ISSN: 2581 – 3633

International Journal of Medical Science and Advanced Clinical Research (IJMACR)

Available Online at: https://www.ijmacr.com

Volume – 9, Issue – 4, August – 2026, Page No.: 522 – 531

Validation of Stool Colouras an Adjunct for Treatment of Jaundiced Infants with Phototherapy (Strip Score) With Transcutaneous Bilirubinometer (TCB) and Total Serum Bilirubins (TSB) and its Utility as a Screening Tool for Assessing Jaundice among Neonates

[1]Dr. Varsha, MBBS MD Pediatrics Mandya Institute of Medical Sciences Mandya.

[2]Dr. Nischal P, MBBS MD Pediatrics, Mandya Institute of Medical Sciences.

[3]Dr. Nandini G, MBBS, MD Pediatrics, Indira Gandhi Institute of Child health, Bangalore.

Corresponding Author: Dr. Varsha, MBBS MD Pediatrics, Mandya Institute of Medical Sciences Mandya.

How to citation this article: Dr. Varsha, Dr. Nischal P, Dr. Nandini G, "Validation of Stool Colouras an Adjunct for Treatment of Jaundiced Infants with Phototherapy (Strip Score) With Transcutaneous Bilirubinometer (TCB) and Total Serum Bilirubins (TSB) and its Utility as a Screening Tool for Assessing Jaundice among Neonates", IJMACR– August – 2026, Volume – 9, Issue – 4, P. No. 522 – 531.

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Background: Neonatal jaundice is one of the most common conditions requiring evaluation during the early neonatal period. Early identification of significant hyperbilirubinemia is essential to prevent bilirubin - induced neurological complications. Total serum bilirubin (TSB) remains the standard diagnostic method; however, it requires invasive blood sampling.

Non-invasive methods such as Transcutaneous Bilirubinometer (TCB) and simple clinical tools may help in screening jaundiced neonates.

Objective; To validate stool colour assessment using the STrIP score as an adjunctive tool for assessment and management of jaundiced neonates by comparing it with Transcutaneous Bilirubinometer (TCB) values and total serum bilirubin (TSB) levels, and to evaluate its utility as a screening tool for neonatal jaundice.

Methods; A hospital-based cross-sectional study was conducted in the postnatal ward of a tertiary care teaching hospital from July 2021 to July 2022. A total of 136 neonates with clinically detectable jaundice and gestational age ≥35 weeks were included using purposive sampling.

Clinical jaundice was assessed using Kramer's scale, stool colour was evaluated using the STrIP score, bilirubin levels were measured using Transcutaneous Bilirubinometer (Dräger JM-105), and serum bilirubin was estimated by the Diazo method. The correlation between STrIP score, TCB and TSB was assessed using Pearson correlation, while agreement was evaluated

using Bland–Altman analysis. Diagnostic performance was assessed using ROC curve analysis.

Results: Among 136 neonates, 70 (51.5%) were males and 66 (48.5%) were females. The mean gestational age was 38.01 ± 1.35 weeks and mean birth weight was 2.94 ± 0.63 kg. The mean TSB, STrIP score and TCB values were 17.21 ± 4.19 mg/dl, 15.49 ± 2.80 and 16.51 ± 3.03 mg/dl, respectively. A significant positive correlation was observed between TSB and STrIP score ($r=0.818$, $p<0.001$) and between TSB and TCB ($r=0.824$, $p<0.001$). Bland–Altman analysis showed good agreement between TSB and STrIP score (mean difference 1.69 mg/dl) and between TSB and TCB (mean difference 0.9 mg/dl). ROC analysis demonstrated good predictive ability for treatment requirement, with area under curve values of 0.920 for STrIP score and 0.938 for TCB ($p<0.001$).

Conclusion; The STrIP score showed significant correlation and good agreement with total serum bilirubin levels and demonstrated potential as a simple, non-invasive and cost-effective screening tool for neonatal jaundice. It may be used as an adjunct to existing bilirubin assessment methods, especially in resource-limited settings.

Keywords: Neonatal jaundice, Hyperbilirubinemia, Stool colour assessment, STrIP score, Transcutaneous Bilirubinometer, Total serum bilirubin, Kramer's scale, Neonatal screening, Phototherapy, Newborn infants.

