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Clinico- Etiological Profile of Neonatal Seizures in A Teaching Hospital of Rajasthan: A Observational Study

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Abstract

Background: Neonatal seizures are among the most common neurological emergencies during the neonatal period and are associated with significant morbidity and mortality. Their etiological profile varies according to population characteristics and available healthcare resources, making early identification of the underlying cause essential for improving outcomes. The present study was conducted to evaluate the clinico-etiological profile, associated risk factors and short-term outcomes of neonatal seizures in a teaching hospital of Rajasthan.

Methodology: This hospital-based observational descriptive study was conducted in the Neonatal Intensive Care Unit (NICU), Department of Pediatrics, Mahatma Gandhi Hospital, Jaipur, from April 2024 to November 2025. A total of 98 term and preterm neonates aged less than 28 days with clinically suspected neonatal seizures were enrolled. Detailed antenatal, natal and postnatal history, clinical examination, seizure characteristics and maternal and neonatal risk factors were recorded. All neonates underwent appropriate laboratory investigations, neuroimaging and electroencephalography (EEG) whenever indicated. The etiology, treatment response and short-term outcomes were documented. Data were analyzed using SPSS version 28.0, and a p-value <0.05 was considered statistically significant.

Results: Most neonates presented within the first 5 days of life (78.57%), and 70.4% developed seizures within 72 hours of birth. A slight female predominance (54.1%) and predominance of term neonates were observed. Tonic seizures were the most common seizure type (29.6%), followed by subtle and focal clonic seizures (20.4% each). The leading etiology was hypoxic-ischemic encephalopathy (HIE), particularly Grade II (23.5%), followed by hyponatremia (17.3%), hypoglycemia (14.3%) and hypocalcemia (12.2%). EEG demonstrated variable abnormalities, while MRI showed greater sensitivity than ultrasonography in detecting neurological lesions. Most neonates showed a good response to treatment (78.6%), and 84.7% were discharged successfully. HIE and low APGAR scores at 1 and 5 minutes were significantly associated with adverse short-term outcomes.

Conclusion: Neonatal seizures occurred predominantly during the early neonatal period, with hypoxic-ischemic encephalopathy being the leading etiology followed by metabolic abnormalities. Most neonates

had favorable short-term outcomes following timely diagnosis and appropriate management. Early recognition of seizures, prompt treatment of perinatal asphyxia and correction of metabolic disturbances are essential to improve neonatal outcomes.

Keywords: Neonatal seizures, Hypoxic-ischemic encephalopathy, Clinico-etiological profile, Neonate, Electroencephalography, Magnetic resonance imaging, APGAR score, Outcome.

1. Introduction

Neonatal seizures constitute one of the most common neurological emergencies during the first 28 days of life and represent an important manifestation of neurological dysfunction in newborns. They are characterized by sudden, paroxysmal and abnormal electrographic activity occurring during the neonatal period. Due to the developmental immaturity of the neonatal brain, seizures demonstrate unique pathophysiology and electroclinical features, making their recognition more difficult than in older children.[1,2] The incidence ranges from 1 to 5.5 per 1,000 live births in term infants and is considerably higher among preterm and low birth weight neonates. The burden remains greater in developing countries such as India, where neonatal seizures contribute significantly to mortality, morbidity and long-term neurological sequelae including cerebral palsy, developmental delay and epilepsy, emphasizing the need for early diagnosis and prompt management.[1,3,4]

The increased susceptibility of the neonatal brain to seizures results from developmental excitatory-inhibitory imbalance caused by high intracellular chloride concentration, immature GABAergic inhibition, early maturation of glutamatergic synapses and premature development of voltage-gated ion channels.[1] Neonatal seizures arise from diverse etiologies including hypoxic-ischemic, infectious, metabolic, structural and genetic causes. Hypoxic-ischemic encephalopathy (HIE) is the leading cause, followed by meningitis, sepsis, metabolic disturbances and intracranial hemorrhage, with etiological patterns varying according to gestational age and timing of seizure onset.[5,6] In India, particularly in Rajasthan, HIE remains the predominant etiology followed by meningitis and metabolic abnormalities, making early identification of the underlying cause essential for improving neonatal outcomes in resource-limited settings.[5,7,8]

