

Accuracy of Transcutaneous Bilirubinometer Estimates Using BiliCheck® in Thai Neonates

Waricha Janjindamai, MD*,
Thirachai Tansantiwong, MD*

* Department of Pediatrics, Prince of Songkla University, Songkhla

Background: Neonatal jaundice is the most frequently encountered diagnostic and therapeutic problem in the newborn. In the jaundiced infant, it is thought that the binding capacity of plasma albumin is exceeded, which allows free bilirubin to diffuse into and accumulate within extravascular tissues, such as the central nervous system. Affected newborns may develop kernicterus. The standard method of serum bilirubin measurement requires blood specimen taken by heel prick or venepuncture which involves pain of the newborn and is time consuming. A non invasive, transcutaneous measurement of bilirubin concentration is developed to be an alternative method as a reliable for the screening method to detect hyperbilirubinemia

Objective: To compare the estimates of serum bilirubin using a recently introduced device called a BiliCheck® and its transcutaneous bilirubinometer index with the standard direct spectrophotometric measurement of serum bilirubin.

Design: Prospective descriptive study.

Material and Method: Estimates of serum bilirubin, as measured using the BiliCheck®, were compared with serum bilirubin concentration measured by direct spectrophotometry in neonates at Songklanagarind Hospital. Transcutaneous bilirubinometer readings were taken on the forehead.

Results: Eighty-two newborns were enrolled in the present study. The means and standard deviations of serum bilirubin concentration and transcutaneous bilirubinometer index were 11.96 ± 2.98 and 11.61 ± 2.93 mg/dl, respectively. There was no statistically significant difference ($p = 0.44$, paired *t*-test). The correlation coefficient between total serum bilirubin and BiliCheck® index was 0.95 with the linear regression equation of $Y = 0.99x + 0.4$.

Conclusion: Serum bilirubin can be accurately measured by the transcutaneous bilirubinometer index in full term newborn infants prior to any intervention modalities

Keywords: Neonatal jaundice, Transcutaneous bilirubinometer

J Med Assoc Thai 2005; 88(2): 187-90

Full text. e-Journal: <http://www.medassocthai.org/journal>

Neonatal jaundice is a common condition in neonates, especially among the Asian races⁽¹⁾. In recent years in the Western world, cases of classical acute bilirubin encephalopathy (kernicterus) have again been observed in otherwise healthy term and near-term infants. Determination of serum bilirubin concentration requires blood sampling which involves pain in newborn and parental distress. In recent years, however, new methods have been developed to evaluate the severity of neonatal jaundice, involving

transcutaneous bilirubinometry TcB, which are easy and non-invasive, and also minimize blood loss to an infant through more invasive blood assays. For instance, the Minolta Air-Shield jaundice Meter has correlated well with serum bilirubin, however, its use has been limited due to limitations involving age, weight and race^(3,4). A recently introduced device called BiliCheck® claims to correct these shortcomings of the Minolta Air-Shield, and early studies in Western countries have shown a strong correlation between its findings and the more traditional serum bilirubin determination^(5,6). However, there has yet been no study to examine the reliability of the BiliCheck® in

Correspondence to : Janjindamai W, Department of Pediatrics, Prince of Songkla University, Hat-Yai, Songkhla, 90110, Thailand.

newborns of Southeast Asia. The present study was undertaken to determine the accuracy of the BiliCheck[®] compared to serum bilirubin assays.

Material and Method

A prospective study was conducted in the neonatal intensive care unit (NICU) at Songklanagarind Hospital, Thailand between March and December 2000. Infants who met the inclusion criteria were term newborn infants with a birth weight equal to or more than 2,500 g, gestational age more than 37 weeks and in whom the primary physician had determined that clinically apparent jaundice necessitated a serum bilirubin determination. Excluded were infants who had received phototherapy or exchange transfusion before the present study. Demographic data were collected through review of the infant's medical records. Total serum bilirubin results, obtained via heel-stick, were sent immediately for analysis with an American optical (AP) unistat bilirubinometer, a direct spectrophotometry technique at wavelength of 454-540 nm.

BiliCheck[®] determinations were made in accordance with the manufacturer's recommendations and the device was calibrated before each measurement. All determinations were obtained from the infant's forehead while the infant was in a quiet state and readings were taken by one investigator only. For each infant five measurements were obtained at one time, in 2 minute intervals, and then averaged to provide one BiliCheck[®] index (BI) measurement. Blood specimen for bilirubine assays were collected by heel stick at the same time of BiliCheck[®] determination.

Statistical analysis

Sample size was calculated by the equation

$$n = \frac{Z^2_{\alpha/2} (2 \sigma^2)}{d^2}$$

$Z^2_{\alpha/2}$ is a type I error, and the authors accepted α at 0.05. σ^2 is a variance of data calculated from a pilot study. $\sigma^2 = 2.93$, d is defined as the difference between the study and control groups, and equal to 1. From the equation above the total sample size required was 66.

Demographic information, BI and total serum bilirubin (TSB) values were entered into the stata database. Correlation coefficients were calculated with the use of linear regression technique between BI and TSB.

