A Prospective Observational Study To Evaluate TOPS Score As An Outcome Predictor In Extramural Referred Neonates Admitted At A Tertiary Care Center

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Abstract: Background: The neonatal period is the most vulnerable time for a child's survival. As survival perspective of extramural neonates significantly relies on the state of neonate at admission, various survival scores like CRIB, SNAP, MINT, TRIPS, TOPS etc. are designed to prognosticate the outcome of neonate at admission. This study was designed to delineate correlation of TOPS score with outcome of referred neonates. Aims And Objectives**:** To recognise correlation of TOPS score with outcomes of extramural neonates. Material And Methods: It was prospective observational study conducted from September 2019 to February 2020 at nicu of tertiary care hospital. Clinico-demographic characteristics and TOPS score were documented in a pre-designed proforma. Hypothermia, Hypoxia, prolonged CRT and Hypoglycemia were defined as<36.5C, <90%, ≥3 secs and <40mg/dl respectively. Each parameter was assigned a score of '1' if abnormal and '0' if normal. Neonates were treated as per standard protocol and their outcome was recorded as survived or expired. Result: Out of 239 neonates 140 (58.6%) were males and 99 (41.5%) were females. The area under the ROC curve (AUROC) for TOPS Total predicting Outcome: Expired vs Outcome: Survived was 0.932. At a cut-off of TOPS Total ≥2, it predicts Outcome: Expired with a sensitivity of 83% and a specificity of * The relative risk (95% CI) for Outcome: Expired when TOPS Total is ≥2 was 25.68. Hypothermia (Chi-squared test, $\chi2 = 38.462$, p = <0.001), hypoxia (Fisher's exact test, $\chi2 = 122.636$, p = <0.001), poor perfusion (shock) (Fisher's exact test, $\chi2 = 103.563$, p = <0.001) are found to be significantly associated with poor outcome. Conclusion: TOPS score is an easy, reliable and applicable tool for outcome prediction of transported neonates. [Halpara S Natl J Integr Res Med, 2022; 13(1): 109-114, Published on 26/01/2022]

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Introduction: The first 28 days of life – the neonatal period is the most vulnerable time for a child's survival[1]. Effective management of sick neonates requires specialized neonatal intensive care units with well-trained human resources. As all medical centers are not capable of providing appropriate levels of care to the neonates, these neonates have to be transported to the dedicated SNCU (Sick newborn care unit). The survival perspective of extramural neonates significantly relies on the state of neonate at admission.

Various survival scores like CRIB (Clinical risk Index for babies)[2], SNAP (Score for neonatal Acute physiology)[3], MINT (Mortality index for neonatal transport)[4], TRIPS (Transport risk index of physiological stability)[5], TOPS (Temperature, oxygen, saturation, skin perfusion and blood sugar level)[6]etc. are designed to prognosticate the outcome of neonate at admission. Many of them are time consuming and require sophisticated instruments and trained personnel. TOPS score is quick, easy to use and without subjective variation. This study was also designed to delineate correlation of TOPS score with outcome of referred neonates.

Aims And Objectives: To recognise correlation of TOPS score with outcomes of extramural neonates.

Material & Methods: It is as follows.

Study Design: Prospective Observational Study

Study Period: September 2019 – February 2020

Site Of Study: NICU of a tertiary care hospital affiliated with a medical college.

Inclusion Criteria: All extramural neonates admitted to the NICU during study period.

Exclusion Criteria: Neonates who left against medical advice (LAMA) or transferred to another health care facility for specific management (e.g., Cardiology, paediatric surgery) were excluded as their survival analysis is not possible.

Methodology: All extramural neonates satisfying inclusion criteria were enrolled in the study. Informed written consent was obtained from parents or guardians of neonates. Clinico-demographic characteristics including details of pregnancy, birth history, sex, weight on admission, transport details, clinical status on admission, and indication of admission, course during hospital stay, final diagnosis and final outcome were recorded in a pre-designed proforma. Neonates were classified as facility referred if they were referred from another health care facility, rest were classified as community referred.

Following transport details were included: Transport vehicle, accompanying person, referring center and pre-transport intervention or stabilization. The referred documents were categorized as 'No document', 'inadequate document' and 'adequate document'. It is considered adequate if all of the required details are mentioned as per predefined proforma

TOPS score was documented as observed on arrival of neonates to NICU. It includes:

1. Temperature assessed by digital thermometer in axilla.
2. Oxygenation by measuring SPO2 with the help of Pulse-oximeter. (Silver line)
3. Perfusion by capillary refilling time (CRT on mid-sternum)
4. Sugar by one touch glucometer.

Hypothermia, Hypoxia, prolonged CRT and Hypoglycemia were defined as <36.5C, <90%, ≥3 secs and <40mg/dl respectively.

