Comparison Study between Serum and Transcutaneous Bilirubin Measurement with Special Reference to Gestational Age

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Abstract: Objective: To compare bilirubin level of transcutaneous bilirubinometer with serum bilirubin in term and pre-term newborn.

Methods: This prospective analytic study were carried out at NICU of tertiary care center from May to September 2014, which include total 410 neonates (250 term & 180 preterm neonates) during the study period. Simultaneous plasma and transcutaneous (sternal regions) bilirubin assay were performed in term and pre-term newborns. Neonates were divided in 3 groups according to their gestational age, group-1 (28wk-33 wk), group-2(34wk-37wk) and group-3 (38wk -41wk). Results: There were strong correlation between plasma and mean transcutaneous bilirubin assay measured in sternal region in group-3 newborn (CV=0.49, r=0.8599, p<0.001). There were no correlation between plasma and transcutaneous bilirubin in group-1(CV=0.15,r=0.3450,p>0.001) and group-2 (CV=0.18,r=0.4521,p>0.001) suggestive of wide variation in transcutaneous bilirubin value & serum bilirubin value. Conclusion: In pre-term newborn transcutaneous bilirubinometry is less accurate than in term newborns,as results are affected by the immature skin and by a different albumin-to-bilirubin binding.

1. Introduction

The incidence of hyperbilirubinemia has been reported to be between 30-60% in full term newborn and nearly 100% in premature infants (3). The accurate measurement of bilirubin concentrations is essential for diagnosis of hyperbilirubinemia and for guiding the clinician with regard to treatment. The gold standard remains the measurement of serum bilirubin concentration. This method however is invasive, painful and costly in terms of workload, time &money. Moreover, repeated blood samplings may lead to significant blood loss, which may be of particular concern in preterm infants. Hyperbilirubinemia during neonatal period is generally benign, but due to the potential toxicity of bilirubin,newborn infants who are at risk of developing significant hyperbilirubinemia should always be monitored in order to prevent complication of neonatal hyperbilirubinemia like bilirubin encephalopathy, bilirubinometry has been shown to correlate with serum bilirubin concentration in term infants(2,8). In preterm infants transcutaneous bilirubinometry is less accurate than in term infants, as results are affected by the immature skin and by a different albumin-to-bilirubin binding (6,9,10).

2. Materials & Methods

The study was carried out in the neonatal intensive care unit of civil hospital, Ahmedabad, during the period over 6 months (May 2014 to September 2014). Study include 410 neonates admitted during the same period, out of which 250 were term neonates and 160 preterm neonates. Inclusion criteria: (1) Neonates between 28 wk to 41 wk admitted in NICU with indirect hyperbilirubinemia.

Exclusion criteria
(1) Neonates with direct hyperbilirubinemia.
(2) Post term neonate (>42wk)

The study was approved by the local ethics committee, and parental consent was obtained. For the study, transcutaneous bilirubin was measured by transcutaneous bilirubinometer over the sternal area & mean of the three reading was considered & level is displayed in mg/dl. This was done within 15 minutes after the blood sampling & serum bilirubin was performed by Diazo method.

For analysis, the mean of three transcutaneous bilirubin readings was taken and compared with the serum bilirubin concentration. The coefficient of variation (CV) of these three measurement was calculated for three group. The relationship between transcutaneous and serum bilirubin values was determined using simple linear regression analysis. The strength of this relationship was quantified by using the Pearson correlation coefficient r. The agreement between both methods was assessed by the method of Bland-Altman. A multiple linear regression analysis was performed to identify confounders to predict serum bilirubin.

3. Results

A total 180 preterm and 250 term neonates were included in study. The group of preterm infants was subdivided into premature neonates between 28 and 33 weeks of gestation (group 1) and premature infants between 34 and 37 week of gestation (group 2). The term neonates between 37 week and 41 weeks of gestation (group 3). The relationship between serum bilirubin concentration and transcutaneous bilirubin concentration for gestational age group 3 was y=0.50x + 77, for group 2 was Y=0.40x + 110 & group 1 was y=0.36x+115. The relationship for all term infants (y= 250,y=0.50x+77,R² =0.49; P <0.01). For group-1 (y=70; y=0.36x+115,R²=0.15;P<0.001) & For group-2 (Y=110,y=0.40x+110,R²=0.18;p>0.001).
Comparing the regression equation of all preterm infants with the term group, the constant for the preterm infants was greater than for term infants. The coefficient variation $R^2$ (0.15) and Correlation coefficient ($r=0.3450$) showed a worse agreement for preterm than for term infants.

