

A Comparative Study Between Thompson Scoring vs Modified Sarnat Staging in Predicting Outcomes in Neonates with Perinatal Asphyxia

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Abstract: Background: Birth asphyxia is one of the commonest causes of neurodevelopmental delay in children. This study is done to assess between Thompson score vs Modified Sarnat score in predicting neurodevelopmental outcome in post asphyxiated Term neonates. Methodology: This study was conducted in Medical Newborn (MNB) in a tertiary care centre in Chennai, Tamil Nadu during the period of July 2021- June 2022. The newborns were subjected to Thompson and Sarnat score on three days and followed up at 6 months with Bayley scale for developmental assessment. Results: Of the 70 neonates enrolled 46(65.71%) were male and 24(34.29%) females. Male to female ratio was 1.5:1 showing increased incidence in male. The most common risk factors associated with asphyxia in this study were Maternal Anaemia 22(31.43%), Gestational diabetes 14(20%), PIH 13(18.57%) and hypothyroid 5(7.14%). Of the 65 neonates followed up at 6 months 92.68% (38) neonates categorized as mild HIE by Thompson had >85% Bayley score with good developmental outcome, 13.84 (9) % neonates who were stated as mild HIE and 61.70(29) stated as moderate HIE by Modified Sarnat grading had good Bayley score and appropriated neurodevelopmental outcome at 6 months. Conclusion: Thompson score and Modified Sarnat score are equally predicting outcome but Thompson score is more specific in categorizing MILD HIE.

Keywords: HIE, Thompson, Modified Sarnat score, Bayley

1. Introduction

Perinatal asphyxia is one of the major causes of mortality among neonates and under 5 in developing countries. It is one of the three main causes of neonatal deaths [1]. Perinatal asphyxia is defined as APGAR score < 7 at 1 minute of life based on NNPD [2] or persistent APGAR of < 3 at 5 minutes of life [6]. Incidence of birth asphyxia is about 8.5% of all live birth all over the world [2]. Hypoxic ischemic encephalopathy (HIE) is the term used to define the neurological sequelae post perinatal asphyxia. 15-20 % of neonates with HIE die during their neonatal period, 30% of the surviving neonates suffer from neurodevelopmental disorders [4]. Neonates surviving HIE without major disability are at increased risk of motor, verbal deficits. They also have a risk of long-term intellectual disability. Predicting the neurodevelopmental outcome early helps in early intervention and stimulation reducing morbidity.

The prediction of neurodevelopmental outcome of the asphyxiated neonates are done with the help of HIE severity scores, assessed during the early days of life. There are various scores that are used to assess the status of the child post asphyxia. Thompson (less commonly) and Modified Sarnat score are being used for the same. Modified Sarnat scoring relies on multiple categories and the final categorization can be subjective sometimes. Thompson score developed from Sarnat score has lesser number of determinants and is a numeric score which makes it more defined and easier to use.

Thompson score comprises of 9 components; severity graded from 0-3 and where 0 is normal. Based on the scores the

severity of HIE is graded as mild HIE (1-10), moderate HIE (11-14) and severe HIE (15-22).

In this study we have compared the efficacy of Thompson and Modified Sarnat score in predicting outcomes in asphyxiated neonates by using BAYLEY 3 scale at follow-up at 6 months of age [3].

2. Materials and Methods

A prospective observational study done during the period of December 2021 to December 2022 in the Medical newborn unit, Institute of child health and hospital for children, Egmore, Chennai. The study population includes neonates who satisfy the criteria for perinatal asphyxia –Apgar less than 7 at 1 minute [2], <3 at 5 minutes [5]. Failure to initiate breath at birth. Gestation age more than 36 weeks, birth weight > 1.8 kg, newborns requiring PPV for > 1 minute [5]. Preterm neonates, neonates with congenital disorders and hyperbilirubinemia bordering kernicterus were excluded from the study.

After obtaining informed consent, antenatal and birth details of the neonates were recorded in a pre-structured proforma. For all recruited neonates Thompson scoring and Modified Sarnat scores were done on days 1,3 and 7. Developmental assessment of these neonates were done at 6 months age using Bayley 3 scale.

The outcome/ neurodevelopmental delay severity was graded with the help of composite scores of Bayley scale.

