Evaluation of the first day transcutaneous bilirubin (TcB) level as a predictor of hyperbilirubinemia in healthy term neonates

Original Article

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Abstract:

Background: The readmission rate for neonatal jaundice has been increased in recent years. This has been attributed to shorter length of postpartum hospital stays without comprehensive follow-up. The purpose of this study was to determine the diagnostic value of pre-discharge transcutaneous bilirubin (TcB) levels for prediction of subsequent hyperbilirubinemia in healthy term neonates.

Methods: Between October and December 2013, a total of 99 healthy term neonates born at the Babol Clinic Hospital of healthy mother were enrolled in a prospective cross sectional study. The TcB levels were measured in all enrolled neonates between 12 and 24 hours of age just before discharge. All newborns were followed-up for jaundice to 10th day. Newborns with clinical jaundice were recalled and their serum bilirubin levels were measured. Appropriate treatment was performed based on the Amirkola Children's Hospital Protocol. TcB levels were compared between the non-treatment and treatment groups.

Results: The mean age of the TcB measuring was 17.5±2.6 hours. A total of 18.1% neonates (18 of 99) were developed severe hyperbilirubinemia (need for treatment). The mean of cutaneous bilirubin level in the non-treatment and treatment groups was 5.2±1.6mg/dl and 6.3±0.9 mg/dl, respectively. The cutaneous bilirubin level at cut-off 6 mg/dl was associated with 80.0% sensitivity and 63.0% specificity. The negative predictive value was 94.6%.

Conclusion: Single TcB measurements at the first 24 hours predict hyperbilirubinemia with a reasonably high degree of accuracy.

Key Words: Neonates, Transcutaneous Bilirubinometry, Hyperbilirubinemia

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Introduction:

Approximately 60% of all neonates will develop clinical jaundice [1]. Hyperbilirubi-nemia is still the most common cause of neonatal readmission to hospital in North America. Despite efforts to identify neonates at risk of hyperbilirubinemia, readmission rate has increased in the United States and Canada due to implementing early hospital discharge of neonates since 1999. Jaundice is the most common cause of readmissions in discharged neonates who are healthy otherwise [2]. Different methods have been used to predict jaundice, so that routine measuring of serum bilirubin level before discharge is the best [3]. Although measuring serum bilirubin level is the gold standard to evaluate bilirubin level, causing pain stress, sampling area infection, requiring laboratory and taking more time in comparison with Tc bilirubinometry caused more using of Tc bilirubinometry [4]. In the other side, early hospital discharge of neonates revealed necessity of using Tc bilirubino-metry. First bilirubinometer was applied in 1980; it still couldn't take measuring serum bilirubin level's place 30 years afterwards [5].

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Tc bilirunometry which could significantly reduce serum-sampling rates was considered as an effective help in different studies [6].

In our country (Iran) the value of using Tc bilirubinometry seems more due to a large number of patients, which causes neonates discharge earlier than world standards, besides measuring serum bilirubin level is being done by venous sampling instead of capillary sampling. The present study was performed in order to implement and evaluate the power of Tc bilirubinometry to predict severe neonatal jaundice (treatment required for jaundice).

Methods:

This cross-sectional prospective study was performed at Babol Clinic hospital in Babol city from October to December 2013. One hundred five healthy neonates with Apgar score [8-10] and birth weight over 2500 gr without anomaly, born from healthy mothers were enrolled in this study.

The exclusion criteria were as follows:

1) Hospitalization due to conditions other than jaundice,

2) Occurrence of other diseases during the follow-up,

3) Lack of access to infants and

4) Hospitalization before measuring TCB. Six neonates were excluded (3 neonates due to incompleted documents, 3 neonates due to unavailability). Ninety nine neonates were followed up.

All of them were discharged in less than 24 hours of birth date while their Tc bilirubin was measured by Bilicheck (David-JH 201A, China) and their demographic information was recorded according to that right before discharge. Neonatal follow up for jaundice continued to 10th day. Neonates with clinical jaundice after measuring serum bilirubin level received appropriate treatment from therapeutic physicians to control the disease and they were referred to Amirkola Children's Hospital to be treated according to its therapeutic protocol if it was needed (table 1).