The clinical manifestations of neonatal seizures differ markedly from those in older children because of electroclinical dissociation. Clinically, seizures are classified as subtle, clonic, tonic and myoclonic, with subtle seizures being the most frequently observed type.[9] Accurate diagnosis requires careful clinical assessment supported by laboratory investigations, neuroimaging and electroencephalographic monitoring, including EEG and amplitude-integrated EEG (aEEG), which are valuable for detecting subclinical seizures and monitoring treatment response.[10] Pharmacological management is centered on phenobarbital as the recommended first-line antiseizure medication, while levetiracetam, phenytoin and midazolam serve as second-line agents in refractory cases.[11]

In the Indian context, particularly in tertiary teaching hospitals of Rajasthan, understanding the local clinico-etiological profile of neonatal seizures is essential because demographic characteristics, disease patterns and availability of diagnostic facilities differ from those in resource-rich countries. Local epidemiological data help develop evidence-based management protocols suitable for resource-constrained settings, improve early diagnosis and treatment, optimize resource utilization and ultimately enhance neonatal outcomes while contributing to locally relevant clinical guidelines.[12]

2. Methodology

The present study was a hospital-based observational descriptive study conducted in the Neonatal Intensive Care Unit (NICU), Department of Pediatrics, Mahatma Gandhi Hospital, Jaipur, from April 2024 to November 2025. The study included both inborn and outborn term and preterm neonates admitted with neonatal seizures. The study included 98 neonates aged less than 28 days who were admitted to the NICU with complaints, history, or clinical evidence suggestive of seizures. Neonates aged less than 28 days (term or preterm; inborn or outborn) whose parents or guardians provided written informed consent were included in the study, whereas neonates older than 28 days, those whose parents did not provide consent, or those who refused the required investigations were excluded.

The study was conducted to evaluate the clinico-etiological profile, associated risk factors and outcomes of neonatal seizures. After applying the inclusion and exclusion criteria, eligible neonates were enrolled following informed parental consent. A detailed antenatal, natal and postnatal history was obtained, followed by comprehensive general physical, systemic and neurological examination. Clinical details regarding seizure characteristics were recorded, and neonates were classified into early-onset seizures (within 72 hours of life) and late-onset seizures (after 72 hours of life). Maternal and neonatal risk factors, including perinatal asphyxia, prematurity, infections and metabolic abnormalities, were systematically assessed.

All enrolled neonates underwent a structured diagnostic evaluation. First-line investigations included Random Blood Sugar (RBS), serum calcium, Complete Blood Count (CBC), C-reactive protein (CRP), blood culture, serum magnesium, serum electrolytes, blood urea, serum creatinine and MRI brain wherever indicated. Depending on the clinical presentation and initial investigation findings, second-line investigations such as Arterial Blood Gas (ABG) analysis, Electroencephalography (EEG), cerebrospinal fluid (CSF) analysis and ultrasonography (USG) of the head were performed. In selected neonates with suspected metabolic, genetic or congenital disorders, Magnetic Resonance Spectroscopy (MRS), metabolic screening, genetic studies and TORCH screening were undertaken. The etiology of seizures was established based on clinical evaluation and investigation findings. All neonates received treatment according to standard NICU protocols, including supportive care, correction of metabolic abnormalities, antimicrobial therapy whenever indicated and antiepileptic medications as required. Clinical progress was monitored throughout hospitalization, and outcomes at discharge, including recovery, improvement, persistence of symptoms or adverse outcomes, were documented. All demographic details, clinical findings, investigation results, treatment received and outcomes were systematically recorded in a pre-designed proforma.

Statistical Analysis

Data were entered and analyzed using SPSS version 28.0. Categorical variables were expressed as frequency and percentage, while continuous variables were summarized as mean ± standard deviation. The Chi-square test, Fisher's exact test, and Mann-Whitney U test were used for statistical analysis, and a p-value <0.05 was considered statistically significant.

