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Effectiveness of Light Emitting Diodes (LED) versus Conventional Phototherapy for Neonatal Jaundice

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Abstract

Background: *Phototherapy is crucially an important aspect for the management of most neonatal jaundice. Neonates are prone to develop bilirubin encephalopathy (kernicterus). LED phototherapy is a new option of managing neonatal jaundice. The objective of this study is to compare the efficacy and safety of LEDs with fluorescent phototherapy in the treatment of indirect hyperbilirubinemia.*

Method: *The study was Experimental research design, prospective study. The Study was conducted at Neonatal unit of Shaheed Suhrawardy Medical College Hospital, Dhaka. Total sample size of the study was one hundred neonates. Fifty for conventional phototherapy and fifty for LED phototherapy. Purposive sampling method was used for the study. The data collection tool of the study was pretested structured questionnaire. The modes of presentation, the clinical examination and investigation findings at admission and during daily follow up were recorded for individual patient.*

Result: *The rate of fall of S. bilirubin was more in those neonates who have had LED phototherapy. As a result, duration of phototherapy as well as hospital stay was less in LED group. Furthermore, higher number of neonates developed rashes in LED group than in conventional group with statistically significant difference. Of course, variables regarding other adverse events did not show any statistically significant difference between two groups.*

Conclusion: *Management of neonatal jaundice may be more effective in LED phototherapy than conventional phototherapy. LED device require shorter duration of phototherapy, thus, shorter hospital stay.*

Key words*: LED, Conventional Phototherapy, Neonatal Jaundice.*

Introduction

Jaundice refers to the yellow appearance of the skin that occurs with the deposition of bilirubin in the dermal and subcutaneous tissue. Jaundice occurs in as many as 60% of all normal newborns within the first week of life.[1] Jaundice in the newborn can occur from an underlying pathological condition, such as iso-immune hemolysis or an RBC enzyme deficiency. However, in some infants with exaggerated physiologic jaundice, and in many infants with pathologic jaundice, bilirubin in the blood reaches very high concentrations that put the infant at risk for bilirubin encephalopathy (kernicterus). In these cases, treatment aimed at decreasing bilirubin concentration is required in order to avoid kernicterus. Effective phototherapy decreasing total bilirubin to safe levels quickly can minimize the risk of bilirubin neurotoxicity. Different phototherapy devices are being used worldwide. Thus, prompt diagnosis and treatment of indirect hyperbilirubinemia is of great importance in newborn. Phototherapy and exchange blood transfusion are two major therapeutic strategies to prevent bilirubin-induced brain damage in neonates. The choice of treatment option depends on the severity of hyperbilirubinemia, but phototherapy is the most frequently used treatment[3]. Conventional phototherapy machine was used for this. But now a days, LED phototherapy machine is available and claimed to be more beneficial.

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Commonly used light sources are fluorescent tubes and halogen spotlights. These light sources, however, have some important limitations. For example, they produce considerable heat and cannot be placed close to the infant. Although this problem can be solved by attaching fiberoptic blankets to the light source, it is not highly effective because of a limited exposure area.[3,4] Because of 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. So, LEDs and fluorescent phototherapy units might be compared in the treatment of neonatal jaundice. But there was no available data whether the LED phototherapy could shorten the duration of phototherapy. For this reason, this study was carried out to assess and compare the efficacy and safety of LEDs with fluorescent phototherapy in the treatment of indirect hyperbilirubinemia in preterm and term infants.

Materials and Methods

A prospective study **was carried out in** the department of paediatrics of Shaheed Suhrawardy Medical College Hospital, Sher-e-Bangla Nagar, Dhaka during June, 2015 to January, 2016. Fifty for conventional phototherapy and fifty for LED phototherapy were included in this study. All neonates presented with jaundice and indicated for phototherapy were selected conveniently. Data were collected in a pretested structured questionnaire for each neonate. Neonates with major congenital anomalies**,** life-threatening condition, direct-reacting component of bilirubin >2 mg/dl, **n**eonatal jaundice due to Rh & ABO incompatibility**,** neonates with perinatal asphyxia, gestational age < 28 weeks, weight less than 1800 gm were excluded.

Fifty neonates of both sexes provisionally diagnosed as neonatal jaundice requiring phototherapy was enrolled following inclusion and exclusion criteria.

The neo BLUE LED phototherapy system was used for one group and the B-100 phototherapy device with four special blue compact fluorescent tubes was used for the other group. The distance between the infant and the light source was kept 12 inches (30.5 cm)in the LED phototherapy and 45 cm in the conventional phototherapy group as recommended. The decisions to start phototherapy were made by the attending neonatologist according to the guidelines for management of hyperbilirubinemia based on birth weight and age. Treatment was stopped when bilirubin will drop into below the range of phototherapy level or half of the blood exchange level or according to neonatologists' advice. Infants were remained unclothed except for a diaper and their eyes covered with eye-pad.

