

Effect of White Plastic Cover around the Phototherapy Unit on Hyperbilirubinemia in Full Term Neonates

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Received: Sep 06, 2012; Accepted: Jan 11, 2013; First Online Available: Feb 06, 2013

Abstract

Objective: Jaundice is a common problem in neonatal period. Phototherapy is the most common treatment for neonatal jaundice. The purpose of this study was to determine the effect of adding white plastic cover around the phototherapy unit on hyperbilirubinemia in full term neonates with jaundice.

Methods: In this randomized controlled trial, over 12 months (October 2009 – September 2010), 182 term neonates with uncomplicated jaundice, admitted to neonatal unit of Imam Reza Hospital (AS) in Kermanshah province of Iran, were selected. They were randomized in two groups. *Control group* received conventional phototherapy without cover around the apparatus and *covered group* received conventional phototherapy with plastic cover around the unit. After enrolment, total serum bilirubin was measured every 12 hours. Phototherapy was continued until the total serum bilirubin decreased to or less than 12.5 mg/dl.

Findings: There were no significant differences between the two groups for gestational age, birth weight, postnatal age, weight (at admission), serum level of hemoglobin, hematocrit and reticulocyte count. Total serum bilirubin in covered group, during the first 48 hours of treatment, declined significantly than in control group (P . value=0.003). The cover around the phototherapy unit not only did not increase the side effects of phototherapy, but also had a positive impact in reducing duration of jaundice (P . value <0.0001) and duration of hospitalization (P . value <0.0001).

Conclusion: The study results showed that using white plastic cover around the phototherapy unit can increase the therapeutic effect of phototherapy.

Iranian Journal of Pediatrics, Volume 23 (Number 2), April 2013, Pages: 143-148

Key Words: Phototherapy; Jaundice; Neonate; Hyperbilirubinemia

Introduction

One of the most common causes of hospitalization of neonates is hyperbilirubinemia, as 60% of term neonates and 80% of preterm neonates are affected in the first week of life^[1]. Phototherapy is the most common therapeutic intervention in these instances. Regardless of gestational age,

absence or presence of hemolysis or degree of skin pigmentation, phototherapy can reduce bilirubin level in all newborns^[2]. Despite the widespread use of phototherapy since 1958, many questions about the methods which maximize the effectiveness of treatment remain unanswered^[3].

Three major variables which affect the efficacy of phototherapy include:

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1. The wavelength of light used to induce photoisomerization. Effective wavelengths for phototherapy are 420 to 480nm and the best lamps for phototherapy include: Special blue lamps (F20 T12/BB and TL52 tubes [Philips]).

2. Lamp energy output (irradiance): Effective phototherapy must provide irradiance well above the levels that have been determined to be minimally effective in producing bilirubin degradation while not exceeding levels beyond which no significant increases in response are evident. In standard phototherapy energy output is about 6 to 12 $\mu\text{W}/\text{cm}^2/\text{nm}$ and in intensive phototherapy, irradiance is increased to 25 $\mu\text{W}/\text{cm}^2/\text{nm}$ or greater. The BiliBed Phototherapy Unit can deliver up to 60 $\mu\text{W}/\text{cm}^2/\text{nm}$.

3. Standard phototherapy lamps are normally positioned within 40 cm of the patient. Increasing the distance from the lamp to the skin surface of the neonate results in a theoretical diminution of light energy by a factor equal to the square of the increase in the distance. The greater the surface exposed, the greater the effectiveness of phototherapy.

Regarding the items said above, it seems that factors increasing reflection of light to the baby's body surface can increase the impact of phototherapy in reducing serum bilirubin level. Sometimes several phototherapy units are used to increase the therapeutic effect^[4]. However, the greater the surface area exposed, the greater the effectiveness of phototherapy^[5]; for this purpose, white covers around the phototherapy apparatus which reflect light, can be used. In developing countries the number of newborns suffering from jaundice is high, and techniques that can increase the efficacy of phototherapy would be ideal, because it accelerates neonates' discharge. The purpose of this study was to determine the impact of using white plastic cover around the phototherapy unit on its efficacy in jaundiced term neonates.

