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Original Research Article

A prospective study to evaluate neonatal trigger score as an early warning system in post-natal wards

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ABSTRACT

Background: The early postnatal period is a critical phase in newborns as major changes occur in this period. Hence, this study was done to determine the utility of Whitt neonatal trigger score (W-NTS) as a clinical tool.
Methods: A prospective observational study was conducted at Kempegowda institute of medical sciences (KIMS) during the period of December 2019 to June 2021. All neonates admitted in postnatal wards of KIMS hospital during the study period were included. Detailed history was taken and NTS observation and scoring chart was applied.
Results: NTS chart was applied on a total of 750 neonates who fulfilled the inclusion criteria. Out of 750 neonates, 136 (18.1%) triggered the NTS chart. Twenty-one (15.4%%) neonates did not require any medical intervention while 115 (84.6%) required intervention (25 in post-natal wards (PNW) and 90 in neonatal intensive care unit (NICU). In our study, NTS score of 2 has 78.89% sensitivity and 97.27% specificity for admission to NICU while specificity (100%) was high in NTS score of ≥3. The area under the ROC curve for the NTS was 0.99 with confidence interval of 0.98-0.999 and standard error of 0.005 which was statistically significant.
Conclusions: Results from this study shows that W-NTS observation chart acts well as an adjunct to clinical assessment in the PNW, with its simplicity allowing for the successful and safe use.

Keywords: PNW, NTS, Early warning system, NICU

INTRODUCTION

The early postnatal period is a critical phase in the lives of newborn babies. Major changes occur in this period because of adjustments to extra-uterine life, physiological immaturity, or exposure to intra-partum risks such as infections.

Following birth, majority of apparently "healthy" neonates are cared for in the post-natal or maternity wards which are not designed to take care of "sick" neonates.

Prior to acute deterioration and subsequent transfer to NICU, neonates often show signs of illness which are often subtle that are not identified.

Early identification and management of these potentially "at risk" neonates are of utmost importance. Based on physiological observations such as heart rate, respiratory rate etc., early warning score (EWS) systems have been validated in adult and pediatric populations to detect deterioration with timely interventions to reduce morbidity and mortality.[1,2]

The NTS is one such scoring system that has been successfully used in UK as an addition to clinical assessment by non-specialists, in early identification of neonates requiring extra care. The available literature regarding the use of such scoring system in neonatal population is scarce, hence this prospective observational study was carried out.

In recent years there has been a growing interest in development of early scoring systems for neonates, but the available literature is scarce.[3-6]

The pediatric early warning system (PEWS) was developed to provide a means for standardized and reproducible identification of admitted pediatric patients at risk for deterioration in clinical status.[7]

In a recent prospective evaluation of NTS in neonates, it has been shown that NTS can be successfully used as an adjunct to clinical assessment by non-specialists, in early identification of neonates requiring extra care.[8]

EWS systems are tools used by hospital care teams to identify the early signs of clinical deterioration to initiate early intervention and management, such as increasing attention, informing or activating a medical emergency team.[10]

A broad range of systems are currently in use with variable accuracy in identifying deterioration.[11]

EWT vary in design but generally are color coded, with varying colors or shades indicating worsening abnormal parameters, which are designed to alert the clinician to act. Some EWTs have specific action prompts which are outlined for clinicians.[9-10]

Current evidence suggests that the triad of i) early detection, ii) timeliness of response, and iii) competency of the clinical response, is critical to defining clinical outcomes.[12]

It is generally accepted that use of EWS systems is valued in identifying subtle deterioration in clinical conditions leading to prior intervention and reduced morbidity and mortality.

There is an urgent need to establish a neonatal early warning (NEW) system, which can be used to monitor the neonates in postnatal wards for early detection and timely intervention of illness.

The W-NTS is one such observation chart designed for neonates at risk of deterioration in postnatal and labor wards which can be performed and interpreted by doctors.[7] By including NTS charts in neonatal case sheets and documenting the observations by doctors, this study is aimed at early identification and management of neonates thereby reducing the potential negative impact of any medical problems.