3. Results

A total of 98 neonates with seizures were enrolled in this observational study. The findings are presented below under demographic characteristics and patient profile, clinical profile, laboratory and neurodiagnostic investigations, etiological classification, treatment details, and short-term outcomes.

Table 1: Demographic and Patient Characteristics (n=98)

Parameters	Frequency (n=98)	Percent
Informant		
Father	45	45.9%
Mother	53	54.1%
Gender		
Female	53	54.1%
Male	45	45.9%
Age Group (days)		
<5	77	78.57%
5-10	11	11.22%
11-15	3	3.06%
16-20	4	4.08%
>20	3	3.06%
Gestational Age		
28-31	11	11.22%
32-35	12	12.24%
36-39	41	41.84%
>39	34	34.69%
Consanguineous Marriage		
Yes	14	14.3%
No	84	85.7%
Inborn/Outborn		
Inborn	54	55.1%
Outborn	44	44.9%
Mode of Delivery		
LSCS	42	42.9%
Vaginal delivery	56	57.1%
Gravidity		
Primigravida	40	40.8%
Multigravida	58	59.2%
Head Circumference (cm)		

Parameters	Frequency (n=98)	Percent
28-30 cm	17	17.35%
30-33 cm	54	55.10%
33-36 cm	27	27.55%
Ballard Score		
≤20	2	2.04%
21-25	0	0.00%
26-30	10	10.20%
31-35	16	16.33%
36-40	66	67.35%
>40	4	4.08%
Onset of Seizures (hrs)		
<72	69	70.4%
>72	29	29.6%

The demographic and baseline characteristics of the 98 neonates included in the study. Mothers were the informants in 54.1% of cases and fathers in 45.9%. Female neonates constituted 54.1% of the study population, while males accounted for 45.9%. Most neonates (78.57%) presented within the first 5 days of life. The majority were born at 36–39 weeks of gestation (41.84%), followed by >39 weeks (34.69%). A history of consanguineous marriage was present in 14.3% of cases. Inborn neonates comprised 55.1% of the study population, and 57.1% were delivered vaginally. Most neonates were born to multigravida mothers (59.2%). A head circumference of 30–33 cm was observed in 55.10% of neonates, and the majority (67.35%) had a Ballard score of 36–40. Seizure onset occurred within the first 72 hours of life in 70.4% of neonates, whereas 29.6% developed seizures after 72 hours, indicating that early-onset neonatal seizures were more common.

Table 2: Comparison of APGAR Scores at 1 and 5 Minutes among Neonates with Seizures

Apgar Score	Mean	Std. Deviation	t-value	p-value
APGAR 1 min	5.133	2.5632	19.823	<0.001
APGAR 5 min	7.571	2.2704	28.653	

The mean APGAR score at 1 minute was 5.133±2.5632, which increased to 7.571±2.2704 at 5 minutes. The high t-values and statistically significant p-value (<0.001) indicate that this improvement is highly significant. These findings suggest that although many neonates had initial distress at birth, their condition improved considerably within the first 5 minutes, reflecting effective early neonatal resuscitation and stabilization.

Table 3: Distribution of Types of Seizures among Neonates

Type of Seizures	Frequency	Percent
Tonic	29	29.6%
Subtle	20	20.4%
Clonic	9	9.2%
Focal clonic	20	20.4%
Multifocal clonic	17	17.3%
Myoclonic	3	3.1%
Total	**98**	**100.0%**

The distribution of seizure types among neonates shows that tonic seizures were the most common, observed in 29 (29.6%) cases. Subtle seizures and focal clonic seizures were equally common, each accounting for 20 (20.4%) cases. Multifocal clonic seizures were seen in 17 (17.3%) neonates, while generalized clonic seizures were less frequent, observed in 9 (9.2%) cases. Myoclonic seizures were the least common type, seen in only 3 (3.1%) cases. These findings suggest that tonic and subtle seizure types predominate in neonates with a considerable proportion also exhibiting focal and multifocal clonic patterns.

