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Original Article

Modified Sick Neonatal Score (MSNS) in Predicting the Outcome of Neonates in Tertiary Care Hospital

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Abstract

Introduction: Neonatal disease severity scoring systems are widely used to predict severity of illness. Existing scoring systems contain variables like pH, PO2 / FiO2 ratio, and base excess, which are difficult to obtain in resource-limited settings. Modified sick neonatal score (MSNS) is based on eight clinical variables which are easy to calculate and are also accurate enough at the same time. This study was done to evaluate MSNS for predicting the outcome of neonates in our settings.

Methods: This was prospective observational study done at neonatal intensive care unit (NICU) of tertiary care hospital in Nepal from February 2021 to January 2022. The parameters required for the score were recorded at admission. Total score was calculated and outcome was noted. Data collected was analyzed using SPSS Statistics for Windows, v21.0. Chi square test, Mann-Whitney U test and ROC analysis were used for statistical analysis.

Results: Total of 195 neonates were discharged and 37 expired. The mean MSNS score among expired was 8.16 ± 1.625 and discharged was 10.99 ± 1.753. For a cutoff score of ≤ 10, sensitivity and specificity; Positive and negative predictive value were 89.2% and 60.5%; 30.7% and 98.3% respectively. The area under the curve (AUC) of MSNS was 0.875 (CI 95%; 0.817 - 0.934). Lower MSNS score was also associated with requirement of iontrope and ventilator support.

Conclusions: MSNS can be used as an important clinical tool for predicting the severity of disease in neonates in resource limited settings.

Introduction

Neonatal mortality is a major concern worldwide. In 2020, 2.4 million neonates died globally, with estimation that child born in South Asia was nine times more likely to die.[1] Nepal is a developing nation where facilities for neonatal care are limited. Neonatal mortality rate was 21 per thousand live birth in Nepal according to National demographic health survey (NDHS) 2016 with no significant decline in last decade.[2] Neonatal sepsis, birth asphyxia and prematurity are leading causes of neonatal deaths.[3]

Neonatal sickness scores can be used to identify sick babies. After identification, use of additional intensive management, preventive measures and early referral to tertiary centre may help to improve outcome. It can be useful tool in making standardized comparison between performances among various NICUs. Scoring systems like clinical risk index for babies (CRIB)[4], Score for Neonatal Acute Physiology (SNAP)[5], SNAP with perinatal extension (SNAPPE)[6] were developed before the guidelines on basic newborn resuscitation was initiated in 2009 and they fail to incorporate recent modifications in neonatal resuscitation and prenatal care. Similarly, many of the scoring systems contain variables, which require investigations like pH, PO_2 / FiO_2 ratio, and base excess, which are difficult to obtain in resource-restricted settings.

Mansoor et al[7] devised simplified modifications of validated scoring system sick neonatal score (SNS) namely: Modified sick neonatal score (MSNS). It is based on eight routinely measured variables in NICUs; scoring of which is depicted in Table 1.

Table 1: Modified Sick Neonatal Score (MSNS)

Parameter	Score 0	Score 1	Score 2
Respiratory effort	Apnea or grunt	Tachypnea (Respiratory rate > 60 / min with or without retractions	Respiratory rate (40 - 60 / min)
Heart rate	Bradycardia or asystole	Tachycardia (> 160 / min)	Normal (100 – 160 / min)
Axillary temperature (oC)	< 36	36 - 36.5	36.5 - 37.5
Capillary refill time (s)	> 5	3 - 5	< 3
Random blood sugar (mg/dl)	< 40	40 - 60	> 60
Spo_2 in room air	< 85	85- 92	> 92
Gestational age (in weeks)	< 32 weeks	32 - 36 weeks + 6/7 days	37 weeks or and above
Birth weight	< 1.5kg	1.5 - 2.49	2.5 and above
Total		Maximum: 16	

This study was conceptualised to calculate MSNS score of neonates admitted at NICU and compare MSNS score with outcomes like need of ventilator support, inotropic support, length of hospital stay and mortality and to determine cut-off value of MSNS for predicting mortality.

