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Original Article

Clinical gestational age assessment in newborns using the new Ballard score

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ABSTRACT

Background The new Ballard score (NBS) is presently considered to be the most reliable method for estimating clinical gestational age (GA) in newborn infants.

Objective The aim of this study was to compare the NBS and Dubowitz/Finnstrom score against ultrasonography assessment of gestational age.

Methods A cross sectional randomized study involving neonates born in Sanglah Hospital, Bali, June to August 2004 was carried out. Gestational age was estimated within the first 24 hour by either Dubowitz/Finnstrom score or NBS confirmed by USG (C-GLMP) as the gold standard.

Results One hundred and fifty-five newborns were enrolled in this study. Subjects were randomly divided into two groups, the Dubowitz/Finnstrom score group (76 newborns) and NBS group (79 newborns). The mean age of mothers was 28.4 years old; mean birth weight was 3151.3 g (SD 596.3 g). The proportion of small for GA, appropriate for GA, and large for GA were 6%, 77% and 17%, respectively. Pearson correlation (*r*) between C-GLMP and Dubowitz/Finnstrom score was 0.71 (P<0.005); and with NBS was 0.79 (P<0.005) .

Conclusion The strength of correlation between either NBS or Dubowitz/Finnstrom score and USG assessment of gestational age are similar **[Paediatr Indones 2006;46:97-102].**

Keywords: *gestational age, newborn, new Ballard score*

The accurate estimation of gestational age (GA) in neonates is important for decisions concerning their management, follow up, and surveillance. Gestational age based on mother's last menstrual period (LMP) is not accurate because of various length of the periods and the possibility of recall bias.[1] Many techniques for clinical GA assessment improved this last decade and the new Ballard score (NBS) was widely recommended nowadays.[2-6]

The aim of this study was to evaluate whether the NBS can replace Dubowitz and Finnstrom score,[7,8] by comparing the two scoring systems with ultrasonography (USG) measurement as the gold standard.

Methods

A cross sectional randomized study was conducted at the Division of Neonatology, Department of Child Health, Sanglah Hospital, Denpasar, Bali, June to August 2004. All neonates born at the hospital within the study period were included except those who were twins, died before the assessment, or had major congenital anomaly, or incomplete maternal data.

All subjects were randomly allocated to underwent GA assessments by either the Dubowizt (vigorous infants)/Finnstrom (asphyxiated or problematic infants) score or NBS within 24 hours of life. The gestational age was confirmed by USG examination done by obstetricians blinded from the score results.[10]

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Maternal data were collected from medical record. The GA was computed in completed days by PregCalPro version 3.2 calculator.[11] USG during pregnancy was done by obstetrician in Sanglah Hospital or private practice. The study protocol was approved by the Committee of Medical Research Ethics of Medical School, Udayana University.

Sample size was estimated by formula for correlational study.[9] With α=0.05 (two tailed), β=0.95, and estimated correlation amongst independent variables of 0.40, subjects required for each group was 75. The correlation coefficient (*r*) was used in the final analysis. Correlation was considered strong if *r* was >0.8; moderate if 0.6-0.79; weak if 0.4-0.59; very weak if <0.4. A P value of <0.01 was considered as significant.

Data were processed using SPSS 11.5 computer program. Correlation coefficient and 95% mean prediction interval were used for the validation. The accuracy was analyzed by paired *t* test.

TABEL 1. CHARACTERISTICS OF THE SUBJECTS

Characteristics	Mean (SD)	[Range]
Mother's age (year)	28.3 (5.3)	[17–41]
GA confirmed USG (day)	273.2 (13.4)	[214–298]
Birth weight (g)	3151.3 (596.3)	[950–5100]
Birth length (cm)	48.9 (2.4)	[36–52]
Head circumference (cm)	33.9 (2.0)	[25–38]
Chest circumference (cm)	32.9 (2.4)	[22–38]
	n= 155	(%)
Sex (boy)	83	(53.5)
SGA	9	(5.8)
AGA	120	(77.4)
LGA	26	(16.8)
Extremely LBW	1	(0.7)
VLBW	2	(1.3)
LBW	14	(9)
Normal BW	129	(83.2)
Macrosomia	9	(5.8)
Delivery		
Vaginal spontaneous	67	(43.2)
Extraction forceps	8	(5.2)
Section caesarian	80	(51.6)
APGAR score		
<7; 1st minute	17	(11)
<7; 5th minute	9	(5.8)

