TRANSCUTANEOUS BILIRUBINOMETRY: CLINICAL APPLICATION

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ABSTRACT

Simultaneous estimations of serum and transcutaneous bilirubin were done in 105 healthy, full term, jaundiced newborns. A good correlation was found between the transcutaneous and serum bilirubin values with coefficient of correlation 0.774. The observed sensitivity was 90%, specificity 78% and positive predictive value 64% at mean serum bilirubin concentration of 9.92 mg/dl. Two action levels at transcutaneous bilirubin values 15 and 18 were also generated that correlated with low and high serum bilirubin values; they can therefore be used for screening of jaundiced full term babies. This study indicates that the transcutaneous bilirubin meter is useful for screening of jaundiced neonates (JPMA 43: 28, 1993).

INTRODUCTION

Neonatal jaundice is common and is often associated with neurological complications. Its management depends on proper clinical assessment and accurate determination of bilirubin levels. Apart from visual estimates, biirubin level can be determined qualitatively by Ingram Icterometer using a clear plastic strip with five different shades of yellow colour[1] or by determining serum bilirubin[2]. The recent trend is to use non- invasive methods like jaundice meter (Minolta/Air Shields) for detection of hyperbilirubinaemias[3]. This study is an attempt to determine the accuracy and reliability of transcutaneous bilirubin measurement in healthy full term newborns and to determine the action levels for screening of babies with jaundice for the need to do the serum biirubin testing.

PATIENTS AND METHODS

One hundred and five full term infants born at Lady Willingdon Hospital during five months period (November, 1991 to March, 1992) were studied. Sixty-six babies were delivered through C-Section for various indications and thirty-nine infants through vaginal route. Their gestational period was more than 37 weeks (expected as well as calculated) and they were not receiving phototherapy or exchange blood transfusion. They were brought from postnatal ward or selected by nursery personnel after screening for jaundice. Transcutaneous bilirubin readings were taken from forehead, chest and sternum by the same examiner (A.L.) within 30 minutes before blood sampling for serum bilirubin measurement and a mean value was determined for every patient. The meter readings when babies were not crying as crying may influence the meter readings by increasing the blood flow in skin. The yellow colour of the skin was measured with theAir Shields jaundice meter. This hand held instrument employs fibreoptic techniques to illuminate the skin and subcutaneous tissues and then spectrophotometrically analyses the intensity of yellow colour of the skin. According to manufacturer's recommendation, battery was charged and then instrument standardized before its use on patients[4]. The total serum bilirubin concentration was determined by a standard diazo method. The coefficient of correlation between transcutaneous bilirubin readings and serum bilirubin concentration was calculated by drawing a regression line and then calculating sensitivity, specificity and positive predictive value at

various serum bilirubin values used as a standard.

RESULTS

A total of 105 (61 males, 44 females) infants were included in the study. Mean birth weight was 3050± 2SD 430 gm and mean age 4.39±2SD 1.64 days. Biirubin value, birth weight and age at sampling are shown in Table 1.

TABLE I.Comparison between study parameters in female and male infants.

	Female	Male	Significance
Number	44	61	P<0.025
Birth weight (mean)	3012 G	3085 G	N.S.
+ 2SD	360 G	310 G	
Mode of delivery			
SVD	18	21	P<0.01*
C-Section	26	40	
Age of sampling (mean)	4.76	5.07	N.S.
(Days) + 2 SD	1.88	1.64	
Serum bilirubin mean (mg/dl)	10.17	9.74	N.S.
+ 2SD	7.88	6.22	
Transcutaneous mean	18.68	17.85	N.S.
Bilirubin value + 2SD	7	6.44	

*X^2 = 12.87 (1df) showing significantly higher ratio of deliveries by C-section.

The number of babies delivered through C Section was significantly higher (P< 0.001) than vaginal deliveries. Among 105 neonates, serum bilirubin level was between 0-4.9 mg/dl in 4 babies, between 5-10 mg/dl in 54 babies, between 10-15 mg/dl in 37 babies, between 15-20 mg/cU in 9 babies and above 20 mg/dl in one baby only. However, 50% babies had serum bilirubin levels in the range 5-10 mg/dl and only 9% had levels above 15 mg/cu. The correlation between serum bilirubin and transcutaneous bilirubin value was plotted on a graph. A regression line was drawn and co-efficient of correlation was calculated and found to be 0.774 (P< 0.01) (Figure).

