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Correlation Of Thompson Score And Modified Sarnat Staging InPredicting Early Neonatal Outcome In Post Asphyxiated Neonates - A Prospective Observational Study

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ABSTRACT

Background: Birth asphyxia, a major cause of neonatal mortality and morbidity, is a significant global challenge, particularly in developing nations. Both the Modified Sarnat Staging and Thompson Scoring systems offer simple, non-invasive methods for early diagnosisand prognosis, which are crucial for guiding clinical decisions and parental counselling. However, the general propensity to use either technique depending on circumstances may lead to inconsistent outcomes. The aim of this study is to determine the correlation between Thompson Score and Modified Sarnat Staging in assessing the outcome in early neonatal period in post asphyxiated neonates.

Material and Methods: A Prospective observational clinical study study was conducted in R. L.Jalappa hospital affiliated to Sri Devaraj Urs Medical College,Kolar. Neonates within the sample size and inclusion criteria were assessed by the same person based on Thompson and Modified Sarnat scoring and were each given a score based on both Thompson and Sarnat modified scoring. Both scores done for each neonate were correlated in assessing for early neonatal outcome in the post asphyxiated neonates.

Results: Among 50 neonates, overall mortality was observed in 16% of neonates.A fair agreement of (74%) was observed between Thompson and Modified Sarnat scores, with both scores showing significant associations with various complications and outcomes .The Receiver Operating Characteristic (ROC) curve analysis demonstrated that the Thompson score's Area under the curve (AUC) was 0.859, indicating strong predictive capability for mortality.

Conclusion: The Thompson Score and Modified Sarnat Staging are effective tools for assessing hypoxic-ischemic encephalopathy severity and predicting neonatal outcomes. The Thompson Score is more accurate and reliable, especially for identifying neonates at risk for adverse outcomes. It is preferred for early assessment and management of post-asphyxiated neonates, leading to better-targeted interventions and improved neonatal care.

Kew words: Birth asphyxia, Hypoxic ischemic encephalopathy, Thompson Score & Modified Sarnat Staging

Introduction:

Birth asphyxia, a significant contributor to neonatal mortality and morbidity, remains a critical challenge worldwide, especially in developing nations. “Each year, an estimated 23% of the 4 million neonatal deaths and 8% of deaths in children under five are associated with signs of asphyxia at birth.[1]Despite advancements in perinatal care, the burden of hypoxic-ischemic encephalopathy (HIE) persists, with a substantial impact on long-term neuro-developmental outcomes”.

Perinatal asphyxia is characterized by a delay in establishing spontaneous breathing or crying immediately after birth, leading to impaired gas exchange, hypoxia, and metabolic acidosis. HIE, the neurological syndrome resulting from perinatal asphyxia, can cause neonatal death or manifest later as cerebral palsy or cognitive impairments.[2] In less developed countries, perinatal asphyxia is a predominant cause of neonatal death and long-term disability. The risk factors, nature of sequelae and available interventions differ significantly from those in industrialized nations, necessitating tailored approaches to management and prevention.

The global burden of perinatal asphyxia is disproportionately high in developing countries, where more than 50% of affected infants die at home. In these regions, the healthcare infrastructure often lacks the resources for advanced diagnostic and therapeutic interventions, exacerbating the impact of asphyxia. Studies indicate that 15%-20% of neonates with HIE die during the neonatal period, and 30% of survivors experience neuro-developmental disorders, including cerebral palsy, epilepsy, and mental retardation.[3]

“The Modified Sarnat score is a widely accepted clinical tool for assessing the severity of neonatal encephalopathy. It evaluates six clinical parameters to classify encephalopathy into mild, moderate, or severe categories. This staging system provides a clear picture of the infant's

neurological status and is integral to the evaluation of new treatment modalities for neonatal encephalopathy.[4] Its simplicity and widespread acceptance make it a valuable tool in both clinical and research settings”.

“In 1997, Thompson et al. introduced a numeric scoring system for HIE, which relies on fewer clinical assessment-based items compared to the Sarnat Staging. Unlike the Sarnat score, the Thompson score does not require categorization of encephalopathy severity but uses a simple numeric score to describe the peak severity. This scoring system is designed to be easy to use without specific training or advanced technologies, making it particularly suitable for low- resource settings”. It can also be used alongside ancillary studies such as EEG and imaging to inform prognosis.[5]

In developing countries, where perinatal asphyxia remains a leading cause of neonatal mortality and morbidity, there is an urgent need for reliable and accessible tools to assess and manage HIE. Both the Modified Sarnat Staging and Thompson Scoring systems offer simple, non-invasive methods for early diagnosis and prognosis, which are crucial for guiding clinical decisions and parental counselling. However, the general propensity to use either technique depending on circumstances may lead to inconsistent outcomes.

Objectives of the study:

- To determine the correlation between Thompson Score and Modified Sarnat Staging inassessing the outcome in early neonatal period in post asphyxiated neonates

MATERIAL AND METHODS

STUDY DESIGN:

A Prospective observational clinical study

STUDY SETTING:

All neonates (>37 weeks) born in R L Jalappa hospital and admitted to NICU fulfillingthe inclusion criteria.

