RESEARCH PAPER

Extended Sick Neonate Score (ESNS) for Clinical Assessment and Mortality Prediction in Sick Newborns referred to Tertiary Care

SOMOSRI RAY[1], RAKESH MONDAL[2], KAUSHANI CHATTERJEE[2], MOUMITA SAMANTA[2], AVIJIT HAZRA[3] AND TAPAS KUMAR SABUI[1]

From Departments of [1]Neonatology and [2]Pediatric Medicine, Calcutta Medical College; and [3] Department of Pharmacology, Institute of Postgraduate Medical Education and Research (IPGME&R); Kolkata, West Bengal, India.

Correspondence to: Dr Rakesh Mondal, Department of Pediatrics, Medical College, 88 College Street, Kolkata 700 073, West Bengal, India. ivanrakesh2001@gmail.com

Received: November 15, 2017; Initial review: March 31, 2018; Accepted: November 21, 2018.

Objective: To evaluate utility of a new Extended Sick Neonate Score (ESNS). to predict 'in-hospital mortality' and compare with Score for Neonatal Acute Physiology – Perinatal Extension II (SNAPPE II) and Sick Neonate Score (SNS). **Design**: Prospective observational study. **Methods**: All extramural sick newborns transported to the neonatology unit of a tertiary care teaching hospital over a period of one year. Correlation between ESNS, SNAPPE-II and SNS scoring, and sensitivity/specificity of each score to predict mortality were determined. **Results**: 961 newborns were enrolled in the study. ESNS, SNAPPE II and SNS were strongly correlated, even when stratified by gestation. ESNS of ≤11 had the best sensitivity (85.9%) and specificity (89.8%). For preterms, ESNS ≤12 had the best sensitivity (92.3%) and specificity (76.7%). ***Conclusion***: ESNS can predict 'in-hospital mortality' outcome with satisfactory sensitivity and specificity.

Keywords: *Death, Sick neonate score, SNAPPE-II, Outcome*.

India contributes to 25% of the neonatal deaths worldwide, accounting for 1 million neonatal deaths each year [1]. There is a need for a reliable but simple scoring systems to assess well-being of newborns at arrival to a tertiary center after transportation over long distances. There are (different) neonatal disease severity scoring systems already in existence [2,3]. Desirable properties of such scoring systems have been described as ease of use, applicability early in course of hospitalization, ability to reliably predict mortality and specific morbidities and ability to discriminate between infants with different outcomes [3]. However not all scoring systems fulfill these criteria.

We have developed a neonatal disease severity scoring system, Extended Sick Neonate Score (ESNS), drawing upon some existing criteria, that we believe is simple to use and can be applied as soon as the newborn presents. In the present study, we compared its ability to predict pre-discharge mortality with Score for Neonatal Acute Physiology – Perinatal Extension II (SNAPPE-II) [4] and the Sick Neonate Score (SNS) [5].

METHODS

This prospective observational study was performed at a tertiary care teaching hospital from 1st January to 31st December, 2015 amongst extramural newborns admitted to our institution. Institutional ethics committee approved the study. Consent was provided by the accompanying parent or a legally acceptable representative of the infant. Neonates with congenital anomaly or those requiring surgical intervention were excluded.

Within 15 minutes of arrival at the neonatal unit emergency, the baby was assessed by measuring oxygen saturation, heart rate, blood pressure, axillary temperature, random blood sugar, weight and arterial blood gas analysis for pH and PaO_2. Non-invasive blood pressure monitor [Philips Medizin Systeme, Boeblingen GmbH Hewlett Packard, Model MX430 Germany], with SpO_2 probe [BPL model 160707, India] and glucometer [Roche, Accu-Chek Performa model CE 0088, India] were used. Perfusion was assessed by checking capillary refilling time, neurological assessment included Moro reflex and respiratory distress was scored by modified Downes' score. All neonates were assigned a score using ESNS and SNAPPE-II. The SNS system was published after data collection for our study was over but we could utilize the same data for retrospective scoring using this system, too.

All the babies were managed and investigated based on existing hospital protocols. In all neonates, their outcome and final diagnosis were recorded.

