Research Article

DOI: http://dx.doi.org/10.18203/2349-3291.ijcp20162389

Comparison of gallium nitride derived light-emitting diodes and compact fluorescent lamp phototherapy units in management of neonatal hyperbilirubinemia

Pankaj Kumar Jain*, Surendra Meena, Kailash Meena

Department of Pediatrics, SMS Medical College, Jaipur, Rajasthan, India

Received: 05 June 2016 Accepted: 02 July 2016

*Correspondence: Dr. Pankaj Kumar Jain,

E-mail: Pankaj18us2001@yahoo.com

Copyright: © the author(s), publisher and licensee Medip Academy. This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial License, which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

ABSTRACT

Background: To compare efficacy of Gallium nitride derived light-emitting diodes (LED) phototherapy with special blue compact fluorescent lamp (CFL) phototherapy in management of neonatal hyperbilirubinemia in terms of rate of fall of serum bilirubin levels, required duration of phototherapy and to compare the incidences of clinically observable side effects between both groups.

Methods: A randomized prospective observational study was carried out at tertiary level of neonatal intensive care unit over a period of one year. Stable neonates of gestation >34 weeks with hyperbilirubinemia requiring phototherapy, were included. Sick babies, Rh iso-immunized babies, those who required and underwent exchange transfusion and whose parents refused for consent were excluded. Babies were enrolled on consecutive basis and after randomization were allocated to receive phototherapy by LED or CFL. CFL and LED were both special blue lights with irradiance maintained above 15 μ W/nm/cm2. Vital parameters and clinically observable side effect were recorded 12 hourly till phototherapy was stopped.

Results: 100 babies were enrolled in each group. Baseline characteristics, causes of jaundice, baseline haemoglobin and TSB were similar in both groups. Base line irradiance was more in LED group compare to CFL group (P=0.0006, highly significant). Rate of fall of serum bilirubin (p < 0.05) was more in LED group. Mean required duration of phototherapy (P=0.02) was less in LED group. Among side effects except Hypothermia, Other side effects were more common in CFL group (p > 0.05).

Conclusions: LED phototherapy is superior to CFL phototherapy in management of neonatal hyperbilirubinemia in terms of efficacy and side effects.

Keywords: Jaundice, Neonate, Phototherapy, Hyperbilirubinemia

INTRODUCTION

Jaundice is the most common abnormal physiological finding in infants during first week of life. Among hospital born neonates in India, 3% develop total serum bilirubin (TSB) levels more than 15 mg/dL.¹

Phototherapy is now the most preferred and standard method of treatment for neonatal hyperbilirubinemia by virtue of its non-invasive nature and its safety. The efficacy of phototherapy depends on the spectrum of light emitted, spectral irradiance delivered to surface of infant and the surface area exposed.² Fever, loose stools, rashes, dehydration are common clinically observable side effect of phototherapy.³

Over the last 2 decades, there has been a constant efforts to develop ways to increase the efficacy of phototherapy and at the same time reduce the side-effects. Since long special blue standard length tube lights (STL) phototherapy and special blue compact fluorescent lamp (CFL) phototherapy equipment's are used in most neonatal units for management of neonatal hyperbilirubinemia. In last couple of years, blue Gallium

nitride derived LEDs have been introduced in India, which are claimed to be better than STLs and CFLs. The manufacturers of LED phototherapy units claims faster decline of Serum Bilirubin levels in icteric neonates and shortens the duration of hospital stay of neonates.

These unique characteristics of LEDs make them an attractive light source for the optimal phototherapy unit. Although LED devices have been shown to be effective than any other phototherapy device in in vitro studies, but the clinical data comparing LEDs with CFL and conventional phototherapy units are limited⁴⁻⁹. So this study was planned to find out clinical efficacy of LED phototherapy units in management of neonatal jaundice in reference to better results and lesser side effects in comparison to CFL phototherapy units.

METHODS

The study was conducted in tertiary neonatal units under S.M.S medical college, Jaipur in new-born admitted for neonatal hyperbilirubinemia in phototherapy range as per AAP charts 2004.2 A total 200 'stable' neonates of gestation more than 34 weeks age hyperbilirubinemia requiring phototherapy (as per AAP guidelines) were enrolled for the study after taking written consent from parents/legal guardians. For the purpose of study, "stable neonate" was defined as "an active baby exclusively on oral feeds with normal vital parameters". Sick babies, Rh iso-immunized babies, those who requiring and already had undergone exchange transfusion and whose parents refused for consent were excluded. These neonates were enrolled on consecutive basis and divided randomly in two treatment groups A&B. Group A included 100 neonates (>34 week), were managed with blue light emitting diode (LED) phototherapy units. Group B included 100 neonates (>34 week), were managed with special blue compact fluorescent lamp (CFL) phototherapy units. Babies who underwent exchange transfusion were replaced by new baby in same group.

