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Transcutaneous Bilirubinometery Compared with Serum Level of Bilirubin in Icteric Neonates in Zahedan

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This study was conducted to evaluate relation between Transcutaneous Bilirubin Index (TCBI) and Plasma Bilirubin Concentration (PBC) and to make a conversion table. One hundred and seventy five newborns (102 term and 73 preterm) that were been hospitalized because of hyperbilirubinemia in 2004 in Ali-Asghar Pediatric Hospital and Ghods Maternity Hospital were studied during 8 months. Serum and transcutaneous bilirubin of these cases were measured and recorded at the time of admit. Results showed that there is no relation between bilirubin and gestational age, newborn age, sex, weight and race but by using stepwise regression model a significant relation between glabellar TCBI and serum bilirubin in both term and preterm newborns (r=0.953 in term newborns and r=0.964 in preterm newborns) was observed. There was a positive correlation coefficient between two methods. With these two formulates: SBil=(0.86*TCBI)-0.82 for term neonates and SBil=(0.88*TCB)-1.32 for preterm neonates. A conversion table for changing TCBI to PBC was developed. Bilitest can be recommended for screening and evaluation of icteric neonates using the conversion table.

Key words: Bilitest, Transcutaneous Bilirubin Index [TCBI], serum bilirubin, hyperbilirubinemia

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INTRODUCTION

Hyperbilirubinemia is a significant problem in the context of early discharge since the bilirubin level usually peaks between the third and fifth day of life in term newborns. This condition is in fact the most frequent cause of readmission accounting for 70 to 85% of cases[1,2]. Discharge soon after birth and beginning of therapeutic interventions in jaundiced depends on the assessment of bilirubin serum levels[3].

The decision to measure Serum Bilirubin (SBR) in a jaundiced baby is subjective and depends on the junior doctor or midwife making a clinical assessment of the color of the baby's skin. Measuring SBR in babies with a concentration below the treatment threshold involves unnecessary blood sampling. The wait for the result may also unnecessarily delay discharge of both the mother and baby from the hospital. Transcutaneous bilirubinometry [TcB] is a non-invasive optical wavebands to measure the yellowness of the skin[4].

The studies regarding transcutaneous bilirubinometry basically concerns an instrument that has been commercially available since the early 1980s. The data concerning this technology indicate that in healthy term newborns the Transcutaneous Bilirubin measurement (TcB) or transcutaneous bilirubin index usually correlates well with the blood bilirubin concentration and that there is a linear relationship between these two parameters[5].

Although the TcB measurements correlate well with Serum Bilirubin (SB) levels, they cannot accurately predict serum bilirubin because of error related to a variety of factors. It is a good tool for screening neonates to determine when a laboratory measurement of serum bilirubin is needed[6].

On the other hand, TcB provides a non-invasive, cost-effective screening method for significant neonatal jaundice, sparing infants and parents physical and emotional stress and medical and nursing personnel extra work and inconvenience[7,8]. Also Bilitest provides reproducible data, saved time and costs and often spared infants a capillary or venous blood sample[9]. The accuracy of the Bilitest was not affected by skin color[10]. Also it provides a convenient, non-invasive possibility for bilirubin estimation in preterm infants, but there are limitations[11]. Bilitest measures transcutaneous bilirubin by utilizing the entire spectrum of visible light (380 to 760 nm) reflected by the skin[12].

Because of different in population characteristics and laboratory methods of assaying bilirubin, the manufacturers of the transcutaneous bilirubinometer recommend that each unit should develop a cut off point for use with this instrument that is appropriate for its population[4].

The purpose of the study was to investigate the relationship between Transcutaneous Bilirubin Index (TCBI) and Plasma Bilirubin Concentration (PBC) and to make a conversion table to use for screening and evaluation of icteric neonates.

METHOD AND MATERIAL

A cross sectional study was performed in 2004 in Zahedan, Islamic Republic of Iran. 102 term neonates and 73 preterm neonates were selected. They were hospitalized during 8 months in Ali-Asghar Hospital and Ghods Maternity Hospital. Neonates with hemolysis sepsis cardiac and pulmonary diseases and ABO incompatibility were excluded. At first cutaneous bilirubin was detected by Bilitest device.

The device was Bilitest a product of Technomedica Company (Russia). Transcutaneous or indirect bilirubinometry is a noninvasive technique which usually measures light reflection at the surface of a newborn's skin and which establishes the correlation between this measurement and the blood bilirubin concentration. It contains a fiber optic photocell. When the instrument is pressed against the infant's skin firmly enough a xenon tube emits a light pulse. The light ray is reflected by the skin and thus transmitted to a dichroic mirror (a mirror that reflects light of a given wavelength while allowing a second color to pass through) via a second group of fiber optic filaments. The mirror separates the color into two light spectra which pass through a blue (complementary color of yellow) filter and a green (complementary color of red) filter respectively. The instrument can thus measure the intensity of reflected yellow light by correcting for absorption attributable to the red color of skin (mainly hemoglobin)[6,13].

Bilitest device is designed for detecting subcutaneous bilirubin in neonates. Optical head of the device was made tangent to skin of glabella region for 3-4 sec. The showed number on LCD monitor called TCBI and was recorded in information sheet. In a duration of maximum 30 min serum level of bilirubin based on blood sample was evaluated by spectrophotometery and was reported in mg dL^{-1}. For descriptive analysis, percentage, mean and standard deviation and for analytical analysis chi-square, Pearson correlation and regression model were used.

Although the method was non invasive but we had oral permission of parents. To eliminate bias due to examiners, only four nurses were selected (Two in Ali- Asghar Hospital and two nurses in Ghod's Maternity Hospital) for transcutaneous bilirubinometery. They were trained in two weeks and were expert in working with the device. Laboratory examiners were blind about the results of TCB.