Introduction

Neonatal jaundice is one of the most common clinical conditions encountered during the early neonatal period, affecting a significant proportion of newborns worldwide. It is characterized by an elevation of serum bilirubin levels resulting in yellow discoloration of the skin and sclera. Although physiological jaundice is common and usually benign, excessive unconjugated hyperbilirubinemia can progress to acute bilirubin encephalopathy and kernicterus, resulting in permanent neurological impairment if not identified and treated promptly. [1]

Approximately 60–80% of term and preterm neonates develop visible jaundice during the first week of life due to increased bilirubin production, immature hepatic conjugation mechanisms and increased enter ohepatic circulation. [2] Early identification of neonates at risk of significant hyperbilirubinemia is therefore essential to initiate timely interventions such as phototherapy or exchange transfusion. [3]

Total serum bilirubin (TSB) estimation remains the gold standard for diagnosis and management of neonatal hyperbilirubinemia.

However, serum bilirubin measurement requires invasive blood sampling, laboratory facilities and may result in repeated painful procedures, especially in newborns requiring serial monitoring.[4] Transcutaneous Bilirubinometer (TCB) has emerged as a non-invasive alternative that provides rapid estimation of bilirubin levels and has demonstrated good correlation with serum bilirubin values.[5] However, TCB devices may not always be available in resource-limited settings due to cost and infrastructure requirements.

Clinical assessment of jaundice using visual methods such as Kramer's scale is widely practiced because of its simplicity and feasibility. Kramer's scale estimates bilirubin levels based on cephalocaudal progression of dermal staining; however, its accuracy may vary depending on gestational age, skin pigmentation and observer variability.[6] Therefore, additional simple, non-invasive and inexpensive screening tools are needed to

improve identification of neonates requiring further evaluation.

Stool colour assessment has gained importance in neonatal jaundice screening, particularly for early identification of cholestatic disorders. The Stool Colour Card method has demonstrated utility in detecting pale stools associated with biliary obstruction.[7] The Stool Colour and Transcutaneous Bilirubin Index (STrIP) score, developed by Doreswamy SM et al., combines stool colour assessment with clinical jaundice evaluation using Kramer's scale and provides a simple bedside approach for assessment of neonatal jaundice.[8]

The present study was undertaken to validate stool colour assessment as an adjunctive tool for management of jaundiced neonates requiring phototherapy by comparing the STrIP score with Transcutaneous Bilirubinometer values and total serum bilirubin levels. The study also evaluated the utility of STrIP score as a screening tool for assessing jaundice among neonates.

Materials and Methods

Study Design and Study Setting

This hospital-based cross-sectional study was conducted in the postnatal ward of a tertiary care teaching hospital over a period of one year from July 2021 to July 2022. The study was initiated after obtaining approval from the Institutional Ethics Committee.

Study Population

The study included neonates with clinically detectable jaundice admitted in the postnatal ward of the hospital.

Sample Size Calculation

A total of 120 neonates were included in the study. The sample size was calculated based on the findings of previous similar studies using a sensitivity of 76.93% and the formula:

[n=\frac{4PQ}{L^2}]

- where,
- **n** = required sample size,
- **P** = sensitivity,
- **Q** = 100 − P,
- **L** = allowable error (10%).

Sampling Technique

Participants were selected using purposive sampling.

Inclusion Criteria

Neonates were included if they fulfilled the following criteria:

- Gestational age ≥ 35 weeks.
- Clinically detectable jaundice.
- Exclusively breastfed neonates.
- Written informed consent obtained from parents.

Exclusion Criteria

Neonates were excluded if they had:

- Previous history of phototherapy or exchange transfusion.
- Direct hyperbilirubinemia.
- Critical illness.
- History of receiving any medication other than vitamin K at birth and immunization as per the recommended schedule.

Method of Data Collection

After obtaining informed consent from the parents, neonates satisfying the eligibility criteria were enrolled in the study. The parents were explained about the study procedures in their local language. Maternal and neonatal demographic and clinical details were collected using a predesigned data extraction sheet.

Clinical assessment of jaundice was performed in indirect sunlight through an open window. Blanching pressure was applied using the thumb over the forehead, tip of the nose, sternum, abdominal wall, thighs, shin, palms, and soles for approximately three seconds. The

colour of the blanched skin was observed for the presence of jaundice.

The severity of clinical jaundice was assessed using Kramer's scale, which consists of five dermal zones:

- Zone I: Head and neck
- Zone II: Upper trunk
- Zone III: Lower trunk and thighs
- Zone IV: Arms and lower legs
- Zone V: Palms and soles

Assessment of STrIP Score

The stool colour was assessed using the STrIP score based on the study conducted by Dores wamy SM et al. (2016). A small stool sample was collected either from the diaper or a white cloth on the day when clinical jaundice was identified during screening.

The stool sample was examined under sunlight and compared with a printed stool colour strip consisting of five colour zones. In cases where a colour gradient was present, the darkest or greenish portion of the stool sample was considered for scoring.