S. bilirubin (total and direct) and other necessary investigations were measured before starting phototherapy. Subsequently blood samples were taken for S. bilirubin at 24 hours interval until the bilirubin level fall down under the phototherapy level or half of exchange transfusion level. A complete blood count, CRP, blood grouping & Rh typing (of infant and mother), blood culture and C/S etc were done according to the unit protocol.

Results

The baseline characteristics including mean age of the neonates at admission, mean gestational age during delivery, mean age at the start of phototherapy, male- female ratio, mean weight of the neonates at admission in both groups showed no significant difference (Table-I).

Table-I

Baseline characteristics of the study patients (N=100)

Characteristics		Conventional group	LED group	P value
1.	Age at admission (hrs), Mean ± SD	56.0± 37.0	54.0± 30.0	0.642
2.	Gestational age(week)	36± 3.1	35± 2.9	0.967
3.	Age at start of phototherapy	78.3± 20.6	76.8± 19.4	0.764
4.	Male	23 (46.0)	22 (0.44)	0.663
5.	Female	27(54.0)	28(56.0)	0.675
6.	M:F ratio	0.85:1	0.79:1	
7.	Weight at admission (gm)	2228±378.2	2187± 389.6	0.126
8.	Frequency of motion./24hrs)	2± 1.6	2± 1.4	-

Table-II

Distribution of clinical findings at admission in the study groups (N=100)

Clinical findings	Conventional group(n=50) n (%)	LED group(n=50) n (%)	P value
Rash	19 (38 %)	21 (42%)	0.683
Fever	23 (46.0)	27 (54.0)	0.140
Hypothermia	2(4%)	3(6%)	0.646
Dehydration	3(6%)	2(4%)	0.646

Table-III

Distribution of diagnosis at start of phototherapy in the study groups (N=100)

Diagnosis	Conventional group(n=50) n (%)	LED group(n=50) n (%)	P value
Preterm	36 (72%)	35 (70%)	0.967
LBW	33 (66%)	34 (68%)	0.499
N. sepsis	28 (56%)	27 (54%)	0.840

Table-IV

Distribution of S. bilirubin level at different time in both groups (N=100)

Variables	Conventional group (Mean±SD)	LED group (Mean±SD)	P value
Level at start of phototherapy (mg/dl)	19.38±4.23	19.98 ± 3.74	0.823
Level at stoppage of therapy (mg/dl)	10.28± 1.98	9.57±1.85	0.211
Total fall (mg/dl) of bilirubin (difference)	9.10 ±2.12	10.41±2.65	0.756

Table-V

Distribution of outcome of phototherapy in both groups (N=100)

Outcome variables	Conventional group (Mean±SD)	LED group (Mean±SD)	P value
Total time required to reach safe level (hrs)	75 ± 12	51±14	0.03
Duration of hospital stays (hrs)	177±23	137±19	0.04
Rate of fall of S. bilirubin (mg/dl/hr)	0.121±0.089	0. 204±0.78	0.02
*Sepsis index	0.90	0.93	0.673

*Sepsis index =Number of sepsis cases prior to phototherapy/ number of sepsis cases at the end of phototherapy

Table V shows outcome of phototherapy in both groups. Total time require to reach safe level of S. bilirubin was 75 hours in conventional group and 51 hours in LED group i,e, duration of phototherapy to reach safe level of S. bilirubin was significantly less in LED phototherapy group in comparison to conventional phototherapy group. Duration of hospital stays was more in conventional phototherapy group than LED phototherapy group.

Rate of fall of S. bilirubin (mg/dl/hr) were 0.121 and 0. 204 in conventional phototherapy group than LED phototherapy group respectively. Fall of S. bilirubin

revealed significant difference between the two groups

Discussion

Recently, LED phototherapy is also available in few health care facilities. But it's effectiveness is not evaluated in Bangladesh.

Most common clinical findings at admission were rashes (38 % vs 42%) and fever (46 % & 52%). Only 2(4%) in conventional phototherapy group & 3 (6%) in LED phototherapy group faced cold stress / mild hypothermia (Table-). There is no available data for the outcome measures of episodes of cold stress or hypothermia [5]. So, data on temperature showed no significant difference between the two groups.

