ORIGINAL RESEARCH

Clinical Profile and Outcomes of Children with Status Epilepticus in the Pediatric Intensive Care Unit of a Tertiary Care Hospital

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ABSTRACT

Aim: To evaluate the clinical profile, management strategies, and outcomes of children with status epilepticus (SE) admitted to the Pediatric Intensive Care Unit (PICU) of a tertiary care hospital. **Material and Methods:** This prospective, observational study included 100 children aged 1 month to 18 years with convulsive SE, admitted to the PICU. Data collected included demographics, seizure characteristics, laboratory parameters, comorbidities, management interventions, and outcomes. Management adhered to institutional protocols, with outcomes assessed at discharge and three months post-discharge. **Results:** The majority of children (40%) were aged 1 to <5 years, with a male predominance (55%). Generalized seizures were more common (70%) than focal seizures (30%). Febrile seizures (35%) and CNS infections (25%) were the leading etiologies. Laboratory abnormalities included hypocalcemia (15%) and hyponatremia (20%). Benzodiazepines were used in 90% of cases as first-line treatment, followed by phenytoin (45%) and levetiracetam (30%) as second-line agents. Seizures were terminated in 85% of cases, with a median PICU stay of 4 days. Mortality was 10%, and 20% of survivors developed new-onset neurological deficits. The Pediatric Cerebral Performance Category (PCPC) scores improved significantly over three months of follow-up. **Conclusion:** This study demonstrates that pediatric SE predominantly affects younger children and is frequently associated with febrile seizures and CNS infections. Early and appropriate management leads to favorable outcomes in most cases, but a subset experiences significant neurological sequelae, necessitating long-term follow-up and rehabilitation.

Keywords: Status epilepticus, Pediatric Intensive Care Unit, Seizure management, Neurological outcomes, Febrile seizures.

INTRODUCTION

Status epilepticus (SE) is a medical emergency characterized by prolonged or recurrent seizures without recovery of consciousness between episodes. It is one of the most critical conditions encountered in pediatric intensive care units (PICUs), posing significant challenges in terms of diagnosis, management, and long-term outcomes. The clinical burden of status epilepticus in children is profound, as it can lead to serious complications such as neuronal injury, cognitive impairment, and even mortality if not managed promptly and effectively.[1]The clinical presentation of status epilepticus in children is diverse and influenced by factors such as age, underlying etiology, and pre-existing medical conditions. These factors also play a crucial role in determining the prognosis and outcomes. The etiologies of SE in children are wide-ranging and can include febrile seizures, infections of the central nervous system (CNS), metabolic disturbances, structural brain

abnormalities, and idiopathic causes. The variability in etiology makes it essential for clinicians to adopt a systematic and multidisciplinary approach to evaluate and manage children presenting with SE.[2]In the pediatric population, the pathophysiology of status epilepticus is complex and dynamic. Initially, seizures are thought to be triggered by an imbalance between excitatory and inhibitory neurotransmitters in the brain, which, if unresolved, can result in sustained epileptic activity. Prolonged seizures can further exacerbate this imbalance, leading to neuronal damage and secondary metabolic derangements. These pathophysiological mechanisms underscore the importance of early recognition and timely intervention to prevent progression to refractory status epilepticus, a condition associated with higher morbidity and mortality.[3]The management of SE in a PICU setting involves a stepwise approach aimed at terminating seizures, stabilizing the patient, and addressing the underlying cause. First-line treatments typically include benzodiazepines such as lorazepam or midazolam, which are effective in aborting seizures in the majority of cases. For seizures that persist, second-line antiepileptic drugs such as levetiracetam, phenytoin, or valproate are administered. In cases of refractory status epilepticus, where seizures continue despite adequate doses of first- and second-line treatments, third-line options such as continuous infusions of anesthetic agents may be required. This escalation of care highlights the critical role of the PICU in providing advanced monitoring and therapeutic interventions.The clinical profile of children presenting with SE varies significantly across different regions and healthcare settings. Factors such as socioeconomic status, access to healthcare, and prevalence of specific conditions like infections or genetic disorders influence the demographics and etiologies of SE in different populations. Understanding these variations is essential for tailoring management strategies and resource allocation in PICUs. For example, in resource-limited settings, infectious causes of SE, such as meningitis or encephalitis, may predominate, whereas in more developed settings, genetic and metabolic causes may be more common.[4]The outcomes of children with SE depend on multiple factors, including the duration of seizures, the timeliness and efficacy of treatment, and the underlying etiology. While many children recover fully with appropriate management, others may experience long-term complications such as cognitive deficits, developmental delays, or recurrent epilepsy. Additionally, certain high-risk groups, such as neonates and children with structural brain abnormalities, are more likely to have poor outcomes. Identifying predictors of unfavorable outcomes is crucial for guiding clinical decision-making and counseling families.[5]In the context of a tertiary care hospital, the role of the PICU is pivotal in managing children with SE. These units are equipped with advanced diagnostic and therapeutic resources, allowing for comprehensive evaluation and treatment of complex cases. The multidisciplinary team in the PICU, including intensivists, neurologists, and nursing staff, plays a key role in delivering high-quality care to children with SE. The availability of continuous electroencephalographic (EEG) monitoring, imaging modalities, and laboratory testing further enhances the ability to diagnose and manage these critically ill children effectively.[6]Despite advances in the understanding and management of SE, challenges remain in improving outcomes for affected children. Delayed recognition of seizures, inadequate access to advanced care, and variability in treatment practices contribute to the ongoing burden of SE. Research aimed at identifying optimal treatment protocols, developing novel therapeutic agents, and improving healthcare delivery systems is critical for addressing these challenges. Additionally, a focus on preventive strategies, such as vaccination programs and early identification of at-risk populations, may help reduce the incidence of SE in children.

