Original Article

Comparison of Risks and Benefits of Light-Emitting Diode and Compact Fluorescent Light Phototherapies in Reducing Hyperbilirubinemia in Neonates

Dr. Kodepelli Manisha[1], Mangalarapu Niharika[2], Nathari Sri Harsha[2], Neha Fathima[2], Oddam Swapna[2]

1. Assistant Professor, Department of Clinical, 2. Department of Pharmacy Practice,

Vaageswari College of Pharmacy, (Affiliated to JNTU Hyderabad), Beside LMD police station, Ramakrishna colony, Karimnagar, Telangana, India-505481

***Corresponding author's E-mail:** maneeshakodipell@gmail.com

Received: 05-11-2024; **Revised:** 27-01-2025; **Accepted:** 11-02-2025; **Published online:** 20-02-2025.

ABSTRACT

Neonatal jaundice, resulting from elevated total serum Bilirubin (TSB) levels, can lead to severe complications, including irreversible Bilirubin encephalopathy if left untreated. This study aimed to assess the comparative efficacy, safety, and cost-effectiveness of Compact Fluorescent Light (CFL) and light-emitting diode (LED) phototherapy for managing neonatal hyperbilirubinemia. A randomized, cross-sectional analysis was conducted over six months, involving 504 neonates (230 males, 274 females), with 193 treated with CFL and 311 with LED phototherapy. Both treatments significantly reduced TSB levels (CFL: 9.17 ± 1.06 mg/dL, LED: 9.05 ± 1.38 mg/dL). The results indicated that CFL phototherapy was associated with a shorter duration of hospital stay, although it presented a higher incidence of side effects compared to LED therapy. Notably, CFL phototherapy emerged as a cost-effective alternative to LED phototherapy, offering the advantage of reducing hospital stay length despite a greater frequency of adverse reactions. The findings suggest that CFL phototherapy could be a viable treatment option for neonatal jaundice, balancing cost-effectiveness with clinical outcomes, while cautioning against the higher potential for side effects. Further studies are needed to explore the long-term safety and optimal use of CFL in neonatal care.

Keywords: Compact Fluorescent Light, Light-Emitting Diode, Total Serum Bilirubin, Hyperbilirubinemia, Neonates, Phototherapy.

INTRODUCTION

Neonatal jaundice, marked through increased total serum Bilirubin (TSB) ranges, is one of the most normal conditions affecting newborns worldwide, impacting approximately 60% of term and 80% of preterm neonates[1]. The situation usually arises from the immaturity of the neonatal liver, which leads to insufficient conjugation and excretion of Bilirubin. If left untreated, this accumulation of Bilirubin can cause severe complications, inclusive of Bilirubin encephalopathy and kernicterus, resulting in irreversible neurodevelopmental impairments[2]. Timely intervention with phototherapy has been demonstrated to be the only remedy for neonatal hyperbilirubinemia. This remedy helps the photoisomerization of Bilirubin into water-soluble isomers that are easily excreted[3]. Globally, neonatal jaundice locations have a full-size burden on healthcare systems, especially in low- and middle-earnings nations (LMICs) wherein sources are limited. The maximum occurrence is reported in Africa, with 667. Eight instances in step with 10,000 stay births, followed by Southeast Asia with 251. Three cases are consistent with 10,000 stay births[4].

In South Asia, neonatal jaundice is the seventh leading reason of neonatal mortality, accountable for 1,309.3 deaths in keeping with 100,000 stay births[5]. In India, the situation influences about 55.2% of newborns, with 19% requiring phototherapy and an extra 10.4% probably making the most of treatment[6]. Addressing this high occurrence and burden necessitates the optimization of phototherapy practices. Compact Fluorescent Lamps (CFLs) and mild-emitting diodes (LEDs) are widely used phototherapy modalities. LEDs are increasingly favored due to their superior power performance, longer operational life, and lower warmth era than CFLs.