Methods

This is a prospective observational study conducted in NICU of Department of Paediatrics, Patan Hospital, Lalitpur, Nepal. from 12 Feb 2021 to 11 Jan 2022. Study was approved by Institutional Review Committee (IRC) of Patan Academy of Health Sciences (PAHS) (Ref: PMP2102111479). All neonates admitted to NICU during study period were included in the study. Convenient sampling was used where all neonates admitted during one year period were enrolled in study. Babies already intubated or on inotropic support were excluded from the study as some parameters of the scoring system can't be applied on such babies. Similarly, babies with gross congenital and surgical anomalies not compatible with life or requiring surgical intervention were excluded along with those who left against medical advice and neonates whose parents wouldn't provide consent for the study. Consent was taken from the patient's parents by on duty doctor. Neonates were assessed immediately on admission. Demographic details with important clinical findings and investigations were recorded on proforma by on duty doctor. All parameters of MSNS are normally recorded others wise on a regular basis. Then, scoring was done using MSNS as shown in Table 1. Babies were followed until discharge or mortality and outcomes were recorded. Primary outcome of the study was mortality or discharge of neonate. Secondary outcome were neonates requiring ventilator support, neonates requiring inotropic support and length of hospital stay. Data was collected on preformed proforma and entered in Microsoft Excel 2013 and statistically analyzed using SPSS Statistics for Windows, v21.0. Continuous variables were expressed as mean or median and Chi square test was used to look for the association between use of inotrope and ventilator with mortality. Independent sample t test was used to see if lower MSNS score is associated with the use of inotrope and ventilator. Receiver operating characteristic (ROC) curve was generated with MSNS as the test variable to predict mortality. Optimum cutoff value was obtained from the ROC curve. Sensitivity, specificity, positive predictive value, and negative predictive value were calculated for the cutoff score. Mann–Whitney U test was used to compare the scores between the expired and discharged groups in each of the individual parameters. P-value of < 0.05 was taken to be significant. Correlation was used to look for the association between MSNS and length of NICU stay

Results

Two hundred fifty-eight neonates were admitted in NICU during this one-year period. Out of 258 cases, 232 cases fulfilled the inclusion criteria. Twenty-six cases were excluded from the study.

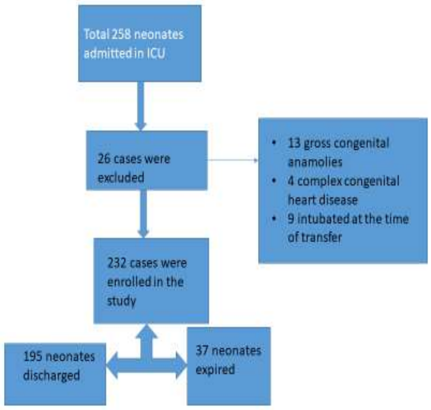

Figure 1: Study flow Chart

All neonates enrolled in the study completed the study.

Table 2: Baseline characteristics of neonates

Parameter	N	%
Gestational age		
Preterm	174	75%
Term	58	25%
Birth weight		
> 2.5 kg	63	27.20%
1.5 -2.5 kg	97	41.80%
< 1.5 kg	72	31.00%
Sex		
Male	147	63.40%
Female	85	36.60%
Mode of delivery		
SVD	45	19.40%
LSCS	187	80.60%
Outcome		
Discharged	195	84.10%
Ventilator support	189	81.46%
Inotrope support	40	17.20%
Expired	37	15.90%

*NIPPV: 78 (41.23%), *IPPV: 111 (58.77%)

Out of 232 neonates, 195 (84.1%) were discharged and 37 (15.9%) expired. Among enrolled neonates, 40 (17.2%) required inotropic support. Thirty two out of 40 neonates i.e. 80% of those neonates that required inotropic support expired whereas eight were discharged. Use of inotrope was associated with mortality (P < 0.001) Lesser MSNS score was associated with the use of inotrope (P < 0.001).

One hundred and eighty nine (81.4%) babies required mechanical ventilator support either non-invasive positive pressure ventilation (NIPPV) or invasive positive pressure ventilation (IPPV). Among those requiring ventilator support, 78 (41.23%) required NIPPV and 111 (58.77%) required IPPV. Out of 111 that required IPPV, 36 (32.43%) expired. Use of mechanical ventilator was associated with mortality (P < 0.001). Lesser MSNS score was associated with the use of ventilator (P < 0.001).

