

Changes on Total Serum Bilirubin and Infant's Position during Phototherapy

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Abstract

Background: Hyperbilirubinemia is a problem that occur during neonate. In management of neonatal hyperbilirubinemia, phototherapy is a method to decrease total serum bilirubin (TSB). During phototherapy, changing position of neonates every 3 hours may reduced TSB rapidly.

Objectives: To analyze the reduction of TSB during conventional phototherapy in supine position exclusively versus alternated position every 3 hours.

Methods: A randomized controlled study was conducted in July to October 2012 in neonatology unit Adam Malik and Pirngadi General Hospital Medan, North Sumatera, Indonesia. Sample was selected i.e physiological neonatal hyperbilirubinemia, with gestational age between ≥ 32 to ≤ 42 weeks. At the beginning of phototherapy, TSB was measured and also after 24 hours phototherapy. The analysis used dependent t-test.

Results: A total 76 neonates were included in this study. In each group, TSB level of 38 neonatal decreased after 24 hours of phototherapy (3.8 mg/dL) in group with position changes every 3 hours mean while 3.7 mg/dL in supine position ($P = 0.751$).

Conclusion: There was no significant difference in the decrease in TSB levels between the groups alternating position every 3 hours and the supine position

Keywords: hyperbilirubinemia, neonates, phototherapy, position

1. INTRODUCTION

Hyperbilirubinemia is an increase of bilirubin level in plasma by 2 standard deviations or above the 90th percentile of expected value of an infant age.¹ This is the most common in newborns,^{2,3} clinically manifests when serum bilirubin levels increases more than 5 to 7 mg/dl,¹ with a quite high incidence rate, especially in premature infants and often occurs in the first week of life.⁴

Phototherapy is a physically apparent therapy using light as a treatment for hiperbilirubinemia.⁵ This treatment goal is to limit the increase bilirubin and to prevent it to become serious permanent neurological complications (Kern icterus).⁶ The effect of phototherapy is associated with higher levels of bilirubin in the skin and light intensity. The light intensity itself is influenced by the distance between light and skin, body surface area, the

type and wavelength of light.^{5,6} Changing position may improve the effectiveness in reducing TSB and shorten duration of this therapy. The evidence supporting this practice of changing position is still limited.⁷

2. METHODS

A randomized controlled trial study was conducted at Unit Neonatology H. Adam Malik and Pirngadi General Hospital from July 2012 to October 2012. Inclusion criteria were hyperbilirubinemia in infants with 32 to 42 weeks, birth age of 24 hours to 7 days, and meet the indications for phototherapy. Exclusion criteria were infants with the indication of exchange transfusion, hemolytic disease, and congenital anomaly.

Considerations for phototherapy was done based on TSB that are customized according to age (hours) and body weight as recommended by AAP for infants with hyperbilirubinemia.

Subjects allocation were performed with simple randomized using sealed envelopes. Before phototherapy, routine blood tests, total serum bilirubin, bilirubin direct, Coomb test and reticulocyte count were performed.

Phototherapy was given by using standard phototherapy unit branded Tessna contained 5 pieces of parallel positioned blue light lamp (Toshiba brand 20WT52). The treatment was given continuously, except while feeding and nursing in the last 30 minutes of every 3 hours. Infants were placed naked in their bed except for a diaper and eye protection. Infants were treated with the lights at a distance of 20 cm between infants and lamps.

Both groups were given additional fluids as much as 10% of the total fluid demand both orally or intravenously. Measurement of TSB level was performed after 24 hours. Examination of the intensity of blue light was performed by using a Radiometer branded Dale 40 produced in 2008. Discontinued of phototherapy was done if TSB levels reached normal limit in accordance with AAP criteria or found any side effects. Measurement of body temperature was done in the armpit of every infant.

Ethics Committee of the Faculty of Medicine, University of Sumatera Utara was approved this study. For parents of infants were obtained verbal and written informed consent.