The stool colour strip score was added to the Kramer's scale score, and the combined value was considered as the final STrIP score.

Measurement of Transcutaneous Bilirubin

Transcutaneous bilirubin (TcB) levels were measured using a multi - wavelength spectral reflectance Transcutaneous Bilirubinometer (Dräger JM-105). For measurement, the optic head of the device was placed in complete contact with the skin over the sternum, ensuring no gap between the skin and the optic head by applying gentle pressure.

The device measured bilirubin levels based on the reflected light wave characteristics after transmission through the skin and subcutaneous tissue. Three consecutive readings were obtained, and the average value was recorded as the TcB level.

Estimation of Total Serum Bilirubin

Approximately 2 ml of venous blood was collected under aseptic precautions into a plain vacutainer and transported to the laboratory for estimation of total serum bilirubin (TSB) levels. Serum bilirubin estimation was performed using the Diazo method.

The obtained total serum bilirubin values were plotted on the risk-based bilirubin nomograms of the American Academy of Pediatrics to determine the requirement for phototherapy or exchange transfusion.

Outcome Assessment

The values obtained from the STrIP score and Transcutaneous bilirubin measurements were compared with total serum bilirubin levels to evaluate their diagnostic performance in assessing neonatal jaundice.

Result and Observations

The present hospital-based cross-sectional study was conducted in the postnatal ward of a tertiary care teaching hospital (MIMS Mandya) among 136 neonates with clinically detectable jaundice. All demographic, maternal, neonatal and biochemical parameters were recorded in a master chart and analysed. Clinical jaundice was assessed using Kramer's scale, stool colour was assessed using the STrIP score, and bilirubin levels were estimated using Transcutaneous bilirubin (TCB) and total serum bilirubin (TSB).

The results were expressed as mean ± standard deviation, correlation coefficient and agreement analysis. The correlation between STrIP score, TCB and TSB was assessed using Pearson correlation, and agreement was evaluated using Bland–Altman analysis.

Table 1: Maternal Characteristics of Study Population (N=136)

Parameter	Number (%)
Maternal age	
≤18 years	3 (2.2%)
>18 years	133 (97.8%)
Mean maternal age	25.17 ± 3.6 years
Range	17–33 years
Parity	
Primipara	49 (36%)
Multipara	87 (64%)

Multi parous mothers constituted 64% of the study population, while 36% were Primiparous.

Table 2: Maternal Blood Group and ICT Status Distribution (N=136)

Maternal blood group	Number (%)
A positive	24 (17.6%)
A negative	7 (5.1%)
B positive	24 (17.6%)
B negative	4 (2.9%)
AB positive	17 (12.5%)
AB negative	5 (3.7%)
O positive	47 (34.6%)
O negative	8 (5.9%)
ICT status	Number (%)
Positive	3 (2.2%)
Negative	133 (97.8%)

O positive was the commonest maternal blood group observed (34.6%), followed by A positive and B positive (17.6% each). Indirect Coombs test was positive in 3 mothers.

Table 3: Neonatal Demographic Characteristics (N=136)

Parameter	Number (%)
Gender	
Male	70 (51.5%)
Female	66 (48.5%)
Male ratio	1.2:1
Gestational age	
Preterm	37 (27.2%)

Term	99 (72.8%)
Mean gestational age	38 ± 1.35 weeks

Among the neonates, males constituted 51.5% and females 48.5%. Majority of neonates were term (72.8%).

Table 4: Birth Weight Characteristics and Gestational Age Related Birth Weight Distribution

Birth weight	Number (%)
<2 kg	4 (2.9%)
2–3 kg	69 (50.7%)
3–4 kg	57 (41.9%)
>4 kg	6 (4.4%)
Mean birth weight	2.94 ± 0.63 kg

Gestational age and weight category	Number (%)
Late preterm SGA	1 (0.73%)
Late preterm AGA	20 (14.7%)
Late preterm LGA	0
Term AGA	84 (61.7%)
Term SGA	25 (18.3%)
Term LGA	6 (4.41%)

Term AGA neonates represented the largest group (61.7%) among neonates with clinical jaundice.

Table 5: Clinical Characteristics and Management of Neonates (N=136)

Parameter	Number (%)
Birth injuries	
Present	17 (12.5%)
Absent	119 (87.5%)
Mode of delivery	
FTVD	54 (39.7%)
LSCS	70 (51.5%)
Vacuum assisted delivery	12 (8.8%)
Treatment received	Number (%)
Phototherapy	72 (52.9%)
Exchange transfusion	4 (2.9%)
No treatment	60 (44.1%)

LSCS was the commonest mode of delivery (51.5%). Phototherapy was required in 52.9% of neonates.

