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CLINICAL PROFILE, RISK FACTORS AND SHORT-TERM OUTCOMES OF NEONATES WITH HYPOXIC-ISCHEMIC ENCEPHALOPATHY IN A TERTIARY CARE CENTRE

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ABSTRACT

Background: Hypoxic-ischemic encephalopathy (HIE) is one of the most important causes of neonatal mortality and long-term neurological morbidity worldwide[1,2]. In developing countries, the incidence remains high due to preventable maternal and intrapartum risk factors.

Objectives

1. To study maternal and neonatal risk factors associated with hypoxic-ischemic encephalopathy
2. To evaluate the clinical profile of neonates with HIE
3. To assess short-term outcomes and correlate them with severity of HIE

Methods: A prospective observational study was conducted in the Neonatal Intensive Care Unit of a tertiary care hospital over a period of two years. A total of **120 term and near-term neonates** with perinatal asphyxia and clinical features of HIE were enrolled. Severity was classified using **Modified Sarnat staging**. Maternal risk factors, neonatal clinical features, need for respiratory support, seizures, and outcomes were recorded. Statistical analysis was performed using SPSS software. Chi-square test was applied for categorical variables, and a p-value <0.05 was considered statistically significant. **Results:** Stage II HIE was the most common presentation (43.3%). Prolonged labor (38.3%), meconium-stained liquor (35%), and pregnancy-induced hypertension (28.3%) were significant maternal risk factors. Seizures were observed in 68.3% of neonates, predominantly in Stage II and III HIE ($p<0.001$). Overall mortality was 16.7%, with the highest mortality in Stage III HIE (43.3%). **Conclusion:** Severity of hypoxic-ischemic encephalopathy and presence of maternal risk factors significantly influence neonatal outcomes. Early identification and timely management can reduce mortality and morbidity.

INTRODUCTION

Perinatal asphyxia continues to be a major contributor to neonatal morbidity and mortality, accounting for nearly one-fourth of neonatal deaths globally[1,2]. Hypoxic-ischemic encephalopathy represents the neurological manifestation of systemic hypoxia and ischemia occurring during the perinatal period[3].

The pathophysiology of HIE involves a cascade of events beginning with reduced cerebral blood flow and oxygen delivery, leading to primary energy failure[4,11]. This is followed by reperfusion injury characterized by excitotoxicity, calcium influx, oxidative stress, inflammatory cytokine release, and delayed neuronal apoptosis. These mechanisms result in varying degrees of brain injury and long-term neurological sequelae.

The **Modified Sarnat staging system** remains the most widely used clinical classification to assess severity and predict prognosis[3]. Neonates with mild HIE usually recover without sequelae, whereas those with moderate and severe HIE are at high risk of mortality and neurodevelopmental impairment.

Identification of maternal and neonatal risk factors is essential for prevention and early intervention. Factors such as prolonged labor, meconium-stained liquor, hypertensive disorders of pregnancy, and emergency operative deliveries are strongly associated with perinatal asphyxia and subsequent HIE[7,10].

OBJECTIVES

1. To identify maternal and neonatal risk factors associated with HIE
2. To study the clinical profile of neonates with HIE
3. To correlate severity of HIE with short-term outcomes

MATERIALS AND METHODS

Study Design

Prospective observational study.

Study Setting And Duration

NICU of Hi-Tech Medical College & Hospital, Bhubaneswar (A Tertiary Care Centre) January 2024 – December 2025

Sample Size

120 neonates diagnosed with hypoxic-ischemic encephalopathy.

Inclusion Criteria

Neonates fulfilling all of the following criteria were included:

Gestational age **≥35 weeks**

History of perinatal asphyxia, defined by:

- Apgar score **≤6 at 5 minutes** and/or
- Need for positive pressure ventilation or advanced resuscitation at birth

Presence of clinical features of hypoxic-ischemic encephalopathy within the first **72 hours of life.**

Exclusion Criteria

Neonates with any of the following were excluded:

- Major congenital malformations
- Inborn errors of metabolism
- Proven neonatal sepsis at the time of admission
- Preterm neonates with gestational age **<35 weeks**

Data Collection

Data were collected using a **pre-designed, structured proforma**. Information was obtained from maternal case records, delivery room notes, and direct clinical examination of the neonates.