Table 4: Distribution of Seizure Frequency per Day among Neonates

Seizures Frequency per day	Frequency	Percent
Single episode	20	20.4%
2-3 episodes	6	6.1%
3-5 episodes	33	33.7%
>5 episodes	25	25.5%
Status epilepticus	14	14.3%
Total	**98**	**100.0%**

The frequency of seizures per day varied among neonates with most experiencing multiple episodes. The most common category was 3-5 episodes per day, seen in 33 (33.7%) cases, followed by more than 5 episodes in 25 (25.5%) neonates. Single seizure episodes were observed in 20 (20.4%) cases, while 14 (14.3%) neonates presented with status epilepticus, indicating severe and continuous seizure activity. Only 6 (6.1%) neonates had 2-3 episodes per day. These findings highlight that a significant proportion of neonates experienced frequent or severe seizures, emphasizing the need for prompt and aggressive management.

Table 5: Etiological Distribution of Neonatal Seizures

Etiology	Frequency	Percent
HIE Grade II	23	23.5%
Hyponatremia	17	17.3%
Hypoglycemia	14	14.3%
Hypocalcemia	12	12.2%
HIE Grade I	11	11.2%
Meningitis/Sepsis	8	8.2%
HIE Grade III	5	5.1%
TORCH Infection	3	3.1%
Inborn errors of metabolism	1	1.0%
Meningitis/ early onset Sepsis	1	1.0%
Pyridoxine Deficiency	1	1.0%
Structural Malformation	1	1.0%
Unknown/Cryptogenic	1	1.0%
Total	**98**	**100.0%**

The etiological distribution of neonatal seizures reveals that hypoxic-ischemic encephalopathy (HIE) was the most common cause, particularly HIE Grade II, observed in 23 (23.5%) cases. Other significant causes included hyponatremia in 17 (17.3%) neonates, hypoglycemia in 14 (14.3%) and hypocalcemia in 12 (12.2%) cases. HIE Grade I and Grade III contributed to 11 (11.2%) and 5 (5.1%) cases respectively. Infectious causes such as meningitis/sepsis accounted for 8 (8.2%) cases, while less common causes included TORCH infection, inborn errors of metabolism, pyridoxine deficiency, structural malformations and cryptogenic causes, each contributing a very small proportion. Overall, the findings indicate that HIE and metabolic disturbances are the main causes of neonatal seizures in this study population.

Table 6: Response to Treatment and Outcome among Neonates with Seizures

Parameters	Frequency (n=98)	Percent
Response to treatment		
Good response	77	78.6%
Partial response	18	18.4%
Poor response	3	3.1%
Outcome at discharge		
Discharged	83	84.7%
LAMA	11	11.2%
Expired	4	4.1%

The response to treatment among neonates with seizures was predominantly favorable. A large majority of cases, 77 (78.6%), showed a good response to treatment, indicating effective management in most neonates. Partial response was observed in 18 (18.4%) cases, while only a small proportion, 3 (3.1%), had a poor response to treatment. These findings suggest that timely and appropriate therapeutic interventions can lead to successful control of seizures in the majority of neonates. The outcome at discharge shows that most neonates had a positive clinical outcome. Out of 98 cases, 83 (84.7%) were successfully discharged, indicating recovery or stabilization. However, 11 (11.2%) cases were discharged against medical advice (LAMA) and 4 (4.1%) neonates expired. These results indicate that while the overall prognosis was favorable for most neonates, a small proportion experienced adverse outcomes, highlighting the severity of neonatal seizures in certain cases.