Subjects and Methods

This randomized controlled trial, was conducted on neonates with hyperbilirubinemia admitted to neonatal unit of Imam Reza Hospital (a tertiary

teaching hospital), Kermanshah, Iran,. The study was carried out during 12 months, from October 2009 to September 2010. Inclusion criteria were: neonates who had complete gestational age of 37 weeks and birth weight $\geq 2500\text{gr}$ and total serum bilirubin level between 18 to 21 mg/dl at the start of phototherapy. All neonates were exclusively breast-fed. Neonates with major congenital anomalies, hemolytic disease, using phenobarbital or herbal medications (such as Alhagi pseudoalhagi, Fumaria parviflora, Zizyphus jujube, Purgative manna and Cichorium Intybus), elevated direct bilirubin (direct bilirubin more than 20% of total serum bilirubin), symptoms of infection and postnatal age less than 48 hours and more than two weeks at the start of phototherapy were excluded.

The decision to initiation and discontinuation phototherapy was based on 2004 AAP guidelines for management of hyperbilirubinemia in term and near-term newborns. Newborns were assigned into two groups, randomly. The control group was treated by standard phototherapy without cover around the unit and the covered group received standard phototherapy with white plastic cover around the phototherapy unit. The cover was made of white shiny plastic with thickness of 2 mm, length of 66, width of 36 and height of 45 cm which covered three sides of the unit; one side was uncovered for observing the newborn or performing procedures (Fig. 1). The distance between the infant and the phototherapy lamps was approximately 40 cm.

All the infants under study, before starting phototherapy had detailed physical examination and necessary tests including determining blood group of mother and infant, peripheral blood smear, reticulocyte count, direct and indirect



Fig. 1: White plastic cover around the phototherapy unit

bilirubin estimation, direct Coombs test; measuring glucose-6-phosphate dehydrogenase enzyme were ordered. After enrolment, the total serum bilirubin was measured every 12 hours and whenever the serum bilirubin level reached 12.5 mg/dl or was less than that, the infant was discharge from the hospital. Axillary temperature of the newborns was measured every six hours and infants were also evaluated during phototherapy for possible side effects such as hyperthermia, rash, dehydration etc. (Criteria for dehydration in studied neonates were oliguria, i.e. urine output <1cc/kg/hour, poor skin turgor and sunken anterior fontanel). For all the studied infants, continuous standard phototherapy units (model DAVID XHZ2-90) with 6 blue lamps (Philips TL 20W/52, Philips Lighting Co., The Netherlands) were used. All units used in the study were serviced before the study. While under phototherapy, neonates were left uncovered except for eye pads and diapers. Duration of phototherapy from the start to the end point was also recorded in hours.

The eligible neonates were randomized by sealed, opaque envelopes to Control group or Covered group. With 95% of confidence level and 80% power of test, 91 neonates for each group was calculated as the minimum sample size. Fig. 2 details the flow of participants in the trial.

To ensure the matching of quantitative variables such as gestational age, we used Leven and independent simple t tests and for qualitative variables such as sex we used chi-square test. The same tests were also used to compare bilirubin level, hospital stay and potential complications in the two groups. We used KS test for ensure the normality of variables distribution for applying parametric or nonparametric tests. In all cases, the confidence level of $P < 0.05$ was considered as significant between the groups. All of the statistical methods were applied by SPSS 16.0. The study was approved by Ethics Committee of Kermanshah University of Medical Sciences. A written informed consent was taken from one of the parents prior to enrollment after explaining the study in their local language. At any time,