Objectives

Objectives of the study were to assess the efficacy of WNTS, for identification of newborns in the postnatal ward requiring medical intervention in the ward and NICU admission.

METHODS

Source of data

All neonates delivered and admitted in postnatal wards of Kempegowda institute of medical sciences hospital, Bengaluru, during the period of study.

Method of collection of data

Study design

Study design was of a prospective observational study.

Study period

Study conducted for 18 months (January 2020-June 2021).

Sample size

Sample size was of 750.

Inclusion criteria

All neonates delivered and admitted in postnatal wards of KIMS hospital Bangalore were included in the study.

Exclusion criteria

Neonates weighing <2 kg at birth, neonates with a gestational age of <35 weeks, neonates admitted to NICU within 30 mins after delivery and neonates with major congenital anomalies were excluded from the study.

Methodology used

Study tools

Study tools used were NTS observation and scoring chart designed and developed by Holme et al.[4]

All the postgraduates, interns and nurses posted in labor ward and postnatal wards will be sensitized regarding the use of NTS observation chart.

All neonates fulfilling the inclusion criteria will be included in the study. At the time of enrolment, an informed written consent will be obtained from the parents. Detailed maternal history will be elicited and recorded.

The NTS chart will be included in all newborn files admitted in the postnatal wards.

Scores will be obtained at 1, 2, 4, 6, 8, 10 and 12 hours after birth and then every 4th hourly until 48 hours old.

Those neonates requiring medical intervention have been followed up till discharge to observe for the following outcomes: medical intervention, duration of NICU/hospital stay, mortality.

How to complete the NTS chart

The neonate's observation will be recorded in the NTS observation and scoring chart (Figure 1) following the example column and instructions on the chart. The first time a NTS chart is used the following will be recorded: The newborn's details: Name, date of birth, birth weight, gestational age and hospital number.

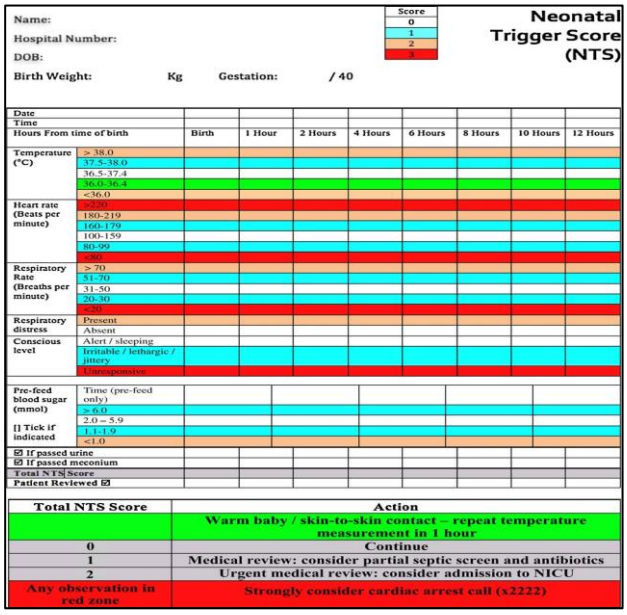

Figure 1: NTS observation and scoring chart designed and developed by Holme et al.[4]

NTS parameters

The 5 core scoring parameters (temperature, heart rate, respiratory rate, respiratory distress, and conscious level) will be assessed and recorded in the colored boxes by a (√).

Additional parameter pre feed should be measured only in following neonates-low birth weight infants (<2000 gm). Preterm infants (<35 weeks), small for gestational age infants (SGA): birth weight <10th percentile, infant of diabetic mothers (IDM), large for gestational age (LGA) infants: birth weight >90th percentile, infants with Rh-hemolytic disease, infants born to mothers receiving therapy with terbutaline/propranolol/labetalol/oral hypoglycemic agents. Any sick neonate such as those with perinatal asphyxia, polycythemia, sepsis, shock etc., and infants on total parenteral nutrition.