Table 7: Association between MRI Brain and USG Head Findings in Neonates with Seizures

MRI Brain	USG Head		Total
	Positive	**Negative**	
Positive	40	6	**46**
Negative	13	39	**52**
Total	**28**	**70**	**98**
Sensitivity	75.5%		
Specificity	86.7%		
Positive Predictive Value	87.0%		
Negative Predictive Value	75.0%		
Diagnostic Accuracy	64.1%		

The association between MRI brain and USG head findings demonstrates a moderate level of agreement between the two diagnostic modalities. Among the neonates, 40 cases showed positive findings on both MRI and USG, while 39 cases were negative on both modalities. However, discrepancies were observed in 6 cases with positive USG but negative MRI findings and 13 cases with positive MRI but negative USG findings, suggesting that although USG is a useful initial screening tool, MRI is more sensitive in detecting certain abnormalities and both modalities complement each other in the evaluation of neonatal seizures. The diagnostic performance analysis showed that USG had a sensitivity of 75.5%, specificity of 86.7%, positive predictive value of 87.0%, negative predictive value of 75.0%, and an overall diagnostic accuracy of 64.1%, indicating that while USG is a useful screening modality, confirmatory MRI may be required in selected cases.

4. Discussion

In the present study, mothers were the informants in 53 (54.1%) cases, while fathers were the informants in 45 (45.9%) cases, reflecting the important role of mothers in early recognition of neonatal seizures. Similarly, Sudia et al. (2015)[13] and Parvin et al. (2014)[14] emphasized that seizure history was primarily obtained from mothers or family attendants. A slight female predominance was observed in the present study, with 53 (54.1%) females and 45 (45.9%) males. This contrasts with previous studies reporting male predominance, including Reddy et al. (2018)[15] (46 males, 38 females), Parvin et al. (2014)[14]

(76.5% males), Nair et al. (2020)[16] (65.33% males), Sehrawat et al. (2025)[17] (57.7% males) and Patel et al. (2023)[18] (56.67% males).

The majority of neonates, 77 (78.57%), presented with seizures within the first 5 days of life, with a mean age of 3.74±5.339 days. Similar early presentation was reported by Parvin et al. (2014)[14] (72.5% within the first 3 days), Agrawal et al. (2020)[19] (53% within 72 hours) and Das & Debbarma (2016)[20] (80% within the first 3 days). Most neonates were term babies, with 41 (41.84%) born at 36–39 weeks and 34 (34.69%) at >39 weeks, while the mean gestational age was 37.23±3.376 weeks. Comparable findings were reported by Nair et al. (2020)[16], where 69.93% were term neonates, Sehrawat et al. (2025)[17] (82.9% term) and Das & Debbarma (2016)[20] (over 90% full-term). In the present study, 84 (85.7%) neonates were born to non-consanguineous parents, while only 14 (14.3%) had a history of consanguineous marriage. Aziz et al. (2015)[21] and Sharma et al. (2020)[22] also highlighted the association of consanguinity with inherited metabolic disorders, although without reporting separate frequencies.

Among the study population, 56 (57.1%) neonates were delivered vaginally and 42 (42.9%) by LSCS. Similar distributions were reported by Patel et al. (2023)[18] (62.2% vaginal, 35.6% LSCS), Kulkarni and Shukla (2021)[23] (63.5% vaginal) and Babu et al. (2025)[12] (58.3% vaginal, 41.7% cesarean). Most mothers were multigravida, accounting for 58 (59.2%) cases, while 40 (40.8%) were primigravida. In contrast, Sudia et al. (2015)[13] reported that 64% of mothers were primigravida and 36% were multigravida. The majority of neonates, 54 (55.10%), had a head circumference of 30–33 cm, with a mean of 32.233±1.488 cm. This was slightly lower than the mean of 33.6±1.55 cm reported by Shakya et al. (2022)[24], while Movahedinia et al. (2025)[25] reported a similar head circumference distribution. Ballard scores of 36–40 were observed in 66 (67.35%) neonates, with a mean score of 36.480±4.493, indicating predominance of near-term and term babies. Similar findings were reported by Nagaram et al. (2017)[26], who found 64.6% full-term neonates, while Ravichandran et al. (2025)[27] supported the reliability of the New Ballard Score for gestational age assessment. In the present study, 69 (70.4%) neonates developed seizures within 72 hours of life, while 29 (29.6%) developed seizures later. This closely corresponds to the findings of Parvin et al. (2014)[14], who reported 72.5% early-onset seizures and Agrawal et al. (2020)[19], who observed seizure onset within 72 hours in 53% of neonates.

