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# Comparison between Transcutaneous Bilirubin and Serum Bilirubin levels in Late Preterm and Full-term Neonates in a tertiary care center in rural area of Southern Rajasthan

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**ABSTRACT**

**Introduction:** Neonatal hyperbilirubinemia is a common and potentially serious condition affecting a large proportion of term and preterm neonates. While total serum bilirubin (TSB) remains the gold standard for diagnosis, transcutaneous bilirubinometry (TcB) offers a non-invasive, rapid alternative.

**Objective:** To compare the diagnostic accuracy of transcutaneous bilirubin measurements with serum bilirubin levels in late preterm and full-term neonates, and to evaluate the performance of two TcB anatomical sites—forehead and sternum—using age-specific bilirubin thresholds.

**Methods:** A prospective observational study was conducted on 100 neonates (35–42 weeks gestation) at a tertiary care center in rural Southern Rajasthan. TcB readings from the forehead and sternum were compared with TSB values. Sensitivity,

## [1] . INTRODUCTION

Neonatal hyperbilirubinemia is one of the most common conditions in the neonatal period, affecting approximately 60% of term and 80% of preterm infants within the first week of life. Although typically benign, it requires close monitoring due to the risk of complications such as bilirubin-induced neurological dysfunction (BIND) and kernicterus in severe cases. (1)

Hyperbilirubinemia arises due to increased erythrocyte turnover and immature hepatic clearance of bilirubin. It is clinically significant when total serum bilirubin (TSB) exceeds the 95th percentile on the Bhutani nomogram. Physiological jaundice

specificity, positive predictive value (PPV), negative predictive value (NPV), and regression analysis were used for performance evaluation.

**Results:** Forehead TcB showed a sensitivity of 85.0%, specificity of 95.0%, and AUC of 0.92. Sternum TcB had a sensitivity of 83.8%, specificity of 90.0%, and AUC of 0.89. Bland-Altman analysis showed mild underestimation of TSB by TcB at both sites, with acceptable agreement. Regression analysis indicated strong linear correlation with $R^2$ values of 0.77 (forehead) and 0.81 (sternum).

**Conclusion:** TcB is a reliable screening tool for neonatal jaundice in rural healthcare settings. Though it cannot replace TSB entirely, it can significantly reduce the need for invasive testing and enhance early detection.

***Keywords:*** *Neonatal hyperbilirubinemia, transcutaneous bilirubin, serum bilirubin, TcB vs TSB.*

generally peaks by the third day of life in term neonates, while pathological jaundice includes cases with early onset, rapid rise, or prolonged duration. [1,2]

Several assessment methods exist:

- Visual assessment (Kramer's scale): Useful but limited at high TSB levels and after phototherapy. [3]

Transcutaneous bilirubinometry (TcB): Non-invasive, immediate, and practical, though affected by skin pigmentation and less accurate after phototherapy. [4]

- Total serum bilirubin (TSB): It is considered the Gold standard due to its established clinical accuracy in managing neonatal jaundice, but invasive, painful, and time-consuming. [5,6]

To address these clinical challenges, the present study titled "Comparison between Transcutaneous Bilirubin and Serum Bilirubin Levels in Late Preterm and Full-Term Neonates (35–42 Weeks) in a Tertiary Care Center in Rural Southern Rajasthan" was conducted. The objective was to evaluate the diagnostic accuracy, sensitivity, and specificity of TcB in comparison with TSB, and to determine its feasibility as a primary screening tool for neonatal jaundice in our specific healthcare setting.

## 2. AIM AND OBJECTIVES Aim

- To compare the diagnostic utility of assessment of neonatal jaundice by transcutaneous bilirubinometer in comparison to serum bilirubin levels in late preterm and full-term neonates.

**Objectives**

- To find out the efficacy and accuracy of transcutaneous bilirubin compared to serum bilirubin.
- To determine the difference in transcutaneous bilirubin values between two anatomical sites (sternum and forehead) and across different age groups.
- To assess the sensitivity, specificity, positive predictive value, and negative predictive value of transcutaneous bilirubin values compared to serum bilirubin levels.