STUDY PERIOD:

September 2022 to December 2023

SAMPLE SIZE CALCULATION

Sample size estimated is based on the sensitivity of Thompson score was 93% inpredicting mortality as reported by study done by Dalip Kumar Bhagwani et al[30] using

below formula[1]

$n=Z_{\alpha 2}^{2}P\hat{}(1-P\hat{})/d^{2}$

"Where P^ is pre-determined value of sensitivity (or specificity) that is ascertained by previous published data or clinician experience/judgment and for α = 0.05, Zα2 is insertedby 1.96".

P^ = 93% or 0.93

d = 7.5% or 0.075.

Using the above values at 95% Confidence level a sample size of 45 subjects was included in the study.

Considering 10% Non-response rate a sample size of 45+ 4.5 = 50 subjects was included in the study.

STUDY PARTICIPANTS:

All babies within the inclusion criteria admitted in NICU in RLJH during the mentionedstudy period was included in the study

"INCLUSION CRITERIA:

1) "Infants>37 weeks of gestation admitted in NICU with any one of following":

A. APGAR score </=7 at 5 minutes of birth"

B. Continued need for resuscitation including endotracheal or mask ventilation at 10minutes after birth".

C. Acidosis within 60 minutes of birth (umbilical cord, arterial, or cord PH<7)"

D. Base deficit>16 mmol/l in umbilical cord or any blood sample within 60 minutesof birth"".

2) "Altered state of consciousness (lethargy, stupor or coma) at least one of the following"

A. "Hypotonia"

B. "Abnormal reflexes(oculomotor and pupillary abnormality)"

C. "Absent or weak suck"

D. "Clinical seizures"

EXCLUSION CRITERIA:

1) "Preterm babies"

2) "Respiratory depression due to"

a. Intracranial bleed,

b. Neonates with major congenital malformations of CVS, CNS, RS

3) "Severe hyperbilirubinemia bordering on kernicterus"

4) "Cases with hypoglycaemia or meningitis as cause of encephalopathy""

Criteria to define follow up outcome:

Outcome measures were grouped as:

A) Primary outcome

a. Death

b. Day of death(hours)

1. <24hours
2. 24-72hours
3. 72hours

B) Secondary outcome

1) Neurological outcome

- Survival without seizures
- Survival with seizures
- Anticonvulsants

a. None

b. 1 Drug

c. 2 Drugs

2) Cardiac outcome-Persistent pulmonary hypertension(PPHN),Hypotension

3) Respiratory outcome-Respiratory distress

4) Hematological outcome-Anemia,Thrombocytopenia,Deranged Coagulationprofile

5) Gastrointestinal outcome-Feed Intolerance

6) Renal outcome-Acute kidney injury

DATA COLLECTION PROCEDURE:

This study was started after obtaining ethical clearance from the institutional ethical committee as well as consents from the parents.

- All babies within the inclusion criteria admitted in NICU in RLJH during the mentioned study period were included in the study.
- After getting informed written consent from the parents or care givers, Thompson and Modified sarnat staging was done for the asphyxiated neonates and correlated with the clinical outcomes of the baby

Ethical considerations: Study was approved by institutional human ethics committee. Informed written consent was obtained from all the parents /guardians of the study participants and only those participants whose parents/ guardians willing to sign the informed consent were included in the study. The risks and benefits involved in the study and voluntary nature of participation were explained to the parents/guardians of the participants before obtaining consent. Confidentiality of the study participants was maintained

METHODOLOGY

This study was conducted in R.L Jalappa hospital affiliated to Sri Devaraj Urs Medical College, a constituent of Sri Devaraj Urs Academy of Higher Education and Research. Neonates within the sample size and inclusion criteria were assessed by the same person based on Thompson and Modified Sarnat scoring and were each given a score based on both Thompson and Sarnat modified scoring. Both scores done for each neonate were correlated in assessing for early neonatal outcome in the post asphyxiated neonates.

Table 1: Thompson score

Sign	**0**	**1**	**2**	**3**
Tone	**Normal**	**Hypertonia**	**Hypotonia**	**Flaccid**
Level of consciousness(LOC)	**Normal**	**Hyperalert,Stare**	**Lethargic**	**Comatose**
Fits	**None**	**<3/day**	**>2/day**	
Posture	**Normal**	**Fisting, cycling**	**Strong distal flexion**	**Decerebrate**
Moro	**Normal**	**Partial**	**Absent**	
Grasp	**Normal**	**Poor**	**Absent**	
Suck	**Normal**	**Poor**	**Absent+/-Bites**	
Respiration	**Normal**	**Hyperventilation**	**Brief apnoea**	**IPPV(apnoea)**
Fontanel	**Normal**	**Full, Not tense**	**Tense**	

