CORRELATION OF THOMPSON SCORE AND MODIFIED SARNAT STAGING IN PREDICTING EARLY NEONATAL OUTCOME IN POST ASPHYXIATED NEONATES - A PROSPECTIVE OBSERVATIONAL STUDY

By

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DISSERTATION SUBMITTED TO

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Under The Guidance Of

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Abstract

Background: Birth asphyxia is a significant contributor to neonatal mortality and morbidity, remains a critical challenge worldwide, especially in developing nations. Even with advances in perinatal care, Hypoxic Ischemic encephalopathy (HIE) continues to have a considerable impact on long term neurodevelopmental outcomes.Here 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 various factors may lead to inconsistent outcomes. Aim: To determine the correlation between Thompson Score and Modified Sarnat Staging in assessing the outcome in early neonatal period in post asphyxiated neonates. Results: Among 50 neonates, overall mortality was observed in 16% of neonates, with deaths occurring within 24 hours (4%), between 24-72 hours (4%), and beyond 72 hours (8%). A significant association was found between both Thompson and Modified Sarnat scores with mortality and other outcomes such as seizures, persistent pulmonary hypertension(PPHN), hypotension, deranged coagulation, thrombocytopenia, anuresis, feeding intolerance, and acute kidney injury. 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 [illegible] the curve (AUC) was 0.939, indicating strong predictive capability for mortality. Conclusion: The Thompson Score's higher sensitivity and specificity in identifying neonates at risk for adverse outcomes suggests it should be preferred for early identification and management of post-asphyxiated neonates. This improved predictive capability could lead to better-targeted interventions, ultimately improving neonatal care and outcomes.

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LIST OF ABBREVIATIONS

Glossary	Abbreviations
APGAR	Appearance, Pulse, Grimace, Activity And Respiration
ATP	Adenosine Triphosphate
AUC	Area Under The Curve
CNS	Central Nervous System
CT	Computed Tomography
CVS	Cardiovascular System
DNA	Deoxyribonucleic Acid
EBP	Evidence-Based Practice
EEG	Electroencephalogram
GFAP	Glial Fibrillary Acidic Protein
GMA	General Movements Assessment
HER	Electronic Health Records
HIE	Hypoxic-Ischemic Encephalopathy
HNNE	Hammersmith Neonatal Neurological Examination
LOC	Level Of Consciousness
LSCS	Lower Segmental Caesarean Section
MRI	Magnetic Resonance Imaging
MV	Mechanical Ventilator
NDO	Neurodevelopmental Outcomes
NICDH	National Institute Of Child Health And Human Development
NICU	Neonatal Intensive Care Units

NPV	Negative Pressure Ventilation
NSE	Neuron-Specific Enolase
NVD	Normal Vaginal Delivery
PC02	Partial Pressure of Carbon Dioxide
PO2	Partial Pressure of Oxygen
PPHN	Persistent Pulmonary Hypertension
PPV	Positive Pressure Ventilation
RCT	Randomized Controlled Trials
RDS	Respiratory Distress Syndrome
ROC	Receiver Operating Characteristic
ROS	Reactive Oxygen Species
RS	Respiratory System
SPSS	Statistical Package for Social Sciences
TH	Therapeutic Hypothermia
TS	Thompson Score
TSS	Total Sarnat Score
WHO	World Health Organization

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CORRELATION OF THOMPSON SCORE AND MODIFIED SARNAT STAGING IN PREDICTING EARLY NEONATAL OUTCOME IN POST ASPHYXIATED NEONATES - A PROSPECTIVE OBSERVATIONAL STUDY

ABSTRACT

Background: Birth asphyxia, a major cause of neonatal mortality and morbidity, is a significant global challenge, particularly in developing nations. Hypoxic-ischemic encephalopathy (HIE), a neurological syndrome resulting from perinatal asphyxia, can cause neonatal mortality or manifest later as cerebral palsy or cognitive impairment. 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. 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, 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.

Results: Among 50 neonates, overall mortality was observed in 16% of neonates, with deaths of (4%) occurring within 24 hours, (4%) between 24-72 hours and (8%) beyond 72 hours. A significant association was found between both Thompson and Modified Sarnat scores with mortality and other outcomes such as seizures, persistent pulmonary

hypertension(PPHN), hypotension, deranged coagulation, thrombocytopenia, anaemia, feeding intolerance, and acute kidney injury. 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

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

OBJECTIVES

Objectives of the study:

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

REVIEW OF LITERATURE

REVIEW OF LITERATURE:

1. Introduction to Neonatal Asphyxia

Neonatal Asphyxia is a significant medical condition characterized by a lack of oxygen and blood flow to a new-born infant during the perinatal period. This condition can result in various degrees of injury to the infant's brain and other organs, potentially leading to long-term neurological deficits or even death if not promptly and effectively managed.

Definition:

"Neonatal asphyxia is defined as the impairment of gas exchange leading to progressive "hypoxemia (decreased oxygen in the blood) and hypercapnia (increased carbon dioxide in the blood), with a resultant metabolic acidosis. It is typically diagnosed when the Apgar score is less than 7 at 5 minutes, or if there is evidence of metabolic acidosis (pH < 7.0 and base deficit > 12 mmol/L) in the umbilical arterial blood at birth""[6]

Epidemiology:

The global incidence of neonatal asphyxia varies significantly, often reflecting disparities in healthcare access and quality. In high-income countries, the incidence is estimated to be about 1 to 6 per 1,000 live births, whereas in low- and middle-income countries, the incidence can be as high as 26 per 1,000 live births . Neonatal asphyxia accounts for approximately 23% of all neonatal deaths worldwide, making it a critical target for neonatal healthcare interventions .[7,8]

Pathophysiology of Neonatal Asphyxia

The pathophysiology of neonatal asphyxia involves a complex interplay of factors leading to cellular hypoxia and subsequent organ damage. The primary mechanism is an

interruption in the delivery of oxygenated blood to the fetal tissues, which can occur due to various antepartum, intrapartum, or postpartum factors.

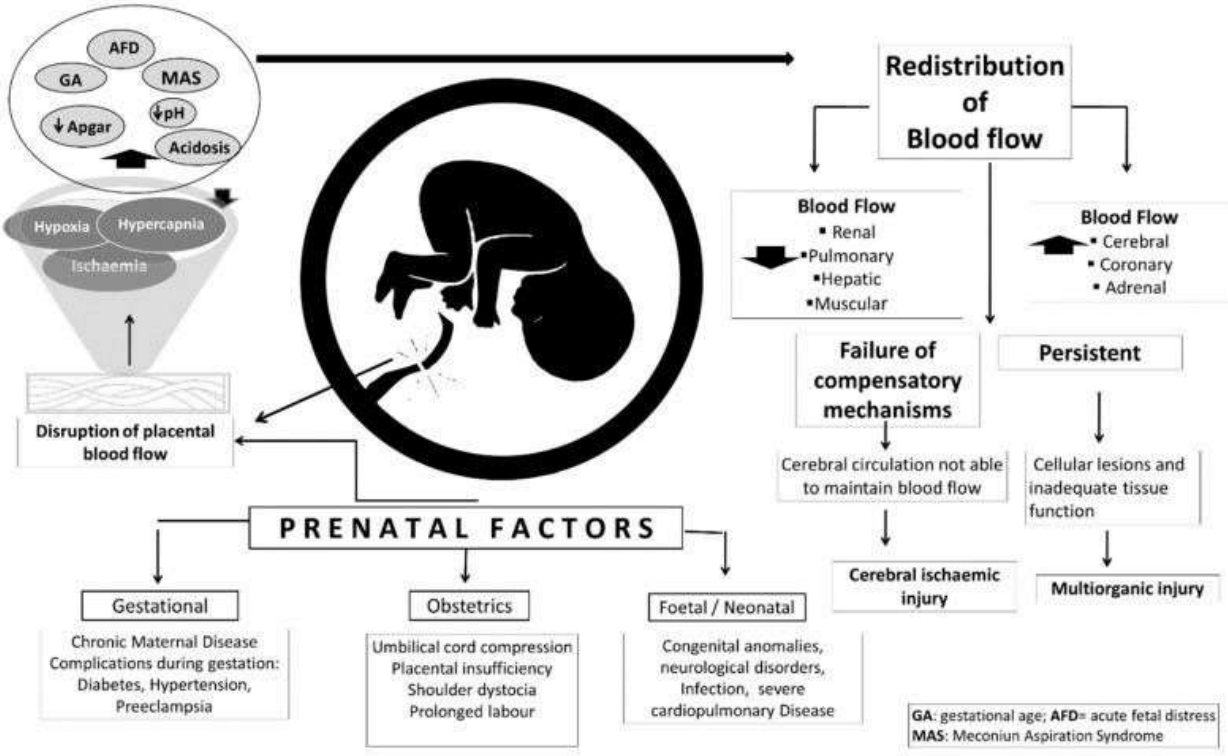


Figure 1: Prenatal risk factors and effect on cerebral ischemic injury[9]

Pathophysiological Mechanisms:

1. Hypoxic-Ischemic Injury:

- Hypoxemia and Hypercapnia: When oxygen delivery is compromised, the fetal blood oxygen level drops (hypoxemia), and carbon dioxide accumulates (hypercapnia), leading to respiratory and metabolic acidosis(ph<7).[10]
- Energy Depletion: Cells switch from aerobic to anaerobic metabolism, resulting in a rapid depletion of ATP and the accumulation of lactic acid, exacerbating metabolic acidosis.
- Cellular Damage: Lack of ATP disrupts cellular homeostasis, leading to ion pump failure, cell swelling, and eventual cell death through necrosis and apoptosis.

2. Reperfusion Injury:

- Oxidative Stress: Reintroduction of oxygen can paradoxically cause further damage through the production of reactive oxygen species (ROS), which can damage cell membranes, proteins, and DNA.[11]
- Inflammatory Response: Hypoxia and subsequent reperfusion trigger an inflammatory response, releasing cytokines and other mediators that can exacerbate neuronal injury.[12]

Clinical Manifestations: Neonatal asphyxia can present with a range of clinical signs, including low Apgar scores, poor muscle tone, respiratory distress, and altered neurological status. Long-term consequences can include cerebral palsy, intellectual disabilities, and other neuro-developmental disorders.

Table 1: Summary of Neonatal Asphyxia

Component	Description
Definition	Neonatal asphyxia is a condition characterized by impaired gas exchange leading to hypoxemia, hypercapnia, and metabolic acidosis in the neonate.
Risk factors	Intrauterine growth restriction, maternal hypertension, placental abruption, prolonged labour, umbilical cord complications, maternal infections.
Clinical manifestations	Poor Apgar scores, Central Nervous System: HIE, Cardiovascular: Myocardial dysfunction, Hypotension ,Respiratory system: Respiratory distress syndrome, Renal: Acute kidney injury ,Gastrointestinal: Feed intolerance, Necrotizing enterocolitis
Diagnosis	Clinical examination, apgar score, blood gas analysis, neuroimaging (ultrasound, MRI), electroencephalography (EEG).
Treatment	Immediate resuscitation (oxygen therapy, ventilation), supportive care (fluid management, anticonvulsants, monitoring of organ function),neuro-protective strategies.

2. Neonatal Outcome Predictors in Asphyxiated Infants

Importance of Early Prediction

Perinatal asphyxia, a condition characterized by impaired gas exchange leading to hypoxemia and hypercapnia, can result in significant neonatal morbidity and mortality. Early prediction of neonatal outcomes in asphyxiated infants is crucial for timely intervention and improved prognosis. Studies indicate that early identification of at-risk infants enables targeted therapeutic strategies, potentially mitigating adverse outcomes such as cerebral palsy, cognitive impairment, and long-term neuro-developmental disabilities.[1,3]

Clinical Relevance

- Therapeutic Interventions: Early prediction allows for prompt initiation of neuro-protective strategies, such as therapeutic hypothermia, which has been shown to reduce the risk of death or disability in term and near-term infants with hypoxic-ischemic encephalopathy (HIE).
- Resource Allocation: Identifying neonates at risk facilitates appropriate resource allocation in neonatal intensive care units (NICUs), ensuring that critically ill neonates receive the necessary level of care and monitoring.
- Parental Counselling: Accurate early prediction aids healthcare providers in counselling parents regarding the potential outcomes and the likely course of treatment, helping to set realistic expectations and prepare for future care needs.[12,13,14]

Common Predictive Tools and Their Efficacy

Several tools and biomarkers are utilized to predict outcomes in asphyxiated infants, each with varying degrees of efficacy. These tools include clinical assessments, biochemical markers, imaging techniques, and advanced neuro-physiological monitoring.

Apgar score

- Description: The Apgar score, developed by Dr. Virginia Apgar in 1952, assesses a newborn's condition at 1 and 5 minutes after birth based on five criteria: heart rate, respiratory effort, muscle tone, reflex irritability, and colour. Each criterion is scored from 0 to 2, with a maximum total score of 10.[15]

- Efficacy: While the Apgar score is useful for initial assessment, its predictive value for long-term outcomes in asphyxiated neonates is limited. Studies have shown that low Apgar scores correlate with increased risk of neurological impairment and mortality, but they are not definitive predictors of specific outcomes.

Umbilical Cord Blood Gas Analysis

- Description**:**This tool measures pH, partial pressure of carbon dioxide (pCO2), and partial pressure of oxygen (pO2) in the umbilical cord blood, providing an objective assessment of metabolic acidosis and the infant's acid-base status at birth.
- Efficacy**:** Cord blood gas analysis is a strong predictor of neonatal outcomes. Low pH and high base deficit values are associated with increased risks of hypoxic-ischemic encephalopathy (HIE) and adverse neurological outcomes. Metabolic acidosis (low pH and high base deficit) is associated with an increased risk of neonatal morbidity and mortality. Lactate levels can indicate the severity of asphyxia but are not consistently reliable as sole predictors.[16]

Neurological Examination (Sarnat Score)

- Description: The Sarnat scoring system classifies the severity of HIE based on clinical findings.

- Efficacy: It is a useful tool for early identification of HIE severity, but its predictive accuracy for long-term outcomes varies depending on the timing of the assessment and the degree of HIE.[4]

Neuroimaging Techniques

- Description:Techniques such as cranial ultrasound, computed tomography (CT), and magnetic resonance imaging (MRI) are used to detect brain injuries.
- Efficacy: MRI, particularly diffusion-weighted imaging, is highly effective in identifying the extent of brain injury and predicting neuro-developmental outcomes in asphyxiated infants.[17]

Amplitude-Integrated Electroencephalography (aEEG)

- Description: aEEG is a simplified form of EEG that monitors cerebral activity and helps detect abnormalities in brain function. It is particularly useful in the first 6 hours of life.
- Efficacy: aEEG has proven to be a reliable predictor of neurological outcomes. Abnormal aEEG patterns, such as burst suppression or low voltage, are associated with poor neuro-developmental outcomes. Early aEEG can help identify candidates for therapeutic hypothermia.[4,18]

Magnetic Resonance Imaging (MRI)

- Description:MRI provides information of structural abnormalities of brain in asphyxiated neonates
- Efficacy: MRI, especially diffusion-weighted imaging (DWI), is highly predictive of long-term neuro-developmental outcomes. Abnormalities detected on MRI within the first two weeks of life correlate strongly with later motor and cognitive impairments.