However, proof evaluating the efficacy, value-effectiveness, and safety of those modalities stays restricted, mainly in LMICs[7]. This has a look at aims to bridge this hole by providing a complete evaluation of CFL and LED phototherapy in coping with neonatal jaundice. This study aims to systematically compare the dangers and benefits of CFL and LED phototherapy in decreasing jaundice among neonates.

The targets of the examiner are as follows:

- **Primary Objectives**

1. To evaluate the length of phototherapy required for CFL and LED devices (in hours).

2. To evaluate the serum Bilirubin discount charges finished with the aid of every modality (mg/dL).

- **Secondary Objectives:**

1. To examine the duration of medical institution life associated with each phototherapy method (in days).

2. To evaluate the price-effectiveness of CFL and LED phototherapy.

3. Analyze unfavorable reactions, such as pores and skin rashes, burns, dehydration, diarrhea, and hypo- or hyperthermia.

Need for the Study

Globally, neonatal jaundice is a major challenge, in particular in useful resource-limited settings. Effective phototherapy strategies are critical for decreasing morbidity and mortality. Despite the giant use of each CFL and LED device, restricted comparative statistics exist on key metrics which include sanatorium stay period and side impact profiles.

MATERIALS AND METHODS

Study Design and Setting

This look became a randomized managed trial performed at more than one healthcare facility in Karimnagar, such as Chalmeda Ananda Rao Institute of Medical Sciences, MathaShishu Hospital, and personal hospitals which include STAR, RBR, SANDEEP, and HOPE Children's Hospital.

The studies spanned six months, from August 2023 to January 2024.

Sample Size and Sampling

A total of 504 neonates with sizeable hyperbilirubinemia requiring phototherapy had been protected, with the pattern length calculated with the use of IBM SPSS statistical software (model 29.0). Stratified random sampling becomes hired to ensure a consultant cohort.

Inclusion Criteria:

1. Neonates with total serum Bilirubin (TSB) stages meet the American Academy of Pediatrics (AAP) guidelines for starting phototherapy.

2. Neonates are eligible for discontinuation of phototherapy whilst TSB degrees drop underneath 10 mg/dL and 12 mg/dL, as in line with AAP recommendations.

Exclusion Criteria

1. Neonates who had received previous phototherapy.

2. Neonates with TSB ranges require trade transfusion in keeping with the AAP nomogram.

3. Neonates necessitate different types of medical intervention past phototherapy.

Study Parameters:

The study evaluated:

1. Demographic details of neonates.

2. Reduction in TSB levels at some stage in remedy.

3. Duration of phototherapy in hours.

4. Cost-effectiveness of phototherapy methods.

5. Adverse outcomes consist of skin rashes, burns, dehydration, diarrhea, and hypo- or hyperthermia.

Data Collection and Documentation

Clinical facts were gathered through the usage of standardized forms via interactions with patient representatives and overview of scientific records. Information on the phototherapy type, dosage, and period becomes meticulously recorded. Preliminary phytochemical evaluation is no longer relevant because of the scientific nature of this have a look at.

Statistical Methods

Data had been analyzed using SPSS (model 29.0). Quantitative variables, inclusive of TSB stages and length of phototherapy, had been expressed as suggested ± trendy deviation. Qualitative variables, like the occurrence of aspect results, have been mentioned as frequencies and probabilities.

A one-way ANOVA was employed to evaluate groups, with a p-value < 0.05 taken into consideration as statistically huge. Stratification based on gestational age, gender, and birth weight become executed to address ability confounding factors.

Level of Significance

The statistical importance threshold became set at a p-cost of 0.05. This rigorous methodology guarantees the repeatability of the test and the reliability of the findings. For future applicability, raw treatment formulations and patient-unique variables have been archived for comprehensive evaluation. This framework helps the reproducibility of clinical outcomes across different healthcare settings.

Ethical Considerations

Ethics approval was received from the institutional ethics committee. Written consent was secured from guardians.

