

## NON INVASIVE TRANS-CUTANEOUS BILIRUBIN AS A SCREENING TEST TO IDENTIFY THE NEED FOR SERUM BILIRUBIN ASSESSMENT IN HEALTHY TERM NEONATES

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### ABSTRACT

**INTRODUCTION:** Hyperbilirubinemia is a common problem in the neonates. It can progress to develop kernicterus unless intervention is initiated. Severity of jaundice and decision for management are usually based on total serum bilirubin (TsB) estimation which technique and results closely correlates with total serum bilirubin levels.

**OBJECTIVES:** To compare the accuracy of visual assessment of jaundice by single trained observer based on Kramer's index with total serum bilirubin levels in healthy term neonates. To compare accuracy of non invasive bilirubin assessment with serum bilirubin levels, to compare trans-cutaneous bilirubin assessment on different sites (forehead and sternum) and to develop a cutoff point of trans-cutaneous bilirubin level for serum bilirubin assessment.

**METHODS:** This prospective study was conducted in the Neonatal unit of the department of Paediatrics at Kasturba Hospital, Manipal. Study period was from October 2007 to June 2008. Clinical assessment of jaundice was done in healthy term neonates by observer (Trained Paediatric Post Graduate Resident) based on Kramer's index. Transcutaneous bilirubin assessment was done on the forehead and sternum of each baby using JM-103 Minolta. Air shields bilirubino meter. Serum bilirubin level was measured within 30 minutes of the clinical assessment for each baby.

**RESULTS:** This study included 187 healthy term neonates. The mean birth weight was 2856.83 gm  $\pm$  493.89 gm and mean gestation was 38.25  $\pm$  1.030 SD. Clinical assessment and Transcutaneous bilirubin (TcB) significantly correlated with total serum bilirubin (TsB), with correlation co-efficient of 0.757 and 0.801 respectively (p 0.0001). Transcutaneous bilirubin assessment over forehead showed a tendency to under estimate total serum bilirubin, with mean difference of -0.31 mg/dl, SD 1.75 mg/dl with 95% confidence interval of the mean -0.60 and -0.02 mg/dl (p value 0.05). Transcutaneous bilirubin assessments between 10 mg/dl to 15 mg/dl correlated accurately with total serum bilirubin levels avoiding blood sampling.

**CONCLUSION:** Trained observer clinical assessment of jaundice can be used for screening neonatal jaundice. Non invasive transcutaneous bilirubin assessment has demonstrated significant accuracy with serum bilirubin level estimates between 48 hours to 7 days on two different sites forehead and sternum.

**KEYWORDS:** Hyperbilirubinemia, Serum Bilirubin, Jaundice.

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## INTRODUCTION

Jaundice comes from the French word 'jaune' which means 'yellow'. When it is said that a baby is jaundiced, it simply means that the colour of the skin appears yellow, which is often seen in the first few days after birth. The yellow colour is due to bilirubin that is produced when red blood cells get old and are broken down by the body.

Jaundice is a common problem in the first week of life. It is a cause of concern for the physician and a source of anxiety for the parents. High bilirubin levels may be toxic to the developing central nervous system and may cause neurological impairment even in term newborns.<sup>2</sup>

Jaundice due to physiological immaturity of newborn babies is seen in nearly 60% of term and 80% of pre term. Adults appear jaundiced when the serum bilirubin level is greater than 2 mg/dl, and newborns appear jaundiced when it is greater than 7 mg/.

The yellow colour usually results from the accumulation of unconjugated, non polar, lipid-soluble bilirubin pigment in the skin. This unconjugated bilirubin (designated indirect acting by nature of the Van den Bergh reaction) is an end product of heme protein catabolism from a series of enzymatic reactions by heme-oxygenase and biliverdin reductase and non enzymatic reducing agents in the reticulo endothelial cells. It may also be due to part in deposition of pigment from conjugated bilirubin, the end product from indirect, unconjugated bilirubin that has undergone conjugation in the liver cell microsome by the enzyme uridine diphosphoglucuronic acid (UDP) glucornyl transferase to form the polar, water-soluble glucornide of bilirubin (direct reacting). Although bilirubin may have a physiologic role as an anti-oxidant, elevated levels of indirect, unconjugated bilirubin are potentially neuro-toxic. Even though the conjugated form is not neuro toxic, direct hyperbilirubinemia indicates potentially serious hepatic disorder or systemic illness.<sup>4</sup>