Table 3: Mean (SD) MSNS score among discharged and expired

Outcome	Mean MSNS Score (SD)	P Value
Discharged	10.99 (1.753)	P < 0.001
Expired	8.16 (1.625)	

The mean MSNS score among expired was 8.16 ± 1.625 and discharged was 10.99 ± 1.753 and the difference being statistically significant at P < 0.001. Mean stay at ICU among expired was 8.73 days and among discharged was 8.44 days which is not statistically significant (P = 0.850). Median stay at ICU was six days with (3-11.75) IQR: nine with minimum stay of one day and maximum duration of stay was 59 days. There was negative weak correlation between MSNS score and duration of hospital stay (Correlation: -0.271; P = 0.00).

Table 4: Frequencies of scores 0, 1, and 2 for each parameter of MSNS among expired and discharged cases.

MSNS Parameter	Score	Discharged, n (%)	Expired, n (%)	P value
Respiratory effort	0	110 (56.4%)	29 (78.4%)	P < 0.05 P = 0.042
	1	55 (28.2%)	6 (16.2%)	
	2	30 (15.2%)	2 (5.4%)	
Heart rate	0	5 (2.6%)	6 (16.2%)	P < 0.05 P = 0.011
	1`	53 (27.2%)	10 (27.0%)	
	2	137 (70.3%)	21 (56.8%)	
Axillary temperature (°C)	0	7 (3.6%)	2 (5.4%)	P < 0.05 P = 0.002
	1	61 (56.8%)	21 (56.8%)	
	2	127 (37.8%)	14 (37.8%)	
Capillary refill time (s)	0	0 (0%)	1(2.7%)	P < 0.001 P = 0.00
	1	24 (12.3%)	12 (32.4%)	
	2	171 (87.7%)	24 (24.9%)	
Random blood sugar (mg/dl)	0	18 (9.2%)	3 (8.1%)	P = 0.929
	1	12 (6.2%)	3 (8.1%)	
	2	165 (84.6%)	31 (83.8%)	
Spo_2 in room air	0	20 (10.3%)	6 (16.2%)	P < 0.05 P = 0.002
	1	87 (44.6%)	25 (67.6%)	
	2	88 (45.1%)	6 (16.2%)	
Gestational age (in weeks)	0	40 (20.5%)	25 (67.6%)	P < 0.001 P = 0.00
	1	100 (51.3%)	6 (16.2%)	
	2	55 (28.2%)	6 (16.2%)	
Birth weight (Kg)	0	45 (23.1%)	27 (73%)	P < 0.001 P = 0.00
	1	90 (46.2%)	7 (18.9%)	
	2	60 (30.8%)	3 (8.1%)	

The discharged neonate had higher frequency of better MSNS score across the parameters. Differences in scores among discharged and expired groups were highly significant for all parameters except random blood sugar. Receiver operating characteristic (ROC) curve generated with MSNS as the test variable to predict mortality in neonates is shown in Figure 2. The area under the curve (AUC) for MSNS was 0.875 (CI 95%; 0.817-0.934) which indicates the prediction accuracy of 87.5%. For cutoff score of ≤ 10, sensitivity, specificity, Positive predictive value (PPV) and negative predictive value (NPV) for predicting mortality were 89.2%, 60.5%, 30.7% and 98.3% respectively.

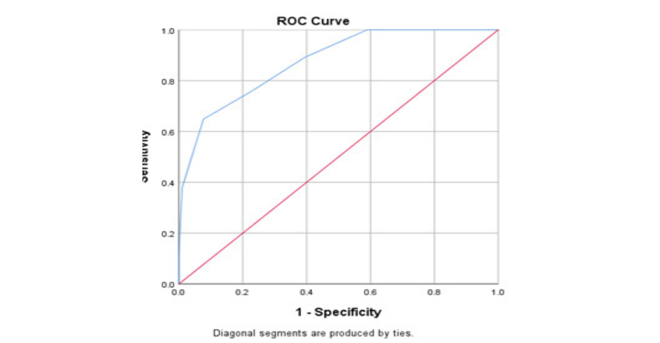

Figure 2: Receiver operating characteristic (ROC) curve generated with total MSNS score as the test variable to predict mortality