TABLE I THE PROPOSED EXTENDED SICK NEWBORN SCORE (ESNS) SYSTEM

Parameter	*Score*		
	0	1	2
Respiratory effort	Apnea	Rate > 60/min ± Retraction	Rate 40-60/min
Heart rate (beats per minute)	Bradycardia/Asystole	>160	100-160
Mean blood pressure	<5th percentile	5-50th	>50th
Axillary temperature (°C)	<36	36.0-36.5	36.5-37.5
Capillary filling time (s)	>5	3-5	<3
Random blood sugar (mg/dL)	<45	45-60	>60
Sp_{O2} (% in room air)	<85	85-92	>92
Moro reflex	Absent	Depressed/Exaggerated	Corresponding to gestational age
Modified Downes' score*	>6	2-6	0-2

**Modified Downe's score represent a composite score including five parameters (each carrying 0, 1, 2 points, with minimum score 0 to maximum score 10) i.e. respiratory rate, retraction, grunt, cyanosis, air entry.*

The score that we have proposed is a modified version of the SNS system with addition of two more parameters, namely Moro reflex and modified Downes' score, and blood pressure interpretation in percentile published by Samanta, *et al.* [6]. The complete ESNS scoring is described in ***Table* I**. Prior to start of study, intra-rater validation of the scoring was done by the same rater, at 10 minute interval, on a cohort of 90 sick newborns. Inter-rater validation was done, at 5 minute intervals, by three different raters on a separate cohort of 30 sick newborns. All raters were pediatric specialists working in the neonatal unit. The correlations were at least 99%.

The study planned to screen 1000 referred newborns over a one year period. Rater validation was done by calculation of the intraclass correlation coefficient (ICC) for individual parameters. Correlation between ESNS and the referral scorings have been explored by constructing scatter plots and calculating Spearman's rank correlation coefficient Rho. The effectiveness of each of the scoring systems in predicting pre-discharge mortality was determined by constructing receiver operating characteristic (ROC) curves and determining the sensitivity and specificity of the cut-off suggested by the ROC analysis. The correlation and ROC analysis were repeated separately for the preterm and term babies in the study cohort. A probability of 5% was considered statistically significant. Statistica version 6 (Tulsa, Oklahoma: StatSoft Inc.; 2001) and MedCalc version 11.6 (Mariakerke, Belgium: MedCalc Software; 2011) software were used for statistical analysis.

RESULTS

During the study period, 1032 neonates were screen. Of the 961 neonates enrolled in the study, 577 (60.04%) were male; 502 (52.24%) hailed from rural areas and the rest from urban areas or slums; 305 (31.74%) were born by cesarean births. Common indications for referral were sepsis (31.6%), birth asphyxia (23.4%) and jaundice (21.4%). The study population comprised 612 (64.68%) term babies.

***Table* II** presents a summary of the three scoring systems used for the whole cohort as well as for the gestational strata. ESNS scores were strongly correlated to both SNS and SNAPPE-II scores.

***Table* III** summarizes the results of the ROC curve analysis for predicting mortality. ESNS and SNAPPE II had better sensitivities and specificities to predict mortality than the SNS system. Using the ESNS system, a

TABLE II SUMMARY OF EXTENDED SICK NEONATE SCORING (ESNS) FOR ASSESSING SICK NEWBORNS COMPARED TO SNAPPE-II AND SNS SYSTEMS

Scoring system	*Median (IQR) Scores*	*Correlation (rho) (95% CI)*
Entire cohort (*n*=96)		
ESNS	13 (12,14)	–
SNAPPE-II	35 (17,63)	–0.79 (–0.81 to –0.76)*
SNS	10 (09,11)	0.94 (0.93 to 0.95)**
Preterm cohort (*n*=348)		
ESNS	13 (10,14)	–
SNAPPE-II	44 (24,74)	–0.81 (–0.84 to –0.77)*
SNS	9 (06,10)	0.91 (0.89 to 0.93)**
Term cohort (*n*=612)		
ESNS	14 (12,15)	–
SNAPPE-II	26.5 (15,57)	–0.75 (–0.79 to –0.72)*
SNS	10 (09,11)	0.96 (0.95 to 0.96)*

$*P<0.001$; $**P<0.05$.

TABLE III TEST CHARACTERISTICS OF EXTENDED SICK NEONATE SCORING (ESNS) SNAPPE-II AND SNS FOR ASSESSING SICK NEWBORNS

Scoring System	*Mortality*	*Area under curve (95% CI)*	*Cut-off Score*	*Sensitivity (%)*	*Specificity (%)*
Whole Cohort					
ESNS	185/961	0.92 (0.90 to 0.93)	≤11	85.90	89.80
SNAPPE-II	185/961	0.97 (0.95 to 0.98)	>61	92.40	88.10
SNS	185/ 961	0.87 (0.85 to 0.89)	≤9	89.70	67.00
Preterm Cohort					
ESNS	91/349	0.89 (0.85 to 0.92)	≤12	92.30	76.70
SNAPPE-II	91/349	0.96 (0.93 to 0.98)	> 61	100.00	81.40
SNS	91/349	0.83 (0.78 to 0.86)	≤9	86.80	61.20
Term Cohort					
ESNS	94/612	0.93 (0.91 to 0.95)	≤11	92.60	93.20
SNAPPE-II	94/612	0.97 (0.95 to 0.98)	>49	100.00	83.60
SNS	94/612	0.90 (0.87 to 0.92)	≤8	74.50	90.20

SNAPPE-II: Score for neonatal acute physiology; SNS: Sick neonate score.

score ≤11 for all babies as well as term babies, and score ≤12 for preterm neonates best predict mortality.

