Modified Sick Neonatal Score: A Modified Score to Evaluate the Burden of Neonatal Morbidity in a Tertiary Care Hospital

MOSAMMAD ALPANA JAHAN[1], MD. ARIF HOSSAIN[2], FATEMA BEGUM[3], AFROZA ISLAM SHUMA[4], ISMAT JAHAN[5], M. A. MANNAN[6], SANJOY KUMER DEY[7]

Abstract

Background: *To assess neonatal mortality, many validated scores have been developed. The modified sick neonatal score (MSNS) is an easy, less complex suitable for both term and preterm neonates. This study was conducted to predict mortality upon admission to a NICU using the MSNS score.*

Methods: *An observational study was conducted in the Department of Neonatology, BSMMU, Dhaka, over a period of one year. Parameters for MSNS score were collected from data sheet. Outcome expressed as survived or expired. All data were analyzed using SPSS 20. To determine the cutoff value for predicting mortality, a receiver operating curve was generated. The cutoff score's sensitivity, specificity, positive predictive value, and negative predictive value were calculated.*

Results: *Among the enrolled 114 neonates, mean gestational age and mean birth weight were 34.22±3.10 weeks and 1967.87±752.33g respectively. About 75.4% neonates were <2500 grams and 70.2% of babies were preterm. During the study period, two third (69.3%) baby survived. The mean MSNS among survived neonate was 11.77± 2.29 and in expired neonates was 9.66±2.32 which was statistically significant (p-<0.01). The area under the ROC curve was 0.740 (95% CI: 0.645-0.835). The optimal cutoff value obtained to predict mortality was 11.50. With this cutoff score the sensitivity and specificity were 80% and 58%. Positive predictive value and negative predictive value were 46% and 87% respectively.*

Conclusions: *MSNS tools can be used to predict early mortality with early referrals and prompt treatment to reduce neonatal mortality.*

Keywords: *Neonatal intensive care unit, Scoring systems, Mortality, Newborns.*

DOI: https://doi.org/10.3329/bjch.v47i2.77650.

Introduction

Global neonatal deaths have fallen from 5 million in 1990 to 2.4 million in 2019, but children are at greatest risk of death in the first 28 days of life. The majority of newborn deaths occur in low- and middle-income countries.[1] By providing high quality prenatal care, skilled obstetrics, maternal and child postnatal care, and care for young and sick newborns, it is possible to improve the survival and health of newborns and end preventable neonatal death.

Improving newborn care is a global concern today and requires tools to monitor system performance and guide service plans for low- and middle-income countries (LMIC). To reduce the neonatal mortality rate and to provide large-scale interventions in LMIC, higher quality monitoring tool is essential.[2,3] Assessing the severity of neonatal illness and the risk of in hospital mortality in the NICU setting is necessary for quality care and rational use of resources.[4] Thus, risk prediction assessment tools are needed for quantifying the severity of clinical conditions and stratifying patients according to specific outcome.

1. Assistant professor, Department of Paediatrics, MH Samorita hospital and medical college, Dhaka, Bangladesh.
2. Medical officer, Department of Neonatology, Bangabandhu Sheikh Mujib Medical University, Dhaka, Bangladesh
3. Medical officer, Bhola Sadar Hospital, Bhola
4. Assistant professor, Dhaka medical college, Dhaka
5. Professor, Department of Neonatology, Bangabandhu Sheikh Mujib Medical University, Dhaka, Bangladesh
6. Associate Professor, Department of Neonatology, Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, Bangladesh
7. Professor, Department of Neonatology, Bangabandhu Sheikh Mujib Medical University, Dhaka, Bangladesh

Correspondence to: Dr. Mosammad Alpana Jahan, Assistant professor, Department of Paediatrics, MH Samorita hospital and Medical College, Mobile: +8801819129848. Email: alpana.jahan @gmail.com

Different tools for assessing and predicting the risk of newborn mortality was developed. These tools included Clinical Risk Index for Babies (CRIB), CRIB II (Infant Clinical Risk Index Update), Score for Neonatal Acute Physiology(SNAP), SNAP Perinatal Extension(SNAPPE), SNAP II and SNAPPE II.[5] Most of the score assess preterm low birth weight babies.