Neurodevelopmental Assessment Tools

- Description: Tools like Bayley Scales of Infant Development and the General Movements Assessment (GMA) are used to evaluate motor and cognitive functions in early infancy.
- Efficacy: These assessments are effective in predicting long-term outcomes but are typically used beyond the neonatal period. GMA, conducted within the first few months, can predict cerebral palsy with high accuracy.[19]

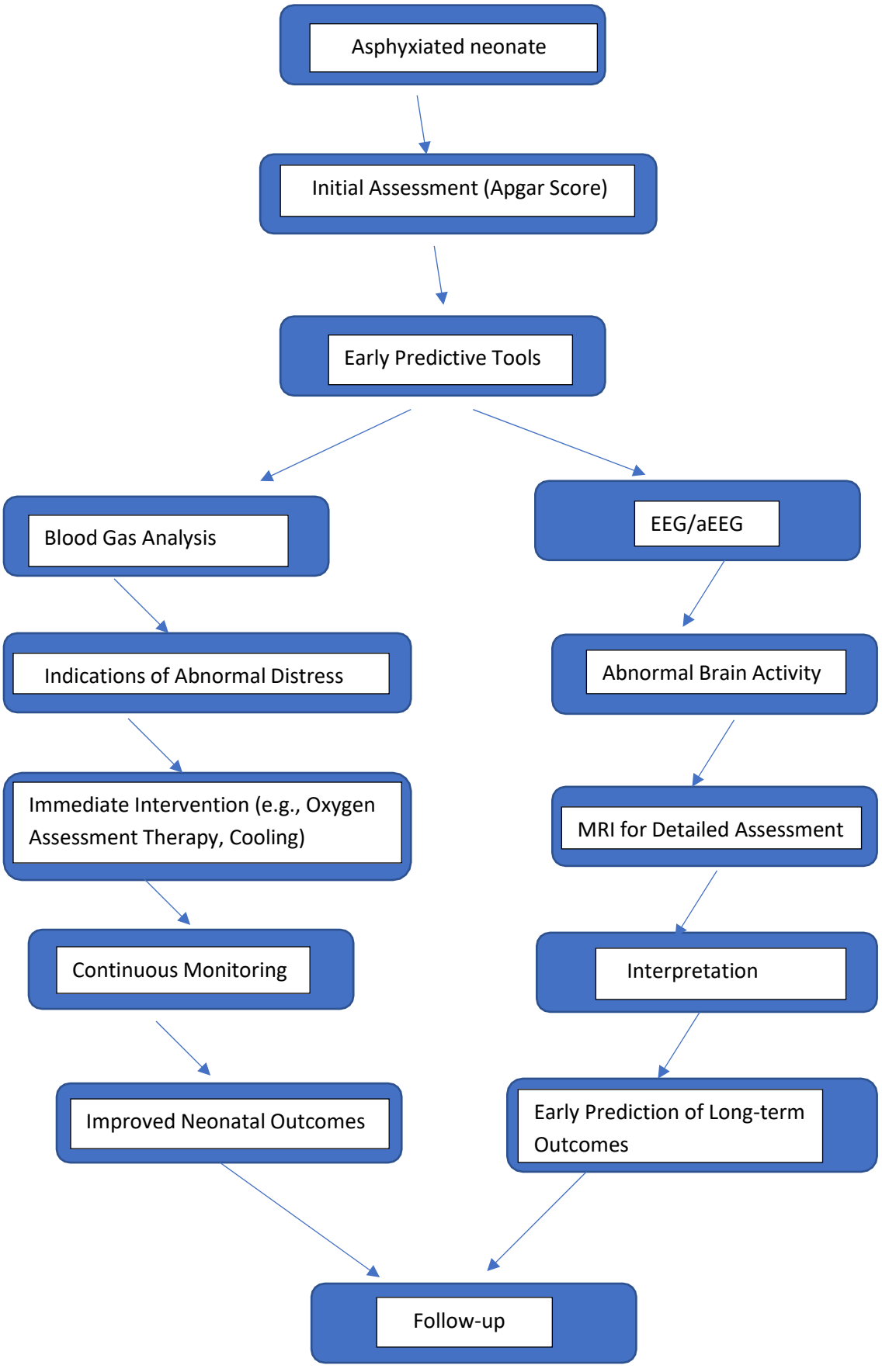
Comparative Efficacy of Predictive Tools

- Studies comparing these predictive tools indicate that a combination of early clinical assessments (e.g., Apgar score, cord blood gas analysis) and advanced neuroimaging (e.g., MRI, aEEG) provides the best predictive accuracy for neonatal outcomes. While each tool has its strengths and limitations, integrated approaches using multiple modalities yield more reliable prognostic information.[20]

Biomarkers

- Description: Emerging research focuses on biomarkers such as neuron-specific enolase (NSE), S100B protein, and glial fibrillary acidic protein (GFAP).
- Efficacy: These biomarkers show promise in predicting the severity of brain injury and long-term outcomes, but further validation in multi-center studies is needed.[21,22]

Figure 2: Flowchart of Early Prediction and Intervention for Asphyxiated Neonates



3. Thompson Score: An Overview

The Thompson Score, also known as the Hammersmith Neonatal Neurological Examination (HNNE), is a scoring system developed to assess neonatal encephalopathy. This review provides a comprehensive overview of the development and rationale, scoring system, interpretation, clinical applications and limitations of the Thompson Score.[23]

Development and Rationale

The Thompson Score was developed by C.M. Thompson and colleagues in the late 20th century to address the need for a reliable, standardized tool to evaluate neonatal neurological status. The primary goal was to create a scoring system that could be easily administered by clinicians to identify infants at risk of neuro-developmental impairments due to hypoxic-ischemic encephalopathy (HIE).

The rationale behind the development of the Thompson Score lies in its ability to provide an objective measurement of the severity of encephalopathy, thereby aiding in the early identification of neonates who require intensive monitoring and intervention. The score was designed to be practical for use in both high-resource and low-resource settings, making it a versatile tool in various clinical environments.[24]

Scoring System and Interpretation

The Thompson Score comprises a series of neurological assessments that evaluate different aspects of an infant's neurological function, including tone, level of consciousness, seizures, posture, and reflexes. Each parameter is scored on a scale from 0 to 3, with higher scores indicating more severe abnormalities.

Components of the Thompson Score:

1. Tone: Assessed by evaluating the infant's posture and movements.
2. Level of Consciousness: Determined by the infant's response to stimuli.
3. Seizures: Documented based on the frequency and severity of observed seizures.
4. Posture: Assessed by observing the infant's spontaneous postural alignment.
5. Reflexes: Evaluated by testing various primitive reflexes.

Table 1: Thompson Score

Parameters	Scoring 0	Scoring 1	Scoring 2	Scoring 3
Tone	Normal	Hypertonia	Hypotonia	Flaccid
Level of consciousness	Alert	Hyperalert	Lethargic	Comatose
Seizures	None	Mid	Moderate	Severe
Moro Reflex	Normal	Diminished	Absent	Absent with spontaneous movement
Grasp Reflex	Normal	Absent	Absent with spontaneous movement	Absent with spontaneous movement
Suck Reflex	Normal	Diminished	Absent	Absent with spontaneous movement
Respiration	Normal	Irregular	Periodic	Apnoeic
Fontanel	Normal	Bulging	Full	Very tense

The total score is calculated by summing the scores for each parameter, with a maximum possible score of 22. The interpretation of the total score helps clinicians categorize the severity of encephalopathy:

- Mild (0-10)
- Moderate (11-14)

- Severe (15-22).

Clinical Applications

The Thompson Score has several important clinical applications:

1. Early Identification of HIE: It helps in the early identification of infants with HIE, allowing for timely intervention and management, which is crucial for improving neuro-developmental outcomes.
2. Monitoring Disease Progression: Serial Thompson Score assessments can be used to monitor the progression of neurological impairment over time, providing valuable information for ongoing treatment decisions .[25]
3. Predicting Outcomes: The score has been correlated with long-term neuro-developmental outcomes, making it a useful tool for predicting the potential prognosis of affected infants.

Limitations

Despite its usefulness, the Thompson Score has certain limitations:

1. Subjectivity: Some elements of the score, such as the assessment of tone and posture, can be subjective and may vary between examiners, potentially affecting the reliability of the score.
2. Limited Scope: The score focuses primarily on neurological function and may not capture other important aspects of neonatal health that could influence outcomes.
3. Resource Constraints: While designed for use in various settings, in practice, the consistent application of the Thompson Score can be challenging in resource-limited environments due to the need for trained personnel .[26]

4. Modified Sarnat staging

The Modified Sarnat staging is an essential clinical tool used in neonatology to assess the severity of hypoxic-ischemic encephalopathy(HIE) in newborns who have suffered from perinatal asphyxia. It is a modification of the original Sarnat and Sarnat staging system developed in 1976, which was designed to provide a systematic method to evaluate the neurological status of asphyxiated neonates and predict their outcomes.

Original Sarnat and Sarnat Staging

In 1976, Sarnat and Sarnat introduced a staging system for HIE based on the clinical observation of 21 full-term neonates who had experienced perinatal asphyxia. Their study identified three stages of HIE—mild (Stage I), moderate (Stage II), and severe (Stage III)—each defined by specific clinical criteria, including level of consciousness, muscle tone, reflexes, and autonomic function. The stages correlated with the likelihood of long-term neurological damage and survival rates:

- Stage I (Mild HIE): Hyper alertness, normal or hyperactive reflexes, normal muscle tone, and mydriasis.
- Stage II (Moderate HIE): Lethargy, hypotonia, diminished reflexes, seizures, and meiosis.
- Stage III (Severe HIE): Stupor or coma, flaccid muscle tone, absent reflexes, and disturbances in autonomic function.

Development of Modified Sarnat Staging

The original Sarnat and Sarnat staging was a ground breaking tool but had limitations due to its qualitative nature. The need for a more comprehensive and detailed assessment led

to the development of the Modified Sarnat staging. The modifications aimed to enhance the sensitivity and specificity of the staging system, improving its utility in clinical and research settings.

Modified Sarnat Staging Criteria

The Modified Sarnat staging retains the three stages of the original system but includes more detailed criteria and emphasizes additional neurological signs:

1. Stage I (Mild HIE):
   - Hyper alertness
   - Normal muscle tone
   - Mild distal flexion
   - Normal or exaggerated deep tendon reflexes
   - Overactive Moro reflex
   - Pupils are dilated and reactive
   - Normal EEG

2. Stage II (Moderate HIE):
   - Lethargy
   - Hypotonia
   - Strong distal flexion
   - Decreased or absent primitive reflexes
   - Seizures
   - Pupils are constricted but reactive
   - Abnormal EEG (slow activity, periodic patterns)

3. Stage III (Severe HIE):

- Stupor or coma
- Flaccid muscle tone
- Absent deep tendon and primitive reflexes
- Prolonged seizures or no response to stimuli
- Pupils are often variable and poorly reactive
- Severely abnormal EEG (suppressed or isoelectric)

Clinical Utility and Validation

Several studies have validated the Modified Sarnat staging system, demonstrating its effectiveness in predicting neonatal outcomes. For instance,Parvanehet al[27] compared the Modified Sarnat staging with neuroimaging findings and found a strong correlation between higher stages of HIE and the severity of brain injury observed on MRI. Other studies have corroborated these findings, highlighting the staging system's prognostic value.

Research comparing the Thompson Score and Modified Sarnat staging has shown that while both tools are valuable, the Modified Sarnat staging provides a more detailed neurological assessment. A prospective observational study by Chalak et al[28] indicated that the Modified Sarnat staging could more accurately predict long-term neuro-developmental outcomes than the Thompson Score, particularly in distinguishing between moderate and severe HIE.

The Modified Sarnat staging is a critical advancement in the assessment of HIE in neonates, providing detailed criteria that enhance the accuracy and predictive value of the original system. It remains a cornerstone in neonatal intensive care units worldwide, guiding

therapeutic interventions and informing prognostic discussions with families. Ongoing research continues to refine and validate this tool, ensuring its relevance in the ever-evolving field of neonatology.

5. Comparative Studies of Thompson Score and Modified Sarnat Staging

Studies on Individual Scoring Systems

- Thompson Score

The Thompson score, developed by Thompson et al. in 1997, is a clinical scoring system used to evaluate neonatal encephalopathy. The score is based on a range of clinical parameters including consciousness, tone, posture, primitive reflexes, autonomic system function, and the presence of seizures. This scoring system is often employed in low-resource settings due to its simplicity and reliance on clinical observation rather than advanced diagnostic tools.

Several studies have validated the Thompson score in various clinical settings. For instance, a study by Shankaran et al demonstrated its utility in predicting outcomes in term neonates with hypoxic-ischemic encephalopathy (HIE).[3] Similarly, a study by Aoki et al found the Thompson score to be effective in predicting short-term neurological outcomes in neonates with perinatal asphyxia .[29]

A study tested a numeric scoring system for assessing hypoxic ischemic encephalopathy (HIE) in newborns to predict neuro-developmental outcomes at one year. Forty-five infants with HIE were assessed, with most undergoing at least one cranial ultrasound. By 12 months, 35 infants had full neurological evaluations and were assessed using the Griffiths Scales of Mental Development. Five infants were evaluated earlier due to death or hospitalization.

Results showed 23 infants were normal, while 17 were abnormal, including 16 with cerebral palsy and one with developmental delay.The HIE score was highly predictive of outcomes, with a peak score of 15 or higher showing a positive predictive value of 92% and a negative predictive value of 82% for abnormal outcomes. The sensitivity and specificity were 71% and 96%, respectively. This scoring system proves valuable for clinicians, especially in resource-limited settings, for assessing and predicting neuro-developmental outcomes in infants with HIE.[5]

A study published by Aoki et al explored the predictive value of the Thompson score for short-term adverse outcomes in neonatal encephalopathy. Conducted by Hirosato Aoki and colleagues as part of the Baby Cooling Registry of Japan Collaboration Team, this observational study included infants (≥36 weeks of gestation) with neonatal encephalopathy who were registered in a multicenter cohort of cooled infants in Japan. The Thompson score was assessed at intervals during the first four days of life. Among 632 infants, 3.3% died, 9.3% survived with respiratory impairment requiring tracheostomy, and 17.9% survived with feeding impairment requiring gavage feeding. The study found that the Thompson score effectively predicted these adverse outcomes, particularly at 72–90 hours. A score of ≥15 had a sensitivity of 0.85 and specificity of 0.92 for predicting death or respiratory impairment, while a score of ≥14 had a sensitivity of 0.71 and specificity of 0.92 for predicting death, respiratory, or feeding impairment. These findings highlight the Thompson score's potential in clinical decision-making, especially for assessing the need for prolonged life support in infants with severe encephalopathy. Notably, a significant proportion of infants with high scores could regain spontaneous breathing and survive without tracheostomy, although many still required gavage feeding.[29]

A study published by Dalip et al during November 2016 investigated the correlation between the Thompson scoring system and early neonatal outcomes in term neonates post-asphyxia. Conducted at Hindu Rao Hospital, New Delhi, the prospective cross-sectional study included 145 full-term neonates with low Apgar scores. Using SPSS 17.0 for statistical analysis, the study found a significant correlation between Thompson scores on day 1 and both morbidity ($p=0.024$) and mortality ($p=0.001$). The study revealed that higher Thompson scores correlated with higher rates of seizures and mortality within the first week of life. The Thompson score proved to be a precise tool with high inter-rater reliability (kappa coefficient of 0.87), allowing for detailed assessment of neonatal encephalopathy severity. The results suggest that the Thompson score is a valuable predictor of early neonatal outcomes in asphyxiated term infants.[30]

The study by Maphake et al, examined the effectiveness of the Thompson score (TS) in predicting early outcomes in neonates with hypoxic-ischemic encephalopathy (HIE) treated with therapeutic cooling at Tembisa Provincial Tertiary Hospital. Conducted retrospectively from January 2018 to August 2019, the study included 93 infants categorized by TS into mild, moderate, and severe HIE. Results showed that a higher TS correlated with longer hospital stays, increased need for antiseizure medication at discharge, and more frequent resuscitation over ten minutes and adrenaline administration. Blood gas analysis linked severe HIE to low pH and high base deficit. Common risk factors included maternal hypertension, meconium aspiration, and prolonged second stage of labour. The study concluded that the TS remains a valuable tool in the therapeutic hypothermia era, effectively predicting early neonatal outcomes and associated complications.[31]

A retrospective observational study published in BMC Paediatrics (2021) by Yoshinori Aoki et al focused on the short-term outcomes of term neonates with mild neonatal encephalopathy due to perinatal asphyxia. Conducted at Tokyo Metropolitan Children's Medical Center between January 2014 and December 2019, the study aimed to assess these outcomes and identify predictors of poor prognosis. The researchers defined abnormal short-term outcomes by criteria such as seizures, abnormal electroencephalography, abnormal brain MRI within the first four weeks, and abnormal neurological examination at discharge. Among the 110 screened infants, 61 were diagnosed with mild encephalopathy, and 18% of these had abnormal short-term outcomes. The study found that a higher Thompson score at admission was significantly associated with these abnormal outcomes. Specifically, a cut-off score of 4 demonstrated high sensitivity (90.9%) and specificity (83.0%) in predicting adverse short-term outcomes. The findings suggest that the Thompson score is a valuable predictor for identifying infants at risk of poor short-term neurological outcomes.[32]

A study on "The Thompson Encephalopathy Score and Short-Term Outcomes in Asphyxiated Newborns Treated With Therapeutic Hypothermia"done by Patricia Thorsen et al, published in 2016, reassesses the Thompson encephalopathy score's relevance in the context of therapeutic hypothermia. This clinical score, previously validated for its high sensitivity and specificity in predicting adverse outcomes like death or severe disability in newborns with perinatal asphyxia, was evaluated for its association with short-term adverse outcomes in a cohort undergoing therapeutic hypothermia. Data from 142 new-borns across 12 neonatal intensive care units, collected during the Pharma Cool multicenter study, were analyzed. Results indicated that a Thompson score of 12 or higher significantly increased the odds of death before discharge and severe epilepsy, but it showed no association with multiple organ failure. Thus, the Thompson score remains a valuable assessment tool for

predicting certain adverse outcomes in asphyxiated newborns treated with therapeutic hypothermia.[33]

- Modified Sarnat Staging

The Sarnat score, a clinical tool introduced in 1976, assesses neonatal encephalopathy severity through six clinical parameters, categorizing the condition as mild, moderate, or severe. Despite its international acceptance and crucial role in evaluating new treatments like therapeutic hypothermia, its application remains inconsistent, often due to inadequate training and a phenomenon known as 'neurophobia' among clinicians. A recent quality improvement initiative at The National Maternity Hospital in Dublin aimed to address these issues by educating staff on the Modified Sarnat Classification through sessions, index cards, and a teaching video. Post-training, staff showed improved confidence and accuracy in using the score. The study highlights the importance of thorough training and frequent application of the Sarnat score, especially before and during therapeutic hypothermia, to ensure reliable neurological assessments and better patient outcomes. This initiative underscores the necessity of systematic training for accurate and reproducible neurological evaluations in neonates.[34]

A study conducted by Simiyu et al at Kilimanjaro Christian Medical Centre (KCMC) in northern Tanzania from November 2014 to April 2015 assessed the prevalence, severity, and early outcomes of hypoxic ischemic encephalopathy (HIE) among newborns. Of the 1752 deliveries during this period, 11.5% (201) experienced birth asphyxia, and 187 of these newborns developed HIE. The study used the Sarnat and Sarnat score for classification, finding that 39.0% had moderate HIE and 10.2% had severe HIE. Observed neurological signs included weak or absent reflexes (46.0%), hypotonia (43.3%), and lethargy (42.2%).

