Original Research Article

Predictors of deranged SPO₂ and hypoglycaemia in neonates to assess neonatal survival and outcome by Rewa scoring system

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ABSTRACT

Background: Early referral to proper level of neonatal care is vital for neonatal survival. Deranged physiological status studied at the time of admission can be predictive of neonatal outcome. The present study was done in an attempt to discover statistically significant, more objective and feasible variables easily assessable by simple low cost devices for identification of sick newborns in need of stabilization and referral to tertiary facility based care. Primary objective was to study predictors of deranged neonatal percentage saturation of oxygen in blood as well as for neonatal hypoglycemia. Secondary objective was to develop a scoring system comprising of both subjective and objective variables to assess neonatal outcome.

Methods: It was a prospective cohort observational study conducted at outborn neonatal intensive care unit in a tertiary level care hospital in Central India. Participants were all outborn neonates of age less than or equal to 28 days from March 2013 to May 2013 admitted in NICU.

Results: A significant association was found between percentage saturation of oxygen in blood (SpO₂) and other deranged neonatal pathophysiological variables i.e. hypothermia (p=0.001); delayed CRT (p=0.001); gestational age (p=0.002); cyanosis (p=0.003); respiratory distress (p=0.001). On applying multivariate binary logistic regression, hypothermia was found to be an important predictor of hypoglycaemia. The survival percentage was 91.5%, 87.7%, 76.5% and 20% with the scores of less than 5, score 6-10, score 11-16 and score >16 respectively.

Conclusions: The scoring system based on both subjective and objective predictors is useful for timely identification and early referral of high risk neonates from primary and secondary level care to higher level. A high score predicts a poor outcome.

Keywords: High risk neonate, Neonatal outcome, Predictors, Scoring system

INTRODUCTION

The infant mortality rate is often regarded as a barometer for overall welfare of a community or country. As such, it has been used by researchers as an outcome to be explained or as an explanatory variable to capture the socioeconomic development of a country.[1] Hence, the maintenance of neonatal health is not only desired but also prioritized by every society. The concept of "Golden

Hour" has been introduced recently in field of neonatology, highlighting the importance of neonatal care in first 60 minutes of postnatal life.[2] Therefore, improved level of neonatal health should be the accepted goal of all communities and early referral to proper level of neonatal care is vital for neonatal survival.

Deranged physiological status studied at the time of admission can be predictive of neonatal outcome. The

present study was done in an attempt to discover statistically significant, more objective and feasible variables easily assessable by simple low cost devices for identification of sick newborns in need of stabilization and referral to tertiary facility based care. It is also hoped that insight gained from this study will enable us to formulate recommendations for training of peripheral health workers in assessing the neonates in need of care thereby ensuring their proper management during transport and early referral to decrease neonatal mortality.

So the objective of this work was to study predictors of deranged neonatal percentage saturation of oxygen in blood as well as for neonatal hypoglycemia and to develop a scoring system comprising of both subjective and objective variables to assess neonatal outcome.

METHODS

Design and setting

This prospective cohort observational study has been carried out in the Outborn NICU, Department of Pediatrics, Gandhi Memorial Hospital, associated with Shyam Shah Medical College Rewa, Madhya Pradesh in 2013.

Inclusion criteria

All outborn newborns of age ≤28 days admitted in NICU with informed consent of parents.

Exclusion criteria

Inborn newborns, orphans and refusal of parents to participate in study.

In the present study a purposive sampling method was adopted to collect the required data. A total of 223 newborns based upon the inclusion criteria were enrolled in this study of 3 months duration. All the newborns were assessed for gestational age by new Ballard score and a semi structured questionnaire based detailed proforma was filled including details of antenatal, natal and postnatal period. All included newborns in the study period were assessed after admission for weight, gestational age, duration of travel to reach hospital, deranged physiological status including delayed capillary refilling time >3 seconds (CRT), hypothermia <36.5°C, cyanosis (central) and respiratory distress, desaturation by pulse oxymeter, SPO_2 <95% for terms and <92% for preterms and hypoglycaemia, RBS <40 mg/dl by glucometer. The majority of definitions and terminologies used in the study were based on standards approved and adopted by NNF of India.