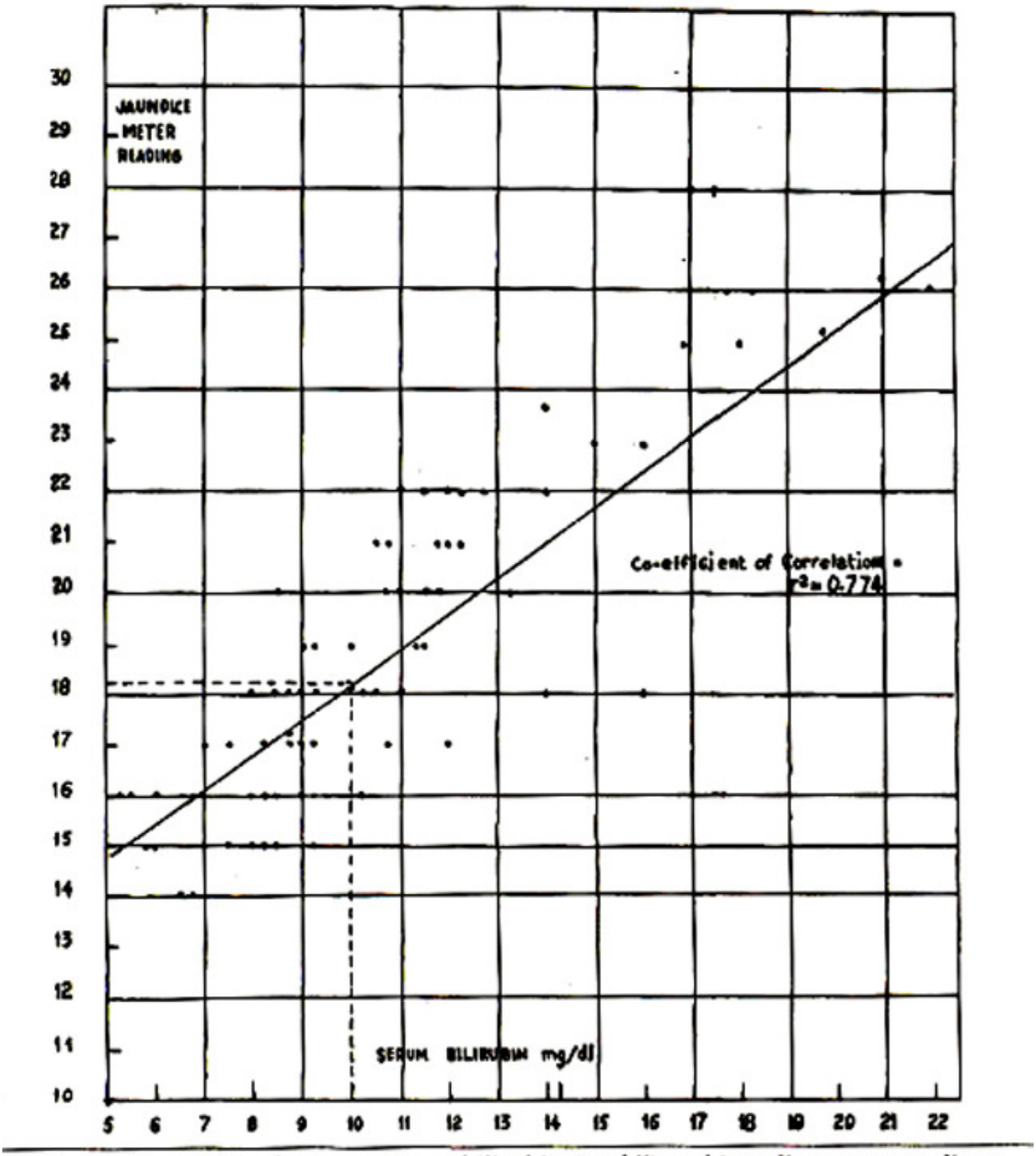

Figure. Correlation between serum bilirubin (mg/dl) and jaundice meter readings among 105 study infants. Action levels generated at transcutaneous bilirubin reading 15 and 18 correspond to serum bilirubin levels 5 and 10 mg/dl respectively.

To determine efficacy of bilirubin meter as a screening device in jaundiced babies, sensitivity, specificity and positive predictive value of transcutaneous bilirubin readings at various serum hilirubin values were estimated as shown in Table II.

TABLE II. Transcutaneous bilirubin estimation as a screening test of raised serum bilirubin.

Transcutaneous bilirubin value vs serum bilirubin level	6 mg/dl*	9.92 mg/dl*	15 mg/dl*
Sensitivity	96.5%	90.62%	90%
Specificity	41.17%	78.08%	98.94%
Positive predictive value	89%	64.4%	90%

*Serum bilirubin levels 6 and 15 mg/dl were arbitrarily selected to detect sensitivity, specificity and predictive value by transcutaneous estimation at low and high values; while level 9.92 mg/dl represents mean serum bilirubin of study infants.

