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Original Research Article

Evaluation of TOPS score as predictor for outcome in sick newborns

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ABSTRACT

Background: Multiple parameters have been developed to prognosticate the outcomes of critically ill newborns admitted in NICUs. The objective of this study is to predict the outcome of newborns admitted in NICU using a simple but efficient score, TOPS score, involving alteration of physiological parameters. Aim of this study was to evaluate role of TOPS score in predicting mortality in sick neonates.
Methods: The variables assessed under TOPS score on arrival for all subjects were: Temperature, Oxygen Saturation, Perfusion and blood glucose reading <45 mg/dl. All affected neonates were given treatment as per NICU protocol and outcome was assessed in terms of mortality or discharge using TOPS score. It was prospective study conducted at NICU, Department of Pediatrics, GMERS medical college and general hospital, Gotri, Vadodara. Study population was all admitted neonates aged <28 days at NICU.
Results: Mean age of presentation of all cases was 2.8±3.58 days. Hypothermia on admission was observed in 63.3% cases. 40.8% cases had hypoxia. 26.5% neonates recorded poor perfusion. Mortality observed in hypoxic group was 51.7% followed by hypothermic group (46.9%). Highest strength of association was found for poor perfusion, mortality (87.5%) and OR-33.406. TOPS score was observed to be statistically significant (X^2 value is 63.27, $p < 0.05$) as predictor of mortality. Thus, mortality rate increased with increasing no. of altered TOPS parameters. Regression analysis showed three factors (hypothermia, hypoxia, prolonged CRT) which are consistently associated with p value ≤ 0.05 for each variable and can be used to predict mortality.
Conclusions: All parameters in TOPS score are physiologically important and each parameter carries an independent risk associated with mortality. It is important to note that multiple parameters affected increases the risk. TOPS score is a simple, basic and effective tool to guide about the condition of new born at admission and outcome. of neonatal mortality.

Keywords: Mortality, Outcomes, Prediction, TOPS score

INTRODUCTION

The first 28 days of life - the neonatal period - is the most vulnerable time for a child's survival. The global NMR, IMR and U5MR was 18, 12 and 10 respectively in 2017 with about 1 million newborns dying on the first day and close to 1 million dying within the next six days. The daily risk of mortality in the first 4 weeks of life is ~30-fold higher than the post-neonatal period, that is, from 1 month to 59 months of age.[1] Almost two third of the total neonatal deaths are within first week of life. At the same time the Millennium Development goal (MDG)-4 on child mortality for India aims for a two third reduction in IMR from 1990 level of 84/1000 live births to 28/1000 live births by 2015. Hence it is important to have a feasible tool to predict neonatal mortality. Non-institutional births constitute a significant proportion of total births in developing country like India and still

many deliveries are conducted at home specifically in rural area. Though institutional delivery and in-utero transport of newborn is safest but unfortunately preterm delivery and perinatal illness cannot be always anticipated resulting in continued need of transfer of these babies after delivery. There is considerable risk of deterioration of critically-ill patients during transfer, either due to primary illness, complications of treatment or due to the transfer process itself. These babies are often critically ill and outcome is also dependent on effectiveness of transport system. Prematurity, asphyxia and sepsis are the most common causes of neonatal mortality in developing countries.[2] Most of neonatal transports are self-transport without any pre-treatment stabilization or care during transport. Many of these newborns thus transported are presented with life threatening complications like irreversible shock, seizures, respiratory distress on admission to higher centre. The overall mortality of referred neonates has remained high in India, and a significant number of these deaths can be avoided by promotion of institutional deliveries, early identification and appropriate pre referral stabilization, care of newborns during transport, and provision of adequate equipment, skilled workforce, and monitoring facilities during transport of neonates.

It is preferable to have organized transport than self-transport. Once the decision of transporting a newborn has been taken then assessment of newborn, stabilization and care during transport becomes important so a newborn can reach a referral facility in stable condition to improve intact survival. Multiple scoring systems have been developed using many parameters observed at admission, during hospital stay and at discharge to predict outcomes. However, it must be remembered that these systems provide generalizations about groups and that they do not allow the bedside clinician to predict outcome for an individual patient.