Temperature: By using a digital thermometer, axillary reading for 3 minutes.

Heart rate: By using a stethoscope, the heart was counted by one full minute by auscultation.

Respiratory rate: By observing and counting the abdominal movements, for one full minute.

Respiratory distress: Looking for hurried respiration (>60/min), noisy breathing, retractions, nasal flaring, grunting, use of accessory muscles of respiration. If any one of the above signs was observed, it was recorded as present.

Level of consciousness: By looking at whether the baby is alert/sleeping/ irritable /lethargic / jittery / unresponsive.

Additional parameters: Pre feed blood sugar by using glucometer.

Calculation of score

Individual parameter scores were entered as per the colour coding by putting a cross (X) in the appropriate coloured box.

The total NTS score was taken by adding the scores for each core parameter and entered.

All the postgraduates, who recorded the observations were given the following instructions: If a neonate scores 0, to continue the same and to observe the baby for next 48 hours as per NTS chart. If a neonate scores 1, the neonatal doctor should be requested to review and strongly consider for performing septic screen and starting IV antibiotics. If a neonate scores 2 or more, they should be reviewed immediately as there is a high chance that they might need NICU care. If a neonate scores 3 (red column on chart), then they need very urgent medical attention, and a cardiac emergency call should be considered.

Neonates who triggered NTS chart and required intervention were followed up until hospital discharge/ deaths (if any).

Ethical approval

The Study was approved by the Institutional Ethics Committee

Statistical analysis

Data were entered into Microsoft excel and statistical analysis was carried out in SPSS software version 17.0. Qualitative variables were presented as frequency and percentages. Quantitative variables were presented as mean (standard deviation) or median(range) depending upon the distribution of data. Bar diagram and pie charts were used for graphical representation of data.

Association between categorical variables were assessed using chi squared test. Association of temperature, heart rate, respiratory rate, respiratory distress, and level of consciousness in relation to NTS triggered and non-triggered neonates was assessed using chi square test. A p value of less than 0.05 was considered as statistically significant.

ROC analysis was performed using NTS score to predict the admission of the baby to ward or NICU. Area under the curve (AUC) were reported along with 95% confidence intervals. Sensitivity, specificity, and diagnostic accuracy were calculated for different cut off values of NTS score.

RESULTS

In our study, it was observed that out of 750 neonates for whom NTS was applied, 50.1% were males while 49.9% were females (Figure 2).

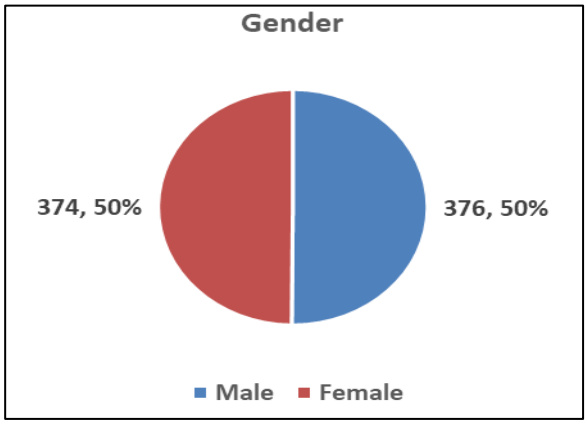

Figure 2: Distribution of study participants according to gender.

Out of 750 neonates for whom NTS was applied, 136 (18.1%) triggered the NTS while the remaining 614 (81.9%) neonates did not trigger the NTS (Figure 3).

