

## Correlation Between Readings on Icterometer, Jaundicemeter and Serum Bilirubin Concentrations in Newborn Infants

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### Summary

Owa JA, Esimai VC, Olowu WA and Jegede OA. **Correlation Between Readings on Icterometer, Jaundicemeter and Serum Bilirubin Concentrations in Newborn Infants.** *Nigerian Journal of Paediatrics* 1995; 22: 24. Readings obtained from the icterometer and the jaundicemeter in term newborns with jaundice, were evaluated against corresponding serum bilirubin concentrations. The correlation coefficients (r) were 0.81-0.85 between icterometer readings and serum bilirubin and 0.86 between jaundicemeter readings and serum bilirubin ( $P < 0.0001$ ). Regression equations were derived for both. The icterometer reading of three and that of jaundicemeter of 20, corresponding to the serum bilirubin concentration of between 9.0 and 10.9mg/dl and 9.9mg/dl are recommended for screening for neonatal hyperbilirubinaemia. In otherwise healthy infants, older than one day, serum bilirubin determination can be avoided if the meter readings are below three and 20, respectively. Above these values, at least, one serum bilirubin determination is recommended. Used in this manner at Primary Health-Care centres, babies developing severe jaundice can be identified early and referred to hospitals for appropriate management. At the tertiary institutions, the number of serum bilirubin concentration determinations can be reduced, thus keeping down the cost of managing jaundiced babies.

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### Introduction

SEVERE neonatal jaundice (NNJ) remains a common and serious public health problem in Nigeria.<sup>1-3</sup> While brain damage due to severe NNJ is unusual among inborn patients,<sup>4-6</sup> 20-50 percent of outborn infants with jaundice have signs of irreversible

brain damage on admission, primarily because of the severity of the jaundice that is invariably caused by the delay in referral of such babies from the primary health-care (PHC) centres to hospitals. Such delays may be attributed to lack of facilities at the PHC to monitor the severity of jaundice.

Recent reports on the Minolta jaundicemeter (JM), a non-invasive equipment for transcutaneous measurement of serum bilirubin in jaundiced newborn babies, indicate that the meter readings on this equipment, have good correlation with total serum bilirubin (SBR) concentration.<sup>7-11</sup> Race, gestational and postnatal ages, respectively and the site of skin where the equipment is applied, have been reported to affect these correlations.<sup>7</sup> For these reasons, standardization of the equipment for different racial groups has been recommended.<sup>8-11</sup> Readings from another non-invasive equipment, the icterometer (ICT), have also been reported to have equally good correlation with SBR concentration.<sup>7,8</sup> The ICT is a perspex with varying grades, numbering one to five, of yellow colour for visual comparison with the blanched skin; it is a simpler and cheaper equipment than the jaundicemeter.

Recognizing that the use of these equipments in PHC centres could be invaluable, the present study was undertaken with the aim of determining the degree of NNJ, using these two equipments. The study also aimed at comparing the meter readings with SBR concentrations as determined by the usual laboratory methods, as well as, at determining appropriate action level of values on the basis of the JM and ICT readings and the SBR concentrations.

### Subjects and Methods

The subjects were apparently normal newborn infants with birthweight >2.5kg and aged between birth and 14 days. The study was undertaken at Ife State Hospital, Ile-Ife and at the Wesley Guild Hospital, Ilesa. At Ife State Hospital, the study was carried out independently by two of the authors, WAO and OAJ, using the ICT. Using the ICT also, one of the other authors, VCE, and a Nurse/Research Assistant jointly performed the study at the Wesley Guild Hospital, Ilesa. There were thus, three sets (two at State Hospital, Ile-Ife and one at the Wesley Guild Hospital, Ilesa) of independent meter readings using the ICT. The aim of taking the three sets of meter readings was to enable us to compare the readings on the ICT when it was used by different operators. The ICT was applied lightly to the tip of the nose and the readings were taken direct from the instrument



*Fig 1: Icterometer applied to the tip of nose of patient. Vertical bars indicate varying grades of yellow colour to be compared with the blanched skin.*