RESULTS

They have a look at revealed vast findings comparing Compact Fluorescent Light (CFL) and Light-Emitting Diode (LED) phototherapy for neonatal jaundice. Demographically, both agencies had been similar in gender distribution, but the CFL institution had a drastically better gestational age (37.04±1.48 weeks vs. 36. Sixty nine±1.Ninety weeks; p=0.01). Both therapies efficiently decreased general serum Bilirubin (TSB) degrees, with comparable put up-treatment values (CFL: nine.17±1.06 mg/dL; LED: nine.05±1.38 mg/dL; p<0.001). The CFL organization validated a significantly shorter mean health facility life (2.39±1. Seventy eight days vs. Three.59±1. Ninety four days; p<0.001), doubtlessly presenting faster healing. Cost-performance records indicated higher expenses for LED phototherapy, even though the distinction turned no longer statistically substantial (p=zero.731). CFL phototherapy predominantly used multi-surface remedy setups, even as LED relied closely on DSPT+SSPT configurations (p<0.001). Regarding safety, CFL confirmed a better incidence of hyperthermia (14.68% vs. 7.53%; (P<0.001). Even as LED had better occurrences of vomiting and dehydration. Both agencies experienced similar charges of skin rash and eye discharge. These outcomes highlight that whilst both methods are effective in Bilirubin

reduction, CFL gives blessings in terms of shorter sanatorium remains and price, with a better but possible occurrence of positive aspect effects.

Table 1: Demographic Data

Demographic Parameters	CFL Group (n=193)	LED Group (n=311)	p-Value
Male	91 (47%)	139 (44%)	- 0.01
Female	102 (52%)	172 (54%)	
Gestational Age (weeks)	37.04±1.48	36.69±1.90	

The demographic parameters among the CFL and LED companies have been comparable in terms of gender distribution, with forty percent adult males and 52% females within the CFL institution, forty-four adult males, and 54% ladies within the LED institution. However, giant differences were determined in gestational age, with the CFL group having an average gestational age of 37.04 weeks ± 1.48, even as the LED group had a barely lower implied gestational age of 36.69 weeks ± 1.90 (p = 0.01), indicating a statistically sizeable variance among the two corporations.

Table 2: Total Serum Bilirubin Levels in mg/dl

TSB Levels	CFL	LED	P-Value
Before Phototherapy	15.37±2.97	15.34±3.05	<0.001
After Phototherapy	9.17±1.06	9.05±1.38	

The table illustrates Total Serum Bilirubin (TSB) degrees earlier than and after phototherapy for CFL and LED companies, with associated p-values. Before phototherapy, both CFL and LED businesses displayed comparable TSB degrees (CFL: 15.37±2.97, LED: 15.34±three.05), with a rather significant p-cost of <0.001. Post-phototherapy, TSB ranges were substantially reduced in both agencies (CFL: nine.17±1.06, LED: nine.05±1.38), indicating the effectiveness of phototherapy in reducing Bilirubin ranges.

Table 3: Total Body Weight in Kgs

Body Weight	CFL	LED	P-Value
Before Phototherapy	2.68±0.39	2.59±0.44	0.063
After Phototherapy	2.47±0.39	2.39±0.43	0.079

The table offers body weight facts for CFL and LED agencies earlier than and after phototherapy, in conjunction with corresponding p-values. Before phototherapy, CFL and LED businesses had implied weights of 2.68±0.39 and a couple of (59 ±0.44), respectively, with a p-value of 0.063. Following phototherapy, both businesses experienced discounts in body weight, averaging 2.47±zero.39 and a couple of.39±zero. Forty-three, respectively, with a p-cost of 0.079.

The desk outlines the suggested period of health center remains for patients treated with CFL and LED phototherapy. The CFL institution exhibited a substantially shorter hospital life, with an average period of 2.39 days (±1.78), compared to the LED organization's implication of 3.59 days (±1.94), indicating a big distinction (p < zero.001). This indicates that CFL phototherapy may additionally make a contribution to expedited recovery and doubtlessly lower healthcare costs related to neonatal jaundice management compared to LED phototherapy.

