ISSN NO. 2320-5407

*Journal homepage:http://www.journalijar.com*
*Journal DOI:10.21474/IJAR01*

*INTERNATIONAL JOURNAL OF ADVANCED RESEARCH*

**RESEARCH ARTICLE**

# NEW BALLARD SCORING SYSTEM; CAN IT BE SIMPLIFIED..!

**Amol Dahyalkar[1], Prashant Patil[2], Amol Joshi[3], Sadhana Raut[3].**

1. Department of Pediatrics, Government Medical College, Aurangabad, Maharashtra.
2. Professor and Head of department, Department of Pediatrics, Government Medical College, Aurangabad, Maharashtra.
3. Assistant professor, Department of Pediatrics, Government Medical College, Aurangabad, Maharashtra.

## *Manuscript Info*

***Manuscript History:***

Received: 12 April 2016
Final Accepted: 19 May 2016
Published Online: June 2016

***Key words:***
GA, Preterm, Simplified and New Ballard Scoring System.

***Corresponding Author***

**Amol Dahyalkar.**

## *Abstract*

**Background:-**Accurate determination of neonatal gestational age (GA) is important for guiding both individual infant management and care-seeking and for epidemiologic purposes. This study was conducted to assess the accuracy of the Simplified Scoring System (SSS) derived from New Ballard scoring System which is simple to evaluate, easy to learn.

**Objective:-**To compare accuracy of NBSS with SSS using LMP corroborated by USG as Reference Standard.

**Method:-**The gestational ages of 524 neonates were estimated by two methods and were compared with the gestational age computed from USG using Pearson coefficient. Validity and accuracy of each method was compared with GA by USG

**Results:-**This was a prospective observational study based on single cross sectional sample of recently delivered neonates at the tertiary care hospital. The GA was calculated by NBSS, SSS and LMP correlated with USG. The highest correlation was found with New Ballard score i.e. 0.73 and correlation with Simplified score and GA-LMP were 0.67, 0.72 respectively. The statistical mean difference of Simplified score system underestimated the GA by 0.23 weeks, whereas the New Ballard score underestimated the GA by 0.09 weeks. However this difference was statically not significant.

**Conclusion:-** SSS has been proposed as simple, easy to administer, having comparable results for assessment of GA. The SSS has comparable validity, accuracy and moderate reliability to the NBSS.



## Introduction:-

Accurate determination of neonatal gestational age (GA) is important for guidingindividual infant management, care-seeking and for epidemiologic purposes. To determine GA in the newborn, clinicians in developing countries rely on prenatal and postnatal indicatorslike first trimester ultrasound (USG),Last menstrual period (LMP) and neonatal assessment such as the Dubowitz[1]or Ballard scoring systems.[2] However in periphery where limited information or technical knowledge is available, healthworkers determine GA of newborns by relying on LMP and/or neonatal birth-weight and available clinical estimates like fundal height and timing of first quickening. Some researchers attempted to refine or simplify neonatal GA estimation systems like Dubowitz and Ballard scores addition of birth weight to scores in Zimbabwe showed promise but lacks external validation.[4]LMP combined with first trimester USG provides the most accurate method for computing the GA.

National Family Health Survey (NFHS) 2005–2006 reports showed a high incidence of small-for-date babies emphasizing real need of a method for estimating GA that is both rapid & accurate[3]. A perfect method for assessment of GA must be accurate, independent of nutrition of baby and is not affected by the babies' general condition. It should be simple, reliable, and easy to learn with less handling of baby. Hence different scores to assess maturity have been developed namely New Ballard Scoring System (NBSS) [2], Dubowitz Scoring System (DSS) [1] and Meharban Singh scoring System (MSS) [6]. However, with limited technical knowledge and skill, it is difficult for paramedical workers to learn & use NBSS which is time consuming & more disturbing for sick Neonates.

Therefore this study was conducted to assess the accuracy of the Simplified Scoring System (SSS) derived from NBSS which is simple to evaluate, easy to learn and consist of only four criteria's which are: Posture, Skin Texture, Breast and External Genitals.

## Material and methods:-

**Design :** Prospective observational study.
**Setting:** Tertiary care GMCH.
**Period :** February 2013 to September 2014.

**Inclusion criteria:-**
**Neonates:-**1. Hospital-delivered,2.Live birth, 3.Available for examination within 24 hours of birth.
**Maternal History:-** 1. Known LMP, 2.Regular cycle, 3.At least one USG Report before 30 weeks, 4.Consent taken.