Each parameter was assigned a score of '1' if abnormal and '0' if normal. Total TOPS score (an aggregate score of all 4 parameters) for each neonate was calculated on admission. Individual and aggregate TOPS scores were related to short-come outcomes; expired or survived. Data was analysed with standard statistical software.

Results: Total 827 NICU admissions were recorded during the study period; out of them 574(69.41%) were intramural and 253(30.59%) were extramural. Out of 253 extramural neonates, 12 took LAMA and 2 neonates with complex congenital heart disease were transferred to cardiac institute, so were excluded from the study, hence total 239 extramural neonates were considered.

Out of 239 neonates 140 (58.6%) were males and 99 (41.5%) were females. Male: female ratio came to be 1.41:1. The mean age at admission was 8.86 days; mean weighing on admission was 2.37±0.58kg.

1)Temperature And Outcome: 62.5% (149/239) neonates had score 0 (temp≥36.5°C) and 37.65% (90/239) neonates had score 1 (temp<36.5°C) for temperature parameter on admission. Out of hypothermic neonates, 23 (9.83%) neonates expired while among 149 non-hypothermic neonates, 1 (0.7%) expired.

Table 1: Association Between Outcome And Temperature (N = 239)

Temperature	Outcome			Chi-Squared Test	
	Survived	Expired	Total	χ2	P Value
Score 0	148 (99.3%)	1 (0.7%)	149 (100%)	38.462	<0.001
Score 1	67 (74.4%)	23 (25.6%)	90 (100%)		
Total	215	24	239		

Chi-squared test was used to explore the association between 'Outcome' and 'Temperature'. There was a significant difference between the survived and expired groups in terms of distribution of Temperature (χ2 =38.462, =<0.001). Hypothermia on admission is associated with poor outcomes.

2)SPO2 And Outcome: 88.7% (212/239) of neonates had score 0 (SpO_2≥90%) oxygenation parameter and 11.3% (27/239) had score 1 (SpO_2<90%). Out of 27 hypoxic neonates, 19 (70.3%) neonates expired.

Table 2: Association Between Outcome And Oxygenation (N = 239)

Oxygenation	Outcome			Fisher's Exact Test	
	Survived	Expired	Total	χ2	P Value
Score 0	207 (97.6%)	5 (2.4%)	212 (100%)	122.636	<0.001
Score 1	8 (29.6%)	19 (70.3%)	27 (100%)		
Total	215	24	239		

Fisher's exact test was used to explore the association between 'Outcome' and 'Oxygenation'. There was a significant difference between the survived and expired groups in terms of distribution of Oxygenation (χ2 = 122.636, p = <0.001). Hypoxia on admission is significantly associated with poor outcomes.

3)Perfusion And Outcome: 87.03% (208/239) of neonates had score 0 (CRT<3sec) for perfusion parameter and 12.97% (31/239) of neonates had score 1 (CRT≥3sec). Out of 31 neonates admitted with poor perfusion, 19 (61%) expired.

Table 3: Association Between Outcome And Perfusion (N = 239)

Perfusion	Outcome			Fisher's Exact Test	
	Survived	Expired	Total	χ2	P Value
Score 0	203 (97.6%)	5 (2.4%)	208 (100%)	103.563	<0.001
Score 1	12 (38.7%)	19 (61.3%)	31 (100%)		
Total	215	24	239		

Fisher's exact test was used to explore the association between 'Outcome' and 'Perfusion'. There was a significant difference between the survived and expired groups in terms of distribution of Perfusion (χ2 = 103.563, p = <0.001). Prolonged CRT on admission is associated with poor outcomes.

4)Sugar And Outcome: 97.90% (234/239) neonates had score 0 (RBS≥40mg/dl) for sugar parameter and 2.09% (5/239) of neonates had score 1 (RBS<40mg/dl) on admission. Out of 5 hypoglycemic neonates, 1 (20%) expired while 23 (95.8%) neonates expired who were not hypoglycemic.

Table 4: Association Between Outcome And Sugar (N = 239)

Sugar	Outcome			Fisher's Exact Test	
	Survived	Expired	Total	χ2	P Value
Score 0	211 (90.2%)	23 (9.8%)	234 (100%)	0.561	0.414
Score 1	4 (80%)	1 (20%)	5 (100%)		
Total	215	24	239		

Fisher's exact test was used to explore the association between 'Outcome' and 'Sugar'. There was no significant difference between the survived and expired in terms of distribution of Sugar (χ2 = 0.561, p = 0.414). Hypoglycemia on admission is not significantly associated with mortality.