Mortality was 9.1%, with a significantly higher rate in severe HIE cases (84.2%) compared to moderate cases (1.4%). By the seventh day post-delivery, 17.1% of newborns showed no improvement from their initial condition. The study concludes that the high prevalence of birth asphyxia leading to moderate and severe HIE underscores the need for improved obstetric care and immediate newborn resuscitation to enhance outcomes.[35]

The Sarnat and Sarnat study from 1976 introduced a staging system for neonatal encephalopathy based on clinical signs and EEG changes, which has been foundational in predicting neurological outcomes. This system is particularly significant as it provides a systematic bedside approach for assessing neonatal encephalopathy, especially in identifying candidates for therapeutic hypothermia. However, its original application involved a small, heterogeneous patient sample, which limits its generalizability and prognostic accuracy.[36]

The Modified Sarnat Staging has been extensively validated and is considered a gold standard in many high-resource settings. Studies have shown a strong correlation between the stage of encephalopathy and long-term neurodevelopmental outcomes. For example, a study by Haung et al highlighted the predictive value of the Modified Sarnat Staging in determining the prognosis of neonates with HIE.[37]

In the study Association of Total Sarnat Score with brain injury and neuro-developmental outcomes after neonatal encephalopathy, Morales et al (2021) investigated the Total Sarnat Score (TSS) as a predictor of brain injury and adverse neuro-developmental outcomes (NDO) in neonates treated with therapeutic hypothermia. They examined 145 infants and found that TSS was significantly correlated with basal ganglia/thalamic injury on MRI and adverse NDO at 2 years. A TSS >12 within 6 hours of birth indicated a high risk of adverse

outcomes, whereas a TSS <4 was associated with intact survival. The prognostic accuracy of TSS was comparable to the modified Sarnat staging, with both systems showing modest predictive capabilities. Despite some overlap in scores for mild and moderate encephalopathy, TSS remains valuable for early prognostication in clinical settings. The study underscores the need for careful clinical assessment and suggests that extreme TSS values can effectively guide early treatment decisions for neonates with encephalopathy.[38]

- Comparative Analysis of Both Scoring Systems

Comparative studies between the Thompson score and the Modified Sarnat Staging have been conducted to determine which system offers better predictive value for neonatal outcomes.

The study by Chansarn et al (2021) evaluates the correlation between the Modified Sarnat Staging (SS) and the Thompson Score (TS) in assessing the severity of hypoxic-ischemic encephalopathy (HIE) in neonates. Conducted on 68 outborn neonates with gestational age over 35 weeks, the study assessed SS and TS at three critical time points: initial call, transport team arrival, and NICU admission. The findings revealed a significant association between SS and TS ($p < 0.01$), with specific TS ranges corresponding to each SS category: normal SS with TS 0-4, mild SS with TS 5-6, moderate SS with TS 7-13, and severe SS with TS $\geq$ 14. The predictive value for outcomes like death or abnormal MRI was highest for scores taken at NICU admission. The study suggests that while SS is traditionally used for determining eligibility for therapeutic hypothermia (TH), TS may offer easier and potentially more objective evaluation, especially in resource-limited settings and varied clinical environments. Further research with a larger sample size is recommended to better

understand the utility of TS compared to SS for early HIE assessment and outcome prediction.[39]

Another comparative study by Azzopardi et al supported these findings, suggesting that the Thompson score could be a feasible alternative in settings where advanced neuroimaging is not available.[10]

A study by Lohan et al investigated the incidence of Hypoxic Ischemic Encephalopathy (HIE) in newborns experiencing perinatal asphyxia, which can lead to significant neurological issues like cerebral palsy. The prospective study included 50 asphyxiated neonates assessed using the Apgar scoring system and Sarnat and Sarnat's HIE staging. Results revealed that 42% of these newborns developed HIE, with severe HIE-III being the most common. Significant correlations were found between low Apgar scores and the severity of HIE. Specifically, lower Apgar scores at 1 and 5 minutes were strongly linked to higher HIE stages, indicating the severity of asphyxia as a predictor for HIE. Despite the study's limitations, such as a small sample size and reliance on clinical assessments, it highlights the need for using both Apgar scores and HIE staging in evaluating and predicting outcomes for asphyxiated newborns. The research emphasizes the importance of immediate resuscitation and suggests that Apgar scores at 10 minutes might be necessary for better neuro-developmental predictions and resuscitation efforts.[40]

The study by Sekhar et al, published in the Asian Journal of Clinical Paediatrics and Neonatology, investigates the correlation between clinical variables and the stages of Hypoxic-Ischemic Encephalopathy (HIE) in newborns. Conducted on 42 asphyxiated neonates using the Sarnat and Sarnat Staging of HIE, the research found no significant

correlation between maternal history, gestational age, mode of delivery, and the severity of HIE. Among the participants, 31% were in HIE stage I, 33% in stage II, and 36% in the severe stage III. Notably, non-stress test results and meconium staining were significantly associated with the severity of HIE, particularly in stage III. The study concludes that analyzing these clinical variables can enhance the accuracy of newborn assessments and enable early intervention, ultimately improving treatment outcomes for HIE patients.[41]

However, some studies argue that the Modified Sarnat Staging, due to its detailed neurological assessment, might provide a more accurate prediction of long-term neuro-developmental outcomes in settings where it can be effectively implemented. For example, a study by Zhou et al emphasized the robustness of the Modified Sarnat Staging in clinical trials involving therapeutic hypothermia.[13]

- Meta-Analysis and Systematic Reviews

Meta-analyses and systematic reviews offer comprehensive evaluations of the efficacy and applicability of the Thompson score and the Modified Sarnat Staging.

The study by Shankaran et al aimed to assess the predictive validity of the amplitude-integrated electroencephalogram (aEEG) in conjunction with the stage of encephalopathy in infants with hypoxic-ischemic encephalopathy (HIE) eligible for therapeutic hypothermia. The prospective study included 108 infants with moderate or severe HIE, and aEEG findings were categorized as normal or abnormal. At 18 months, 49% of infants experienced death or disability. Severe HIE and abnormal aEEG were associated with the primary outcome in univariate analysis, but only severe HIE remained predictive in multivariate analysis. The addition of aEEG pattern to HIE stage did not significantly improve predictive value.

Therefore, the study concluded that the aEEG background pattern did not enhance the predictive value of encephalopathy stage in predicting adverse outcomes in infants with HIE.[42]

Another meta-analysis by Jacobs et al (2013) focused on the outcomes of therapeutic hypothermia in neonates with HIE and examined the role of different scoring systems in patient selection and outcome prediction. The analysis found that while both scoring systems are useful, the choice between them should depend on the clinical setting and available resources.[43]

6. Correlation Between Thompson Score and Modified Sarnat Staging

Several studies have sought to explore the correlation between these two assessment tools. For instance, Azzopardi et al found a moderate correlation between Thompson scores and Modified Sarnat stages in predicting the severity of neonatal encephalopathy and the likelihood of adverse neuro-developmental outcomes.[10]Another study by Thompson et al reported that higher Thompson scores were generally associated with higher Sarnat stages, suggesting a degree of concordance between the two assessment methods.[5]

Table 2: Correlation of Thompson Score and Modified Sarnat Staging in Predicting Early Neonatal Outcome

Parameter	**Thompson Score**	**Modified Sarnat Staging**	**Predictive Value for Early Neonatal Outcome**
Assessment Criteria	- **Thompson Score**: Muscle tone, level of consciousness, fits, posture, etc.	- **Sarnat Staging**: Level of consciousness, muscle tone, reflexes, seizures, etc.	Both scores assess neurological function and predict severity of HIE.
Score Range	0-22	Stage 1: Mild, Stage 2: Moderate, Stage 3: Severe	Higher scores or stages indicate more severe neurological impairment.
Time of Assessment	Sequential daily assessments	Initial assessment within 6 hours, follow-up assessments daily	Early assessment is crucial for timely intervention and outcome prediction.
Outcome Prediction	- Higher Thompson Scores correlate with worse outcomes. - Useful for monitoring progress.	- Higher Sarnat stages correlate with worse outcomes. - Useful for determining therapeutic hypothermia eligibility.	Both scores are useful in predicting long-term neuro-developmental outcomes.
Use in Clinical Practice	Commonly used in NICUs for ongoing assessment	Widely used to guide therapeutic hypothermia	Both scores aid in decision-making for therapeutic interventions.

Statistical Methods Used in Correlation Studies

- The studies investigating the correlation between the Thompson score and Modified Sarnat staging typically employ a variety of statistical methods to quantify the relationship between these two scales.
- Correlation Coefficients: Pearson or Spearman correlation coefficients are commonly used to measure the strength and direction of the relationship between the two scores.
- Regression Analysis: Logistic regression is often used to examine the predictive power of one score over the other. For instance, studies may use logistic regression models to determine how well the Thompson score can predict the Modified Sarnat stage, controlling for potential confounders like gestational age and birth weight.
- Receiver Operating Characteristic (ROC) Curves: ROC curve analysis is employed to evaluate the diagnostic accuracy of the Thompson score in identifying various stages of the Modified Sarnat staging. The area under the ROC curve (AUC) provides a measure of the test's overall ability to discriminate between different levels of encephalopathy severity.[32]

Clinical Significance of Correlation

- Understanding the correlation between the Thompson score and Modified Sarnat staging has important clinical implications.
- Enhanced Diagnostic Accuracy: A strong correlation between these two assessment tools can enhance diagnostic accuracy in clinical settings, allowing for more reliable identification of the severity of neonatal encephalopathy. This is critical for timely and appropriate therapeutic interventions.
- Predictive Validity: The correlation supports the use of either score in predicting long-term neuro-developmental outcomes. For instance, higher Thompson scores and higher

Sarnat stages both correlate with poorer neurological outcomes, enabling clinicians to identify at-risk infants who may benefit from early intervention and closer monitoring.

- Standardization of Care: Consistent correlation findings across studies may encourage the standardization of assessment protocols for neonatal encephalopathy, leading to more uniform care practices and potentially improved outcomes for affected infants.
- Thus, the correlation between the Thompson score and Modified Sarnat staging is supported by various studies, employing robust statistical methods to establish the relationship. The clinical significance of this correlation lies in its potential to improve diagnostic accuracy, predictive validity, and standardization of care for neonatal encephalopathy.

7. Prediction of Early Neonatal Outcomes

Definition of Early Neonatal Outcomes

Early neonatal outcomes refer to the health status and clinical conditions of a newborn within the first week of life. These outcomes are critical indicators of neonatal health and can include measures such as birth weight, Apgar scores, the presence of congenital anomalies, and conditions such as neonatal sepsis, respiratory distress syndrome (RDS), hypoxic-ischemic encephalopathy (HIE), and mortality. Early neonatal outcomes are essential for understanding the immediate impact of prenatal and perinatal care and are predictive of longer-term health and developmental trajectories.[1,6]

Predictive Accuracy of Thompson Score

The Thompson Score, developed by Thompson et al[5] , is a clinical tool used to assess the severity of hypoxic-ischemic encephalopathy (HIE) in newborns. This scoring system

evaluates a range of neurological signs, including tone, level of consciousness, and the presence of seizures, with a higher score indicating more severe encephalopathy.

Studies have shown that the Thompson Score has good predictive accuracy for early neonatal outcomes in infants with HIE. A study by Azzopardi et al demonstrated that the Thompson Score, when applied within the first hours of life, could reliably predict the severity of HIE and subsequent neuro-developmental outcomes. The score's simplicity and reliance on observable clinical signs make it a valuable tool in settings where advanced diagnostic imaging may not be readily available.[10]

Predictive Accuracy of Modified Sarnat Staging

The Modified Sarnat Staging is an adaptation of the original Sarnat and Sarnat (1976) classification, which categorizes the severity of HIE based on clinical and electroencephalographic (EEG) findings. This staging system divides HIE into three stages: mild (stage I), moderate (stage II), and severe (stage III), each associated with specific clinical features and EEG patterns.

Research indicates that the Modified Sarnat Staging is highly effective in predicting early neonatal outcomes, particularly in assessing the risk of mortality and long-term neuro-developmental impairments. According to studies by Shankaran et al and the NICHD Neonatal Research Network, infants classified as stage II or III are at a significantly higher risk of adverse outcomes compared to those in stage I. The Modified Sarnat Staging's ability to incorporate both clinical and EEG data enhances its predictive accuracy and utility in clinical practice.[3]

Combined Use of Both Scoring Systems

Combining the Thompson Score and Modified Sarnat Staging can enhance the predictive accuracy for early neonatal outcomes by leveraging the strengths of both systems. The Thompson Score's ease of use and reliance on observable clinical signs complement the comprehensive assessment provided by the Modified Sarnat Staging, which includes EEG findings.

Several studies suggest that using both scoring systems in tandem can improve early identification and stratification of infants at risk for severe outcomes. For instance, a study by Thayyil et al found that combining the Thompson Score with the Modified Sarnat Staging resulted in more accurate predictions of neonatal and long-term neurodevelopmental outcomes than using either system alone. This combined approach allows for a more nuanced assessment of HIE severity, facilitating timely and appropriate clinical interventions.[44]

8. Prospective Studies in Neonatal Asphyxia

Methodological Approaches

Prospective studies in neonatal asphyxia are crucial for understanding the condition's etiology, outcomes, and potential interventions. The methodological approaches in these studies often involve:

1. Cohort Selection: Prospective studies typically select cohorts based on gestational age, birth weight, Apgar scores, and clinical diagnosis of asphyxia. The cohorts are followed over time to observe outcomes.
2. Data Collection: Data is gathered through clinical observations, biochemical markers, neuroimaging, and developmental assessments. Commonly used tools include blood gas analysis, MRI, and neuro-developmental scales like the Bayley Scales of Infant and Toddler Development.