The data from the study were analysed using the software MS excel and SPSS 18 for windows. Appropriate univariate and bivariate analysis were carried out using chi-square test for categorical variables. Multivariate analysis using binary logistic regression for finding

predictors of deranged SPO_2 as well as for neonatal hypoglycaemia was carried out.

RESULTS

Out of the 223 newborns enrolled in the study, 214 (96%) were delivered in hospital, 6 (2.70%) at home and 3 (1.30%) delivered on their way to the hospital. Majority of the neonates 196 (87.89%) belonged to rural area. One hundred and forty nine (66.8%) were term and 74 (33.2%) were preterm babies. There were no post term admissions during the study period. Males outnumbered the females by 157 (70.40%) against 66 (29.60%) females. Low birth weight (LBW) accounted for 34.97% (n=78), very low birth weight (VLBW) neonates for 13% (n=29) and 25 extremely low birth weight neonates (ELBW) for 11.2%.

Table 1: Neonatal outcome by Rewa scoring system.

Determinants of neonatal mortality	Score
Admission weight in kg	
≥2 kg	1
<2 kg	2
Gestation maturity	
Term	1
Preterm	2
Duration of travel	
<2 hours	1
≥2 hours	2
Deranged physiological status	
Hypothermia	2
CRT >3 seconds	2
Respiratory distress	2
Cyanosis	2
SPO2	
<92% in preterms/ <95% in terms	2
Random blood sugar	
<40 mg/dl	2

The mortality percentage among enrolled newborns was 15.70%. The common deranged physiological states shared by these were abnormal SPO_2 in 74.3% babies, followed by respiratory distress and delayed CRT of >3 seconds each in 71.4% babies, hypothermia in 54.3%, hypoglycaemia in 28.6%, prematurity in 22.9% babies and cyanosis in 11.22% babies.

In the present study, significant association was found between SPO_2 and other deranged neonatal pathophysiological variables using bivariate analysis applying chi-square test viz. hypothermia p=0.001; delayed CRT p=0.001; gestational age p=0.002; cyanosis p=0.003; respiratory distress p=0.001 (Table 2). In logistic regression analysis taking SPO_2 as dichotomous outcome variable, temperature, delayed CRT (>3 seconds), cyanosis and respiratory distress were found to be predictors for low SPO_2 (Table 3).

Table 2: Bivariate analysis showing association of SPO₂ and RBS with neonatal pathophysiological variables.

Variables		Deranged		Normal		Total		P value
		No.	%	No.	%	No.	%	
SPO₂								
Weight	<2 kg	36	38.3	44	34.1	80	35.9	0.520
	≥2 kg	58	61.7	85	65.9	143	64.1	
Temperature	Hypothermic (37.5C)	38	40.4	92	71.3	130	58.3	0.001
	Normal	56	59.6	37	28.7	93	41.7	
Duration of travel	<2 hours	69	73.4	104	80.6	173	77.6	0.202
	>2 hours	25	26.6	25	19.4	50	22.4	
CRT	<3 sec	90	69.8	28	29.8	118	52.9	0.001
	>3 sec	39	30.2	66	70.2	105	47.1	
Respiratory distress	Present	26	20.2	62	66.0	88	39.5	0.001
	Absent	103	79.8	32	34.0	135	60.5	
Gestation age	Preterm	42	44.7	32	24.8	74	33.2	0.002
	Full term	52	55.3	97	75.2	149	66.8	
Cyanosis	Present	2	1.6	10	10.6	12	77.6	0.003
	Absent	127	98.4	84	89.4	211	22.4	
RBS								
Weight	<2 kg	24	38.7	56	34.8	80	35.9	0.584
	≥2 kg	38	61.3	105	65.2	143	64.1	
Temperature	Hypothermic (36.5°C)	40	64.5	53	32.9	93	41.7	0.001
	Normal	22	35.5	108	67.1	130	58.3	
Duration of travel	<2 hours	48	77.4	125	77.6	173	77.6	0.972
	>2 hours	14	22.6	36	22.4	50	22.4	
CRT	<3 sec	37	59.7	68	42.2	105	47.1	0.019
	>3 sec	25	40.3	93	57.8	118	52.9	
Respiratory distress	Present	24	38.7	64	39.8	88	39.5	0.887
	Absent	38	61.3	97	60.2	135	60.5	
Gestation age	Preterm	27	43.5	47	29.2	74	33.2	0.041
	Full term	35	56.5	114	70.8	149	66.8	