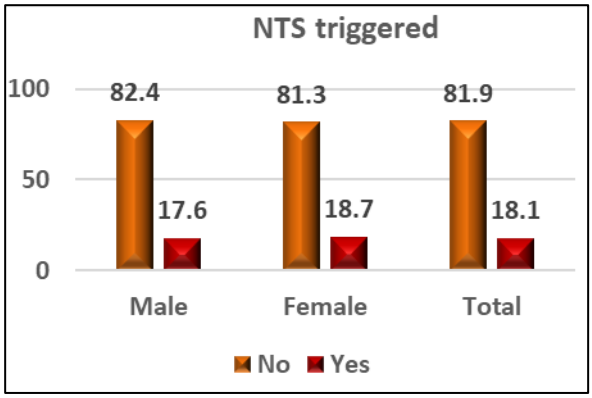

Figure 3: Distribution of study participants who triggered NTS.

Correlation of temperature, heart rate and respiratory rate in relation to triggering of NTS among study participants is depicted in Table 8. Temperature, respiratory rate, and heart rate between NTS triggered and non-triggered study groups showed a highly significant correlation ($p<0.05$) (Table 1).

Among the study population, it was observed that respiratory distress was present in 63/136 (8.4%) neonates who triggered the NTS chart whereas it was absent in all neonates who did not trigger the NTS chart (100%) which was statistically significant ($p<0.05$).

The level of consciousness was normal in all the neonates who did not trigger the NTS (100%) whereas it was abnormal in 19/136 neonates (2.5%) who triggered the NTS chart which was statistically significant ($p<0.05$) (Table 2).

In our study it was observed that, out of 750 neonates, 614 neonates who did not trigger the NTS chart had a score of 0. Among neonates who triggered the NTS chart, 28/136 (20.6%) neonates had a score of 1, 99/136 (72.8%) neonates had a score of 2, 9/136 (6.6%) neonates had a score of 3 and none had a score of 0 which was found to be highly significant statistically ($p<0.05$) (Table 3).

Out of 136 neonates who triggered the NTS, 115 (84.6%) required medical intervention. Remaining 21 (15.4%) neonates did not require any medical intervention and remained well in PNW (Figure 4).

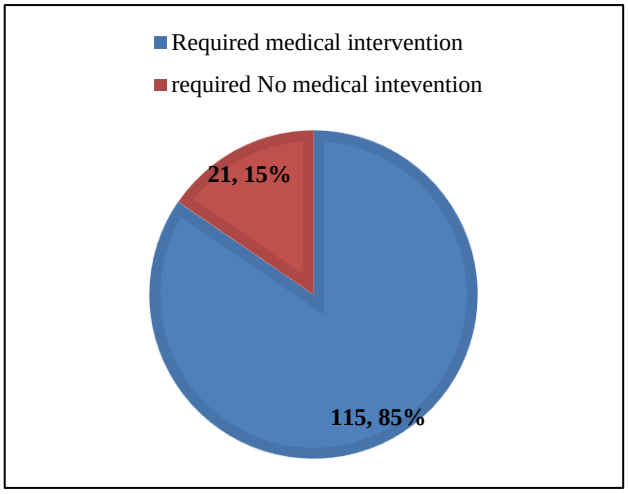

Figure 4: Need of medical intervention among study participants who triggered NTS.

It was observed that among NTS triggered neonates, 21/136 (15.4%) did not require any medical intervention and were "well" neonates whereas, 115/136 (84.6%) required medical intervention. Among 614 neonates who did not trigger NTS, none required any medical intervention (100%). It was found that among neonates who triggered NTS and required medical intervention, 90

(66.2%) were treated in NICU while 46 (33.8%) were managed in PNW. Both the observations were found to be highly significant statistically ($p<0.05$) (Table 4).

In the present study, it was found that 21 neonates who triggered NTS but did not require medical intervention were diagnosed as "well babies" and discharged from the hospital (Table 5).

Characteristics of study participants who triggered NTS and required intervention in PNW is depicted in Table 6.

Asymptomatic hypoglycemia was present in 13 neonates who were managed in PNW with following treatment modalities: spoon feeding (EBM/Formula) in addition to direct breast feeding nutritional education on breast feeding, nutritional education on breast feeding and GRBS monitoring and all of them were discharged.