Results

During the study period, 332 babies were delivered at the Department of Obstetrics & Gynecology, Sanglah Hospital. One hundred and fifty-five newborns fulfilling the inclusion criteria were enrolled and randomly allocated into two groups, 76 in the Dubowitz/Finnstrom and 79 in the NBS groups. The characteristics of study subjects can be seen in **Table 1.** There were 3 very low birth weight (VLBW) newborns (2%), 1 extremely low birth weight (ELBW; birth weight 1000 gr), four 4 birth weight (LBW) (9%), and 9 macrosomic infants (6%). According to Lubchenco's curve, there were 9 (6%) small-for-gestational age (SGA) newborns, 120 (77%) appropriate-for-gestational age (AGA), and 26 (17%) large-for-gestational age (LGA) (**Figure 1**).

All neonates were examined within 30 minutes–16 hours of age (mean 1 hour 20 minutes). There were 55 neonates born to first-pregnant mothers. Eighty (51.6%) neonates we delivered by cesarean section. The five most common delivery complications were minor locus caused by scar from previous caesarian section (16 subjects), premature rupture of the membrane (16), fetal malposition (10), severe pre-eclampsia (7), and flawed obstetric history. There were 9 newborns with moderate-to-severe asphyxia (Apgar score of <7 at first 5 minute), 3 of them were examined using Dubowitz score after they had good response for resuscitations, 2 using Finnstrom score and 4 using new Ballard score.

C-GLMP ranged from 30-43 weeks. The smallest C-GLMP was 30 weeks and 4 days (214 days). Eight subjects had estimated gestational age over 293

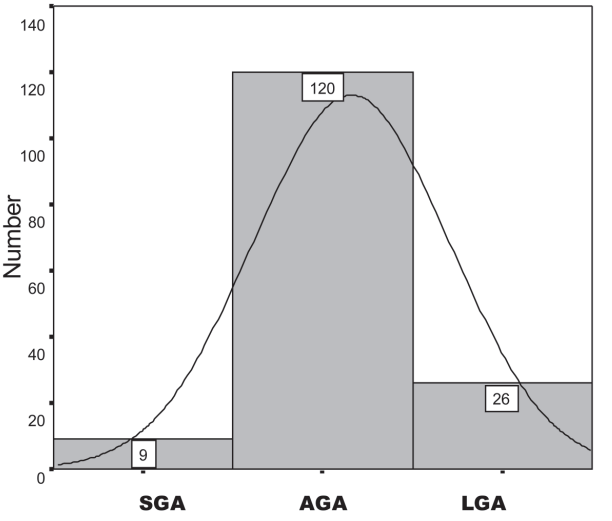

FIGURE 1. THE DISTRIBUTION OF BIRTH WEIGHT FOR GESTATIONAL AGE ACCORDING TO LUBCHENCO'S CURVE.

TABLE 2. DISTRIBUTION OF GESTATIONAL AGE ASSESSMENT

Gestational age based on USG (weeks)	Total	Dubowitz/ Finnstrom score (%)	New Ballard score (%)
30-<37	14	9 (12)	5 (6)
37-<42	140	67 (88)	73 (92)
≥42	1	-	1 (1)
Total	155	76	79

TABLE 3. PEARSON COEFFICIENT CORRELATION OF (*R*) BETWEEN GESTATIONAL AGE BY DUBOWITZ/FINNSTROM OR NBS AND THAT OF USG EXAMINATION

		Dubowitz/ Finnstrom score	New Ballard score	Total
GLMP	*(r)*	0.71**	0.79**	
	C- *(r²)*		0.5	0.63
	(p)	.00	.00	
	Pair *t* test (day)[1]	4.2 (SD 8.9)	0.3 (SD 8.6)	
	(n)	76	79	155

**Strong correlation

days, 4 of them were examined using Dubowitz score revealing gestational age of 266–292 days (6–30 days differed), 4 were assessed by NBS revealing gestational age of 272–289 days (5–25 days differ). One subject was assessed as post-mature on NBS (294 days), which was 10 days older (over-estimated) compared to C-GLMP interpretation (**Table 2**).

The Pearson correlation (**Table 3**) between C-GLMP and Dubowitz/Finnstrom score was r=0.71 (P<0.005), while between C-GLMP and NBS was r = 0.79 (P<0.005). Logistic regression analysis (**Figure 2** & **3**) of C-GLMP and Dubowitz/Finnstrom score revealed r^2 of 0.5 and between C-GLMP and NBS of 0.63.