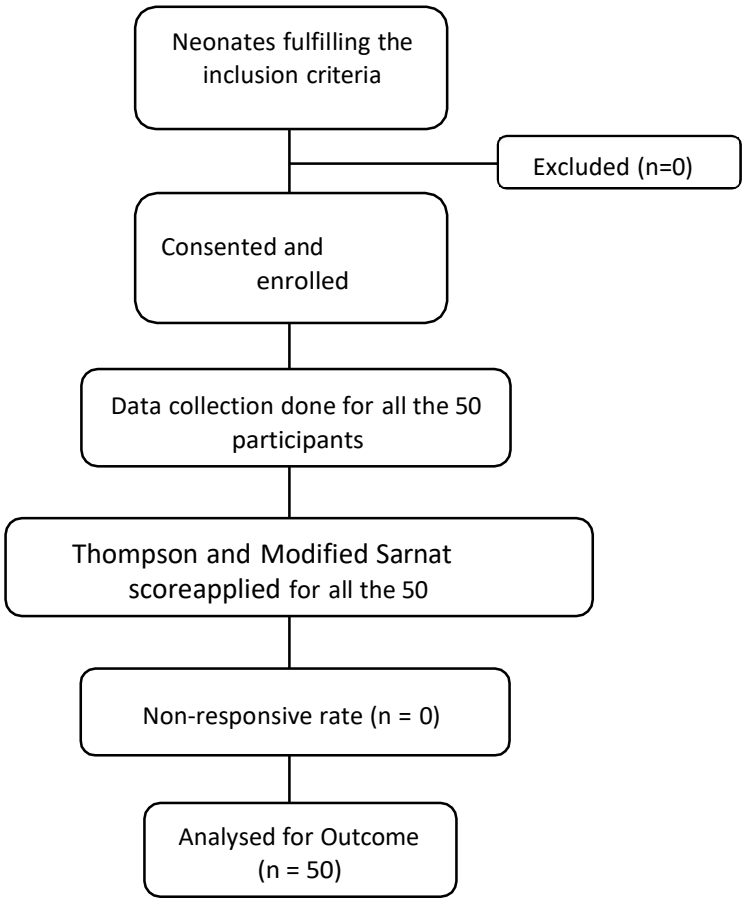
Maximum score=22 Mild HIE-1-10Moderate HIE-11-14 Severe HIE-15

Table 2: The modified sarnat staging for Neonatal Encephalopathy

Severity	Stage 1(Mild)	Stage 2(Moderate)	Stage 2(Severe)
Level of consciousness(LOC)	Hyper alert	Lethargic/Obtunded	Stupor or coma
Activity	Normal	Decreased	Absent
NeuromuscularControl Muscle tonePosture Tendon reflexes	Normal Mild distal flexion Overactive	Mild hypotonia/hypertonia Strong distal flexion Overactive	Flaccid/rigid Intermittent decerebration Decreased or absent
Complex reflexesSuck Moro Tonic neck	Weak Strong,low threshold Slight	Weak/absent Weak,incomplete,high threshold Strong	AbsentAbsent Weak or Absent
Autonomic Nervous system Pupils Heart rate Respiratory rate	Dilated pupil Tachycardia Regular	Constricted pupil Bradycardia Periodic breathing	Variable:often unequal,poor light reflex,fixed,dilated Variable Apnoea

Seizure	**None**	**Common;focal or multifocal**	**Uncommon(excluding decerebration**

CONSORT FLOW CHART REGARDING SUBJECTS INVOLVED IN THESTUDY



RESULTS

Table 3: Score categories for Thompson and Modified Sarnat score

Score categories	**Thompson score**	**Modified Sarnat score**
Mild	20(40.0%)	29 (58.0%)
Moderate	12(24.0%)	20 (40.0%)
Severe	18(36.0%)	1 (2.0%)
Total	**50 (100%)**	**50 (100%)**

Regarding Thompson score among 50 neonates, 20(40.0%) were in mild category, 12(24.0%) were in moderate category and 18(36.0%) were in severe category. The Modified Sarnat score done among 50 neonates, 29 (58.0%) were in mild category, 20 (40.0%) were in moderate category and 1 (2.0%) wasin severe category.

Figure 1: Bar diagram shows Score categories for Thompson and Modified Sarnat score