Four neonates had probable sepsis. All the neonates received IV antibiotics as septic screen was positive in all the cases. All of them were discharged

Four neonates had fever following immunization which was managed by antipyretics and reassurance.

Four neonates had dehydration fever which was managed by regular breast feeding, temperature monitoring, antipyretics, and reassurance.

Among the study population, 90 neonates triggered NTS and required medical intervention in NICU. Following are the characteristics of neonates requiring intervention in NICU (Table 7).

Transient tachypnea of newborn (TTNB) was present in 44 neonates requiring intravenous fluids, oxygen support, and mechanical ventilation. All of them were discharged.

Meconium aspiration syndrome (MAS) was present in 21 neonates of whom 15 had mild MAS requiring O_2 support (<40% FIO_2) and IVF while 3 had moderate MAS requiring O_2 support (>40% FIO_2), IVF and IV antibiotics and 3 had severe MAS requiring mechanical ventilation. All neonates were discharged from the hospital without any significant morbidity.

Dehydration fever was diagnosed in 15 neonates requiring IVF and blood investigations. They were discharged from the hospital without any significant morbidity.

Ten neonates had Probable sepsis. All the neonates received IV antibiotics as septic screen was positive in all the cases blood culture was negative. All of them were discharged.

In our study, score 1 had 99.14% sensitivity and 96.69% specificity, while score 2 had 73.28% sensitivity and 99.37% specificity and score 3 had 7.76% sensitivity and 100% specificity for predicting requirement of medical intervention (ward or NICU) (Table 8).

In our study, it was observed that AUROC was 0.99 with 95% confidence interval of 0.98-0.999 and standard error of 0.005. The value was statistically significant ($p<0.001$) indicating the NTS chart as excellent test for identifying sick neonates in PNW and for further NICU admission (Table 9).

In our study it was observed that the ROC curve was following the left-hand border and the top border of ROC space indicating NTS score was more accurate in identifying neonates who are deteriorating and requiring medical intervention in NICU.

However, the accuracy of the test depends on how well the test separates the group being tested into those with and without the disease. To measure that, Area under the receiver operating characteristic curve (AUROC) needs to be calculated.

In our study it was observed that, among 90 neonates who triggered NTS chart and required medical intervention in NICU, score of 1 has 100% sensitivity and 93.03% specificity, while score of 2 has 100% sensitivity and 97.27% specificity and score of 3 had 10% sensitivity and 100% specificity for predicting requirement of intervention in NICU. Specificity was high for all scores (Table 10).

In our study it was observed that all neonates who triggered NTS (136) all were discharged with no mortality noted. Among neonates who did not trigger NTS, all were discharged with no significant morbidity. This observation was statistically significant.

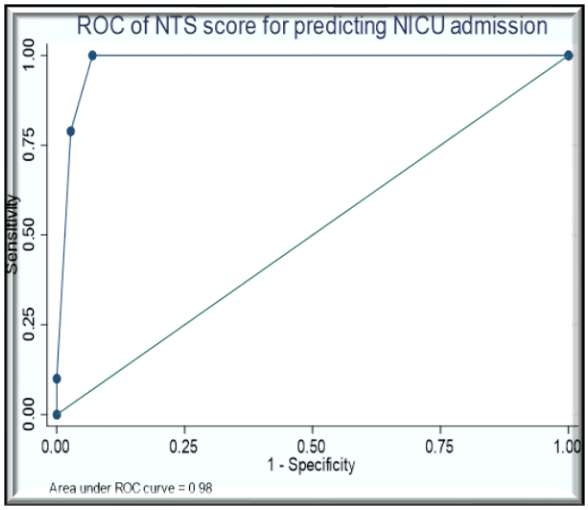

Figure 5: ROC curve of NTS for NICU admission. The closer the curve follows the left-hand border and then the top border of ROC space, the more accurate is the test.