In the present study, the mean APGAR score was 5.133±2.5632 at 1 minute and 7.571±2.2704 at 5 minutes, with both values showing statistical significance ($p<0.001$). Similar findings were reported by Tekgul et al. (2006)[28], who observed mean 1-minute APGAR scores below 6 among neonates with seizures. Nagarajan et al. (2012)[29] also reported that a 5-minute APGAR score <7 was significantly associated with adverse neurological outcomes, while Patil et al. (2022)[30] found that a 5-minute APGAR score <7 was associated with prolonged NICU stay, poor treatment response and increased mortality.

Tonic seizures were the most common seizure type in the present study, occurring in 29 (29.6%) neonates, followed by subtle seizures in 20 (20.4%), focal clonic seizures in 20 (20.4%), multifocal clonic seizures in 17 (17.3%), clonic seizures in 9 (9.2%) and myoclonic seizures in 3 (3.1%). In contrast, Sudia et al. (2015)[13] reported subtle seizures in 63.33% and tonic seizures in 19.33%, while Agrawal et al. (2020)[19] observed subtle seizures in 75% and tonic seizures in 17.3%. Das & Debbarma (2016)[20] also reported subtle seizures as the predominant type (42.6%), and Patel et al. (2023)84 found subtle seizures in 44.4% followed by tonic seizures in 38.9%.

The most common seizure frequency pattern in the present study was 3–5 episodes per day in 33 (33.7%) neonates, followed by >5 episodes per day in 25 (25.5%) and a single seizure episode in 20 (20.4%) neonates. Chaudhary et al. (2023)[31] reported that 43.5% of neonates had a single seizure episode, while the remaining experienced multiple episodes. Sehrawat et al. (2025)[17] further observed that more than five seizure episodes were associated with a poorer prognosis, supporting the clinical significance of recurrent seizures.

The leading etiology in the present study was HIE Grade II in 23 (23.5%) neonates, followed by hyponatremia in 17 (17.3%), hypoglycemia in 14 (14.3%), hypocalcemia in 12 (12.2%) and HIE Grade I in 11 (11.2%). Overall, HIE accounted for approximately 39.8% of cases, making it the most common etiology. Similar findings were reported by Das & Debbarma (2016)[20] (HIE 56%), Nair et al. (2020)[16] (HIE 52%), Sudia et al. (2015)[13] (perinatal asphyxia 53%, metabolic causes 16% and infections 10%), Sehrawat et al. (2025)[17] (HIE 45.18% and hypoglycemia 15.55%) and Patel et al. (2023)[18] (birth asphyxia 41.1%, hypoglycemia 17.8%, sepsis 14.5% and hypocalcemia 12.2%), all of whom identified HIE as the predominant cause of neonatal seizures.

Regarding short-term outcome, 83 (84.7%) neonates were discharged, 11 (11.2%) left against medical advice (LAMA) and 4 (4.1%) expired, indicating a favorable outcome in most cases. Comparable discharge rates were reported by Chaudhary et al. (2023)[31] (approximately 86% survived), Kulkarni and Shukla (2021)[23] (83.8% discharged, 5.4% LAMA and 10.8% mortality) and Rama Chary et al. (2020)79 (87.93% discharged uneventfully). In contrast, Sehrawat et al. (2025)[17] reported a higher mortality rate of 22.9%, while Babu et al. (2025)[12] observed favorable outcomes in 53.3% of neonates, neurological sequelae in 16.7% and mortality in 20%.

5. Conclusion

The present study concludes that neonatal seizures occur predominantly within the first 72 hours of life, with a slight female predominance and a higher proportion of term neonates. Hypoxic-ischemic encephalopathy (particularly Grade II) was the leading etiology, followed by metabolic abnormalities such as hyponatremia, hypoglycemia and hypocalcemia. Motor manifestations, especially abnormal body movements and jerky limb activity, were the most common clinical presentations. EEG demonstrated variable abnormalities, while MRI was more sensitive than USG in detecting neurological lesions. Most neonates had favorable short-term outcomes and were successfully discharged, although HIE and low APGAR scores at 1 and 5 minutes were significantly associated with adverse outcomes. Early recognition, prompt management of perinatal asphyxia and timely correction of metabolic disturbances are essential for improving neonatal outcomes.