Neonatal Acute Physiology Score (SNAP) included 34 routinely available vital parameters and laboratory test results and included all birth weight babies,[6-8] but in SNAP score number of variables are more and take longer time to apply. The Clinical Risk Index for Babies (CRIB) Score is used to predict mortality for infants with less than 32 weeks of gestation. The score utilizes six different variables obtained routinely during the first 12 hours of life included both clinical and lab parameters. CRIB-II is the modified version which included birth weight less than 1,500 g.[9] All these scoring systems uses investigations like pH, pO2/FiO2 ratio, and base excess making them unsuitable for resource limited settings.[10]

Thus, it is needed to strike a balance between complex scores that are difficult to complete due to the large number of variables, and a simple model that is easy to use. It is also important to remember that no score can completely quantify the complex factors responsible for the morbidity of individual babies.

In 2015, a score with less complexity known as the Sick Neonate Score (SNS) was proposed. This score uses 7 basic vital parameters but didn't include gestational age and birth weight. The parameters were: Respiratory effort, heart rate, mean blood pressure, axillary temperature, capillary filling time, random blood sugar and SpO2.[11] Gestational age and birth weight are very important determinants of newborn survival. Thus, in 2019, Modified Sick Neonatal Score (MSNS) was created which includes 6 parameters of SNS and added gestational age and birth weight and significantly higher sensitivity and specificity were obtained.[12]

Bangladesh has achieved its MDG-4 goal of reducing under-five mortality earlier than planned. Unfortunately, however, neonatal mortality remains fairly high (20/1000 births), accounting for two-third of all deaths under the age of five.[13] Currently, scoring system in NICU's in Bangladesh is less practiced. A severity assessment system is needed to compare the performance of the SCANU and encourage early referral of sick babies to a more well-equipped center. Therefore, this study was designed to assess mortality risk of both term and preterm neonates in NICU by using the Modified Sick Neonatal Score (MSNS). To reduce the in-hospital mortality by giving more attention, this tool can be used as triage during the time of admission to assess the severity of sickness.

Materials and Methods

This prospective observational study was conducted in the Department of Neonatology in BSMMU, Dhaka, over a period of one year from July 2020 to June 2021. All admitted inborn neonates were enrolled in the study after getting informed written consent from parents. Death within 12h after admission or required admission after 12 hours of age, neonates with major congenital malformations and newborns who were discharged against medical advice were excluded from the study.

This study is a secondary analysis of data collected for a previous study titled "Neonatal mortality risk assessment using score for neonatal acute physiology with perinatal extension II (SNAPPE II) score in a neonatal intensive care unit". Some data were incorporated with that study. Approval was obtained from the IRB for that study (IRB no. BSMMU/2020/6666).

The Demographic details of the mother and infants such as maternal age, number of gestations, antenatal corticosteroid and mode of delivery was recorded from patient's profile. The data were collected within 12 hours of postnatal age. The disease severity was assessed immediately at admission and scored using Modified Sick Neonatal Score (MSNS), as depicted in Table-I. MSNS uses 6 parameters from SNS and included gestational age and birth weight. All the parameters assessed for MSNS score were collected from patient's history sheet.

All the enrolled admitted infants received standard care according to NICU protocol. The primary outcome measured in the study was neonatal death or survival up to 28 days. MSNS was used which have 8 parameters. Each parameter has a score 0 to 2. A Score of 0 means the worst, and score 2 implied the best possible clinical setting for each of the parameters.