3. STATISTICAL ANALYSIS

Data were processed using a computerized program with CI 95% and level of significance $P < 0.05$. To see the difference of reduction in TSB levels between two groups, was used t-independent test. To see the difference of TSB levels before and after treatment, was used t-dependent test..

4. RESULTS

There were 89 neonates who suffered neonatal hyperbilirubinemia and 9 were excluded (4 infants had hyperbilirubinemia direct, 3 infants suffered from congenital anomaly and 2 infant refused). Eighty infants fulfilled the inclusion and exclusion criteria, from which four did not complete the study (2 infants were taken home before the treatment was completed, and 2 others did not have complete medical record due to the parent's unwillingness about invasive procedure of blood sampling). Achievable population were 76 infants. From both units, 52 infants (68%) were admitted to H. Adam Malik General Hospital and 24 other (32%) were admitted to Pirngadi General Hospital. All subjects were divided as infants with alternated positions and supine only positions. Every 3 hours, infants from the first group were positionally alternated supine to prone position and viceversa. (figure 1)

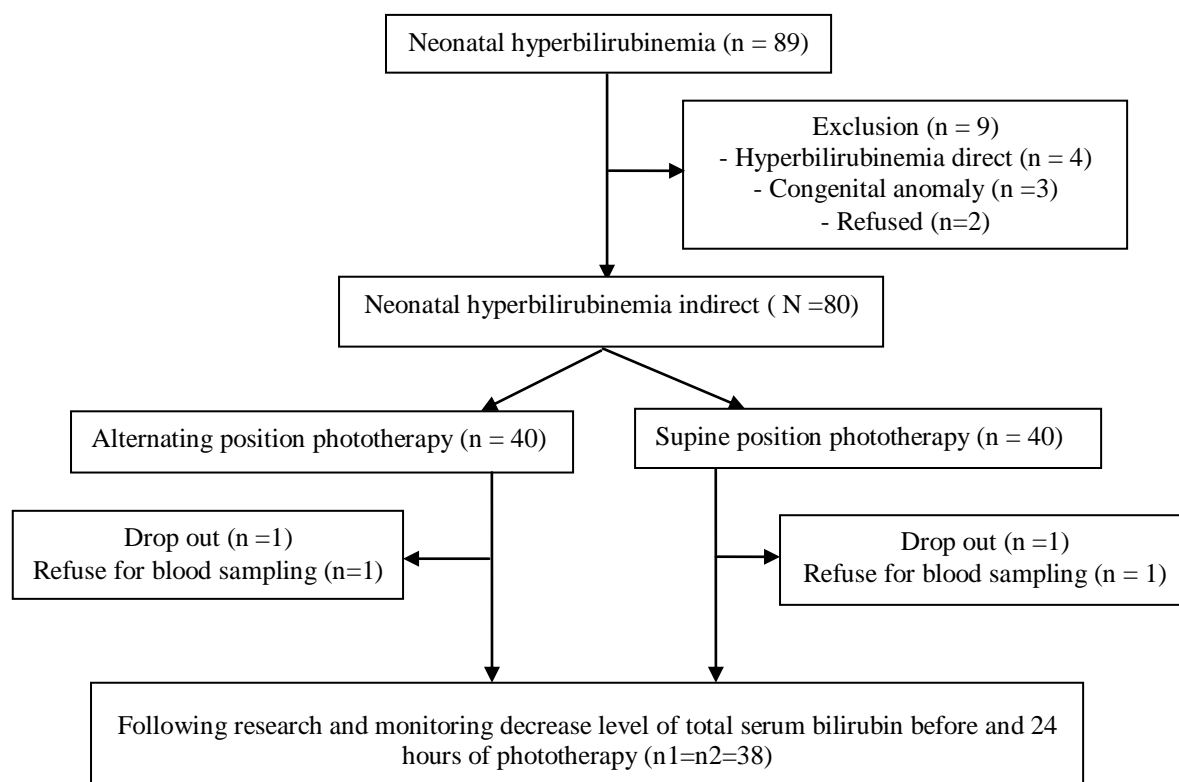


Figure1. Study flow chart

Table1. Baseline characteristics in the study

Characteristics	Position			
	Alternating (n = 38)		Supine (n = 38)	
Day care (days), mean (SD)	5.0	(1.39)	5.0	(1.20)
Gender, n (%):				
- Male	15	(39.5)	20	(52.6)
- Female	23	(60.5)	18	(47.4)
Birth weight ‘	2810.5	(660.42)	2509.1	(57.02)
Gestational age, n (%)				
- 34 – 36 weeks	16	(42.1)	27	(71.0)
- 37 – 39 weeks	18	(47.4)	8	(21.0)
- 40 - 42 weeks	4	(10.5)	3	(8.0)
Temperature (°C), mean (SD)	36.9	(0.92)	36.9	(0.29)
Feeding during, n (%)				
- Breast milk	11	(29.0)	12	(31.6)
- Formula	6	(15.8)	10	(26.3)
- Breast milk and formula	21	(55.2)	16	(42.1)
Haemoglobin	14.3	(3.43)	15.3	(3.80)
Hematocrite	37.8	(8.53)	36.9	(8.96)
Leucocyte	11.8	(5.44)	12.4	(5.95)
Trombocyte	170105.3	(50123.00)	187084.1	(52559.75)
Reticulocyte	1.9	(0.65)	2.1	(0.29)