**Exclusion Criteria:-**
**Neonates:-**1.Twins,2.Birth asphyxia, 3.Major illness within 48 hours of birth, 4.Congenital anomalies, 5.Neurological depression, 6.Breech, 7.Shock.

**Maternal History:-**1. Irregular cycles, 2.Received Oral contraceptive within six months prior to conception,3. Pregnancy related complications or chronic diseases.

**Study procedure:-**The study was conducted after obtaining the approval of Institutional Ethics Committee.The sample size was calculated by taking the level of significance as 5%, expected precision as 3% and preterm prevalence as 12.3%. 10% of sample increased by assuming nonresponse. Consecutive 524 babies were selected as per inclusion & exclusion criteria. Informed consent was obtained and care was taken to optimize hygiene and minimize risks related to handling of fragile preterm. Babies were examined naked in supine position with head and body in a straight axis within 24 hours of birth in a warm room with good diffuse light. The observer was not blinded to the GA-LMP and GA-USG of the neonate. Neonates were evaluated for GA by two different scoring systems;

1. NBSS2.SSS.

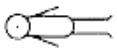
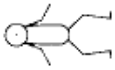
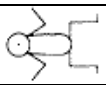
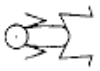
**Method I:-**From date of LMP, GA was calculated as the number of completed weeks from the first day of mother's LMP. This method is referred to as GA-LMP. The GA obtained by USG before 30 weeks noted and referred as GA-USG.

**Method – II:-**
**New Ballard score:-** GAs was determined according to the method described by Ballard et al [2] using 6 physical and 6 neurological criteria. The GA corresponding to the total score was obtained from the table and referred as GA-NBSS.

**Method - III**
The simplified score was developed keeping following points in mind.

1. The SSS contains items from both neurological and physical characteristics, which are simple, easy to learn.
2. Assessment of genitalia allows the variations in estimating GA due to gender differences.
3. As there are lesser items (four), it is quite easy to use as a picture is provided for the posture.

**Table I:-**Maturity score of the SSS

| MATURITY SIGN | -1 | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|---|
| Posture | |  |  |  |  |  | |
| Skin | sticky, friable, transparent | gelatinous, red, translucent | smooth pink, visible veins | superficial peeling &/or rash, few veins | cracking, pale areas, rare veins | parchment, deep cracking, no vessels | leathery, cracked, wrinkled |
| Breast | Imperceptable | barely perceptable | flat areola no bud | stippled areola 1-2 mm bud | raised areola 3-4 mm bud | full areola 5-10 mm bud | |
| Genitals (Male) | scrotum flat, smooth | scrotum empty, faint rugae | testes in upper canal, rare rugae | testes descending few rugae | testes down, good rugae | testes pendulous, deep rugae | |
| Genitals (Female) | clitoris prominent & labia flat | prominent clitoris & small labia minora | prominent clitoris & enlarging minora | majora&minora equally prominent | majora large, minora small | majora cover clitoris &minora | |

Total score is calculated by adding the individual scores of posture, skin, breast and genitals.

**Total Score: _____ GA: _____**

| **Score** | -4 | -2 | 0 | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 | >16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Weeks** | 22 | 24 | 26 | 28 | 30 | 32 | 34 | 36 | 38 | 40 | 42 | 44 |

**Method for Assessment of GA from the Total Score of the simplified score:-**
We estimated neonates having GA ranging from 22 weeks to 44 weeks. This GA was determined by the reference standard i.e. LMP corroborated by USG. Scoring was distributed evenly with increasing maturity with highest score of >16 corresponding to 44weeks.

**Statistical analysis:-**
This was done using Microsoft Excel and Graph Pad Prism version 5and analyzed by One way ANOVA with post-hoc Dunnet test with P value <0.05 considered significant.

**Reliability** was evaluated from the degree of correlation (Pearson correlation coefficient (r)) with GA by GA -USG. Correlation r>0.8was consideredstrong; 0.6-0.79moderate; 0.4-0.59weak; <0.4very weak.

**Validity** was defined as the percentage of infants for whom GA by method was within 2 weeks of GA by dates of USG.

**Accuracy** was defined as the mean difference in weeks between GA by method and GA by USG. Smaller the mean difference, more accurate the method.

## Results:-

Male preponderance with 286(54.58%) patients being male in our study group and 238 (45.42%) were female with male: female ratio1.2:1 was found.