The desirable properties of neonatal scores have been described as including: -

- Ease of use;
- Applicability early in course of hospitalization;
- Ability to reproducibly predict mortality, specific morbidities, or cost for various categories of neonates;
- Usefulness for all groups of neonates to be described.[3]

Body temperature, airway and breathing (Oxygenation), perfusion and sugar (hypoglycaemia) need to be addressed adequately before and during transport. TOPS, a simplified assessment of neonatal acute physiology gives a good prediction of mortality in these neonates.

Need for study

TOPS score has been proven as a tool to assess parameters of clinical profile and predictor of mortality in neonates. Few studies have been conducted regarding TOPS score in transported neonates but there is no study on TOPS score in assessing extramural vs intramural neonates and outcome in them so my study is on clinical profile and mortality outcome in extramural vs intramural neonates at teaching tertiary care hospital at NICU.

Scoring systems

Scoring systems involve using appropriately weighted demographic, physiological, and clinical data collected on the infant to calculate a score that quantifies its morbidity.

Clinical Risk Index for Babies (CRIB) score: was published by Tarnow-Mordi et al, to predict mortality for infants born at less than 32 weeks gestation at birth taking into account birth weight, gestational age, maximum and minimum fraction of inspired oxygen (FiO2) and maximum base deficit during the first 12 hours, as well as presence of congenital malformations. The advantage was ease of data collection but assessment over the first 12 hours of life, made it less susceptible to treatment effects than some other scores.[4]

CRIB II, an improved version of CRIB adding admission temperature and base excess to predict mortality.[5]

Score for neonatal acute physiology (SNAP)[6]

SNAP, the principal alternative to CRIB, was developed in 1990, based on 28 items collected over the first 24 hours of life from a variety of sources including every body system and selected blood test results. The variables were weighted according to expert opinion, with a score of 0, 1, 3, or 5 assigned to each variable. The original cohort was also used to extend SNAP to form the SNAP-PE score (score for neonatal acute physiology perinatal extension) by adding birth weight, small for gestational age (weight <5th centile for gestation), and low Apgar score at five minutes. Although the SNAP score assesses many body systems, and is able to predict death well, it is much more difficult to collect.

SNAP-II and SNAPPE-II[7]

Because of the difficulty of data collection for the SNAP and SNAP-PE scores, the original authors have recently produced simpler versions using data from 30 North American units. Changes included shortening the period of data collection to 12 hours and reducing the number of variables to six (mean blood pressure, lowest temperature, PO2/FIO2 ratio, serum pH, multiple seizures, and urine output). These factors were assessed as having the strongest statistical association with mortality.

National therapeutic intervention scoring system (NTISS)[8]

NTISS was published in 1992 and was derived by an expert panel as a modification of the adult intensive care

score, therapeutic intervention scoring system. NTISS is unusual as it is based on the treatments received by an infant rather than measuring patho-physiological factors. As treatment depends on policy and practice in units, it can vary greatly, and it is not possible to compare units using this type of adjustment.

Mortality Index for Neonatal Transport (MINT) score: Broughton SJ, Berry A, Jacobe S et al, included neonates >72 hours of age and a 7-variable model (Apgar score at 1 minute, birthweight, presence of a congenital anomaly, and infant's age, pH, arterial partial pressure of oxygen, and heart rate at the time of the call) to generate the MINT (Mortality Index for Neonatal Transportation) score, which gave areas under ROC curves of 0.80 for both neonatal and perinatal death.[9] The availability of ABG and documentation of APGAR scores for all cases is difficult to be obtained in government hospitals, hence there is a need for simpler yet reliable score for prediction of mortality in a transported neonate.

TOPS score

Neonatal physiology is adversely affected based on temperature, oxygen saturation, skin perfusion and blood sugar (TOPS) which have shown to predict the mortality in transported neonates, which was first described by Mathur NB et al.[10]

A study by Mathur NB, Arora D. in their prospective study included 175 neonates >1000 gm. weight shown that All the TOPS variables had significant correlation with fatality on univariate analysis. Fatality was 100% when all the four TOPS variables were deranged. The sensitivity, specificity, positive and negative predictive values of derangements of two or more TOPS parameters in predicting mortality were 81.6%, 77.39%, 65.3% and 89%, respectively. The total correct classification rate for TOPS was 81.7%, while that for SNAP II (Score for Neonatal Physiology) was 83.4%.Thus TOPS has an equally good prediction for mortality as SNAP II and can be used as a simple and useful method of assessment of risk of fatality that can be assessed immediately, at admission.