(Fig 1). When the ICT was in use, the degree of jaundice was graded one to five and when the intensity was between two grades of yellowness, the half was recorded. For example, between two and three, the grading is 2.5. The Minolta/Air Shield jaundicemeter (JM) readings were done solely by JAO. The instrument was gently applied on the baby's forehead (Fig 2) for a few seconds, as recommended by the manufacturer in the operator's manual (Minolta/Air-Shields). At operation, the JM gives out a flash which penetrates the skin and this is reflected back to the instrument and a digital display on it gives an index of the SBR concentration.

Venous blood was withdrawn immediately after the meter reading from each subject for the determination of SBR concentration, using the traditional laboratory methods.<sup>12</sup> The determination was performed at Ile-Ife State Hospital, using the bilirubinometer (Bilometer D) and at Wesley Guild Hospital, using AO-bilirubinometer (Advanced Instruments, Inc, USA).

Approval to carry out the study was obtained from the Research and Ethical Committees of the Faculty of Health Sciences, Obafemi Awolowo University and Obafemi Awolowo University Teaching Hospital Complex, Ile-Ife respectively. Prior to the start of the study, an informed consent was obtained from the parents of each baby. Statistical analysis was done, using Statgraphics<sup>R</sup> computer programme by Manugistics.™ For each set of readings, linear regression analysis was performed and correlation coefficient ( $r$ ) and coefficient of determination ( $r^2$ ) were determined. Student's 't' test was used to determine signifi-

cance of differences. Similar analysis was carried out for a set of paired readings for the JM and ICT.



Fig 2: jaundicemeter applied to patient's forehead.

### Results

There were five paired sets of reading on the meters (Table I). The first three of these five sets of readings, compared the readings on ICT with the SBR concentrations. The fourth set compared the readings on JM and the SBR concentrations, while the fifth set compared the readings on the ICT and JM. As can be seen, the ICT reading of three was found to be equivalent to SBR concentration of between nine and 10.9mg/dl and the JM reading of 19.8; the JM reading of 20 was equivalent to SBR of 9.9mg/dl (Table I). The data derived from the regression analysis are shown in Table II. The correlation coefficient ( $r$ ) between SBR concentrations and ICT readings were 0.85, 0.84 and 0.81 with

TABLE I

Patients, ICT, JM Readings and SBR Concentrations Corresponding to Cut-off Points on the ICT and JM

Equipment	No of Patients	Meter Readings			Equivalent SBR concentration on ICT&JM
		Mean	SD	Range	
ICT	50	3.2	1.0	1.5-5	3.0
SBR (mg/dl)	50	13.0	7.8	4-39.8	10.9
ICT	28	3.3	0.8	2-5	3.0
SBR (mg/dl)	28	10.9	4.7	4.7-27.8	9.0
ICT	147	2.8	1.0	1-5	3.0
SBR (mg/dl)	147	9.0	5.5	1.4-32.6	10.2
JM	213	18.5	5.6	3-46	20.0
SBR (mg/dl)	213	8.2	5.3	1.4-32.6	9.9
JM	143	18.5	5.9	5-46	19.8
ICT	143	2.8	1.0	1-5	3.0

SBR = Serum bilirubin, ICT = Icterometer, JM = Jaundicemeter, SD = Standard deviation.

coefficient determinations ( $r^2$ ) of 71.9 percent, 70.4 percent and 66.1 percent respectively, ( $t=11.1, 7.9$  and  $16.8$ ,  $P < 0.0001$ ). This means that 71.9 percent, 70.4 percent and 66.1 percent of the data were accounted for by the regression line. For the readings on JM and SBR concentrations, the  $r$  and  $r^2$  values were 0.86 and 74.2 percent ( $t=24.6$ ,  $P < 0.0001$ ). There was also a good correlation between readings on the JM and ICT, with  $r$  and  $r^2$  values of 0.78 and 61.0 percent ( $t=14.8$ ,  $P < 0.0001$ ). The regression lines for ICT readings on SBR concentration (Fig 3), for JM readings on SBR concentration (Fig 4) and for ICT readings on JM readings