**Table II:-** Distribution according to GA by different scores and USG.

| GA (weeks) | No of babies' n (%) | | |
|---|---|---|---|
| | **USG** | **NBSS** | **SSS** |
| <32 | 01 (0.19) | 02 (0.38) | 00 (00) |
| ≥32 to <34 | 02 (0.38) | 05 (0.95) | 06 (1.14) |
| ≥34 to <38 | 132 (25.20) | 144 (27.68) | 140 (26.71) |
| ≥38 | 389 (74.23) | 373 (70.99) | 378 (72.13) |
| **Total** | **524** | | |

As assessed by GA-USG 389 (74.23%) were in the ≥ 38 weeks, 132 (25.20%) were in ≥ 34 to < 38 weeks, 02 (0.38 %) were in ≥ 32 to < 34 weeks and 01 (0.19%) was< 32 weeks.

**Table III:-**Comparison of mean GA of GA-NBSS, GA-SSS with GA-USG

| GA (weeks) | Mean ± SD | | | |
|---|---|---|---|---|
| | **USG** | **LMP** | **NBSS** | **SSS** |
| **<32** | 28.3± 0 | 30.6 ± 0.57 | 29.60 ± 2.83 | (n=0) |
| **≥32 to <34** | 33.45 ± 0.07 | 33.48±0.19 | 32.80±0.57 | 33 ± 0 |
| **≥34 to <38** | 36.44 ± 1.02 | 36.52 ± 0.95 | 38.42 ± 1.68 | 36.16 ± 0.91 |
| **≥38** | 39.26 ± 0.87 | 39.46 ± 0.91 | 39.27 ± 0.78 | 39.14 ± 1.09 |
| **Overall** | 38.51 ± 1.61 | 38.78 ± 1.65 | 38.42 ± 1.67 | 38.28 ± 1.73 |
| **P value as compared to USG** | - | <0.05 | >0.05 | >0.05 |

As compared to GA-USG as reference standard, the NBSS scores was overestimating neonates in <32 weeks GA group by 1.3 weeks. In group ≥32 to <34weeks GA -NBSS and SSS underestimated GA by 0.65 weeks and 0.45 weeks respectively than GA -USG. In group ≥34 to <38, NBSS was overestimating by 1.9 weeks and SSS was underestimating by 0.28 weeks compared with GA-USG. In a group of ≥38 weeks GA the NBSS was overestimating by 0.01 weeks whereas SSS scores were underestimating by 0.12 weeks as compared to GA-USG. P value in NBSS and SSS as compared to USG was not significant (P>0.05). P value in LMP compared to USG was significant i.e. P<0.05 using One way ANOVA with post-hoc Dunnet test. The statistical mean difference of SSS underestimated the GA by 0.23 weeks, whereas the NBSS underestimated the GA by 0.09 weeks. P value in NBSS and SSS compared to USG was not significant (P>0.05). There difference was statistically not significant.

**TableIV:-**Comparison of Correlation of NBSS, SSS and GA-LMP with GA-USG usingPearson correlation coefficient

| | **Correlation with GA USG** |
|---|---|
| GA –LMP | 0.726058 |
| GA-NBSS | 0.738609 |
| GA –SSS | 0.673005 |

The highest correlation was found with the NBSS (0.73) as compared to SSS (0.67) and GA-LMP (0.72). There was moderate reliability between NBSS and SSS as compared to GA-USG.

**Table V:-** Correlation of each item of NBSS with GA-LMP, with GA-NBSS and with GA-USG

| Items from NBSS | NBSS | LMP | USG |
|---|---|---|---|
| **Posture** | 0.620142 | 0.43246 | 0.470612 |
| **Square window (wrist)** | 0.536294 | 0.340812 | 0.388339 |
| **Arm (Recoil)** | 0.534777 | 0.31081 | 0.310805 |
| **Popliteal angle** | 0.490157 | 0.338747 | 0.490157 |
| **Scarf sign** | 0.522123 | 0.360304 | 0.376692 |
| **Heel to ear** | 0.518893 | 0.518893 | 0.379706 |
| **skin** | 0.518697 | 0.644526 | 0.40038 |
| **Lanugo** | 0.537444 | 0.308482 | 0.537444 |
| **Plantar surface** | 0.586101 | 0.586101 | 0.340811 |
| **Breast** | 0.490783 | 0.589294 | 0.447904 |
| **Eye/ Ear** | 0.523512 | 0.302798 | 0.337081 |
| **Genitals** | 0.52895 | 0.52895 | 0.417684 |

Highest correlation by GA-NBSS was showed by posture (0.62), plantar surface (0.58), Lanugo (0.53), square window (0.53), arm recoil (0.53), eye/ear (0.52)and genitals (0.52) all showing correlations > 0.5.