Severe developmental delay – composite score in domains - <70

Moderate – composite score – 70-84

Normal or acceptable – 85 to 100

Statistical Analysis

All statistical test were two tailed tests. Statistical analysis was carried out using the SPSS, version 22 statistical software. $P \leq 0.05$ was considered statistically significant. Association between Risk factors score and THOMPSON SCORE /SARNAT score were assessed using chi square test.

3. Results

Of the 70 neonates enrolled 46(65.71%) were males and 24(34.29%) were females **Fig 1**

On assessing the APGAR scores of the 70 neonates, at 1 minute 8 (11.42%) neonates had APGAR of <3 and 62 (88.57%) had and APGAR of 4-6. At 5 minutes, 3 (4.28%) neonates had an APGAR of < 3, 14(20.00%) had 4-6 APGAR and 55(78.57%) had an APGAR of ≥ 7 **Table 1 / Fig 2**

Risk factor analysis: Neonates born to mothers who have registered pregnancy early had a better APGAR. Neonates born with short duration of labour had an APGAR of 7 (61).

Neonates born with cord around the neck had poor APGAR (19).

Of the 5 neonates died before day 7 of life, all 5 were categorized as severe HIE by Thompson score, while 3 were categorized as severe and 2 as moderate by Modified Sarnat score. Thompson was more specific in categorizing severity and predicting death. **Table 2.**

On assessing Thompson score on day 7 of life, of the 65 alive neonates (36)55.38% had no HIE, 15.38% (10) had Mild HIE, 15.38% (10) neonates had Moderate HIE and 13.84% (8) neonates had Severe HIE. **Table 3**

On assessing Modified Sarnat score, 55.38% (36) neonates had No HIE, 13.84% (9) neonates had Grade 1 HIE, 16.92 % (11) had Grade 2 HIE and 13.84% (9) neonates had Grade 3 HIE. **Table 5**

Of the 5 neonates died before day 7 of life, all 5 were categorized as severe HIE by Thompson score, while 3 were categorized as severe and 2 as moderate by Modified Sarnat score. Thompson was more specific in categorizing severity and predicting death. **Table 6**

On assessing evolution of Thompson score from day from day 1 to day 7 55.38% (36) neonates improved to no HIE. **Table 4**

Clinical outcomes of the neonates were divided into 3 categories. 67.69% (44) of the neonates were normal with-out developmental delay or seizures.24.61% (16) of them were living with developmental delay seizures and on AED. 7.69% (5) had developmental delay alone. **Fig 3**

Developmental assessment was done at 6 months age using Bayley scale which was compared with the Thomson and

Sarnat score separately. On comparing Thompson score with Bayley scale, 100% (36) neonates with No HIE, 80% (8) Mild HIE and 20% (2) Moderate HIE had good development ($> 85\%$ composite score).20% (2) Mild HIE and 50% (5) Moderate HIE had a composite score of 70-85% with moderate developmental delay. 30% (3) Severe HIE neonates had $<70\%$ score with severe developmental delay. Thompson score has predicted Severe developmental delay in most of the neonates and those neonates who recovered without HIE on day 7 of life 100% had good developmental outcome with a P value of <0.001 as in **table 7.**

On comparing Sarnat score on day 7 of life with Bayley at 6 months 100% (36) neonates with No HIE, 66.66% (6) Mild HIE and 36.36% (4) Moderate HIE had good developmental outcome. 33.33% (3) Grade 1 HIE, 36.36% (4) Grade 2 HIE and 11.11% (1) Grade 3 had moderate developmental delay. 27.27% (3) Grade 2 and 88.88% (8) Grade 3 HIE had Severe developmental delay. Sarnat has equally predicted good development in all the neonates who had No HIE on day 7, with a P value <0.001 shown in **table 7.**

Receiver Operating Characteristic (ROC) curves comparing the predictive accuracy of the **Thompson score** and **Sarnat grading system** for adverse neurodevelopmental outcome (Bayley score $<70\%$) at 6 months of age. Both systems demonstrated excellent discriminatory ability, with an AUC of 0.98 for the Thompson score and 0.97 for the Sarnat grading. The Thompson score showed marginally superior predictive performance. **Fig 4**

