

Comparison Between Transcutaneous Bilirubinometry and Measurement of Jaundice by Digital Photography in Neonates

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Background:

Neonatal jaundice or is a common medical problem in newborns. Serum bilirubin level is the gold standard for identifying neonates with increased risk of severe hyperbilirubinemia, but the procedure needs venipuncture which is painful and may result in skin infection of the newborns. Equipment for transcutaneous bilirubin level measurement (TCB) is effective to screen for neonatal hyperbilirubinemia but the equipment was very expensive. Digital photography and evaluation by computer program was reported to be useful for screening of neonatal jaundice.

Purpose:

To study the correlation between serum microbilirubin level (SMB), transcutaneous bilirubinometry (TCB) and digital photographic yellow level (DPYL) in evaluation of neonatal jaundice.

Methods:

This research was approved by Committee on Human Related to Research Involving Human Subjects, Faculty of Medicine Ramathibodi Hospital, Mahidol University on 21th January 2015. Forty two newborns born in Ramathibodi Hospital were recruited during 15 August 2015 – 31 October 2015. At 48 hours or more after birth, serum microbilirubin were measured and recorded. TCB was also evaluated by using JM 103 bilirubinometer at the chest of the newborn and the value were recorded. Digital photograph was also taken at the chest of the newborn and the yellow levels of the newborn skin were analyzed by using the Photoshop computer program. Serum microbilirubin levels and TCB at the chests of the newborns were determined at more than 24 hours after birth. Digital photographs was taken at the chests of the newborns and were analyzed by using Photoshop computer program to determine the yellowish level of neonatal skin. The results of 3 methods were compared. Statistics for data analysis were frequency, percentage, mean and standard deviation. Chi-square test, Fisher's exact test and linear regression analysis were used for hypothesis testing with the significant level at $p < 0.05$.

Results:

The mean serum microbilirubin level was 12.07 ± 1.649 mg/dl. There was a good correlation between SMB and TCB ($r^2=0.761$), between SMB and DPYL ($r^2=0.766$) and between TCB and DPYL ($r^2=0.935$).

Conclusion:

Yellow level (DPYL) estimation correlated well with SMB and TCB. Digital photographic can be used to determine the jaundice level in newborns and can be used as a screening test for neonatal jaundice especially in places where resources are limited.

Title:

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Keywords:

Serum microbilirubin level (SMB), digital photo graphic yellow level (DPYL). and transcutaneous bilirubinometry (TCB)

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Abstract Summary:

Study the correlation between serum microbilirubin level (SMB), transcutaneous bilirubinometry (TCB) and digital photo graphic yellow level (DPYL) in evaluation of neonatal jaundice. This research was a quasi-experimental study. 42 newborns in Ramathibodi Hospital.

Content Outline:**Introduction**

Neonatal jaundice or hyperbilirubinemia is one of the most common complication in the newborns⁽¹⁾. It is often a harmless clinical condition as the result of normal adaptive physiological processes which generally occurs between 3 and 5 days after birth and then resolves over the next 7 to 10 days. Jaundice is normally first found on the newborn's face, progressing to the trunk and extremities as the serum bilirubin concentration increases⁽²⁾. However, extreme neonatal hyperbilirubinemia may result in bilirubin encephalopathy (kernicterus), causing irreversible brain damage to newborns⁽³⁾.

The incidence of neonatal jaundice or hyperbilirubinemia has been reported to be more than 30% in full-term newborns and about 100% in premature infants⁽⁴⁾. Hyperbilirubinemia is more prevalent in Asian population⁽⁵⁾. A study in Canada found that 6.7% of newborns (predominantly white) had jaundice with a peak of total serum bilirubin (TSB) ≥ 230 $\mu\text{mol/L}$ (13.5 mg/dL)⁽⁶⁾.

The current gold standard to measure bilirubin levels is total serum bilirubin (TSB) and serum microbilirubin (SMB) determination from a blood sample which can be obtained by venipuncture or skin cutting at the sole of newborns. It is an invasive procedure which is painful and may result in skin infection. Non-invasive methods of bilirubin measurements have been developed (1). In 1980, Yamanouchi et al. (7) and the Minolta Camera Company developed one of the first clinically applicable transcutaneous bilirubin measurement. Since then there have been numerous technological advances that have led to improve accuracy and reliability in assessing jaundice. Currently there are two popular equipment for transcutaneous bilirubinometry, i.e. BiliCheck and JM-103, which have been validated through extensive study⁽⁸⁾. If screening by TCB indicates that a neonate is at increased risk for clinically significant hyperbilirubinemia, serum bilirubin should be measured by the clinical laboratory^(8, 9). However, at present the equipment of measurement of TCB is very expensive.

In 2009, Leartveravat S. (10) designed a new noninvasive method to measure jaundice level of the newborn by using digital photography. With the help of Photoshop he could assess the yellow level of the skin of newborn in a digital photograph. He found good correlation between total serum bilirubin (TSB) and measurement of jaundice by digital photography (DPYL). This study aimed to evaluate correlation between serum microbilirubin, transcutaneous bilirubinometry (TCB) by JM-103 equipment and jaundice measurement by digital photography (DPYL) in neonates.

Materials and Methods

This research was approved by Committee on Human Related to Research Involving Human Subjects, Faculty of Medicine Ramathibodi Hospital, Mahidol University on 21th January 2015. Forty two newborns born in Ramathibodi Hospital were recruited during 15 August 2015 – 31 October 2015. At 48 hours or more after birth, serum microbilirubin were measured and recorded. TCB was also evaluated by using JM 103 bilirubinometer at the chest of the newborn and the value were recorded. Digital photograph was also taken at the chest of the newborn and the yellow levels of the newborn skin were analyzed by using the Photoshop computer program.

