Super LED Lamps and Compact Fluorescent Lamps in the Management of Neonatal Jaundice

Patricia O. Onianwa
https://orcid.org/0000-0002-0095-810X
University College Hospital, Ibadan, Nigeria

Iyanuoluwa O. Adubi
https://orcid.org/0000-0002-2132-2987
University College Hospital, Ibadan, Nigeria
adubiiyanu@gmail.com

Temitope O. Alonge
https://orcid.org/0000-0002-9999-1865
University College Hospital, Ibadan, Nigeria

Abiodun J. Otegbayo
https://orcid.org/0000-0001-8992-9411
University College Hospital, Ibadan, Nigeria

Olaoluwa S. Yaya
University of Ibadan, Nigeria

Olubunmi V. Ojo
University College Hospital, Ibadan, Nigeria

Funmiso T. Ola
https://orcid.org/0000-0001-8399-9427
University College Hospital, Ibadan, Nigeria

Bolaji O. Layemo
University College Hospital, Ibadan, Nigeria

Oluwatoyin R. Emiola
University College Hospital, Ibadan, Nigeria

Alice O. Mosebolatan
University College Hospital, Ibadan, Nigeria

Abstract

Neonatal jaundice is a colossal issue worldwide, particularly in developing countries. About 60 per cent of term and 80 per cent of preterm babies develop jaundice during the first week of life. Approximately 5–10 per cent of all newborns need phototherapy to prevent this commonest morbidity in neonatal life. The commonly used light sources are special blue fluorescent tubes, compact fluorescent tubes and halogen spotlights. In recent years, a new type of light source, light-emitting diodes (LEDs), has been incorporated into phototherapy.

UNISA university of south africa PRESS

Africa Journal of Nursing and Midwifery
https://upjournals.co.za/index.php/AJNM/index
Volume 20 | Number 2 | 2018 | #3657 | 14 pages

https://doi.org/10.25159/2520-5293/3657
ISSN 2520-5293 (Online)

The study assessed the significant difference between the baseline total and the level of bilirubin for the first four days of using compact fluorescent lamps (CFLs) and super LED phototherapy lamps. It also examined the significant difference in the responses of male and female neonates to the two intervention methods as well as the significant difference in the median weights of neonates on the day of discharge based on the two intervention methods. The count of the baseline total serum bilirubin when using LED lamps was 11.71 and 8.86 when using CFL lamps. The total serum bilirubin count when using LED lamps decreased from 11.12 to 5.30, and from 9.11 to 6.32 when using CFLs. However, there was no significant difference in the responses of male and female neonates to the two intervention methods and the median weights of neonates on the day of discharge.

Keywords: compact florescent lamp; neonatal jaundice; super light-emitting diode lamp

Introduction and Background

Globally, neonatal jaundice is a very common condition occurring in up to 60 per cent of term and 80 per cent of preterm newborns in the first week of life (Ullah, Rahman, and Hedayati 2016, 558–568). It affects up to 84 per cent of term newborn babies (Bhutani et al. 2013). According to Bhutani, Stark and Lazzeroni (2013), jaundice is the yellowish appearance of the skin that occurs as a result of the deposition of bilirubin in the dermal and subcutaneous tissue. Vaez (2016) stated that neonatal jaundice is a serious condition that may result in fatal complications if not treated properly and in a timely manner.

According to the Department of Health and Human Services (2014), a typical treatment of jaundice involves phototherapy, which sends wavelengths of blue light to convert the bilirubin into photoisomers that can pass through the bile without needing to be conjugated with albumin. This phototherapy is usually extensive and quite effective, significantly reducing the amount of bilirubin present in the blood until the red blood cell production slows down. Light-emitting sources which are used for phototherapy are categorised into four categories of which two are of paramount importance to this study. Firstly, fluorescent lamps (FLs) which have been used widely in the treatment of newborn jaundice during the last 40 years and which are categorised into two groups, namely long tubes and folded (compact) tubes. Their most important advantage is that these devices are cheap. However, during their application it should be noted that the lamps lose irradiance through time and they have a limited life span. Moreover, their irradiance alters according to the beam's colour (blue, white, or green). Secondly, light-emitting diodes (LED) which are blue LED light sources based on the electric stimulation of a mineral (gallium nitride), and due to pure emission in the range of blue light, they produce less heat. Therefore, these light sources are placed very close to the skin, which in turn maximises the absorbed irradiance at the surface of the skin (Sadeghnia, Ganji, and Armanian 2014).