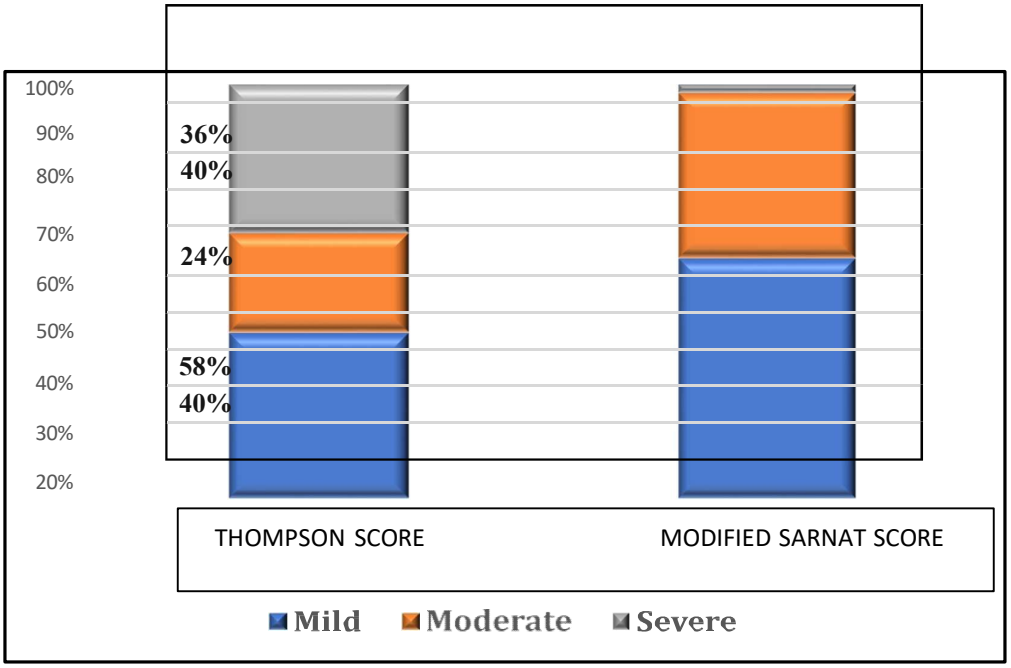


Table 4: Comparison between Thompson score and complications

Complications		Thompson score			Test statistic	P value
		Mild (n=20)	derate (n=12)	Severe(n=18)		
Mortality	Yes	0	2(25.0)	6(75.0)	---	0.010#
	No	20(47.6)	10(23.8)	12(28.6)		
Mortality at <24 hrs.	Yes	0	1(50.0)	1(50.0)	---	0.510#
	No	20(41.7)	11(22.9)	17(35.4)		
Mortality at 24-72 hrs.	Yes	0	1(50.0)	1(50.0)	---	0.510#
	No	20(41.7)	11(22.9)	17(35.4)		
Mortality at >72 hrs.	Yes	0	0	4(100.0)	---	0.015#
	No	20(43.5)	12(26.1)	14(30.4)		

CNS seizures	Yes	0	12(41.4)	17(58.6)	---	0.001#
	No	20(95.6)	0	1(4.8)		
PPHN	Yes	2 (7.6)	7 (26.9)	17 (65.3)	27.31	0.0001*
	No	18 (75.0)	5 (20.9)	1 (2.1)		
Hypotension	Yes	0	3(15.0)	17(85.0)	---	0.001#
	No	20 (66.7)	9(30.0)	1(3.3)		
Deranged coagulation	Yes	3 (15.7)	5 (26.3)	11 (58.0)	8.633	0.010*
	No	17 (54.8)	7(22.5)	7(22.5)		
bocytopenia	Yes	4 (15.3)	6 (23.0)	16 (61.5)	14.4	0.0001*
	No	16 (61.5)	6 (23.0)	4 (15.5)		
Anemia	Yes	0	0	14(100.0)	---	0.001#
	No	20(55.6)	12(33.3)	4(11.1)		
Feed Intolerance	Yes	1 (5.2)	3 (15.7)	15 (78.9)	25.80	0.0001*
	No	19 (61.2)	9 (29.0)	3(9.8)		
te kidneyinjury	Yes	0	3(20.0)	12(80.0)	---	<0.001#
	No	20(57.1)	9(25.7)	6(17.1)		

Statistical test used: Chi square test and Fisher's exact test.

***p value <0.05 is considered statistically significant**

#pvalue based on fisher's exact test

Comparing neonatal mortality with Thompson score, 2 (25%) were under moderate category and 6 (75%) were under severe category. Percentageof mortality was significantly higher among neonates falling under severeThompson score when compared to other category with the p value of 0.010. Among 2 neonatal deaths observed within 24 hours of life, 1(50%) death was

under moderate Thompson score and 1 (50%) was under severe Thompson score. Among 2 neonatal deaths occurred between 24 to 72 hours, 1(50%) was under moderate Thompson score and 1 (50%) was under severe Thompson score. All the 4 neonatal deaths occurred after 72 hours wereunder severe Thompson score. Neonatal mortality observed after 72 hours was under severe Thompson score and it was significant with the p value of

0.015. Comparing CNS outcome with Thompson score, 12 (41.4%) neonates who had seizures were in moderate category and 17 (58.6%) were under severe category. Percentage of CNS outcome(seizures) was significantly higherin severe Thompson score when compared to other category with the p value of 0.001. Among 26 PPHN cases, 2 (7.6%) were categorized as mild, 7 (26.9%)were in moderate Thompson score and 17 (65.3%) were in severe Thompson score. The percentage of PPHN was significantly higher in severe Thompson score when compared to mild and moderate Thompson score with the p valueof <0.001. Among 20 neonates who had hypotension, 17 (85%) neonates wereunder severe category followed by 3 (15%) neonates under moderate Thompson score and this difference is significant with the p value of 0.001.