The data were collected and analyzed in SPSS Statistics for Windows, version 20.0. Results were expressed as mean with standard deviation, and percentages using appropriate tables. chi-square test and independent T-test were used to find out the association between the individual parameters and outcome. In order to predict mortality, the receiver operating characteristic (ROC) curve was created using MSNS as the test variable. The ROC curve was used to determine the ideal cutoff value. The cutoff score's sensitivity, specificity, positive predictive value, and negative predictive value were computed. The cutoff score's positive and negative predictive values were calculated.

Results

Total inborn neonates admitted to NICU, BSMMU during the study period were 133. Among them 19 neonates were excluded. A total of 114 neonates were analyzed for the study. Table 1 showing the parameter used for MSNS score.

Table I

Parameters of MSNS with scoring

Parameter	Score 0	Score 1	Score 2
Respiratory effort	Apnea or grunt	Tachypnea (respiratory rate >60/min) withor without retractions	Normal (respiratory rate40–60/min)
Heart rate	Bradycardia or asystole	Tachycardia (>160/min)	Normal (100–160/min)
Axillary temperature (°C)	<36	36–36.5	36.5–37.5
Capillary refilling time (s)	>5	3–5	<3
Random blood sugar (mg/dl)	<40	40–60	>60
SpO2 (in room air)	<85	85–92	>92
Gestational age (in weeks)	<32 weeks	32 to 36 weeks + 6/7 days	37 weeks and above
Birth weight (kg)	<1.5	1.5–2.49	2.5 or above
Total		Total Maximum 16	

Table-II

Baseline characteristics of the enrolled neonates

Variables	N-114 (%)
Gestational age(week), Mean±SD	34.22±3.10
Gestational age	34 (29.8)
<32 week	
32-36 weeks	44 (38.6)
≥37 weeks	36 (31.6)
Birth weight (g), Mean±SD	1967.87±752.33
<1500gm	34 (29.8)
1500-2499gm	52 (45.6)
>2500gm	28 (24.6)
Sex	
Male	63(55.8)
Female	50 (44.2)
Mode of delivery	
NVD	23(20.2)
LUCS	91 (79.8)
Antenatal corticosteroid	46(40.4)
Age at admission (Minutes), Mean±SD	16.75 ±8.09
Hospital stay (day) Mean±SD	12.30±9.25

Continuous data are presented as mean ± SD and categorical data as number and percentage.

According to Table 2, the mean gestational age and birth weight of the enrolled neonates were 34.223.10 weeks and 1967.87752.33 g respectively. Two-thirds (75.4%) of the study's neonates had birth weights of less than 2500 grams, and about 70.2% of the infants were preterm. Females constituted 44.2%. The average length of stay in the hospital was 12.30 days.

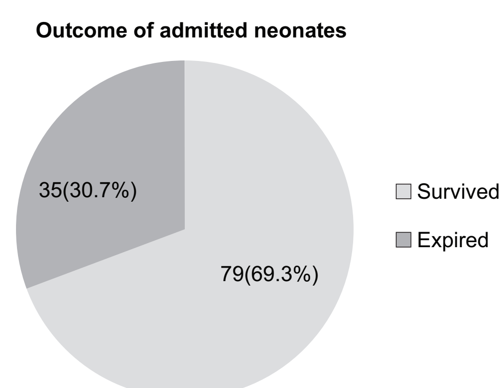

Fig.-1 *showing the outcome of enrolled neonates. About two –third baby survived during the study period.*

The mean MSNS among survived and expired neonates is statistically significant (p-value<0.01). (Table III)

Table IV showing the scores 0, 1, and 2 for each MSNS parameter among survived and expired cases. The survived neonates had higher frequency and better MSNS scores across the parameters.

Table III

Mean MSNS among outcome

Variable	Survived	Expired	p-value
Mean MSNS	11.77± 2.29	9.66±2.32	.000

Chi-square test for categorical data. p- < 0.05 considered as significant.

