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To Compare Efficacy of Conventional Double-Surface Phototherapy and LED Phototherapy in Neonatal Hyperbilirubinemia

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Abstract

Background: Phototherapy is the primary treatment for neonatal hyperbilirubinemia. LED Phototherapy is proposed to provide higher irradiance with lower heat production & improved bilirubin reduction.

Objective: To compare the efficacy & safety of Conventional Double-Surface Phototherapy (CDSP) & LED Phototherapy (LED-PT) in term neonates with non-hemolytic hyperbilirubinemia.

Methods: A prospective comparative study was conducted on 100 term neonates, divided equally into CDSP (n=50) & LED-PT (n=50) groups. Total serum bilirubin (TSB) was measured at baseline, 6 h, 12 h, 24 h, & every 12 h thereafter. Primary outcomes were rate of bilirubin decline & duration of phototherapy. Secondary outcomes included complications & need for exchange transfusion.

Results: LED-PT achieved significantly greater mean bilirubin reduction at 24 hours (6.9 ± 1.5 mg/dL) compared to CDSP (4.7 ± 1.6 mg/dL; $p<0.001$). Mean duration of phototherapy was shorter in the LED-PT group (22.6 ± 4.2 hours) vs CDSP (29.8 ± 5.1 hours; $p<0.001$). Adverse effects such as hyperthermia & dehydration were lower in LED-PT.

Conclusion: LED Phototherapy is more effective & safer than conventional double-surface phototherapy for treating neonatal hyperbilirubinemia.

Keywords: Neonatal jaundice, LED phototherapy, Double Surface Phototherapy, hyperbilirubinemia, bilirubin.

Study Design: Prospective Comparative Study.

INTRODUCTION

About 60% of term infants suffer from the common illness known as neonatal hyperbilirubinemia. If severe jaundice is not treated right away, kernicterus may result. Bilirubin is transformed by phototherapy into water-soluble isomers that can be eliminated without conjugation [1].

Heat emission, limited irradiance, bulb instability, & high energy consumption are some of the disadvantages of conventional fluorescent phototherapy devices. Narrow-spectrum blue

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light (460–490 nm), increased irradiance, reduced heat, & improved energy efficiency are all produced by LED Phototherapy systems [2].

This study was undertaken to compare the clinical efficacy & safety profile of **Conventional Double-Surface Phototherapy (CDSP)** & **LED Phototherapy (LED-PT)** in term neonates with non-hemolytic hyperbilirubinemia.

A rise in the amount of bilirubin in the blood is known as hyperbilirubenimia. Physiological jaundice is defined as jaundice caused by neonates' physiological immaturity to cope with increasing bilirubin production. Between 24 & 72 hours of life is when visible jaundice typically manifests. In term babies, TSB (total serum bilirubin) levels typically increase to a peak of 12 to 15 mg/dl on the third day of life before declining [3]. TSB can increase by more than 15 mg/dl in preterm infants, with the peak amount occurring between 3 & 7 days of life. When TSB concentrations are outside of the physiological jaundice range, which is loosely defined as more than 5 mg/dl on the first day, 10 mg/dl on the second day, & 12–15 mg/dl beyond that in term newborns, pathological jaundice is considered to be present. If the bilirubin level is 17 mg/dl or more, the reason & potential treatment, like phototherapy, should be assessed. Jaundice occurs in the first week of life in about 60% of term babies & 80% of preterm neonates.

A medical procedure known as phototherapy uses light with a wavelength of 420–480 nm to lower bilirubin levels in newborns through a process known as photo isomerisation. Neonates with hyperbilirubinemia are treated with phototherapy units that convert stored unconjugated bilirubin on the skin's surface. When bilirubin is exposed to the right wavelength of light, it transforms into water-soluble, non-toxic isomers that the liver can more easily break down & remove from the circulation. In the meantime, a number of factors, including sufficient light exposure to the skin surface area, the spectrum of light employed (wavelength 460 nm), & irradiance, were taken into account to lower the bilirubin content in neonates using phototherapy treatment [4-5].

MATERIALS & METHODS

Study Design

A prospective comparative study in a tertiary care neonatal unit over 12 months.

Study Population

100 term neonates requiring phototherapy as per AAP guidelines.

Group Allocation

- **Group A – CDSP:** 50 neonates
- **Group B – LED-PT:** 50 neonates

Inclusion Criteria

- Term neonates (≥37 weeks)

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- Birth weight ≥2500 g
- Non-hemolytic hyperbilirubinemia
- Requirement of phototherapy as per AAP charts

Exclusion Criteria

- Hemolytic disease (positive Coombs test)
- Sepsis
- Major congenital anomalies
- Prior phototherapy
- Prematurity

Procedures

TSB was measured at:

- Baseline
- 6 hours
- 12 hours
- 24 hours
- Every 12 hours thereafter until TSB fell below the phototherapy threshold.