Among 19 neonates having deranged coagulation, 3(15.7%) were under mild Thompson score, 5 (26.3%) were under moderate thompson score and 11 (58%) were under severe Thompson score. Deranged coagulation was observed highly in severe Thompson score when compared to other categoriesof Thompson score and the difference is statistically significant with the p value of 0.010.Among 26 neonates who had thrombocytopenia, 16 (61.5%) were under mild grade , 6 (23%) neonates under moderate Thompson score and 4 (15.3%) under severe thompson score. All 14 neonates who had anemia

were categorized under severe Thomson score. Regarding feed intolorence observed in 19 neonates, 1 (5.2%) was in mild category of thompson score, 3 (15.7%) were in moderate category and 15 (78.9%) were in severe category. Among 14 neonates having acute kidney injury, 3 (20%) were in moderate Thompson score and 12 (80%) were in severe thompson score. The percentage of thrombocytopenia, anemia, feed Intolerance and acute kidney injury was highly seen in severe grade of thompson score when compared to mild and moderate category of thompson score with the p value of less than 0.05 respectively.

Table 5: Comparison between Modified Sarnat score and complications

Complications		**Modified Sarnat score**		**Test statistic**	**P value**
		Mild (n=29)	**Moderate o severe (n= 21)**		
Mortality	Yes	2(25.0)	6(75.0)	4.258	0.039*
	No	27(64.3)	15(35.7)		
Mortality within <24 hrs.	Yes	1(50.0)	1(50.0)	0.055	0.815
	No	28(58.3)	20(41.7)		
tality between24-72 hrs.	Yes	0	2(100.0)	---	0.343#
	No	29(60.4)	19(39.6)		
Mortality after >72 hrs.	Yes	1(25.0)	3(75.0)	1.944	0.163
	No	28(60.9)	18(39.1)		
CNS seizures	Yes	11(37.9)	18(62.1)	11.416	0.0001*
	No	18(85.7)	3(14.3)		
PPHN	Yes	8(30.8)	18(69.2)	16.488	0.0001*
	No	21(87.5)	3(12.5)		
Hypotension	Yes	2(10.0)	18(90.0)	31.527	0.0001*
	No	27(90.0)	3(10.0)		
Deranged	Yes	5(26.3)	14(73.7)	12.629	0.0001*
coagulation	No	24(77.4)	7(22.6)		
	Yes	8(30.8)	18(69.2)		

Thrombocytopenia	No	21(87.5)	3(12.5)	16.488	0.0001*
Anemia	Yes	1(7.1)	13(92.9)	20.645	0.0001*
	No	28(77.8)	8(22.2)		
Feed Intolerance	Yes	2(10.5)	17(89.5)	28.352	0.0001*
	No	27(87.1)	4(12.9)		
te kidneyinjury	Yes	2(13.3)	13(86.7)	17.550	0.0001*
	No	27(77.1)	8(22.9)		

Statistical test used: Chi square test;

*p value <0.05 is considered statistically significant

#p value based on fisher's exact test

Comparing neonatal mortality with Modified Sarnat score, 2 (25%) werein moderate category and 6 (75%) were in severe category. Percentage of mortality was significantly high in moderate to severe modified sarnat score when compared to mild modified sarnat score category with the p value of 0.039.Among 2 neonatal deaths observed within 24 hours, 1(50%) was in mild modified sarnat score and 1 (50%) was in severe modified sarnat score.Among 2 neonatal deaths occurred between 24 to 72 hours, all were in severe modified sarnat score.Among 4 neonatal deaths occurred after 72 hours, 1(25%) was in mild modified sarnat score and 3 (75%) were in moderate to severe modified sarnat score.Among 29 neonates under mildmodified sarnat score, 11 (37.9%) had seizures and among 21 neonates in moderate to severe modified sarnat score ,18 (62.1%) had seizures. CNS seizures were highly seen in moderate to severe modified sarnat score with the p value of 0.0001.Among 26 neonates having PPHN, 8 (30.8%) were categorized as mild, 18 (62.1%) were in moderate to severe modified sarnat score. The percentage of PPHN was significantly high in moderate to Severe modified sarnat score when compared to mild modified sarnat score with the p value of <0.0001. Hypotension was observed in 18(90%) neonates under moderate to severe modified sarnat score and 2 (10%) neonates under mild modified sarnat score and this difference is significant with the p value of 0.001.Among 19 neonates having deranged coagulation profile, 5 (26.3%) were in mild modified sarnat score and 14 (73.7%) were in moderate to severe modified sarnat score. Deranged coagulation was observed highly in moderateto severe sarnat score when compared to other category of sarnat score andthe difference is statistically significant with the p value of 0.0001.Thrombocytopenia was observed in 18 (69.2%) neonates under moderate to severe modified sarnat score and 8 (30.8%) were in mild modified sarnat score, this difference is statistically significant with the p value of 0.0001.Among 14 neonates who had anemia, 1(7.1%) was in mild modified sarnat score and 13 (12.5%) were in moderate to severe sarnat score and this difference is significant with the p value of 0.0001. Regarding feed intolorence observed in 19 neonates, 2 (10.5%) were in mild category of modified sarnat score and 17(89.5%) were in moderate to severe category of modified sarnat score. Among 14 neonates having acute kidney injury, 2(13.3%) were in mild category and 13(86.7) were in moderate to severe category of modified sarnat score.