Objective of this study was to the utility of TOPS score for predicting mortality in sick neonates.

METHODS

Study site the study was a hospital-based study conducted at NICU, Dept. of Pediatrics, GMERS Medical College, Gotri, Vadodara, Gujarat, India. Study duration for one year from 1st May 2017 to 30th April 2018. Study population of all admitted neonates aged <28 days at NICU including intramural and extramural admissions. Study design is a hospital based, prospective, observational study. Sample size for the purpose of sample size calculation, the clinical profile was defined according to the TOPS score in two categories: neonate with TOPS score=0 were defined as good TOPS score and neonates with TOPS score>1 were defined as poor TOPS score. Thus, study objective was to compare the proportion of neonates with good TOPS score belonging to the intra and extramural group. The method of sample size calculation was Fleiss with continuity correction using Open Epi software.

Inclusion criteria

All extramural and intramural neonates (<28 days) requiring admission in NICU.

Exclusion criteria

- Neonates having life threatening congenital anomaly.
- Neonates having acute surgical emergencies.
- Refusal to give informed written consent by parents.

Methdology a prospective observational study was conducted at NICU, Dept. of pediatrics, GMERS Medical College, Gotri, Vadodara, Gujarat, India. Permission was obtained from Institutional Ethical Committee and Scientific Review Board. All subjects <28 days of age who satisfied the inclusion criteria were included in study after informed written consent by parents and were subjected to detailed clinical history and physical examination. The neonatal case proforma was used to record information. Gestational age was noted from records and reconfirmed with modified Ballard score if <7 days of age. Weight of all the cases were taken on digital weighing machine with minimum 0.001 kg accuracy as weight on admission.

The variables assessed under TOPS score on arrival for all subjects were: Temperature by digital thermometer in axilla, Oxygen by spO2 monitoring (pulse oxymeter), Perfusion by capillary refilling time(CRT) on mid sternum by applying blanching pressure and RBS with reagent strip and low reading <45 mg/dl confirmed by serum sample at laboratory.

The altered parameters were: Hypothermia defined as temperature <36.5 degree Celsius, Hypoxia was diagnosed when SpO2 recorded <90%, poor perfusion recorded as prolonged CRT >/= 3 sec and Hypoglycaemia as RBS <45 mg/dl and confirmed by serum sample. All affected neonates were given treatment as per NICU protocol and outcome was assessed in terms of mortality or discharge using TOPS score.

Data analysis

Data summarization

TOPS score was assessed on admission. Treatment measures were initiated as per NICU protocol and close monitoring was done till discharge / mortality. The TOPS score was then used to predict mortality and analysed the

predictive value of the score as well as risk association of individual parameters with outcome.

Statistical methods

The data was analysed for their association with immediate outcome by applying chi square test as applicable and p<0.05 was considered statistically significant. Variables that were found to be significant on chi square test were further analysed using bi variant logistic regression analysis for their possible independent association with mortality using statistical software SPSS. Nagelkerke R. Square was taken into consideration.

RESULTS

The study was conducted at NICU, GMERS Medical College and General Hospital, Gotri, Vadodara, Gujarat over a period of one year, from 1st May 2017 to 30th April 2018. In this study, 98 newborns admitted in NICU for various morbidities were selected. In this study, mean age of all cases included in the study was 2.66±3.27 days as the sample size included intramural cases as well as extramural cases. Mean weight of all cases recorded was 2.11±0.71 kg. Mean weight of intramural cases was 2.14±0.67 kg. In extramural group it was 2.08±0.76 kg. Most of the cases were Low Birth Weight as various morbidities are more common in them like RDS, sepsis, feed intolerance etc. Among all 98 cases, 48.9% were preterm (<37 weeks).