Furthermore, the U.S. National Library of Medicine (2016), stated that the rate of complications associated with neonatal jaundice are relatively low in countries such as the United States that have access to advanced technology and equipment such as super LED lamps. Also, most hospitals in the US have ready access to phototherapy for the few babies that develop jaundice during their time in the hospital, and complications associated with jaundice are quite rare owing to this ease of access (Boskabadi, Maamouri, and Mafinejad 2011). Several studies in developed countries showed that there was a statistical significant difference in the use of super LED lamps in the management of neonatal jaundice (Bhat et al. 2016; De Carvalho et al. 2011; Ngerncham et al. 2012; Sherbiny et al. 2016; Tridente and De Luca 2012).

Kolawole, Obueh and Okandeji-Barry's (2016) study was on the prevalence of neonate jaundice rather than the effectiveness of super LEDs over compact fluorescent lamps (CFLs). They reported that neonatal jaundice accounted for a total prevalence of 52.6 in 1 000 of the total number of cases they reviewed.

Statement of the Research Problem

Nigeria is the most populous country in Africa, with more than 150 million people. Unfortunately, the prevalence of neonatal jaundices is 52.6 in 1 000 (Kolawole, Obeuh, and Okandeji-Barry 2016), thus signifying the need to assess phototherapy and comparing the effectiveness of super LEDs over CFLs.

Currently, findings show that no study has been done in Nigeria on a retrospective review of the effectiveness of super LED lamps over CFLs in the management of neonatal jaundice. However, the few studies that have been done only explored the prevalence of neonatal jaundice (Kolawole, Obueh and Okandeji-Barry 2016; Onyearugha, Onyire, and Ugboma 2011).

Further, it was observed in the University College Hospital in Ibadan that a neonate who is born in the hospital and has neonatal jaundice will receive treatment that starts with CFLs. It was also noted by nurses working in the neonatal wards that the neonates who had jaundice and that were treated with CFLs had a poor neonatal outcome as compared to the neonates treated with LEDs. Therefore, evaluating the effectiveness of super LED lamps over CFLs in the management of neonatal jaundice is a paramount step to better the strategy in effective management of neonatal jaundice, ensuring a good outcome and ultimate improvement in neonates with jaundice.

Significance of the Study

Findings from this study will add important information to the literature regarding the effectiveness of super LED lamps over CFLs in the management of neonatal jaundice in developing countries such as Nigeria. Also, it will help hospital management, either in developed or developing countries, to scale-up the use of super LED lamps over CFLs.

Objectives of the Study

The objectives of the study include (1) to evaluate the effectiveness of super LED lamps over CFLs in the management of neonatal jaundice, (2) to assess the baseline total and conjugated level of bilirubin on admission and after treatment with CFLs and super LED phototherapy lamps, (3) to test for the significant difference between baseline total and the level of bilirubin for the first four days of using CFLs and super LED phototherapy lamps, and (4) to test the significant difference in the response of male and female neonates to the two intervention methods and the significant difference in the median weights of neonates on the day of discharge based on the two intervention methods.

Research Methodology

Research Design

The study was a descriptive, retrospective cohort design to evaluate the effectiveness of super LED lamps over CFLs in the management of neonatal jaundice at the University College Hospital in Ibadan, Nigeria.

Research Setting

This study was carried out at the University College Hospital which is strategically located in Ibadan in south-west Nigeria. Ibadan is the largest city in West Africa, and is the seat of the premier university in Nigeria. The Department of Information Technology, one of the departments at the hospital, deals with several responsibilities such as retrieving and keeping records of patients who are on admission and who have been discharged.

The records of the neonates were retrieved and reviewed at the Health Information Department of the University College Hospital.

Population

The study population was case files of neonates who had neonatal jaundice and who received treatment with CFLs between January 2010 and December 2012, and neonates who were treated with super LED lamps between January 2013 and December 2015 at the University College Hospital, Ibadan.

Sample and Sampling Technique

The data applied in this work are secondary data. Hence, using the purposive sampling technique 34 case files were retrieved of neonates with jaundice cared for by nurses. These neonates received treatment under CFLs and super LED lamps between January 2010 and December 2012 and the other neonates received treatment under the innovative super LED lamps between January 2013 and December 2015.