The percentage of mortality, CNS seizures, PPHN, Hypotension, Deranged coagulation, Thrombocytopenia, Anemia, GI outcome and Renal outcome was observed highly in Moderate to severe sarnat staging whencompared to mild sarnat staging with the p value showing less than 0.05respectively

Table 6: Comparison between Thompson and modified sarnat score

Modified SANART score	Thompson score		Total	Kappa statistics	P value
	Mild	Moderate to severe			
Mild	18 (36.0)	11 (22.0)	29 (58.0)	0.496	0.0001*
oderate tosevere	2 (4.0)	19(38.0)	21 (42.0)		
Total	20 (40.0)	30 (60.0)	50 (100.0)		

Statistical test used: Kappa analysis

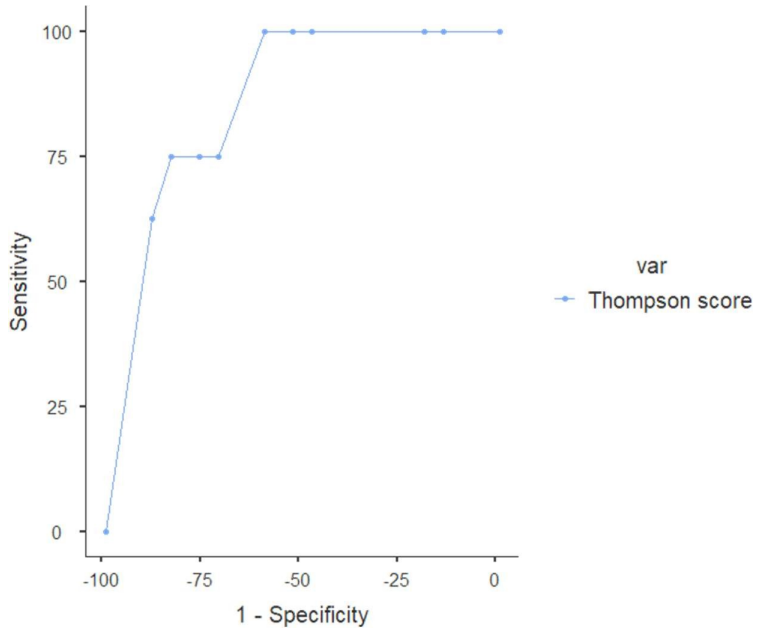
*p value <0.05 is considered statistically significant

There is a fair agreement between Thompson and modified sarnat score. Itrightly classified only (74%) of the cases.

Table 7: ROC curve - Thompson score with mortality

	Cutoff value	sensitivity	specificity	PPV	NPV	ouden's index	Area under the curve
Thompson score	15	100%	59.52%	32%	100%	0.595	0.859
	18	75%	83.33%	46.15%	94.59%	0.583	0.859

Figure 2: ROC curve



DISCUSSION:

Thompson and Modified Sarnat Scores:

The distribution of neonates across Thompson and Modified Sarnat score categoriesprovides insights into the severity of neonatal encephalopathy and its associated outcomes.The higher proportion of neonates classified as severe by the Thompson score (36%)compared to the Modified Sarnat score (2%) raises questions about the criteria used in eachscoring system and their sensitivity in identifying neonates at risk of adverse outcomes.[6] Previous studies have reported variations in the distribution of neonates across severity categories based on different scoring systems, highlighting the challenges in standardizingthe assessment of neonatal encephalopathy.[7] The discrepancy between the Thompson andModified Sarnat scores underscores the importance of selecting appropriate assessment toolstailored to the clinical context and population under study.

Mortality Rates:

The mortality rates at different time points provide insights into the temporal patterns of neonatal deaths and their association with severity categories based on Thompson and Modified Sarnat scores. The higher mortality rate observed in neonates classified as severe by both scoring systems suggests an association between the severity of neonatal encephalopathy and adverse outcomes, including mortality.

Comparing these findings with previous studies[8], similar associations between the severity of neonatal encephalopathy and mortality rates have been reported, emphasizing the prognostic value of early assessment and classification of neonatal encephalopathy. However, the relatively small sample size of this study may limit the generalizability of its findings, warranting validation in larger cohorts.

The study found a 58% prevalence of CNS seizures among neonates, consistent with previous research. However, the higher prevalence could be attributed to differences in patient populations, NICU protocols, or diagnostic criteria for CNS seizures. The study also found that 52% of newborns were diagnosed with Persistent Pulmonary Hypertension of the Newborn (PPHN), while 40% had hypotension. These findings align with previous literature, which highlights the prevalence of PPHN and hypotension in neonates, especiallythose born

prematurely or with perinatal asphyxia. However, the study reported a lower prevalence of PPHN (42%) but a similar prevalence of hypotension (39%).[9]

All neonates experienced respiratory failure, highlighting the importance of early detection, intervention, and respiratory support strategies in neonatal care. Haematological abnormalities in neonates, such as deranged coagulation (38%), thrombocytopenia (52%), and anemia (28%), were also reported. However, the study reported a higher prevalence of thrombocytopenia (65%) but lower rates of deranged coagulation (25%) and anaemia (20%).

Feed Intolerance and acute kidney injury were also found to be high, with 38% of neonates having feed intolorence and 30% having acute kidney injury. However, the study reported lower rates of feed intolerance (25%) but similar rates of acute kidney injuries (32%).