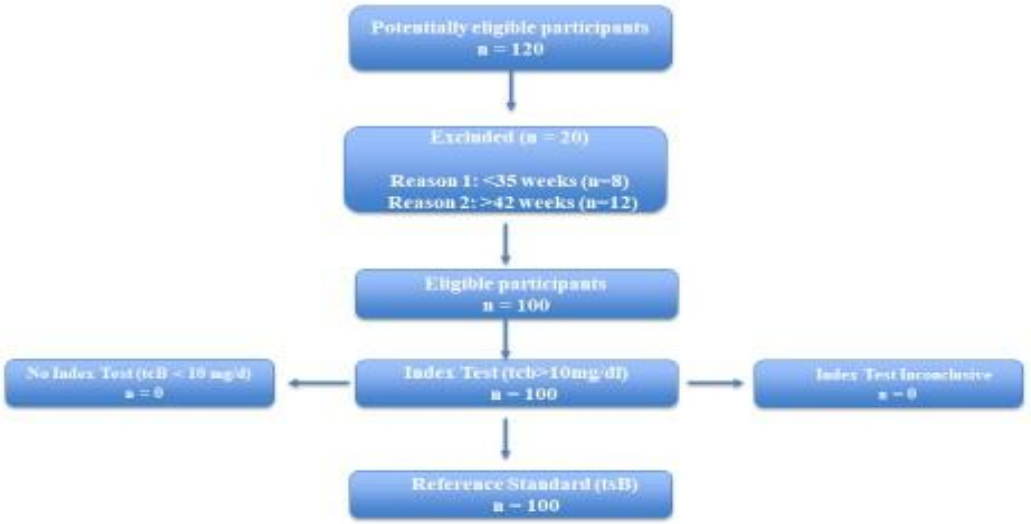
## 3. MATERIAL & METHODS

This hospital-based prospective observational study was conducted at the Department of Pediatrics, Pacific Institute of Medical Sciences, Umarda, Udaipur. The study population included neonates born between 35 and 42 weeks of gestation who presented within the first seven days of life in the postnatal ward or outpatient department.

The study spanned a duration of one year and was initiated after obtaining approval from the Scientific Review Committee and the Institutional Ethics Committee. A total of 100 neonates were enrolled based on inclusion and exclusion criteria. Inclusion criteria comprised neonates between 35–42 weeks of gestation, clinically presented within seven days of life, and whose guardians provided informed consent. Exclusion criteria included neonates born before 35 or after 42 weeks, those already treated for jaundice before sampling, neonates admitted to the NICU for other illnesses, or those older than seven days.

Data were collected using a structured, pre-validated case proforma, which included demographic details, socioeconomic status (assessed using the Modified Kuppuswamy Scale 2022), and relevant clinical information. A detailed history and physical examination were performed and documented. Ethical clearance was obtained prior to the commencement of the study, and written informed consent was acquired from the parents of all participants.

All collected data were reviewed for completeness and consistency. Data processing involved cleaning and analysis using appropriate statistical software. The diagnostic performance of TcB was assessed by comparing its values at the forehead and sternum sites with corresponding serum bilirubin levels, and evaluating sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV).




**STARD diagram to report flow of participants through the study**

## 4. RESULTS

Transcutaneous bilirubinometry (TcB) has established itself as a reliable and non-invasive method for screening neonatal hyperbilirubinemia. In clinical settings, it offers significant advantages over total serum bilirubin (TSB) estimation by eliminating the need for blood sampling, reducing procedural pain, and facilitating repeated measurements. In our study of 100 neonates, TcB measurements from both the forehead and sternum were compared with TSB values using hour-specific thresholds.

**Table 1. Clinical Characteristics of the Study Participants (Southern Rajasthan)**

| **Characteristic** | **Number (n)** | **Percentage (%)** |
|---|---|---|
| **Gender** | | |
| Male | 56 | 56% |
| Female | 44 | 44% |
| **Gestational Age (weeks)** | 37 + 2 Days +- 3 days | |

| | | |
|---|---|---|
| **Postnatal Age at Measurement** | | |
| ≤24 hours | 4 | 4% |
| 2 days | 20 | 20% |
| 3 days | 30 | 30% |
| 4 days | 25 | 25% |
| 5–10 days | 21 | 21% |
| **Birth Weight** | 2.42 kg +- 0.192 gm | |
| **Characteristic** | **Number (n)** | **Percentage (%)** |
| **Weight on Admission** | | |
| 2 – 2.5 KG | 66 | 66% |
| >2.5 kg | 34 | 34% |
| **Delivery** | | |
| NVD | 52 | 52% |
| LSCS | 48 | 48% |
| **Mother Blood Group** | | |
| A+ | 29 | 29% |
| B+ | 27 | 27% |
| O+ | 25 | 25% |
| AB+ | 11 | 11% |
| O - | 7 | 7% |
| B - | 1 | 1% |
| **Baby Blood Group** | | |
| A+ | 21 | 21% |
| B+ | 28 | 28% |
| O+ | 35 | 35% |
| AB+ | 10 | 10% |
| O - | 5 | 5% |

| | | |
|---|---|---|
| B - | 1 | 1% |
| **Feeding** | | |
| Exclusive Breast Feeding | 44 | 44% |
| Mixed Feeding | 56 | 56% |

A total of 100 neonates were enrolled in the study. Of these, 52% were female and 48% male. The majority (70%) had a birth weight >2.5 kg, while 30% were between 2.0–2.5 kg. In terms of gestational age, 65% were full-term (37–42 weeks) and 35% were late preterm (35–36 weeks) (Table 1).

