital in Dakshina Kannada district from August to September 2016. Following ethical committee clearance the neonates looking icteric by clinical examination were randomly allocated to receive CFL or LED phototherapy. Baseline, 24 hour total serum bilirubin and rectal temperature was measured.

Results: A total of 50 neonates were randomly allocated into two groups with almost similar characteristics between the two groups with respect to gender, type of delivery and gestational age. The mean bilirubin values (in mg/dl) among neonates in the CFL group and LED group were 14.8 and 15.6 respectively and post 24 hour values were 11.54 and 10.68 respectively. The mean difference in the reduction in the bilirubin values before and after receiving phototherapy between the two groups were significant ($p < 0.001$). The increase in temperature was lesser among LED treatment group.

Conclusions: LED therapy is better than the CFL therapy in terms of mean reduction in the total serum bilirubin after a fixed duration of time and lesser raise in temperature among the neonates.

Keywords: LED, Neonates, Phototherapy

INTRODUCTION

In neonates, high levels of total serum bilirubin (TSB) can cause severe and irreversible brain damages. Thus, prompt diagnosis and treatment of indirect hyperbilirubinemia is of great importance in this age group. Phototherapy and exchange blood transfusion are

two major therapeutic strategies to prevent bilirubin-induced brain damage in neonates.¹ The choice of therapy depends on the severity of hyperbilirubinemia, however phototherapy is the most frequently used treatment.

Efficacy of phototherapy is dependent on the colour (wavelength) and intensity (irradiance) of the light

emitted during phototherapy, the exposed body surface area and the duration of exposure.^{1,2} In the current guidelines of American Academy of Paediatrics (AAP), intensive phototherapy is defined as the use of blue light (in the 430 - 490 nm band) delivered at 30 microwatts/cm²/nm or higher to the greatest body surface area as possible.^{3,4} Commonly used light sources are fluorescent tubes and halogen spotlights. These light sources, have some important limitations. They produce considerable heat and cannot be placed close to the infant. Although this problem can be solved by attaching fiber optic blankets to the light source, it is not highly effective because of a limited exposure area.^{1,5} Due to these limitations, light-emitting diodes (LEDs) have recently been investigated as possible alternatives in phototherapy units. LEDs produce low heat so that they can be placed very close to the infant. The life span of LEDs is longer and their energy consumption is lower than that of the conventional light sources, which make them more cost-effective and also provide a narrow spectral band of monochromatic light with a special wavelength of 458 nm and high intensity, which overlaps the absorption spectrum of bilirubin.^{1,5}

This study therefore aims to compare the efficacy between phototherapy equipped with light emitting diode (LED) to compact fluorescent lamp (CFL) in the treatment of neonatal hyperbilirubinemia among late preterm and term (35 of gestation or more) healthy newborns manifesting with hyperbilirubinemia after two days of life.

METHODS

A hospital-based intervention study was conducted among 50 neonates in the neonatal intensive care unit (NICU) of a private medical college teaching hospital in Dakshina Kannada district from August to September 2016. Ethical committee clearance was obtained from the Institutional Ethics committee prior to the commencement of the study. Neonates born in the hospital during the study period, with gestational age more than equal to 35 weeks, being breastfed and healthy were included for the study. Sick and ill neonates requiring ventilator support, IV fluids, neonates with haemolytic /Rh incompatibility, requiring triple surface phototherapy or exchange transfusion were excluded from the current study. Among the included neonates, those looking icteric on clinical examination were subjected to baseline serum bilirubin estimation after written informed consent was obtained from the parents. Subjects with bilirubin level above the cut off level as laid by the American Academy of Paediatricians chart were randomly allocated to either receive CFL phototherapy or LED phototherapy. Relevant history and complete physical examination was performed for all the neonates. Serum bilirubin levels were checked at baseline and after 24 hours of phototherapy. The rate of decline of serum bilirubin and total duration of phototherapy was measured at frequent intervals and therapy was stopped

on achieving serum bilirubin levels below the cut off range. Rectal temperature also was recorded every 12 hours. Eye pads were used for protecting the eyes of all the study subjects.

The obtained data was entered in Microsoft excel and analysed using the latest licensed version of Statistical Package for Social Sciences (SPSS). Results were expressed in percentages. Tests of significance were used to determine the statistical significance between the groups and a p-value of < 0.05 was considered to be significant.

