

Original Research Article

Clinical and etiological profile of neonatal seizures in neonatal intensive care unit: a tertiary care hospital-based study

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ABSTRACT

Background: Neonatal seizures are the most common neurological emergency in the neonatal period and are associated with significant morbidity and mortality. Biochemical abnormalities represent an important and potentially reversible cause of neonatal seizures, particularly in resource-limited settings where electroencephalographic monitoring is often unavailable. This study aimed to evaluate the clinico-etiological profile of neonatal seizures among neonates admitted to the neonatal intensive care unit (NICU).

Methods: This one-year prospective observational study was conducted in the neonatal unit of a tertiary care hospital in the Bundelkhand region. Term and preterm neonates with first-onset seizures within 28 days of life and no prior antiepileptic exposure were included, while those with major congenital malformations, jitteriness, tetanic spasms, or previous anticonvulsant treatment were excluded. Detailed clinical characteristics, seizure types, etiological factors, and biochemical parameters, including blood glucose and serum electrolytes, were systematically evaluated.

Results: Out of 1475 NICU admissions, 188 neonates developed seizures (incidence 12.74%); 150 cases were included for analysis. Most neonates (82%) presented within the first three days of life, with a male predominance (60%). Subtle seizures were the most common type (40%). Hypoxic-ischemic encephalopathy (HIE) (31.3%) was the leading etiology, followed by sepsis (27.3%). Biochemical abnormalities were observed in 28% of cases, with hypoglycemia (11.3%) and hypocalcemia (10%) being the most frequent. Preterm neonates showed a higher incidence of metabolic disturbances. All neonates with isolated biochemical abnormalities recovered completely following appropriate correction. Overall mortality was 9.3%, predominantly among neonates with HIE and sepsis.

Conclusion: HIE remains the leading cause of neonatal seizures. Biochemical abnormalities are common, reversible contributors and are associated with excellent outcomes when promptly corrected. Routine metabolic evaluation in all neonates with seizures is essential to improve prognosis and minimize unnecessary anticonvulsant use.

Keywords: Neonatal seizures, Hypoxic-ischemic encephalopathy, Hypoglycemia, Hypocalcemia, Neonatal intensive care unit

INTRODUCTION

Neonatal seizures are the most common neurological disorder.¹ A seizure is defined as paroxysmal electrical discharge from the brain which may manifest as motor, sensory, behavioral, or autonomic dysfunctions.² Due to cerebral immaturity, neonatal seizures differ clinically from those in older children and are often subtle and

underdiagnosed.³ It is most common neurological emergency in the newborn period, associated with significant morbidity and mortality.⁴ The incidence ranges from 1.5–3.7 per 1,000 live births in term neonates and 6–12% in very low birth weight infants.⁵ Brain damage may result from a delay in diagnosis and treatment of seizures, which can occur in a variety of ways, including generalized tonic, multifocal clonic, and subtle activity.⁶

Neonatal seizures often indicate an underlying neurological disorder, and their timing is closely related to etiology and prognosis.⁷ Seizures within 12–24 hours of birth are indicator of hypoxic-ischemic encephalopathy, while later onset points to infection, hemorrhage, or stroke.⁸ Careful clinical assessment is essential to identify serious intracranial pathology.⁹

Because of the scarcity of EEGs in resource-limited neonatal ICUs, clinical observation remains critical to seizure diagnosis.¹⁰ The most common cause is hypoxic-ischemic encephalopathy, followed by infections, bleeding, and metabolic abnormalities.¹¹ Biochemical abnormalities are a common, treatable cause of newborn seizures. Biochemical abnormalities are among the most common causes of neonatal seizures, occurring either in isolation or alongside other etiologies for which there is a specialized treatment.

Untreated newborn seizures can cause long-term neurological and intellectual damage, which can be avoided with early detection and therapy. The identification and treatment of biochemical abnormalities is critical in the evaluation of newborn seizures and may lessen the need for extended anticonvulsant therapy and associated detrimental effects. This study sought to assess the clinico-etiological profile of neonatal seizures in neonates hospitalized to a tertiary care teaching hospital.

METHODS

Study design

This prospective observational, hospital-based study was conducted over a period of one year in the newborn unit of a tertiary care teaching hospital after approved by the Institutional Ethics Committee. Written informed consent was obtained from parents or guardians prior to enrollment.

