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Original Research Article

Transcutaneous bilirubin measurement in preterm infants less than 35 weeks of gestation

Sneha Saladi, Surabhi H. Shamakrishna*, Sahana Giliyaru, Rajanish Kanduri Vishwanatha Gupta

Rajarajeswari Medical College and Hospital, Bengaluru, India

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***Correspondence:**
Dr. Surabhi H. Shamakrishna,
E-mail: surabhi.hs90@gmail.com

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ABSTRACT

Background: Neonatal hyperbilirubinemia is a common clinical condition in preterm infants due to hepatic immaturity and increased bilirubin production. Monitoring bilirubin levels is essential to prevent bilirubin-induced neurological dysfunction. Total serum bilirubin (TSB) estimation is considered the gold standard for diagnosis and monitoring; however, repeated blood sampling in preterm infants may lead to iatrogenic blood loss, procedural pain and increased risk of infection. Transcutaneous bilirubin (TcB) measurement offers a rapid, non-invasive alternative for bilirubin estimation, but its reliability in very preterm infants requires further evaluation.
Methods: A hospital-based cross-sectional study was conducted over twelve months (June 2024-July 2025) in the neonatal intensive care unit in RajaRajeswari Medical College and Hospital. Preterm infants born before 35 weeks of gestation fulfilling inclusion criteria were enrolled. Transcutaneous bilirubin measurements were obtained using a TcB device from the forehead or sternum. Blood samples for serum bilirubin estimation were collected simultaneously or shortly after TcB measurement. Data were analysed using SPSS version 23. Pearson correlation coefficient and Bland–Altman analysis was used to assess correlation and agreement between TcB and TSB values.
Results: Sixty-three paired TcB and TSB measurements were analysed. The mean TcB value was 8.20±1.70 mg/dl, while the mean TSB value was 8.75±1.80 mg/dl. A strong positive correlation was observed between TcB and TSB ($r=0.864$, $p<0.001$). Bland–Altman analysis showed a mean difference of 0.546 mg/dl with acceptable limits of agreement.
Conclusions: Transcutaneous bilirubin measurement demonstrates strong correlation and good agreement with serum bilirubin levels in preterm infants less than 35 weeks of gestation. TcB is a reliable non-invasive tool for monitoring neonatal jaundice and may reduce the need for frequent blood sampling in neonatal intensive care units.

Keywords: Hyperbilirubinemia, Neonatal intensive care unit, Preterm infants, Serum bilirubin, Transcutaneous bilirubin

INTRODUCTION

Neonatal jaundice is one of the most frequently encountered clinical conditions during the early neonatal period and occurs more commonly and with greater severity among preterm infants than term neonates. Infants born before 35 weeks of gestation are particularly vulnerable due to immature hepatic conjugation mechanisms, increased enterohepatic circulation and a shorter lifespan of red blood cells. These factors contribute to increased bilirubin production and reduced clearance, predisposing preterm infants to significant hyperbilirubinemia. If not recognized and managed appropriately, severe hyperbilirubinemia may lead to bilirubin-induced neurological dysfunction and long-term neurodevelopmental impairment.[1] Total serum bilirubin estimation remains the gold standard for the evaluation and monitoring of neonatal jaundice. However, preterm

infants frequently undergo repeated blood sampling for clinical monitoring in neonatal intensive care units. Such invasive procedures may result in cumulative iatrogenic blood loss, anemia, increased need for blood transfusions, procedural pain and a higher risk of infection.[2] These concerns highlight the importance of identifying reliable non-invasive alternatives for monitoring bilirubin levels in this vulnerable population.

Transcutaneous bilirubinometry has emerged as a promising non-invasive method that estimates bilirubin concentration by measuring skin reflectance at specific wavelengths. The technique allows rapid, painless and repeatable assessment of bilirubin levels without the need for blood sampling.

Several studies have demonstrated good correlation between transcutaneous bilirubin and serum bilirubin levels in term and late preterm infants.[3] However, the accuracy and reliability of TcB measurements in very preterm infants remain an area of ongoing investigation. Differences in skin thickness, maturity, hydration and exposure to phototherapy may influence device readings.[4] Therefore, validation of transcutaneous bilirubin measurement specifically in preterm populations is necessary before it can be widely adopted as a reliable clinical monitoring tool.

The present study was conducted in a tertiary care neonatal intensive care unit to evaluate the accuracy and reliability of transcutaneous bilirubin measurement in preterm infants less than 35 weeks of gestation by comparing TcB values with laboratory-measured total serum bilirubin levels.