Data Collection Instrument

The instrument used for this study was a self-designed, structured checklist comprising two sections: Section A focused on the demographic profile of the neonates. Section B elicited information on the baseline serum bilirubin level, the date of commencement of phototherapy, the duration of the treatment, the weights of the babies, and the levels of serum bilirubin at day (1–4) and date of completion.

Inclusion Criteria

1. Gestational age (24–38 weeks)
2. Birth weight (≤ 2.5 kg)
3. Postnatal age (less than/equal to 38 weeks)

Exclusion Criteria

1. Gestational age (≥ 38 weeks)
2. Birth weight (≥ 2 kg)
3. Newborns with ABO blood type or Rh incompatibility (pathological jaundice)
4. Neonates without sepsis and birth asphyxia
5. Babies older than 20 days

Validity and Reliability

Face validity of the self-designed instrument was determined by checking the checklist for typographical mistakes, ambiguous statements and constructs and proper arrangement of the checklist items. The content validity of the research instrument was examined by an expert in neonatal care at the University College Hospital in Ibadan.

Ethical Considerations

The ethical approval and clearance to conduct the study was obtained from the Institute for Advanced Medical Research and Training, College of Medicine, University of Ibadan, Nigeria. The approval number is UI/EC/17/0231. Permission was also granted by the Head of Department, Information Technology, before the study started. Anonymity and confidentiality were ensured.

Data Collection Procedure

Data were extracted from the case notes for four weeks.

Data Analysis

Data were analysed using the Statistical Package for Social Sciences version 22.0. Descriptive and inferential statistics were employed in analysing the significance level of $P < 0.05$.

Results

The demographic characteristics of neonates are shown in Figure 1.

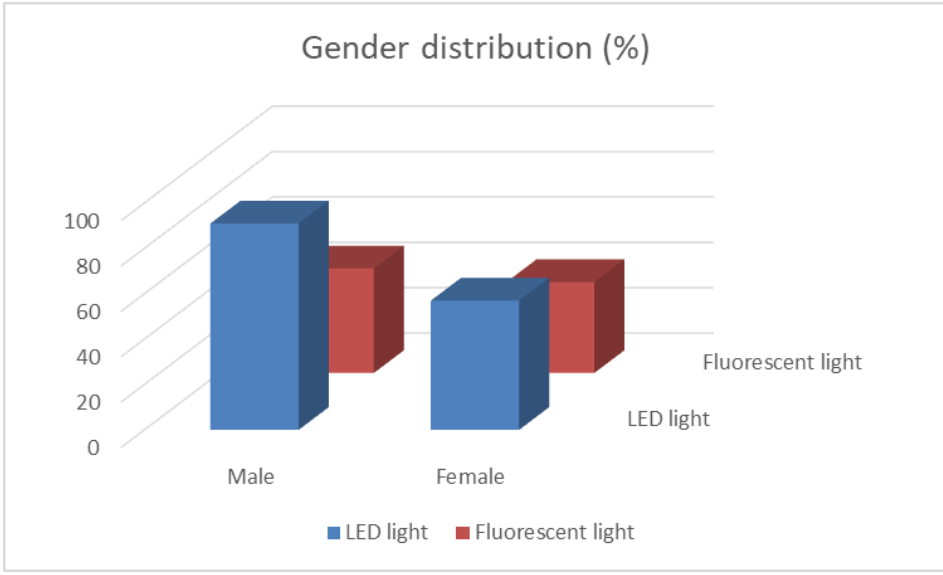

Figure 1: Male-to-female ratio of the neonates in the LED and CFL groups

As reflected in Figure 1, the majority of the neonates were male (61.5%, 53.5%) in both interventions.

