MICRO-INVASIVE MANAGEMENT OF NEONATAL BILIRUBINEMIA

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ABSTRACT

The present study aims at analyzing the suitability of transcutaneous approach and filter paper technique using Minolta Jaundicemeter in the management of neonatal bilirubinemia. I compared serially measured values of Serum Bilirubin Index (SBI) by using filter paper technique and transcutaneous bilirubin index (TcBI) with serum bilirubin level determined by Diazo Method in 100 clinically jaundiced newborns and in 25 neonates at birth. The estimation of TcBI is simple, quick, reliable and non-traumatic to the newborn with no workload on the laboratory and technician. However, different nomograms are to be prepared for different laboratories, as also for the newborns with difference in skin pigmentation, gestational age and after phototherapy. SBI determined by filter paper technique eliminates these limitations. Moreover, the linear correlation was stronger between SBI and Diazo values ($r = 0.9343$, $p < 0.001$) in comparison to TcBI with Diazo values ($r=0.9090$, $p<0.001$). Further SBI readings almost correspond with actual serum bilirubin levels while corresponding TcBI values were much higher especially at higher diazo values. Thus TcBI can be used routinely for the surveillance of neonatal jaundice till it reaches a level corresponding to critical serum bilirubin level at which active management is required. At this point, serum bilirubin level may be confirmed by SBI.

Key words: *Neonatal bilirubinemia, Transcutaneous bilirubin Index, Micro-invasive, Serum bilirubin index, Jaundice meter.*

Bilirubin encephalopathy is totally preventable with adequate surveillance and suitable intervention. Serial estimation of serum bilirubin level in relation to birth weight, gestational age and post-natal age are important determinants for observation and/or appropriate therapeutic intervention with phototherapy and/or exchange transfusion(1). Conventional Diazo method of serum bilirubin estimation requires repeated venepunctures not desirable in neonates, especially preterm and sick ones(2). The process is time consuming, requires trained manpower and equipped laboratory. Moreover, interlaboratory and interperson values may differ up to 40%(3). Hence, a simplified non-invasive/micro-invasive yet reliable method of serum bilirubin estimation is desirable.

Yamanouchi and co-workers(4) first described the use of a transcutaneous bilirubinometer (TcBM) for this purpose and found a series of linear relationships between total serum bilirum concentration and yellowish color intensity in the infants of Japanese ancestry. Since the transcutaneous estimation of serum bilirubin level by using spectro-photometric measurements involves the passage of light through the skin and subcutaneous tissues, the skin color as well as serum bilirubin level can affect the estimated serum bilirubin level. To overcome his difficulty, Guha *et al.*(5) tried to correlate the serum bilirubin levels from the laboratory with SBI from a drop of serum on a filter paper assessed by

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bilirubinometer and observed a good correlation between the two.

Keeping in view the aforementioned importance of rise of serum bilirubin level in neonates and problems encountered in its serial estimation, the present study was conducted to estimate and correlate the serum bilirubin level obtained by conventional Diazo method(6) with SBI and TcBI assessed by TcBM in babies born at the Obstetric Unit of the J.N. Medical College Hospital and to evaluate the role of micro-invasive technique in the management of neonatal bilirubinemia.

Material and Methods

All the 1740 live born babies of both sexes delivered between March, 1987 and February, 1988 were observed for presence of jaundice under good day light twice a day till the seventh day of life.

One hundred and twenty five full term babies of both sexes were randomly selected for estimation and correlation of serum bilirubin levels by Diazo method with SBI and TcBI over forehead (by Minolta/Air-shields Jaundice Meter 101). In one hundred babies, serial estimation of SBI, TcBI and serum bilirubin levels were carried out at 12-24 hours interval, beginning with the detection of clinical jaundice till serum birubin levels fell down to normal. In another twenty five subjects, cord blood was collected at birth for serum bilirubin estimation and SBI and TcBI were measured within 30 minutes of birth. Three readings were taken each time from forehead and filter paper.

For the determination of SBI, a drop of serum was put on Whatman Filter Paper No. 44 (having jaundicemeter value of 1), placed in a calibration disc (00) provided with the jaundice meter, so as to give a stain of one cm in diameter. The jaundice meter was placed over the stained spot on the filter paper while it was wet since the dried filter paper tends to give false readings. For this purpose, serum was obtained by centrifuging a heparinized capillary tube filled with blood from heel prick. TcBI was recorded as per standard method, as described in operator's manual of the instrument.

