Correlation of acute physiological parameters with immediate outcome among neonates transported to special care newborn unit: A prospective study

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ABSTRACT

Background: Several sick neonates require transfer to tertiary level care neonatal unit for treatment. The facilities of neonatal transport in India are not optimal and the newborn thus transported can become hypothermic, hypoxic, and/or hypoglycemic which can affect the neonatal outcome. These parameters can be maintained during transport by adopting simple measures. **Aim:** Study impact of acute physiological parameters during transfer of neonates on their immediate outcome by using TOPS score. TOPS Score -temperature, oxygensaturation, perfusion (assessed by capillary refill time), blood Sugar. **Materials and Methods:** This prospective observational study was conducted at the special care newborn unit, Indore enrolling 513 transported neonates. TOPS scoring for each neonate was done at admission, and then the parameters of the TOPS score were correlated with the outcome at 48 h of admission. **Results:** A total of 513 transported newborns were assessed, 48.73% newborns were hypothermic, 33.91% had poor perfusion, 28.46% were hypoxemic, and 22.22% were hypoglycemic. Hypoxemia and hypoglycemia had the highest sensitivity (93.39% and 80.18%, respectively) while hypoglycemia had the highest specificity (92.87%). **Conclusion:** TOPS score is a useful and easy to use the method to assess the physiological status and predict early mortality in transported neonates.

Key words: *Mortality, Neonatal transport, Outcome, Temperature, Oxygen saturation, Perfusion score*

India continues to have the highest number of neonatal deaths in the world despite a fall in the national neonatal mortality rate over past two decades. There is interplay of different demographic, educational, socioeconomic, biological, and care-seeking factors, which are responsible for the disparities and the high burden of neonatal mortality [1]. The non-institutional and institutional births where baby cannot be managed are required to be transferred to a higher center. Importance of safe and effective neonatal transport cannot be overemphasized. Currently, facilities of such neonatal transport in India are very limited and concentrated to larger cities [2]. Many of neonatal transports are self-transport without any pre-treatment stabilization or care during transport. The newborn thus transported can become hypothermic, hypoxic, and/or hypoglycemic which can have serious clinical implications [3]. With the availability of limited resources, stabilization and monitoring of newborns during their transport is a challenge. A tool for monitoring the acute physiological parameters of such babies can be very useful for this purpose. The desirable properties of such a tool are ease of use, applicability early during transport and hospitalization and ability to reproducibly predict mortality [4].

Several scores and scales have been used by the researchers for this purpose [5-8]. One such scale is TOPS score. Although other researchers have also used this tool in their studies [3,4,8,9], the results are conflicting. Hence, we conducted this study to evaluate the predictability of acute physiological parameters during transfer of neonates in on their immediate outcome using TOPS score. TOPS score consists of **t**emperature **o**xygen saturation**, p**erfusion as assessed by capillary refill time (CRT) and blood **s**ugar.

METHODS

This prospective observational study was conducted among newborns transferred to the special care newborn unit (SCNU) of a tertiary level care hospital in central India from April 2016 to August 2017. Approval for conducting the study was obtained from the Institutional Ethics Committee. A written consent was obtained from the parents/caregivers of the newborns included in the study. The inclusion criteria included the neonates <7 days with transportation time <½ an hour. Extremely low birth weight babies, babies with lethal congenital malformations, and acute surgical emergencies, whose parents/caregivers left against medical advice or failed to give consent were excluded.

Sample Size

Based on the past 12 months admission rate (April 2016 to August 2017) in the SCNU with requisite inclusion and exclusion

criteria, a convenient sample size of 513 consecutive babies was included in the study.