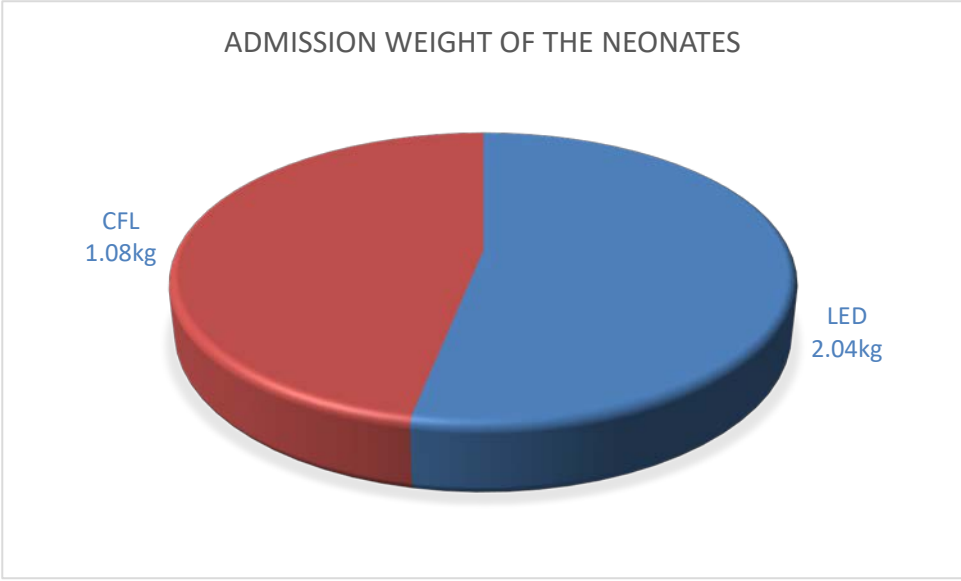

Figure 1.1: Admission weight of the neonates in both interventions

As reflected in Figure 1.1, the average admission weight of the neonates treated with LED lamps is 2.04 kg and that of the neonates treated with CFLs 1.80 kg.

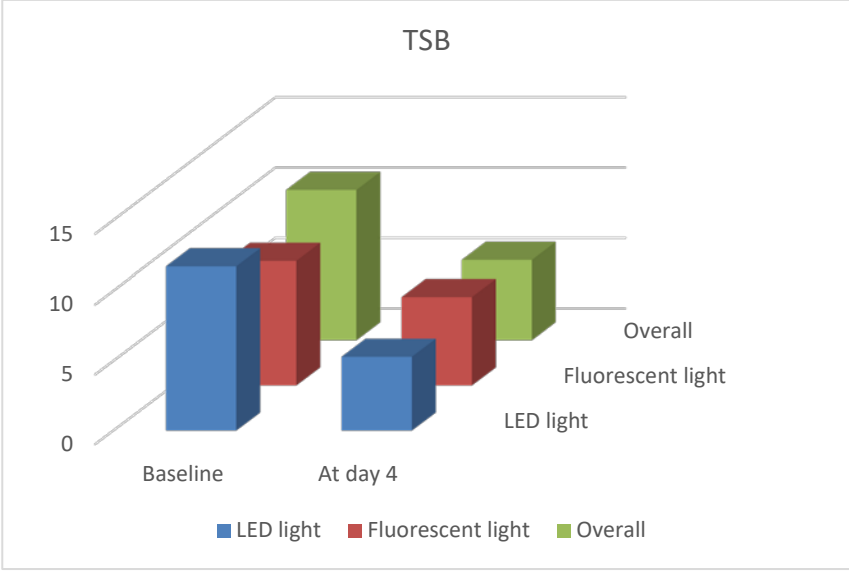

Figure 2a: The baseline level of total serum bilirubin (TSB) on admission and after treatment with CFLs and super LED phototherapy lamps