Albumine	2.7	(0.16)	2.7	(0.18)
CRP, n (%):				
- Positive	0	(0)	0	(0)
- Negative	38	(100)	38	(100)
Coomb test, n (%):				
- Positive	0	(0)	0	(0)
- Negative	38	(100)	38	(100)
Light irradiance (µW/cm ² /nm)	8.5	(0.50)	8.4	(0.55)

Baseline characteristic feature of infants in both alternating and supine only groups can be seen in table 1. Assessment includes day care, gender, birth weight, gestational age, body

temperature, feeding, hemoglobin, hematocrit, leucocytes, platelets, reticulocyte, CRP, Coomb test and light irradiance.

Table2. Total serum bilirubin level in alternating and supine position group before and after 24 hours phototherapy

Position	Before phototherapy	After 24 hours phototherapy	P (95% CI)
Alternating :			
Total serum bilirubin (mg/dL), mean (SD)	14.6 (3.24)	10.8 (3.38)	0.0001 (3.969;4.587)
Direct bilirubin	0.6 (0.24)	0.4 (0.21)	0.0001 (0.163;0.249)
Supine :			
Total serum bilirubin	16.1 (2.37)	12.4 (2.44)	0.0001 (3.320;4.122)
Direct bilirubin	0.6 (0.24)	0.4 (0.20)	0.0001 (0.138;0.296)

At the initial examination of the total serum bilirubin levels, the difference between the groups was found significant.

Table3. Reduction of total serum bilirubin level in two groups after 24 hours phototherapy

	Position		
	Alternating (n = 38)	Supine (n = 38)	P (95% CI)
Total serum bilirubin decreasing			
Serum bilirubin (mg/dL), mean (SD)	3.8 (2.42)	3.7 (1.23)	0.751 (1.086;0.789)
Direct bilirubin (mg/dL), mean(SD)	0.2 (0.15)	0.2 (0.15)	0.278 (0.121;0.036)

Table 3 shows that reducing TSB levels between alternating and supine position found no significant differences

5. DISCUSSION

Hyperbilirubinemia is one of the problems that often are found in new born baby.⁷ The assessment of baseline characteristics in both groups from this study includes gender, birth weight, gestational age, body temperature, feeding, hemoglobin, hematocrit, leucocytes, platelets, reticulocyte, CRP, Coomb tests, and light irradiance. The average age of neonatal phototherapy began at age 4 to 5 days, this is related to an increase in bilirubin levels peak at age 3 to 5 days.⁸