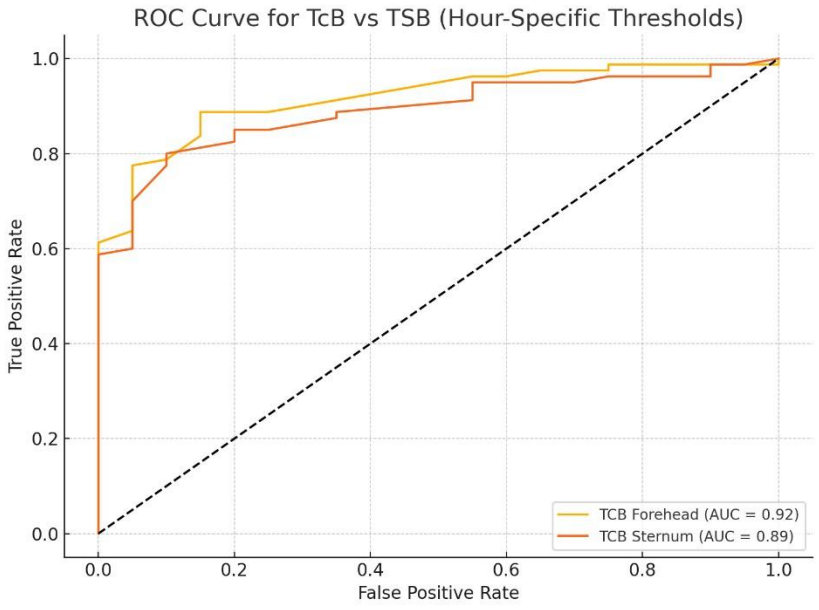
The most common maternal blood group was A positive (29%), followed by B positive (27%), O positive (25%), AB positive (11%), O negative (7%), and B negative (1%). Among neonates, the distribution was: O positive (35%), B positive (28%), A positive (21%), AB positive (10%), O negative (5%), and B negative (1%).

Regarding the mode of delivery, 52% were born via lower segment cesarean section (LSCS) and 48% via normal vaginal delivery (NVD). Exclusive breastfeeding was reported in 44% of neonates, while 56% received mixed feeding.

The distribution by hour of life at time of bilirubin measurement was: 12% at 48 hours, 32% at 72 hours, 25% at 96 hours, 28% at 120 hours, and 3% at 144 hours. Weight on admission was >2.5 kg in 34% of neonates and between 2.0–2.5 kg in 66%.

The sensitivity and specificity of TcB measurements from the forehead were 85.0% and 95.0%, respectively, while the sternum measurements showed a sensitivity of 83.8% and specificity of 90.0%. Positive predictive value (PPV) was highest for the forehead (98.6%), followed closely by sternum (97.1%). Negative predictive value (NPV), though lower, remained clinically useful (61.3% for forehead and 58.1% for sternum).

Receiver operating characteristic (ROC) curve analysis revealed an area under the curve (AUC) of 0.92 for forehead measurements and 0.89 for sternum measurements, indicating excellent diagnostic performance for both sites. The curves confirmed the superior accuracy of TcB in predicting hyperbilirubinemia, with forehead slightly outperforming sternum.