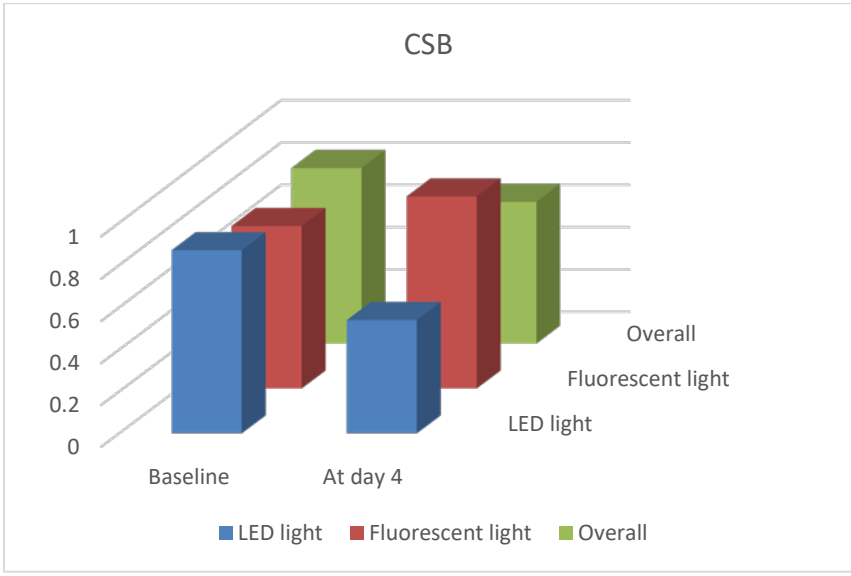

Figure 2b: The baseline level of conjugate serum bilirubin (CSB) on admission and after treatment with CFLs and super LED phototherapy lamps

As reflected in Figures 2a and 2b above, the baseline TSB count of neonates treated with LED lights was 11.71 compared to the count of 8.86 for those treated with CFLs. Looking at the baseline CSB from the first day to the second day, the LED light intervention indicated a count of 0.80 on the first day and this increased to a count of 0.92 on the second day, while in the case of CFLs, there was a marginal increase in the counts from 0.80 to 0.83.

Table 1: The result of the baseline total and the level of bilirubin for the first four days of using fluorescent lamps and super LED phototherapy lamps

LED light									
Groups	*N*	*Average*	*F statistic*	*p-value*	*Groups*	*N*	*Average*	*F statistic*	*p-value*
TSB_day1	148	11.12	45.24***	0.000	CSB_day1	142	0.80	5.00***	0.002
TSB_day2	147	9.87			CSB_day2	144	0.92		
TSB_day3	145	8.16			CSB_day3	143	0.80		
TSB_day4	131	5.30			CSB_day4	128	0.54		

As reflected in Table 1, the results indicate a significant difference across the days with TSB values, reducing significantly as indicated by an F-value of 45.24 ($p = 0.000$). The CSB values increased up to day 2 and later reduced to 0.5, which indicates a drop beyond the initial value of 0.8. Thus, this also showed the significance of the F-test at $p = 0.002$.

Table 2: The responses of male and female neonates to the two intervention methods

	LED light		*Fluorescent light*	
Duration of treatment (days)	*Male*	*Female*	*Male*	*Female*
Mean	5.00	4.74	6.07	6.83
SD	2.07	1.60	3.64	4.84
t-statistic	0.869		−0.813	
Prob.	0.386		0.419	

As indicated in Table 2, the results indicate that there is no significant difference in the duration of treatment of neonates by gender, for the two intervention methods.

Table 3: The result of the significant difference between the discharge weights of neonates

Treatment	*Mean weight*	*N*	*Std. Deviation*	*t-statistic*	*Prob.*
LED light	2.13	144	.78477	1.086	0.279
CFL	2.02	86	.74005		

As reflected in Table 3, the result showed no statistical significant difference between the discharged weights of babies with the two interventions.

Discussion of Findings

According to Sadeghnia, Ganji and Armanian (2014), phototherapy remained the treatment modality for hyperbilirubinemia since the late 1950s. Further, the advent of newer and better types of phototherapy has increased the options to be used and with that the confusion as well. Moreover, several types of bulbs have been used for providing phototherapy from blue fluorescent bulbs in the late 1950s to the current LED bulbs. All of them had their share of disadvantages, which include heating issues, intensity problems to wavelength matching, among others. Therefore, the latest advancement in the usage of LED has made it popular owing to the fact that it is safe and a more effective option over the use of CFLs (Sadeghnia, Ganji, and Armanian 2014). This retrospective review cohort study aimed to study the effectiveness of LED lights in comparison to the frequently used CFLs for the provision of phototherapy to neonates.

The findings of the study showed that the majority of the neonates were male (61.5%, 53.5%) in both intervention methods as shown in Figure 1. This is similar to a study in Nigeria on the prevalence and associated factors of neonatal jaundice by Onyearugha, Onyire, and Ugboma (2011). It was reported that out of the 83 inborn babies, 46 (55.4%) were male, and 37 (44.6%) were female, giving a male/female ratio of 1.2:1. Also, 40 of the outborn babies (56.3%) were male and 31(43.7%) female, giving a male/female ratio of 1.25:1. The findings of this study also support those of Murmu, Das and Suneer (2017), who conducted an evaluation of the benefits and efficacy of LED devices with respect to the conventional fluorescent tube phototherapy, which stated that boy babies were 120 (60%) and girl babies were 80 (40%), with a boy-to-girl ratio of 1.5:1. Therefore, this ratio inferred that male neonates are more at risk of hyperbilirubin than female neonates owing to their immaturity and genetic composition.