We found that the level of albumin in both groups was 2.7 mg/dL. Albumin functioned as a carrier for indirect bilirubin to be conjugated in the liver for further degradation process.^{8,9} Albumin bound bilirubin is a dianion form. Every 1 g of albumin has a capacity to bind able to bind bilirubin as much as 8.3 mg, infants with the level of albumin as much as 3.0 to 3.5 g/dL should be able to bind bilirubin as much as 25 to 28 mg/dL (428 to 479 $\mu\text{mol/L}$).^{9,10} A clinical trial research in Iran showed that infusion of albumin 20 % of 1g/kg body weight in term neonates who had hyperbilirubinemia and exchange transfusion thereafter could lower indirect bilirubin level significantly compared to the group that only performed exchange transfusion without infusion of albumin.¹⁰

Phototherapy is indicated in infants with hyperbilirubinemia based on total serum bilirubin and risk factors,^{11,12} or the increasing amount of TSB level according to age in full term infants, or body weight in preterm neonates, which is in accordance with the recommendation of the *American Academy of Pediatrics* (AAP).¹³ Changing position has been known to maximize the area exposed to light resulting the reduction of phototherapy duration.⁷

Our findings the decreasing amount of serum bilirubin levels before and after 24 hours of phototherapy showed a statistically no significant result between the alternating positioned group and the supine only positioned group ($P=0.751$). A randomized study in Israel on 30 aterm infants reported that total serum bilirubin level decreased significantly in infants with supine position.¹⁴

A randomized controlled trial in Iran on 50 aterm infants that reported an insignificant difference in the reduction of total serum bilirubin level between infants who received phototherapy in supine position and those who received phototherapy in changing position

every 150 minutes.¹⁵ A study of 24 hour phototherapy on 44 hyperbilirubinemia aterm infants from Okayama (Japan) reported that the reduction of TSB level between supine position and the six hourly changed position group weren't significant.¹⁶

The effectiveness of phototherapy depend on the irradiance of the light generated by the light source using blue light.^{17,18} The best distance to reduce levels of TSB is 10 cm with a decrease in total serum bilirubin levels of approximately 58 % compared with a distance of 30 cm with a decrease in total serum bilirubin levels of around 45 % and 50 cm with a decrease in total serum bilirubin levels of approximately 13 %.^{6,19} *American Academy of Pediatrics* (AAP) recommends phototherapy with a distance of 10 cm except by using halogen light source.¹¹ A distance of 20 cm between lamps and infant was used in this study.

Phototherapy standard should provide a light irradiance of 8 to 10 $\mu\text{W/cm}^2/\text{nm}$. *American Academy of Pediatrics* (AAP) defines intensive phototherapy as a phototherapy producing a light irradiance of at least 30 to 40 $\mu\text{W/cm}^2/\text{nm}$ and wavelentgths covering the entire surface of the neonate's body.¹⁴

In this research we found that the change in irradiance of light before and after phototherapy, either in alternated position group or supine position group, is still in normal range which is 8.5 $\mu\text{W/cm}^2/\text{nm}$ and 8.4 $\mu\text{W/cm}^2/\text{nm}$, respectively.

Monitoring of body temperature and fluid administration was performed intensively. Breastfeeding was given every 3 hours in exclusively breastfeed infants. When the infants received intravenous fluids, the amount of fluid was increased by 10 % of the total fluid demand per day. The body temperature was measured hourly.⁹ when the body temperature of the neonates was more 37.5°C, the room temperature was adjusted or the neonate was moved temporarily from phototherapy unit until his or her body temperature reached 36.5°C to 37.5°C.

Side effects of hyperthermia were found in both groups 6 infants in alternated position changed in 6 infants, the group in supine position include 4 infants with temperatures ranging from 37.7°C to 37.9°C. Both group of infants with hyperthermia moved temporarily from the unit phototherapy until the temperature become normal.

6. CONCLUSION

Decreasing TSB levels were not significant in infant between groups alternating position every 3 hours and supine position.

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