## Discussion:-

In developed countries, it is not the survival of extreme infants that is at stake, but the neurologicaloutcome of the survivors. The question of GA remains fundamental because of high cost of treating a survivor, which is inversely proportional to the GA. On other hand, in developing countries where means are limited, knowledge of GA is still important in deciding how to ration health care.[5]**Prioritizingreferral to SNCU / NICU of premature baby will definitely reduce complications associated with the prematurity such as hyaline membrane disease.**??

As compared to GA-LMP corroborated by USG as reference standard, the NBSS and SSS were underestimating neonates in ≥38 weeks and overestimating ≥32 to <38 weeks GA groups. The number of babies in SSS was close to that assessed by GA-LMP corroborated by USG as Reference Standard. **Erman et al (2006)[10]** found NBSS (+1 day and SD 8 days) to be more accurate than Dubowitz/Finnstrom score (+4 days and SD 9 days) in contrast to **CGLMP**which was considered as gold standard.

In our study, it was found that the SSS underestimated the GA by 0.23 weeks, whereas the NBSS underestimated the GA by 0.09 **weeks.NBSS** accuracy was more than that of SSS.**S Bindushaet al (2014)[11]** found that the simplified method based on physical criteria underestimated the GA by 0.58 weeks whereas NBSS overestimated the GA by 0.31weeks. **Rosenberg RE et al (2009)[12]** found that both LMP and Ballard tended to underestimate GA compared to ultrasound while Dubowitz tended to overestimate GA, while LMP underestimated the ultrasound finding by one day with a wide confidence interval (±11 days), NBSS underestimated GA by 2.9 days (±7.8) and the Dubowitz score overestimated GA by 3.9 days (±7).This was because study population consisted only of preterm infant with average GA of <33 weeks. **Sunjoh F.et al (**2004)[14]found that the Eregie model was the most accurate with the lowest mean difference of 0.259 ± 1.376 weeks followed by the NBSS with mean difference of 0.335 ± 1.518 weeks. The Dubowitz method is fairly accurate with a mean difference of 0.5 ±1.31. In the Farr method mean difference was 1.228± 1.495. The overall low accuracy of Farr method supports the need of neurological criteria in improving the accuracy of a method. However at low GA i.e. < 28 weeks and between 28-31 weeks the Farr method was reasonably accurate.

In the present study we considered GA-USG as Reference Standard, the NBSS was overestimating neonates in <32wks GA group by 1.3 wks. In group ≥32 to <34wks GA NBSS and SSS underestimating by 0.65 wks., 0.45 wks respectively as compared to GA-USG. In group ≥34 to <38 wks NBSS was overestimating by 1.9 wks and SSS were underestimating by 0.28 wks compared to GA USG. In a group of ≥38 wks GA the NBSS was overestimating by 0.01 wks, SSS scores was underestimating by 0.12 wks as compared to GA-USG. P value in NBSS and SSS compared to USG was not significant (P>0.05). However their difference was statistically not significant.

A study conducted by **Gabriel MA et al** (**2006**)[13]estimated the agreement between two methods of GA assessment, NBS and USG or LMP and found that in very preterm newborns, NBS overestimates GA. This was similar to present study in groups of <32 wks and ≥34 to <38 wks GA.

In this study the GA was calculated by NBSS, SSS and LMP correlated with USG. The highest correlation was found with NBSS i.e. 0.73 and correlation with SSS and GA-LMP were 0.67, 0.72 respectively. There was no significant difference between these two methods as correlation was moderate between these methods. **Erman et al (2006)[10]** correlation (r) was moderate between C-GLMP with Dubowitz/Finnstrom score (r=0.71) and NBS (r=0.79).**S.Bindusha et al (2014) [11]**studied the GA assessed by the NBSS and the simplified physical method correlated well with the GA estimated from the date of mother's last menstrual period. Pearson coefficient correlated strongly between GLMP with Ballard GA(r=0.92) score and Physical GA score (r=0.91).

**Sunjoh F.et al (2004) [14]**studied the correlation between the GA by each method and the GA by dates was equally good for the methods of Dubowitz, New Ballard, the Eregie with similar correlation coefficients of 0.94, 0.933, and 0.933, respectively.