The sensitivity of transcutaneous bilirubin reading was found to be 90.5%, specificity 78% and positive predictive value 64% at mean serum bilirubin value of 9.92 mg/dl.

DISCUSSION

Non-invasive measurement of bilirubin has been done by all practicing paediatricians by observing presence or absence of jaundice and noting its extent. A number of inherent limitations are however present like observer variability, effect of daylight, race and skin blood flow as between any two infants. Many factors other than serum bilirubin are responsible for difference in skin colour. Visual estimates, neither accurate nor precise, have therefore been supplemented with transcutaneous bilirubinometer readings[5]. This study determined the relationship between transcutaneous and serum bilirubin values taken simultaneously. Significantly more male babies were referred for this study (58% vs 42%) as they develop jaundice more often; possibly due to the effects of sex hormones or there is a selection bias for a better medical care for males in our social set-up. Babies born through C-Section outnumbered those born through vaginal route (63% vs 37% with $P< 0.001$). Babies delivered through normal vaginal route are discharged earlier than those born through C-Section. Various Sites of transcutaneous biliruhinometry have been used. However, the overall mean of values from forehead, chest and sternum when compared with individual means was found to correlate better with serum bilirubin concentration[7]. Transcutaneous bilirubin readings were taken at three different sites and mean value were used for correlation. A coefficient of correlation with r value 0.774 was found in this study. Better correlation has been found by others with a r value 0.9-0.95[3,6,7]. The differences may be due to variation in the study design. Firstly, one sample each was taken from 105 neonates. Taking multiple samples and readings from same patients decreases the random error and increases the r value. Secondly, only jaundiced babies we included in this study while in most other studies, all infants were included, thereby increasing the range covered by the data and increasing the r value[8]. Poor correlation is observed when heterogenous population is studied under non-steady state conditions. In clinical practice, populations and chemistry laboratories are homogenous and thus transcutaneous bilirubin estimation cannot routinely replace serum bilirubin measurements[5]. Therefore, the usefulness of transcutaneous bilirubinometer as a screening device for hyper bilirubinemias was assessed. The screening of babies with clinical jaundice does not give a precise level of bilirubin but helps to decide whether the jaundiced newborn needs determination of serum bilirubin. Two action levels were arbitrarily generated that correlate with serum bilirubin values of 5 and 10 mg/dl. According to regression line, transcutaneous bilirubin values were 15 and 18 respectively. Serum bilirubin should be determined at a high reading of 18 or more and not at a low reading of 15 or less. The decision to take a

blood sample when transcutaneous bilirubin reading is in the range 15 to 18 is based on clinical discretion. A screening device's accuracy is defined in terms of sensitivity, specificity and predictive value. The sensitivity of 90%, specificity 78% and positive predictive value 64% are all highly significant in this study. The sensitivity approached 96.5% for low serum bilirubin readings (6 mg/dl) while specificity increased from 41.5% to 98% at high serum biirubin values of 15 mg/dl. This implies that bilirubinometer can strongly indicate whether infant has high serum bilirubin value or not kundson[9] found a good correlation (r=0.84) between transcutaneous bilirubinometry and serum bilirubin readings in 207 full term healthy newborns. He defined action points at bilirubin concentration of 175 u mole/land 225 u mole/l. Observed sensitivityof jaundice meter was 87%, specificity 72% and positive predictive value of 72%. Transcutaneous bilirubin measurement at birth or changes within 24 hours have also been used to detect infants at risk of significant hyper biirubinemia (>15 mg/dl) by determining the ratio of increase of transcutaneous bilirubin during the first 24 hours per Kg birth weight[10]. Clinically healthy mature newborns are at a lower risk of developing bilirubin dependent brain damage even at a serum bilirubin levels upto 200-250 u mole/1 (11.76-14.7 mg/dl) [11]. Serum bilirubin levels were <10 mg/dl in 55% of newborns in this study where serum sampling was not necessary. Only 9. 5% babies had values above 15 mg/dl. Therefore use of ascreening device with suitable action levels could prevent excessive bilirubin sampling. This helps to avoid discomfort of needle pricks to babies and also decreases laboratory work load. A screening device should be cost effective so that it can be employed at various levels of neonatal care. At the present moment, due to high cost (approximately 2500 U.S.$) its use is only justified at large maternity hospitals or large neonatal units for screening purposes. It is also important to note that each neonatal unit should establish its own correlation between transcutaneous bilirubin and serum bilirubin values. Due to differences in lab standards, meter observation, observer variations and race differences a universally acceptable correlation and regression line cannot be drawn[5].

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