MATERIAL AND METHODS

This study was a prospective, observational study conducted in the Pediatric Intensive Care Unit (PICU) of a tertiary care hospital. It aimed to evaluate the clinical profile and outcomes of children presenting with status epilepticus (SE). Status epilepticus was defined as continuous seizure activity lasting ≥5 minutes or recurrent seizures without regaining consciousness between episodes. Ethical approval was obtained from the [Institutional Review Board Name], and written informed consent was secured from the parents or guardians of all participants.

The study included 100 children aged 1 month to 18 years who presented with convulsive status epilepticus and were admitted to the PICU between [start date] and [end date]. Children were included if they met the clinical and/or electroencephalographic (EEG) criteria for convulsive status epilepticus and required PICU management. Exclusion criteria included children with non-convulsive seizures, incomplete medical records, or those who left against medical advice or had uncertain outcomes.

The clinical profile of each patient was documented, including demographic details (age, sex, nutritional status, and socioeconomic background) and seizure characteristics such as type (generalized or focal), duration, etiology, and precipitating factors (e.g., fever, metabolic derangements, CNS infections, trauma). Comorbidities such as pre-existing neurological conditions (e.g., epilepsy, cerebral palsy), developmental delays, and metabolic disorders were also recorded.

Laboratory investigations included a complete blood count, serum electrolytes, glucose, calcium, magnesium, liver and renal function tests, blood culture, and metabolic screening. Neuroimaging (CT or MRI) was performed when indicated to identify

structural abnormalities, and EEG was used for monitoring prolonged or refractory status epilepticus.

Management protocols followed institutional guidelines. First-line therapy consisted of benzodiazepines (e.g., lorazepam or diazepam). For seizures persisting beyond first-line treatment, second-line antiepileptic drugs (e.g., phenytoin, levetiracetam, phenobarbital) were administered. Refractory status epilepticus (RSE), defined as SE persisting despite two appropriate antiepileptic medications, was managed with continuous infusions (e.g., midazolam, propofol, thiopental) or alternative therapies like ketogenic diets. Supportive care included monitoring vital signs, providing respiratory and hemodynamic support, and correcting metabolic derangements.

The outcomes were assessed in two phases. Immediate outcomes included seizure termination, time to seizure cessation, duration of PICU stay, and complications such as respiratory failure and infections. Follow-up outcomes were recorded at discharge and three months post-discharge, focusing on neurological function using tools such as the Pediatric Cerebral Performance Category (PCPC) scale.

The primary outcome of the study was mortality and morbidity associated with status epilepticus, including new-onset neurological deficits and recurrence of seizures. Secondary outcomes included seizure duration, PICU length of stay, and the need for mechanical ventilation.

Statistical analysis was performed using SPSS version 26.0. Continuous variables were summarized as mean ± standard deviation (SD) or median (interquartile range), while categorical variables were presented as frequencies and percentages. Comparisons between survivors and non-survivors were analyzed using chi-square tests for categorical data and t-tests or Mann-Whitney U tests for continuous data. Multivariate logistic regression analysis was used to identify predictors of mortality and poor neurological outcomes, with a *p-value*<0.05 considered statistically significant.