Maternal Variables

- Maternal age and parity
- Antenatal complications such as pregnancy-induced hypertension, anemia, and antepartum hemorrhage

- Intrapartum risk factors including prolonged labor, meconium-stained liquor, fetal distress, and mode of delivery

Neonatal Variables
- Gestational age and birth weight
- Apgar scores at 1 and 5 minutes
- Need and type of resuscitation at birth
- Onset of neurological symptoms
- Presence of seizures
- Feeding difficulty
- Respiratory distress and requirement of respiratory support

Assessment And Staging Of Hypoxic-Ischemic Encephalopathy

All enrolled neonates were clinically assessed and staged according to the **Modified Sarnat staging** within the first **24 hours of admission**. Based on neurological examination, neonates were categorized into:
- **Stage I (Mild HIE)**
- **Stage II (Moderate HIE)**
- **Stage III (Severe HIE)**

Management Protocol

All neonates received **standard supportive management** as per NICU protocol. Management strategies were **not altered for the purpose of the study**.

Supportive Care

Supportive management included:
- Maintenance of **normoglycemia, normoxia, and normocapnia**
- Fluid and electrolyte management
- Early initiation of enteral feeds when clinically stable
- Control of seizures using appropriate antiepileptic drugs
- Respiratory support with oxygen, CPAP, or mechanical ventilation as required
- Maintenance of normal blood pressure and adequate perfusion

Therapeutic Hypothermia (Therapeutic Cooling)

Neonates diagnosed with **moderate to severe HIE (Stage II and Stage III)** who met eligibility criteria were offered **therapeutic hypothermia** as per institutional protocol.

Eligibility Criteria For Therapeutic Cooling
- Gestational age **≥35 weeks**
- Age **≤6 hours at initiation**
- Evidence of perinatal asphyxia
- Clinical features of **moderate or severe HIE**

Cooling Protocol
- **Whole-body cooling** was initiated within **6 hours of life**
- Target core temperature was maintained at **33–34°C**
- Cooling was continued for **72 hours**
- Core temperature was continuously monitored using rectal or esophageal temperature probes
- Controlled rewarming was performed at a rate of **0.5°C per hour** until normothermia was achieved

During therapeutic hypothermia, neonates were closely monitored for:
- Cardiorespiratory stability
- Electrolyte imbalance
- Coagulopathy
- Arrhythmias and hypotension

Outcome Measures

The following **short-term outcomes** were assessed:
- Occurrence of seizures
- Requirement of mechanical ventilation
- Duration of NICU stay
- Neurological status at discharge
- Mortality during hospital stay

A **favorable neurological outcome** was defined as survival without abnormal tone, feeding difficulty, or persistent seizures at discharge.

Ethical Statement

Ethical approval was obtained from the Institutional Ethics Committee of Hi-Tech Medical College and Hospital, Bhubaneswar.

Statistical Analysis

Data were analyzed using SPSS v26. Categorical variables were expressed as percentages. Chi-square test was used for comparison. A p-value <0.05 was considered statistically significant.

RESULTS

Table 1: Maternal Risk Factors Associated With HIE (n = 120)

Risk Factor	Number	Percentage	p-value
Prolonged labor	46	38.3%	0.01
Meconium-stained liquor	42	35.0%	0.02
Pregnancy-induced hypertension	34	28.3%	0.03
Maternal anemia	30	25.0%	0.04
Emergency LSCS	40	33.3%	0.02

Observation

Prolonged labor and meconium-stained liquor were the most common maternal risk factors and showed statistically significant association with HIE (p<0.05).

Table 2: Distribution Of Neonates According To HIE Severity

HIE Stage	Number	Percentage
Stage I	38	31.7%
Stage II	52	43.3%
Stage III	30	25.0%

Observation

Stage II HIE was the most common presentation, accounting for nearly half of all cases.

Table 3: Clinical Profile Of Neonates According To HIE Severity

Clinical Feature	Stage I	Stage II	Stage III	p-value
Seizures	4 (10.5%)	38 (73.1%)	30 (100%)	<0.001
Poor feeding	6 (15.8%)	40 (76.9%)	30 (100%)	<0.001
Respiratory distress	8 (21.1%)	32 (61.5%)	29 (96.7%)	<0.001
Mechanical ventilation	2 (5.3%)	20 (38.5%)	29 (96.7%)	<0.001

Observation

Seizures, respiratory distress, and need for mechanical ventilation increased significantly with severity of HIE (p<0.001).

Table 4: Short-Term Outcomes According To HIE Severity

Outcome	Stage I (n=38)	Stage II (n=52)	Stage III (n=30)	p-value
Favorable neurological outcome	35 (92.1%)	35 (67.3%)	7 (23.3%)	<0.001
Unfavorable neurological outcome	2 (5.3%)	9 (17.3%)	10 (33.3%)	<0.001
Mortality	1 (2.6%)	8 (15.4%)	13 (43.3%)	<0.001

Observation

Mortality and unfavorable neurological outcomes increased significantly with severity of HIE. Nearly half of neonates with Stage III HIE did not survive.