Inclusion criteria

All term and preterm neonates admitted during the study period with first-onset seizures within the first 28 days of life, including both inborn and outborn neonates and no prior exposure to antiepileptic drugs were included.

Exclusion criteria

Neonates with major congenital malformations, those who received prior antiepileptic drugs and presenting with jitteriness or tetanic spasms were excluded.

A detailed antenatal history and baseline characteristics were recorded, including age at onset, duration, frequency, and type of seizures, along with antenatal, natal, and postnatal risk factors such as maternal drug exposure or diabetes, prolonged rupture of membranes, perinatal asphyxia, traumatic delivery, prematurity, small-for-gestational-age status, low birth weight, sepsis, meningitis,

intracranial hemorrhage, and hyperbilirubinemia. The neonatal vital signs and general examination findings were recorded. Gestational age was assessed using the New Ballard score, and CNS examination with HIE staging was done as per modified Sarnat criteria.¹² Blood glucose and serum electrolytes were measured before treatment.

Data for all selected cases were recorded in a master chart using a Microsoft Excel spreadsheet. Statistical analysis was carried out on statistical package for the social sciences (SPSS) version 25.0. Data were presented as mean±SD (min-max) and in percentage.

RESULTS

A total of 1,475 neonates were admitted to the NICU during the study period, of whom 188 developed seizures (incidence 12.7%); 150 cases were randomly selected for analysis. Most neonates presented within the first 3 days of life (82%), with a male predominance (60%).

Vaginal delivery accounted for 62% of births, and 82% were inborn. Term neonates constituted 76%, preterm 18%, and post-term 6%. Low birth weight (<2.5 kg) was observed in 42% of cases, with a mean birth weight of 2.58±0.46 kg. Seizures occurred on day 1 in 50%, days 2–3 in 36%, days 4–7 in 10%, and after day 7 in 4%. Subtle seizures were most common (40%), followed by clonic (38%) and tonic (22%) types.

Hypoxic-ischemic encephalopathy was the leading cause of seizures (31.3%), followed by sepsis (27.3%). Biochemical abnormalities were identified in 28% of neonates, most commonly hypoglycemia (11.3%) and hypocalcemia (10%), followed by hypomagnesemia (4.7%) and hyponatremia (2%). No identifiable cause was found in 2.7% of cases (Table 1).

Table 1: Distribution of cases according to etiology.

Etiology	No. of cases	Percentage
HIE	47	31.33
Sepsis	41	27.33
Meningitis	6	4.00
Intracranial hemorrhage	7	4.67
Hypoglycemia	17	11.33
Hypocalcemia	15	10.0
Hypomagnesemia	7	4.67
Hyponatremia	3	2.00
Hyperbilirubinemia kernicterus	3	2.00
Unknown	4	2.67
Total	150	100

Subtle seizures were most common overall, particularly among term and preterm neonates, while tonic seizures were predominantly observed in post-term and term neonates (Table 2).

Table 2: Association of type of seizure with term/preterm.

Type of seizure	Term	Preterm	Post-term	Total
Subtle	45	15	0	60
Clonic	45	12	0	57
Tonic	24	0	9	33
Total	114	27	9	150

Hypoglycemia and hypocalcemia were more frequent in preterm neonates, while hyponatremia and hypomagnesemia were distributed in both term and

preterm groups. Subtle seizures were predominantly associated with hypocalcemia and hypoglycemia, whereas Tonic and clonic seizures were more frequently associated with hypoglycemia and hypomagnesemia (Tables 3 and 4).

Of the 150 neonates, 132 were discharged, 4 left against medical advice, and 14 expired. Among the 14 expired cases, hypoxic-ischemic encephalopathy accounted for 5 deaths, followed by sepsis (3), meningitis (2), intracranial hemorrhage (1), kernicterus (1), and unknown etiology (2). All neonates with hypoglycemia, hypocalcemia, hypomagnesemia, and hyponatremia survived (Figure 1).

Table 3: Association of type of seizure with term/ preterm.

Biochemical abnormalities	Pre-term	Term	Post-term
Hypoglycemia (n=17)	9	7	1
Hypocalcemia (n=15)	9	5	1
Hyponatremia (n=3)	1	1	1
Hypomagnesemia (n=7)	4	3	0

Table 4: Association of biochemical abnormalities with term/pre-term.