Table 4: Mean Duration of Hospital Stay

Variables	CFL	LED	P-Value
Mean Duration of hospital stay (Days)	2.39±1.78	3.59±1.94	<0.001

Table 5: Cost-Effectiveness for Each Phototherapy

Variables	CFL	LED	P-Value
Mean Duration of hospital stay (Days)	2.39±1.78	3.59±1.94	<0.001

The desk outlines the value-efficiency assessment between CFL and LED agencies, in conjunction with related p-values. CFL is well-known and shows a value-efficiency of 658. Eightyfour±953.0 gadgets, at the same time as LED demonstrate a drastically better value-efficiency of 2917.09±904.77 units, with a p-value of zero.731. This indicates that LED lighting structures might be extra price-efficient in comparison to CFL options, no matter the non-extensive difference indicated with the aid of the p-price.

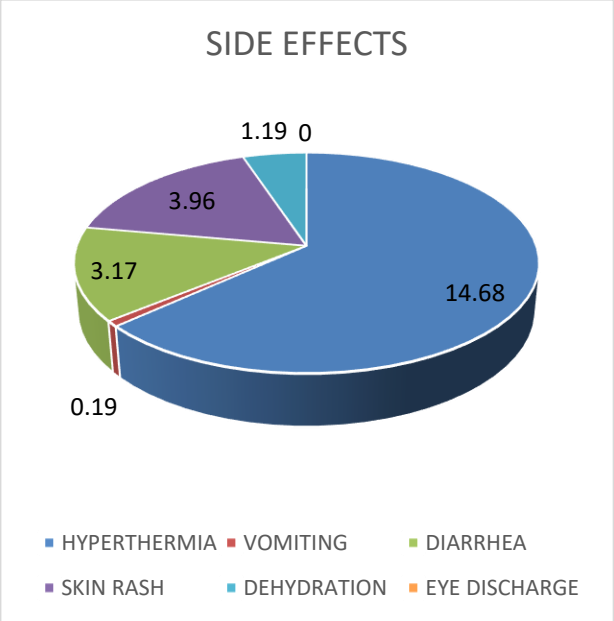
Table 6: Type of Surface Used in Phototherapy

Type of Surface	CFL (3.68±1.98)	LED (5.56±1.85)	P-Value
TSPT+DSPT+SSPT	9 (4.6%)	5(1.56%)	<0.001
TSPT+DSPT	3(1.56%)	1(0.52%)	
DSPT+SSPT	47(24.4%)	166(59.0%)	
TSPT	4(2.08%)	0(0%)	
DSPT	23(11.9%)	27(9.60%)	
SSPT	106(55.2%)	82(29.18%)	

The table outlines the distribution of surface types used in phototherapy, comparing CFL and LED organizations. CFL remedy predominantly utilized TSPT+DSPT+SSPT (4.6%) and DSPT+SSPT (24.4%) configurations, at the same time as LED treatment favored DSPT+SSPT (59.0%) setups. Significant differences were found in surface kind distribution among the two agencies (p < 0.001). These findings underscore versions in treatment modalities, probably influencing the efficacy and results of phototherapy for neonatal jaundice.

Table 7: Side Effects Profile -CFL & LED Devices

Side Effects	CFL (1.676±2.192)	LED (1.577±2.183)	P-Value
Hyperthermia	74 (14.68%)	38(7.53%)	<0.001
Vomiting	1(0.19%)	13(2.57%)	0.014
Diarrhea	16(3.17%)	13(2.57%)	0.043
Skin rash	20(3.96%)	22(4.36%)	0.212
Dehydration	6(1.19%)	21(4.16%)	0.080
Eye discharge	0 (0%)	2 (0.39%)	0.240