Furthermore, the findings from the study showed that the count of baseline TSB of neonates with LED lights was 11.71 compared to the count of 8.86 for CFLs. For CSB from the first day to the second day, the LED light intervention indicated a count of 0.80 on the first day and this increased to a count of 0.92 on the second day, while in the case of CFLs, there was a marginal increase from 0.80 to 0.83 as shown in Figure 2. This is similar to a study done by Bhat et al. (2016). In the study conducted for three years with 230 patients with jaundice, 54 neonates were placed under super LED phototheraphy, while 176 patients received treatment with CFLs. The outcome of the study revealed that the super LED phototheraphy was found to be more efficient than using CFLs. The study is also in line with the findings from the study by De Carvalho et al. (2011). According to their report, high-intensity phototherapy significantly reduces TSB in non-haemolytic severe hyperbilirubinemia and decreases the need for exchange transfusion. Colindres et al. (2012) on the contrary, reported that super LED phototherapy was found to be as effective as conventional therapy using blue fluorescent lights or halogen lights. Also, Onyearugha, Onyire and Ugboma's (2011) study differs from the findings of this study, with the report that 28 of the inborn babies (33.7%) had a spontaneous regression of their serum bilirubin level without intervention of either CFL or LED. Tridente and De Luca's (2012) findings did not support the findings from this study, by stating that super LED and other phototherapy devices appeared to be equally effective in reducing TSB in term or late preterm neonates. This may be owing to the fact that the spectrum of light emitted, the irradiance and body surface area covered are more with the use of super LED phototherapy, while the passage of meconium and adequate caloric intake of the neonate bring about the gradual decrease in the bilirubin level.

This study also showed that there was a significant difference in the baseline TSB and the level of bilirubin in the first four days of using CFLs and super LED phototherapy as shown in Table 1. There was a significant difference across the days with TSB values, reducing significantly as indicated by ($p = 0.000$) and the conjugate level (CSB) value to be significant with $p = 0.002$. This is in line with the findings of Maharoof et al. (2017), who reported that the mean difference in the reduction in the bilirubin values in the neonates before and after receiving phototherapy between the two groups was

significant ($p < 0.001$). A study done by Sherbiny et al. (2016), also showed that neonates treated with super LEDs had statistically significantly higher success rates with a p value of 0.003 and significantly higher bilirubin decline rates in both haemolytic and non-haemolytic subgroups than those treated conventionally with CFLs. Majid, Eliadarani and Badiei's (2012) study was at variance with the report of the author's findings in this study. Majid, Eliadarani and Badiei (2012) reported that there was no significant difference between the decreasing rate in the bilirubin level in the two methods, CFL and LED phototherapy, in the treatment of preterm infants with neonatal jaundice. However, the decreasing rate in the bilirubin level in neonates with jaundice in this study further confirms that the super LED phototherapy is effective in the management of neonatal jaundice. Some studies did not support the findings in this study, such as those by Colindres et al. (2012), Ngerncham et al. (2012), and Takci et al. (2013). The former reported that the rate of plasma bilirubin which decreased during phototherapy in the "blue light" group was significantly higher than in the "LED" group ($p = 0.03$), while Colindres et al. (2012) reported that the differences in the mean duration of fall in the bilirubin level of neonates with jaundice treated with phototherapy in each of the three groups were not statistically significant. The latter reported that intensive phototherapy with either CFT or LED provided a rapid decrease in bilirubin levels in the first few hours of exposing the jaundiced neonates.

The findings from this study also showed that there was no significant difference in the mean duration of treatment of neonates by gender by the two intervention methods as shown in Table 2. In similar findings by Sadeghnia, Ganji and Armanian (2014) where they compared the effect of fluorescent lamps and quartz halogen incandescent filament lamps in the treatment of hyperbilirobinemia in newborns with the gestational age of 35 weeks or more, the results showed that the chi-square test and Fisher's exact test on gender distribution, blood type and Rh revealed no meaningful difference in the management of jaundice with the ($P > 0.05$). Kolawole, Obueh and Okandeji-Barry's (2016) findings were at variance, having reported that there was a significant prevalence ($p \leq 0.05$) of neonatal jaundice in males (67.4) than in females (43.6) after intervention with LED phototherapy. However, in this study, it may be inferred that responses of neonates at the special care unit is not gender biased.