Discussion

In present study, 232 neonates were enrolled and parameters of MSNS were recorded. 75% of the neonates were preterm and 72.8% of neonates weighed less than 2500 gm. Neonatal mortality among study population was 15.9%, which is comparable with the national average.[2] Mean MSNS score in our study can be compared with two studies done in India by Mansoor et al[7]and Shivaramakrishnababji N et al[8] where MSNS mean (SD) score among expired was 9.93 (2.26) and 8.22 (2.96) and among discharged was 14.06 (1.67) and 13.4 (2.14) respectively. Lower the MSNS score, greater was the probability of mortality. Similarly, lower score in each of the parameters was significantly associated with mortality. Lower MSNS score in our study was associated with the longer duration of NICU stay (correlation: - 0.271; P = 0.00). However, in the study done by Muktanet al9 and Shrestha et al[10], no significant correlation was found between SNAPPE II score and length of NICU stay.

MSNS score can also be used to predict the need of inotrope or mechanical ventilator support. Lower MSNS score in our study was not only associated with mortality but also with the use of inotrope or mechanical ventilator ($P < 0.001$). Previous studies have not looked for the association between neonatal sickness severity score and use of inotrope and ventilator. Our findings might be very useful however further studies with large sample size is necessary to confirm this hypothesis.

In our study, AUC was 0.875 with sensitivity of 89.2% and specificity of 60.5% which is comparable with the one done by original author Mansoor et al[7] with AUC 0.913 where sensitivity was 80% and specificity was 88.8% when cutoff score of ≤ 10 was used and also with study by Shivaramakrishnababji n et al[8] where sensitivity and specificity were 86.9% and 51.1% respectively and were AUC was 0.811. In near future, Government of Nepal has planned to fully equip all district hospitals with SNCU services and all zonal and above hospitals to equip with NICU instruments.[11] MSNS used in present study can thus be used for determining prognosis and early referral from SNCU to NICU facility.

MSNS has better sensitivity and specificity compared to original SNS. At a cutoff score ≤ 8, SNS had sensitivity of 58.3% and specificity of 52.7%.[12] In addition to this, it also has better sensitivity and specificity compared to SNAPPE II which is currently the most used neonatal scoring system. In a study done in India by Harsha et al,[13] SNAPPEE-II score of ≥ 37 had sensitivity and specificity of 76.9% and 87.1% respectively. Whereas in study done by Muktan et al[9] at BPKIHS, Dharan, Nepal, SNAPPEE-II score of ≥ 38 had sensitivity of 84.4% and specificity of 91%.

Furthermore, previous scoring system either has large parameters making it difficult and time consuming or else includes sophisticated investigations like FiO_2, serum Ph, base deficit which are not readily available in resource limited settings. Whereas some scoring system can be applied only to preterm babies. All these reasons make scoring systems like SNAP, SNAP-II, SNAPPE, SNAPPE-II, CRIB, CRIB 2 not an ideal neonatal severity scoring.

MSNS is equally valuable for resource-constrained setting. Score ≤ 10 is useful to predict mortality and can also be used to predict the need of ventilator support and ionotropic support. It has advantage of being easy to use and applicability to both preterm and term neonates. However, with the use of neonatal sickness severity scoring in prognostication, there might be increase in tendency of early withdrawal of treatment of sick neonates with lesser MSNS score. Further studies to look into such tendencies might also be necessary to discourage such practice. The study was done in a single centre with limited number of sample size, which is major limitation of the study. Maternal risk factors like gestational diabetes, pregnancy induced hypertension, mother receiving antenatal steroids were not taken into account which might directly affect neonatal outcome. Scoring was done only at the time of admission; serial scoring would have provided additional information.

Conclusions

MSNS was devised with simple clinical variables and doesn't need sophisticated investigations. It has good sensitivity and specificity and can be applied to both term and preterm neonates. MSNS is useful neonatal disease severity score based on resource availability and simplicity.

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