DISCUSSION

Effective control of neonatal jaundice requires strong comparative facts on phototherapy modalities. This examination affords insights into the demographic, medical, and economic components of Compact Fluorescent Light (CFL) and Light-Emitting Diode (LED) phototherapy in lowering serum Bilirubin ranges. The demographic analysis found out similar gender distribution between the CFL and LED businesses. However, the CFL organization had a notably higher suggested gestational age (37.04±1.48 weeks vs. 36. Sixty nine±1.Ninety weeks; p=zero.01). This difference aligns with observations by way of Swain et al., who emphasized the function of gestational maturity in influencing phototherapy outcomes[1]. Further assisting this, Mohammadizadeh et al. highlighted that preterm neonates regularly require tailor-made phototherapy due to immature Bilirubin clearance mechanisms[2]. This finding underscores the need for individualized remedy techniques based totally on demographic parameters. Both CFL and LED phototherapy successfully reduced TSB degrees publish-remedy, reaching similar efficacy (CFL: 9.17±1.06 mg/dL; LED: 9.05±1.38 mg/dL; p<0.001).

Khunte et al. corroborate this remark, reporting no great differences in Bilirubin reduction rates between these two modalities[3]. Mani et al. Also concluded that even as both gadgets are efficacious, the selection may additionally rely upon aid availability and clinical settings[4]. These constant findings validate the equivalence of CFL and LED phototherapy in coping with neonatal hyperbilirubinemia. Minimal weight loss changes into found in each business put up-phototherapy, with no large variations (p=0.079). Weight loss throughout phototherapy is commonly attributed to multiple insensible water loss and metabolic demands, as cited by way of Kumar et al.[5]. Onianwa et al. additionally located comparable trends, emphasizing the need for meticulous hydration control in neonates undergoing phototherapy[6]. This highlights the significance of supportive care at some point in phototherapy to minimize unfavorable consequences.

The CFL group exhibited a shorter sanatorium life (2.39±1.78 days) in comparison to the LED group (3.59±1.94 days; p <0.001) Outcomes. The CFL institution exhibited a shorter medical institution stay (2.39±1.Seventy eight days) in comparison to the LED organization (three.59±1.Ninety four days; p<0.001). Reddy et al. Attributed similar findings to the better warmness output of CFL gadgets, which might also accelerate Bilirubin breakdown[7]. However, Mani et al. Argued that the longer hospital stay related to LED phototherapy may be offset with the aid of its lower incidence of damaging effects[4]. These contrasting results highlight the trade-offs between faster healing and safety considerations in phototherapy. Although CFL phototherapy changed into less expensive (658). Eighty four±953. Zero devices) in comparison to LED (2917.09±904. Seventy seven gadgets), the value difference became no longer statistically widespread (p=0.731). Onianwa et al. In addition determined that even as CFL devices have lower advanced costs, LEDs may offer more long-term cost efficiency due to decreased electricity intake and protection requirements[6]. This suggests that economic concerns have to factor into device selection, mainly in resource-limited settings.

The CFL group predominantly applied TSPT+DSPT+SSPT (4.6%) and DSPT+SSPT (24.4%) configurations, whilst the LED organization favored DSPT+SSPT setups (fifty-nine. 0%). Onianwa et al. mentioned that multi-surface phototherapy setups improve Bilirubin discount using growing mild exposure[6]. Khunte et al. additionally, emphasized that floor-kind versions affect the efficacy of phototherapy[3]. These findings suggest that the configuration of the phototherapy tool is an important aspect in optimizing remedy consequences. Hyperthermia was drastically more frequent inside the CFL organization (14.68 t%) in comparison to the LED institution (7. Fifty three %; p<0.001), steady with findings by using Swain et al., who attributed this to the higher warmth output of CFL devices[1]. However, LED phototherapy confirmed barely higher fees of vomiting and dehydration, possibly due to its prolonged utilization time. Onianwa et al. Highlighted that at the same time as CFL gadgets may additionally cause more thermal-related facet consequences, LED gadgets are associated with gastrointestinal disturbances[6]. These findings emphasize the need for careful tracking of unfavorable results all through phototherapy.