Discussion

Gestational age assessment was performed at mean time of 1 hour 20 minutes. This could avoid factors that may decrease the accuracy of physical criteria of both scoring systems. After 12 hours, newborns' skin becomes dry which can decrease the accuracy of skin fold examination.[12] Ballard *et al*[7,13] recommended doing the examination within 12 hours after birth on preterm babies (<26 weeks) to achieve good accuracy. For others, examination performed within 96 hours after birth still gave 92% accuracy. Sanders *et al*,[14] Krisnamohan *et al*,[15] Skapinker *et al*,[16] and Donovan *et al*[17] recommended immediate examination to avoid blood vessel regressions on anterior capsule of eye lens in preterm infants (<34 weeks).

NBS is more detailed and adapted to fetal growth physiology. In this scoring system, foot length should be examined if the plantar creases have not been

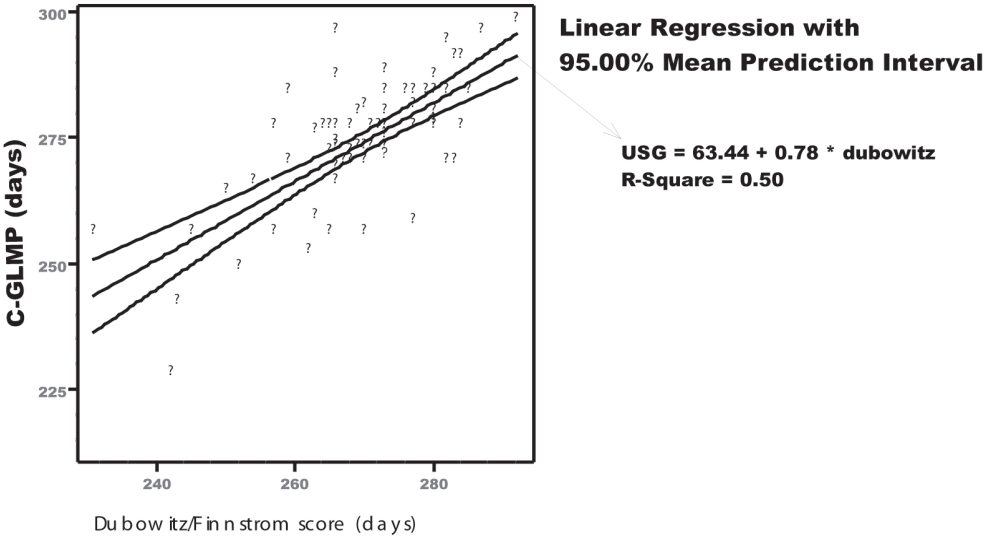

FIGURE 2. SCATTER PLOT OF C-GLMP TO DUBOWITZ/FINNSTROM SCORE

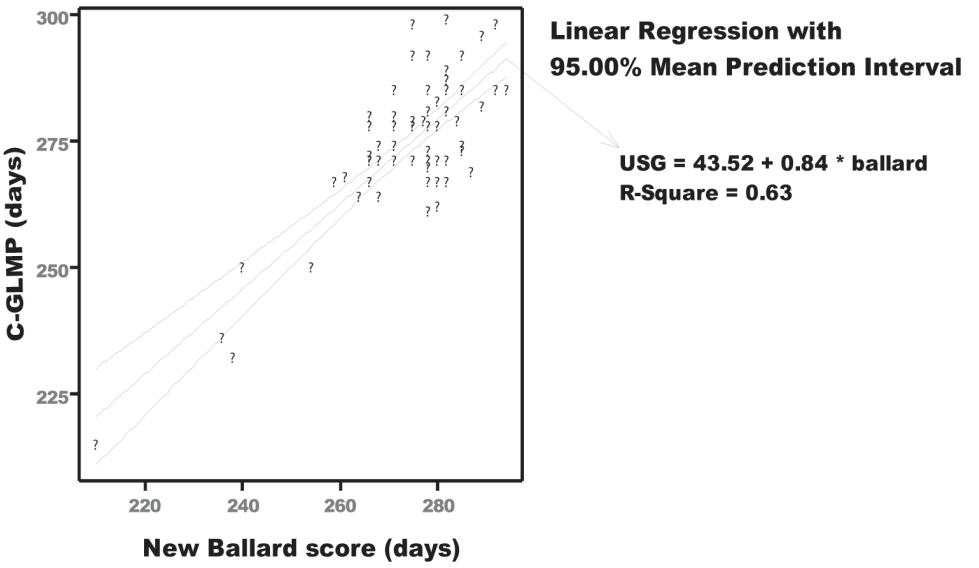

FIGURE 3. SCATTER PLOT OF C-GLMP TO NBS

present, or the eyelids should be examined if ears, breast, and genital examinations are unreliable. To examine preterm infants of <28 week gestation, it also has more advantages compared to Dubowitz/ Finnstrom score. Simple neuromuscular examination which do not over-manipulate neonates can be performed even to those with complications.

In this study, there were 9.7% preterm delivery (less than 37 weeks) based on C-GLMP. For these preterm neonates, especially the extremely ones (<28 weeks), accurate estimation of gestational age other than body weight is really important for their management. In this case, the NBS has advantages of being applicable for neonates of less than 28 week gestational age.[14,18-21]

Post-maturity (>42 week gestation) is an indication for pregnancy termination. Assessment by C-GLMP was less accurate for postmature infants since it could not detect physical signs, such as long finger nails, skin parchment, and thick ear cartilage, while by Dubowitz score, neither arm wrist window nor head on ventral suspension position could not be assessed. In this study, the number of extremely preterm newborns and post-term ones (>42 weeks) was small, so no conclusion could be made.