Table 5: Total TOPS Score And Outcome Of Neonates

TOPS	Expired	Survived	Total(N)
0	1(0.68%)	146(99.32%)	147
1	3(5.26%)	54(94.74%)	57
2	2(20%)	8(80%)	10
3	17(70.83%)	7(29.17%)	24
4	1(100%)	0(0%)	1
Total	24(10.04%)	215(89.96%)	239

5.26% (3/54), 20% (2/10), 70.83% (17/24) and 100% (1/1) of neonates expired, who had TOPS score 1, 2, 3 and 4 respectively. Altered TOPS parameters on admission are associated with poor outcomes. As the number of altered parameters increases, mortality also increases. 1

neonate expired who got admitted with normal TOPS parameters.

Comparison Of The 2 Subgroups Of The Variable Outcome In Terms Of TOPS Total (N = 239): Non-parametric tests (Wilcoxon-Mann-Whitney U Test) were used to make group comparisons. The mean (SD) of TOPS Total in the Outcome: Survived group was 0.42 (0.72). The mean (SD) of TOPS Total in the Outcome: Expired group was 2.58 (0.93). The median (IQR) of TOPS Total in the Outcome: Survived group was 0 (0-1). The median (IQR) of TOPS Total in the Outcome: Expired group was 3 (2.75-3). The TOPS Total in the Outcome: Survived ranged from 0 - 3. The TOPS Total in the Outcome: Expired ranged from 0 - 4. There was a significant difference between the 2 groups in terms of TOPS Total (W = 349.500, p = <0.001), with the median TOPS Total being highest in the Outcome: Expired group.

Figure 1: ROC Curve Analysis Showing Diagnostic Performance Of TOPS Total In Predicting Outcome: Expired Vs Outcome: Survived (N = 239)

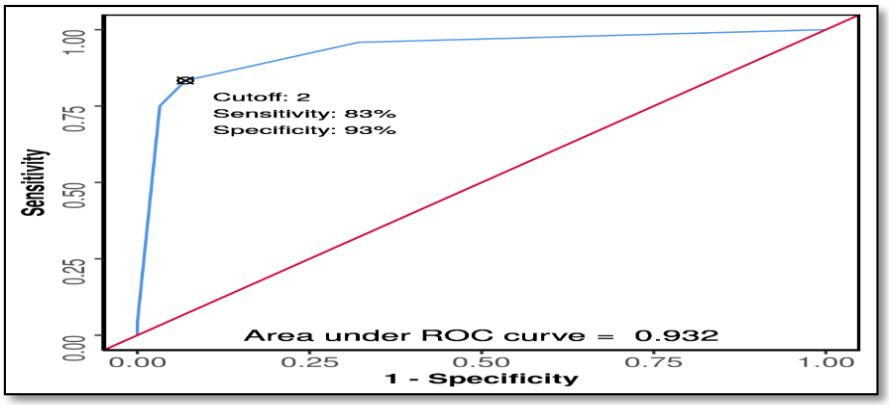

Table 6: Diagnostic Parameter Of TOPS Score (Cut Off ≥ 2)

Parameter	Value (95% CI)
Cut-off (p value)	≥ 2 (<0.001)
AUROC	0.932 (0.874 - 0.99)
Sensitivity	83.3% (63-95)
Specificity	93.0% (89-96)
Positive Predictive Value	57.1% (39-74)
Negative Predictive Value	98.0% (95-99)
Diagnostic Accuracy	92.1% (88-95)
Positive Likelihood Ratio	11.94 (7.1-20.09)
Negative Likelihood Ratio	0.18 (0.07-0.44)

AUC near to 1 in ROC means the test has good measure of separability. The area under the ROC curve (AUROC) for TOPS Total predicting Outcome: Expired vs Outcome: Survived was 0.932 (95% CI: 0.874 - 0.99), thus demonstrating excellent diagnostic performance. It was statistically significant (p = <0.001). The relative risk (95% CI) for Outcome: Expired when TOPS Total is ≥2 was 25.68 (11.48-57.47).

Table 7: Diagnostic Accuracy Of TOPS Parameter

Variable	Sensitivity	Specificity	PPV	NPV	Diagnostic Accuracy	Ranking Of The Diagnostic Accuracy
Temperature	95.8% (79-100)	68.8% (62-75)	25.6% (17-36)	99.3% (96-100)	71.5% (65-77)	5
Oxygenation	79.2% (58-93)	96.3% (93-98)	70.4% (50-86)	97.6% (95-99)	94.6% (91-97)	1
Perfusion	79.2% (58-93)	94.4% (90-97)	61.3% (42-78)	97.6% (94-99)	92.9% (89-96)	2
Sugar	4.2% (0-21)	98.1% (95-99)	20.0% (1-72)	90.2% (86-94)	88.7% (84-92)	4
TOPS Total (Cut-off: 2 by ROC)	83.3% (63-95)	93.0% (89-96)	57.1% (39-74)	98.0% (95-99)	92.1% (88-95)	3

For prediction of mortality, hypothermia was found to be the most sensitive parameter followed by total TOPS score cut off (≥2). Hypoxia had highest diagnostic accuracy (94.6%) followed by hypoperfusion (92.9%) while total TOPS ≥2 had diagnostic accuracy of 92.1%. Out of 239 neonates 24(10.05%) neonates expired and 215(89.95%) survived.