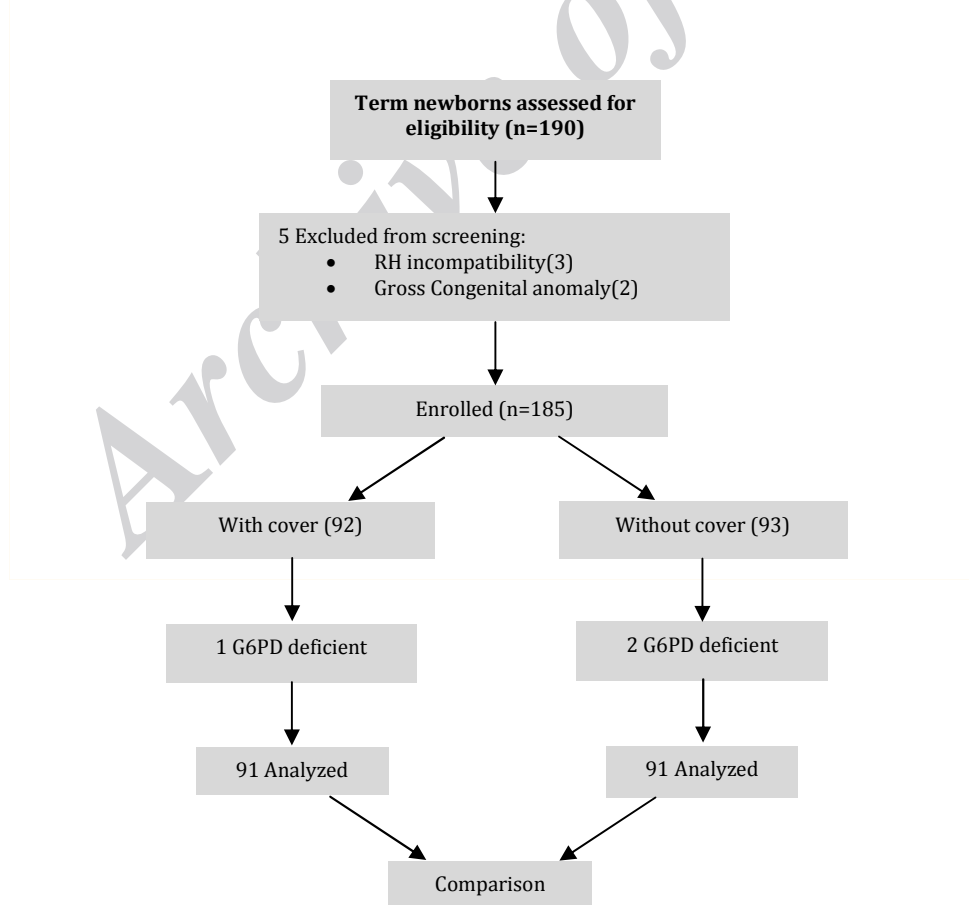


Fig 2: The Flow Chart of study on white plastic cover around the phototherapy unit

Table 1: Demographic parameters in two group conventional phototherapy with and without cover

Parameters	Covered group (n=91)	Control group (n=91)	P value
	Mean (SD)	Mean (SD)	
Female/male	59/32	59/32	1.000
Gestational age (wks)	38.2 (0.7)	38.1 (0.7)	0.4
Birth weight (g)	3082 (362)	3182 (386)	0.07
Post natal age at admission (d)	5.8 (1.9)	6.2 (2.1)	0.2
Weight at admission (g)	3054 (351)	3085 (349)	0.5
Hemoglobin (g)	15.4 (1.6)	15.1 (1.9)	0.2
Hematocrit (%)	44.1 (4.8)	5.5(44)	0.9
Reticulocyte count (%)	1.76 (1.1)	0.8(1.7)	0.7

SD: Standard Deviation

parents were free to withdraw their neonates from the study.

Findings

A total of 185 full term infants entered the study. One neonate was excluded from the covered group and two cases were excluded from the control group due to G6PD deficiency. Finally 182 babies, who had the eligibility criteria, were enrolled. There were 91 babies in each group.

The study groups showed no significant difference in gestational age, male/female ratio, birth weight and other neonatal variables (Table 1). Serum bilirubin levels at admission and in 12 hour intervals after starting phototherapy were measured (Table 2). Serum bilirubin in covered group was significantly more decreased than in infants of the control group. The decline has been shown as reduction of the number of hospitalized infants and also decreased serum level of bilirubin.

Complications in infants during phototherapy were evaluated. As can be seen in Table 3, using cover around the phototherapy unit not only did not increase phototherapy complications but also showed positive effects in decreasing duration of hospital stay.

