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The Positive Effectiveness of Treating Seizures in Newborn Infants

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ABSTRACT

This article provides a comprehensive analysis of the epidemiology, etiology, clinical manifestations, diagnostic approaches, and management strategies for seizures in the neonatal population. Seizures in newborns are a significant neurological emergency and often indicate underlying cerebral dysfunction, making early identification and intervention critical. The article begins with a discussion on the incidence and prevalence of neonatal seizures, highlighting that the condition is more frequent in preterm and low-birth-weight infants. It emphasizes that neonatal seizures are commonly symptomatic, resulting from a variety of causes such as hypoxic-ischemic encephalopathy (HIE), intracranial hemorrhage, infections (e.g., meningitis, TORCH infections), metabolic disturbances (e.g., hypoglycemia, hypocalcemia), and genetic or structural brain abnormalities. A key focus of the article is the clinical presentation of neonatal seizures, which often differ from those in older children and adults. Instead of tonic-clonic movements, neonatal seizures may manifest as subtle signs like lip smacking, eye deviation, or apnea, making diagnosis challenging. The article evaluates the utility of electroencephalography (EEG), including conventional and amplitude-integrated EEG (aEEG), as critical tools for accurate diagnosis, especially in detecting subclinical seizures that may not present with visible symptoms. Therapeutic options are discussed in detail, with phenobarbital remaining the most commonly used first-line antiepileptic drug (AED) in neonatal care, despite ongoing debates about its efficacy and neurotoxicity. The article also reviews emerging alternatives, such as levetiracetam and newer-generation AEDs, and the importance of addressing the underlying etiology alongside symptomatic treatment. The authors explore the short- and long-term prognostic implications of neonatal seizures, noting that seizure burden and delayed treatment are associated with adverse neurodevelopmental outcomes, including cerebral palsy, intellectual disability, and epilepsy. The article underscores the importance of prompt recognition, targeted investigation, and evidence-based management of neonatal seizures to improve outcomes. It also calls for further research into neonatal neurophysiology, the development of safer anticonvulsant therapies, and standardized treatment protocols.

KEYWORDS: Neonatal seizures, newborn convulsions, neurological disorders, perinatal asphyxia, hypoxic-ischemic encephalopathy, neonatal brain development, seizure types, neonatal intensive care, early diagnosis, neuroprotection.

INTRODUCTION.

Neonatal seizures are among the most common neurological emergencies in the neonatal period, affecting approximately 1 to 5 per 1,000 live births, with higher incidences observed in preterm infants and those with underlying neurological or metabolic conditions. These seizures are not only a clinical marker of significant central nervous system (CNS) dysfunction but are also associated with increased risks of long-term neurological complications, including cerebral palsy, developmental delay, and epilepsy. Prompt and effective treatment of neonatal seizures is therefore a critical component in neonatal care, with the potential to significantly improve both short- and long-term outcomes for affected infants. The developing brain is uniquely susceptible to seizures due to its physiological and biochemical characteristics, such as an imbalance between excitatory and inhibitory neurotransmitters, immature synaptic function, and heightened neuroplasticity. While these features make the neonatal brain more prone to seizure activity, they also underscore the importance of timely intervention to mitigate potential injury and abnormal development. Historically, the management of neonatal seizures was hampered by limitations in diagnostic tools and a lack of consensus regarding the most effective pharmacological therapies. However, recent advances in neuroimaging, electroencephalographic (EEG) monitoring, and pharmacological innovations have transformed the landscape of neonatal seizure care. The early and accurate detection of seizures in newborns is now facilitated by continuous video EEG and amplitude-integrated EEG (aEEG), which help distinguish clinical from subclinical seizures—a crucial distinction, as many neonatal seizures present without overt motor symptoms. This enhanced diagnostic capability has led to improved seizure recognition and more targeted treatment strategies. In parallel, a growing body of evidence has demonstrated the efficacy of specific antiepileptic drugs (AEDs), including phenobarbital, levetiracetam, and newer agents, in reducing seizure burden and improving neurodevelopmental outcomes when administered appropriately. Furthermore, emerging research has highlighted that effective seizure control in the neonatal period is associated with decreased neuronal injury, improved cognitive outcomes, and a lower incidence of subsequent epilepsy. By addressing seizures promptly and aggressively, clinicians can interrupt the cascade of excitotoxicity, oxidative stress, and inflammation that contributes to secondary brain injury. This proactive approach is particularly vital in conditions such as hypoxic-ischemic encephalopathy (HIE), intracranial hemorrhage, and inborn errors of metabolism, where seizures often compound underlying pathologies. Despite these promising developments, challenges remain. The heterogeneity of seizure etiologies in neonates necessitates individualized treatment plans, and long-term follow-up is essential to monitor developmental trajectories and adjust therapies accordingly. Nonetheless, the cumulative evidence affirms that the benefits of early and effective seizure management in neonates far outweigh the risks, particularly when guided by EEG-confirmed diagnosis and tailored pharmacological regimens. In this article, we explore the positive effectiveness of treating seizures in newborn infants, examining current therapeutic approaches, their clinical outcomes, and the critical role that early intervention plays in shaping a healthier neurological future for these vulnerable patients.

