

Determining and comparing the level of bilirubin in icteric full-term neonates, using three different methods: portable jaundice meter, lab data and clinical estimation

Abstract

Introduction: Neonatal jaundice is a common phenomenon. The gold standard for determining bilirubin levels is total serum bilirubin using a blood sample in a laboratory setting. Unfortunately this is an invasive and painful method which compared to portable bilirubinometer devices is associated with some delays in revealing data. Therefore a convenient and non-invasive method could be substituted.

Materials and methods: This is a cross-sectional analytic study conducted on 52 term infants with jaundice in Shahid Sadooghi hospital during summer to winter 2015 in Yazd, Iran. At the first, the bilirubin level was estimated through clinical assessment by a nurse. Then bilirubin level in newborns was measured with Jaundice meter GM103 in the area between the eyebrows. Finally, blood samples from neonates were taken and sent to the lab. All demographic data and measured bilirubin amounts were analyzed by software SPSS v.17.

Results: The mean serum bilirubin level in newborns reported by the laboratory was 14.39 ± 5.13 however the mean for bilirubin level in newborns measured by the portable device and assessed by the nurse were 12.84 ± 3.7 and 13.5 ± 3.5 respectively. The comparison tests including Chi-square and Student T test showed a statistically significant difference between all these methods ($P < 0.05$).

Conclusion: The data showed that regarding to a statistically significant difference between bilirubin measurement methods ($P < 0.05$), these methods cannot be used as alternatives to each other and determining of serum bilirubin as the preferred method should always takes priority.

Keywords: jaundice, jaundicemeter, clinical estimation, total serum bilirubin

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Lookzadeh M Hosein,¹ Sadeghi M Samira,² Noori-shadkam Mahmood,¹ Salehi Heidar,² Khadijeh Nasiriani³

¹Assistant professor of neonatology, Department of Pediatrics, Shahid Sadoughi University of Medical Sciences, Iran

²Medical student, Shahid Sadoughi University of Medical Sciences, Iran

³Nursing- Midwifery School of Shahid Sadoughi University

Correspondence: Salehi Heidar, Medical student, School of Medicine, Shahid Sadoughi University of Medical Sciences, Yazd, Iran, Tel +989363547015, Email dr.h.salehi@gmail.com

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Introduction

Neonatal Jaundice or Neonatal Icterus or Neonatal Hyperbilirubinemia all mean skin discoloring to yellowish appearance in neonates. The disease is a common problem that 60% of term infants and 80% of preterm infants are affected.¹ Some degrees of elevated level of serum bilirubin in all newborns are expected (more than 2 milligrams per deciliter) but term newborn jaundice could only be visible in half of them with the bilirubin levels higher than 5 milligrams per deciliter.² There are two main categories of jaundice in newborns including indirect hyperbilirubinemia and direct hyperbilirubinemia.³ Among the causes of rising indirect bilirubin, physiological jaundice, Krigler-Najar syndrome, Gilbert's syndrome, breast milk jaundice, ABO blood group and RH incompatibility, and G6PD deficiency are noted.⁴ Infection, cholestasis, neonatal sepsis, neonatal metabolic diseases (Galactosemia, tyrosinemia, etc.) are examples of diseases that lead to direct hyperbilirubinemia.⁵ Hyperbilirubinemia is known as the most common causes of hospital readmission after discharge in normal newborns.⁶ Kernicterus is a neurological syndrome caused by deposition of unconjugated bilirubin in basal ganglia and nuclei of the brain stem.⁷ Therefore, determining of bilirubin level in order to early detection of hyperbilirubinemia and prevention of brain damage caused by kernicterus is required. The gold standard for determining

bilirubin levels is total serum bilirubin determined on a blood sample in a laboratory setting. Unfortunately this is an invasive and painful method which compared to portable bilirubinometer devices is associated with some delays in revealing data and requires serial blood sampling.⁸ The first attempt to measure bilirubin through the skin was carried out in 1960.⁹ Early devices were not accurate enough to detect bilirubin level effectively, but they improved gradually and nowadays these machines are used as a noninvasive, safe, painless and simple way to estimate the bilirubin level through the skin. However, still a lot of concerns about the accuracy of existing devices can be found on medical literatures.¹⁰ In addition the clinical estimation of jaundice, another diagnostic method measures the amount of bilirubin, can be served as an approximate method but not an exact one.¹¹ Based on this method, under the tongue and sclera of the eye where the first signs of hyperbilirubinemia appeared will undergo to investigate.

By Kramer law, if only the face involved in yellowish discoloration, bilirubin levels between 5 and 7; from the chest to the navel about 10; to the lower abdomen 15 and Up to 20 milligrams per deciliter is estimated if discoloration extends to toe.¹²

In this study, we aimed to determine and compare the level of bilirubin in three different ways including GM-Jaundice meter, serum

bilirubin and bilirubin level estimated in clinical investigation. The results of this study will clarify the accuracy of Jaundice meter in determining the mean serum bilirubin as a noninvasive, quick and simple method for using in hospitals and neonatology clinics.