RESULTS AND DISCUSSION

In term neonates 41 (40.2%) and in preterm group 31 (42.5%) were female. There was no significant difference in sex distribution between two groups. Mean age of term neonates was 6.41±4.74 days and of preterm was 5.74±6.15 days and 6.13±5.37 in all of neonates (Table 1).

Mean cutaneous bilirubin in females was 17.75±5.52 and in males was 17.93±5.98. There was no significant difference between males and females. Mean serum bilirubin level in females was 14.37±4.98 mg dL^{-1} and in males was 14.73±5.48 mg dL^{-1}. There was no significant difference between males and females.

Also there was no significant correlation between serum bilirubin level and neonate's age and their weight (Table 2).

For each term and preterm neonates a regression model with stepwise method was used to evaluate relation between age, weight, sex and cutaneous bilirubin with serum bilirubin. Both of models demonstrated significant relation between cutaneous and serum bilirubin. Final model for term neonates ($r = 0.953$, $p<0.001$) was:

S.Bil = 0.86 * T.C.B-0.82

Based on this model if one unit to be added to cutaneous bilirubin, 0.86 units will be added to serum bilirubin.

Also for preterm neonates a regression model with stepwise method showed significant relation between independent variables such as age, weight, sex and cutaneous bilirubin but no relation with serum bilirubin. Final model for preterm neonates ($r = 0.964$, $p<0.001$) was:

S.Bil = 0.88 * T.C.B-1.32

Based on this model if one unit to be added to cutaneous bilirubin, 0.88 units will be added to serum bilirubin.

For comparing term and preterm regression models another model was used to evaluate relation between serum bilirubin with cutaneous bilirubin and gestational age. The gestational age was eliminated from model that means serum bilirubin can be estimated by cutaneous bilirubin without any other confounders. The last regression model was:

S.Bil = 0.876 * T.C.B-1.06 ($r = 0.962$)

Based on this model if one unit to be added to cutaneous bilirubin, 0.876 units will be added to serum bilirubin.

Table 1: Characteristics of icteric neonates hospitalized in Zahedan

Neonates	Term (102 neonates)	Pre-term (73 neonates)
Age (day)	6.41±004.74	5.741±006.15
Weight	2789.90±501.75	2049.600±542.73
Serum bilirubin (mg dL^{-1})	15.70±004.58	13.100±005.79
Transcutaneous bilirubin	19.10±005.06	16.180±006.32

Table 2: Correlation between weight and age of the neonates with transcutaneous and serum bilirubin

Correlation	Term	Pre-Term
Serum bilirubin and age	$r=0.089_{NS}$	$r=0.247_{NS}$
Serum bilirubin and weight	$r=0.117_{NS}$	$r=0.206_{NS}$
Transcutanous bilirubin and age	$r=0.028_{NS}$	$r=0.212_{NS}$
Transcutaneous bilirubin and weight	$r=0.044_{NS}$	$r=0.207_{NS}$

NS = Non significant

Table 3: Conversion measures of serum bilirubin and cutaneous bilirubin

Serum bilirubin (mg dL^{-1})	Cutaneous bilirubin (mg dL^{-1})
3.32	5
4.20	6
5.07	7
5.95	8
6.82	9
7.70	10
8.58	11
9.45	12
10.33	13
11.20	14
12.08	15
12.96	16
13.83	17
14.71	18
15.58	19
16.46	20
17.34	21
18.21	22
19.09	23
19.96	24
20.84	25
21.72	26
22.59	27
23.47	28
24.34	29
25.22	30
26.10	31
26.97	32
27.85	33

Based on the results of regression model a conversion table was developed to assist examiners to estimate serum bilirubin promptly after getting cutaneous bilirubin (Table 3).

Results showed high correlation between the TcB and the bilirubin concentrations. Several researchers observed the same results[3,4,14-16]. Also in our study a conversion table for changing TCBI to PBC was developed. It seems that we can use this table for screening and evaluation of icteric neonates confidentially.

Serum level of bilirubin and cutaneous bilirubin had no significant relation with sex, age and weight, it means that age, sex and weight had no affect on detected bilirubin and we can use the conversion table in both sex and every age and weight. Regression model in term and

preterm neonates did not have any difference so we can use formulate (S.Bili=0.876*TCB-1.06) in all infants.

In present study TCBI less than 9 was as safe signal and TCBI more than 16 was equal to 220 mic mol L^{-1} of bilirubin (PBC). That means a TCBI<9 does not need to anymore evaluation and TCBI>16 is in range of physiologic jaundice (12 mg dL^{-1}). Some studies have reported a TcB cut-off point to show hyperbilirubinaemia[4,16].

Results indicated that Bilitest in higher bilirubin showed big different, so it cannot be used directly to make decisions about transfusions or phototherapy in neonates. This results as the same as several results of other studies[4,6,17].

However, TcB measurements can be used to determine the need for blood sampling in jaundiced babies and will reduce the number of blood samples taken. Since usually parents don't like invasive methods (like blood sampling), TCB could be a good choice to screen and follow up neonatal jaundice. The use of this technology requires close ties with a clinical laboratory in order to ensure optimal and safe utilization. It is necessary to determine of a decision level for eliminating practically all potential false negatives and reducing as much as possible the number of serum bilirubin tests performed.

This assessment report brings out the importance of making early postnatal discharge part of a prenatal program that includes a systematic early visit (no later than the third day after discharge from hospital) to the mother and infant. Since TcB is effective in detecting cases where a serum bilirubin measurement is required making this technology part of a well-established prenatal program presents numerous benefits that could offset the costs associated with it.

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