Neonates stratified in two groups: Those who needed treatment as treatment group and the rest as non-treatment group. The collected data of these two groups were analyzed by SPSS 22, t-test statistical tests and Pearson correlation coefficient and using ROC curve and achieving area under appropriate cross point of curve.

Results:

A total of 99 neonates participated in this study, 51(51.5%) and 48(48.5%) neonates were female and male, respectively. All neonates who needed treatment, treated by UV light treatment (phototherapy). Mean gestational age was 38.70±0.60 weeks and the mean neonatal birth weight was 3643.87±426.94 gr. The age of neonates at Tc bilirubinometry was between 12 and 24 hours after birth (mean 17.53±2.64 hours). The mean cutaneous bilirubin level measured in studied neonates was 5.42±1.62 mg/dl (table 2).

The mean cutaneous level of bilirubin in non-treatment group including 81 neonates (81.81%) and in treatment group (according to therapeutic protocol of Amirkola Children's Hospital) including 18 neonates (18.18%) was 5.22±1.67 mg/dl and 6.32±0.91 mg/dl, respectively (P= 0.009) (table 3).

Comparing ROC curves of cutaneous bilirubin level of treatment with non-treatment groups showed that cutaneous bilirubin level 6 mg/dl is the most appropriate cut-off to predict severe neonatal jaundice (treatment required for jaundice), which has 80% sensitivity and 63% specificity. Considering that therapeutic criteria of Amirkola Children's Hospital are lower than American Academy of pediatrics (AAP) criteria, we compared treatment-required neonates (according AAP guideline) with the rest of neonates. 9 neonates (9.09%) required treatment according to AAP protocol.

The mean cutaneous bilirubin level in this group was 6.68±0.50 mg/dl. Non-treatment group consisted of 90 neonates (90.90%) and mean cutaneous bilirubin level was 5.30±1.64 mg/dl (P= 0.014). Comparing ROC curves of cutaneous bilirubin level of treatment with non-treatment groups according to AAP guideline revealed that cutaneous bilirubin level 6 mg/dl is the most appropriate cut-off to predict severe neonatal jaundice (treatment required according to AAP) and has 100% sensitivity.

Table 1: Amirkola Children's Hospital therapeutic protocol for neonatal jaundice treatment in healthy term neonates [12]

Day1	Day 2	Day 3	Exchange Transfusion		Discharge
	(mg/dl)		With risk factor	Without risk factor	Age≥72hour
TSB*≥5	TSB≥10	TSB≥15	TSB≥20 mg/dl	TSB≥25 mg/dl	And TSB≤10 mg/dl

* TSB=Total Serum Bilirubin

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Table 2: Baseline demographic data for neonates (Mean±SD)

Characteristics of Neonates	N	Minimum	Maximum	Mean	Std. Deviation
Maternal age(year)	99	17	40	28.72	4.54
GA(w)	99	37.28	40.28	38.70	0.60
W(gr)	98	2600	5000	3643.88	426.94
Age at Tc bilirubinometry(hour)	99	12	24	17.54	2.65
TCB*(mg/dl)	99	0.7	7.7	5.43	1.62
TSB(mg/dl)	41	8.20	21	13.34	2.82

*TCB=Transcutaneous Bilirubin

Table 3: TCB level, P value in non-treatment and treatment groups based on Amirkola Children's Hospital therapeutic protocol for neonatal jaundice treatment in healthy term neonates (Mean±SD)

	Group	N	Mean	Std. Deviation	P-value
TCB	Non-treatment	81	5.23	1.68	0.009
	Treatment	18	6.32	0.92	

Table 4: TCB level, P value in non-treatment and treatment groups based on AAP guideline for neonatal jaundice treatment (Mean±SD)

	Group	N	Mean	Std. Deviation	P-value
TCB	Non-treatment	90	5.30	1.64	0.014
	Treatment	9	6.69	0.51	

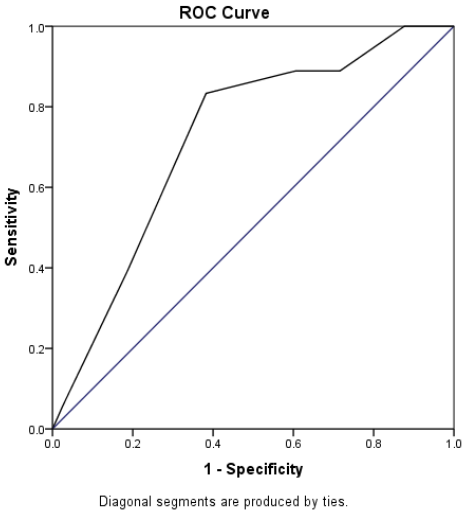

Figure: 1. Receiver operating characteristic (ROC) curve of transcutaneous bilirubin (TCB) at the treatment group, based on Amirkola Children's Hospital protocol, area under the curve is 0.722