Materials and methods

This is a cross-sectional analytic study conducted on 52 term infants with jaundice who had presented to Shahid Sadooghi hospital while they need determining bilirubin levels based on clinical investigations during summer to winter 2015 in Yazd, Iran. The population studied includes all term infants admitted to the hospital with jaundice who need blood sampling to evaluate serum bilirubin levels. Being term, healthy and without any underlying diseases but merely indirect hyperbilirubinemia considered as Inclusion criteria. Those neonates with direct hyperbilirubinemia, previously took phototherapy, already have a skin disease, scarring, hematoma or hemangioma at the area between the eyebrows and Incompatible in terms of ABO and RH were excluded. Samples were collected from all newborns admitted to the hospital with hyperbilirubinemia until the sample size was completed. The sample size based on previous studies and statistical analysis was determined as 52 patients. The method of collecting data was using questionnaires, which have already been designed. The questionnaire has two parts: The first part is related to demographic indicators which included birth weight, current weight, baby's age and age of the infant's mother at the birth. The second part relates to write down bilirubin level which contains bilirubin level with bilirubinometer, total and direct serum bilirubin, the amount of bilirubin based on clinical signs estimated by the nurse, RH and blood group and hematocrit in both mother and baby. First, estimating the bilirubin level was done by a nurse through clinical signs. Then bilirubin levels in all newborns with Jaundice meter GM103 on the area between the eyebrows were measured. This measurement was performed 3 times for each baby and the mean was reported by the device. Finally, the baby's blood samples were taken at the same time and up to 30 minutes total serum bilirubin was determined by photometric method. In this method, bilirubin in the presence of di azo 2 and 4 di chloro aniline forms a red nitrogenous compound in an acidic environment, so the intensity of the color can be measured in a photometrical basis which is directly related to the amount of bilirubin. All measurements for bilirubin levels were recorded in three categories including less than 10mg/dl, 10 to 15 and over 15 based on previous similar articles in this matter.¹³ Finally all demographic and data from measuring bilirubin were entered to the questionnaire and analyzed by software Spss17. Chi-square test to compare the means and Student T test were used. Statistical tests were considered significant at $\alpha=0.05$.

Results

The results of the study showed that the mean birth weight was 3007.11±474.21grams and the mean weight on admission was 2941.76±6grams. The mean gestational age was 37.21±1.8weeks and

the mean age at admission was 6.13±2.4days (Table 1).

Based on the results, the frequency of maternal blood group was determined as follows: Blood group A 28.8%, blood group B 26.9%, blood group AB 15.4% and 28.8% for blood group O. And also the frequency of maternal RH was 67.3% Positive and 17% RH negative.

Distribution of blood group among the studied neonates revealed as follows: Blood group A 38%, blood group B 36%, blood group AB 4% and 22% for blood group O. In addition, 66% of infants were RH positive and 34% RH negative.

The results of the study regarding to neonatal bilirubin levels showed that the mean for serum bilirubin was 14.39±5.13; the mean for bilirubin reported by portable bilirubinometer was 12.84±3.7 and the mean for estimated bilirubin level reported by the nurse was 13.5±3.5.

Table 1 Distribution of blood group and Rh

%	n	BG/Rh	
28.8	15	A	Mother blood group
26.9	14	B	
15.4	8	AB	
28.8	15	O	
67.3	35	+	RH mother
32.7	17	-	
38	19	A	Neonate blood group
36	18	B	
4	3	AB	
22	12	O	
66	34	+	RH neonate
34	18	-	

Based on the results regarding to serum bilirubin level according to lab data the following distribution revealed: 9.6% of infants with bilirubin levels less than 10mg/dl; 46.2% of bilirubin levels were within the range of 10 to 15 and 44.2% of them were more than 15mg/dl.

The distribution of bilirubin levels according to portable bilirubinometer were as follows: 25% of infants with bilirubin levels less than 10mg/dl; 48.1% of bilirubin levels were within the range of 10 to 15 and 26.9% of them were more than 15mg/dl.

Finally, the distribution for clinically estimated bilirubin levels reported as follows: 9.8% of infants with bilirubin levels less than 10mg/dl; 58.8% of bilirubin levels were within the range of 10 to 15 and 31.4% of them were more than 15mg/dl (Table 2).

Table 2 Distribution of bilirubin levels in three methods

I0> mg/dl		I0-15 mg/dl		I5< mg/dl		
%	n	%	n	%	n	
26.9	14	48.1	25	25	13	Bilirubinometer
44.2	23	46.2	24	9.6	5	Total Serum Bilirubin
31.4	19	58.8	30	9.8	6	clinical Estimation

Based on the results of our study, there were no significant correlation in all means comparison tests ($P > 0.05$) between bilirubin levels reported through above three mentioned methods with the mother's age at pregnancy, with the age of neonate, with neonatal weight at admission, with birth weight, with maternal blood group, with Infantile blood group, with maternal RH, with infantile RH and with hematocrit level of the neonates respectively. The current study revealed that there were significant differences between these three different methods based on means comparison test ($P\text{-value} < 0.05$) and Pearson correlation coefficient ($r > 0.3$).