Neonatal Mortality

The current study found that neonatal mortality was significantly higher in the severe Thompson score category, with 75% of deaths in this group ($p=0.010$). This aligns with the findings of previous studies, such as Aoki et al[10], which also reported higher mortality ratesin neonates with severe Thompson scores compared to those with moderate or mild scores . Similarly, a study by Dalip et al[11] indicated that a higher Thompson score is associated with increased mortality, particularly within the first 72 hours post birth .

CNS Seizures

Our study demonstrated a significant association between severe Thompson scores and the incidence of CNS seizures ($p=0.001$). This is consistent with the findings of Lauren et al.[12] who found that infants with higher Thompson scores were more likely to experience seizuresand other neurological complications . Another study by Maphake et al[13]supports this, showing that severe Thompson scores are predictive of increased seizure activity in neonates

.Persistent Pulmonary Hypertension of the Newborn (PPHN)

The incidence of PPHN was significantly higher in neonates with severe Thompson scores ($p<0.001$). This finding is corroborated by studies like Mohd et al[14] which identified a strongcorrelation between high Thompson scores and the occurrence of PPHN.

Hypotension and Deranged Coagulation

Hypotension and deranged coagulation were also significantly more prevalent in neonates with severe Thompson scores ($p=0.001$ and $p=0.010$, respectively). These results are in line with previous research by Alan et al[15] who found that severe Thompson scores were associated with higher incidences of cardiovascular instability and coagulopathies in neonates. Moreover, Shankaran et al[16] observed similar patterns, highlighting that abnormal aEEG could predict poor cardiovascular outcomes in neonates.

Thrombocytopenia, Anaemia, Feed intolerance, and Acute Kidney Injury

Our findings indicate that thrombocytopenia, anaemia, Feed intolerance, and Acute Kidney Injury were significantly associated with severe Thompson scores ($p<0.05$). This is supported by a study by Thorsen et al[17]which demonstrated that higher Thompson scores were predictive of haematological and renal complications in neonates.

Modified Sarnat Score Comparison

The modified Sarnat score also showed a significant association with neonatal complications, including mortality, CNS seizures, PPHN, hypotension, deranged coagulation, thrombocytopenia, anaemia, Feed intolerance, and Acute Kidney Injury ($p<0.05$). This is consistent with the findings of Anna et al[18] who demonstrated that higher Sarnat scores are correlated with worse neonatal outcomes.

Agreement Between Thompson and Modified Sarnat Scores

The Kappa analysis revealed a fair agreement between the Thompson and modified Sarnat scores (Kappa = 0.496, p=0.0001), correctly classifying 74% of cases. This moderate agreement suggests that while both scoring systems are useful, they may capture slightly different aspects of neonatal health. A study by Panaddda et al[19] supports this, indicating thatwhile both scores are correlated, they may not be entirely interchangeable due to differences in their assessment criteria and focus.

ROC Curve Analysis

The ROC curve analysis for the Thompson score with mortality showed an area under the curve (AUC) of 0.859, indicating good predictive value. The optimal cut-off value of 15

provided 100% sensitivity and 59.52% specificity. These findings are similar to those reported by Shalak and Perlman[2] who found that higher Thompson scores had good predictive accuracy for neonatal mortality. The AUC of 0.859 is comparable to the values reported in other studies, such as those by Maphake et al[20] which demonstrated the Thompson score's effectiveness in predicting adverse neonatal outcomes.

LIMITATIONS:

While the study provides valuable insights into neonatal health outcomes and their associations with various factors, it's important to acknowledge its limitations: The study's sample size may be relatively small, limiting the generalizability of its findings to broader populations. A larger and more diverse sample could provide a better representation of neonatal outcomes across different demographics and settings.

Secondly, if the study was conducted in a single healthcare facility or region, the findings may not reflect variations in neonatal care practices and outcomes observed in different healthcare settings. Multi-centre studies would offer a more comprehensive understanding ofneonatal health outcomes.

CONCLUSION:

The study reveals that the Thompson Score and Modified Sarnat Staging are useful tools for assessing hypoxic-ischemic encephalopathy severity and predicting early neonatal outcomes.However, the Thompson Score offers a more accurate and reliable prediction of outcomes compared to the Modified Sarnat Score. The Thompson Score's higher sensitivity and specificity in identifying neonates at risk for adverse outcomes suggest it should be preferredfor early identification and management of post-asphyxiated neonates. This improved predictive capability could lead to better-targeted interventions, ultimately improving neonatal care and outcomes. The Thompson Score is superior in predicting early neonatal outcomes in post-asphyxiated neonates, supporting its use as a more effective tool for early assessment and intervention in neonatal intensive care units. The study highlights the prevalence of complications such as CNS seizures, PPHN, and hypotension, as well as the impact of maternal age and mode of delivery on neonatal health. Overall, the results contribute to our understanding of neonatal care practices and underscore the importance of targeted interventions to reduce morbidity and mortality rates in neonates.

