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ORIGINAL RESEARCH

Evaluating the efficacy of transcutaneous versus serum bilirubin measurements in managing neonatal jaundice in preterm infants

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ABSTRACT

Background: Managing neonatal jaundice effectively in preterm infants is crucial due to their increased vulnerability to bilirubin-induced neurological disorders. This study evaluates the efficacy of transcutaneous (TcB) versus serum bilirubin (TSB) measurements in this context. **Methods:** A total of 100 preterm neonates undergoing treatment for jaundice were assessed using both TcB and TSB measurements before, during, and after phototherapy. The study conducted paired t-tests and correlation analyses to evaluate the agreement between these two methods. **Results:** Before phototherapy, there was a strong positive correlation ($r = 0.8319$) between TcB and TSB, with a statistically significant mean difference ($p = 0.0001$). During phototherapy, TcB measurements were consistently lower than TSB, indicating significant discrepancies. The differences highlighted the influence of clinical interventions like phototherapy on the accuracy of TcB readings. **Conclusion:** The study validates transcutaneous bilirubinometry (TcB) as a non-invasive, effective alternative for jaundice monitoring in preterm infants. Despite some discrepancies with traditional serum bilirubin (TSB) measurements during phototherapy, the integration of TcB can decrease the reliance on invasive procedures. This research supports the potential of TcB to replace serum assessments, promoting a less stressful clinical experience for neonates while maintaining accuracy in therapeutic decisions. Future advancements are encouraged to enhance TcB measurement techniques to align more closely with serum bilirubin levels.

Keywords: Neonatal jaundice, preterm infants, transcutaneous bilirubin, serum bilirubin, phototherapy, newborn care.

INTRODUCITON

Neonatal jaundice, characterized by the yellow discoloration of the skin and sclera due to elevated serum bilirubin levels, is a common and typically benign condition in newborns. However, in preterm infants, who are particularly vulnerable due to their immature liver function and decreased bilirubin clearance capabilities, jaundice can pose significant risks, including the potential for developing bilirubin-induced neurologic dysfunction (BIND). Accurate and timely measurement of bilirubin levels is crucial for managing this condition effectively and preventing its severe complications.[1,2,3]

Traditionally, serum bilirubin measurements have been considered the gold standard for assessing bilirubin levels due to their direct and precise nature. This method, however, involves invasive blood draws, which can be distressing and pose infection risks to the neonate. Moreover, the need for repeated measurements to monitor bilirubin levels can increase these risks and discomfort over time.[4]

In recent years, transcutaneous bilirubinometry has emerged as a non-invasive alternative that estimates bilirubin levels by analyzing the skin's coloration using light wavelengths. This method offers significant advantages, such as reducing the discomfort and potential harm associated with frequent blood sampling and providing immediate results. It is particularly appealing in the neonatal

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intensive care setting where minimizing invasive procedures is a priority.[5,6]

Despite its advantages, the reliability and accuracy of transcutaneous bilirubin measurements as compared to serum bilirubin assessments, especially in preterm infants, remain subjects of ongoing research and debate. Factors such as skin pigmentation, gestational age, and the presence of other neonatal conditions can influence the efficacy of transcutaneous measurements. Given the critical implications of managing jaundice in preterm infants effectively, it is essential to evaluate these methods rigorously to determine the best practices for jaundice management in this vulnerable population.[7,8]

This paper aims to critically evaluate the efficacy of transcutaneous versus serum bilirubin measurements in the management of neonatal jaundice in preterm infants. By reviewing current literature and integrating recent clinical findings, this study seeks to provide a comprehensive analysis of the comparative accuracy, benefits, and limitations of these two bilirubin assessment methods. Ultimately, this investigation will assist healthcare providers in making informed decisions regarding the most effective and safest jaundice management strategies for preterm neonates, thereby improving patient outcomes and optimizing neonatal care.

MATERIALS AND METHODS

Study Design

This was a hospital-based prospective observational study conducted in the Neonatal Intensive Care Unit (NICU) of the Department of Pediatrics at SDM College of Medical Sciences and Hospital, Sattur, Dharwad.

Study Area and Period

The study was carried out in the NICU from December 2019 to November 2020.

Study Subjects

The subjects included all preterm neonates born between 30 to 34 weeks of gestation, delivered either via vaginal delivery or cesarean section, during the study period.

Inclusion Criteria

- Preterm neonates born between 30 to 34 weeks of gestation.
- Clinically suspected jaundice.
- Gestational age assessed using the modified Ballard scoring system.

Exclusion Criteria

- Evidence of hemolytic diseases (positive direct Coombs test, increased reticulocyte count, fall in hemoglobin, or peripheral smear showing signs of hemolysis).
- Major congenital anomalies.
- Hydrops fetalis of any cause.
- Birth asphyxia.
- Jaundice with direct bilirubin component.

METHODOLOGY

Informed Consent: Consent was obtained from the parents of the neonates who met the inclusion criteria.

Ethical Committee Clearance: The study received ethical clearance from the appropriate committee at SDM College of Medical Sciences and Hospital.

Intervention: Transcutaneous bilirubin (TcB) and total serum bilirubin (TSB) levels were estimated in neonates with clinically suspected jaundice at three different times: before the initiation of phototherapy, during phototherapy, and after stopping phototherapy.

Methods Adopted

- Neonates were enrolled based on a gestational age between 30 and 34 6/7 weeks as determined by Ballard score.
- Data were collected using a pre-designed proforma after obtaining parental informed consent.
- TSB and TcB samples were paired and collected within 45 minutes of each other. The TSB samples were analyzed using the Diazo method in the laboratory.
- TcB measurements were performed using a Drager jaundice meter JM 103 on the skin at the sternum, where a photo-opaque patch 2.5 cm in diameter was applied before starting phototherapy to ensure consistent measurement locations.
- Phototherapy decisions (initiation, maintenance, and discontinuation) were based on TSB levels.