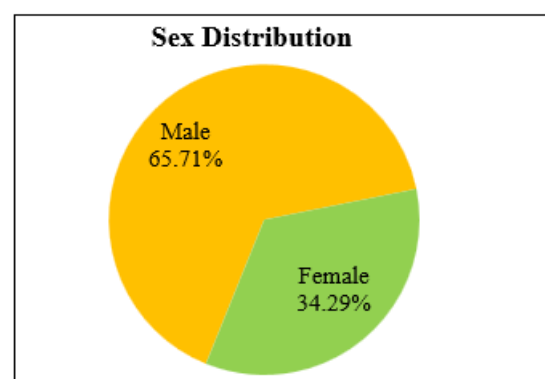


Figure 1: Pie diagram shows the sex distribution of neonates

Table 1: Depicts the APGAR scores at birth – 1 and 5 minutes

		Number of neonates	%
APGAR at 1 minute	4 - 6	62	88.57%
	< 3	8	11.42%
Apgar at 5 minutes	< 3	3	4.20%
	4-6	14	20.00%
	≥ 7	55	78.57%

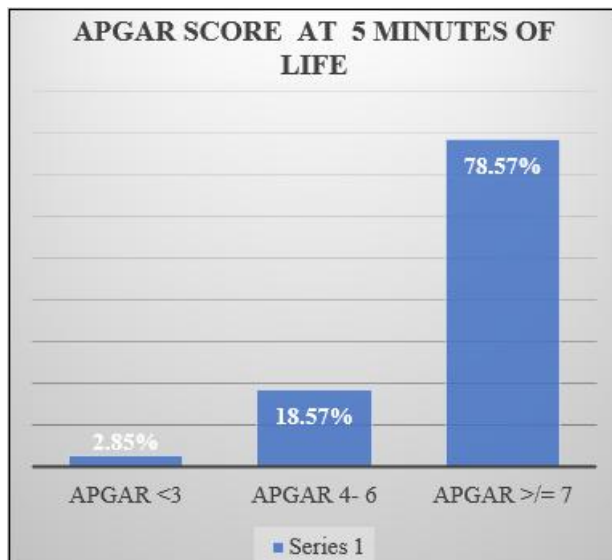


Figure 2: Represents APGAR score at 5 minutes of life.

Table 2: Depicts death due to severe HIE

		n	%
Death before day 3	No	68	97.14%
	Yes	2	2.86%
Death between day 3 - 7	No	67	95.71%
	Yes	3	4.29%
Death after day 7	No	70	100.00%
	Yes	0	0.00%

Table 3: Depicts Thompson score distribution on Day 7 of life

Level	No. of neonates	%
NO HIE	36	55.38%
Mild	10	15.38%
Moderate	10	15.38%
Severe	9	13.84%
Total	65	100.0%

Table 4: Evolution of Thompson score day 1 and 7

Thompson score	Day 1 (n=70)	Day 7 (n=65)
Mild	41	10
Moderate	15	10
Severe	14	9
No HIE	nil	36
Death	nil	5

Table 5: Depicts Modified Sarnat score distribution on day 7 of life

Level	No. of neonates	%
NO HIE	36	55.38%
Grade1	9	13.84%
Grade2	11	16.92%
Grade3	9	13.84%
Total	65	100.0%

Table 6: Depicts death due to severe HIE

		n	%
Death before day 3	No	68	97.14%
	Yes	2	2.86%
Death between day 3 - 7	No	67	95.71%
	Yes	3	4.29%
Death after day 7	No	70	100.00%
	Yes	0	0.00%

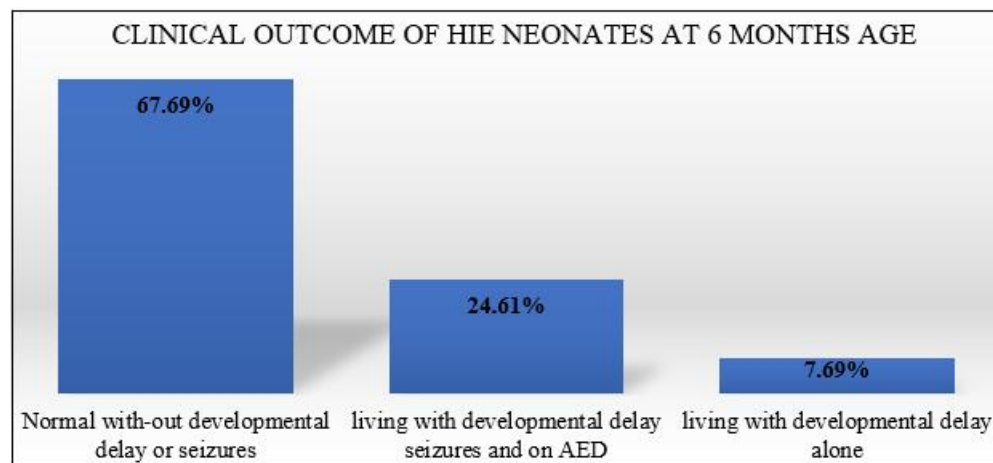


Figure 3: Depicts clinical outcome of HIE neonates at 6 months age

Table 7: Depicts comparison of Thompson and Sarnat scores with Bayley at 6 months age