Data Collection and Analysis

The temperature was assessed using a digital thermometer kept in the axilla of the baby for 3 min. Oxygenation was assessed by measuring oxygen saturation (SpO_2) by pulse oximeter. CRT was measured at the sternum of the baby to assess perfusion. Blood glucose level was obtained by glucometer. All the clinical examinations were measured by the resident doctor on duty. Hypothermia, hypoxia, prolonged CRT, and hypoglycemia were defined as the temperature <36.5°C, oxygen saturation <87%, CRT more than 3 s, and blood sugar <45 mg/dl, respectively [10-13]. Each parameter was assigned a score of "1" if abnormal and "0" if normal. Total TOPS score (an aggregate score of all four parameters) for each baby was calculated at the time of admission. Individual and aggregate TOPS score were correlated with the outcome within 48 h of admission, i.e., expired or survived.

Statistical Analysis

Data were analyzed using the SPSS software version 21.0 (Statistical Package for the Social Sciences, IBM Inc. New York). Continuous variables were analyzed using *t*-test. Categorical variables were analyzed using Chi-square test and multiple logistic regression tests. Sensitivity, specificity, positive and negative predicted values, and area under the receiver operating characteristic (ROC) curve were calculated for validation of TOPS score. For calculating "p" value Pearson Chi-square test was used. For predictors of mortality, $p<0.05$ was considered significant.

RESULTS

Among 513 transported babies, 329 males (64.13%) and 184 females (35.86%), who fulfilled the inclusion criteria were enrolled. Mean duration of travel was 1.45±0.66 h. The incidence of hypothermia, hypoperfusion, hypoxemia, and hypoglycemia was found to be 48.73%, 33.91%, 28.46%, and 22.22%, respectively (more than one physiological parameters were present in each newborn) (Table 1). Their immediate outcome was assessed at 48 h after admission in terms of death or survival. Out of 513 babies, 106 died, mortality rate being 20.6% among the transported babies. Hypoxemia was found to be the most prevalent abnormal parameter (n=99, 67.8%), followed by prolonged CRT (n=88, 50.5%), hypoglycemia (n=85, 74.5%), and hypothermia (n=40, 16%) in the babies who died within 48 h post admission. As compared to the babies who survived, this difference was statistically significant for all (Table 2).

When composite TOPS score was considered, 274 babies (53.4%) were found to have normal score, i.e., "0", followed by scores of 3 (n=97, 18.9%), 2 (n=71, 13.8%), 1 (n=38, 7.4%), and 4 (n=33, 6.5%). Mean of TOPS scores was 1.175±1.486. All the babies with a normal score of "0" were alive at 48 h post admission, while those with worst scores of 4 showed a maximum proportion of deaths (24/33=72.7%) (Table 3).

The overall sensitivity and specificity were 95.3% and 75.4%, respectively, and the area of ROC curve was 0.901 (95% confidence interval [CI]: 0.930 – 0.872) with a standard error of 0.015 (Fig. 1). Thus, in our study TOPS score done at admission was found to be a good predictor of mortality in immediate post admission period.

When an individual parameter of the TOPS score was considered, it was found that for prediction of mortality at 48 h post admission, hypoxemia and hypoglycemia were found to be the most sensitive parameters with a sensitivity of 93.39% and 80.18%, respectively, and negative predictive values of 98.09% and 94.73%, respectively. Hypoglycemia had the highest specificity (92.87%) and maximum positive predictive value (74.56%) (Table 4). The most common mode of neonatal transport was auto rickshaws (46%) followed by ambulance (20%), taxi (16%), and bus (18%).

DISCUSSION

The study was conducted among 513 transported newborn babies who fulfilled the inclusion criteria. Mortality rate was high among

Table 1: Pathophysiological characteristics of studied newborns on admission (with reference to TOPS scoring system)

Parameters	Number of neonates (%)
Hypothermia (<36.5°C)	249 (48.7)
Hypoperfusion (CRT>3 s)	173 (33.9)
Hypoxemia (oxygen saturation<85%)	145 (28.4)
Hypoglycemia (RBS<45 mg/dl)	113 (22.2)
Total	513