Table 1: Correlation of temperature, heart rate and respiratory rate in relation to NTS triggered and non-triggered neonates.

Variables	NTS triggered-no		NTS triggered-yes		Total		P value
	N	%	N	%	N	%	
Total	614		136		750		
Temperature in degrees Celsius							
36-36.4	5	0.8	4	2.9	9	1.2	<0.001**
36.5-37.4	591	96.3	94	69.1	685	91.3	
37.5-38.0	18	2.9	31	22.8	49	6.5	
>38	0	0	7	5.1	7	0.9	
Heart rate							
100-159	614	100	131	96.3	745	99.3	<0.001**
160-179	0	0	5	3.7	5	0.7	
Respiratory rate							
31-50	460	74.9	40	29.4	500	66.7	<0.001**
51-70	154	25.1	92	67.6	246	32.8	
>70	0	0	4	2.9	4	0.5	

**Chi-square test was applied. (Statistically significant p<0.05).

Table 2: Association of categorical variables- respiratory distress and level of consciousness in relation to NTS triggered and non-triggered neonates.

Variables	NTS triggered-no		NTS triggered-yes		Total		P value
	N	%	N	%	N	%	
Total	614		136		750		
Respiratory distress							
Absent	614	100	73	53.6	687	91.6	<0.001**
Present	0	0	63	45.6	63	8.4	
Level of consciousness							
Alert/sleeping	614	100	117	86.0	731	97.5	<0.001**
Irritable/lethargy/jittery	0	0	19	14.0	19	2.5	

**Chi-square test was applied. (Statistically significant p<0.05).

Table 3: Correlation of NTS scores in relation to NTS triggered and non triggered neonates.

NTS score	NTS triggered-no		NTS triggered-yes		Total		P value
	N	%	N	%	N	%	
0	614	100	0	0	614	81.9	<0.001**
1	0	0	28	20.6	28	3.7	
2	0	0	99	72.8	99	13.2	
3 or more	0	0	9	6.6	9	1.2	
Total	614	100	136	100	750	100	

**Chi-square test was applied (Statistically significant p<0.05).

Table 4: Association of requirement of medical intervention and place of intervention in relation to NTS triggered and non-triggered neonates.

Variables	NTS triggered-no		NTS triggered-yes		Total		P value
	N	%	N	%	N	%	
Total	-	-	-	-	-	-	
Intervention							
No	614	100	21	15.4	634	84.5	<0.001
Yes	0	0	115	84.6	116	15.5	
Place of intervention							
Well neonates	614	100.0	0	0	614	81.9	<0.001
NICU	0	0	90	66.2	90	12.0	
PNW	0	0	46	33.8	46	6.1	

Chi-square test was applied (Statistically significant p<0.05).

Table 5: Characteristics of study participants who triggered NTS requiring no intervention, (n=21).

Intervention required	Place of intervention	Diagnosis	Nature of intervention	Outcome
No	Nil	Well baby	Nil	Discharged

Table 6: Characteristics of study participants who triggered NTS requiring intervention in PNW, (n=25).

Intervention required	Place of intervention	Diagnosis	Nature of intervention	Outcome
Yes	PNW	Asymptomatic hypoglycemia, (n=13)	Spoon feeding with EBM*/ formula in addition to direct breast feeding, nutritional education, GRBS# monitoring	Discharged
		Probable sepsis, (n=04)	Intravenous antibiotics, septic workup.	Discharged
		Dehydration fever, (n=04)	Breast feeding, temperature monitoring, blood investigations, antipyretics, reassurance	Discharged
		Fever following immunization, (n=04)	Antipyretics, reassurance	Discharged

*EBM-Expressed breast milk, GRBS-Glucometer random blood sugar.

Table 7: Characteristics of neonates who triggered NTS requiring intervention in NICU, (n=90).