A paired t test was used to compare BI and TSB. The results are presented as the means \pm SD. Statistical significance is implied by a p-value of less

than 0.05. The study was approved by the Ethics Committee Boards of Prince of Songkla University, and written informed consent was obtained from the mothers before the present study.

Results

A total of 82 infants were enrolled in the present study. Forty-two (51.2%) were male and 40 (48.8%) were female. The mean birthweight was 3,128 g ranging from 2,390 g to 4,400 g. The mean gestational age was 38.3 weeks, ranging from 35 to 41 weeks. The mean age at the study was 65 hours, ranging from 16 to 144 hours.

TSB ranged from 5.3 to 19.4 mg/dl (mean \pm SD = 11.96 \pm 2.98 mg/dl). BI ranged from 4.5-19.0 mg/dl (mean \pm SD = 11.61 \pm 2.93mg/dl). The Pearson correlation coefficient, r , between TSB and BI was 0.95 (95% CI = 0.21-0.40) $p < 0.001$ and the linear regression equation was $y = 0.99x + 0.4$ (Fig. 1). The mean (\pm SD) difference between the TSB and BI was 0.35 \pm 0.63 mg/dl ($p > 0.05$).

Discussion

The shortening of newborn hospital stays after birth and the observation that kernicterus is still occurring has drawn attention to the importance of identifying and monitoring the jaundiced newborn infant. Since visual assessment of hyperbilirubinemia is subjective, inaccurate and confounded by skin color and hemoglobin concentration, it is often necessary to obtain laboratory measurements of the TSB. A convenient, accurate and noninvasive method for estimating serum bilirubin concentration would be of benefit to physicians, infants and families.

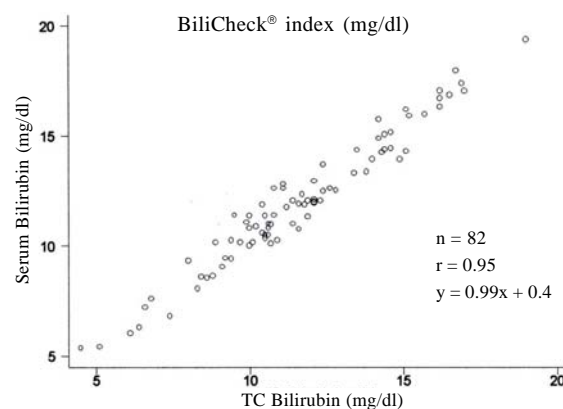


Fig. 1 Scatter diagram for Regression and error plots for comparison of total serum bilirubin and BiliCheck[®] index

The original Minolta Air-Shields jaundice meter has important disadvantages, including significant variations in readings produced by differences in skin pigmentation. Also, the displayed value is not a serum bilirubin level but is an index that must be converted to a serum bilirubin level in each hospital. The new BiliCheck[®], which utilizes the principle of spectral subtraction, generally has been shown to correlate with bilirubin measurements^(7,8).

In the present study, all of the babies had yellowish skin, and the correlation coefficient for the BiliCheck[®] ($r = 0.95$) was comparable to those obtained by Bhutani et al ($r = 0.91$)⁽⁵⁾, Rubeltelli et al ($r = 0.89$)⁽⁶⁾, Knupfer et al ($r = 0.73$)⁽⁹⁾ and Wong et al ($r = 0.87$)⁽¹⁰⁾. The SD results were also similar at ± 0.63 mg/dl in the present study, ± 0.55 mg/dl in Bhutani et al⁽⁵⁾, ± 0.76 mg/ml in Rubeltelli et al⁽⁶⁾ and ± 0.67 mg/dl in Wong et al⁽¹⁰⁾.

A limitation of the present study is that the serum bilirubin was analysed by a clinical laboratory method rather than the ideal method of high performance liquid chromatography (HPLC). The present study used the American optical (AP) unistat bilirubinometer, using direct spectrophotometry at wave length 454-540 nm, which has been shown to be an accurate and precise assay for total serum bilirubin⁽¹¹⁾.

Conclusion

Transcutaneous bilirubin sampling is easy to perform and pain-free for the infant and the test gives an immediate result. The accuracy and the precision of the transcutaneous bilirubin in the present study was observed to be-comparable to the serum bilirubin, with a high correlation coefficient between transcutaneous bilirubin and serum bilirubin. BiliCheck[®] could be used as a screening device at early discharge, or be applied in visible jaundice, term infants, prior to any intervention modalities and to assist clinicians in determining the need for additional follow up. The findings of the present study indicate that for Thai term neonates, BiliCheck[®] is an accurate

method for screening jaundiced and early-discharge infants to reduce the number of blood samples required for serum bilirubin.