We also tried to understand which items within each score had high correlation with GA-LMP,GA-USG as well as the score itself. The items in the NBSS showed lower correlation to GA-LMP and GA-USG as compared to total score itself. The highest correlation by GA-NBSS was shown by posture (0.62).Other were plantar surface (0.58), Lanugo (0.53), square window (0.53), arm recoil (0.53), eye/ear (0.52) and genitals (0.52) all showing moderate correlation i.e. more than 0.5. By GA-USG highest correlation was shown by Lanugo (0.57).Other were popliteal angle (0.49), posture (0.47), breast (0.44) and genitals (0.41).Though the correlation of individual item was low but collectively they were found equally effective as compared to NBSS.As there was no statistical difference.

**Sunjoh F.et al (2004)[14]**foundhigh correlation in case of external criteria which were skin color (0.801), skin texture (0.800), breast size (0.764) plantar creases (0.760), and ear firmness (0.718) and neurological criteria were posture (0.762), scarf sign (0.718), and ventral suspension (0.705).

**Brueton, et al (1973)[7]**found that the highest correlation with nipple formation followed by edema and the least correlation with genitalia. Best neurological criteria were ventral suspension and popliteal angle.

## Conclusion:-

As compared to NBSS, the new **SSS**scale has comparablevalidity, accuracy and moderate reliability to the NBSS; while being simple, very easy to use and producing comparable results for assessment of GA.

## Recommendation:-

Such SSS if incorporated in clinical practice would be helpful in Minimizing Handling of babies, Minimizing time to assess maturity, with minimal training to the Health Care Worker&Iterators variability; needs to be studied further.

## Bibliography:-

1. Dubowitz LMS, Dubowitz V, Goldberg C. Clinical assessment of gestational age in the newborn infant. J Pediatr. 1970; 77: 1-10.
2. Ballard JL, Khoury JC, Wedig K. New Ballard Score expanded to include extremely premature infants. J Pediatrics 1991; 119:417-423.
3. International Institute for Population Sciences (IIPS) and ORC Macro (2006). National Family Health Survey (NFHS-3), 2005-06: India. Mumbai: IIPS.
4. Feresu SA, Harlow SD, Gillespie BW, Welch K, Johnson TR. Birth weight-adjusted Dubowitz methods: re-ducing misclassification of assessments of gestational age in a Zimbabwean population. Cent Afr J Med. 2003 May-Jun; 49(5-6):47-53.
5. P Opara. Gestational Age Assessment inthe Newborn – A Review. The Internet Journal of Pediatrics and Neonatology. 2009 Volume 12 Number 2.
6. MSingh M, Razdan K, Ghai O. P. Modified scoring system for assessment of gestational age in newborn. IndianPediatr. 1975; 12:311

7. Brueton M J, Palit A, Prosser R. Gestational age assessment in Nigerian newborn infants. Arch Dis Child 1973; 8:318 –20.
8. Parkin JM, Hey EN, Clowers JS. Rapid assessment of gestational age at birth. Arch. Dis. Child. 1967; 51:259.
9. Ballard JL, Novak KK, Marshall D. A simplified score for assessment of fetal maturation of newly born infant. J. Ped. 1979; 95:769.
10. Erman, Wayan R, Soetjiningsih. Clinical gestational age assessment in newborns using the new Ballard score. PaediatrIndones. 2006; 46:97-102.
11. Bindusha S, Rasalam CS, Sreedevi N. Gestational age assessment of newborn – clinical trial of a simplified method – a case report. Transworld Medical Journal 2014;2(1):24-28
12. Rebecca E. Rosenberg, A.S.M. Nawshad , Ahmed U, Ahmed S, Saha S.K. et al. Determining Gestational Age in a Low-resource Setting: Validity of Last Menstrual Period . 2009 Jun; 27(3):332-338.
13. Marín Gabriel MA, Martín Moreiras J, Lliteras Fleixas G, Delgado Gallego S, Pallás Alonso CR, de la Cruz Bértolo J et al.Assessment of the new Ballard score to estimate gestational age. An Pediatric (Barc). 2006 Feb; 64(2):140-5.)
14. **F. Sunjoh, A. K. Njamnshi, F. Tietche and I. Kago.** Assessment of Gestational Age in the Cameroonian Newborn Infant: A Comparison of Four Scoring Methods. Journal of Tropical Pediatrics 2004 50(5):285-291.
15. Feresu SA. Does the modified Ballard method of assessing gestational age perform well in a Zimbabwean population? Cent Afr J Med. 2003 Sep-Oct; 49(9-10):97-103.