Intervention required	Place of intervention	Diagnosis	Nature of intervention	Outcome
Yes	NICU	TTNB*, (n=44)	Oxygen support, intravenous fluids and mechanical ventilation	Discharged
		MAS#, (n=21)	Oxygen support, intravenous fluids, intravenous antibiotics and mechanical ventilation	Discharged
		Dehydration fever, (n=15)	Dehydration correction by intravenous fluids, blood investigations.	Discharged
		Probable sepsis, (n=10)	Intravenous antibiotics, septic work up	Discharged

Abbreviations: *TTNB-transient tachypnea of newborn; #MAS-Meconium aspiration syndrome.

Table 8: Diagnostic accuracy of NTS scores in predicting requirement of intervention (ward or NICU).

Cut off	Sensitivity (%)	Specificity (%)	Accuracy/correctly classified (%)
≥0	100	0	15.47
≥1	99.14	96.69	97.07
≥2	73.28	99.37	95.33
≥3	7.76	100	85.73

Table 9: Receiver operating characteristic curves for the NTS for NICU admission.

Parameters	ROC area	S. Error	95% CI	P value
NTS score	0.99	0.005	0.98-0.999	<0.001

Table 10: Diagnostic accuracy of NTS scores in predicting requirement of intervention in NICU.

Cut off	Sensitivity (%)	Specificity (%)	Accuracy/correctly classified (%)
≥0	100	0	12
≥1	100	93.03	93.87
≥2	78.89	97.27	95.07
≥3	10	100	89.20

DISCUSSION

The patient, family members and care givers have a right to expect and receive the best possible medical care. An important component of this expectation is early recognition of any clinical deterioration occurring in hospitalized patients.

In adult and pediatric population, numerous early warning scoring systems are in widespread use.[1,2] In recent years, there has been a growing interest in development of similar structured scoring system for newborn babies.

The W-NTS is one such scoring system that has been successfully used in UK as an adjunct to clinical assessment by non-specialists, in early identification of neonates requiring extra care.[8] As explained earlier, literature review regarding the use of such scoring system in neonatal population is sparse, hence this prospective observational study was carried out.[3-6]

NTS score cutoff for medical review

The sensitivity and specificity cutoffs of NTS are shown in Table 8. In our study it was observed that NTS score of 1 was a cutoff score at which a neonatal doctor should be informed for a medical review (Sensitivity 99.14%, specificity 96.69%). The observations were found similar when compared to the recommendations postulated from retrospective study conducted by Holme et al (Sensitivity 92.7%, specificity 71.6%) and prospective study conducted by Robinson et al (Sensitivity 100%, specificity 86.1%).[4,8]

Score cutoff for admission to NICU

The area under the ROC curve was 0.99 (Figure 5). The sensitivity and specificity cutoffs of the NTS for NICU admission are shown in Table 10. In our study it was observed that a score of 2 (Sensitivity 78.89%, specificity 97.27%) was strongly associated with increased need for intensive care admission ($p<0.001$), whereas a score of 0 was highly predictive of being well enough to remain in PNW ($p<0.001$). These observations are similar when compared to the recommendations postulated by a retrospective study conducted by Holme et al (Sensitivity 79.3%, specificity 93.5%) and prospective study conducted by Robinson et al (Sensitivity 82.5%, specificity 95%).[4,8]

Reliability of NTS score

In our study it was observed that a score of 2 was strongly associated with increased need for NICU admission. However, in present study, 4.5% of neonates requiring NICU admission scored <2 (n=4). This is because all neonates had only tachypnea (NTS score of 1).

It was also found that 21 "well" neonates triggered the NTS chart but did not require any medical intervention. This is because there was misinterpretation of level of consciousness (irritability-NTS score 1) and respiratory rate >50 cycles per minute (NTS score-1) as tachypnea in "well" neonates.

Out of 136 neonates who triggered the NTS, 115 (84.6%) required medical intervention. Among neonates requiring intervention, 25/115 (21.7%) were treated in PNW while 90/115 (78.3%) were admitted in NICU for intervention.