Steps in evaluation of yellow level of newborn skin by Photoshop computer program (version 1998) were as follow.

1) Set the standard of color of RGB system.

1.1) white color (red green and blue were set at = 255)

1.2) black color (red green and blue were set at = 0)

1.3) gray color (red green and blue were set at = 128)

2) Automatic adjustment of white balance of the photograph using standard color paper.

3) Measurement of yellow level of newborn skin by calculation the different percentage between Y (yellow) color minus M (magenta) color at lighting setting at 70%.

The data were analyzed using the SPSS program version 18 licensed for Mahidol University. Data analysis was done by using percentage, mean and standard deviation. Kolmogorov-Sminov test was used to evaluate normal distribution of data. Chi-square test, Fisher's exact test and Linear regression analysis were used to test the hypothesis with the significant level at $p < 0.05$

Results

General characteristics

Most of mothers (40.8%) were 29-34 years old and mean of maternal age was 32 ± 6.14 years. More than half (57.1%) had bachelor degree or above. More than half (52.4%) of the mothers were primipara. Thirty six percent had gestational age 37 weeks or more. Forty three percent had more than 8 antenatal visits. Thirty eight percent of mothers had blood group O and 31% had blood group B. Most of mothers (59.52%) were not given oxytocin for augmentation of labour before delivery. Sixty percent of mothers had caesarean section for delivery.

Most of newborns (71.4%) weighed between 2501- 3500 kilograms at birth and mean weight was 3027.14 ± 69.88 grams. Mean age at jaundice evaluation was 59.78 ± 18.32 hours after birth. Most of newborns had Apgar score 9 – 10 (61.9%) at 1st minute after birth and 71.4% had Apgar score= 10 at 5 minutes after birth.

The mean and standard deviation of SMB was 12.07 ± 1.649 mg/dl, TCB 12.33 ± 1.72 mg/dl and DPYL $31.46 \pm 7.568\%$. The distribution of these three measurements analyzed by Kolmogorov-Sminov test and showed normal distribution.

Correlation between serum microbilirubin level (SMB), transcutaneous bilirubinometry (TCB) and level of jaundice measured by digital photography (DPYL) were show in Figure 1 – 3. Regression equation for the correlation between SMB and TCB was $SMB = 1.762 + 0.836(TCB)$ with $r^2 = 0.761$ / ($p < 0.05$). The regression equation for correlation between SMB and DPYL was $SMB = 6.073 + 0.191(DPYL)$ with $r^2 = 0.766$ / ($p < 0.05$). The regression equation for correlation between TCB and DPYL was $TCB = 5.414 + 0.22 (DPYL)$ with $r^2 = 0.935$ / ($p < 0.05$).

Discussion

Jaundice in the newborns is the most common condition and requires medical attention. The yellowish coloration of the skin and sclera in newborns is the result of accumulation of unconjugated bilirubin. In newborns, unconjugated hyperbilirubinemia reflects a normal transitional phenomenon. However, in some newborns, serum bilirubin levels may rise excessively, which can be the cause for concern because unconjugated bilirubin is neurotoxic and can cause death or lifelong neurologic sequelae in newborns who survive (kernicterus)⁽⁴⁾. For these reasons, diagnostic evaluation of neonatal jaundice is important and necessary to prevent neonatal morbidity and mortality⁽⁷⁾.

Measurement of neonatal jaundice serum microbilirubin level (SMB) is the gold standard. However SMB needs neonatal blood sampling which needs skin puncture or venipuncture which is painful and can lead to skin infection in the newborns.

Since 1980, noninvasive measurement of bilirubin level (TCB) was proposed by Yamanouchi et al. as a screening test for SMB in evaluation of neonatal jaundice^(8,11). The common equipments of TCB are Billicheck or JM 103 which are options for universal screening of neonatal jaundice. If TCB screening indicates that a neonate is at an increased risk for clinically significant hyperbilirubinemia, SMB should be followed. It is also important to be aware that TCB appears to underestimate bilirubin concentrations at 206–240 mmol/L or 12–14 mg/dl and should be confirmed by the clinical laboratory⁽¹⁾. The available literatures demonstrated excellent linear correlation between SMB and TCB for these two devices in term and late preterm neonates. JM-103 and BiliCheck reach almost 100% sensitivity to predict hyperbilirubinaemia^(8,11). But both instruments of TCB are very expensive and cannot be afforded by hospitals especially in the rural areas.

DPYL was proposed by Leartveravat S. in 2009⁽¹⁰⁾. He used sony cybershort camera found that digital photography with aid of a computer program could be used to measure yellow level of neonate skin (DPYL). DPYL was found to be well correlated and can be used in place of TCB.

Digital camera is now popular for use in daily life and is not very expensive. Photoshop is also a popular computer program as a high-end image editor for the Macintosh and Windows. The original Mac versions were the first to bring affordable image editing down to the personal computer level in the late 1980s. Since then, Photoshop has become the de facto standard in image editing. Although it contains a large variety of image editing features, one of Photoshop's most powerful capabilities is layers, which allows images to be rearranged under and over each other for placement. Photoshop is designed to read from and convert to a raft of graphics formats but uses its own native format for layers. It can also determine the components of colours in the picture.

This study showed good correlation between DPYL with TCB and SMB. DPYL could be used done in the hospital in rural areas use where SMB and TCB are not available.

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