3. Outcome Measures: The primary outcomes assessed in these studies are survival rates, neurological outcomes, and long-term developmental milestones. Secondary outcomes may include incidence of seizures, cerebral palsy, and cognitive impairments.
4. Statistical Analysis: Multivariate analysis, survival analysis, and regression models are frequently employed to adjust for confounding variables and determine the associations between neonatal asphyxia and subsequent outcomes.[2,3]

Findings from Prospective Observational Studies

Prospective observational studies have provided significant insights into neonatal asphyxia:

1. Incidence and Risk Factors: Studies have identified risk factors such as maternal health issues, delivery complications, and intrauterine growth restriction as significant contributors to neonatal asphyxia. For example, the National Institute of Child Health and Human Development (NICHD) Neonatal Research Network has documented these associations extensively.
2. Short-term Outcomes: Research indicates that immediate therapeutic interventions, such as hypothermia therapy, can reduce mortality and improve neurological outcomes. Shankaran et al demonstrated that hypothermia treatment within six hours of birth significantly lowers the risk of death or moderate/severe disability in affected neonates.
3. Long-term Outcomes: Prospective studies tracking children into early childhood and beyond show that neonatal asphyxia is linked with higher rates of cerebral palsy, cognitive impairments, and behavioural issues. Long-term follow-up studies, such as those by the Cool Cap Study Group by Gluckman et al underline the importance of early intervention and continuous monitoring.[13]

4. Neuroimaging Findings: MRI studies have shown patterns of brain injury that correlate with clinical outcomes. For instance, Rutherford et al highlighted that specific patterns of brain lesions are predictive of later neurodevelopmental outcomes.[17]

Implications for Clinical Practice

The findings from prospective studies have profound implications for clinical practice.[10,43]

1. Early Identification and Intervention: Enhanced screening protocols for at-risk pregnancies and timely diagnosis of neonatal asphyxia are crucial. Implementing standardized protocols for immediate resuscitation and the initiation of therapeutic hypothermia has become a clinical standard.
2. Therapeutic Hypothermia: The adoption of hypothermia therapy as a standard treatment for neonatal asphyxia is a direct outcome of these studies. It is recommended for infants with moderate to severe hypoxic-ischemic encephalopathy to improve survival rates and neuro-developmental outcomes.
3. Multidisciplinary Approach: The management of neonatal asphyxia requires a multidisciplinary approach, involving neonatologists, neurologists, radiologists, and developmental specialists to provide comprehensive care and follow-up.
4. Parental Support and Counselling: Providing psychological support and counselling to parents of affected neonates is vital. Educating families about potential outcomes and involving them in the care process can improve the overall management and support for these infants.
5. Policy and Guidelines: Evidence from prospective studies informs national and international guidelines for the management of neonatal asphyxia. Organizations like the American Academy of Paediatrics and the World Health Organization rely on these findings to update clinical guidelines and policies.

Prospective studies in neonatal asphyxia have significantly advanced our understanding of the condition, leading to improved diagnostic, therapeutic, and management strategies. The rigorous methodological approaches and comprehensive findings from these studies underscore their critical role in shaping clinical practice and improving outcomes for affected infants. Continued research is essential to further refine these strategies and address remaining gaps in knowledge.

9. Current Gaps in Literature and Future Directions

Identified Gaps in Current Research

Despite substantial progress in neonatal care, several gaps persist in the literature. One significant area is the limited understanding of the long-term outcomes of preterm infants, particularly those related to neuro-developmental and cognitive functions. Many studies focus on immediate postnatal outcomes but lack comprehensive follow-up data into childhood and adulthood.[45]

Another gap is in the area of personalized medicine for neonates. Research often adopts a one-size-fits-all approach, ignoring the individual variability in response to treatments. Factors such as genetic makeup, environmental influences, and unique clinical conditions are not sufficiently accounted for in current studies.[46]

Moreover, there is a scarcity of research on the efficacy and safety of new therapeutic interventions and technologies. While innovations like telemedicine and advanced respiratory support show promise, rigorous, large-scale randomized controlled trials (RCTs) are needed to validate their benefits and address safety concerns.[47]

Suggested Areas for Further Study

To address these gaps, several areas warrant further investigation:

1. Long-Term Follow-Up Studies: Comprehensive longitudinal studies tracking preterm infants into adulthood can provide valuable insights into the long-term impacts of neonatal interventions on neurodevelopment, cognitive function, and overall health.[48]
2. Personalized Neonatal Care: Research should focus on developing personalized treatment plans based on genetic, epigenetic, and environmental factors. This approach could optimize outcomes by tailoring interventions to the specific needs of each neonate.[44]
3. Advanced Therapeutic Interventions: More RCTs are necessary to evaluate new treatments and technologies. Studies should focus on the safety, efficacy, and cost-effectiveness of interventions such as stem cell therapy, non-invasive ventilation techniques, and telemedicine applications in neonatal care.[49]
4. Parental and Family Support: Research exploring the best practices for involving and supporting families in neonatal care can improve both neonatal and parental outcomes. Studies should investigate the psychological, social, and economic impacts of having a neonate in intensive care.[50]

Potential Impact on Neonatal Care Practices

Addressing these research gaps can significantly enhance neonatal care practices. Long-term follow-up studies can inform guidelines for monitoring and supporting preterm infants as they grow, potentially reducing the incidence of neuro-developmental disorders and improving quality of life. Personalized care approaches can lead to more effective and efficient treatments, reducing hospital stays and improving survival rates.

Advanced therapeutic interventions, validated through robust research, can revolutionize neonatal care by offering safer and more effective treatment options. Finally, improving family support mechanisms can lead to better outcomes not only for the infants but also for their families, promoting a holistic approach to neonatal care.

10. Conclusion

Summary of Key Findings

The literature review has underscored several critical findings within the realm of clinical practice. Firstly, there is a significant emphasis on the importance of evidence-based practice (EBP) in enhancing patient outcomes. Studies consistently show that integrating EBP leads to improved clinical decision-making and patient care standards. Secondly, the role of interdisciplinary collaboration is highlighted as essential for delivering holistic and effective care. Research indicates that collaborative practices among healthcare professionals lead to better health outcomes and increased patient satisfaction. Thirdly, advancements in technology, particularly in telemedicine and electronic health records (EHR), have been found to significantly improve access to care and streamline clinical workflows.

Relevance to Clinical Practice

The findings from this review are highly relevant to contemporary clinical practice. The integration of EBP is not just a theoretical ideal but a practical necessity that can substantially improve patient care. Clinicians are encouraged to continually update their knowledge and skills in line with the latest research to ensure they are providing the best possible care. The emphasis on interdisciplinary collaboration also has practical implications, suggesting that healthcare institutions should foster a culture of teamwork and communication to enhance patient outcomes. Moreover, the adoption of advanced technologies like telemedicine and EHR can address some of the persistent challenges in healthcare delivery, such as access to care and administrative efficiency.

Future Perspectives

Looking forward, several areas warrant further exploration and development. There is a need for ongoing research into the most effective strategies for implementing EBP in various clinical settings, particularly in resource-limited environments. Additionally, future

studies should explore the long-term impacts of interdisciplinary collaboration on patient outcomes and how these practices can be systematically integrated into healthcare systems. The role of technology in healthcare will continue to evolve, and future research should focus on optimizing telemedicine and EHR systems to further enhance their effectiveness and user-friendliness. Finally, the importance of personalized medicine, driven by advancements in genomics and biotechnology, is an emerging field that promises to revolutionize patient care and should be a key focus of future clinical research.

MATERIALS & METHODS

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 fulfilling the 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% in predicting 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 $\alpha = 0.05$, $Z\alpha 2$ is inserted by 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 mentioned study 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 10 minutes 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 minutes of 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 Coagulation profile

   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

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 3: 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**
Neuromuscular Control **Muscle tone** **Posture** **Tendon reflexes**	**Normal** **Mild distal flexion** **Overactive**	**Mild hypotonia/hypertonia** **Strong distal flexion** **Overactive**	**Flaccid/rigid** **Intermittent decerebration** **Decreased or absent**
Complex reflexes **Suck**	**Weak** **Strong,low**	**Weak/absent** **Weak,incomplete,high**	**Absent** **Absent**

Moro **Tonic neck**	**threshold** **Slight**	**threshold** **Strong**	**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**

STATISTICAL ANALYSIS:

Data entry

The data were entered using Microsoft Office Excel 2013 and analyzed using SPSS software version 17.

Data cleaning

Before analyzing the data each variable was acquired to check for missing values, blank values and typing errors. The corresponding case numbers were used to trace the questionnaires and the information was rechecked and entered.

Descriptive statistics

Shapiro-Wilk test was used to find the normal distribution. Continuous variables follows normal distribution like age was expressed as mean and standard deviation. Description of categorical variables like Age Category, Weight category, Mode of delivery, APGAR score at 1min, APGAR score at 5 min, Mode of resuscitation, Score categories for

Thompson and Modified Sarnat score, Mortality rate at different time points, seizures reported among neonates

Cardiac outcome observed in neonates, Respiratory failure observed in neonates, Haematological outcome observed in neonates, Feeding Intolerance observed in neonates and Acute kidney injury observed in neonates was expressed as frequency and proportion.

Test of significance

Chi square test was employed to compare the distribution of qualitative variables between the groups. Fisher's exact test was used when more than 20% of cells have expected frequencies less than 5.ROC curve obtained for Thompson score with mortality. Kappa statistics was used to compare between Thompson and modified sarnat score. All tests were two tailed and results were considered statistically significant if the p-value is <0.05 at 95% confidence interval.

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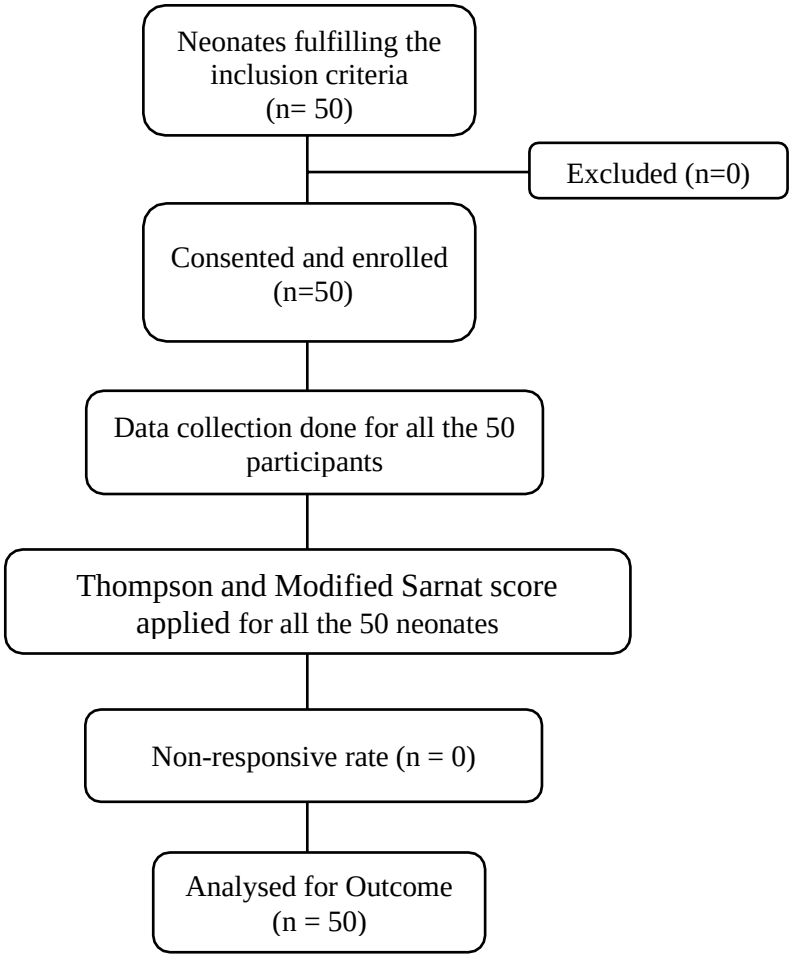
CONSORT FLOW CHART REGARDING SUBJECTS INVOLVED IN THE STUDY



RESULTS

RESULTS

Table 4: Distribution of mothers according to their age

Age	Frequency(n=50)	Percentage
≤ 25 Years	11	22.0%
>25 Years	39	78.0%
Total	**50**	**100.0%**

Out of 50 mothers, 11 (22%) mothers were aged less than or equal to 25 years and 39 (78%) aged were more than 25 years

Figure 3: Pie diagram shows distribution of mothers according to their age

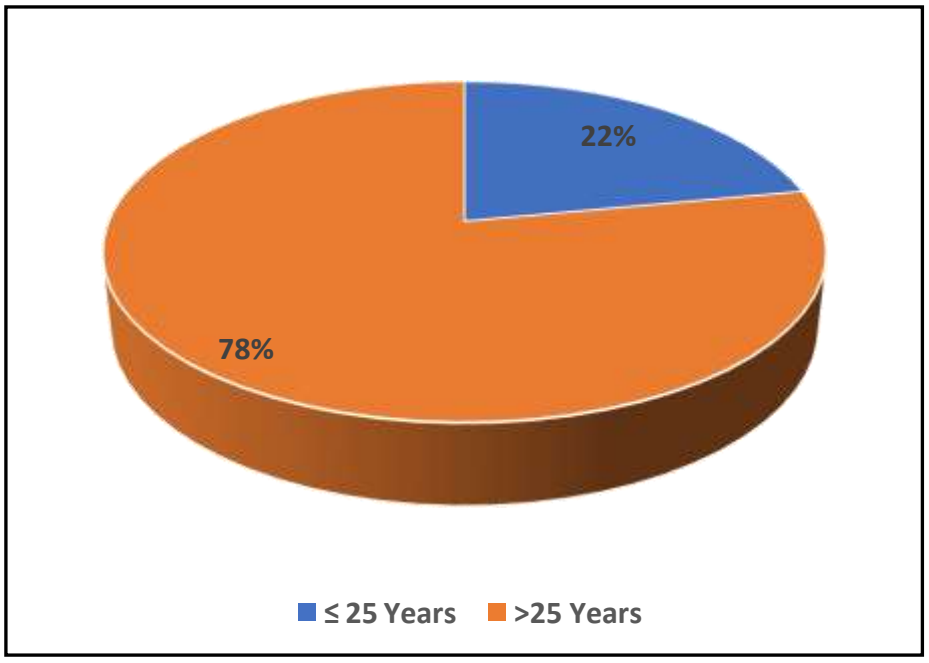


Table 5: Distribution of neonates according to weight (in kgs)

Weight (kg)	Frequency(n=50)	Percentage
2.5-3	35	70.0 %
3.1-3.5	12	24.0 %
>3.5	3	6.0 %
Total	**50**	**100.0**%

The mean weight of neonates was 2.990 ± 0.283 kgs with minimum being 2.44 kgs and maximum being 3.80 kgs.

Figure 4: Pie diagram shows Distribution of notates according to weight (in kgs)

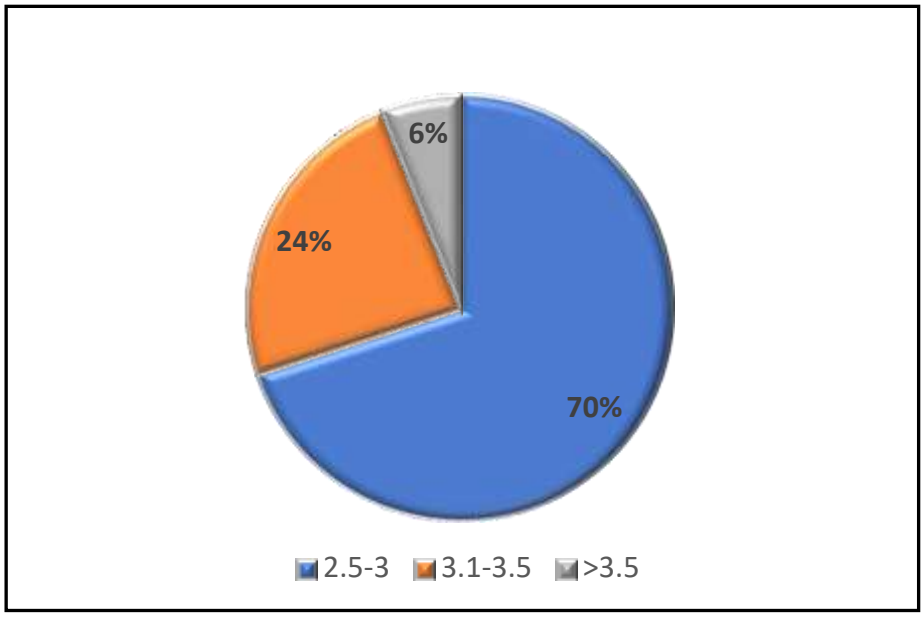


Table 6: Distribution of neonates according Mode of delivery

Mode of delivery	Frequency(n=50)	Percentage
LSCS	31	62.0 %
NVD(Normal vaginal delivery)	14	28.0 %
Vaccum assisted NVD	5	10.0 %
Total	**50**	**100.0**%

Among 50 neonates, 31 (62.0%) neonates delivered through LSCS, 14 (28%) neonates had normal vaginal delivery and 5 (10%) delivered through vacuum assisted normal vaginal delivery.