The light emitting diode (LED) phototherapy units used in our neonatal unit were supplied by BIRD MEDITECH, Mumbai comprise of 9 special blue gallium nitride light emitting diode bulb (12w, operational voltage100-250Ac, 50Hz), emit blue light in 450-470nm (peak absorb wave 458nm) with irradiance of >25μw/cm²/nm. It has wide effective area, long life (20,000 hour), do not emit infrared radiation. Special blue compact fluorescent lamp (CFL) phototherapy units used were supplied by Bird Meditech Mumbai, India comprised of 4 special blue CFL's (Philips PL-L 18w/52/4p, made in Poland) and 2 white CFL's (Osram Dulux L 18W/865 FPL 18E D, made in Korea) mounted on metal frame with adjustable heights. The lamps were covered by special transparent sheet that focuses and prevent scattering of light.

After inclusion, information was collected and recorded with respect to demographic characteristics and causes of

jaundice. Serum bilirubin concentration was measured just before the commencement of phototherapy (0 hours) and then every 24 hours. Before starting phototherapy on each subject, the spectral irradiance was checked for both type of phototherapy unit by photo radiometer. Our target was to maintain irradiance above 15µW/cm2/nm at all times and tubes/lamps were replaced whenever necessary, to maintain this irradiance. Both type of phototherapy units were adjusted at same height (25 cm). All infants were kept unclothed under phototherapy but genitalia and eyes were covered. All the new-born in study were managed with single surface continuous phototherapy and removed from under the light only for feeding, changing and blood sampling. All babies were examined thoroughly daily and monitored every 12 hourly for vitals, weight, urine output, temperature, clinical jaundice, development of rashes, number of stools and sign of dehydration. Phototherapy was discontinued after falling total serum bilirubin level less than photo range (as per AAP charts).

Statistical analysis

All data collected were entered in excel sheet to prepare master chart. Qualitative data were summarized as percentage and quantitive data were summarized as mean(s) and standard deviation(s).

Chi-square (\times^2) test was used to find out the significance of difference between proportions & percentages. While unpaired 't' test was used to find out significance of difference between two means. 'P' value less than 0.05 (<0.05) was taken as significant difference.

RESULTS

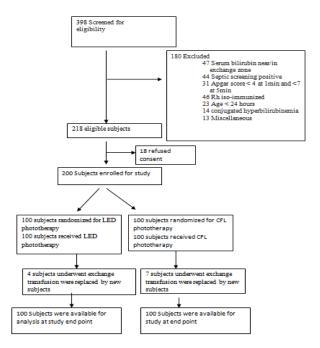


Figure 1: Trial flow.

Table 1: Baseline information.

Parameters	Group A (N-100) (%)	Group B (N-100) (%)	P value	
Males	44 (44)	47(47)]	
Females	56(56)	53(53)	0.607	
Mean gestation age (weeks)	38.48	38.42	0.846	
Preterm babies	38	39	1.000	
Mean birth weight (kg)	2.56	2.54	0.834	
Mean age of onset of jaundice (hrs)	69.28	69.25	>0.05	
Normal vaginal delivery	51(51)	55(55)	0.471	
LSCS	49(49)	45(45)		
Breast feed	83(83)	81(81)]	
Top feed	17(17)	19(19)	0.743	
Cephalohematoma	11(11)	14(14)		
Oxytocin	13 (13)	17 (17)	11.000	
Cephalohematoma+ Oxytocin	1	1] 1.000	
ABO incompatibility	39 (38)	38 (38)	0.884	
Hemolysis on peripheral smear	0	0		
Baseline irradiance in (μW/nm/cm2 (mean ± SD)	48.91± 9.24	40.63±8.03	0.0006	
Baseline TSB in mg/dL (mean ± SD)	16.79 ± 1.65	16.78 ± 1.81	0.9772	
Base line hemoglobin in g/dl (mean ± SD)	16.21 ± 1.95	16.19±1.79	0.528	

Of 398 babies with gestation more than 34 weeks who received photo-therapy, 200 babies, who satisfied the eligibility criteria after excluding those whose parents refused for consent were included in study on consecutive basis after randomization.