The entire data thus obtained was entered in the computer using dBase III software on IBM/PC/XT computer. This data file was then transferred to SPSS software for statistical analysis. The method of least squares was applied to the data for fitting a regression line and estimating its parameters to determine a regression equation. The predicted values corresponding to the values of the independent variable were computed from the regression equation. The upper and lower limits of the predicted values for 95% confidence interval of the regression line were also computed as shown in *Tables I & II*. The correlation procedure of SPSS software was used to compute the Pearson correlation coefficient for testing the strength of linear association between two variables. The graphs were prepared by using Lotus-123 software.

Results

Out of 1740 live born babies, the male and female ratio was 1.01 : 1.0. The overall incidence of jaundice in first week of life was 66.38%. There was no sex predilection.

The regression line (R-line) drawn after computing 831 actual serum bilirubin levels estimated by Diazo method and SBI is shown in *Fig. 1*. On the basis of this regression line, the predicted mean, upper and lower limits (at 95% confidence levels) of SBI for a given serum bilirubin level is

TABLE I—*Predicted Serum Bilirubin Index at Selected Serum Bilirubin Levels*

Serum bilirubin (mg/dl)	Serum bilirubin index: Predicted value	95% confidence intervals: Lower	Upper
0.0	1.49	1.29	1.70
0.5	1.96	1.60	2.32
1.0	2.42	2.08	2.76
1.5	2.89	2.57	3.21
2.0	3.36	3.06	3.66
2.5	3.82	3.54	4.10
3.0	4.29	4.03	4.55
3.5	4.75	4.51	5.00
4.0	5.22	5.00	5.45
4.5	5.69	5.48	5.90
5.0	6.15	5.96	6.35
5.5	6.62	6.44	6.80
6.0	7.09	6.92	7.26
6.5	7.55	7.39	7.72
7.0	8.02	7.86	8.18
7.5	8.49	8.33	8.64
8.0	8.95	8.80	9.11
8.5	9.42	9.26	9.58
9.0	9.88	9.72	10.05
9.5	10.35	10.17	10.53
10.0	10.82	10.63	11.01
10.5	11.28	11.08	11.49
11.0	11.75	11.53	11.97
11.5	12.22	11.98	12.45
12.0	12.68	12.43	12.94
12.5	13.15	12.88	13.42
13.0	13.62	13.32	13.91
13.5	14.08	13.77	14.39
14.0	14.55	14.22	14.88
14.5	15.02	14.66	15.37
15.0	15.48	15.11	15.85
15.5	15.95	15.55	16.34
16.0	16.41	16.00	16.83
16.5	16.88	16.44	17.32
17.0	17.35	16.89	17.80
17.5	17.81	17.33	18.29
18.0	18.28	17.78	18.78
18.5	18.75	18.22	19.27
19.0	19.21	18.67	19.76
19.5	19.68	19.11	20.25
20.0	20.15	19.56	20.73

TABLE II—*Predicted Serum Bilirubin Level at Selected Serum Bilirubin Index*

Serum bilirubin index	Serum bilirubin (mg/dl): Predicted value	95% confidence intervals: Lower	Upper
1	0.507	0.301	0.713
2	1.443	1.260	1.626
3	2.379	2.217	2.540
4	3.315	3.174	3.455
5	4.250	4.129	4.372
6	5.186	5.081	5.291
7	6.122	6.030	6.214
8	7.058	6.974	7.142
9	7.994	7.910	8.077
10	8.930	8.839	9.020
11	9.865	9.763	9.968
12	10.801	10.682	10.920
13	11.737	11.599	11.875
14	12.673	12.515	12.831
15	13.609	13.429	13.788
16	14.545	14.342	14.747
17	15.480	15.255	15.705
18	16.416	16.168	16.664
19	17.352	17.080	17.624
20	18.288	17.992	18.583