Irradiance levels were standardized:

- CDSP: 15–20 μW/cm²/nm
- LED-PT: 30–35 μW/cm²/nm

Outcome Measures

Primary outcomes:

1. Rate of bilirubin decline
2. Total duration of phototherapy

Secondary outcomes:

- Side-effects
- Need for exchange transfusion

Statistical Analysis

t-test & Chi-square test were applied. $p < 0.05$ considered significant.

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RESULTS

Table 1: Baseline Characteristics of the Study Population

Parameter	CDSP (n=50)	LED-PT (n=50)	p-value
Mean Birth Weight (g)	2890 ± 340	2920 ± 310	0.52
Mean Gestational Age (weeks)	38.4 ± 1.1	38.6 ± 1.0	0.41
Sex (Male %)	58%	56%	0.83
Baseline TSB (mg/dL)	17.9 ± 2.1	18.1 ± 2.0	0.63

Table 2: Mean TSB Levels at Different Time Intervals (mg/dL)

Time Interval	CDSP	LED-PT	p-value
Baseline	17.9 ± 2.1	18.1 ± 2.0	0.63
6 hours	16.8 ± 1.8	15.9 ± 1.6	0.01
12 hours	15.3 ± 1.9	13.8 ± 1.5	<0.001
24 hours	13.2 ± 1.7	10.6 ± 1.3	<0.001

LED-PT showed significantly faster bilirubin decline at all intervals.

Table 3: Clinical Outcomes

Outcome	CDSP	LED-PT	p-value
Duration of Phototherapy (hours)	29.8 ± 5.1	22.6 ± 4.2	<0.001
Rate of Bilirubin Decline (mg/dL/hour)	0.31 ± 0.07	0.46 ± 0.09	<0.001
Hospital Stay (days)	3.1 ± 0.8	2.4 ± 0.6	<0.001
Need for Exchange Transfusion	Nil	Nil	-

LED-PT reduced the duration of therapy by approximately **24%**.

Table 4: Adverse Effects

Adverse Effect	CDSP (n=50)	LED-PT (n=50)	p-value
Hyperthermia	7 (14%)	1 (2%)	0.03
Dehydration	5 (10%)	1 (2%)	0.09
Skin Rash	8 (16%)	2 (4%)	0.04
Loose Stools	6 (12%)	4 (8%)	0.51
Phototherapy Failure	0 (0%)	0 (0%)	-

LED-PT was associated with fewer adverse effects.

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DISCUSSION

This study shows that when it comes to lowering bilirubin levels in term newborns, LED Phototherapy outperforms traditional double-surface phototherapy. The LED PT group had a shorter total treatment duration & a noticeably greater bilirubin decrease in the first 24 hours. These results are consistent with growing evidence that LED units improve phototherapy efficiency due to their high spectrum irradiance & minimal heat emission [6]. Improved safety & thermal stability with LED systems are shown by fewer side effects, including rash & hyperthermia. The reduction in bilirubin levels in newborns may also be influenced by the length of phototherapy. There was a statistically significant mean difference between the two groups' irradiation durations.

According to Jardine & Woodgate's explanation in the clinical evidence journal, the length of phototherapy varies depending on the sort of phototherapy employed. However, because the average quality of RCTs is low-quality data, many people are still unaware of the proper length of phototherapy, despite the majority being based on RCT research [7].

With advancement in phototherapy, comparative studies on efficacy of LED and Conventional Phototherapy for treatment of hyperbilirubinemia have yielded varying results. In this study, we compared the effect of LED versus Conventional Phototherapy on rate of decrease in total serum bilirubin levels, and their side effects[8].

In this study the side effects in both the groups were minimal. However other studies observed a significantly higher incidence of skin rashes with conventional phototherapy group. Majority of the neonates in our study maintained euthermia under phototherapy. This was similar to the studies by Uras N et al. and Seidman et al. [9-10].

According to Uras et al. (2009), the Conventional group lost more weight during phototherapy (161+/-110gms) than the LED group (142+/-41.699gms) [9]. Uras et al. also found that phototherapy was successful in both the LED & Conventional groups [9]. According to a study by Martins et al. [11], 12% of children in the LED group experienced side effects compared to 20% of babies treated with Conventional Phototherapy. About 80% of 200 newborns treated with phototherapy in a Likert scale study report showed more comfort with LED Phototherapy, while only 20% chose Conventional Phototherapy. Given that more people are choosing LED phototherapy, there is a clear statistical difference [p=0.012], indicating a significantly higher preference and perceived comfort with LED Phototherapy compared to Conventional systems. The research is comparable to that conducted by Seidman et al. [12]

CONCLUSION

LED Phototherapy is more effective, efficient, and safer than Conventional Double-surface Phototherapy for treating neonatal hyperbilirubinemia. It should be considered the preferred modality for Phototherapy in neonatal care units.

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LIMITATIONS

- Single-center study
- No long-term follow-up
- Cost-effectiveness analysis not included

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