RESULTS

The study subjects were randomly allocated into two groups to either receive CFL or LED phototherapy. Each group consisted of 25 subjects with an almost similar gender representation.

Fifty six percent of the neonates receiving CFL therapy and 52% receiving LED therapy underwent normal vaginal delivery. The mean gestational age among the two groups was 39.25±1.24 weeks and 38.96±1.27 weeks respectively. Comparison between the two groups with respect to the above mentioned characters revealed no statistical significance establishing similarities in the group with respect to these characters thereby making them comparable, as seen in Table 1.

Table 1: Baseline characteristics of subjects (n = 50).

Characteristics	CFL n (%)	LED n (%)	P value
Gender			
Male	10 (40.0)	14 (56.0)	0.258
Female	15 (60.0)	11 (44.0)	
Type of delivery			
Normal vaginal	14 (56.0)	13 (52.0)	0.777
LSCS	11 (44.0)	12 (48.0)	
Gestational age			
≥38 weeks	21 (84.0)	20 (80.0)	1.00
>36 - <38 weeks	4 (16.0)	5 (20.0)	
Mean±SD	39.25±1.24	38.96±1.27	

Table 2 reveals that the mean bilirubin values (in mg/dl) among neonates in the CFL group and LED group were 14.8 and 15.6 respectively. This difference in the means was not statistically significant ensuring the comparability of the groups. Following 24 hours of phototherapy, the bilirubin values (in mg/dl) there was a reduction in the mean bilirubin values to 11.54 and 10.68 respectively. This difference was however statistically significant with the reduction being more in the group receiving LED therapy (0.022).

Temperature estimation (in 0F) before and after phototherapy revealed a slight increase in the rectal

temperature of the neonates in both the groups, but there was no statistical significance in the difference between the groups.

As shown in table 3, the comparison of the mean difference in the reduction in the bilirubin values before and after receiving phototherapy revealed a 3.29 mg% reduction in the bilirubin levels among the neonates belonging the CFL therapy group and 4.9 mg% reduction in the LED group. This difference in the reduction was highly statistically significant ($p < 0.001$) indicating the superiority of LED over CFL in the reduction in bilirubin levels in the specified duration of time (24 hours). The pictorial representation of the same is explained using error plots as shown in figure 1, depicting a greater reduction in the bilirubin among LED treated neonates in comparison to CFL treated with a highly statistical difference depicted by the non-overlapping of the confidence intervals. The overall mean increase in the axillary temperature of the neonates following CFL and LED therapy was 0.5 0F and 0.3 0F respectively. This difference in the increase in temperature was not significantly different further justifying the rationale for

use of LED than CFL in the treatment of hyperbilirubinemia.

Table 2: Mean Bilirubin and Temperature of intervention and control group (n=50).

Characteristics	Means \pm SD	P-value
Baseline Bilirubin values before therapy (in mg/dl)		
CFL phototherapy	14.82 \pm 1.34	0.052
LED therapy	15.61 \pm 1.29	
Bilirubin values after 24 hours (in mg/dl)		
CFL phototherapy	11.54 \pm 1.39	0.022*
LED therapy	10.68 \pm 1.61	
Absolute change in bilirubin values (in mg/dl)		
CFL phototherapy	14.35 \pm 1.30	0.029*
LED therapy	15.16 \pm 1.23	
Baseline temperature before therapy (in °F)		
CFL phototherapy	98.39 \pm 0.33	0.477
LED therapy	98.42 \pm 0.036	
Temperature after 24 hours (in °F)		
CFL phototherapy	98.89 \pm 0.48	0.177
LED therapy	98.70 \pm 0.49	

*statistically significant

Table 3: Mean difference in the bilirubin and temperature following therapy (n = 50).

Characteristics	Before therapy Means±SD	After therapy Means±SD	Mean difference	P value
Bilirubin values (in mg/dl)				
CFL phototherapy	14.82±1.34	11.54±1.39	3.29±1.1	< 0.001*
LED therapy	15.61±1.29	10.68±1.61	4.9±0.9	
Temperature				
CFL phototherapy	98.39±0.33	98.89±0.48	0.50±0.4	0.071
LED therapy	98.42±0.036	98.70±0.49	0.28±0.4	