		Bayley at 6 months						n	Chi square test
		<70%		70%-85%		>85%			
		n	%	n	%	n	%		
	No HIE	0	0.00%	0	0.00%	36	100%	36	
Grading With Thompson	Mild	0	0.00%	2	20.00%	8	80.00%	10	$\chi^2=76.03$ $\pi<0.001^{***}(\Sigma)$
	Moderate	3	30.00%	5	50.00%	2	20.00%	10	
	Severe	9	100%	0	0.00%	0	0.00%	9	
	No HIE	0	0.00%	0	0.00%	36	100	36	
Sarnat Grade	Grade1	0	0.00%	3	33.33%	6	66.66%	9	$\chi^2=30.49$ $\pi<0.001^{***}(\Sigma)$
	Grade2	3	27.27%	4	36.36%	4	36.36%	11	
	Grade3	8	88.88%	1	11.11%	0	0.00%	9	

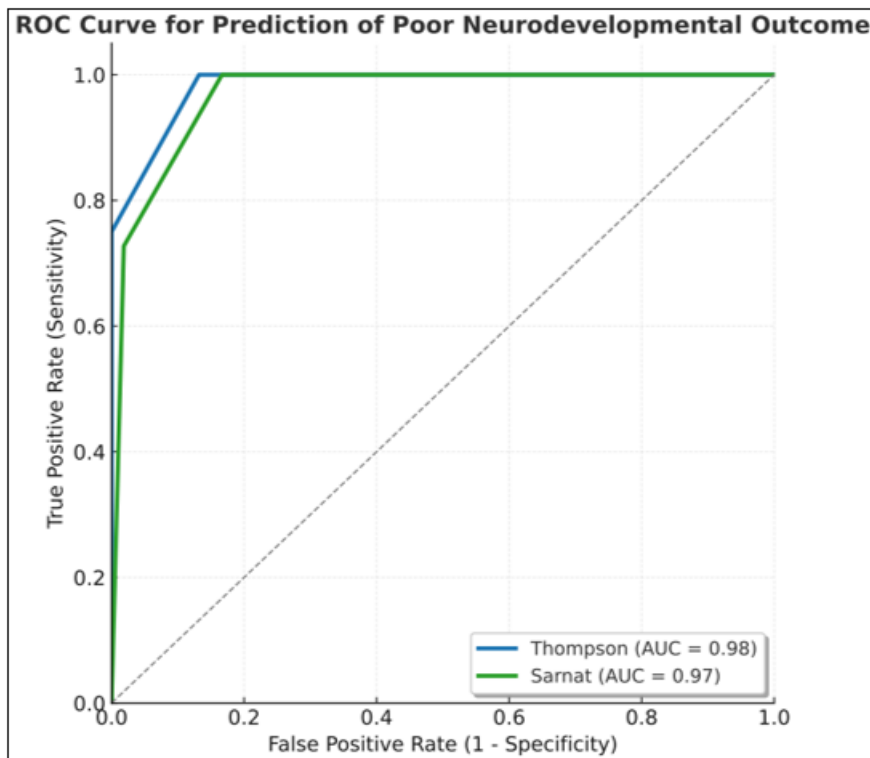


Figure 4: ROC curve comparing predictive accuracy of both the scores

4. Discussion

Perinatal asphyxia is defined as APGAR score of <7 at 1 minute of life. ⁽²⁾

Incidence of birth asphyxia is 8.5 % of all live births all over the world. ⁽²⁾ Neonates with severe perinatal asphyxia develop HIE which is an important cause of permanent neurological damage leading to death, cerebral palsy, mental retardation and global developmental delay.

In our study, 70 neonates with perinatal asphyxia were enrolled and HIE scoring was done for 3 days. These neonates were followed up at 6 months of age with developmental assessment.