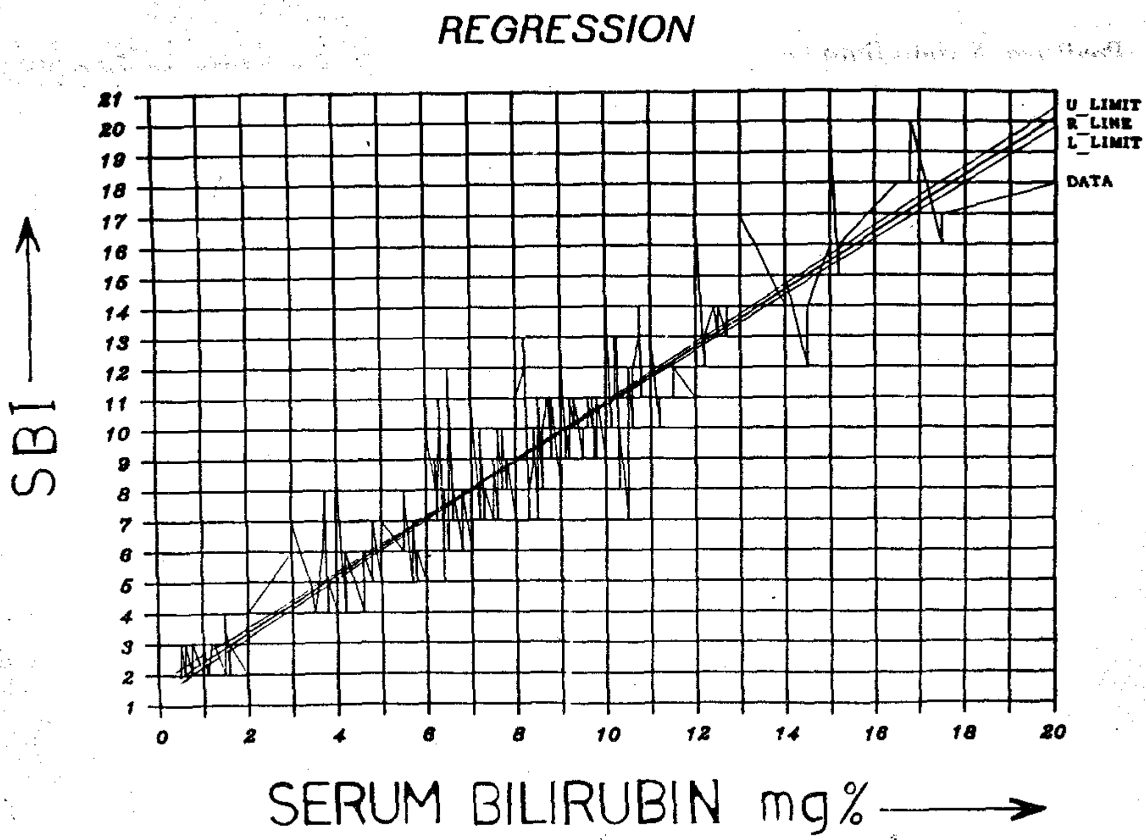

Fig. 1. Regression predicting serum bilirubin index (SBI) at serum bilirubin levels. U = Upper, R = Regression, L = Lower.

presented in *Table I. Table II* shows the predicted serum bilirubin levels for selected SBI readings. Similarly, serum bilirubin levels (822 readings) and TcBI readings taken at forehead are presented in *Fig. 2*. There was linear correlation between serum bilirubin levels and SBI and TcBI readings, with coefficients of correlation of 0.9343 and 0.9090, respectively. This was highly significant in both cases ($p<0.001$). However, the SBI values reflect the actual serum bilirubin levels more truly than TcBI value. Thus, whereas, the predicted mean Minolta readings from serum stain for Diazo values of 10, 15 and 20 are 10.82, 15.48 and 20.15, respectively, the corresponding TcBI readings are 20.49, 27.72 and 34.94 respectively (*Fig. 3*).

Discussion

Since the first report by Yamanouchi *et al.* in 1980(4) and subsequently substantiated by other workers from India(7-9) as well as abroad(10-14), TcBM has emerged as a safe, simple, reliable yet non-invasive method of management of neonatal bilirubinemia. It saves time, reduces trauma to the newborn and workload on the lab.