Table IV

Frequencies of scores 0, 1, and 2 for each MSNS parameter among survived and expired cases

MSNS parameter	Score	Survived, *n(%)*	Expired, *n(%)*	P-value
Respiratory effort		03 (3.75)	2(5.71)	
	1	60 (75.9)	25 (71.42)	.840
	2	16 (20.25)	8(22.85)	
Heart rate	0	1 (1.26)	1(2.85)	
	1	9 (11.39)	5(14.28)	.751
	2	69(87.34)	29(82.85)	
Axillary temperature (°C)	0	16(20.25)	28(80.0)	
	1	19(24.05)	4(11.42)	.000
		244(55.69)	3(8.57)	
Capillary refilling time (s)	0	1 (1.26)	0(0)	
	1	3 (3.79)	5 (14.28)	.107
	2	75(94.93)	30(85.71)	
Random blood sugar (mg/dl)	0	0(0)	1(2.85)	
	1	10(12.65)	4(11.42)	0.318
	2	69(87.34)	30(85.71)	
SPo2 (in room air)	0	6(7.59)	7(20)	
	1	26 (32.91)	14(40)	.069
	2	47(59.49)	14(40)	
Gestational age (in weeks)	0	21(26.58)	13(37.14)	
	1	29(36.70)	15(42.85)	.201
	2	29 (36.70)	7(20)	
Birth weight (kg)	0	17 (21.51)	17(48.57)	
	1	42 (53.16)	10 (28.57)	.010
	2	20(25.31)	8(22.85)	

Independent t- test for continuous data. p-< 0.05 considered as significant.

Table V

The Area under ROC Curve and Diagnosis Accuracy of MSNS Scoring System (N=114)

Parameter	Cut-off point	Sensitivity	Specificity	PPV %	NPV %	Accuracy %
MSNS score	11.5	89.00%	58.00%	46.00%	87.00%	65.00%

Screening analysis of MSNS score, in predicting mortality using the most suitable cut-off point. AUC: Area under the curve, PPV: Positive predictive value, NPV: Negative predictive value

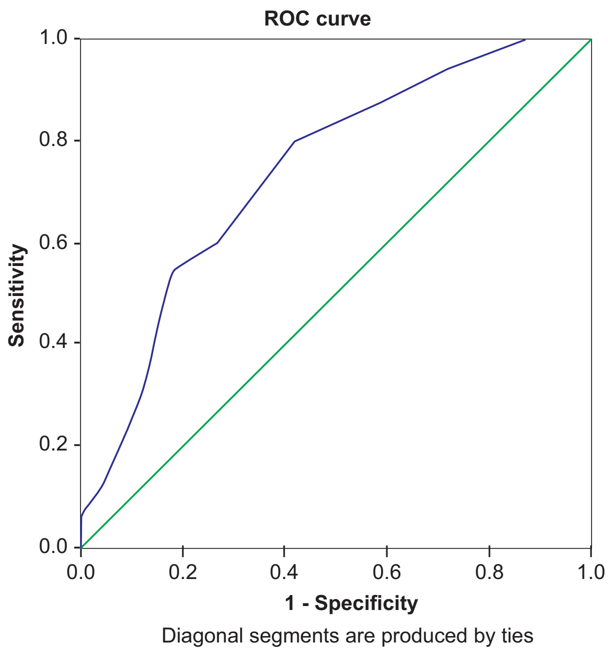

Fig.-2: *Receiver operating characteristic (ROC) curve to predict mortality by using total MSNS score*

Figure 2 showing the receiver operating characteristic (ROC) curve generated using MSNS as a test variable for predicting mortality. The area under the ROC curve was 0.740 (95% CI: 0.645-0.835). The optimal cutoff value obtained to predict mortality was 11.50. With a cutoff score of 11.50, the sensitivity and specificity in predicting mortality were 80% and 58%, respectively. For predicting mortality, Positive predictive value and negative predictive value were 46% and 87%. (Table-5) The lower the score, the higher the probability of mortality.