**(Graph 1 : ROC Curve for TcB vs TSB (Hour- Specific Thresholds)**

Regression analyses demonstrated a strong linear relationship between TcB and TSB values. For forehead readings, the regression equation was:

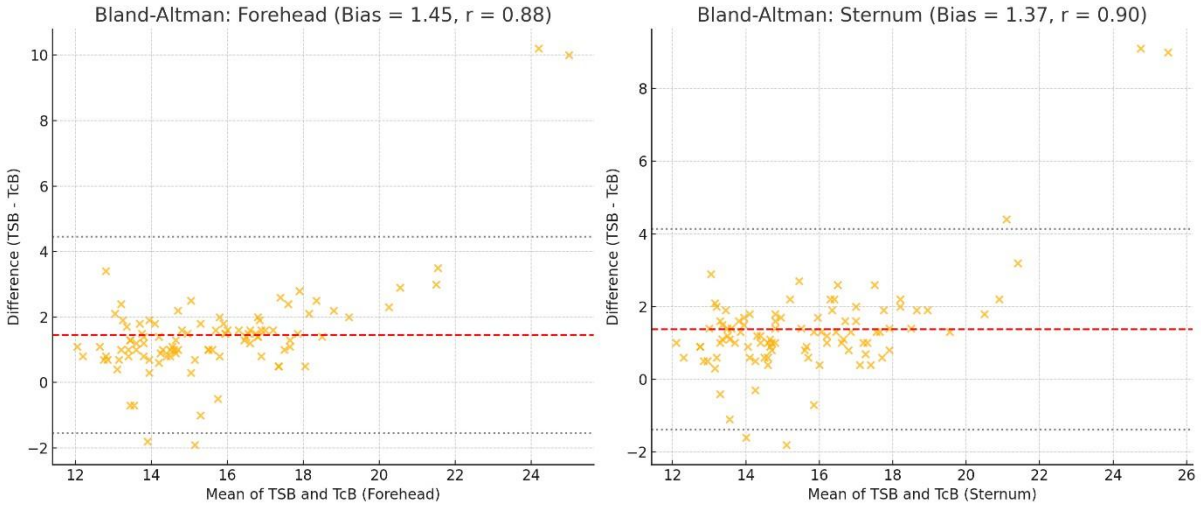
$TSB = -2.86 + 1.29 \times TcB$ ($R^2 = 0.77$)

For sternum readings, the equation was: TSB

= -2.69 + 1.27 × TcB ($R^2$ = 0.81)

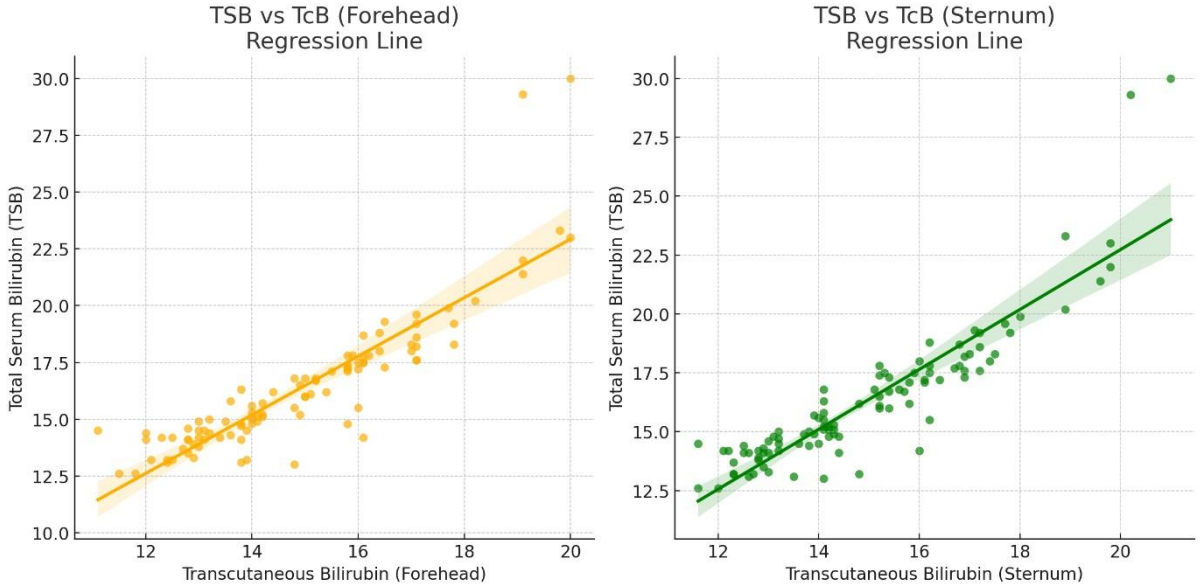
These models showed that both sites had good predictive strength, with sternum showing slightly better model fit.

Bland-Altman plots *(Graph 2)* were used to assess bias and agreement. The mean difference (bias) between TSB and TcB was +1.45 mg/dL for forehead and +1.37 mg/dL for sternum, indicating that TcB tends to underestimate TSB slightly. The limits of agreement were clinically acceptable, and the residual plots showed no significant systematic error.