References

1. Pressler RM, Abend NS, Auvin S, Boylan G, Brigo F, Cilio MR, De Vries LS, Elia M, Espeche A, Hahn CD, Inder T. Treatment of seizures in the neonate: guidelines and consensus-based recommendations—special report from the ILAE task force on neonatal seizures. Epilepsia. 2023 Sep.
2. Stieren ES, Rottkamp CA, Brooks-Kayal AR. Neonatal Seizures. Neoreviews. 2024 Jun 01;25(6):e338-e349.

3. Vos T, Lim SS, Abbafati C, Abbas KM, Abbasi M, Abbasifard M, Abbasi-Kangevari M, Abbastabar H, Abd-Allah F, Abdelalim A, Abdollahi M. Global burden of 369 diseases and injuries in 204 countries and territories, 1990-2019: a systematic analysis for the Global Burden of Disease Study 2019. The lancet. 2020 Oct 17;396(10258):1204-22.
4. Sonavane P. Associated Risk Factors for Development of Neonatal Seizures in Patients Admitted in NICU. European Journal of Cardiovascular Medicine. 2025 Jul 23;15:570-6.
5. Singh CP, Seep S. Assessment of the prevalence of meningitis in clinically suspected cases of early and late onset neonatal sepsis. International Journal of Contemporary Pediatrics. 2024;11(2):157-161.
6. Singh S, Vangala AR. Incidence and Outcomes of Hypoxic-Ischemic Encephalopathy in NICU Admissions: A Retrospective Cohort Study from Jaipur, India. Journal of Contemporary Clinical Practice. 2025 Jan 30;11:219-21.
7. Garg A, Suthar R, Sundaram V, Kumar P, Angurana SK. Clinical profile, aetiology, short-term outcome and predictors of poor outcome of neonatal seizures among out-born neonates admitted to a neonatal unit in Paediatric emergency of a tertiary care hospital in North India: A prospective observational study. Tropical Doctor. 2021 Jul;51(3):365-71.
8. Verma SK, Dabi JC, Rawat S, Dabi B. Clinico-epidemiological study of neonatal seizures from a tertiary care hospital of Western Rajasthan, India. Int J Contemp Pediatr. 2019 Nov;6(6):2463-8.
9. Khaje A, Mousavi SH, Golmohammadi M, Tavakolikia Z, Miri-Aliabad G, Keeykha R, Keykha M, Fayyazi A, Akhlaghpasand M. Investigating and determining the risk factors of neonatal seizures in NICU patients in the South of Iran. Journal of Pediatric and Neonatal Individualized Medicine (JPNIM). 2021 Feb 12;10(1):e100129-.
10. Falsaperla R, Saporito MA, Scalia B. Treatment of neonatal seizures: from guidelines to precision therapy. Molecular and Cellular Pediatrics. 2025 Jul 4;12(1):8.
11. Alghamdi F, Almalki E, Pathan A, Farag M, Arif J, Aamir ME. Antiseizure medications for neonatal seizures: Insights from ILAE guidelines. Neuro Pharmac J. 2024;9:1-6.
12. Babu GS, Mohan R, Reddy JM, Ramya C. Study of Clinico-etiological cause of neonatal seizure and its outcome neonatal intensive care unit. Journal of Contemporary Clinical Practice. 2025 Jun 3;11:63-9.
13. Sudia S, Berwal PK, Nagaraj N, Jeavaji P, Swami S, Berwal A. Clinicoetiological profile and outcome of neonatal seizures. Int J Contemp Pediatr. 2015 Oct;2015: 389-94.
14. Parvin R, Salim AF, Rahman M, Chowdhury K, Sultana A, Ahmed S, Rahman KZ. Neonatal seizures: Correlation between clinico-etiological profile and EEG findings. Bangladesh Journal of Child Health. 2014 Aug 16;38(1):19-23.
15. Reddy KV, Soren C, Jagtap S, Pardhasaradhi Y, Satish S. Clinico-etiological profile of neonatal seizures in term neonates. Journal of the Pediatrics Association of India. 2018 Oct 1;7(4):211.
16. Nair BK, Sharma J, Chaudhary S. Clinicoetiological profile of neonatal seizure in a newborn care unit of a tertiary care teaching hospital in Northern India. Journal of Clinical Neonatology. 2020 Jan 1;9(1):27-31.
17. Sehrawat P, Rakholia R, Deopa B, Kumar A. Clinico-etiological profile of neonatal seizures and factors determining outcome in a tertiary referral center of North India. Asian Journal of Medical Sciences. 2025 Mar 1;16(3):92-6.