Table 3: Logistic regression analysis for finding predictors of SPO₂.

Variables	B	S.E.	Sig.	Exp. B	95% CI of Exp. B	
					Lower	Upper
Weight	0.031	0.358	0.932	1.031	0.511	2.079
Temp	0.499	0.180	0.006(S)	1.648	1.157	2.346
Duration of travel	0.123	0.401	0.759	1.131	0.515	2.482
Delayed CRT	0.656	0.171	0.001(S)	1.928	1.378	2.697
Cyanosis	-2.182	0.877	0.03(S)	0.113	0.020	0.629
Respiratory distress	-1.771	0.348	0.001(S)	0.170	0.086	0.337
Gestation age	0.126	0.188	0.504	1.134	0.784	1.641

A higher percentage (64.5%) of hypothermic babies were hypoglycemic as compared to normothermic babies (35.5%) and this difference was significant statistically using chi-square test (p=0.001) (Table 2).

In logistic regression analysis taking hypoglycaemia as dichotomous outcome variable, only temperature was found to be an important predictor of hypoglycaemia (Table 4).

Based on these findings a scoring system was developed with the inclusion of these two objective variables i.e., SPO₂ and blood glucose level. Objective variables were added to make the score more useful and reliable over subjective variables (like hypothermia, cyanosis, RDS, gestational age, weight of neonates babies, duration of travel of baby to the tertiary centre as it affects their survival) scoring.

Table 4: Logistic regression analysis for finding predictors of hypoglycaemia.

Variables	B	S.E.	Sig.	Exp. B	95% CI of Exp. B	
					Lower	Upper
Weight	0.219	0.335	0.513	1.245	0.646	2.399
Temp	0.615	0.171	0.000	1.850	1.322	2.588
Duration of travel	-0.204	0.385	0.597	0.816	0.383	1.736
CRT	0.308	0.170	0.071	1.360	0.974	1.900
Cyanosis	-0.921	0.643	0.152	0.398	0.113	1.403
Respirtory distress	0.579	0.357	0.105	1.784	0.885	3.594
Gestation age	0.149	0.175	0.392	1.161	0.825	1.635

Table 5: Distribution of neonatal survival according to NORS system derived by this study.

Outcome	Group I	Group II	Group III	Group IV		P value*
	≤5 score	6-10 score	11-16 score	16 score	Total	
	n=71	n=73	n=51	n=10	n=205	
Survived	65 (91.5%)	64 (87.7%)	39 (76.5%)	2 (20%)	170	0.000
Expired	6 (8.5%)	9 (12.3%)	12 (23.5%)	8 (80%)	35	

*χ^2=34.358, df=3, p=0.000

An arbitrary neonatal score meant to assess their survival was developed using subjective variables and objective variables. Score value of 2 was assigned to all the abnormal values of physiological subjective variables as well as to deranged objective variables. Also in the subjective variables, score value of 2 was given to birth weight at admission <2 kg, preterm baby and duration of travel >2 hours. These variables (birth weight <2 kg, preterm gestation, duration of travel >2 hours and other deranged pathophysiological variables) have been given a score of 2 as these have been found to be independent factors to affect neonatal survival. Minimum possible score is 3 and maximum possible score is 18. If score of deranged physiological status was 4 or less 1 extra point was given and for score >4, 2 extra points were given (Table 1).