Biochemical abnormalities	Subtle	Tonic	Clonic
Hypoglycemia (n=17)	6	5	6
Hypocalcemia (n=15)	9	3	3
Hyponatremia (n=3)	0	1	2
Hypomagnesemia (n=7)	3	0	4

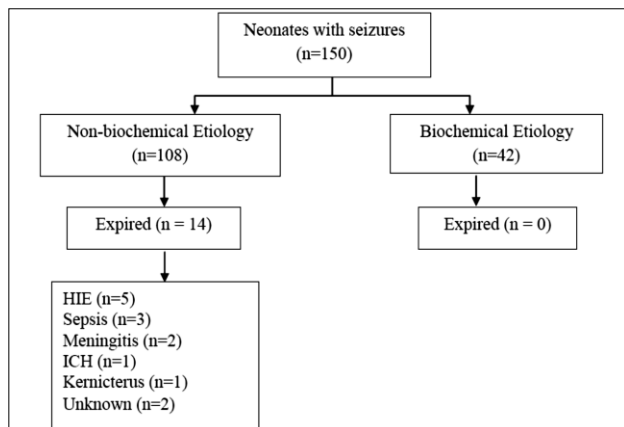


Figure 1: Outcomes of neonatal seizures, showing mortality among neonates with biochemical etiology or non-biochemical etiologies.

DISCUSSION

Neonatal seizures are the most common neurological disorder, occurring more frequently in preterm neonates. Biochemical abnormalities are common contributors. In this study, 82% of seizures occurred within the first three days of life (mean age 2.41±3.07 days), consistent with previous reports linking early-onset seizures to acute perinatal insults such as hypoxia, metabolic disturbances, and sepsis.^{13,14}

Subtle seizures were the most common type (40%), followed by clonic (38%) and tonic seizures (22%), consistent with previous studies. Sudia et al reported subtle seizures in 63.33% of neonates, while Dinesh Das et al similarly observed subtle seizures as predominant (42.6%).^{13,15}

Hypoxic-ischemic encephalopathy was the most common etiology (31.3%), followed by sepsis (27.3%), while metabolic disturbances collectively accounted for 28% of cases. Similar studies have identified HIE as the leading cause of neonatal seizures, with variations in the contribution of metabolic and infectious etiologies likely reflecting differences in study populations and referral patterns.^{16,17}

Hypoglycemia (40.47%) and hypocalcemia (35.71%) were the most common metabolic abnormalities among neonates with seizures. These disturbances were more frequent in preterm neonates, particularly hypoglycemia (9/17) and hypocalcemia (9/15). These findings are consistent with studies by Kumar et al and Suganthi et al, which identified hypoglycemia and hypocalcemia as the most common metabolic causes of neonatal seizures.^{18,19}

Overall, 132 neonates (88%) were discharged, 4 (2.7%) left against medical advice, and 14 (9.3%) expired. Mortality was highest in neonates with hypoxic-ischemic encephalopathy and sepsis, followed by meningitis,

intracranial hemorrhage, and kernicterus. All neonates with isolated metabolic disturbances recovered completely without antiepileptic therapy, emphasizing the importance of early biochemical correction. This study's mortality rate is close to other studies, such as Kher et al, who observed a 26% mortality rate, Nunes et al (24.7%), and Sahana et al found 18.5% mortality rate.²⁰⁻²² The study shows that HIE remains the leading cause of death among term neonates, while sepsis and intracranial hemorrhage are more critical among preterm neonates.

Limitations

Neonatal seizures in this study were identified using clinical criteria alone, as continuous video EEG monitoring was unavailable, possibly leading to underestimation of seizure incidence. The limited sample size also restricts the generalizability of the findings. Larger, long-term studies are required to better define the association between biochemical abnormalities and neonatal seizures.

CONCLUSION

Early detection and management of metabolic disturbances were associated with excellent prognosis, with 100% survival in affected neonates. Mortality occurred exclusively in neonates with hypoxic-ischemic encephalopathy, sepsis, meningitis, intracranial hemorrhage, or kernicterus, reflecting the severity of the underlying conditions. Hypoxic-ischemic encephalopathy remained the most common etiology, highlights the importance of optimal antenatal and perinatal care for its prevention. Biochemical abnormalities can be the primary or secondary cause of seizures; timely repair decreases anticonvulsant use, improves prognosis, and minimizes long-term neurological consequences.

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