Discussion

The present results show that using white plastic cover around the phototherapy unit can accelerate decreasing serum level of bilirubin in neonates, and decreases duration of hospital stay, without increasing phototherapy complications. Other studies conducted in this field show results similar to the findings of our study. In a study performed by Djokomulijanto et al to evaluate the use of white curtains around the beds of infants treated by phototherapy, 97 newborns were studied. The results showed that the rate of bilirubin level decline in case group (25.24 $\mu\text{mole/l}$) was

Table 2: Total serum bilirubin (TSB) changes in case and control groups (with and without cover)

Parameters	Covered Group	Control Group	P value
TSB at admission	19.5 (1.3) [n=91]	19.6 (1.1) [n=91]	0.5
TSB at 12h after starting phototherapy	16.0 (2.2) [n=91]	16.9 (2) [n=91]	0.009
TSB at 24h after starting phototherapy	13.7 (2.1) [n=86]	14.8 (2.3) [n=90]	0.001
TSB at 36h after starting phototherapy	12.6 (1.9) [n=62]	13.6 (2.4) [n=78]	0.005
TSB at 48h after starting phototherapy	12 (1.9) [n=30]	13.3 (2.1) [n=52]	0.003
TSB at 60h after starting phototherapy	11.6 (2.5) [n=7]	13.1 (2.3) [n=31]	0.1
TSB at 72h after starting phototherapy	10.7 (0.7) [n=2]	12.5 (2.3) [n=18]	0.3
TSB at 84h after starting phototherapy	0	12.4 (2.5) [n=10]	-
TSB at 96h after starting phototherapy	0	13.5 (2.1) [n=4]	-
TSB at 108h after starting phototherapy	0	15.0 (4.1) [n=2]	-

Table 3: Phototherapy side effects and primary outcomes in both groups (with and without cover)

Parameters	Covered group (n=91)	Control group (n=91)	P value
Skin rash	18	16	0.8
Dehydration	0	0	-
Hyperthermia	3	4	1.00
Mean duration of phototherapy(h)	36.6 (12.9)	50.3 (23.8)	<0.0001
Mean duration of hospital stay (h)	43.1 (13.3)	85.2 (23.8)	<0.0001

significantly greater than in control group (24.27 μ mole/l) ($P<0.001$) [6]. Also duration of phototherapy in the case group was dramatically shorter (12 hours) than in control group. Additionally, in the case group no increase in the rate of complications of phototherapy was observed than in control group[6].

In our study the neonates with hemolysis were excluded because their serum bilirubin rises rapidly and the potential of need for intensive phototherapy or blood exchange is high. In another study, unlike our study, no dramatic difference was found in the phototherapy duration between the two groups[7], perhaps because of using a cover with low reflection coefficient. In Hansen' et al study, using white pads around the infant's bed during phototherapy resulted in Irradiance increase and thus shortened the duration of phototherapy[8].

Recently it has been shown that the use of LED (Light Emitting Diode) lamps in the phototherapy units are as effective as fluorescent lamps in the treatment of jaundice, while producing less heat[9]. Also, a study conducted by Salehzadeh et al showed that the use of mirror behind phototherapy lamps can enhance the effectiveness of phototherapy without increasing the risk of hyperthermia[10]. In our study, the neonates were regularly evaluated for phototherapy complications. The cover did not interfere with feeding or nursing procedure.

As shown by the above studies and our study results, it seems that using a white plastic cover around the phototherapy unit can enhance the phototherapy effect in reducing serum bilirubin level, as it increases the reflection of the light on the baby's body surface. This method can decrease duration of treatment in infants without increasing the side effects of phototherapy.

Although we found some limitations in our study, our results are still very impressive. The

sample size is not big enough and this may mask otherwise significant results. Another limitation was, we didn't check average irradiance (as measured in units of microwatts per square centimeter per nanometer (μ W/cm²/nm)) on the skin surface of newborns because we had no access to a photo radiometer.

Conclusion

These study results showed that using white plastic cover around the phototherapy unit increases the effects of phototherapy in reducing bilirubin level of serum and decreases duration of infants' hospitalization, without increasing phototherapy side effects.

Acknowledgement

We thank Mrs Shokofeh Javid for her collaboration. This clinical trial study was registered in IRCT with registration number IRCT201010184961N1

Conflict of Interest: None

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