### Group 1 (28wk to 33wk)

<table>
<thead>
<tr>
<th></th>
<th>Mean Transcutaneous Bilirubin (mg/dl)</th>
<th>Serum Bilirubin (mg/dl)</th>
<th>Coefficient Variation (CV)</th>
<th>Correlation coefficient</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group-1 (28wk-33wk)</td>
<td>9.6±1.9 mg/dl</td>
<td>14.6±2.1 mg/dl</td>
<td>$R^2=0.15$</td>
<td>$r=0.3450$</td>
<td>p&gt;0.001</td>
</tr>
<tr>
<td>Group-2 (34wk-37wk)</td>
<td>10.4±1.6 mg/dl</td>
<td>13.7±2.3 mg/dl</td>
<td>$R^2=0.18$</td>
<td>$r=0.4521$</td>
<td>p&gt;0.001</td>
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<tr>
<td>Group-3 (38wk-41wk)</td>
<td>15.6±2.3 mg/dl</td>
<td>16.6±2.9 mg/dl</td>
<td>$R^2=0.49$</td>
<td>$r=0.8599$</td>
<td>P&lt;0.001</td>
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### Discussion

Principal mechanism of TCB is, when Light passes through inbuilt fiberoptics and reflectometer and is analyzed by...
computerized spectro photometer to provide immediate
digital display of total bilirubin (16).

Transcutaneous bilirubin (TcB) determination has become a
valuable aid in avoiding significant neonatal hyperbilirubinemia (19) and has significantly reduced the
number of heel stick blood samplings and their complications (20). Severe hyperbilirubinemia ( kernicterus
and, irreversible neurological sequelae) in newborns is
preventable through appropriate follow-up, diagnosis, and
treatment, such as phototherapy and exchange transfusions.
Neonatal jaundice is more prevalent in the Asian population,
which may lead to a higher risk of developing kernicterus.

It has been shown that the accuracy of measurements
decreases when performed by several investigators, we took
measurements were performed by one person

The preterm infants in present study were divided into two
group 28wk to 33wk (Group -1) & 34wk to 37wk (Group -2),the reason for sub dividing this group was that the most
very premature infants clinically clearly represented a
separate group by being sicker or needing support
(e.g. parental feeding, coffeein, oxygen etc) and thereby, in
addition to younger gestational age were at higher risk for
bilirubin encephalopathy.

In preterm infant due to immaturity of skin as
result are affected by the immature skin and a
forehead more difficult especially when studying more
premature infant due to their smaller size or to nasal CPAP
bonnet.

In present study, there was strong correlation between
transcutaneous bilirubin and serum bilirubin in term baby
with coefficient variation $R^2=0.49$, coefficient correlation
$r=0.8599$ & $P<0.001$, while there was poor correlation
between transcutaneous bilirubin and serum bilirubin in
preterm baby with coefficient variation $R^2=0.15$, coefficient

Similarly study carried by Mishra S,Chawda D, Agawal R
there was strong correlation between transcutaneous bilirubin and serum bilirubin in term neonate. Study do not
confer correlation between transcutaneous bilirubin and plasma bilirubin concentration in preterm infants.

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correlation $r=0.3450$ & $P>0.001$ for group-1 (28wk-31wk) &
coefficient variation $R^2=0.18$, coefficient correlation
$r=0.4521$ & $P>0.001$ for group-2 (34wk-37wk).

Study carried by Mahajan G, Kaushal RK, Sanchayan N
found same findings with strong correlation in term value
with coefficient variation $R^2=0.53$, coefficient correlation
$r=0.8319$ & $P<0.001$ & poor correlation found between
transcutaneous bilirubin and serum bilirubin in preterm baby
with $R^2=0.17$, $r=0.3120$ & $P>0.001$ (18).

Similar study carried by Mishra S, Chawda D, Agawal R
there was strong correlation between transcutaneous bilirubin and serum bilirubin in term neonate. Study do not
confer correlation between transcutaneous bilirubin and plasma bilirubin concentration in preterm infants, as result are affected by the immature skin and a
different albumin to bilirubin binding (11,13,15). Gronmann K, Roser M, Rolinski B also confer similar finding with poor
correlation between serum bilirubin and transcutaneous bilirubin in preterm infant due to immaturity of skin as
compare to term infant (12).

It has been shown that the accuracy of measurements
decreases when performed by several investigators, we took
care that all measurements were performed by one person
always over the infant’s sternum (11,13,15). Choosing the
sternum as sampling site is due to large measurement area of
the bilichk instrument making measurement over the
forehead more difficult, especially when studying more
premature infant due to their smaller size or to nasal CPAP
bonnet.

5. Conclusion

In pre-term newborn transcutaneous bilirubinometry is less
accurate than in term newborns, as results are affected by the
immature skin and by a different albumin-to-bilirubin
binding, while TCB can be used as non-invasive, painless &
reliable method for bilirubin measurement in term newborn
as it is comparable to serum bilirubin.

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