Base lines variables like sex, preterm babies, gestation age, birth weight, age of onset of jaundice, mode of feeding, mode of delivery, oxytocin used during delivery, cephalohematoma, ABO incompatibility, base line hemoglobin and baseline serum bilirubin levels were comparable in both groups (P>0.05). But base line irradiance were significantly more in LED group compare to CFL group [P=0.0006(HS)] (Table 1).

Outcome variable like fall of serum bilirubin in 1st 24 hours (p=0.0091), per hour rate of fall of serum bilirubin (p=0.009) were significantly more in LED group compare to CFL group and required duration phototherapy (p=0.023) was significantly less in LED group (Table 2).

We compared fall in serum bilirubin in 1st 24 hours only because number of babies available in subsequent analysis reduced significantly and this would make analysis unbalanced.

Table 2: Outcome variables.

Parameters	LED group (N-100)	CFL group (N-100)	P value
Mean serum bilirubin fall in 1 st 24 hours in mg/day (mean±sd)	3.07±1.82	2.45±1.65	0.0091
Mean per hour fall in serum bilirubin in mg/dl/hr (mean±sd)	0.127±.075	0.101±.068	0.009
Duration of phototherapy in hours (mean±sd)	33.83±12.82	38.35±14.96	0.023

Table 3: Distribution of clinically observable side effects.

Adverse effects	CFL (N	CFL (N=100)		LED (N=100)	Total (n=200)		Chi aguana	(m² voluo
	No.	%	No.	%	No.	%	Chi-square	'p' value
Dehydration	8	8	2	2	10	5	2.63	0.1048
Fever	24	24	1	1	25	12.5	22.12	0.0000
Loose Motion	14	14	4	4	18	9	4.94	0.0262
Rashes	17	17	4	4	21	10.5	7.66	0.0056
Hypothermia	1	1	10	10	11	5.5	8.53	0.0035

In present study among 200 neonates commonest adverse effect was Fever in 25 (12.5%), less common were Rash in 21 (10.5%) and Mild diarrhoea in 18 (9%), least common was dehydration 10 (5%) and Hypothermia in 11(5.5%). Side effects were significantly (<0.05) less in LED group except hypothermia which was significantly (p value=0.0035) more in LED group than CFL group

(Table 3). All these side effects were benign and mild in nature.

DISCUSSION

In our study we included stable and healthy neonates of more than 34 completed weeks of gestation age, suffering from neonatal hyperbilirubinemia, requiring phototherapy that developed jaundice between 2nd-7th days, so that the outcome would not be influenced by co-morbidity.

To compare the efficacy of 2 modes of phototherapy, it is essential that the baseline TSB values be comparable, because the rate of hourly decline of TSB is greater at high baseline TSB levels.⁵

In our study, baseline TSB values were almost comparable with only marginal difference that would not affect outcome significantly. Base line irradiance were significantly more in LED group compare to CFL group (P=0.0006).

In similar study by Kumar et al, they reported mean baseline photo irradiation in CFL $28.7\pm2.7~\mu\text{W/cm}^2/\text{nm}$ and mean baseline photo irradiation in LED $47.0\pm3.3~\mu\text{W/cm}^2/\text{nm}$ at distance of 30 cm (p value<0.001).

In the present study the mean fall in serum bilirubin in 1st 24 hours of phototherapy was found more statistically significant in LED phototherapy group as compare to CFL phototherapy group (p=0.009).

Similarly study of Kargol BS et al comparing efficacy of LED phototherapy with conventional phototherapy shows that absolute fall of serum bilirubin after 24 hour of phototherapy in LED group was significantly higher than in conventional phototherapy group. In their study photo irradiance in LED group was $35\mu W/cm^2/nm$ and in conventional phototherapy group was $10\text{-}15~\mu W/cm^2/nm$ which shows that with increase in photo irradiance the rate of serum bilirubin increases as we found in our study.

The studies of Martins et al adjusted the devices to obtain a similar exposed surface area, but high irradiance in LED group $(37\pm9\mu\text{w/cm}^2/\text{nm} \text{ vs. } 21\pm6\mu\text{w/cm}^2/\text{nm})$ resulted in better efficacy with LED units.⁶

In our study the absolute rate of fall in serum bilirubin after phototherapy was significantly more in LED group compare to CFL group (p=.022). In study of Maisels et al rate of fall after phototherapy in Blue fluorescent tube group was 0.35±0.25 mg/dl/hr and in LED group was 0.27±0.25 mg/dl/hr (p value=0.20). In their study mean per hour fall of serum bilirubin (absolute fall rate) of phototherapy in both groups was statistically not significant probably because they used similar photo irradiance by adjusting distance. Similarly in study of Seidman DS et al LED was found as effective as conventional phototherapy unit because they also used similar photo irradiance by adjusting distance.^{8,9} These study strengthen the point that when intensity of light will increase, efficacy of phototherapy unit will also improve as in our study.