Those requiring NICU admission majority had NTS score of 2 (77/90 = 85.6%) and NTS score of 3 (9/90=10%) which suggests that hypothesis that NTS score of 2 or more is needed for urgent review by neonatal doctor and NICU admission.

The W-NTS was produced as an established track and trigger scoring system in neonatal population where early warning systems were unexplored topics.[8]

The present prospective evaluation supported the postulated score cutoffs from retrospective research by Holme et al and Robinson et al that a neonate scoring ≥1 was more likely to require a medical review and a score of ≥2 was more likely to require NICU admission.[4,8]

It is worth noting here that the outcome of retrospective and prospective chart review indicated that standard of care system was effective in identifying a deteriorating newborn, however, by including NEWS, it helped us to identify them in a timely manner and intervene early.

When using a score to determine which babies potentially need septic screen/antibiotics, sensitivity is important over specificity, showing that an optimum score of 2 is required for intervention. When choosing a "consider admission" trigger score, a higher specificity is desirable to avoid unnecessary admissions and neonate-mother separations.

As discussed above, not all neonates requiring NICU admission reached the presumptive NTS score cut-off of 2 (n=4, 4.5%). To reduce such unnecessary admissions and to increase the sensitivity of NTS score, following modifications in the NTS chart were suggested:

Due to poor sensitivity in cases of hypoglycemia (n=4), we suggest that neonates who are on blood sugar monitoring in PNW should be viewed as high risk with NTS score of 1. It is also suggested to include neonates with the following risk factors (infant of diabetic mothers, neonates with >2-2.5 kg, neonates with >36 weeks gestation to 36+5 days of gestation, neonates born to mothers with PROM >18 hours etc.,) as an immediate score 1 which will effectively reduce the score threshold needed to trigger a review/intervention.

Regarding those neonates who scored as tachypnea as per NTS chart but was normal respiratory rate in actual and required unnecessary NICU admission, the cutoff range to trigger the NTS score 1 in respiratory rate parameter (color code-Blue) needs to be changed from (Respiratory rate 50-70 cycles/min) to (Respiratory rate 60-70 cycles/min).

Some non-specific clinical signs and symptoms (Bilious vomiting, excessive crying, icterus till palms and soles, refusal of feeds, decreased urine output etc.,) indicate significant pathology but do not fit into an observation style chart like NTS chart. It is suggested to include them to increase the sensitivity and specificity of the chart, inserting a "tick if present" box with an immediate score of 2 requiring prompt medical review.

The purpose of this study is to discuss the implementation of NEWS by identifying unwell or deteriorating newborn babies and to initiate the proper interventions based upon clinical condition of neonate.

If NTS is to be used as an aid in decision-making, it is important to know the indications for admission to NICU in different institutions (which could depend on the nursing skill, presence of high dependency unit etc.). This highlights the importance of multi-centre NTS score validation.

The NTS chart was solely used as an observational chart without dictating specific-score dependent interventions and were not directly involved in any clinical-decision making and a specialist doctor (pediatrician/ neonatologist) deciding on the necessary treatment. This shows that there was no reliance on the score to guide subsequent primary treatment measures to non-specialists during emergency (if specialist doctor is not available).

Limitations

Limitation was multi-center validation of NTS score is required.

CONCLUSION

This prospective observational study supports the utility of NTS as a valuable tool for assessment of neonates in PNW. It supports the recommendations postulated by previous retrospective and prospective research done in UK. NTS can be successfully used as an adjunct to clinical assessment by non-specialist to identify babies that may require an escalation in their care, and by enabling earlier detection of the sick neonate, NTS has proven to be of clinical value. It provides a comprehensive assessment check list and empowers novice trainees, health care assistants and midwives by offering clear guidance on when to seek senior's assistance. Further research of the early warning systems in neonatal population is required in India as this is a new concept which needs to be explored.

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Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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