TABLE II

Correlation Coefficient ( $r$ ), Coefficient of Determination ( $r^2$ ) and Relationships between ICT, JM Readings and SBR Concentrations

Relationship	No of Patients	$r$ Value	$r^2$ (Percent)	$t$	$P$
ICT&SBR	50	0.85	71.9	11.1	<0.0001
ICT&SBR	28	0.84	70.4	7.9	<0.0001
ICT&SBR	147	0.81	66.1	16.8	<0.0001
JM&SBR	213	0.86	74.2	24.6	<0.0001
ICT&JM	-	0.78	61.0	14.8	<0.0001

(Fig 5) show the recommended screening cut-off point for the ICT as three, while the corresponding SBR concentrations varied between 9.0mg and 10.9mg/dl. For the JM, the value of 20 corresponded to SBR concentration of 9.9mg/dl. The corresponding values on the JM to ICT three, was 19.8.

Correlation Between Readings on Ictrometer, Jaundicemeter and Serum Bilirubin Concentrations in Newborn Infants

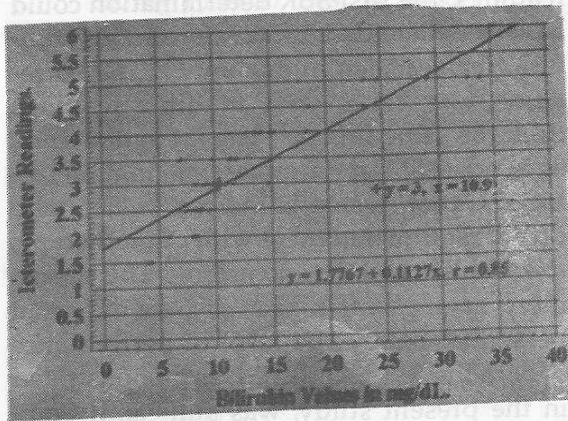


Fig 3: Linear regression of ictrometer readings on serum bilirubin concentration (SBR). The SBR concentration of 10.9mg/dl corresponding to ICT reading of 3 is indicated by \* on the line of identity.

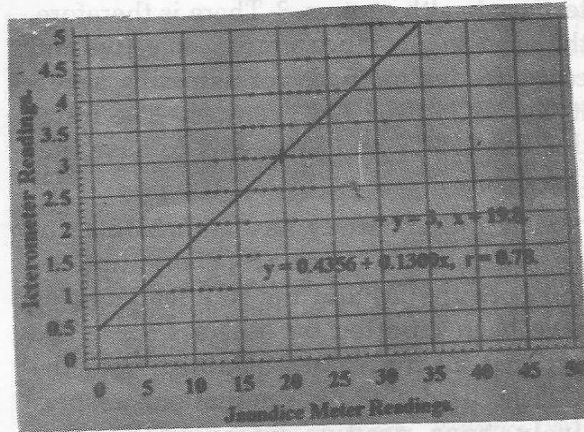


Fig 5: Linear regression of ictrometer (ICT) readings on jaundicemeter (JM) readings. The JM reading of 19.8 corresponding to ICT reading of 3 is indicated by \* on the line of identity.

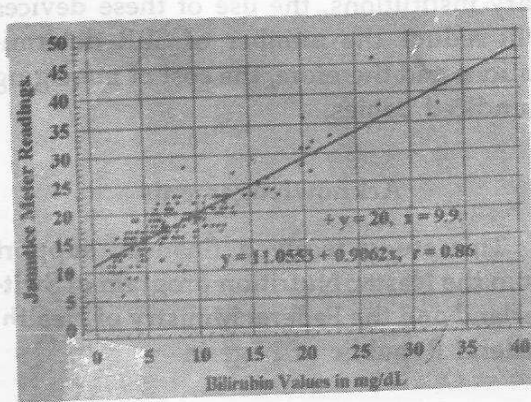


Fig 4: Linear regression of jaundicemeter (JM) readings on serum bilirubin concentration (SBR). The SBR concentration of 9.9mg/dl corresponding to JM reading of 20 is indicated by \* on the line of identity.