METHODS

A hospital-based cross-sectional study was conducted over a period of twelve months in the neonatal intensive care unit of a tertiary care teaching hospital. The study population consisted of preterm infants born before 35 weeks of gestation who were admitted to the NICU during the study period and fulfilled the eligibility criteria.

Preterm neonates admitted to the NICU requiring bilirubin monitoring were eligible for inclusion after obtaining written informed consent from parents or legal guardians. Infants with major congenital anomalies, those who had received blood transfusions and those with skin conditions affecting transcutaneous bilirubin measurement were excluded. Infants receiving phototherapy at the time of measurement were also excluded to avoid interference with TcB readings.

Transcutaneous bilirubin measurements were obtained using a calibrated transcutaneous bilirubinometer according to the manufacturer's instructions. Measurements were performed over the forehead or sternum, which are standard sites for TcB assessment in neonates. To minimize temporal variability, TcB measurement was performed immediately before blood sampling whenever possible. Blood samples for total serum bilirubin estimation were collected simultaneously or shortly after TcB measurement using standard NICU blood sampling procedures. Serum bilirubin levels were analyzed in the hospital laboratory using routine biochemical methods. Clinical and demographic variables recorded for each infant included gestational age, birth weight, gender, postnatal age at the time of measurement, transcutaneous bilirubin value and total serum bilirubin value.

Data were entered into a structured database and analyzed using the Statistical Package for Social Sciences (SPSS) version 23 and Microsoft Excel. Descriptive statistics were used to summarize the study population and bilirubin values. The relationship between TcB and TSB values was assessed using Pearson's correlation coefficient. Agreement between the two methods was evaluated using Bland–Altman analysis.

Subgroup analysis was performed to assess correlation across gestational age groups. An independent t-test was used to compare bilirubin levels between male and female infants. Multivariate linear regression analysis was conducted with serum bilirubin as the dependent variable and transcutaneous bilirubin, gestational age and birth weight as independent variables. A p-value less than 0.05 was considered statistically significant.

The study was conducted after obtaining approval from the Institutional Ethics Committee and confidentiality of patient information was strictly maintained.

RESULTS

A total of sixty-three paired transcutaneous bilirubin and total serum bilirubin measurements were analysed in preterm infants less than 35 weeks of gestation admitted to the neonatal intensive care unit during the study period. The mean transcutaneous bilirubin level was 8.20±1.70 mg/dl, while the mean total serum bilirubin level was 8.75±1.80 mg/dl. The mean difference between the two methods indicated that TcB slightly underestimated serum bilirubin levels in most cases (Table 1).

Correlation analysis revealed a strong positive linear relationship between transcutaneous bilirubin and serum bilirubin values. The Pearson correlation coefficient was 0.864 with a statistically significant p value of less than 0.001, indicating a high degree of association between the two measurement methods (Figure 1).

Agreement between TcB and TSB values was further assessed using Bland–Altman analysis. The mean difference between the two methods was 0.546 mg/dL, with limits of agreement ranging from −0.585 to 1.677 mg/dl. These findings suggest clinically acceptable agreement between the two measurement techniques (Figure 2). Subgroup analysis based on gestational age

demonstrated that the strong correlation between TcB and TSB values was maintained across different gestational age categories. Gender-based comparison using an independent t-test showed no statistically significant difference between male and female infants in bilirubin measurements (Table 2).

Overall, the results indicate that transcutaneous bilirubin measurements closely reflect serum bilirubin levels and can be used reliably for monitoring hyperbilirubinemia in preterm infants.

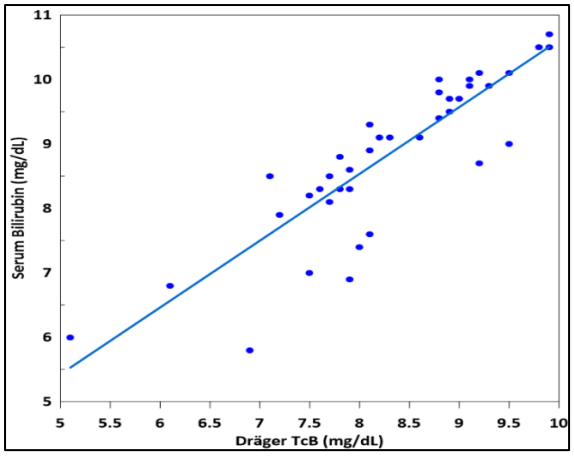


Figure 1: Scatter plot showing correlation between transcutaneous bilirubin (TcB) and total serum bilirubin (TSB).