Figure 5: Bar diagram shows Distribution of notates mode of delivery

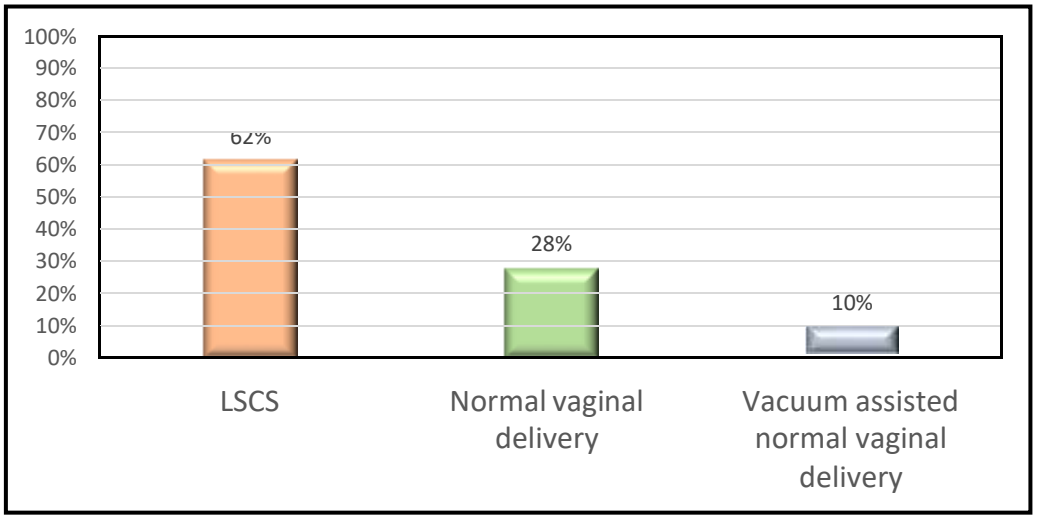


Table 7: APGAR Score at One minute

APGAR score at 1min	Frequency(n=50)	Percentage
2	10	20.0 %
3	40	80.0 %
Total	**50**	**100.0**

APGAR score at one minute among 50 neonates, 10 (20%) had 2 score and 40 (80%) had 3 APGAR score at 1 min

Figure 6: Doughnut diagram shows Apgar score at 1min

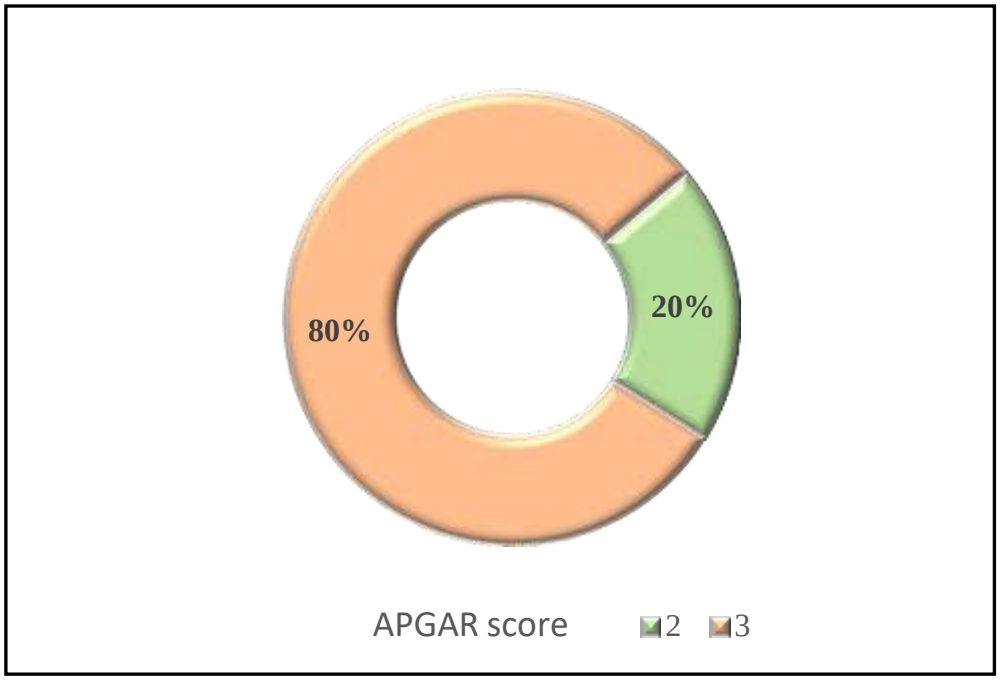


Table 8: Distribution of APGAR score at 5 min

APGAR score at 5 min	Frequency(n=50)	Percentage
4	10	20.0%
5	34	68.0%
7	6	12.0%
Total	**50**	**100.0%**

APGAR score at 5 min among 50 neonates, 10 (20%) had APGAR score of 4, 34 (68%) had APGAR score of 5 and 6 (12%) had APGAR score of 7.

Figure 7: Pie diagram shows distribution of APGAR score at 5 min

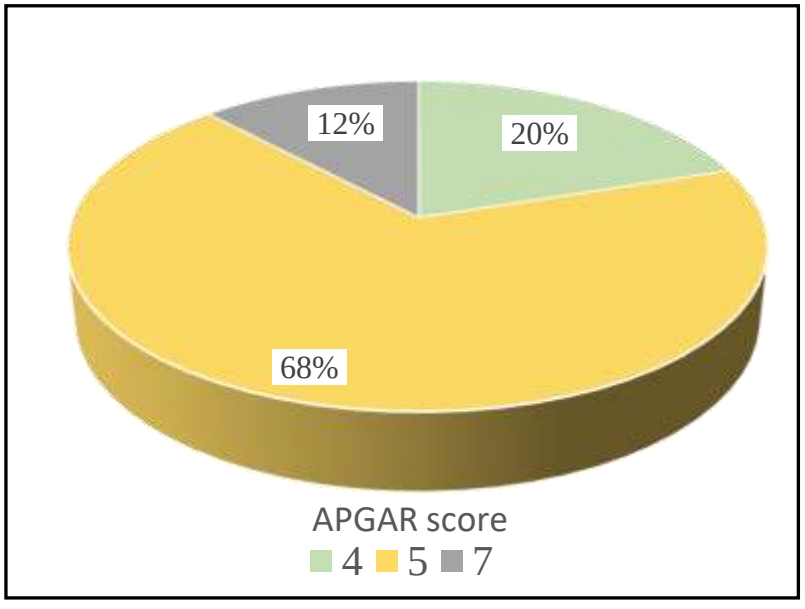


Table 9: Oxygen support

Oxygen support	Frequency(n=50)	Percentage
Mechanical Ventilator (MV)	16	32.0%
Positive pressure ventilation (PPV)	34	68.0%
Total	**50**	**100.0 %**

Out of 50 neonates, 16 (32%) neonates required mechanical ventilation and 34 (68%) neonates required positive pressure ventilation.

Figure 8: Pie diagram shows distribution of oxygen support

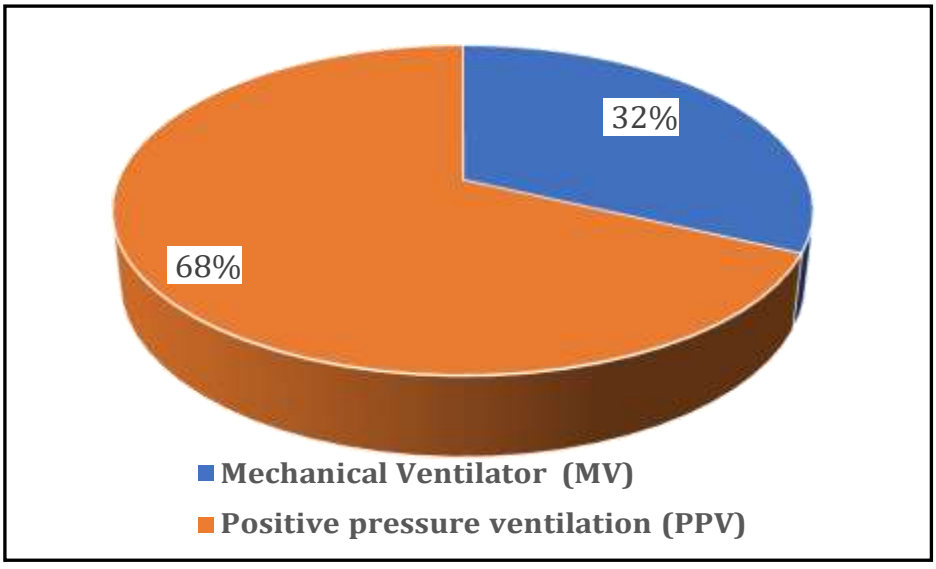


Table 10: Score categories for Thompson and Modified Sarnat score

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%) was in severe category.

Figure 9: Bar diagram shows Score categories for Thompson and Modified Sarnat score

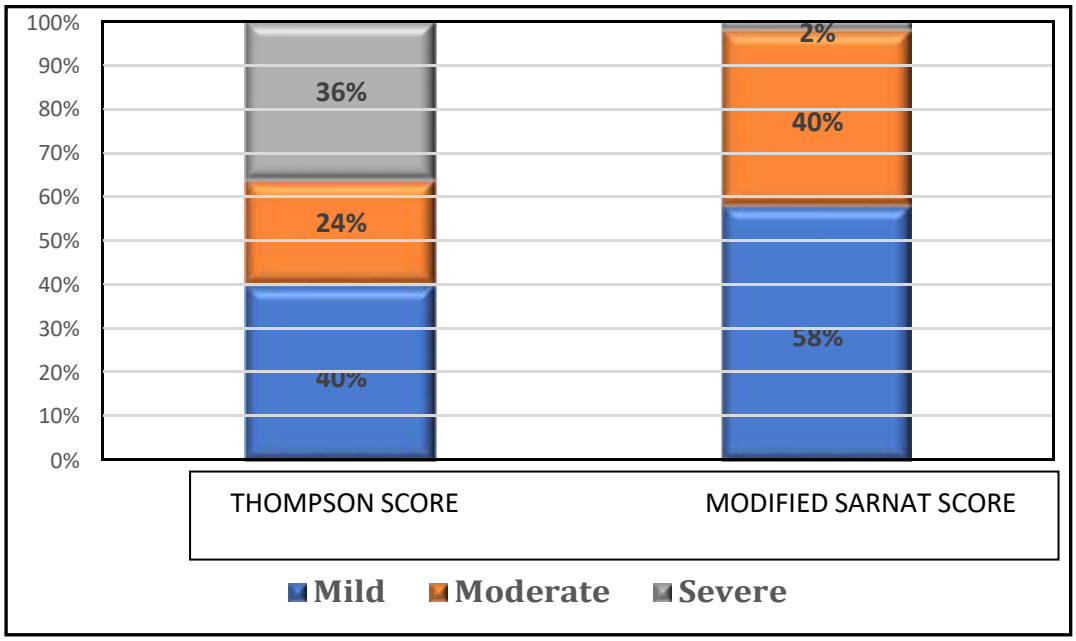


Table 11: Mortality rate at different time points

Death	Frequency(n=8)	Percentage
<24hours	**2**	**25.0 %**
24-72hours	**2**	**25.0 %**
>72hours	**4**	**50.0 %**

Out of 8 deaths observed among 50 neonates, 2 (25%) deaths occurred within 24 hours, 2 (25%) deaths occurred between 24 to 72 hours and 4 (50%) deaths occurred after 72 hours.

Figure 10: Pie diagram shows Mortality rate at different time points

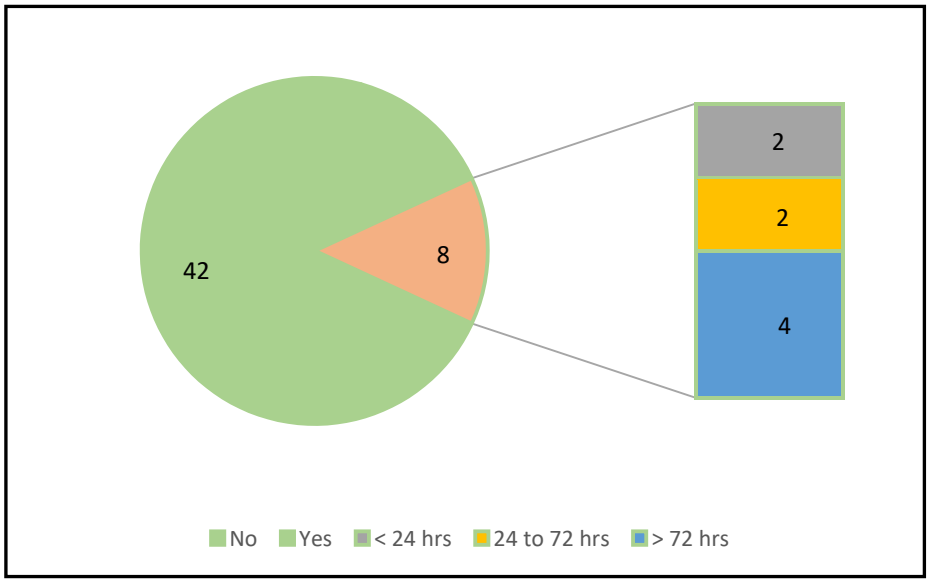


Table 12: CNS outcome(seizures) reported among neonates

CNS seizures	Frequency(n=50)	Percentage
Yes	29	58.0 %
No	27	42.0 %
Total	**50**	**100.0 %**

Among 50 neonates, 29 (58%) had CNS seizures.

Figure 11: Pie diagram shows distribution of CNS outcome(seizures)

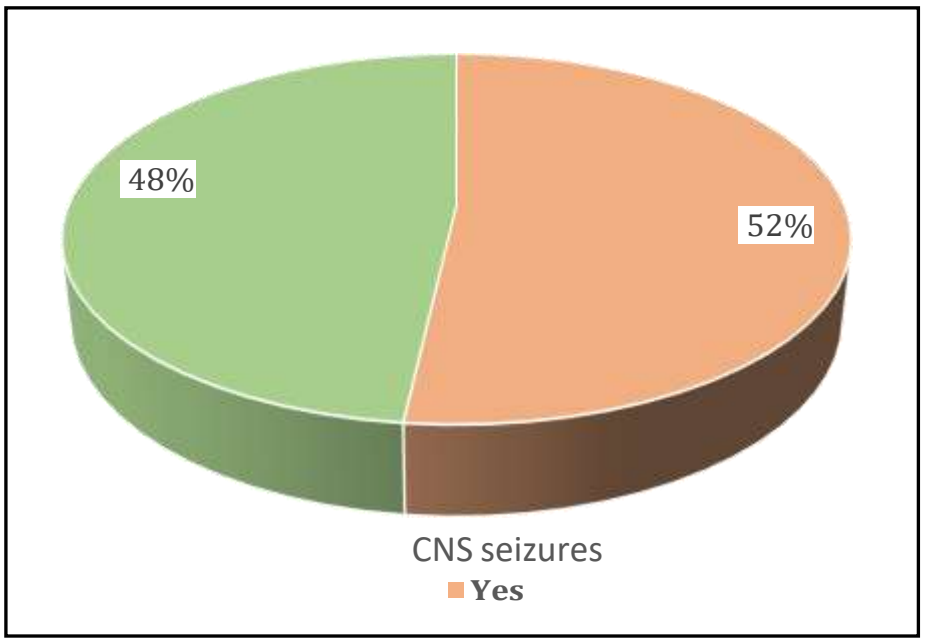


Table 13: Cardiac outcome observed in neonates

Cardiac outcome*	Frequency(n=50)	Percentage
Persistent Pulmonary Hypertension of the Newborn (PPHN)	26	52.0 %
Hypotension	20	40.0 %
None	4	8.00%
Total	**50**	**100.0 %**

*Multiple cardiac outcomes were observed in individual neonates

Regarding cardiac outcome, 26 (52%) newborns had Persistent Pulmonary Hypertension and 20 (40%) neonates had hypotension and 4 neonates didn't have any cardiac outcome