DISCUSSION

In the present study, extended sick newborn score had a strong correlation with SNAPPE-II and SNS for predicting mortality in sick hospitalized neonates even when stratified by gestation.

Mathur, *et al*. [2] used just four variables – temperature, oxygenation, capillary refill time (for perfusion) and blood sugar – (TOPS) at admission. The authors concluded that TOPS was comparable to SNAP II for prediction of mortality. Lee, *et al*. [17] developed a transport risk index of physiologic stability (TRIPS) score using four parameters (temperature, respiratory dysfunction, systolic blood pressure, and response to noxious stimuli) which was subsequently revalidated as TRIPS-II. Broughton, *et al*. [18] developed a score called Mortality Index for Neonatal Transportation (MINT) using seven parameters (birth weight, Apgar score at 1 min, age, congenital abnormality, pH, PaO_2 and intubation) applicable at the time of call.

From the feasibility point of view our score is simple to apply for a trained healthcare worker with access to equipment that would be considered routine for any specialized newborn care unit. It would be easier to apply than SNAPPE-II since it does not include the parameters PO_2/FiO_2 ratio, blood pH, multiple seizures and urine output. Assessing the last two parameters requires an observation period of 12 hours, while our proposed system can be applied immediately. However, the present study did not assess for morbidity risk as has been done with SNAPPE-II [9].

In conclusion the proposed extended sick neonate score (ESNS) can be applied rapidly and reliably to newborns referred from the periphery to tertiary care in resource constrained settings. The ESNS can predict 'in-hospital mortality' outcome with satisfactory sensitivity and specificity and would be useful irrespective of gestational age. However, further studies are required to validate this scoring system at multiple centers.

Contributors: SR: data collection and interpretation, initial draft, manuscript revision; RM: study conceptualization, data interpretation, revision and finalizing the draft; KC: literature search, acquisition of data and manuscript drafting; MS: study conduct, interpretation of data, manuscript drafting; AH: statistical analysis, data interpretation and manuscript revision; TKS: advisor in manuscript writing, patient management, revising the draft. All authors approved the final version of the draft and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of the work.
Funding: None; *Competing Interest*: None stated.

WHAT THIS STUDY ADDS?

- The Extended Sick Neonate Score (ESNS) can predict 'in-hospital mortality' outcome with good sensitivity and specificity at admission in all gestational ages.

REFERENCES

1. Lawn JE, Cousens S, Zupan J. 4 million neonatal deaths: When? Where? Why? Lancet. 2005;365:891-900.
2. Mathur NB, Arora D. Role of TOPS (a simplified assessment of neonatal acute physiology) in predicting mortality in transported neonates. Acta Paediatr. 2007;96:172-5.
3. Dorling JS, Field DJ, Manktelow B. Neonatal disease severity scoring systems. Arch Dis Child Fetal Neonatal Ed. 2005;90:F11-6.
4. Richardson DK, Corcoran JD, Escobar GJ, Lee SK. SNAP-II and SNAPPE-II: simplified newborn illness severity and mortality risk scores. J Pediatr. 2001;138:92-100.
5. Rathod D, Adhisivam B, Bhat BV. Sick neonate score – a simple clinical score for predicting mortality of sick neonates in resource restricted settings. Indian J Pediatr. 2016;83:103-6.
6. Samanta M, Mondal R, Ray S, Sabui T, Hazra A, Kundu C, *et al*. Normative blood pressure data for Indian neonates. Indian Pediatr. 2015;52:669-73.
7. Lee SK, Aziz K, Dunn M, Clarke M, Kovacs L, Ojah C, *et al*. Canadian Neonatal Network Transport Risk Index of Physiologic Stability, version II (TRIPS-II): A simple and practical neonatal illness severity score. Am J Perinatol. 2013;30:395-400.
8. Broughton SJ, Berry A, Jacobe S, Cheeseman P, Tarnow-Mordi WO, Greenough A for Neonatal Intensive Care Study Group. The mortality index for neonatal transportation score: A new mortality prediction model for retrieved neonates. Pediatrics. 2004;114:e424-8.
9. Harsha SS, Archana BR. SNAPPE-II (Score for Neonatal Acute Physiology with Perinatal Extension-II) in predicting mortality and morbidity in NICU. J Clin Diagn Res. 2015;9:SC10-2.