Table 8: Association Between Outcome And Parameters

Parameters	Outcome		P Value
	Survived (N = 215)	Expired (N = 24)	
Temperature* **			<0.001[1]
Score 0	148 (68.8%)	1 (4.2%)	
Score 1	67 (31.2%)	23 (95.8%)	
Oxygenation* **			<0.001[2]
Score 0	207 (96.3%)	5 (20.8%)	
Score 1	8 (3.7%)	19 (79.2%)	
Perfusion* **			<0.001[2]
Score 0	203 (94.4%)	5 (20.8%)	
Score 1	12 (5.6%)	19 (79.2%)	
Sugar			0.414[2]
Score 0	211 (98.1%)	23 (95.8%)	
Score 1	4 (1.9%)	1 (4.2%)	
TOPS Total***	0.42 ± 0.72	2.58 ± 0.93	<0.001[3]

***Significant at p<0.05, 1: Chi-Squared Test, 2: Fisher's Exact Test, 3: Wilcoxon-Mann-Whitney U Test. Presence of hypothermia, hypoxia, poor perfusion and raised TOPS score on admission were significantly associated with mortality.

Discussion: Neonatal transport is continuously evolving and has developed to a cornerstone of modern perinatal medicine. Although the regionalization of perinatal care and delivery of high-risk neonates in appropriately designed centres improves neonatal outcome, neonatal transport represents an invaluable resource in order to guarantee tertiary level care throughout the region.

A highly trained, adequately skilled and well-equipped transport team is key in order to provide a good quality of care for a wide variety of clinical disorders and their potential complications. A safe and efficient neonatal transport begins in the referring hospital. An optimal communication between the referring team and the transport team is paramount.

Besides collecting information, the transport team may advise the referring team about specific steps to undertake until arrival[7]. Being a tertiary care institute with level 3 NICU, we get many external neonates referred from the community as well as from health facilities. This study was undertaken to analyse clinical, demographic and transport characteristics of external referred neonates.

In our study we observed that out of 239 neonates 140 (58.6%) were males and 99 (41.5%) were females. Male: female ratio came to be 1.41:1. Studies done by Suresh Kumar et al[8] and Venkateshwaran et al[9] had observed male to female ratio of 1.47:1 and 1.43:1 respectively.

In studies done by Suresh Kumar et al[8] and Dalal Ekta et al[12], 46.67% and 55.3% of neonates were hypothermic. In our study, 37.65% neonates were hypothermic. Hypothermia can be prevented during transport by KMC and thermal control devices. Hence, it should be promoted.

Suresh Kumar et al[8] and Ekta Dalal et al[12] had observed occurrence of hypoxia in 39.23% and 27.4% neonates respectively. In our study, 11.3% of neonates were hypoxic which is lower than other studies. Hypoxia can be prevented by assessing pre-transfer SpO_2 and arranging transfer in ambulance with oxygenation facility.

Study done by Suresh Kumar et al[8] has observed 14.61% of neonates had poor perfusion on admission. pretransfer assessment and prompt corrective measures can prevent morbidity and mortality due to shock in referred neonates.

In present study, out of 239 neonates 24(10.05%) neonates expired and 215(89.95%) survived.

Table 9: Total TOPS Score And Outcome: Comparison With Other Studies

TOPS Score	Present Study	Suresh Kumar Verma et al[8]	Ekta Dalal et al[12]
	Expired 24/239 (10.04%)	Expired 81/390 (20.76%)	Expired 71/300 (23.66%)
0	1/140 (0.71%)	1/128 (0.78)	----------
1	3/64 (4.68%)	14/105 (13.33%)	12/121 (9.91%)
2	2/10 (20%)	35/112 (31.25%)	17/48 (35.41%)
3	17/24 (70.83%)	23/35 (65.72%)	29/37 (78.3%)
4	1/1 (100%)	8/10 (80%)	13/13 (100%)

Conclusion: TOPS score is an easy, reliable and applicable tool for outcome prediction of transported neonates. It gives a quick and accurate overview of the clinical condition of neonates on arrival to NICU. Hence, it gives guidance for prompt initiation of therapeutic measures. So, the TOPS score of all neonates should be done at NICU.

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