References

1. Maisels MJ. Jaundice. In: Avery GB, Fletcher MA, MacDonal MG, eds. Neonatology: Pathophysiology management of the newborn. 5th ed. Philadelphia: Lippincott, Williams and Wilkins, 1999: 765-819.
2. Ebbensen F. Reoccurrence of kernicterus in term and near term infants in Denmark. Acta Paediatr 2000; 89: 1213-7.
3. Janjindamai W, Pochanukul A, Chanvitan P. Transcutaneous bilirubinometry measurements in full term neonates. Songkla Med J 2001; 19: 61-7.
4. Knudsen AA. Prediction and non-invasive assessment of neonatal jaundice in the term healthy newborn infant. Acta Paediatr 1996; 85: 393-7.
5. Bhutani VK, Gourley GR, Adler S, et al. Non-invasive measurement of total serum bilirubin in a multiracial predischARGE newborn population to assess the risk of severe hyperbilirubinemia. Pediatrics 2000; 106: E17.
6. Rubaltelli FF, Gourley GR, Loskamp N, et al. Transcutaneous bilirubin measurement: A multicenter evaluation of a new device. Pediatrics 2001; 107: 1264-71.
7. Engle WD, Jackson GL, Sendelbach D, et al. Assessment of a transcutaneous device in the evaluation of neonatal hyperbilirubinemia in a primarily hispanic population. Pediatrics 2002; 110: 61-7.
8. Slusher TM, Angyo IA, Bode-Thomcis F, et al. Transcutaneous bilirubin measurements and serum total bilirubin levels in indigenous African infants. Pediatrics 2004; 113: 1636-41.
9. Knupfer M, Pulzer F, Braun L, et al. Transcutaneous bilirubinometry in preterm infants. Acta Paediatr 2001; 90: 899-903.
10. Wong CM, Van Dijk PJE, Laing IA. A comparison of transcutaneous bilirubinometers: Spect Rx Bilicheck[®] versus Minolta Air Shield. Arch Dis Child Fetal Neonatal Fd 2002; 87: F137-40.
11. Gourley GR, Bhutani V, Johnson L, et al. Measurement of serum bilirubin in newborn infants: common clinical laboratory methods versus high performance liquid chromatography. Pediatr Res 1999; 45: 283A.

ความแม่นยำในการวัดระดับบิลิรูบินผ่านทางผิวหนังในทารกไทยโดยเครื่อง BiliCheck®

วาริชา เจนจินตามัย, ธิรัชชัย ตันสันติวงศ์

ความเป็นมา: ภาวะตัวเหลืองเป็นปัญหาที่พบบ่อยในทารกแรกเกิดและจำเป็นต้องให้การวินิจฉัยและรักษาอย่างรวดเร็วเพื่อป้องกันความพิการจากบิลิรูบินเข้าสู่สมอง (kernicterus) การวินิจฉัยโดยการเจาะเลือดเพื่อตรวจดูระดับบิลิรูบินเป็นวิธีมาตรฐานที่ยอมรับโดยทั่วไป แต่การเจาะเลือดเป็นหัตถการที่ทำให้ทารกเกิดความเจ็บปวด และใช้เวลา จึงมีการพัฒนาเครื่องวัดระดับบิลิรูบินผ่านทางผิวหนังเพื่อตรวจคัดกรองภาวะตัวเหลืองทำได้อย่างรวดเร็วและไม่เกิดความเจ็บปวด

วัตถุประสงค์: เพื่อเปรียบเทียบค่าบิลิรูบินในซีรัมซึ่งวัดโดยวิธี direct spectrophotometry ซึ่งเป็นวิธีมาตรฐานกับค่าดัชนีความเหลืองทางผิวหนังโดยวัดจากเครื่อง BiliCheck®

รูปแบบการวิจัย: การศึกษาไปข้างหน้า

วัสดุและวิธีการ: ทำการวัดค่าดัชนีความเหลืองทางผิวหนังเปรียบเทียบกับค่าซีรัมบิลิรูบินในทารกครบกำหนด ซึ่งคลอดในโรงพยาบาลสงขลานครินทร์ โดยทำการตรวจวัดดัชนีความเหลืองที่บริเวณหน้าผากทารกแรกเกิด

ผลการศึกษา: ทารกแรกเกิดจำนวน 82 รายมีค่าเฉลี่ยและค่าเบี่ยงเบนมาตรฐานของค่าบิลิรูบินในซีรัมและค่าดัชนีความเหลืองที่วัดได้ทางผิวหนังเท่ากับ 11.96 ± 2.98 และ 11.61 ± 2.93 มก./ดล. ตามลำดับค่าสัมประสิทธิ์สหสัมพันธ์เท่ากับ 0.95 โดยมีสมการถดถอยคือ $y = 0.99x + 0.4$ โดยค่า $p = 0.44$ (paired t-test) พบว่าไม่มีความแตกต่างทางสถิติระหว่างค่าที่วัดได้จาก 2 วิธี

สรุป: ค่าดัชนีความเหลืองทางผิวหนังจากการวัดด้วย BiliCheck® สามารถใช้แทนค่าซีรัมบิลิรูบินได้ ในทารกแรกเกิดครบกำหนดที่ยังไม่ได้รับการรักษาด้วยการส่องไฟรักษาและเปลี่ยนถ่ายเลือด