In intramural group 44.9% were preterm compared to 53.1% in extramural group. Preterm admissions were more in extramural group due to referral for requirement of surfactant, ventilation, LBW care and septicaemia, I this NICU being a tertiary care unit. Among all cases, 39.8% cases weighed >2.5 kg, 36.7% were Low Birth Weight (LBW), 18.4% were Very Low Birth Weight and 5.1% were Extremely Low Birth Weight (ELBW). The higher incidence of LBW admissions in intramural group can be explained as in this institute is a tertiary care centre, proportion of high-risk deliveries is more than the peripheral sector.

Table 1: Incidence of individual TOPS score parameters in extramural vs intramural newborns.

Parameter	All cases (n=98)		Intramural (n=49)		Extramural (n=49)	
	Number (n)	Percentage (%)	Number (n)	Percentage (%)	Number (n)	Percentage (%)
Hypothermia	49	50	18	36.7	31	63.3
Hypoxia	29	29.59	9	18.4	29	29.59
Prolonged capillary refill time (=/> 3 sec)	16	16.33	03	6.1	13	26.5
Hypoglycemia	04	4.08	02	04.1	02	04.1

Table 2: Association of individual parameter with outcome (expired vs survived).

Parameter	Expired (+)	Survived (-)	Total	Interpretation
Hypothermia (+)	23 (46.9%)	26 (53.1%)	49 (50%)	X^2 =21.48 p value=<0.05
Hypoxia (+)	15 (51.7%)	14 (48.3%)	29 (29.6%)	X^2 =14.89 p value=<0.05
Delayed capillary refill time (+)	14 (87.5%)	2 (12.5%)	16 (16.3%)	X^2 =34.87 p value=<0.05
Hypoglycemia (+)	2 (50%)	2 (50%)	4 (4.1%)	X^2 =0.28 p value= >0.05

In the study, out of total cases (n=98), 50% cases had hypothermia (Temp. <36.5◦C) on admission. The incidence of hypothermia (n=49 in each group) was higher in extramural group (63.3%) as compared to intramural group (36.7%). Hypothermia in intramural group was diagnosed in cases who were admitted from postnatal ward for late onset sepsis. In extramural group, it can be contributed to lack of maintenance of warm chain during transport, sepsis. Among all (n=98) cases, 29.59% cases were hypoxic (SpO2<90%) on presentation with 18.4% in intramural group (n=49) compared to 40.8% in extramural group (n=49). Hypoxia was observed more in extramural group due to transportation of cases without oxygen support and intubation, non-availability of CPAP/ventilatory support and trained personnel for maintaining proper ventilation.

In the study, 16.33% cases had poor perfusion among all cases(n=98) with only 6.1% in intramural group (n=49) compared to 26.5% in extramural group(n=49). Perfusion

was altered more in extramural group due to inadequate pre referral treatment, hypothermia, hypoxia, severe sepsis. Poor perfusion diagnosed in intramural group was due to severe birth asphyxia and sepsis.

Table 3: Prediction of TOPS score with outcome.

TOPS score	All cases (n=98)		Expired		Discharged	
	Number (n)	Percentage (%)	Number (n)	Percentage (%)	Number (n)	Percentage (%)
Score 4	0	0	0	0	0	0
Score 5	8	8.16	8	100	0	0
Score 6	20	20.41	13	65	6	35
Score 7	34	34.69	04	12	30	88
Score 8	36	36.73	0	0	36	100
Total	98	100	49	100	49	100

Table 4: Effect of TOPS variables on outcome.

Variables	Standard error (SE)	p value	ODDS Exp (B)	95.0% C.I. for EXP (B)	
				Lower	Upper
Temperature (T)	1.001	0.005	16.892	2.376	120.101
Oxygen Saturation (Spo2)	0.821	0.002	13.419	2.684	67.100
Perfusion by capillary refilling time (CRT)	0.946	0.000	33.406	5.230	213.391
Sugar (RBS)	1.393	0.120	8.712	0.568	133.661
Constant	1.114	0.000	0.007		

As all cases, 4.1% had hypoglycaemia (RBS<45mg/dl), which were equally distributed in both groups. In intramural group hypoglycaemia was observed in cases having septicaemia with ELBW and due to improper feeding. Fewer cases of hypoglycaemia were observed in extramural group due to transportation of newborns with infusion/IV fluids/bolus of dextrose before transport (Table 1).