In our study, Pearson coefficient correlation was moderate between C-GLMP with Dubowitz/ Finnstrom score (r=0.71, P<0.005) and NBS (r=0.79, P<0.005). We found no significant difference between these two methods. Ballard *et al*[11] pre-

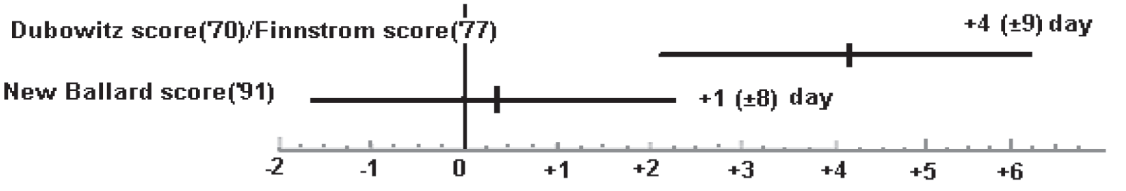

FIGURE 4. ACCURACY OF DUBOWITZ/FINNSTROM SCORE AND NEW BALLARD SCORE FOR ASSESSING GA IN 155 BABIES OF 30-<43 WEEKS GESTATION WITH CERTAIN MATERNAL MENSTRUAL DATES: BAR SHOWS THE RANGE OF DATES IN WHICH 95% OF ALL ESTIMATES FELL.

viously found a strong correlation ($r = 0.97$) between NBS and C-GLMP. In linear regression with 95% mean prediction interval, NBS ($r^2=0.65$) had higher correlation with C-GLMP than Dubowitz/Finnstrom score ($r^2=0.5$).

Ultrasound examination performed in the first and second trimester has a ±7 days accuracy and considered as a gold standard by some researchers.[22-24] In this study, NBS (+1 day and SD 8 days) was found to be more accurate than Dubowitz/Finnstrom score (+4 days and SD 9 days) contrasted to C-GLMP as the gold standard. Another study[25] showed that Dubowitz score accuracy compared with C-GLMP (USG done under 19 week gestational age) was +6 (SD 16 days). In our study of 155 newborns, the GA range was 30–42 weeks, while there were 347 subjects in that study with gestational age between 32–42 weeks. The limitation in this study included no antenatal care control, especially in USG examination in the first and second trimester. Karunasekera *et al*[26] in the first 24-hour examination of 200 newborns found the accuracy of Dubowitz score of +2.18 weeks (14–16 days).

In conclusion, the strength of correlation between either NBS or Dubowitz/Finnstrom score and USG assessment of gestational age are similar**.** Considering the more simple approach, we recommended NBS training program for medical students, nurses, midwives. For better accuracy, we should also performed ophthalmoscope examination of eye lens blood vessels. Further studies with bigger sample, especially on infants less than 30 weeks and over 42 weeks gestational age are needed.

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