Discussion

To predict neonatal mortality, several scoring systems were developed. Based on the notable differentiation and calibration of each dataset, Modified Sick Neonatal Score (MSNS) is a promising tool. This study shows 70.2% of babies were preterm, two-thirds of the study's neonates had birth weights less than 2500 grams and overall mortality was 30.7%. A study conducted in Bangladesh shows the hospital mortality rate was 38% which was similar to our study.[14]

MSNS has a maximum total score of 16. In this study MSNS mean (SD) score, among survived neonate was 11.7 ±2.29 and among expired was 9.66 ±2.32. The differences were statistically significant (p-< 0.01). The MSNS scores of expired neonates were significantly lower. Lower scores in each of the MSNS's individual parameters were associated with death when they were correlated with outcome. Our result had similarities with other studies.[12,15] In other scoring systems, the higher the score, the higher the rate of mortality. In a study SNAPPE-II, score of 37 and above were associated with higher mortality.[16]

This study was conducted in the NICU using MSNS, a new system for assessing the severity of neonatal disease. In this study, MSNS had a sensitivity of 80% and a specificity of 58% with an optimum cutoff score of 11.5 was used to predict mortality. The area under the ROC curve was 0.740 (95% CI: 0.645-0.835). The first MSNS study done in India over a period of one year had better sensitivity and specificity (as compared to this study). The first MSNS study had a sensitivity of 80% and a specificity of 88.8% when an optimum cutoff score of ≤10 was used to predict mortality with the ROC curve 0.913 (95% CI: 0.879–0.946).[12] In another study the sensitivity was 88.24%, specificity 95.2%, positive predictive value 57.69% and negative predictive value was 99% when the cut-off score of 10 was obtained.[15] In SNS study,[11] An ROC showed a sensitivity of 58.3 % and specificity of 52.7% with a cutoff value ≤8.

Other complex scores such as SNAPPE-II score in assessing Neonatal mortality risk, found sensitivity, specificity, positive and negative predictive value of score ≥38 in estimating overall mortality were 84.4, 91, 66.7 and 96.5% respectively.[17] Another study using Clinical Risk Index for Babies (CRIB II) Scoring system showed, with cutoff point of ≥11, the sensitivity was 94.9% with the predictive value 74.0% and specificity 82.4% compared to birth weight and gestational age.[18]

For better Performance in NICU's and to reduce the burden of mortality, disease severity assessment tool can help. These results provide an opportunity to improve the identification of dying newborns, guide triage decisions in the neonatal intensive care unit and between units, and enable appropriate staffing.

Conclusions

MSNS is a useful neonatal disease severity assessment tool for both term and premature babies that can be used in the neonatal intensive care unit with limited resources. In this study, a cutoff score of 11.5 is used to predict mortality. This tool helps to stratify risks and can guide resource allocation and treatment decisions upon NICU admission.

Study limitations

- This study did not assess co-morbidities that can affect mortality such as PNA, IVH, NEC etc.
- This study score did not include maternal risk factors which are necessary to assess neonatal mortality.
- This study was conducted at a single institution with small sample size.

Recommendation

The Modified Sick Neonatal Scores can be used by nurses and clinicians in the neonatal intensive care unit for both term and preterm in resource-limited settings to quickly identify sick newborns that require additional intervention. In addition, newborns identified by the score can benefit from a prioritized series of interventions that are part of NICU care, such as for hypoglycemia, parenteral fluid or antibiotic IV insertion, correction of hypothermia by rewarming the newborn, and respiratory support for distress or apnea.

Further research is needed to validate neonatal mortality scores in low resource facilities. Neonatal scoring tools that predict the risk of postnatal neonatal mortality at LMIC should continue to be a priority.