Most of the neonates presented at admission with additional illness other than neonatal jaundice. The diagnosis at start of phototherapy were preterm (72% vs 70%), LBW (66% vs 68%), neonatal sepsis (56% vs 54%) either alone or in combination along with neonatal jaundice.

The baseline mean S. bilirubin level at start of phototherapy (mg/dl) was 19.38±4.23 in conventional group and 19.98 ± 3.74 in LED group. Level at the stoppage of therapy (mg/dl) was 10.28± 1.98 in conventional group and 9.57±1.85 in LED group. Mean of total fall (mg/dl) of bilirubin (difference) was 9.10 ±2.12 in conventional group and 10.41±2.65 in LED group. There was no significant difference between the two groups regarding all the variables.

Study carried out by Takcý et al showed that mean serum bilirubin level had decreased to 10.9 ± 2 mg/dl at the end of the phototherapy[6]. This finding was almost nearer to our study.

Total time require to reach safe level of S. bilirubin was 75 hours in conventional group and 51 hours in LED group i,e, duration of phototherapy to reach safe level of S. bilirubin was significantly less in LED phototherapy group in comparison to conventional phototherapy group. Duration of hospital stays was more in conventional phototherapy group than LED phototherapy group. The differences between the two methods were significant. Rapid fall of S. bilirubin was probably result of rapid clearance S. bilirubin from blood by rapid isomerization of indirect bilirubin. Shorter hospital stay was also result of rapid fall of bilirubin in LED group. This indirectly reduces the nosocomial complications and cost of patient management.

The LEDs unit, however, resulted in less frequent hyperthermia, while 28.1% of infants in the fluorescent group experienced hyperthermia (though mild). These results were similar with most of the previous reports indicating that LEDs units are as effective as conventional phototherapy units[7-9].

The 'rate of fall of bilirubin' and 'duration of phototherapy' have been the two main outcomes investigated by the previous studies, as well as this study[10]. In the randomized controlled trial by Martins *et al*. on preterm neonates, comparing indium gallium nitrate LEDs with halogen phototherapy, results showed greater decrease in TSB levels and shorter duration of phototherapy in the LEDs group. These results could be attributed to the lesser irradiance of halogen lamps and broad spectrum of light emitted by them in comparison to LEDs[11]. A meta-analysis by Kumar and colleagues on available randomized trials indicated a comparable rate of fall of bilirubin as well as duration of treatment in the LEDs and non-LEDs phototherapy groups; but in separate analysis of studies comparing LEDs with halogen light sources, mean duration of phototherapy was significantly shorter with LEDs devices. This difference was not observed in the studies comparing LEDs with fluorescent light sources. Thus, it seems possible that LEDs light sources are more effective than halogen lamps for phototherapy in neonatal jaundice[10].

A study carried out in Turkey showed that the rate of mean bilirubin decline was 47.2 ± 9%[6].

There was a significant difference in the amount of bilirubin reduced after exposure to light over a 2-hour time period (% reduction of bilirubin) among the four devices; at 120 minutes after exposure, the amount of bilirubin left was lowest for the CFL (16%) and highest for the indigenous LED unit (41%)[12]. The rate of bilirubin decrease was 0.84 ± 0.41 mg/dl/h in the first four hours, and it was calculated as 0.47 ± 0.1 mg/dl/hr for 20.6 hours [6].

Although most of the previous studies reported rare and comparable side effects in LEDs and non- LED phototherapy groups[13], they found a higher incidence of hyperthermia with fluorescent tubes. However, all of the cases were mild and transient and we did not observe any severe side effect. Therefore, regarding better safety and efficacy, LED phototherapy seems to be better than conventional phototherapy with halogen or fluorescent light sources in preterm

infants, though further studies are required in this regard.

Though rashes at the start of phototherapy in both groups were almost similar but significantly more number of neonates developed rashes in conventional group (62%) than the LED group (46%). Fever was noted in both groups (50% vs 48%) with no significant difference. No neonate developed hypothermia in either group. Only one neonate (2%) in conventional group and none in LED group developed dehydration. The overall findings suggest the adverse effects of phototherapy. So, adverse outcome like rashes may be more commonly seen in conventional phototherapy than LED phototherapy in treating neonatal jaundice.

LED phototherapy provides excellent clinical outcomes. The uniformity, intensity and wavelength of emitted light results in a 28% increase in bilirubin breakdown[5-8].

Conclusion

LED phototherapy is more effective than conventional phototherapy in treating neonates with indirect hyperbilirubinemia. Considering shorter hospital stay, increased rate of reduction of bilirubin and total time required to reach safe level of bilirubin, LED phototherapy seems to be a better option than current conventional phototherapy in treating neonatal jaundice.

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