On the basis of total score neonates were assigned to group I with score ≤5, group II with score 6-10, group III with score 11-16 and group IV with score >16 (Table 5).

On comparing the survival of neonates in 4 groups, it was found that mortality was statistically significantly higher in babies with high NORSS score. Thus, a statistically significant association was seen between higher scores and a reduced survival rate of babies (Table 5). Test applied was chi-square test.

DISCUSSION

Most common causes of mortality in our setting were found to be birth asphyxia (40%) followed by shock (37.1%), respiratory distress syndrome (RDS) (25.9%), neonatal sepsis (NNS) (20%), LBW (17.1%) and hemorrhage (14.2%). The higher rate of mortality could be attributed to the fact that sick newborns from neighboring four districts were being referred to our tertiary level care unit and sometimes the travel time was 6-8 hours.

The features shared in the event of mortality were abnormal $SP0_2$ (<95 in terms and <88% in preterms) in 74.3% babies, followed by respiratory distress and CRT >3 seconds each in 71.4% babies, hypothermia in 54.3%, hypoglycaemia in 28.6%, prematurity in 22.9% babies and cyanosis in 11.4% babies.

Blood glucose estimation has been recommended in neonates with or without signs and symptoms of hypoglycaemia.[3] Hypoglycaemia associated with neurological symptoms in newborn period carries poor prognosis with respect to permanent neurological damage.[4] After birth, most neonates make the physiological adjustment necessary to reach a normal SPO_2 of atleast 90% without delay.[5] As some neonates do not make that transition readily, an easily applied non-invasive monitor to evaluate a newborns progress and to follow the effects of resuscitation would be of significant value.

In previous studies, various determinants of case fatality were considered to design referral scoring systems. SNAP score took 26 parameters for observation and assessment over a period of 24 hours.[6] In CRIB score, assessment of 6 parameters was done.[7]

Parameters taken in SNAP2 however required invasive investigations which included lowest blood pH (<7.20), PaO_2/FiO_2 ratio (<2.50), multiple seizures, MAP ≤29 mmHg, urine output (<1ml/kg/hr) and lowest temperature (≤96ºF).[8] These scoring systems are good research tools but difficult to be performed by paramedics at peripheral level from where most referrals are done in Indian circumstances. One more remarkable scoring system in

this field is TOPS score which includes temperature, oxygenation, perfusion and blood glucose in sick neonates.[9] In a study done by Rao et al, variables taken were admission weight, gestation maturity, duration of travel to reach hospital and deranged physiological status viz, hypothermia, CRT >3 seconds, respiratory distress, cyanosis.[10] These are subjective variables for assessment of sick newborns by peripheral health workers and require certain level of skill and experience in the assessor. The NORS score was derived in an attempt to add more objective variables in the existing scoring system to define the outcome in a better way.

Moreover, more studies with large sample size is required to be done to know efficacy and adequacy of this scoring system for early referral of newborns. Adequate timely skilled training of health care workers at peripheries for early recognition of deranged physiological status of newborn and timely assessment of health care workers to update their skills is a real challenge and limitation of study.

CONCLUSION

This scoring system may be used for timely identification and early referral of high risk newborns resulting in arrest of progression of morbidity and help in recovery. Identification of sick newborns by community health workers is at present also and more so in future will be the mainstay for referral. Hence, skill upgradation and strengthening for SPO_2 and blood glucose monitoring is recommended, to provide them with an objective and more reliable tool.

Recommendations

There is a need for a large community-based study using this high-risk score to further validate these results and establish this method of scoring. The same scoring system at the time of admission may be used to assess the predicted mortality in SNCUs for further assessment of level of quality care.

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