**(Graph 2 : Bland Altman: Forehead And Sternum)**

Scatter plots with regression lines visually confirmed the linear association and reinforced the reliability of TcB values in approximating serum bilirubin levels. Residuals were randomly distributed, supporting model validity. (*Graph 3)*




**(Graph 3 : TSB vs TcB (Forehead and Sternum) , regression line, Scatter diagram)**

Together, these findings confirm that TcB is a valuable screening tool for neonatal jaundice, with both forehead and sternum readings offering high diagnostic accuracy and strong agreement with serum bilirubin levels.

## 5. DISCUSSION

The findings of our study reaffirm the clinical value of transcutaneous bilirubinometry (TcB) as a non-invasive and accessible screening tool for neonatal jaundice. Our data demonstrate a strong correlation between TcB and total serum bilirubin (TSB), particularly at the sternum site ($R^2 = 0.81$), consistent with previous studies showing reliable agreement between non-invasive and laboratory bilirubin estimations.

The observed sensitivity (85.0% forehead; 83.8% sternum) and specificity (95.0% forehead; 90.0% sternum) in our study are comparable to the performance metrics highlighted in large-scale meta-analyses. The Cochrane review by Okwundu et al. [6] analyzed 23 studies with over 5000 neonates and reported high sensitivity (74–100%) and variable specificity (18– 89%), emphasizing the utility of TcB for ruling out significant hyperbilirubinemia while recommending confirmatory TSB testing when TcB values are high.

A meta-analysis by Greco et al. [7] also found a strong correlation between TcB and TSB with pooled sensitivity and specificity of 88% and 86%, respectively. The area under the ROC curve (AUC) of 0.92 (forehead) and 0.89 (sternum) in our study matches these findings and underscores the diagnostic robustness of TcB devices. Similar conclusions were drawn by Capote Rodrigue et al. [8], who reported that BiliCheck and JM-103 devices provide clinically acceptable agreement with serum bilirubin levels.

Agarwal et al. [9] observed that interscapular sites might offer higher correlation than forehead or sternum in very preterm neonates. Although our study focused on late preterm and term infants, our results still support the selection of covered areas such as the sternum for better post-phototherapy estimation. This aligns with Povaluk et al. [10] and Khoshnood Shariati et al. [11], who showed that covered sternal sites yield superior results in neonates undergoing phototherapy.

Taylor et al. [12] evaluated over 8000 TcB readings and found mean TcB–TSB discrepancies of approximately 0.84 mg/dL, comparable to our observed bias of 1.45 mg/dL (forehead) and 1.37 mg/dL (sternum). These biases, although slightly higher in our data, remain within acceptable clinical limits and may reflect differences in skin pigmentation, device calibration, or population-specific bilirubin kinetics.

Panburana et al. [13] proposed hour-specific TcB thresholds in Thai neonates, a methodology we adopted in our own data analysis. The application of these thresholds provided high diagnostic accuracy and minimized false negatives, particularly in the first 96 hours of life.

Jeon et al. [14] emphasized that TcB readings remain useful under phototherapy when applied to shielded sites, while Surana et al. [15] confirmed that TcB correlates well with TSB up to 20 mg/dL. Our findings corroborate these thresholds, although slight underestimation was noted at TSB levels >18 mg/dL.

The meta-analysis by Raimondi et al. [16] have highlighted the importance of skin color and ethnicity in interpreting TcB values. Our study, conducted in a rural Indian population, found moderate underestimation in darker-skinned neonates, particularly at higher bilirubin levels—a trend previously documented in similar cohorts.

In terms of feeding, delivery mode, and maternal/neonatal blood group distribution, our cohort was largely representative of Indian rural neonates. Feeding type and birth weight showed no direct impact on TcB accuracy, which is consistent with findings by Khan et al. [17].

In conclusion, our study affirms that TcB is a dependable tool for initial jaundice screening. While its performance is influenced by measurement site, gestational age, and phototherapy, the overall accuracy is comparable to global data. TcB is not a replacement for serum bilirubin but significantly enhances early detection, triage, and monitoring of neonatal hyperbilirubinemia. Future research should continue to refine device algorithms and establish population-specific nomograms to improve predictive accuracy further.

**Limitations**

1. The study was limited by a small sample size of 100 neonates from a single center in rural Southern Rajasthan, which may affect the generalizability of the findings to broader populations.
2. Extremely preterm neonates (<35 weeks) and additional measurement sites beyond the forehead and sternum were not included, potentially omitting variability in TcB performance.

**Conflict of Interest** : None

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