In detailed, the Pearson correlation coefficient between serum bilirubin and bilirubin level determined by portable bilirubinometer was 0.826 ($r > 0.3$) and $p = 0.000$ ($P\text{-value} < 0.05$). This finding demonstrates that there is a significant difference between these two methods of determining the bilirubin level.

The Pearson correlation coefficient between bilirubin levels determined by portable bilirubinometer and clinical estimation method was 0.881 ($r > 0.3$) and $p = 0.026$ ($P\text{-value} < 0.05$). This finding also demonstrates that there is a significant difference between bilirubin levels based on clinical estimation and portable bilirubinometry and finally the Pearson correlation coefficient between serum bilirubin and bilirubin level in clinical estimation was 0.827 ($r > 0.3$) and $p = 0.004$ ($P\text{-value} < 0.05$). Just as previously mentioned results, this finding also indicates a significant difference between bilirubin levels based on clinical estimation and determination of bilirubin levels in a laboratory setting.

All of these findings are summarized in Table 3: The correlation between different methods of determining the level of bilirubin

Table 3 The correlation between different methods of determining the level of bilirubin

	Serum bilirubin	Bilirubinometer	Clinical estimation
Clinical Estimation	0.827	0.881	
Pearson correlation p-value	0.004	0.000	
Bilirubinometer	0.826		0.881
Pearson correlation p-value	0		0
Serum Bilirubin		0.826	0.827
Pearson correlation p-value		0	0.004

Discussion and conclusion

The main goal of this study was to determine and compare the level of bilirubin in three different ways including Jaundice meter, measurement of serum bilirubin and clinical estimation of bilirubin level. The study showed that bilirubin level detected in those three

mentioned methods was not significantly associated with some maternal or infantile variables including mother's age at pregnancy, the age of neonate, neonatal weight at admission, birth weight, maternal blood group, Infantile blood group, maternal RH, infantile RH and hematocrit level of the neonate ($P > 0.05$). In other words there is no correlation between these variables and bilirubin levels measured in above mentioned three methods so these variables have no effects on the level of bilirubin.

Moreover, the results showed that there were Significant differences ($P < 0.05$) and significant Pearson correlation coefficient ($r > 0.3$) between these three techniques of bilirubin measurement; In other words, these three mentioned methods cannot be used interchangeably.

The study findings of Kitsomart and colleagues showed that determining bilirubin levels by portable jaundicemeter JM-103 is a reliable measurement method that was incompatible with the findings of our study.¹⁴

Saidi et al.¹⁵ in their study showed that there is a significant difference between serum bilirubin measured values and data revealed by portable jaundicemeter. This means that the accuracy of jaundicemeter device as a means of monitoring serum bilirubin in neonatal jaundice is not approved; therefore this finding was as same as the finding of our study.¹⁵

A study conducted in Italy revealed that using jaundicemeter as a method for measuring bilirubin in the first 60hours of life is accompanied by false values but After 60hours the false values decline. According to the statistical significant difference ($P = 0.074$) in this study, it can be concluded that measuring the level of bilirubin depends on the age of the baby; so this finding was inconsistent with our results, considering the lack of a significant correlation between the two variables.¹⁶

It was found in another study conducted in Shiraz that Respirationics bilirubinometer device is reliable for monitoring the bilirubin levels mainly at the amounts less than.¹⁵ However this finding was incompatible with the results of our study in which the amount of serum bilirubin in all three categories were not significantly correlated with those reported by portable bilirubinometer.¹⁷

In another study conducted in Yazd, the mean serum bilirubin and bilirubin levels measured by JH20-1 device were compared to each other. The results showed that the sensitivity decreases in bilirubin levels higher than 12 so it cannot be reliable within this range; but at less than 12 can be used as an alternative to serum bilirubin. This finding was also incompatible with the data revealed in our study¹⁸ and also in a study conducted by Esmaeelpour found that there were some significant differences between mother RH and infant age with serum bilirubin levels, in other words these variables have an effect on serum bilirubin level. But based on the results of our study, a significant difference was not found between the mother RH and infant's age with the serum bilirubin.¹⁹

In the field of the current research, some severe cases of neonatal jaundice can be prevented in a prophylactic manner by educating parents, healthcare providers and even doctors to achieve a comprehensive insight regarding to the importance of determining bilirubin levels especially for those neonates who are at exact risk; and the frequency of neurological deficits caused by neonatal hyperbilirubinemia can be reduced by using this strategy. Therefore,

regular neonatal follow up, particularly in the early days of birth which are associated with the highest incidence of jaundice, using the most appropriate method – serum bilirubin – for detecting high risk neonates is recommended to all healthcare staff in order to prevent irreversible and persistent neurological and other neonatal diseases.

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Conflict of interest

There is no conflict of interest in this research.

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