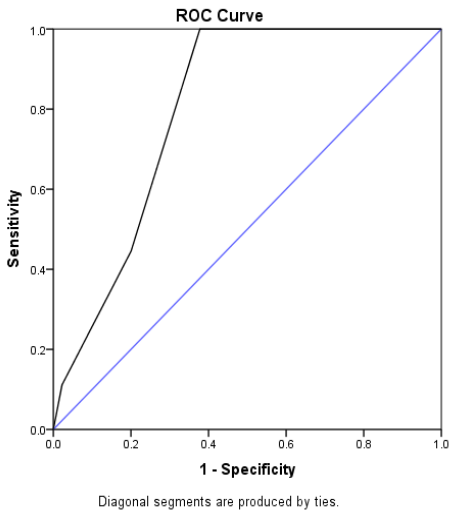

Figure 2: Receiver operating characteristic (ROC) curve of transcutaneous bilirubin (TCB) at the treatment group, based on AAP protocols for treatment neonatal jaundice, area under the curve is 0.801

Discussion:

Results of the current study showed that measuring cutaneous bilirubin level between 12 and 24 hours after birth can predict severe neonatal jaundice (treatment required for jaundice) in first week with high sensitivity. Different methods have been used to predict neonatal jaundice such as measuring umbilical cord bilirubin level in a study performed by Bernaldo AJ in 2004, umbilical cord bilirubin level was considered and he concluded that if UC bilirubin level exceeds 2 mg/dl, 53% of neonates will require UV light treatment [7].

In the study of Shahfarahat et al.'s in 2013, UC bilirubin level was considered as predictor of

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pathologic hyperbilirubinemia. They found that there was significant statistical difference in UC bilirubin level between treatment group (bill>15 mg/dl) and non-treatment group, and this test had 68.86% sensitivity and 61.18% specificity by considering UC bilirubin level at cut-off 2 mg/dl. The present study had 80% sensitivity and 63% specificity in predicting treatment required for jaundice (according to hospital protocol) preferred to measure UC bilirubin level regarding to expenses, ease of doing and sensitivity.

In 2002, Sarici SU et al.'s conducted a study and they used serum bilirubin level of 6th hour after birth as predictor of severe hyperbilirubinemia to determine hemolysis. According to acquired results, if bilirubin level of 6th hour after birth is among 4 to 6 mg/dl, it will predicts almost all neonates who develop severe jaundice. In study performed by Alpay F and colleagues in 2000, they used measuring of first day bilirubin level as predictor of severe hyperbili-rubinemia. Results showed that bilirubin level 6 mg/dl in first day of age predicted almost all neonates who would become very icteric and need UV light treatment [10].

In our study, measuring cutaneous bilirubin level in first day had 100% sensitivity at cut-off 6 mg/dl (according to AAP guideline) preferred regarding to being non-invasive ease of doing. A study performed in the United States in order to evaluate cutaneous bilirubin level as predictor of jaundice showed that using bilirubin level at cut-off 75 percentile before discharge had 100% sensitivity and 88% specificity [11].

In the current study cutaneous bilirubin level at cut-off 6 mg/dl in first 24 hours after birth had 100% sensitivity and 60% specificity in predicting severe jaundice (treatment required for jaundice) according to AAP guideline.

At present time because of a large number of patients, the neonates were discharged earlier than standard period in many of health care centers. In our country (Iran), hospital beds are not enough for a large number of patients, therefore very early neonatal discharge (less than 24 hours of admission) which occurs for most of neonates increases the readmission rate due to jaundice; thus, it is necessary to perform more evaluation on it, besides paying more attention to value of measuring cutaneous bilirubin level within first 24 hours after birth.

Considering early neonatal discharge in our country, measuring cutaneous bilirubin level before discharge even in first day of age, predicts treatment required for jaundice in neonates with high sensitivity to make parents informed and warned.

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