Figure 12: Simple bar diagram shows cardiac outcome observed in neonates

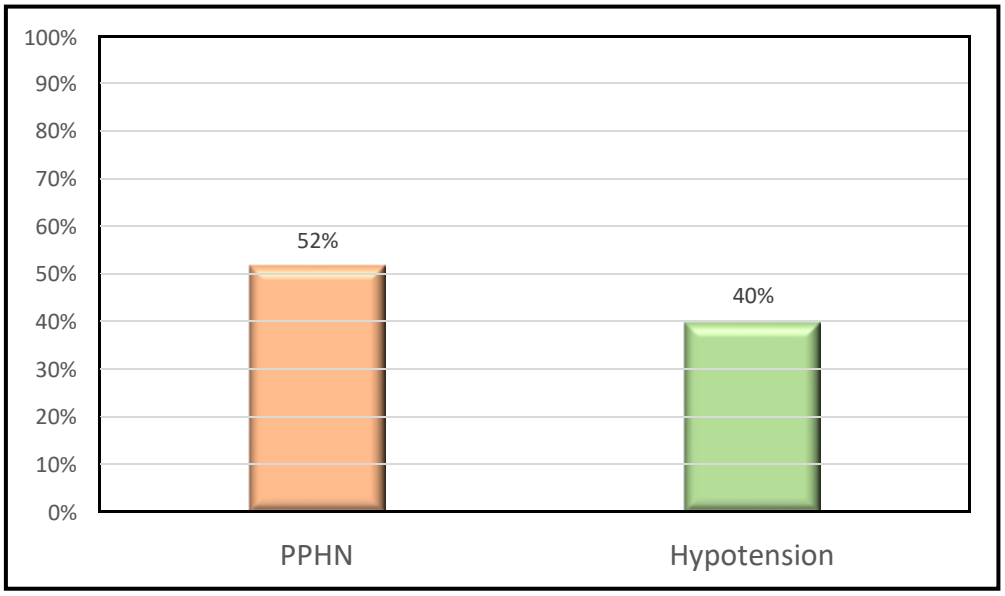


Table 14: Respiratory outcome(respiratory distress) observed in neonates

Respiratory failure	Frequency(n=50)	Percentage
Yes	50	100.0
No	0	0
Total	**50**	**100.0**

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All the 50 (100%) neonates had respiratory failure

Figure 13: Simple bar diagram shows Respiratory outcome observed in neonates

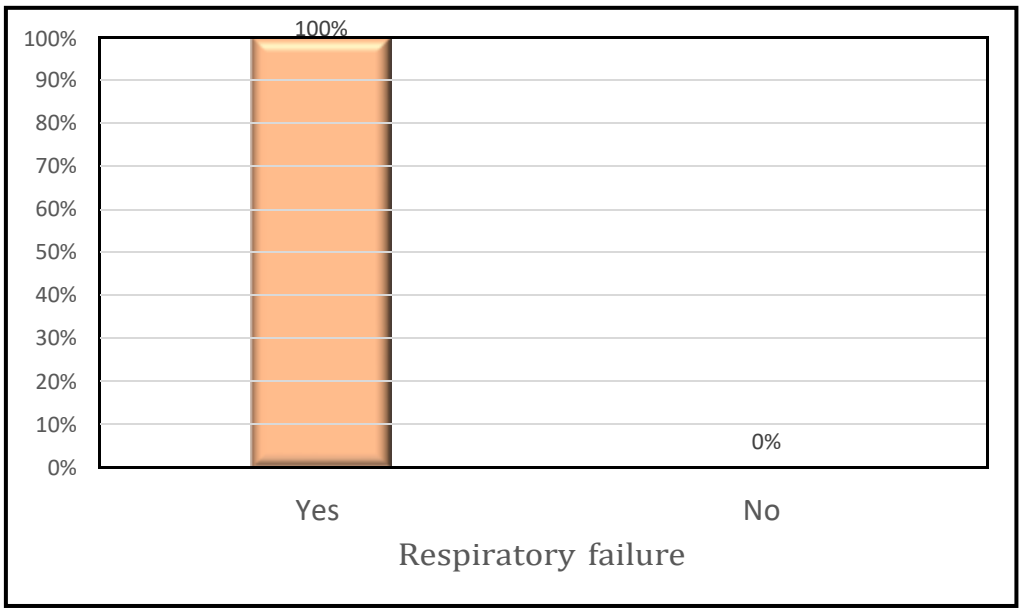


Table 15: Hematological outcome observed in neonates

Hematological outcome	Frequency	Percentage
Deranged coagulation	19	38.0 %
thrombocytopenia	26	52.0 %
Anemia	14	28.0 %

*Multiple hematological outcomes were observed in individual neonates

Among 50 neonates who had hematological outcome, 19(38%) had deranged coagulation, 26 (52%) had thrombocytopenia and 14(28%) had anemia.

Figure 14: Simple bar diagram shows Hematological outcome observed in neonates

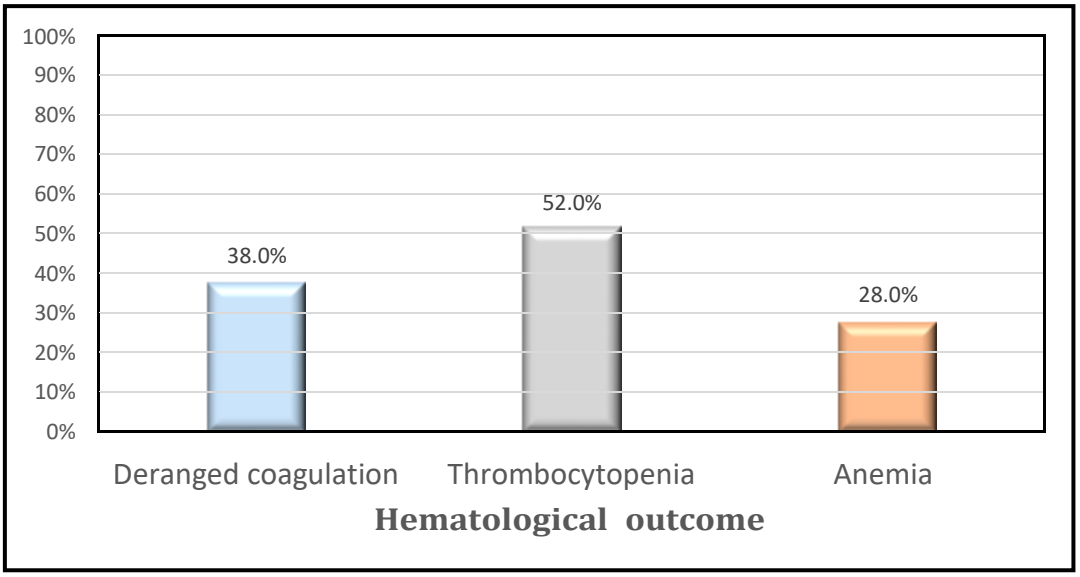


Table 16: **Gastrointestinal outcome(Feed Intolerance) observed in neonates**

Feeding Intolerance	Frequency(n=50)	Percentage
Yes	19	38.0
No	31	62.0
Total	**50**	**100.0**

Among 50 neonates, 19 (38%) neonates had Feed Intolerance.

Figure 15: Pie diagram shows distribution of Feed Intolerance

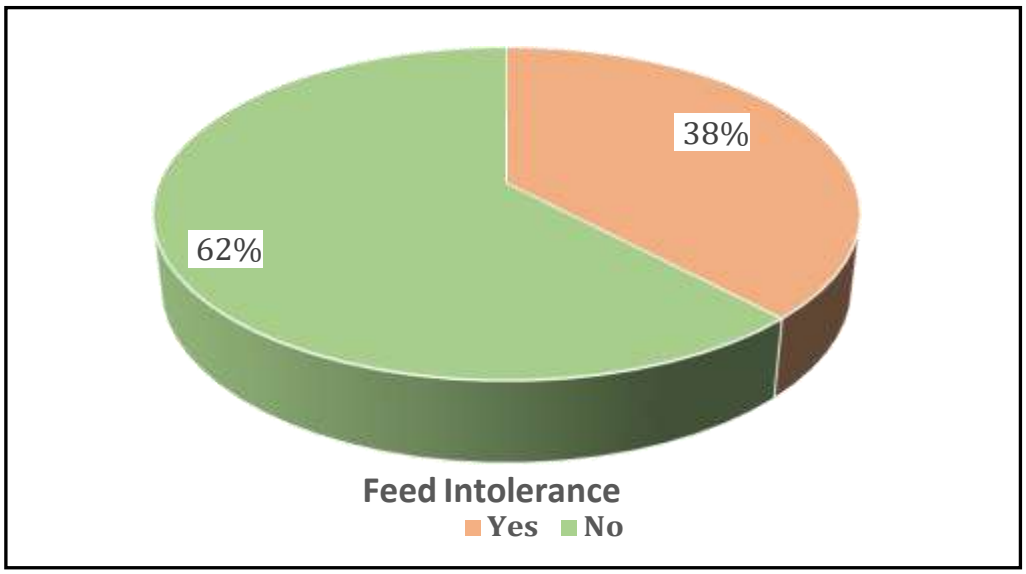


Table 17: Renal outcome(Acute kidney injury)observed in neonates

Acute kidney injury	Frequency(n=50)	Percentage
Yes	15	30.0
No	35	70.0
Total	**50**	**100.0**

Among 50 neonates, 15 (30%) had Acute kidney injury

Figure 16: Pie diagram shows distribution of Acute kidney injury

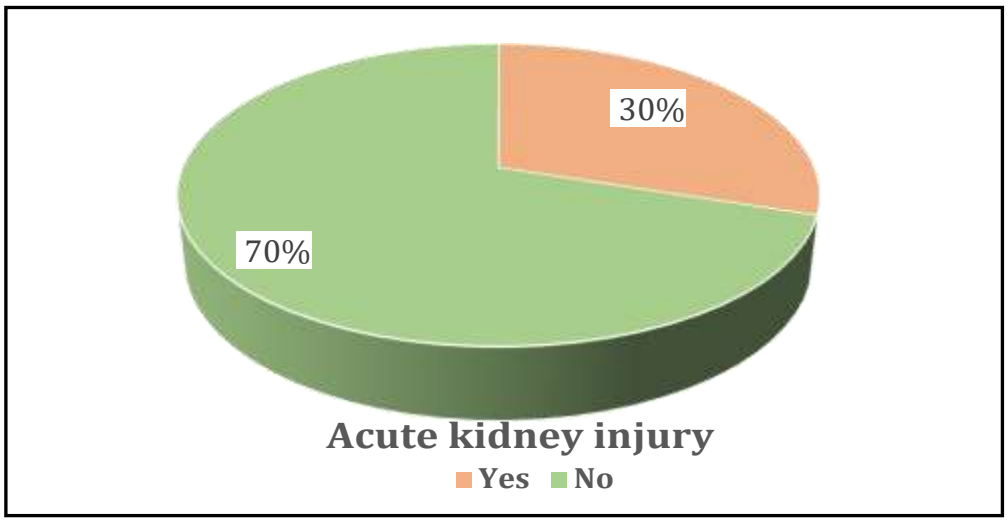


Table 18: Comparison between Thompson score and complications

Complications		Thompson score			Test statistic	P value
		Mild (n=20)	Moderate (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)		
Thrombocytopenia	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)		
Acute kidney injury	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. Percentage of mortality was significantly higher among neonates falling under severe Thompson 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 were under 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 higher in 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 value of <0.001. Among 20 neonates who had hypotension, 17 (85%) neonates were under 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 categories of 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 19: Comparison between Modified Sarnat score and complications

Complications		Modified Sarnat score		Test statistic	P value
		Mild (n=29)	Moderate to 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)		
Mortality between 24-72 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 coagulation	Yes	5(26.3)	14(73.7)	12.629	0.0001*
	No	24(77.4)	7(22.6)		
Thrombocytopenia	Yes	8(30.8)	18(69.2)	16.488	0.0001*

	No	21(87.5)	3(12.5)		
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)		
Acute kidney injury	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%) were in 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 mild modified 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 moderate to severe sarnat score when compared to other category of sarnat score and the 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 when compared to mild sarnat staging with the p value showing less than 0.05 respectively

Table 20: 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*
Moderate to severe	2 (4.0)	19(38.0)	21 (42.0)		
Total	20 (40.0)	30 (60.0)	50 (100.0)		

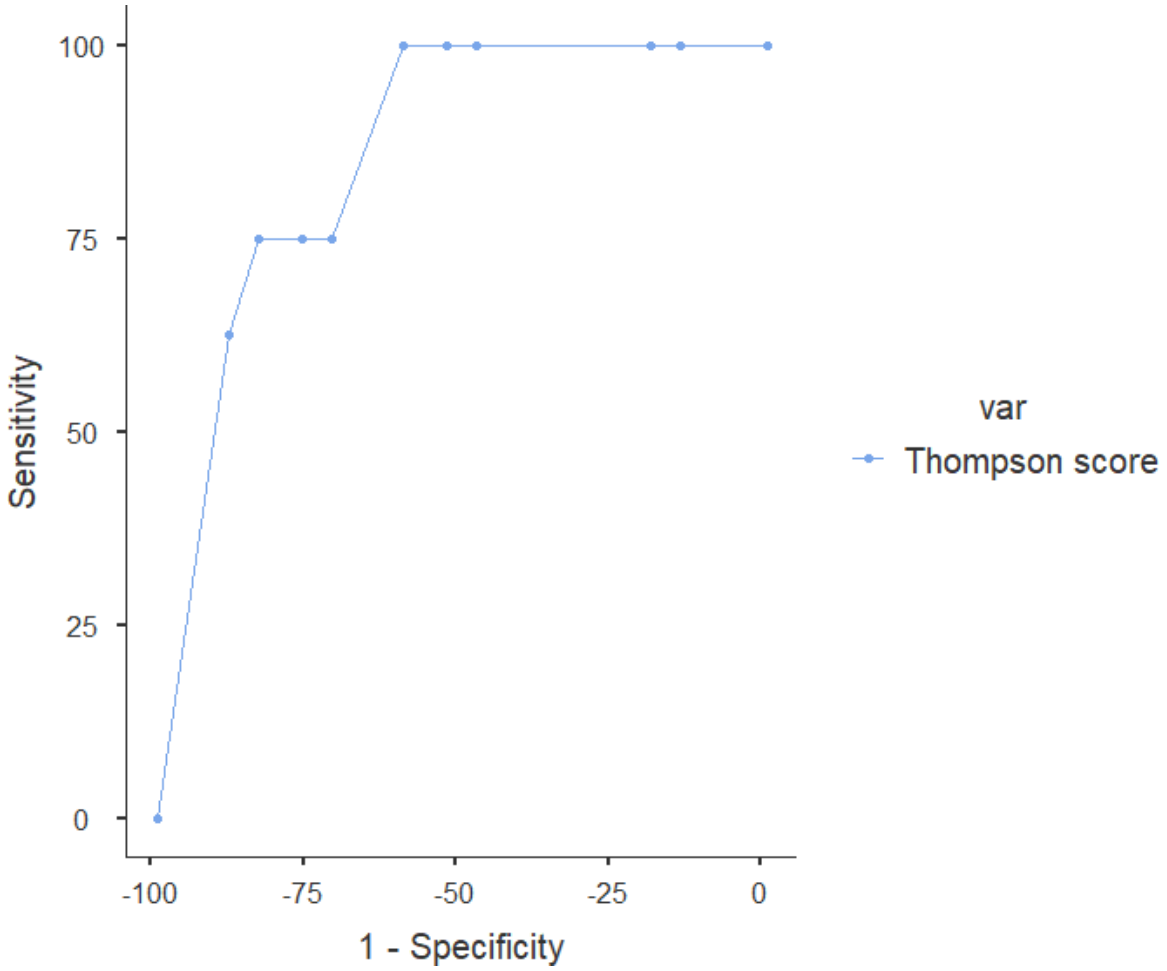
Statistical test used: Kappa analysis
***p value <0.05 is considered statistically significant**

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

Table 21: ROC curve - Thompson score with mortality

	Cutoff value	sensitivity	specificity	PPV	NPV	Youden'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 17: ROC curve



DISCUSSION

DISCUSSION:

Maternal Age Distribution: In this study, the majority of mothers were older than 25 years, comprising 78% of the total sample, while 22% were 25 years or younger. This distribution aligns with the global trend of increasing maternal age at childbirth, driven by various factors such as delayed childbearing due to educational pursuits, career advancement, and socioeconomic factors.[51] However, the proportion of younger mothers in this study appears lower than in some previous studies, where adolescent pregnancies may be more prevalent, potentially due to differences in demographic characteristics and healthcare access.[52]

Neonatal Weight Distribution: The distribution of neonatal weights in this study shows that the majority of neonates fell within the 2.5-3 kg weight range, comprising 70% of the sample. This is consistent with the normal range for birth weights, as defined by the World Health Organization[53] (WHO) (World Health Organization, 2019). However, the proportion of neonates in the lower weight range (<2.5 kg) appears lower than reported in some studies from resource-limited settings, where low birth weight is more prevalent due to factors such as maternal malnutrition, inadequate prenatal care, and infectious diseases.[54]

Mode of Delivery: The distribution of mode of delivery indicates that the majority of neonates were delivered via Lower Segment Caesarean Section (LSCS), accounting for 62% of the sample. Normal Vaginal Delivery (NVD) and Vacuum-assisted NVD (V NVD) accounted for 28% and 10%, respectively. This predominance of LSCS aligns with global trends showing increasing rates of caesarean deliveries, often attributed to factors such as maternal request, obstetric complications, and healthcare provider preferences.[55]However, the proportion of caesarean deliveries in this study may be higher than recommended by the WHO, which suggests an optimal caesarean section rate of 10-15%.[56]

Comparing these findings with previous studies, variations in maternal age distribution, neonatal weight, and mode of delivery may reflect differences in healthcare systems, cultural norms, and socioeconomic factors across populations. For example, studies from low-income countries may report higher proportions of younger mothers, lower birth weights, and higher rates of vaginal deliveries due to limited access to healthcare resources and higher prevalence of obstetric complications .[57]

APGAR Scores and Mode of Resuscitation:

The APGAR scores at one minute and five minutes are critical indicators of neonatal well-being and immediate postnatal adaptation. The high percentage of neonates with APGAR scores of 3 or above at one minute (80%) and at five minutes (98%) indicates overall satisfactory neonatal transition to extra uterine life. This finding aligns with previous research indicating that the majority of neonates achieve adequate APGAR scores shortly after birth.[58] However, the study's proportion of neonates requiring resuscitation interventions, with 32% receiving mechanical ventilation and 68% positive pressure ventilation, raises concerns about the need for immediate medical interventions despite apparently normal APGAR scores. This suggests the presence of underlying clinical conditions requiring intervention beyond what can be inferred from APGAR scores alone.[59]

Comparing these findings with previous studies like Sven et al[60] , similar proportions of neonates requiring resuscitation interventions have been reported in settings with comparable levels of neonatal care. However, further investigation is warranted to understand the specific indications for resuscitation and the outcomes associated with different modes of intervention.