*-statistically significant

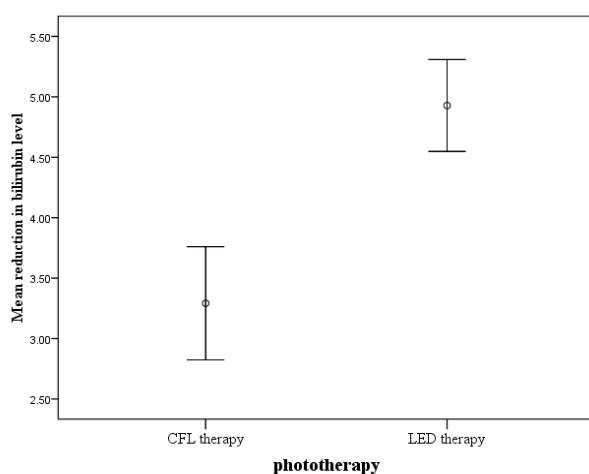


Figure 1: Error plots depicting mean reduction in the bilirubin levels (n = 50).

DISCUSSION

Phototherapy has been the treatment modality for hyperbilirubinemia since the late 1950s.⁶ The advent of newer and better types of phototherapy has increased the options to be used and with that the confusion as well. Many types of bulbs have been used for providing phototherapy from blue fluorescent bulbs in the late 50s to the current LED bulbs. All of them had their share of disadvantages ranging from heating issues, intensity problems to wavelength matching. The latest advancement is the usage of LED in all fields which is being marketed as a better, safer and more efficient option than the conventional methods.^{7,8}

This interventional study aimed to study the efficacy of LED in comparison to the frequently used CFL light used for provision of phototherapy to neonates. This hospital based study recruited fifty neonates and randomly

allocated them into two groups to receive either CFL therapy or LED therapy. The groups were similar with respect to characteristics like gender, gestational age and type of delivery thereby making the groups comparable with respect to those. Study by Yüksek YS et al and by Takcı S et al in Ankara, Turkey, reported similar results as the current study with no significant difference between the two groups.^{9,10} The groups when compared based on the baseline bilirubin estimated prior to and after phototherapy revealed a significant reduction in the bilirubin values. There was no statistically significant baseline difference in the total bilirubin values between the two groups indicating that any significant reduction might have been due to the phototherapy received.

This non-significant difference in the baseline total bilirubin values was also seen by Ekisariyaphorn R et al, Yüksek YS et al, Takcı S et al and Kumar P et al from Chandigarh.^{2,4,9,10} Following 24 hours of phototherapy, there was a statistically significant ($p = 0.02$) reduction in the bilirubin levels in the present study whereas none of the above mentioned studies showed a statistical significance in the reduction.⁵

This difference might be due to many confounding factors like the age, exact duration of phototherapy, physiological variations etc. This study has tried to assess the heating effect of continuous phototherapy resulting in hyperthermia in a neonate due to the intervention. Therefore, baseline and 24 hour axillary temperature was measured in both the groups. It was evidenced that there was 0.5 vs 0.2 °F increase in the temperature in the CFL vs. LED group respectively, but this difference was not statistically significant. This point towards the fact that there is a slight increase in temperature but the rise in temperature due to the use of LED was lower than the CFL usage even though the difference was not significant. Ekisariyaphorn R et al however found a statistically significant rise in the temperature among those neonates that received conventional (non LED) therapy substantiating the fact that temperature rise is higher among non LED used phototherapy than LED used one.⁴

To substantiate the fact that the significant reduction in the bilirubin level among LED phototherapy managed neonates in comparison to CFL managed was due to the intervention per se, the differences in the mean serum bilirubin between pre and post therapy was estimated which was highly statistically significant ($p < 0.001$) similar to the findings by Yüksek YS et al who reported a statistically significant ($p = 0.008$) difference in the means between the two groups.⁹

CONCLUSION

LED therapy is better than the CFL therapy in terms of mean reduction in the total serum bilirubin after a fixed duration of time and lesser raise in temperature among the neonates. This helps to position the source of therapy

closer to the neonate providing better irradiance and lesser side effects due to heating if LED is used. Moreover, the longer life span and lesser costs of LED bulbs make it an ideal choice for use for phototherapy

As this study was done among healthy late pre-term and term infants, it is difficult to generalize it to all neonates i.e. neonates with complications and other underlying disorders. This warrants further research regarding the changes and reactions than might play a role in determining the response to LED phototherapy to ensure the universality of usage of LED for the management of hyperbilirubinemia.

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