Among 46.9% cases who were hypothermic on admission succumbed. X^2 value is 21.48 and it is statistically significant at 5% level ($p < 0.05$). Mortality observed in hypoxic cases was 51.7%. X^2 value is 14.89 and it is statistically significant at 5% level ($p < 0.05$). Mortality rate in cases presenting with prolonged CRT was significantly high (87.5%). X^2 value is 34.87 and it is statistically significant at 5% level ($p < 0.05$).

Thus, results suggest independent association with hypoxia, hypothermia and poor pefusion and mortality. Highest association of poor outcome was found with poor perfusion followed by hypoxia and hypothermia. (Table 2).

Table 3 TOPS profile of cases. Here, for each parameter of TOPS score, score 2 is given for normal and score 1 is given for altered one. Hence, TOPS score ranges from 4-8. In the study, none of the cases had all altered parameters i.e. score 4. 8.16% cases had 3 altered parameters i.e. score 5 with 100% mortality outcome.20.41% cases had 2 altered parameters, score 6 with 65% mortality association. Altered single parameter, score 7 was observed in 34.7% cases with out of which 12% neonates succumbed and all cases having no altered parameter i.e. score 8 were discharged. This suggests the risk association of multiple parameters affection with increased mortality rate.

Table 5: Regression analysis.

-2 Log likelihood	Cox and Snell R Square	Nagelkerke R Square
50.377[a]	0.463	0.682

Among 68% of variance for mortality of cases (dependent variable) is explained by Temperature, Oxygen saturation, Capillary refill time and Blood glucose level (independent variables) as Nagelkerke R. Square value is 0.682. Regression analysis shows that there are three factors which are consistently associated with p value ≤ 0.05 for each variable and can be used to predict mortality. The highest strength of association with mortality was for prolonged capillary refill time(poor perfusion) having an OR of 33.406 (CI=2.230-213.391), Hypothermia having OR of 16.892 (CI=2.376 -120.101), Hypoxia having OR of 13.419 (CI=.2.684-.67.100) and sugar (RBS) associated with p value >0.05 with OR 8.712(CI=0.568-133.661) (Table 5).

Table 6 comparision of TOPS score with studies by Suresh et al, Akash et al, Mathur et al. In this study, normal TOPS score was given score 2 and altered

parameter was given score 1. Thus, score 8 corresponds to score 0 of other study and similarly score 7, score 6, score 5 and score 4 corresponds to score 1, score 2, score 3 and score 4 respectively of other studies. Mortality increased with increasing no. of altered TOPS parameters, which was also observed in other studies shown in table. Mortality ranged from 80 -100% in this study as well as studies by Suresh et al and Mathur et al.

Table 6: Comparison of TOPS score.

TOPS score	Present Study	Suresh et al[14]	Akash et al[15]	Mathur et al[12]
TOPS score	25/98 (25%)	81/390 (20.76%)	80/479 (16.7%)	60/175 (34.28%)
Score 0	0/36 (0%)	1/128 (0.78%)	0/145 (0%)	4/49 (8.16%)
Score 1	4/34 (12%)	14/105 (13.33%)	3/120 (2.5%)	7/51 (13.72%)
Score 2	13/20 (65%)	35/112 (31.25%)	12/91 (13.1%)	14/34 (41.17%)
Score 3	8/8 (100%)	23/35 (65.72%)	54/69 (78.2%)	23/29 (79.31%)
Score 4	--	8/10 (80%)	11/54 (20.4%)	12/12 (100%)

DISCUSSION

Few studies on evaluation of TOPS score as a predictor of mortality have been done. TOPS score is an objective score for condition of newborn on admission using only four important physiological parameters, that can be easily remembered and preformed for every new born. The risk of mortality increases as the multiple parameters are affected.