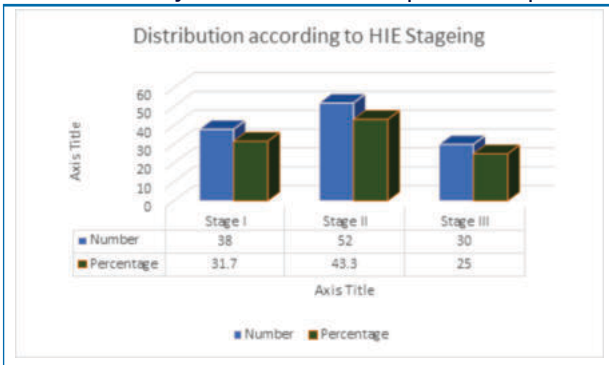

Figure 1: Distribution of HIE Stages

A bar diagram showing Stage II as the most common HIE category, followed by Stage I and Stage III.

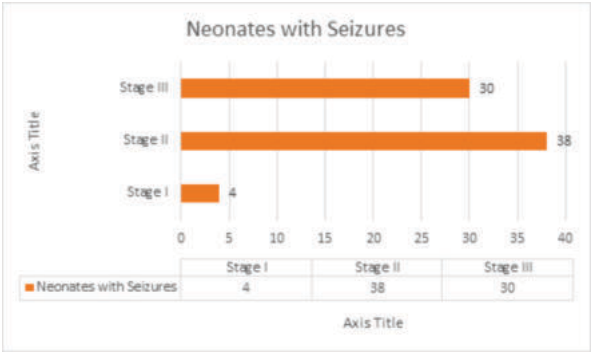

Figure 2: Seizure Occurrence by HIE Severity

Graph demonstrates a steep increase in seizure occurrence from Stage I to Stage III.

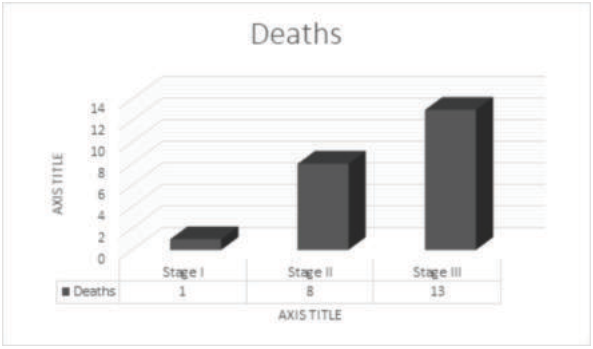

Figure 3: Mortality According to HIE Stage

Bar chart shows markedly higher mortality in Stage III compared to Stage I and II.

DISCUSSION

The present study highlights the strong association between maternal risk factors, severity of hypoxic-ischemic encephalopathy, and neonatal outcomes. Prolonged labor and meconium-stained liquor were the most frequent risk factors, emphasizing the role of intrapartum hypoxia.

Seizures were significantly more common in moderate and severe HIE, reflecting extensive neuronal injury[6,8]. The requirement for mechanical ventilation increased sharply with severity, indicating multisystem involvement.

Mortality showed a strong correlation with HIE severity. Nearly 43% mortality in Stage III underscores the grave prognosis associated with severe encephalopathy[9,12]. These findings are consistent with previous studies from developing countries.

Early identification of high-risk pregnancies, improved intrapartum monitoring, and timely neonatal resuscitation can significantly reduce the incidence and severity of HIE.

CONCLUSION

Hypoxic-ischemic encephalopathy remains a significant cause of neonatal morbidity and mortality. The severity of encephalopathy at presentation is a strong determinant of clinical outcomes. Maternal intrapartum risk factors such as prolonged labor and meconium-stained liquor contribute substantially to the occurrence of HIE and are largely preventable with appropriate antenatal and intrapartum care. Neonates with moderate and severe hypoxic-ischemic encephalopathy are at significantly higher risk of seizures, respiratory compromise, and mortality. Early clinical staging and prompt supportive management are essential to improve survival and neurological outcomes. Strengthening perinatal care services, improving intrapartum monitoring, and ensuring timely referral to tertiary care centers are crucial steps toward reducing the burden of hypoxic-ischemic encephalopathy.

LIMITATIONS

- Single-center study
- Short-term follow-up only
- Long-term neurodevelopmental outcomes not assessed

Future Scope

- Multicenter studies with larger sample size
- Long-term neurodevelopmental follow-up
- Evaluation of neuroprotective strategies

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