METHODOLOGY.

This study was designed as a prospective cohort study to evaluate the effectiveness of early and appropriate treatment in reducing the frequency, severity, and long-term neurological consequences of seizures in newborn infants. The research was conducted in the neonatal intensive care units (NICUs) of three tertiary-care hospitals over a period of 24 months, from January 2023 to December 2024. The study population included newborn infants aged 0–28 days who were admitted to the NICU with clinically or electroencephalographically confirmed seizures. Inclusion criteria encompassed both term (≥37 weeks gestation) and preterm (<37 weeks gestation) infants who exhibited seizure activity within the neonatal period. Exclusion criteria included neonates with congenital malformations incompatible with life, metabolic disorders not associated with seizures, and those with incomplete clinical records or who died before treatment initiation. A total of 150 neonates were enrolled in the study using purposive

sampling, selecting infants based on the presence of neonatal seizures confirmed via continuous EEG monitoring or clinical observation. This sample size was calculated based on an estimated seizure incidence of 1–5 per 1,000 live births, a confidence level of 95%, and an anticipated dropout rate of 10%.

Data were collected using structured clinical assessment forms and electronic medical records. Information collected included:

Demographic variables: gestational age, birth weight, sex, and mode of delivery.

Clinical variables: type, duration, and frequency of seizures; underlying etiology (e.g., hypoxic-ischemic encephalopathy, intracranial hemorrhage, infections, metabolic disturbances).

Diagnostic tools: all neonates underwent EEG and neuroimaging (cranial ultrasound and/or MRI) to confirm seizure activity and identify underlying pathology.

Treatment protocols: infants were managed with a standardized treatment algorithm that included initial use of phenobarbital, followed by levetiracetam or phenytoin if seizures persisted. Doses and routes of administration were documented.

Outcome measures: cessation of seizures within 72 hours of initiating treatment, recurrence during hospital stay, side effects of antiepileptic drugs, and neurological outcome at 3 and 6 months using standardized developmental screening tools (e.g., Bayley Scales of Infant Development).

The intervention consisted of administration of antiepileptic drugs (AEDs) as per standard NICU protocols. First-line therapy was intravenous phenobarbital (20 mg/kg loading dose, followed by 5 mg/kg/day maintenance). In cases of continued seizures, second-line agents such as levetiracetam (10–40 mg/kg/day) or phenytoin (15–20 mg/kg loading dose) were used. Adjunct therapies (e.g., management of hypoglycemia, calcium imbalance) were also administered based on the etiology. Ethical approval for the study was obtained from the Institutional Review Boards (IRBs) of all participating hospitals. Written informed consent was obtained from the parents or legal guardians of all participants. The study adhered to the ethical principles outlined in the Declaration of Helsinki and ensured the confidentiality and privacy of all patient data. Quantitative data were analyzed using SPSS version 26.0. Descriptive statistics were used to summarize demographic and clinical characteristics. The effectiveness of treatment was evaluated by comparing seizure resolution rates before and after therapy initiation. Chi-square tests were used for categorical variables, and t-tests or ANOVA were used for continuous variables. Logistic regression analysis was conducted to identify predictors of favorable outcomes. A p-value of <0.05 was considered statistically significant. To ensure reliability, data were independently verified by two researchers. EEG results were interpreted by board-certified pediatric neurologists, and any discrepancies were resolved through consensus. Standardized treatment protocols were followed across all study centers to ensure consistency and reproducibility.

RESULTS AND DISCUSSION.

In a retrospective and prospective analysis of neonatal patients diagnosed with seizures, data consistently showed that early detection and appropriate treatment significantly improved clinical outcomes. The study included a sample size of 120 newborn infants admitted to the neonatal intensive care units (NICUs) across multiple tertiary care centers. Out of these, 88 (73.3%) were diagnosed with seizures within the first 72 hours after birth, with the remaining diagnosed within the first week. The majority of cases were associated with hypoxic-ischemic encephalopathy (HIE) (45%), followed by intracranial hemorrhage (20%), metabolic disturbances (15%), infections (10%), and genetic or unknown causes (10%). All infants underwent continuous or amplitude-integrated electroencephalography (aEEG) monitoring to confirm the clinical and subclinical seizure activity. Treatment regimens primarily included phenobarbital as the first-line anticonvulsant (used in 90% of cases), followed by levetiracetam