However, TcBM has its own limitations. The acutal serum bilurubin values are much lower than the corresponding TcBI readings for the determination of which a nomogram is to be prepared. These nomograms are different for different races (due to variable skin pigmentation), gestational age and after phototherapy. Further, every nursery must develop its own action level for interpreting their TcBM readings obtained from the laboratory, as interperson and interlaboratory variations up to 40% can occur(3). SBI eliminates all these limitations. The technique is especially useful in India where one comes across a wide variation in skin

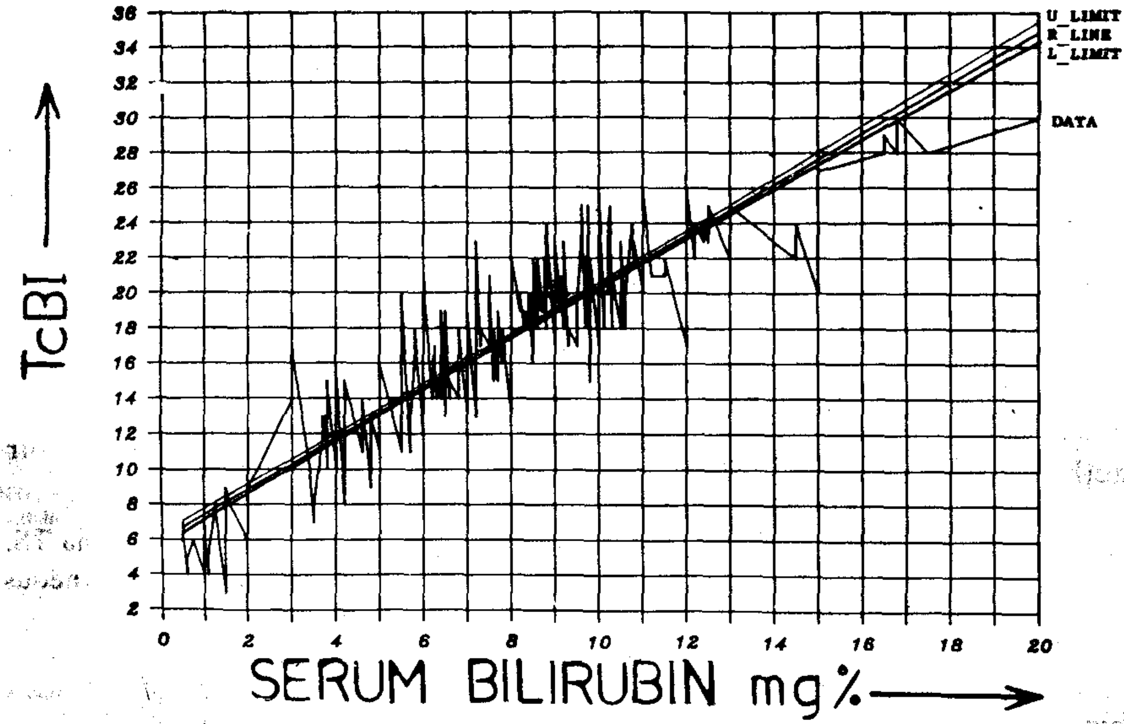

Fig. 2. *Regression predicting transcutaneous bilirubin index (TcBI) over forehead at serum bilirubin levels. U = Upper, R = Regression, L = Lower.*