CONCLUSION

This examination highlights the comparative efficacy, safety, and value-effectiveness of Compact Fluorescent Light (CFL) and light-emitting diode (LED) phototherapy in coping with neonatal hyperbilirubinemia. Both modalities successfully decreased total serum Bilirubin (TSB) tiers, achieving a post-treatment way of 9.17±1.06 mg/dL (CFL) and 9.05±1.38 mg/dL (LED), demonstrating their scientific software. The CFL group exhibited a shorter implied clinic stay of 2.39±1.Seventy-eight days in comparison to a

few.59±1.Ninety-four days for the LED organization (p<0.001), suggesting quicker recuperation with CFL therapy. Cost evaluation discovered a decrease suggest fees associated with CFL phototherapy (658.Eighty four±953.Zero units) compared to LED (2917.09±904.Seventy seven gadgets), even though this distinction becomes no longer statistically large (p=0.731).

Adverse events had been greater frequent with CFL therapy, with hyperthermia going on in 14.68% of cases as opposed to 7.53% in the LED group (p <0.001).

Conversely, the LED institution had barely higher occurrences of vomiting (2.Fifty seven% vs. Zero.19%; p=zero.014) and dehydration (four.16% vs. 1.19%; p=0.080), which have been not vast but clinically incredible. Multi-floor phototherapy configurations (DSPT+SSPT) had been more commonplace with LED therapy (59.0%) in comparison to CFL (24.4%; p<0.001), Emphasizing their function in remedy efficacy. Additionally, both gadgets tested the minimum effect on neonatal weight, with reductions of zero.21 kg (CFL) and 0.20 kg (LED) publish-treatment.

These findings underscore the medical versatility of each device, with CFL imparting quicker recovery and lower advance charges, and LED providing greater safety and capability long-time period value savings. A tailored technique primarily based on hospital resources, clinical needs, and patient demographics is crucial for optimizing phototherapy consequences. Future studies using non-invasive Bilirubin monitoring and larger pattern sizes are advocated to in addition validate these observations.

Limitations

This takes a look at invasive Bilirubin measurements. Future research may want to gain from non-invasive tracking to provide more frequent statistics points.

Source of Support: The author(s) received no financial support for the research, authorship, and/or publication of this article

Conflict of Interest: The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

REFERENCES

1. Swain N, Nayak MK, Sahoo JP, Panda SK, Rath S. Comparison of Effectiveness of Light Emitting Diode (LED) versus Compact Fluorescent Light (CFL) Phototherapy in Neonatal Hyperbilirubinemia. 2023.
2. Mohammadizadeh M, Eliadarani FK, Badiei Z. Is the light-emitting diode a better light source than the fluorescent tube for phototherapy of neonatal jaundice in preterm infants? Advanced Biomedical Research. 2012 Jan 1;1(1):51-58.
3. Widhiastuti E. Light-emitting diode phototherapy for neonatal hyperbilirubinemia: A literature review. Holistik Jurnal Kesehatan. 2024 Feb 26;17(9):817-26.
4. MANI S, PANNEERSELVAM K, RANGARAJ S, RAMRAJ B, SUNDAR S. Effects of Different Types of Phototherapy Units on Neonatal Jaundice: A Cross-sectional Study. Journal of Clinical & Diagnostic Research. 2022 Jun 1;16(6):50-56.
5. Kumar P, Murki S, Malik GK, Chawla D, Deorari AK, Karthi N, Subramanian S, Sravanthi J, Gaddam P, Singh SN. Light-emitting diodes versus compact fluorescent tubes for phototherapy in neonatal jaundice: a multi-center randomized controlled trial. Indian Pediatrics. 2010 Feb;47:131-7.
6. Onianwa PO, Adubi IO, Alonge TO, Otegbayo AJ, Yaya OS, Ojo OV, Ola FT, Layemo BO, Emiola OR, Mosebolatan AO. Super LED lamps and compact fluorescent lamps in the management of neonatal jaundice. Africa Journal of Nursing and Midwifery. 2018 Oct 10;20(2):14-19.
7. Kumar P, Murki S, Malik GK, Chawla D, Deorari AK, Karthi N, Subramanian S, Sravanthi J, Gaddam P, Singh SN. Light-emitting diodes versus compact fluorescent tubes for phototherapy in neonatal jaundice: a multi-center randomized controlled trial. Indian Pediatrics. 2010 Feb;47:131-7.