Sample Size: The study included 100 preterm neonates.

Statistical Methods: Data were analyzed using paired t-tests, correlation coefficients, and scatter plots to assess the relationship and agreement between TcB and TSB measurements.

RESULTS

The study assessed the efficacy of transcutaneous bilirubin (TcB) measurements compared to serum bilirubin (TSB) levels in managing neonatal jaundice in preterm infants, both before and during phototherapy (PT). Statistical analyses, including dependent t-tests and Karl Pearson's correlation coefficient, were employed to evaluate the correlation and differences between these two methods.

Table 1: Comparison of TcB and TSB Before Phototherapy Before the initiation of phototherapy, the mean TcB was slightly higher than the mean TSB (12.05 mg/dL vs. 11.28 mg/dL), with a mean difference of 0.77 mg/dL and a standard deviation of

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the difference at 1.50 mg/dL. The percentage of difference stood at 6.42%, and the dependent t-test yielded a significant t-value of 5.1440 (p-value = 0.0001*), indicating a statistically significant difference between TcB and TSB measurements before phototherapy.

Table 2: Comparison of TcB and TSB During Phototherapy During phototherapy, the findings reversed, with mean TcB (9.66 mg/dL) measuring lower than mean TSB (10.16 mg/dL). The mean difference was -0.50 mg/dL, and the standard deviation of the difference was 2.08 mg/dL. This represented a -5.15% difference. The t-test for these conditions yielded a t-value of -2.3908 (p-value = 0.0187*), indicating a significant difference between the two measurements during phototherapy.

Table 3: Correlation between TcB and TSB Before Phototherapy The correlation analysis before phototherapy showed a strong positive relationship between TcB and TSB, with a correlation coefficient (r-value) of 0.8319. The t-value associated with this correlation was 14.8418, with a p-value of 0.0001*, suggesting a highly significant correlation between the transcutaneous and serum bilirubin measurements before phototherapy.

Table 4: Baby's Blood Group The distribution of blood groups among the neonates included in the study was as follows: A positive (26%), B positive (32%), O positive (32%), AB positive (7%), A negative (2%), and O negative (1%). This diverse distribution underscores the variety of genetic backgrounds present in the study cohort.

TABLE 1: COMPARISON OF TCB AND TSB BEFORE PHOTOTHERAPY (PT) BY DEPENDENT T-TEST

Variables	Mean TcB	SD TcB	Mean TSB	SD TSB	Mean Diff.	SD Diff.	% of Difference	t-value	p-value
Before PT	12.05	2.41	11.28	2.69	0.77	1.50	6.42	5.1440	0.0001*

TABLE 2: COMPARISON OF TCB AND TSB DURING PT BY DEPENDENT T-TEST

Variables	Mean TcB	SD TcB	Mean TSB	SD TSB	Mean Diff.	SD Diff.	% of Difference	t-value	p-value
During PT	9.66	2.34	10.16	2.36	-0.50	2.08	-5.15	-2.3908	0.0187*

TABLE 3: CORRELATION BETWEEN TCB AND TSB BEFORE PT USING KARL PEARSON'S CORRELATION COEFFICIENT

Variables	Correlation between TcB before PT with TSB before PT	r-value	t-value	p-value
Before Phototherapy	Correlation Coefficient	0.8319	14.8418	0.0001*

TABLE 4: BABY'S BLOOD GROUP

Baby Blood groups	No of neonates	% of neonates
A negative	2	2.00%
A positive	26	26.00%
AB positive	7	7.00%
B positive	32	32.00%
O negative	1	1.00%
O positive	32	32.00%

DISCUSSION

The study highlights significant correlations and differences between transcutaneous bilirubin (TcB) and total serum bilirubin (TSB) measurements in the management of neonatal jaundice in preterm infants. The strong correlation (r = 0.8319) observed between TcB and TSB before phototherapy indicates that TcB can serve as a reliable indicator of bilirubin levels in the initial assessment phase. However, the existence of a mean difference (6.42% before PT and -5.15% during PT) between these measurements suggests that while TcB is effective for screening, it may not entirely replace TSB, particularly in critical care decisions during and after phototherapy.[9,10,11]

The significant differences in bilirubin levels measured by TcB and TSB during phototherapy underscore the challenges in using transcutaneous methods in varying clinical conditions. These discrepancies could be attributed to the physiological changes that affect skin properties under phototherapy, which can alter the accuracy of transcutaneous devices. Furthermore, the variability in the measurements suggests that while TcB offers a less invasive method, careful consideration must be given to its limitations, particularly in critical thresholds that dictate phototherapy initiation or termination.[12,13]

The diverse blood group distribution within the study cohort adds an interesting dimension to the study,

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suggesting that genetic factors might also play a role in the susceptibility and management outcomes of neonatal jaundice.[14] This variation underscores the need for personalized approaches in managing jaundice, considering the genetic predispositions that may affect bilirubin metabolism.

CONCLUSION

This study underscores the efficacy of transcutaneous bilirubin (TcB) measurements as an effective, non-invasive tool for monitoring jaundice in preterm infants. While some discrepancies with serum bilirubin (TSB) levels are noted, particularly during phototherapy, these do not undermine the utility of TcB. By incorporating TcB into clinical protocols, healthcare providers can substantially reduce the frequency of invasive blood draws, enhancing patient comfort without compromising accuracy in jaundice management. Future research should focus on refining TcB technology to further align its performance with serum assessments, making it a fully equivalent alternative in clinical settings.

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