One simple approach that has been used elsewhere to determine the need for serum bilirubin testing is the progression of yellow discolouration of the skin from cephalo-caudal progression using the Kramer's rule. The scale is based on a 1969 study of 108 full term infants which found that bilirubin concentrations correlated to 5 specific 'dermal zones' (1) head and neck, (2) upper trunk, (3) lower trunk and thighs, (4) arms and legs below the knees, (5) hands and feet. Lowest total serum bilirubin levels were associated with yellow discolouration of the head and neck only and highest levels where the discolouration extended to the hands and feet.

Transcutaneous bilirubinometer (TcB; Minolta Air shields Jaundice meter) proved to be a useful new device for the clinical screening of neonatal jaundice. It is non-invasive, non traumatic and easy to operate. Study demonstrated a good correlation between transcutaneous bilirubinometer reading and serum bilirubin.<sup>6</sup> The transcutaneous bilirubinometer is a reflectometer which permits the non invasive monitoring of neonatal hyper bilirubinemia.<sup>7</sup>

**Figure 1: JM-103 Minolta Air shields Transcutaneous bilirubinometer**



## MATERIAL AND METHODS

This prospective study was conducted in the neonatal unit of the department of Paediatrics at Kasturba Hospital, Manipal. Study period was from October 2007 to June 2008. Healthy term neonates from birth upto day seven (7) postnatal age with jaundice were included in the study.

Term neonates were included in the study where visual observation of jaundice by trained paediatric postgraduate raised concern for risk of hyperbilirubinemia and necessitated serum bilirubin determination. Clinical assessment of jaundice was done in each baby in diffuse natural day light by observer, based on Kramer's index.

Transcutaneous bilirubin assessment was done on the forehead and sternum of each baby using JM-103 Minolta Air shields bilirubinometer. Serum bilirubin level was measured within 30 minutes of the clinical assessment for each baby. Specific age in hours at the time of study was recorded along with birth weight and gender.

All Transcutaneous bilirubin assessments were performed by one investigator using JM-103 Minolta Air shields bilirubinometer. The fibre optic probe was placed against the forehead and sternum of the infant in supine position. Gentle pressure was applied during measurement to ensure an event contact of the probe and skin. These three (3) consecutive

scans were performed and a computerized mean value was displayed as transcutaneous bilirubin in mg/dl. Total serum bilirubin (TsB) was measured by clinical laboratory method by using direct spectral method.

## RESULTS

Correlation between transcutaneous bilirubinometer (forehead) and total serum Bilirubin measurement

**Table 1: Correlation between TcB and TsB value**

S.No.	Mg/dl	Mg/dl	Correlation coefficient (r)
1.	Clinical assessment	Total serum bilirubin	0.757
2.	TcB (forehead)	Total serum bilirubin	0.798
3.	TcB (sternum)	Total serum bilirubin	0.801

The correlation coefficient between clinical assessment, TcB forehead and sternum with total serum bilirubin values were significant ( $r=0.757$ ,  $r=0.798$ ,  $r=0.801$  respectively,  $p>0.0001$ ).

**Table 2: Comparison between transcutaneous bilirubinometer (forehead) versus total serum bilirubin**

S.No.	Forehead (mg/dl)	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16-17.9
	n=187	n=10	n=26	N=53	N=40	N=40	n=18
1.	6-7.9	5	3	0	0	0	0
	n=8	50.0%	11.5%				
2.	8-9.9	4	12	12	2	2	0
	n=32	40.0%	46.2%	22.6%	5%	5%	
3.	10-11.9	1	10	24	11	3	0
	n=49	10%	38.5%	45.3%	27.5%	7.5%	
4.	12-13.9	0	1	14	19	18	3
	n=55		3.8%	26.4%	47.5%	45%	16.7%
5.	14-15.9	0	0	2	8	16	10
	n=36			3.8%	20%	40%	55.6%
6.	16-17.9	0	0	1	0	1	5
	n=7			1.9%		2.5%	27.8%

The accuracy of TcB (forehead) reading over forehead was 50%, 46.2%, 45.3%, 47.5%, 40% and 27.8% in range of 6-7.9mg/dl, 8-9.9mg/dl, 10-11.9 mg/dl, 12-13.9 mg/dl, 14-15.9 mg/dl and 16-17.9 mg/dl respectively.