Finally, the findings of this study also showed that there was no significant difference between discharged weights based on the two interventions as shown in Table 3. This is similar to a study by Murmu, Das and Suneer (2017), who stated that there was no statistical significant difference regarding the weight of the babies during initiation and stoppage of phototherapy in the two groups of neonates treated with CFL and LED phototherapy.

Limitations of the Study

The retrospective cohort design and the purposive sampling method applied in this study are obvious limitations. Thus, the findings of this study cannot be generalised to the entire population. Also, the bias inherent in self-reporting cannot be ruled out.

Conclusion and Recommendations

Jaundice usually becomes clinically apparent to parents and health practitioners (such as nurses and paediatricians), hence the need for immediate treatment to prevent complications such as kernicterus. This can be achieved by instituting and providing more phototherapy devices. It is evident in the study that LED phototherapy is more effective in bringing down the serum bilirubin level. It also showed that neonates with hyperbilirubin treated with LEDs had better neonatal outcomes as compared to those treated with CFLs. LED is a safe rescue treatment for severe neonatal hyperbilirubinemia and its implementation will reduce the need of exchange transfusion. Hence, the use of LED phytotherapy could be a resourceful technique in the view of its effectiveness in the management of neonatal jaundice. There is a need to explore the views of nurses in providing comfort to jaundice neonates treated with super LED lamps.

References

Bhat, J. I., I. A. Qazi, A. A. Ahangar, B. A. Charoo, A. Ahmed, and I. Ahmad. 2016. "Efficacy of Different Types of Phototherapy Devices: A 3-Year Prospective Study from Northern India." *Journal of Clinical Neonatology* 5 (3): 153–56. https://doi.org/10.4103/2249-4847.191245.

Bhutani, V. K., A. R. Stark, and L. C. Lazzeroni. 2013. "Initial Clinical Testing Evaluation and Risk Assessment for Universal Screening for Hyperbilirubinemia Screening Group. Predischarge Screening for Severe Neonatal Hyperbilirubinemia Identifies Infants Who Need Phototherapy." *Journal of Pediatrics* 162 (3): 477–482.

Bhutani, V. K., A. Zipursky, H. Blencowe, R. Khanna, M. Sgro, F. Ebbesen, J. Bell, E. Mori, T. M. Slusher, N. Fahmy, V. K. Paul, L. Du, A. A. Okolo, M. de Almeida, B. O. Olusanya, P. Kumar, S. Cousens, and J. E. Lawn. 2013. "Neonatal Hyperbilirubinemia and Rhesus Disease of the Newborn: Incidence and Impairment Estimates for 2010 at Regional and Global Levels. *Pediatric Research* 74:86–100. https://doi.org/10.1038/pr.2013.208.

Boskabadi, H., G. Maamouri, and S. Mafinejad. 2011. "The Effect of Traditional Remedies (Camel's Thorn, Flixweed and Sugar Water) on Idiopathic Neonatal Jaundice." *Iranian Journal of Pediatrics* 21 (3): 325–30.

Colindres, J. V., C. Rountree, M. A. Destarac, Y. Cui, M. P. Valdez, M. H. Castellanos, Y. Mirabal, G. Spiegel, R. Richards-Kortum, and M. Oden. 2012. "Prospective Randomized Controlled Study Comparing Low-Cost LED and Convectional Phototherapy for Treatment of Neonatal Hyperbilirubinemia." *Journal of Tropical Pediatrics* 58 (3): 178–83. https://doi.org/10.1093/tropej/fmr063.

De Carvalho, M., C. C. Mochdece, C. A. M. Sá, and M. E. L. Moreira. 2011. "High-Intensity Phototherapy for the Treatment of Severe Nonhaemolytic Neonatal Hyperbilirubinemia." *Acta Paediatrica* 100 (4): 620–23. https://doi.org/10.1111/j.1651-2227.2011.02170.x.

Department of Health and Human Services. 2014. “Neonatal eHandbook.” Accessed 6 May 2016. http://www.health.vic.gov.au/neonatalhandbook/conditions/jaundice-in-neonates.html.