CRT: Capillary refill time, RBS: Random blood sugar

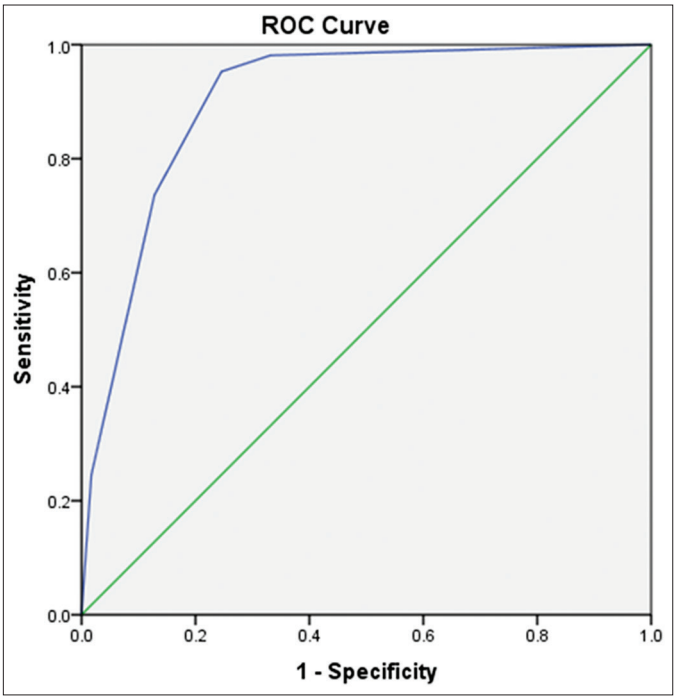

Figure 1: Receiver operating characteristic curve of temperature, oxygen saturation, perfusion score

Table 2: Distribution of outcome according to individual parameters of TOPS score

Parameters	Newborns survived during first 48 h of admission	Newborns died during first 48 h of admission	p value
Hypothermia	210	40 (16%)	*0.003
Hypoxemia	47	99 (67.8%)	*0.00
Hypoperfusion	86	88 (50.57%)	*0.003
Hypoglycemia	29	85 (74.56%)	*0.00
Total	407	106	

*p-statistically significant (p<0.05). TOPS: Temperature, oxygen saturation, perfusion

Table 3: Outcome with reference to TOPS scores

TOPS score	Total number of neonates (%)	Number of neonates survived during first 48 h of admission (%)	Number of neonates died during first 48 h. of admission (%)
0	274 (53.4)	274 (53.4)	0
1	38 (7.4)	35 (92.2)	3 (7.8)
2	71 (13.8)	50 (70.4)	21 (29.6)
3	97 (18.9)	39 (40.2)	58 (59.8)
4	33 (6.5)	9 (27.3)	24 (72.7)

TOPS: Temperature, oxygen saturation, perfusion

Table 4: Test characteristics of individual parameters

Parameter	Hypothermia (%)	Hypoxemia (%)	Hypoperfusion (%)	Hypoglycemia (%)
Sensitivity	37.73	93.39	16.98	80.18
Specificity	48.40	88.45	21.13	92.87
Positive predictive value	16	67.80	5.30	74.56
Negative predictive value	74.90	98.09	49.42	94.73

the newborns who were transported without prior stabilization and proper monitoring during the transport [2,14,15]. With the primary aim of assessing the status of vital acute physiological parameters during the transport and their effects on immediate outcome, TOPS score was used in our study. The scoring was done at the time of admission. Other researchers have also used this tool in their studies [3,4,8,9]. The composite TOPS score and its individual parameters have been used by these authors for predicting the outcome of transported newborns.

The mean duration of transport in our study was 1.45 h. In the study published by Verma *et al.,*[9] 71.79% neonates took between 1 and 4 h while 6.41% took longer (>4 h) to reach the tertiary care center. Mori *et al.* [16] did a systematic review and cohort study to investigate the association between duration of interfacility transport and perinatal mortality and found that those neonates, who were transported for >90 min had more than twice the rate of neonatal death (rate-ratio [RR] 2.26, 95% confidence interval [CI]: 1.26–4.04), and those transported for between 60 and 89 min had an 80% higher rate of neonatal death (RR 1.81, 95%CI: 1.07–3.06), both compared with those transported for between 30 and 59 min, after adjusting for the confounding effects. These results showed that quick transfer along with stabilization and monitoring during the neonatal transport can decrease the neonatal mortality in transported babies.