Forehead assessment of transcutaneous bilirubin with serum bilirubin showed strong correlation in the respective group categories.

**Table 3: Comparison between transcutaneous bilirubinometer (sternum) with total serum bilirubin**

S.No.	Sternum (mg/dl)	6-7.9	8-9.9	10-11.9	12-13.9	14-15.9	16-17.9
	n=187	n=10	n=26	N=53	N=40	N=40	n=18
1.	6-7.9	5	1	0	0	0	0
	n=6	50.0%	3.8%				
2.	8-9.9	4	13	13	1	2	0
	n=33	40.0%	50%	24.5%	2.5%	5%	
3.	10-11.9	1	10	21	8	0	0
	n=40	10%	38.5%	39.6%	20%		
4.	12-13.9	0	2	15	17	16	0
	n=50		7.7%	28.3%	42.5%	40%	
5.	14-15.9	0	0	3	14	18	11
	n=46			5.7%	35%	45%	61.1%
6.	16-17.9	0	0	1	0	4	7
	n=12			1.9%		10%	38.9%

The accuracy of TcB reading over sternum was 50% in TsB range of 6-7.9 mg/dl and 8-9.9 mg/dl. In the other TsB ranges, the accuracy varied from 38.9% to 45%.

Sternum assessment of transcutaneous bilirubin with total serum bilirubin showed strong correlation in the respective group categories.

**Table 4: Sensitivity and specificity of TcB (forehead) to predict TsB levels**

Total Serum Bilirubin	Transcutaneous bilirubinometer (forehead) mg/dl	Sensitivity	Specificity
10mg/dl	10.45	79.3%	77.8%
12mg/dl	12.05	81.1%	82.4%
13mg/dl	12.35	82.4%	81.4%
15mg/dl	13.60	83.9%	82.9%

The sensitivity and specificity of TcB at an increment of 1mg/dl when compared to TsB levels of 10, 12, 13 and 15 mg/dl which were the hour specific thresholds that indicates the need for phototherapy.

As shown in this table sensitivity was equal to specificity for transcutaneous bilirubinometer cut off value of 10.45, 12.05, 12.35 and 13.60 mg/dl. Thus predicting accurate correlation with total serum bilirubin reading and transcutaneous bilirubinometer reading at these four values.

Transcutaneous bilirubinometer (forehead) values between 10 to 15 mg/dl correlate accurately with total serum bilirubin.

## CONCLUSION

1. Visual assessment of jaundice by trained observer based on Kramer's index could be used for screening purpose in neonatal jaundice.
2. Transcutaneous bilirubinometer assessment could be used for screening purpose of neonatal jaundice between 48 hours of age to 7 days of life.
3. Non invasive transcutaneous bilirubin assessment by JM-103 has demonstrated significant accuracy when compared to total serum bilirubin measured by clinical laboratory method. It can be favourably used as a screening test to identify the need for serum bilirubin measurement when transcutaneous bilirubin levels are more than 10,12,13,15 mg/dl at specific age in hours.
4. Transcutaneous bilirubinometer could be accurately used to measure bilirubin for screening purpose at two different sites namely forehead and sternum.
5. Transcutaneous bilirubinometer values between 10 mg/dl to 15 mg/dl accurately measures total serum bilirubin. Hence, total serum bilirubin assessment based on blood sampling could be avoided between 10 mg/dl to 15 mg/dl of Transcutaneous bilirubinometer assessment. The measurement technique is rapid and simple. It is easy to perform repeated measurements over time. Thus reducing the like hood of error.
6. Transcutaneous bilirubinometer measurements beyond 15mg/dl require to be correlated with total serum bilirubin levels.

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