Table 6: Neonatal Blood Group Distribution, Blood Group Incompatibility, and Time of Screening Among the Study Population (N = 136)

A. Neonatal Blood Group Distribution

Blood Group	n (%)
A positive	41 (30.1)
B positive	37 (27.2)
O positive	28 (20.6)
AB positive	11 (8.1)
A negative	6 (4.4)
O negative	5 (3.7)
AB negative	4 (2.9)
B negative	4 (2.9)

B. Blood Group Incompatibility

Parameter	Total Cases	Incompatibility, n	Compatible (Set-up), n
ABO group	47	1	46
Rh group	11	1	10

C. Time of Screening for Clinical Jaundice

Time of Screening	n (%)
<48 hours	26 (19.1)
48–72 hours	73 (53.7)
>72 hours	37 (27.2)

Mean age at screening: 62.8 ± 15.8 hours.

Observation: A positive (30.1%) was the most common neonatal blood group, followed by B positive (27.2%) and O positive (20.6%). One case each of ABO and Rh incompatibility was identified. Most neonates (53.7%) were screened between 48 and 72 hours of life.

Table 7: Descriptive Statistics of Study Parameters

Parameter	Mean ± SD	Median	IQR
Birth weight (kg)	2.94 ± 0.63	2.9	2.5–3.4
Gestational age (weeks)	38.01 ± 1.35	38	37–39
TSB (mg/dl)	17.21 ± 4.19	16.9	15.1–19.7
STrIP score	15.49 ± 2.80	16	14–17
TCB (mg/dl)	16.51 ± 3.03	16.9	14.5–19.4

Table 8: Correlation Between TSB with STrIP Score and TCB

Parameter	Mean ± SD	Correlation coefficient (r)	p value
TSB vsSTrIP score	17.21 ± 4.19 vs 15.49 ± 2.80	0.818	<0.001
TSB vs TCB	17.21 ± 4.19 vs 16.51 ± 3.03	0.824	<0.001

A significant positive correlation was observed between TSB and STrIP score and between TSB and TCB values.

Table 9: Bland–Altman Agreement Analysis

Comparison	Mean difference	95% CI
TSB vsSTrIP score	1.69	-1.82 to 5.14
TSB vs TCB	0.9	-2.1 to 3.9

Bland–Altman analysis showed good agreement between TSB and both STrIP score and TCB measurements.

Table 10: ROC Analysis and Subgroup Correlation ROC Analysis for Prediction of Treatment Requirement

Parameter	AUC	Cut-off	Sensitivity (%)	Specificity (%)	p value
TSB	0.943	15.95	90.8	81.7	<0.001
STrIP score	0.920	15.5	86.5	88	<0.001
TCB	0.938	16.25	89.5	81.5	<0.001

Subgroup analysis showed significant correlation between higher bilirubin levels (>20 mg/dl) and STrIP score (r=0.632, p<0.001). Similarly, TCB showed significant correlation with higher TSB levels (>20 mg/dl) (r=0.646, p<0.001).

Discussion

Neonatal jaundice remains a significant clinical concern because of the potential risk of bilirubin-induced neurological dysfunction. In the present study, 136 neonates with clinically detectable jaundice were evaluated using Kramer's scale, STrIP score, Transcutaneous bilirubin measurement and total serum bilirubin estimation.

In the present study, the mean gestational age of neonates was 38.01 ± 1.35 weeks, with 72.8% being term neonates and 27.2% being preterm neonates. The mean birth weight was 2.94 ± 0.63 kg. Similar demographic characteristics have been reported in studies evaluating bilirubin screening methods among newborns, where majority of jaundiced neonates were term infants.[9]

Male predominance was observed in the present study, with males constituting 51.5% of the study population and a male-to-female ratio of 1.2:1. Male sex has been reported as a risk factor associated with increased incidence of neonatal hyperbilirubinemia, although the exact mechanism remains multifactorial.[10]

In this study, the majority of neonates were screened between 48–72 hours of life (53.7%), with a mean screening age of 62.8 ± 15.8 hours. This period corresponds with the usual peak of physiological

jaundice and is considered an appropriate time for bilirubin assessment before discharge. The American Academy of Pediatrics recommends risk-based bilirubin assessment before discharge to identify infants requiring further monitoring or treatment.[3]

The mean TSB level in the present study was 17.21 ± 4.19 mg/dl, while the mean TCB value was 16.51 ± 3.03 mg/dl. A strong positive correlation was observed between TSB and TCB (r=0.824, p<0.001). These findings are consistent with previous studies demonstrating a strong correlation between Transcutaneous bilirubin measurements and serum bilirubin levels.[5],[11] TCB provides a reliable non-invasive method for bilirubin screening and reduces the need for repeated blood sampling.