Thompson and Modified Sarnat Scores:

The distribution of neonates across Thompson and Modified Sarnat score categories provides 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 each scoring system and their sensitivity in identifying neonates at risk of adverse outcomes.[31]

Previous studies have reported variations in the distribution of neonates across severity categories based on different scoring systems, highlighting the challenges in standardizing the assessment of neonatal encephalopathy.[61] The discrepancy between the Thompson and Modified Sarnat scores underscores the importance of selecting appropriate assessment tools tailored 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[58], 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, especially those born prematurely or with perinatal asphyxia. However, the study reported a lower prevalence of PPHN (42%) but a similar prevalence of hypotension (39%).[62]

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[32], which also reported higher mortality rates in neonates with severe Thompson scores compared to those with moderate or mild scores .

Similarly, a study by Dalip et al[30] 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[63] , who found that infants with higher Thompson scores were more likely to experience seizures and other neurological complications . Another study by Maphake et al[31]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[64] which identified a strong correlation 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[65] who found that severe Thompson scores were associated with higher incidences of cardiovascular instability and coagulopathies in neonates. Moreover, Shankaran et al[42] 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[33]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[36] 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[39] supports this, indicating that while 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[31] which demonstrated the Thompson score's effectiveness in predicting adverse neonatal outcomes.

LIMITATIONS

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 of neonatal health outcomes.

CONCLUSION

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 preferred for 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.

SUMMARY

SUMMARY:

The study conducted aimed to comprehensively assess various aspects related to neonatal health and outcomes, focusing on factors such as maternal age, neonatal weight, mode of delivery, APGAR scores, resuscitation methods, neurological and systemic complications, mortality rates, and the association between Thompson and Modified Sarnat scores with these outcomes. Here's a detailed summary of the study findings:

- Maternal Characteristics: The study began by examining the distribution of mothers based on their age. Among the 50 mothers studied, 22% were aged 25 years or younger, while 78% were older than 25 years.
- Neonatal Weight: The neonates were categorized based on their weight. The majority (70%) fell within the weight range of 2.5-3 kg, followed by 24% between 3.1-3.5 kg, and 6% above 3.5 kg. The mean weight was 2.990 ± 0.283 kg, with a range from 2.44 kg to 3.80 kg.
- Mode of Delivery: Regarding the mode of delivery, 62% of the neonates were delivered via Lower Segment Caesarean Section (LSCS), 28% through normal vaginal delivery (NVD), and 10% through vacuum-assisted NVD.
- APGAR Scores: At one minute, 80% of neonates had an APGAR score of 3, while 20% had a score of 2. At five minutes, 68% had a score of 5, 20% had a score of 4, and 12% had a score of 7.
- Oxygen support: Positive pressure ventilation (PPV) was the predominant mode of oxygen delivery, utilized in 68% of cases, while mechanical ventilator (MV) support was used in 32% of cases.
- Neonatal Complications: Neurological complications such as CNS seizures were reported in 58% of neonates. Cardiac outcomes included Persistent Pulmonary

Hypertension of the Newborn (PPHN) in 52% and hypotension in 40% of cases. All neonates (100%) experienced respiratory failure.

- Systemic Complications :Haematological outcomes included deranged coagulation (38%), thrombocytopenia (52%), and anaemia (28%). Feed intolerance was present in 38% of cases, while Acute Kidney Injury affected 30% of neonates.
- Mortality Rates: Overall mortality was observed in 16% of neonates, with deaths occurring within 24 hours (4%), between 24-72 hours (4%), and beyond 72 hours (8%).
- Association with Thompson and Modified Sarnat Scores: The Thompson score was categorized into mild, moderate, and severe categories, with corresponding percentages of 40%, 24%, and 36%, respectively. The Modified Sarnat score categorized neonates into mild and moderate to severe groups, with percentages of 58% and 42%, respectively.
- Association with Complications: A significant association was found between both Thompson and Modified Sarnat scores with mortality, CNS seizures, PPHN, hypotension, deranged coagulation, thrombocytopenia, anaemia, Feed intolerance, and Acute Kidney Injury.
- Comparison between Thompson and Modified Sarnat Scores: A fair agreement (74%) was observed between Thompson and Modified Sarnat scores, with both scores showing significant associations with various complications and outcomes.
- ROC Curve Analysis: The Receiver Operating Characteristic (ROC) curve analysis for Thompson score with mortality showed an Area under the curve (AUC) of 0.859, indicating good predictive ability.

This study provides a comprehensive overview of neonatal health outcomes, encompassing maternal characteristics, neonatal weight, mode of delivery, APGAR scores, resuscitation

methods, and various complications. It highlights the significant associations between Thompson and Modified Sarnat scores with mortality and other complications, emphasizing the importance of early assessment and intervention in neonatal care. The findings suggest that both scoring systems can serve as valuable tools in predicting outcomes and guiding clinical management. However, further research is warranted to validate these findings and explore additional factors influencing neonatal health and outcomes.

RECOMMENDATIONS:

- Early Screening and Intervention: Implement routine screening protocols for neonates using standardized scoring systems like Thompson and Modified Sarnat scores to identify high-risk cases early. This can facilitate prompt intervention and improve outcomes.
- Enhanced Maternal Care: Provide comprehensive prenatal care programs targeting mothers, especially those in the younger age group, to ensure optimal maternal health and reduce the risk of adverse neonatal outcomes.
- Mode of Delivery Considerations: Evaluate the mode of delivery on a case-by-case basis, considering factors such as maternal health, foetal distress, and potential neonatal complications to minimize adverse outcomes.
- Training and Education: Offer training programs for healthcare professionals on neonatal resuscitation techniques and the management of common complications such as CNS seizures, PPHN, and hypotension to improve clinical outcomes.
- Multidisciplinary Approach: Foster collaboration among obstetricians, neonatologists, paediatricians, and other healthcare providers to ensure comprehensive care for both mothers and neonates, particularly in cases with complex medical needs.

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ANNEXURE

PATIENT INFORMATION SHEET

Correlation of Thompson Score and Modified Sarnat Staging in predicting early neonatal outcome in post asphyxiated neonates -A Prospective Observational Study

Principal investigator: DR.KALAVAKURU MOUNA/ DR.KRISHNAPPA.J

I Dr.KALAVAKURU MOUNA, Post graduate student in Department at Sri Devraj Urs Medical College, will be conducting a study titled**" A Prospective Observational Study-Correlation of Thompson and Modified Sarnat staging in predicting early neonatal outcome in post asphyxiated neonates** for my dissertation under the guidance of Dr.KRISHNAPPA.J, Professor in Department of Paediatrics. The participants of this study include 50 infants> 37weeks of gestation admitted in NICU with APGAR </=7 at 5minutes of birth.You will not be paid any financial compensation for the participation of your newborn in this research project.

All the data will be kept confidential and will be used only for research purpose by this institution. You are free to provide consent for the participation of your newborn in this study. You can also withdraw your newborn from the study at any point of time without giving any reasons whatsoever. Your refusal to participate will not prejudice you to any present or future care at this institution.

Name and Signature of the Principal Investigator

Contact number : 9686014778

Date-

ರ೦ಿcೆ್ಗಿಯಮ೦ಾಹ೦ಿತಿಹಾಳ೦ೆ

''ಉಸ೦ಿರುಗಟ್ಟ೦ಿದನ೦ಂತರದನವಜ೦ಾತಶಿಶುಗಳಲ್ಲಿಆರ೦ಂಭಿಕನವಜ೦ಾತಫಲ್ಲತಾಂಶವನು೦ುಊಹ೦ಿಸುವಲ್ಲಿಥ೦ಾ೦ಂಪ್ಸನ್ಮತುಮಾಪ೦ಕ ಪಡಿಸಿದ ಸರ್೦ಾಪಟ್೦ಸಟ೦ೋಜ೦ಂಗ೦ುನ೦ಿರೋಕ್ಷಿತಅವಲ೦ಿcೋಕನದಅಧ್೦ಯನ-ಸಹಸ೦ಂಬ೦ಂಧ್''

ಪ್ರಧಾನತನಿಖಾಧ೦ಿಕ೦ಾರ: ಡ೦ಾ.ಕಲವಕ೦ರುಮ೦ೌನ/ಡ೦ಾ.ಕೃಷ೦ಣಪ್ಪ.ಜಿ.

ರ್೦ಾನುಡಾ.ಕಲವಕುರುಮೌರ್೦ಾ,
ಶಿರ೦ಿದ೦ೆವರಾಜ್ಅರ್ಸ೦ುಪಡ೦ಿಕಲಾಾಲ೦ೋಜನಲ್ಲ೦ಿವ೦ಿಭ೦ಾಗದರ್ಸ೦ಾ೦ುತಕ೦ೋತುರವಿದಾಯರ್ಥಪ,
ಥಾಂಪ್ಸನ್ಅವರನ೦ಿರ೦ಕ್ಷಿತಅವಲ೦ಿc೦ಕನದಅಧ್ಯಯನಮತ೦ು೦ುತೃತ೦ಿ೦ಯಆರೈಕೆಯಲ್ಲಿಉಸ೦ಿರ೦ುಗ ಟ್ಟ೦ಿದನ
ವಜಾತಶಿಶುಗಳಲ್ಲಿಆರಂಭಿಕನವಜಾತಫಲ್ಲತಾಂಶವನುುಊಹಿಸಲುಮಾಪ್ಪಡಿಸಿದಸರ್೦ಾಪಟ್೦ಿಸಟೋಜಂ
ಗ್ಎ೦ಂಬಶ೦ೀರ್ಷಪಕೆಯಅಧ್ಯಯನವನ೦ು೦ುನಡೆಸ೦ುತುದ೦ೆ. ಕ೦ೋಲಾರದಕ೦ೋ೦ಂದರದಲ್ಲ೦ಿ,
ಮಕಾಳವ೦ಿಭಾಗದಪ್೦ಾರಧಾಯಪ೦ಕರಾದಡ೦ಾ.ಕೃಷ೦ಣಪ್ಪ.ಜಿಅವರಮ೦ಾಗಪದಶಪನದಲ್ಲ೦ಿನನ೦ುಪ್ರಬಂಧ್ಕ ೦ಾ೦ಾಗಿ. ಈಅಧ್ಯಯನದಲ್ಲ೦ಿಭಾಗವಹಿಸ೦ಿದವರ೦ು 45 ಶ೦ಿಶ೦ುಗಳ೦ು> 37
ವಾರಗಳಗಭಾಪವರ್ಸ೦ೆಯನ೦ು NICU ನಲ್ಲ೦ಿ APGAR</=7 ರ್೦ಿc೦ಂದಿಗೆ 5
ನಿಮಿಷ೦ಗಳಲ್ಲ೦ಿಜನ೦ಿಸಿದರ೦ು.
ಈಸ೦ಂಶ೦ೆc೦ಧ್ರ೦ಾಯೋಜರ್೦ೆಯಲ್ಲ೦ಿನಿಮ೦ಮಗ೦ುವ೦ಿನಭಾಗವಹಿಸ೦ುವ೦ಿಕೆಗಾಗಿನ೦ಿಮಗೆಯ೦ಾವ೦ುದೋಹಣಕ೦ಾ ಸಿನಪ್ರಹಾರವನುುಪ್೦ಾವತಿಸಲಾಗುವುದಿಲಿ.
ಎಲಾ೦ಿಡೋಟ್೦ಾವನ೦ು೦ುಗೌಪ೦ಿವ೦ಾಗಿಇರಸಲ೦ಾಗ೦ುತುದೆಮತ೦ು೦ುಈಸ೦ಂರ್ಸ೦ೆಯಂದಸಂಶ೦ೆc೦ಧ್ರ೦ಾಉದೆದ೦ೋಶಕಾಾಗಿ ಮಾತರಬಳಸಲಾಗುತುದೆ.
ಈಅಧ್ಯಯನದಲ್ಲ೦ಿನಿಮಮಮಗ೦ುವ೦ಿನಭಾಗವಹಿಸ೦ುವ೦ಿಕೆಗ೦ೆಒಪ್ಪ೦ಗೆ೦ೋಡಲ೦ು೦ೋವ೦ುಸವತ೦ಂತರ೦ಾಗಿದ೦ಿ೦ರ.
ಯ೦ಾವ೦ುದೋ೦ಾರಣಗಳನ೦ು೦ೋಡದೆ೦ೋವ೦ುಯ೦ಾವ೦ುದೋಸಮಯದಲ್ಲ೦ಿನಿಮಮಮಗ೦ುವನ೦ು೦ುಅಧ೦ಯನದಿಂದ ಹಿಂಪ್ಡೆಯಬಹುದು.
ಭಾಗವಹ೦ಿಸಲ೦ುನಿಮಮನಿರ೦ಾಕರಣೆಯ೦ುಈಸ೦ಂರ್ಸ೦ೆ ೦ಾವ೦ುದೋಪ೦ರಸ೦ುತಅಥವಾಭವ೦ಿಷ್ಯದಕ೦ಾಳಜಗೆನಿ ೦ೆಯಲ್ಲ**ಮು**ಮನುುಪ್೦ೂವಾಪಗರಹಮಾಡುವುದಿಲಿ.

ಪ್ರಧಾನತನಿಖಾಧಿಕಾರಯಹೆಸರುಮತುುಸಹಿಸಂಪ್ಕಪಸಂಖೆಯ
:9686014778ದಿರ್೦ಾ೦ಂಕ-

INFORMED CONSENT FORM

Date:

I, Mr/Mrs_____,have been explained in my own vernacular language that my newborn will be included in **Correlation of Thompson score and Modified Sarnat staging in predicting early neonatal outcome in post asphyxiated neonates-A Prospective Observational Study.**I hereby give my valid written informed consent without any force or prejudice for recording the observations of haematological and clinical parameters . The nature and risks involved have been explained to me, to my satisfaction. I have been explained in detail about the study being conducted. I have read the patient information sheet and I have had the opportunity to ask any question. Any question that I have asked, have been answered to my satisfaction. I provide consent voluntarily to allow my newborn as a participant in this research. I hereby give consent to provide history, undergo physical examination, undergo the procedure, undergo investigations and provide its results and documents etc to the doctor / institute etc. For academic and scientific purpose the operation / procedure, etc may be video graphed or photographed. All the data may be published or used for any academic purpose. I will not hold the doctors / institute etc responsible for any untoward consequences during the procedure / study.