Kolawole, S. E., H. O. Obueh, and O. R. Okandeji-Barry. 2016. “Prevalence of Neonatal Jaundice in Eku Baptist Community Hospital in Delta State Nigeria.” *Journal of Public Health and Epidemiology* 8 (5): 87–90. https://doi.org/10.5897/JPHE2015.0779.

Maharoof, M. K., S. A. Khan, P. R. Saldanha, and R. Mohamed. 2017. “Comparison of Light Emitting Diode and Compact Fluorescent Lamp Phototherapy in Treatment of Neonatal Hyperbilirubinemia.” *International Journal of Contemporary Pediatrics* 4 (2): 341–5. http://dx.doi.org/10.18203/2349-3291.ijcp20170083.

Majid, M., F. K. Eliadarani, and Z. Badiei. 2012. “Is the Light-Emitting Diode a Better Light Source than Fluorescent Tube for Phototherapy of Neonatal Jaundice in Preterm Infants?” *Advanced Biomedical Research* 1:51. https://doi.org/10.4103/2277-9175.100158.

Murmu, M. C., L. Das, and C. M. Suneer. 2017. “Evaluation of the Benefits and Efficacy of Light Emitting Diode (LED) Device with Respect to Conventional Fluorescent Tube Phototherapy Device in Neonatal Hyperbilirubinemia in Near Term and Full Term Neonates.” *Journal of Pediatric Research* 4 (5): 333–42. https://doi.org/10.17511/ijpr.2017.05.08.

Ngerncham, S., K. Jirapaet, R. Suvonachai, R. Chaweerat, P. Wongsiridej, and T. Kolatat. 2012. “Effectiveness of Conventional Phototherapy versus Super Light-Emitting Diodes Phototherapy in Neonatal Hyperbilirubinemia.” *Journal of the Medical Association of Thailand* 95 (7): 884–9.

Onyearugha, C. N., H. A. A. Onyire, and H. A. Ugboma. 2011. “Neonatal Jaundice: Prevalence and Associated Factors as Seen in Federal Medical Centre Abakaliki, Southeast Nigeria.” *Journal of Clinical Medicine and Research* 3 (3): 40–45.

Sadeghnia, A. M. G., and A. M. Armanian. 2014. “Comparison between the Effect of Fluorescent Lamps and Quartz Halogen Incandescent Filament Lamps on the Treatment of Hyperbilirobinemia in Newborns with the Gestational Age of 35 Weeks or More.” *International Journal of Preventive Medicine* 5:1187–92.

Sherbiny, H. S., D. M. Youssef, A. S. Sherbini, R. El-Behedy, and L. M. Sherief. 2016. “High-Intensity Light-Emitting Diode vs Fluorescent Tubes for Intensive Phototheraphy in Neonates.” *Paediatrics and International Child Health* 36 (2): 127–33. https://doi.org/10.1179/2046905515Y.0000000006.

Takci, S., S. Yiğit, G. Bayram, A. Korkmaz, and M. Yurdakök. 2013. “Comparison of Intensive Light-Emitting Diode and Intensive Compact Fluorescent Phototherapy in Non-Hemolytic Jaundice.” *Turkish Journal of Pediatrics* 55 (1): 29–34.

Tridente, A., and D. de Luca. 2012. “Efficacy of Light-Emitting Diode versus Other Light Sources for Treatment of Neonatal Hyperbilirubinemia: A Systematic Review and Meta-Analysis.” *Acta Paediatrica* 101 (5): 458–65. https://doi.org/10.1111/j.1651-2227.2011.02561.x.

Ullah, S., K. Rahman, and M. Hedayati. 2016. “Hyperbilirubinemia in Neonates: Types, Causes, Clinical Examinations, Preventive Measures and Treatments: A Narrative Review Article.” *Iranian Journal of Public Health* 45 (5): 558–68.

U.S. National Library of Medicine. 2016. “Newborn Jaundice.” Accessed 3 May 2016. https://www.nlm.nih.gov/medlineplus/ency/article/001559.htm.

Vaez, A. 2016. “Knowledge and Attitudes of Mothers on Neonatal Jaundice in Saravan, Iran.” Honours thesis, Eastern Kentucky University. https://encompass.eku.edu/honors_theses/337.