The present study demonstrated a significant positive correlation between TSB and STrIP score (r=0.818, p<0.001). This indicates that stool colour assessment combined with clinical jaundice evaluation can provide useful information regarding bilirubin severity. The STrIP score showed good correlation with serum bilirubin values, suggesting its potential role as a simple bedside screening tool, especially in settings where bilirubin estimation facilities are limited.

The Bland–Altman analysis demonstrated good agreement between TSB and STrIP score, with a mean difference of 1.69 mg/dl (95% CI: -1.82 to 5.14). Similarly, agreement between TSB and TCB showed a mean difference of 0.9 mg/dl (95% CI: -2.1 to 3.9). These findings indicate that both STrIP score and TCB measurements have acceptable agreement with serum bilirubin estimation.

The ROC analysis demonstrated excellent diagnostic performance of all three parameters for predicting treatment requirement. The area under the curve was 0.943 for TSB, 0.938 for TCB and 0.920 for STrIP score, all showing statistical significance (p<0.001). The STrIP score demonstrated a sensitivity of 86.5% and specificity of 88% at a cut-off value of 15.5, indicating its usefulness as a screening tool.

Subgroup analysis showed that STrIP score had a stronger correlation with higher bilirubin levels (>20 mg/dl) (r=0.632, p<0.001), whereas correlation was weaker among neonates with bilirubin levels below 15 mg/dl. Similarly, TCB showed significant correlation with higher TSB levels. This suggests that STrIP score may be particularly useful in identifying neonates with clinically significant hyperbilirubinemia requiring intervention.

The major advantage of STrIP scoring is its simplicity, non-invasive nature and applicability at bedside without requiring expensive equipment. It may serve as an adjunctive screening method along with clinical assessment and bilirubin estimation. However, serum bilirubin measurement remains essential before initiating definitive treatment decisions.

The findings of the present study suggest that stool colour assessment combined with Kramer's clinical assessment (STrIP score) correlates well with TSB and TCB values and may serve as an effective screening tool for neonatal jaundice, particularly in resource-limited healthcare settings.

Conclusion

The present study demonstrates that the STrIP score has a significant positive correlation and good agreement with total serum bilirubin levels, comparable to Transcutaneous bilirubin measurements. With good sensitivity and specificity for predicting treatment requirement, STrIP score can serve as a simple, non-invasive and cost-effective bedside screening tool for

assessing neonatal jaundice, particularly in resource-limited settings. However, serum bilirubin estimation remains essential for confirming diagnosis and guiding definitive treatment decisions.

References

1. Maisels MJ, Mc Donagh AF. Phototherapy for neonatal jaundice. N Engl J Med. 2008; 358:920–928.

2. Bhutani VK, Wong RJ, Stevenson DK. Hyperbilirubinemia in preterm infants. Clin Perinatol. 2016; 43:215–232.

3. American Academy of Pediatrics Subcommittee on Hyperbilirubinemia. Management of hyperbilirubinemia in the newborn infant 35 or more weeks of gestation. Pediatrics. 2004; 114:297–316.

4. Olusanya BO, Osibanjo FB, Slusher TM. Risk factors for severe neonatal hyperbilirubinemia in low and middle-income countries. J Perinatol. 2015;35:694–700.

5. Engle WD, Jackson GL, Sendelbach D, Manning D, Frawley WH. Assessment of neonatal jaundice with Transcutaneous bilirubin measurements. J Pediatr. 2002; 140:473–477.

6. Kramer LI. Advancement of dermal icterus in the jaundiced newborn. Am J Dis Child. 1969; 118:454–458.

7. Chen SM, Chang MH, Du JC, et al. Screening for biliary atresia by infant stool color card in Taiwan. Pediatrics. 2006; 117:1147–1154.

8. Doreswamy SM, et al. Stool colour assessment and Transcutaneous bilirubin measurement in neonatal jaundice evaluation. 2016.

9. Maisels MJ, Watchko JF. Treatment of jaundice in low birthweight infants. Arch Dis Child Fetal Neonatal Ed. 2003;88:F459–F463.

10. Newman TB, Xiong B, Gonzales VM, Escobar GJ. Prediction and prevention of extreme neonatal hyperbilirubinemia in a mature health system. Arch Pediatr Adolesc Med. 2000; 154:1140–1147.

11. Nagar G, Vandermeer B, Campbell S, Kumar M. Reliability of Transcutaneous bilirubin devices in term neonates: a systematic review. Pediatrics. 2013; 132: 871–881.