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REFERENCES:

1. Lawn JE, Cousens S, Zupan J, Lancet Neonatal Survival Steering Team. 4 million neonatal deaths: when? Where? Why? Lancet Lond Engl 2005;365(9462):891–900.
2. Perlman JM, Wyllie J, Kattwinkel J, Wyckoff MH, Aziz K, Guinsburg R, et al. Part 7: Neonatal Resuscitation: 2015 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care

Science With Treatment Recommendations. Circulation 2015;132(16 Suppl 1):S204-241.

3. Shankaran S, Laptook AR, Ehrenkranz RA, Tyson JE, McDonald SA, Donovan EF, et al. Whole-body hypothermia for neonates with hypoxic-ischemic encephalopathy. N Engl J Med 2005;353(15):1574–84.

4. Sarnat HB, Sarnat MS. Neonatal encephalopathy following fetal distress. A clinical and electroencephalographic study. Arch Neurol 1976;33(10):696–705.

5. Thompson CM, Puterman AS, Linley LL, Hann FM, van der Elst CW, Molteno CD, et al. The value of a scoring system for hypoxic ischaemic encephalopathy in predicting
neurodevelopmental outcome. Acta Paediatr Oslo Nor 1992 1997;86(7):757–61.

6. Maphake J, Naidoo H, Coetzee M, Becker P. The accuracy of the Thompson score in predicting early outcome in neonates with hypoxic ischaemic encephalopathy treated with therapeutic cooling in a tertiary hospital. South Afr Med J Suid-Afr Tydskr Vir Geneeskd 2023;113:1269–74.

7. Pierrat V, Haouari N, Liska A, Thomas D, Subtil D, Truffert P, et al. Prevalence, causes, and outcome at 2 years of age of newborn encephalopathy: population based study. Arch Dis Child Fetal Neonatal Ed 2005;90(3):F257-261.

8. Garite TJ, Clark R, Thorp JA. Intrauterine growth restriction increases morbidity and mortality among premature neonates. Am J Obstet Gynecol 2004;191(2):481–7.

9. Singh Y, Lakshminrusimha S. Pathophysiology and Management of Persistent Pulmonary Hypertension of the Newborn. Clin Perinatol 2021;48(3):595–618.

10. Aoki Y, Kono T, Enokizono M, Okazaki K. Short-term outcomes in infants with mild neonatal encephalopathy: a retrospective, observational study. BMC Pediatr 2021;21:224.

11. Bhagwani DK, Sharma M, Dolker S, Kothapalli S. To Study the Correlation of Thompson Scoring in Predicting Early Neonatal Outcome in Post Asphyxiated Term Neonates. J Clin Diagn Res JCDR 2016;10(11):SC16–9.

12. Weeke LC, Vilan A, Toet MC, van Haastert IC, de Vries LS, Groenendaal F. A Comparison of the Thompson Encephalopathy Score and Amplitude-Integrated
Electroencephalography in Infants with Perinatal Asphyxia and Therapeutic Hypothermia. Neonatology 2017;112(1):24–9.

13. Maphake J, Naidoo H, Coetzee M, Becker P. The accuracy of the Thompson score in predicting early outcome in neonates with hypoxic ischaemic encephalopathy treated with therapeutic cooling in a tertiary hospital. South Afr Med J Suid-Afr Tydskr Vir Geneeskd 2023;113:1269–74.

14. Mat Bah MN, Tan RYH, Razak H, Sapian MH, Abdullah N, Alias EY. Survival and associated risk factors for mortality among infants with persistent pulmonary hypertension of the newborn in Malaysia. J Perinatol 2021;41(4):786–93.

15. Horn AR, Swingler GH, Myer L, Linley LL, Raban MS, Joolay Y, et al. Early clinical signs in neonates with hypoxic ischemic encephalopathy predict an abnormal amplitude-integrated electroencephalogram at age 6 hours. BMC Pediatr 2013;13(1):52.

16. Shankaran S, Pappas A, McDonald SA, Laptook AR, Bara R, Ehrenkranz RA, et al.

Predictive value of an early amplitude integrated electroencephalogram and neurologic examination. Pediatrics 2011;128(1):e112-120.

17. Thorsen P, Weide MCJ van der, Groenendaal F, Onland W, Straaten HLM van, Zonnenberg I, et al. The Thompson Encephalopathy Score and Short-Term Outcomes in Asphyxiated Newborns Treated With Therapeutic Hypothermia. Pediatr Neurol 2016;60:49–53.

18. Mrelashvili A, Russ JB, Ferriero DM, Wusthoff CJ. The Sarnat score for neonatal encephalopathy: looking back and moving forward. Pediatr Res 2020;88(6):824–5.

19. Chansarn P, Torgalkar R, Wilson D, Fan CPS, Widjaja E, Whyte H, et al. Correlationof Thompson and modified Sarnat scores in neonatal hypoxic ischemic encephalopathy.J Perinatol 2021;41(6):1522–3.

20. Maphake J, Naidoo H, Coetzee M, Becker P. The accuracy of the Thompson score in predicting early outcome in neonates with hypoxic ischaemic encephalopathy treated with therapeutic cooling in a tertiary hospital. South Afr Med J Suid-Afr Tydskr Vir Geneeskd 2023;113:1269–74.