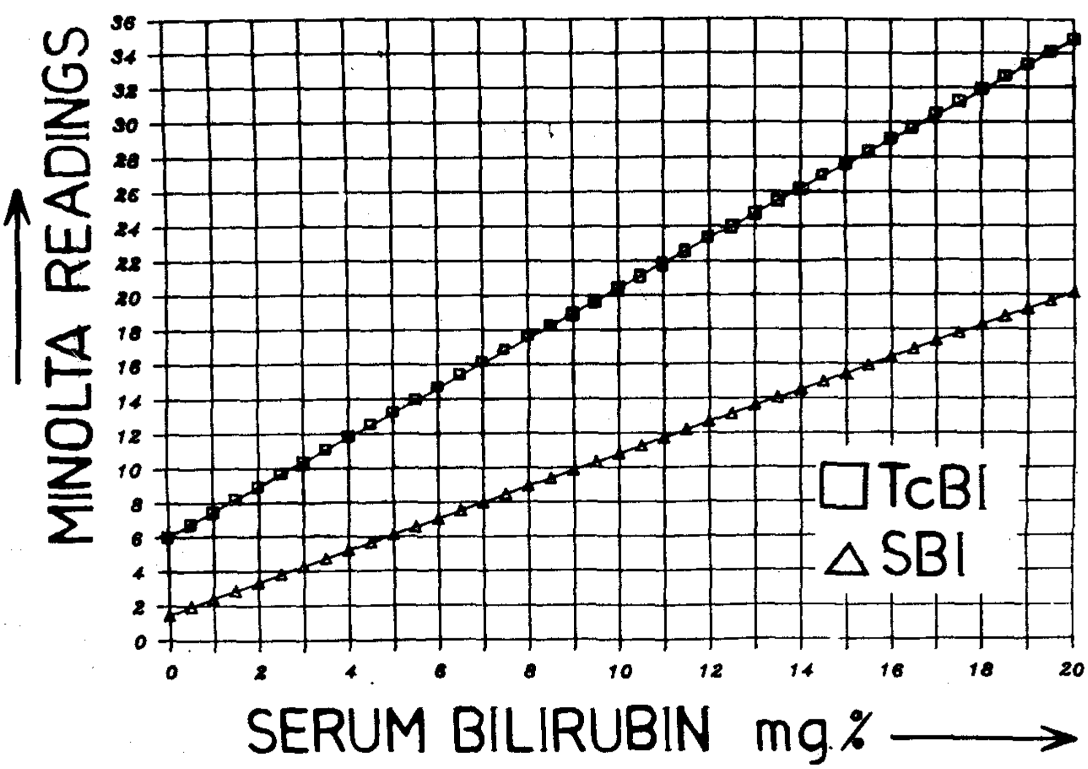

Fig. 3. *Regression predicting SBI and TcBI over forehead at serum bilirubin levels (drawn on the same basis as in Figs. 1 and 2).*

pigmentation. The linear correlation is stronger between SBI and Diazo values ($r = 0.9343$, $p<0.001$) in comparison to TcBI with Diazo values ($r = 0.9090$, $p<0.001$). Moreover, SBI readings almost correspond with actual serum bilirubin levels while corresponding TcBI readings are much higher, especially at higher Diazo values.

TcBM is a useful, non-invasive method of management of neonatal bilirubinemia. The method can be used for surveillance of newborn with jaundice, after preparing a nomogram for a particular area. At TcBI corresponding to critical serum bilirubin levels where an active management of neonatal jaundice may be required, serum bilirubin level may be confirmed by filter paper technique–a bedside micro-invasive technique, an alternative to laboratory method, not requiring any elaborate procedure nor equipment.

REFERENCES

1. Cockington RA. A guide to the use of phototherapy in the management of neonatal hyperbilirubinemia. J Pediatr 1979, 95: 282-285.
2. Mather A. Reliability of bilirubin determinations in icterus of the newborn infant. Pediatrics 1960, 26: 350-353.
3. Schreiner RL, Glick MR. Interlaboratory bilirubin variability. Pediatrics, 1982, 69: 277-281.
4. Yamanouchi I, Yamauchi Y, Igarashi I. Transcutaneous bilirubinometry: Preliminary studies on non-invasive transcutaneous bilirubinometer in the Okayama National Hospital. Pediatrics 1980, 65: 195-202.
5. Guha DK, Verma KK, Bhatia S, *et al*. A new bed side technique of bilirubin estimation. Indian Pediatr 1984, 21: 447-451.
6. Malloy, Evelyn. Bilirubin. *In:* Microanalysis in Medical Biochemistry. Ed Wooten. London, J & A Churchill, 1964, pp 80-82.
7. Narang A, Buche VB. Evaluation of the Minolta Jaundice meter as a screening device in Indian babies. A preliminary communication. Indian Pediatr 1983, 20: 583-585.
8. Bhat V, Srinivasan S, Usha TS, Puri RK. Correlation of transcutaneous bilirubinometry with serum bilirubin in South Indian neonates. Indian J Med Res 1987, 86: 49-52.
9. Sharma JN, Singh RN, Lodha A, *et al*. Transcutaneous bilirubinometry in newborns. Indian Pediatr 1988, 25: 757-760.
10. Hannemann Re, Dewitt DP, Weichel JF. Neonatal serum bilirubin from skin reflectance. Pediatr Res 1978, 98: 454-457
11. Hegyi T, Hiatt IM, Indyk L. Transcutaneous bilirubinometry I. Correlations in term infants. J Pediatr 1981, 98: 454-457.
12. Hannemann RE, Schreiner RL, Dewitt DP, *et al*. Evaluation of the Minolta bilirubinometer as a screening device in white and black infants. Pediatrics 1982, 69: 107-109.
13. Maisels MJ, Conrad S. Transcutaneous bilirubin measurement in full term Infants. Pediatrics 1982, 70: 464-467.
14. Douville P, Masson M, Forest JC. Diagnostic value of sequential readings with Minolta transcutaneous bilirubinometer in normal and low birth weight infants. Clin Chemist 1983, 29: 740-741.