References

1. World Health Organization. Newborns: improving survival and well-being. World health organisation, Geneva. 2020.
2. Bhutta ZA, Das JK, Bahl R, Lawn JE, Salam RA, Paul VK, et al. Can available interventions end preventable deaths in mothers, newborn babies, and stillbirths, and at what cost? Lancet. 2014;384(9940):347–70.
3. Dickson KE, Simen-Kapeu A, Kinney MV, Huicho L, Vesel L, Lackritz E, de Graft Johnson J, von Xylander S, Rafique N, Sylla M, Mwansambo C. Every Newborn: health-systems bottlenecks and strategies to accelerate scale-up in countries. The Lancet. 2014 Aug 2;384(9941):438-54.
4. Fleisher BE, Murthy L, Lee S, Constantinou JC, Benitz WE, Stevenson DK. [4] Neonatal severity of illness scoring systems: a comparison. ClinPaediatr (Phila). 1997; 36(4):223-37.
5. Fowlie PW. CRIB in relation to nosocomial bacteraemia in VLBW or preterm. [8] Arch Dis child. 1996;75:149-52.
6 Richardson DK, Gray JE, McCormick MC, Workman K, Goldman DA. Score [3] for neonatal acute physiology: a physiology severity index for neonatal intensive care. Pediatrics. 1993; 91(3):617-23.
7. Escobar GJ, Fischer A, Li DK, Kremers R, Armstrong MA. Score for neonatal [4] acute physiology: validation in three kaiser permanente neonatal intensive care units. Pediatrics. 1995 ; 96(5 Pt 1):918-22.
8. Petridou E, Richardson DK, Dessypris N, Malamitsi Puchner A, Mantagos S, [5] Nicolopoulos D, et al. Outcome prediction in Greek neonatal intensive care units using a score for neonatal acute physiology (SNAP). Pediatrics. 1998; 101(6):1037-44.
9. Patrick SW, Schumacher RE, Davis MM. Methods of mortality risk adjustment in the NICU: a 20-year review. Pediatrics. 2013;131(Suppl 1):S68-74.
10. Dorling JS, Field DJ, Manktelow B. Neonatal disease severity scoring systems. Archives of Disease in Childhood-Fetal and Neonatal Edition. 2005 Jan 1;90(1): F11-6.
11. Rathod D, Adhisivam B, Vishnu Bhat B. Sick neonate score-a simple clinical score for predicting mortality of sick neonates in resource restricted settings. The Indian Journal of Pediatrics. 2016 Feb;83:103-6.
12. Mansoor KP, Ravikiran SR, Kulkarni V, Baliga K, Rao S, Bhat KG, Baliga BS, Kamath N. Modified sick neonatal score (MSNS): A novel neonatal disease severity scoring system for resource-limited settings. Critical care research and practice. 2019 May 9;2019.
13. National Institute of Population Research and Training (NIPORT) and ICF. 2023. Bangladesh Demographic and Health Survey 2022: Key Indicators Report. Dhaka, Bangladesh, and Rockville, Maryland, USA: NIPORT and ICF.
14. Kumar A. Risk Factors and Trends in Neonatal Mortality in a Special Care Newborn Unit in a Tertiary Care Hospital in Bangladesh (Doctoral dissertation, Johns Hopkins University). 2019.
15. Padar C, Rajan A, Shriyan A, Oommen RA, Padar C. Modified Sick Neonatal Score and Delta: Modified Sick Neonatal Scores As Prognostic Indicators in Neonatal Intensive Care Units. Cureus. 2022 Aug 25;14(8): e28414.
16. Harsha SS, Archana BR. SNAPPE-II (Score for Neonatal Acute Physiology with Perinatal Extension-II) in predicting mortality and morbidity in NICU. Journal of clinical and diagnostic research: JCDR. 2015 Oct;9(10):SC10.
17. Muktan D, Singh RR, Bhatta NK, Shah D. Neonatal mortality risk assessment using SNAPPE-II score in a neonatal intensive care unit. BMC pediatrics. 2019 Dec;19(1):1-4.
18. Ezz-Eldin ZM, Hamid TA, Youssef MR, Nabil HE. Clinical risk index for babies (CRIB II) scoring system in prediction of mortality in premature babies. Journal of clinical and diagnostic research: JCDR. 2015 Jun;9(6):SC08.