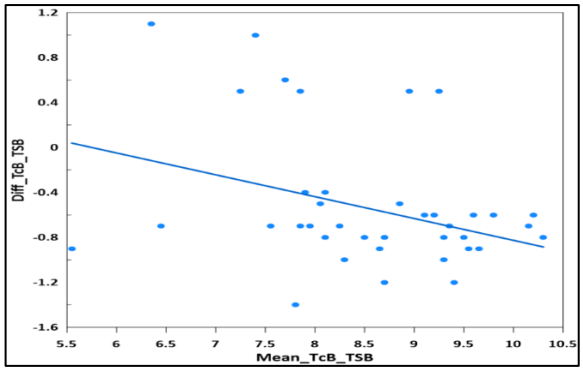


Figure 2: Bland–Altman plot of agreement between TcB and TSB measurements.

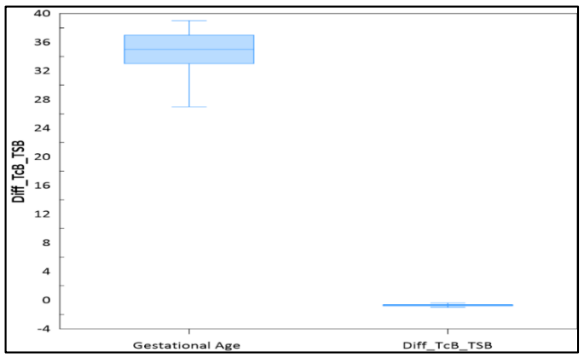


Figure 3: Correlation between gestational age and transcutaneous bilirubin levels.

Table 1: Descriptive statistics of TcB and TSB levels in preterm infants (<35 weeks gestation).

Variable	Mean (mg/dl)	Standard deviation	Minimum	Maximum	n
TcB	8.20	1.70	5.10	12.50	63
TSB	8.75	1.80	5.40	12.50	63
Difference (TSB–TcB)	0.551	0.58	-0.70	1.80	63

Table 2: Gender-wise comparison of TcB and TSB values.

Comparison	t-statistic	P value	Interpretation
Female vs Male	0.42	0.68	No statistically significant difference

DISCUSSION

The present study evaluated the accuracy and clinical reliability of transcutaneous bilirubin measurement in preterm infants less than 35 weeks of gestation by comparing it with total serum bilirubin levels in a tertiary care neonatal intensive care unit. The findings demonstrated a strong positive correlation between TcB and TSB values, indicating a close linear relationship between the two measurement methods. Similar results have been reported in previous studies where TcB measurements showed strong correlation with serum bilirubin levels in preterm populations.[5] Agreement analysis using the Bland–Altman method further demonstrated that the difference between TcB and TSB values remained within clinically acceptable limits. Although TcB slightly underestimated serum bilirubin levels, the magnitude of difference was small and unlikely to significantly influence routine clinical monitoring. The present study also demonstrated consistent correlation across different gestational age groups. This finding is particularly important because extremely preterm infants are highly vulnerable to the complications associated with repeated blood sampling. Reliable non-invasive bilirubin monitoring in this population may significantly reduce procedural burden and improve patient comfort. Gender-based analysis did not reveal any statistically significant difference in bilirubin measurements between male and female infants, supporting previous observations that gender does not

significantly influence bilirubin levels or the performance of transcutaneous bilirubinometry.[7] From a clinical perspective, these findings highlight the potential role of transcutaneous bilirubinometry in reducing the need for repeated invasive blood sampling in neonatal intensive care units. Frequent laboratory investigations in preterm infants may lead to cumulative blood loss and increased transfusion requirements.[8] Incorporating TcB monitoring into routine neonatal care protocols may therefore help minimize iatrogenic complications while maintaining effective bilirubin monitoring.

However, certain limitations should be considered when interpreting the results. The sample size was relatively small and device-specific factors or inter-observer variability in TcB measurements were not evaluated separately. Larger multicentre studies may further validate the reliability of TcB monitoring across diverse clinical settings. Despite these limitations, the present study provides valuable evidence supporting the use of transcutaneous bilirubin measurement as a reliable and non-invasive method for monitoring neonatal jaundice in preterm infants.

CONCLUSION

Transcutaneous bilirubin measurement demonstrates a strong correlation and clinically acceptable agreement with total serum bilirubin levels in preterm infants less than 35 weeks of gestation. It is a reliable, non-invasive tool for monitoring neonatal hyperbilirubinemia and may significantly reduce the need for repeated invasive blood sampling in neonatal intensive care units. Incorporation of transcutaneous bilirubinometry into routine clinical practice has the potential to improve patient comfort and minimize iatrogenic complications in this vulnerable population.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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