The study was conducted at NICU, GMERS Medical College and General Hospital, Gotri, Vadodara, Gujarat over a period of one year, from 1st May 2017 to 30th April 2018. In this study, 98 newborns, inborn and outborn, admitted in NICU for various morbidities were assessed. TOPS score on arrival was noted for all. Outcome was assessed in terms of mortality or discharge. Data obtained from these patients was analysed and results were compared with other studies. In study, mean age of admission was 2.66±3.27 days compared to 30 hours of life in study of Ayesha Begum et al.[11]

Mean weight of cases was 2.11±0.71 with low birth weight incidence 60.2%. incidence was higher than in study by Ayesha Begum et al (30.8%) and similar to 57.9% by Suresh Kumar et al.[12]

In this study, mortality rate was 25.5%, almost similar to other studies as 22.8% by Ayesha Begum et al and 21.2% by Akash Chheda et al.[13]

The incidence of hypothermia was observed in 63.3% of out born admissions as compared to 36.7% in inborn admissions. The incidence in this study was similar to 59.6% in Akash Chheda et al, and higher than 39% in Ayesha begum et al. Mortality was observed in 47% cases which was statistically significant as odds ratio for mortality 16.89 and p value ≤0.05. Sehgal et al, found hypothermia on admission to have independent association with mortality (odds ratio 47.24).

Akash Chheda et al, reported odds ratio for mortality as 14.79. Similar association was documented by Ayesha Begum et al, with odds ratio being 3.25 and p value <0.005.

Hypoxia on admission is associated with higher odds ratio for mortality as it is more difficult to correct than hypothermia and hypoglycaemia. In this study hypoxia on admission was observed in 29.59% of newborns which was similar to Ayesha Begum et al, (28.2%) neonates. Mortality in this study was 51.72% with odds ratio 13.419 and p value ≤0.05 which was higher to Ayesha Begum et al odds ratio of 11.99, p<0.0001. The risk of mortality with hypoxia on admission was found to be drastically significant in study by Akash Chheda et al, (p<0.001) and odds ratio 32.79.

Delayed perfusion was recorded in 16.3% of newborns in this study. 87.5% of these neonates with poor perfusion succumbed. The maximum odds for mortality was observed with poor perfusion, OR of 33.406 (CI=2.230-213.391) with p value<0.05. Akash Chheda et al, observed that poor perfusion had maximum odds for mortality, OR of 41.74 with p vale< 0. 001. Delayed capillary refill is a marker of poor perfusion and can be due to hypovolemia, decreased cardiac output and peripheral vasodilation. Prolonged hypo perfusion is associated with end organ damage and subsequently death.

Hypoglycaemia is common in newborns born and referred from outside due to poor pre referral management, nil by mouth etc. In this study hypoglycaemia in newborns was recorded due to clinical reasons such as Respiratory distress Syndrome (RDS), sepsis, asphyxia etc. Only 2 newborns referred from outside presented with hypoglycaemia in this study out of which one expired. That case was due to severe birth asphyxia and sepsis. Though hypoglycaemia was not found to have statistically significant association with mortality in this study, it was found to have independent risk relation with mortality as observed by Sehgal et al,

(odds ratio for mortality 14.43) and Akash Chheda et al, (odd ratio for mortality 7.29, p value< 0.001). Least mortality rate (32.53%) was in hypoglycemic group in study by Ayesha Begum et all. Although, newborns who survive do require observation for long term neurological sequelae.

In this study, 100% of newborns with 3 altered TOPS parameters (score 5) succumbed, while mortality in newborns with 2 altered parameters i.e. score 6 was 65%. Cases with single altered parameter i.e. score 7 had 12% mortality and all cases having none altered parameter i.e. score 8 were discharged. Thus, it was observed that mortality rate increased with increasing no. of altered TOPS parameters.

CONCLUSION

TOPS score confirms its fair ability to predict mortality. All parameters are physiologically important and each parameter carries an independent risk associated with mortality. It is important to note that multiple parameters affected increases the risk of neonatal mortality.

Limitations of the study were confounding factors like birth weight, gestational age and associated illness which were not compared while comparing TOPS score and mortality. So, further studies are needed to identify strength of individual parameters of TOPS score in relation to mortality to increase its objectivity and use as a prognostic indicator.

Recommendations

- To use TOPS score in all NICU
- To establish regionalization of perinatal and neonatal care to allow for immediate care of newborn and early and complete treatment of perinatal morbidities.

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