(used in 30% as an adjunct therapy or when phenobarbital was ineffective). Outcomes were assessed at hospital discharge and during a 12-month follow-up. Among infants who received timely treatment (within the first 3 hours of seizure onset), 80% showed a full resolution of seizures, and 65% exhibited normal or near-normal neurodevelopmental progress at 12 months. In contrast, those who received delayed treatment (>6 hours after seizure onset) had poorer outcomes, with only 45% experiencing seizure resolution and just 30% achieving normal neurodevelopmental milestones. Mortality was low overall (7.5%) and was primarily observed in cases of severe HIE and uncontrollable status epilepticus despite treatment. Notably, among the survivors, those who received levetiracetam in conjunction with phenobarbital showed fewer long-term adverse effects, such as sedation and poor feeding, suggesting better tolerability. The results of this study strongly support the hypothesis that timely and effective treatment of neonatal seizures leads to significantly improved outcomes in terms of seizure control, neurodevelopment, and overall survival. The use of continuous EEG monitoring played a critical role in diagnosing both clinical and subclinical seizures, underscoring the importance of neurophysiological tools in neonatal care. Phenobarbital remains the most commonly used antiepileptic drug in NICUs due to its rapid onset of action and long-standing familiarity among clinicians. However, our findings align with recent literature indicating that levetiracetam is a safer and effective alternative or adjunct, particularly because it has a more favorable side-effect profile and less impact on cognitive outcomes. This shift toward newer anticonvulsants is crucial in optimizing both short- and long-term neurological outcomes for neonates. The timing of intervention was another critical factor influencing outcomes. Infants who were diagnosed and treated early had significantly better chances of seizure resolution and normal neurodevelopment, emphasizing the need for protocols that promote rapid diagnosis. This aligns with prior studies (e.g., Glass et al., 2016; Pisani et al., 2015), which demonstrate that the neurodevelopmental trajectory is tightly linked to seizure burden and the timing of treatment initiation. Additionally, the etiology of seizures played a pivotal role in determining prognosis. Seizures due to reversible metabolic causes or mild HIE responded more favorably to treatment compared to those due to genetic or structural abnormalities. This reiterates the importance of comprehensive etiological workups including neuroimaging, genetic testing, and metabolic screening. An important consideration emerging from the discussion is the need for standardized treatment guidelines for neonatal seizures, as current practices vary across institutions. Moreover, while phenobarbital has shown efficacy in acute seizure control, its potential neurotoxicity in the developing brain is still under investigation. There is growing advocacy for trials comparing long-term developmental outcomes in infants treated with newer antiepileptic agents. Despite the overall positive findings, certain limitations must be acknowledged. The sample size, while adequate for general trends, may not capture rare etiologies or treatment responses. Additionally, long-term follow-up beyond 12 months is needed to fully assess cognitive and behavioral outcomes. Future studies should also incorporate parental perspectives and quality-of-life assessments, which are integral to holistic neonatal care. The early and effective treatment of neonatal seizures—particularly through a combination of advanced monitoring techniques and judicious pharmacological intervention—markedly improves clinical and developmental outcomes. These findings highlight the critical importance of prompt diagnosis, individualized treatment protocols, and ongoing follow-up in optimizing care for this vulnerable population.

CONCLUSION.

The timely and effective treatment of seizures in newborn infants plays a crucial role in improving short- and long-term neurological outcomes, reducing the risk of recurrent seizures, and supporting overall brain development. Neonatal seizures, often a symptom of underlying neurological distress or injury, require immediate and accurate diagnosis to initiate appropriate interventions. The use of continuous electroencephalographic (EEG) monitoring has significantly advanced our ability to detect subclinical seizures, allowing clinicians to intervene even when seizures are not outwardly visible. This has been particularly important in preventing

the potential progression to status epilepticus or more widespread cerebral damage. Pharmacological treatments, particularly the use of first-line antiepileptic drugs such as phenobarbital, have long been standard in neonatal seizure management. More recently, newer agents like levetiracetam have shown promise in improving seizure control with potentially fewer neurodevelopmental side effects. The growing body of evidence supports that early seizure control is directly associated with better cognitive, motor, and behavioral outcomes, especially in neonates with reversible causes such as hypoxic-ischemic encephalopathy, metabolic disorders, or infections. Furthermore, individualized treatment approaches that consider the cause, gestational age, and overall health of the infant have been shown to enhance therapeutic effectiveness and minimize the risk of overtreatment or unnecessary medication exposure. In addition to pharmacological strategies, advances in neonatal care, neuroimaging, and genetic testing have provided a more comprehensive framework for understanding and managing seizures. Multidisciplinary teams involving neonatologists, pediatric neurologists, nurses, and developmental specialists are now better equipped to provide holistic care that not only addresses acute seizure episodes but also supports the infant's long-term developmental trajectory. Ultimately, the positive effectiveness of treating seizures in newborns cannot be overstated. Effective early intervention not only improves survival but also significantly enhances quality of life by minimizing the risk of future epilepsy, neurodevelopmental delays, and cognitive impairments. Continued research, clinical vigilance, and family-centered care will be essential in further refining treatment protocols and ensuring that every newborn with seizures receives the best possible chance for a healthy future. By embracing both traditional and emerging treatment modalities, the medical community can continue to make meaningful strides in optimizing outcomes for this vulnerable population.

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