_____ _____

(Signature & Name of Pt. Attendant) (Signature/Thumb impression &

Name of Parent/Guardian)

(Relation with patient)

Witness:

_____

(Signature & Name of Research person/doctor)

ಮಂತಿನೋಡಿದಒಪ್ಪಗೆನಮಂರ್ಪೆ

ದಿರ್ಾಂಕ

ರ್ಾನು, ಶ್ರೀ/ಶ್ರೀಮತಿ _____,

ನನುಮಗುವನುಥಂತಾಪ್ಪನಮತ್ತುಮಂತಪ್ಪಡಿಸಿದಸರ್ಾಪಟ್ಟವರೋದಿಕೆಯಲ್ಲಿನಿರೋಕ್ಷಿತಅವಲೆಂಕೋಕನಅಧ್ಯಯನ-

ಪ್ರಸಪರಸಂಬಂಧ್ಪಲ್ಲಿರ್ಸೋರಸಲಾಗುವುದುಎಂದುನನುಸವಂತಸೆಳೆಯಭಾಷೆಯಲ್ಲಿವಿವರಸಲಾಗಿದಹೆಮಟ್ಟೆಲಾಜಕಲ್ತುಕ್ಲಿನಿಕ

ಲ್ಪಯತಾಂಕಗಳಅವಲೆಂಕೋಕನಗಳನುುದಾಖಲ್ಲಸಲುಯಂತಾವುದೋಬಲಅಥವಾಪ್ೂವಾಪಗರಹವಿಲಿದೆಒಪ್ಪಗೆಒಳಗೆಂಡಿರುವಸವಭಾ

ವಮತ್ತುಅಪ್ಾಯಗಳನುುನನಗೆವಿವರಸಲಾಗಿದೆ, ನನುತೃಪ್ತುನಡೆಸುತಿರುವಅಧ್ಯಯನದಬಗೆನನಗೆವಿವರವಾಗಿವಿವರಸಲಾಗಿದೆ

ರ್ಾನುರೆಂಕೋಗಿಯಮಂತಿಹಾಳಕೆಯನುುಬಿದದೋರ್ೆಮತ್ತುಯಂತಾವುದೋಪ್ರಶೆಯನುುಕೋಳಲುನನಗೆಅವಕಾಶವಿದೆರ್ಾನುಕೋಳದಯಂತ

ವುದೋಪ್ರಶೆಗೆನನುತೃಪ್ತುಗೆಉತ್ತುರಸಲಾಗಿದೆನನುಮಗುವನುುಈಸಂಶೆಂಕೋಧ್ರ್ಯಲ್ಲಿಪ್ಾಲುಂಕೆಳುುವಂತೆಅನುಮತಿಸಲುರ್ಾನುಸು

ಯಂಪ್ೆರೋರಣೆಯಂದಒಪ್ಪಗೆಯನುುಸೋಡುತ್ತುರೋರ್ಇತಿಹಾಸವನುುಒದಗಿಸಲು, ದೈಹಿಕಪ್ರೀಕ್ಷೆಗೆಒಳಗಾಗಲು,

ಕಾಯಪವಿಧಾನಕ್ಕುಒಳಗಾಗಲು,

ತನಿಖೆಗೆಒಳಗಾಗಲುಮತ್ತುುಅದರಫಲ್ಲತಾಂಶಗಳುಮತ್ತುದಾಖಲೆಗಳನುುಇತಾುದಿಗಳನ್ುವೈದುರು /

ಸಂರ್ೆಇತಾುದಿಗಳಗೆಒದಗಿಸಲುರ್ಾನುಈಮಂಲಕಒಪ್ಪಗೆನಿೋಡುತ್ತುರೋರ್ೆ.

ಶೈಕ್ಷಣಿಕಮತ್ತುವೈಜ್ಞಾನಿಕಉದೆದುಶಕಾುಗಿಕಾಯಾಪಚರಣೆ / ಕಾಯಪವಿಧಾನ,

ಇತಾುದಿಗಳನುುವಿೋಡಿಯಗಾುಫ್ಅಥವಾಛಾಯಾಚಿತರಮಾಡಬಹುದುಎಲಾಿೋಟ್ಾವನುುಪ್ರಕಟ್ಸಬಹುದುಅಥವಾಯಾವುದೋ

ಶೈಕ್ಷಣಿಕಉದದೋಶಕಾುಗಿಬಳಸಬಹುದುಕಾಯಪವಿಧಾನ /

ಅಧ್ಯಯನದಸಮಯದಲ್ಲಿಯಾವುದೋಅಹಿತಕರಪ್ರಣಾಮಗಳಗರ್ಾನುವೈದುರು /

ಸಂರ್ೆಇತಾುದಿಗಳನುುಹಂಚಿಕೆಗಾರರರ್ಾುಗಿಮಾಡುವುದಿಲಿ

ಸಹಿಮತ್ತುಪ್ಂ. ಪ್ರಚಾರಕರಹೆಸರು)

(ಸಹಿ/ಹೆಬ್ೆರಳನಗುರುತುರೆಂಕೋಗಿಯ/ರಕ್ಷಕನಹೆಸರು

ರೆಂಕೋಗಿಯಂದಿಗಿನಸಂಬಂಧ್

ರ್ಾಟ್ಣ ಸಂಶೆಂಕೋಧ್ಕಾುಮುಖ್ಯ/ವೈದುರಸಹಿಮತ್ತುಹೆಸರು

PROFORMA

SL NO: DATE: APGAR SCORE:

NAME OF MOTHER: GPE(AT BIRTH)

AGE OF MOTHER: TONE: AF:

NAME OF FATHER: POWER: PALLOR:

ADDRESS: SUCK: CYANOSIS:

GESTATIONAL AGE: CRY:

DATE OF BIRTH: VITALS:

TIME OF BIRTH: HR: RR:

PRESENTATION: CFT: PP:

MODE OF DELIVERY: **CNS**

INDICATION OF LSCS: SPONTANEOUS EYE OPENING

MODE OF OXYGEN DELIVERY: ACTIVITY:

RISK FACTORS: CONVULSIONS:

DATE OF ADMISSION:

REASON FOR ADMISSION

MODIFIED SARNAT STAGING

DATE				
TIME				
Level of consciousness				
Activity				
Neuromuscular control				
Muscle tone				
Posture				
Stretch reflexes				
primitive reflexes				
SARNAT STAGING Suck				
Moro				
Tonic neck				
Autonomic function				
Pupils				
Heart rate				
Seizure				

THOMPSON SCORING

Date				
Time				
Tone				
LOC				
Fits				
Posture				
Moro				
Grasp				
Suck				
Respair				
Fontanelle				
Total				

FOLLOW UP OUTCOMES

DATE				
A.PRIMARY OUTCOME				
1.DEATH				
<24HOURS				
24-72HOURS				
>72HOURS				
B. SECONDARY OUTCOME				
1.NEUROLOGICAL OUTCOME				
A.SURVIVAL WITHOUT SEIZURES				
B. SURVIVAL WITH SEIZURES				
C.ANTICONVULSANTS				
NONE				
1 DRUG				
>/= 2 DRUGS				
2.CARDIAC OUTCOME				
3.RESPIRATORY OUTCOME				
4.HEMATOLOGICAL OUTCOME				
5.GASTROINTESTINAL OUTCOME				
6.**RENAL OUTCOME**				

MASTER CHART

SL NO.	UHID	AGE OF MOTHER	B.WT	GESTATIONAL AGE	MODE OF DELIVERY	APGAR	OXYGEN SUPPORT	THOMPSON SCORE	MODIFIED SARNAT SCORE	DEATH <24HOURS	DEATH 24-72OURS	DEATH >72HOURS	SURVIVAL WITHOUT SEIZURES	SURVIVAL WITH SEIZURES	NO ANTICONVULSANTS	1 ANTICONVULSANT	>/=2 ANTICONVULSANTS	CARDIAC OUTCOME	RESPIRATORY FAILURE	HEMATOLOGICAL OUTCOME	GI OUTCOME	RENAL OUTCOME
1	188762	29	3.2kg	38w	lscs	3/10 5/10	mv	moderate(15)	mild	YES							YES	pphn,hypotension	YES	deranged coagulation profile,thrombocytopenia	feed intolerance(FI)	AKI
2	188546	32	3kg	39w	lscs	3/10 5/10	mv	severe(22)	mild			yes					yes	pphn,hypotension	YES	deranged coagulation profile,thrombocytopenia,anemia	FI	AKI
3	188675	26	2.8kg	37w	NVD	3/10 5/10	mv	severe(22)	moderate		yes						yes	pphn,hypotension	YES	deranged coagulation profile,thrombocytopenia,anemia	FI	AKI
4	195662	30	2.9kg	39w	lscs	2/10 4/10	mv	moderate(15)	moderate		yes						yes	pphn,hypotension	YES	deranged coagulation profile,thrombocytopenia	FI	AKI
5	187501	24	3kg	40w	lscs	3/10 5/10	ppv	mild(10)	mild				yes		yes			no	YES	no	no	no
6	188186	27	2.8kg	39w	NVD	3/10 5/10	ppv	mild(10)	mild				yes		yes			no	YES	no	no	no
7	188624	28	3kg	38weeks	NVD	3/10 5/10	ppv	mild(9)	mild				yes		yes			no	YES	no	no	no
8	193626	29	3.2kg	38weeks	NVD	3/10 5/10	ppv	mild(10)	mild				yes		yes			no	YES	no	no	no
9	198984	25	2.7kg	37w	lscs	3/10 5/10	ppv	mild(8)	mild				yes		yes			no	YES	no	no	no
10	202931	22	2.9kg	39w	lscs	3/10 5/10	PPV	mild(10)	mild				yes		yes			no	YES	no	no	no
11	197665	27	3.4kg	40weeks	nvd	2/10 4/10	PPV	moderate(15)	moderate					yes			YES	pphn,hypotension	YES	deranged coagulation profile	FI	AKI
12	208301	28	3.2kg	39w	lscs	3/10 5/10	PPV	mild(10)	mild				yes		yes			no	YES	no	no	no
13	209975	31	2.9kg	40w	lscs	3/10 5/10	PPV	mild(8)	mild				yes		yes			no	YES	no	no	no
14	212068	34	3kg	38w	lscs	3/10 5/10	ppv	moderate(14)	mild					yes		yes		no	YES	deranged coagulation profile,thrombocytopenia	no	no
15	215342	29	3kg	40w	lscs	3/10 5/10	PPV	mild(10)	mild				yes		yes			no	YES	no	no	no
16	214817	29	2.8kg	40w	NVD	3/10 5/10	ppv	moderate(12)	mild					yes		yes		no	YES	deranged coagulation profile,thrombocytopenia	no	no
17	215841	27	2.9kg	40w	NVD	3/10 5/10	ppv	mild(10)	mild				yes		yes			no	YES	no	no	no
18	216158	30	3kg	39w	NVD	3/10 5/10	PPV	mild(10)	mild				yes		yes			no	YES	no	no	no
19	227680	25	3.2kg	38w	lscs	3/10 5/10	PPV	mild(8)	mild				yes		yes			no	YES	no	no	no
20	231218	22	2.8kg	38w 5d	NVD	3/10 5/10	ppv	moderate(15)	mild					yes		yes		pphn	YES	deranged coagulation profile,thrombocytopenia	no	no

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21	188654	26	3.1kg	40w 2d	lscs	2/10 4/10	mv	severe(22)	moderate			yes					YES	pphn,hypotension	YES	deranged coagulation profile,thrombocytopenia	FI	AKI
22	263798	27	3kg	41w 2d	NVD	3/10 5/10	PPV	moderate(15)	mild					yes		YES		pphn	YES	deranged coagulation profile,thrombocytopenia	no	no
23	269372	23	2.8kg	40w	NVD	3/10 5/10	PPV	mild(8)	mild				yes		yes			no	YES	no	no	no
24	271858	28	2.9kg	42w	nvd	2/10 4/10	mv	severe(22)	severe			yes					YES	pphn,hypotension	YES	deranged coagulation profile,thrombocytopenia	FI	AKI
25	275422	29	3.1kg	40w	lscs	2/10 4/10	ppv	severe(18)	moderate					yes			YES	pphn,hypotension	YES	deranged coagulation profile,thrombocytopenia	FI	AKI
26	280869	32	3kg	37w 4d	lscs	2/10 4/10	ppv	severe(17)	moderate					yes			YES	pphn,hypotension	YES,pnemothorax	deranged coagulation profile,thrombocytopenia	FI	AKI
27	286352	29	2.8kg	39w 5d	lscs	3/10 5/10	ppv	severe(17)	moderate					yes			YES	pphn,hypotension	YES	deranged coagulation profile,thrombocytopenia,anemia	FI	AKI
28	285447	25	2.9kg	39w	lscs	3/10 5/10	ppv	mild(10)	mild				yes		yes			no	YES	no	no	no
29	291670	34	2.92kg	37w	V nvd	2/10 4/10	mv	severe(22)	moderate					yes		YES		hypotension	YES,pnemothorax	deranged coagulation profile,thrombocytopenia,anemia	FI	no
30	184487	19	3.3kg	39w 5d	V nvd	3/10 5/10	ppv	mild(10)	mild				yes		yes			no	YES	deranged coagulation profile,thrombocytopenia	no	no
31	293759	24	3kg	40w	lscs	2/10 4/10	mv	severe(22)	moderate					yes		YES		pphn,hypotension	YES	deranged coagulation profile,thrombocytopenia,anemia	FI	no
32	292556	29	2.8kg	39w	LSCS	3/10 5/10	ppv	mild(8)	mild				yes		yes			no	YES	no	no	no
33	296572	28	2.66kg	37w	lscs	3/10 5/10	ppv	moderate(12)	mild					yes				no	YES	no	no	no

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34	296269	23	3.4kg	40w 5d	lscs	2/10 4/10	mv	severe(22)	moderate					yes			YES	pphn,hypotension	YES,pnemothorax	deranged coagulation profile,thrombocytopenia,anemia	FI	no
35	297148	25	3.2kg	41w 2d	lscs	3/10 7/10	ppv	mild(10)	mild				yes		yes			no	YES	deranged coagulation profile,thrombocytopenia	no	no
36	299101	28	2.54kg	38w	nvd	2/10 4/10	mv	severe(18)	moderate					yes			yes	pphn,hypotension	yes	deranged coagulation profile,thrombocytopenia,anemia	feed intolerance(FI)	AKI
37	326723	29	3.46kg	39w 6d	lscs	3/10 5/10	mv	severe(16)	moderate					yes			YES	pphn	yes	deranged coagulation profile,thrombocytopenia,anemia	no	no
38	337839	29	2.88kg	37w	lscs	3/10 5/10	ppv	moderate(15)	mild					yes		yes		pphn	yes	deranged coagulation profile	no	no
39	342543	27	2.68kg	37w	V nvd	3/10 5/10	mv	severe(22)	moderate			yes					YES	pphn,hypotension	yes	deranged coagulation profile,thrombocytopenia,anemia	no	no
40	337839	29	2.88kg	37w	lscs	3/10 5/10	ppv	severe(16)	moderate					yes			YES	pphn,hypotension	YES	deranged coagulation profile,thrombocytopenia,anemia	feed intolerance(FI)	AKI
41	355251	28	2.84kg	39w	lscs	3/10 5/10	ppv	moderate(14)	mild					yes		yes		pphn	YES	deranged coagulation profile	no	no
42	361882	30	3.22kg	38w	nvd	3/10 5/10	mv	severe(22)	moderate					yes			YES	pphn,hypotension	YES	deranged coagulation profile,thrombocytopenia,anemia	feed intolerance(FI)	AKI
43	362759	26	2.44kg	37w3d	V nvd	3/10 7/10	ppv	mild(10)	moderate				yes		yes			no	YES	no	no	no
44	366816	27	2.72kg	40w	lscs	3/10 7/10	ppv	mild(9)	moderate				yes		yes			no	YES	no	no	no
45	368163	31	3.7kg	40w	lscs	3/10 7/10	ppv	moderate(15)	mild					yes		yes		pphn	YES	deranged coagulation profile	no	no
46	368713	28	2.76kg	37w 3d	lscs	3/10 5/10	mv	severe(22)	moderate					yes			YES	pphn,hypotension	YES,pnemothorax	deranged coagulation profile,thrombocytopenia,anemia	feed intolerance(FI)	AKI
47	370336	32	3.6kg	39w	lscs	3/10 7/10	ppv	moderate(14)	mild					yes		yes		pphn	YES	deranged coagulation profile	no	no
48	370946	28	2.7kg	37w	lscs	3/10 7/10	ppv	mild(8)	mild				yes		yes			no	YES	no	no	no

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49	372506	30	3.8kg	38w	lscs	3/10 5/10	mv	severe(18)	moderate	yes							YES	pphn,hypotension	YES	deranged coagulation profile,thrombocytopenia,anemia	feed intolerance(FI)	AKI
50	373890	29	2.7kg	37w	V nvd	3/10 5/10	mv	severe(17)	moderate					yes			YES	pphn,hypotension	YES	deranged coagulation profile,thrombocytopenia,anemia	feed intolerance(FI)	AKI