Discussion

Physicians who manage jaundiced babies rely on SBR concentrations to decide on the appropriate management policy to be undertaken. Serum bilirubin determination is therefore, one of the most essential laboratory investigations to be carried out in the neonatal period.<sup>1</sup> Unfortunately, SBR determination is not always available for most of these babies because the required equipment and reagents are expensive and the expertise required is often not available in the PHC centres where these babies are usually first seen. Without facilities to monitor SBR concentration, the staff at the PHC usually resort to managing such cases with glucose water, exposure to sunlight etc, thus contributing to delays in referral of cases to second or tertiary institutions. Many of these babies therefore, develop

kernicterus by the time the first SBR determination is carried out in the secondary or tertiary health centres.<sup>5</sup> There is therefore, the need to introduce simple, objective and cost-effective methods for assessing severity of NNJ at the PHC centres. The introduction of ICT and JM seems to have met this need.

The present study has confirmed a linear correlation between SBR concentrations and both the JM and the ICT readings, as have been reported by others.<sup>7-10 13</sup> The fact that all the values obtained from the ICT, JM and SBR determinations respectively, have positive linear relationship suggests that they all measured the severity of jaundice in the same direction. The present level of correlation, even between SBR concentration and ICT, was as good as the correlation coefficient observed between actual SBR concentrations obtained from two methods of SBR determination from the same sera as well as from the same institution.<sup>11</sup> The advantages of the two instruments include the simplicity in their use, immediately available results and noninvasiveness. Both the JM and the ICT are cost-effective as screening devices to identify jaundiced infants whose degree of jaundice requires SBR determination.

From the present findings, it is recommended that a reading of three on the ICT and 20 on the JM, be regarded as the minimum points at which the mean SBR concentration was between 9 and 11mg/dl. There was no baby with SBR concentration greater than 15mg/dl at these points. For most babies who develop jaundice from the second or third day of life without obvious haemolysis, SBR concentration of 15mg/dl

is almost without risk of brain damage.<sup>13</sup> Based on the above recommended meter readings, the first SBR determination could have been avoided in 54.8 percent of jaundiced babies seen in our unit.<sup>3</sup> The correlation was better with multiple readings from the same infant.<sup>7</sup> The JM is therefore, as good as SBR determinations, in monitoring the progress of jaundiced babies who do not require treatment with phototherapy, or exchange blood transfusion.<sup>7</sup> This means more savings on reagents, patients', and personnel time. The level of performance of both the ICT and the JM, as demonstrated in the present study, was sufficiently reliable to recommend their widespread use as screening methods in neonatal jaundice. With their introduction into the PHC centres, babies developing severe jaundice would be readily identified and referred early to secondary or tertiary institutions for appropriate management in order to prevent irreversible brain damage. At tertiary institutions, the use of these devices will reduce the number of SBR determinations and therefore, the cost of managing jaundiced babies.

#### Acknowledgements

This study received financial support from the Nestac Nutrition program of Switzerland and the Federal Ministry of Health, Federal Republic of Nigeria.

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### Introduction

Acute glomerulonephritis (AGN) is the most common non-suppurative renal disease of childhood. Although it accounts for 0.5 percent of all hospital admissions for children in the United States of America (USA),

its true incidence is unknown. This has been explained by the large number of children with mild and unrecognized disease. For example, Kaplan *et al*<sup>1</sup> have reported that 50 percent of patients discovered to have acute AGN during an epidemic were asymptomatic. Most cases of the disease in African children are said to follow impetigo.<sup>2</sup> There is however, very little information on the epidemiology of the disease in different parts of the African continent.<sup>3</sup>

Here in Nigeria, studies on childhood AGN have been undertaken in various parts,<sup>4</sup> but to our knowledge, no study on this

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