TOPS score was assigned to the babies at the time of admission to assess their acute physiological parameters, namely temperature, oxygenation, perfusion, and blood sugar, and their effect was assessed on the mortality rate within 48 h of admission. Babies with better TOPS score had less mortality at 48 h post admission. Our results are like the ones published by other researchers. Mathur *et al.* [8] in their study found that sensitivity, specificity, positive, and negative predictive values of two or more deranged TOPS score parameters in predicting mortality were 78.3%, 86.1%, 74.6%, and 88.4%, respectively. They concluded that assessment of TOPS score was an easy way to predict mortality at the time of admission. Studies done by Begum *et al.* [4] and Dalal *et al.* [3] showed that more the number of deranged parameters, higher was the mortality rates in transported babies. However, unlike our study, these studies did not have a criterion of 48 h post admission for this prediction of outcome. In our study, the babies who had all the parameters as normal at admission survived at 48 h post admission, indicating a good negative predictive value of abnormal TOPS score done at admission. Hence, TOPS score can not only be used to predict mortality, but it can also be used as a monitoring tool for neonatal assessment during the transportation.

When individual parameters of the TOPS score were correlated with the outcome, hypoxemia and hypoglycemia were found to be the most sensitive parameters for predicting the mortality at 48 h in our study. In a study done by Begum *et al.* [4] prolonged CRT indicating poor perfusion was found to be the strongest predictor of mortality. Dalal *et al.* [3] concluded that failure to correct the deranged parameter at 1-h post admission was significantly associated with high mortality. Verma *et al.* [9] in their study found the highest mortality in poor perfusion group, whereas hypoglycemic babies had the least expiries. In the same

study, hypothermia and hypoxia were found to be the most sensitive parameters with the best negative predictive value, while hypoperfusion had the highest specificity and maximum positive predictive value. Differences in the predictive values of individual parameters in different studies indicate diversity in numbers and clinical characteristics of study groups, variation in modes and total duration of transport, seasonal variations, and timings of outcome measures. Large multicentric studies with uniform study protocols are needed to further validate the findings of these individual studies.

Several scoring tools using acute physiological parameters have been devised and studied for predicting neonatal mortality in different neonatal cohorts including the transported ones. These include Score of Neonatal Acute Physiology (SNAP) [5] and its extensions (SNAP-II, SNAP Perinatal Extension (PE)-II) [17], Mortality Score of Neonatal Transport (MINT) [6], Transport Related Mortality Score (TEMS) [7], and Clinical Risk Index for Babies (CRIB) [18]. In their study, Mathur *et al.* [8] compared the performance of TOPS score with SNAP-II and concluded that the TOPS has an equally good prediction of mortality when compared to SNAP-II. They suggested that it can be used as a simple tool to assess the mortality risk at the time of admission in transported newborns. In a study done by Sutcuoglu *et al.*[7], three scores were applied simultaneously, and their performance was compared for predicting the mortality in transported babies. They found that the sensitivity of MINT score for predicting mortality was higher than SNAPPE-II and TERMS. However, specificity was higher in TERMS score. The negative predictive value was highest in MINT score, whereas TERMS has the highest positive predictive value.

Being a single center and limited period study, our results could have been affected by the geographical limitations, seasonal variations, and modes of transport available. Effect of other confounding factors such as gestational age, underlying diagnosis, and maternal risk factors are also not captured in our study. Nevertheless, they can be useful in formulating the local guidelines for the interinstitutional neonatal transport.

CONCLUSION

TOPS score done at the time of admission is an easily applied scoring system for predicting the risk of early mortality after admission in transported neonates. Increasing number of deranged parameters increases the likelihood of mortality. We suggest further studies with larger sample size including more centers and newborn infants with diverse clinical problems to further improve the validity and reliability of the TOPS and other scoring systems.

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