18. Patel S, Mehta N. Study of clinical and etiological profile of neonatal seizures in tertiary care hospital. National Journal of Medical Research. 2023;13(01):7-12.
19. Agrawal V, Bagri DR, Sharma JN, Singh R. Clinico-aetiological profile and outcome patterns of neonatal seizures at a tertiary care centre. Int J Contemp Pediatr. 2020 Feb;7(2):316-20.
20. Das D, Debbarma SK. A study on clinico-biochemical profile of neonatal seizure. Journal of Neurology Research. 2016 Dec 22;6(5-6):95-101.
21. Aziz A, Gattoo I, Aziz M, Rasool G. Clinical and etiological profile of neonatal seizures: a tertiary care hospital based study.
22. Sharma KK, Bidhan S, Paimode SD. A clinico-etiological evaluation of neonatal seizures in a tertiary care hospital: a prospective cohort study. International Journal of Contemporary Pediatrics. 2020 March;7(3):659-663.
23. Kulkarni SK, Shukla DA. Study of clinico-etiological profile of neonatal seizures in term neonates at a tertiary care hospital. MedPulse International Journal of Pediatrics. August 2021; 19(2): 38-41.
24. Shakya A, Bhatta NK, Singh RR, Yadav SP, Thakur J. Gestational age specific anthropometric postnatal percentile charts for neonates born at tertiary hospital in Eastern Nepal. BMC pediatrics. 2022 Feb 15;22(1):94.
25. Movahedinia M, Mirjalili SR, Ardekani NA, Shamsi F. Efficacy and safety of intravenous Levetiracetam as first-line treatment for neonatal clinical seizures: A single-center study (2021−2023). Eneurologicalsci. 2025 Aug 29:100583.
26. Nagaram PP, Piduru P, Munagala VK. Neonatal seizures and outcome in a NICU of a tertiary care hospital of Andhra Pradesh-an two year study. International Journal of Contemporary Pediatrics. 2017 Apr 25;4(3):1004.
27. Ravichandran S, Suhana F, Krishnamoorthi R, Priya P. Accuracy of Gestational Age Estimation in Newborns using New Ballard Score - An Observational Study. JCHR. 2024;14(3):2945-50.
28. Tekgul H, Gauvreau K, Soul J, Murphy L, Robertson R, Stewart J, Volpe J, Bourgeois B, du Plessis AJ. The current etiologic profile and neurodevelopmental outcome of seizures in term newborn infants. Pediatrics. 2006 Apr 1;117(4):1270-80.
29. Nagarajan L, Palumbo L, Ghosh S. Classification of clinical semiology in epileptic seizures in neonates. european journal of paediatric neurology. 2012 Mar 1;16(2):118-25.
30. Patil A, Patil S. Clinical categorisation and etiology of seizures in children admitted at a tertiary care centre in North Karnataka. Medica Innovatica. 2022 Jan 1;11(1).
31. Chaudhary N, Paudel A, Chaudhary D, Gupta BK. Clinico-Etiological Profile and Outcome of Neonatal Seizures-A Hospital-Based Cross-Sectional Study in Western Nepal. Journal of Universal College of Medical Sciences. 2023 May 11;11(01):2-6.
32. Rama Chary KS, Kumar N. Clinico-etiological profile of neonatal seizures in term neonates at a tertiary hospital. MedPulse International Journal of Pediatrics. March 2020; 13(3): 69-72.