Of the 70 neonates enrolled 46(65.71%) were males and 24(34.29%) were females.

On assessing the APGAR scores of the 70 neonates, at 1 minute 8 (11.42%) neonates had APGAR of <3 and 62 (88.57%) had and APGAR of 4-6. At 5 minutes, 3 (4.28%) neonates had an APGAR of <3 , 14(20.00%) had 4-6 APGAR and 55(78.57%) had an APGAR of ≥ 7 .

In a study conducted by Bhagwani D Kumar et al. ⁽⁴⁾, APGAR at 1 minute was < 3 in 58(40%) neonates and 4-6 in 87(60%) neonates.

In this study, 2(2.86%) neonates died before day 3 of life and, 3 (4.29%) neonates died between day 3-7 of life. All 5 neonates were categorized as severe HIE by Thompson score, whereas Modified Sarnat has classified 3 as severe and 2 as moderate HIE, Thompson score was able to predict death precisely more than Modified Sarnat score.

Bhagwani D Kumar et al ⁽⁴⁾ in their study has stated that out of the 145 neonates enrolled in their study 11 died before 7 days of which, 7 died before day 3 of life.

On assessing the HIE scores on day 7 – 41 neonates had mild HIE, 15 were moderate and 9 had mild HIE based on Thompson score. Modified Sarnat score has categorized 9 (13.84%) neonates as mild HIE, 47 as moderate and 9 neonates as severe HIE.

Natarajan, Girija et al ⁽⁹⁾. in their study, they have assessed Modified Sarnat score of 528 neonates – 71% had moderate HIE and 29% had severe HIE.

In our study all the neonates who had returned to Thompson HIE score 0 by day 7 had a good neurodevelopmental outcome at 6 months age which was contradicting to the results obtained by Caravale et al ⁽¹³⁾, who has showed that 4 (14%) of 28 infants who had a normal score on day 7 had abnormal outcome at 1 year age.

In our study, we have assessed the neurodevelopmental outcome of surviving asphyxiated neonates at 6 months age, the results were, 26.15% (17) had severe developmental delay, 13.84% (9) had moderate developmental delay and 60% (39) had normal or acceptable neurodevelopment.

On correlating Thompson score separately with Bayley score at 6 months age, the 9 (13.84%) neonates who were categorized as Severe HIE on day 7 of life had severe developmental delay at 6 months with a Bayley composite score of <70 at 6 months age. Similar results were obtained by Abdulqawi et al ⁽¹¹⁾.

On correlating Sarnat score separately with Bayley at 6 months age, 88.9% with Grade 3 HIE and 27.3% with Grade 2 HIE had poor neurodevelopmental outcome.

The neonates who returned to no HIE on day 7 by Modified Sarnat score had good neurodevelopmental outcome at 6 months age. This was consistent with the results obtained by Dilenge et al.⁽¹⁴⁾, and Sarnat and Sarnat⁽¹⁵⁾.

Chi-square analysis of both Thompson and Modified Sarnat score in assessing neurodevelopmental outcome at 6 months age showed significant correlation with p value <0.001.

In our study, ROC curves were derived to compare the accuracy of both scores in predicting neurodevelopmental outcomes, both were statistically significant predictors (p < 0.001). The slightly higher AUC of the Thompson score suggests it may provide superior predictive accuracy compared to the Sarnat system. This difference may be attributable to the greater granularity of the Thompson score, which is a numerical scale capturing subtle gradations in clinical signs, whereas the Sarnat system uses broader categorical stages. Prior literature has similarly highlighted the higher sensitivity and reproducibility of the Thompson **score**, with reduced inter-observer variability, making it particularly useful for bedside application even in resource-limited settings.

Both scoring systems show a strong and statistically significant association with developmental outcome at 6 months. As severity of HIE increases, the proportion of infants with poor developmental outcomes (Bayley <70%) also increases.

5. Conclusion

Both the Thompson score and Sarnat grading are statistically significant predictors of neurodevelopmental outcome at 6 months. However, The Thompson score may offer better discriminatory power, especially in distinguishing moderate from mild cases, as shown by its higher Chi-square value. The Sarnat grade is simpler and still effective but may have more variability in moderate cases. Thompson score offers a marginal advantage in prognostication. This supports its wider clinical utility for early risk stratification and counselling of families

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