In study of Kargol BS et al comparing efficacy of LED phototherapy with conventional phototherapy shows the absolute fall of serum bilirubin phototherapy was higher

in LED group $(0.30\pm0.2~\text{mg/dl/hr})$ compare to conventional phototherapy group ($0.13\pm0.1~\text{mg/dl/hr})$ (p value=0.003). It was due to higher photo-irradiance in LED group.

In similar study by Kumar et al, they reported mean rate of fall in CFL was 0.19 ± 0.14 mg/dl/hr and in LED group it was 0.19 ± 0.13 mg/dl/hr at distance of 30 cm, difference was not significant.(p value>0.05). So according to their study CFL and LED were equally effective in terms of reduction rate of bilirubin.

In our study, Mean duration of phototherapy required in LED group was significantly less compared to CFL group as 'p' value (p=0.023) was significant. Only single similar study carried out by Kumar et al (2010) reported almost same duration in both CFL and LED group (P=0.44) and at any time point similar proportion of neonates were under phototherapy in both group.

Most of side effects appears significantly more in CFL groups compare to LED group except mild dehydration which had no significant difference in both group (p value=0.104). Hypothermia was highly significantly more in LED group (p value=0.003). This difference in side effects in CFL and LED group appears due to infrared and UV light generated in CFL group which produce heat, responsible for more adverse effect compare to LED group which was free from these light.

The initial cost of the LED equipment and the recurring cost of the LED lamps were higher than CFL equipment's. We did not record the useful life-span of each type of lamp, and hence we cannot comment on the per hour cost efficiency of LED versus CFL lamps.

CONCLUSION

We concluded that LED phototherapy is superior to CFL phototherapy in management of neonatal hyperbilirubinemia in terms of efficacy and side effects.

Funding: No funding sources Conflict of interest: None declared

Ethical approval: The study was approved by the

Institutional Ethics Committee

REFERENCES

- National Neonatology Forum of India. National Neonatal Perinatal Database Network. Report 2002-2003. New Delhi: 2004.
- American Academy of Pediatrics. Clinical practice guidelines subcommittee on hyperbilirubinaemia. Management of hyperbilirubinaemia in the newborn infant 35 or more week of gestation. Pediatrics. 2004;114(1):297-316.
- 3. Drew JH, Marriage KJ, Bayle VV, Bajraszewski E, Namara JM. Phototherapy: Short and long term complications. Arch Dis Child. 1976;51:454-6.

- 4. Kumar P, Murki S, Malik GK, Chawla D, deorari AK, Karthi N, et al. Light-emitting diodes versus compact fluorescent tubes for phototherapy in neonatal jaundice: A multi-center randomized controlled trial. Indian Pediatrics. 2010;47:131-7.
- 5. Karagöl BS, Erdeve O, Atasay B, Arsan S. Efficacy of light emitting diode phototherapy in comparison to conventional phototherapy In neonatal jaundice Journal of Ankara University Faculty of Medicine. 2007;60(1):31-4.
- 6. Martins BM, De Carvalho M, Moreira ME, Lopes JM. Efficacy of new micro processed phototherapy system with five high intensity light emitting diodes (Super LEDs). J Pediatr Rio J. 2007;83:253-8.
- 7. Maisels MJ, Kring EA, DeRidder J. Randomized controlled trial of light-emitting diode phototherapy. J Perinatol. 2007;27(9):565-7.

- 8. Seidman DS, Moise J, Ergaz Z, Laor A, Vreman HJ, Stevenson DK, Gale R A new blue light-emitting phototherapy device: a prospective randomized controlled study. J Pediatrics. 2000;136(6):771-4.
- 9. Seidman DS, Moise J, Ergaz Z, Laor A, Vreman HJ, Stevenson DK, et al. A prospective randomized controlled study of phototherapy using blue and blue-green light-emitting devices, and conventional halogen-quartz phototherapy. J Perinatol. 2003;23(2):123-7.

Cite this article as: Jain PK, Meena S, Meena K. Comparison of gallium nitride derived light-emitting diodes and compact fluorescent lamp phototherapy units in management of neonatal hyperbilirubinemia. Int J Contemp Pediatr 2016;3:1045-9.