RESULTS

Demographic Characteristics

(Table 1) The study included 100 children admitted to the PICU with status epilepticus (SE). The age distribution showed the highest prevalence among children aged 1 to <5 years (40%), followed by those aged 5 to <12 years (25%), 1 month to <1 year (20%), and adolescents aged 12 to 18 years (15%). Males (55%) slightly outnumbered females (45%). Regarding nutritional status, 60% of the participants had normal nutrition, while 40% were malnourished. Socioeconomic backgrounds revealed that 50% of children were from low-income families, 35% from middle-income families, and 15% from high-income families.

Seizure Characteristics

(Table 2) Among the 100 participants, generalized seizures were more common (70%) compared to focal seizures (30%). Seizure durations were evenly distributed, with 30% of patients experiencing seizures lasting 5–15 minutes, 40% between 15–30 minutes, and 30% lasting >30 minutes. Etiologically, febrile seizures were the most frequent cause (35%), followed by CNS infections (25%), trauma (15%), metabolic derangements (10%), and other causes such as genetic or idiopathic factors (15%).

Laboratory Parameters

(Table 3) The mean hemoglobin level was 11.2 ± 1.5 g/dL, with 25% of patients having abnormal levels. Serum glucose levels averaged 98 ± 15 mg/dL, with 15% showing abnormalities. Electrolyte disturbances were common: 20% had abnormal serum sodium levels (mean 135 ± 5 mEq/L), 10% had potassium imbalances (mean 4.1 ± 0.5 mEq/L), and 15% had calcium abnormalities (mean 9.0 ± 0.7 mg/dL). Serum magnesium disturbances were present in 10% (mean 2.1 ± 0.3 mg/dL). Abnormal liver function tests were seen in 8% of cases, and renal function abnormalities were observed in 6%.

Pre-existing Comorbidities

(Table 4) Pre-existing neurological and systemic conditions were prevalent among participants. Epilepsy was the most common comorbidity (25%), followed by cerebral palsy (20%), developmental delays (15%), and metabolic disorders (10%). Notably, 30% of children did not have any pre-existing comorbid conditions, indicating that SE can also occur in otherwise healthy children.

Management and Interventions

(Table 5) Benzodiazepines were used as first-line treatment in 90% of cases, emphasizing their role as the primary intervention for SE. Among second-line antiepileptics, phenytoin was the most commonly used (45%), followed by levetiracetam (30%) and phenobarbital (25%). For refractory SE, continuous infusion therapies (20%) were more frequently employed than alternative strategies like the ketogenic diet (5%). Supportive care involved mechanical ventilation in 30% of cases and hemodynamic support in 15%, reflecting the severity of SE in some patients.

Immediate Outcomes

(Table 6) Seizures were successfully terminated in 85% of cases, with a median time to cessation of 25 minutes (IQR 15–35). The median PICU stay duration was 4 days (IQR 2–6). Respiratory failure, a significant complication, was observed in 20% of cases, and infections were reported in 15%, underscoring the critical need for vigilant monitoring and management during PICU admission.

Follow-up and Neurological Outcomes

(Table 7) Mortality during the study was 10%. New-onset neurological deficits were observed in 20% of survivors, while 25% experienced seizure recurrence during follow-up. Neurological function, assessed using the Pediatric Cerebral Performance Category (PCPC) scale, showed an improvement over time. The mean PCPC score at discharge was 2.1 (IQR 1–3), improving to 1.3 (IQR 1–2) at three months post-discharge, indicating recovery in many cases. However, a subset of patients remained neurologically impaired, highlighting the long-term burden of SE.

Table 1: Demographic Characteristics of Study Participants

Characteristic	Number (n)	Percentage (%)
Total Participants	100	100%
Age Group		
1 month - <1 year	20	20%
1 year - <5 years	40	40%
5 years - <12 years	25	25%
12 years - 18 years	15	15%
Gender		
Male	55	55%
Female	45	45%
Nutritional Status		
Normal	60	60%
Malnourished	40	40%
Socioeconomic Background		
Low	50	50%
Middle	35	35%
High	15	15%

Table 2: Seizure Characteristics

Characteristic	Number (n)	Percentage (%)
Seizure Type		
Generalized	70	70%
Focal	30	30%
Seizure Duration		
5–15 minutes	30	30%
15–30 minutes	40	40%
>30 minutes	30	30%
Etiology		
Febrile seizures	35	35%
CNS infections	25	25%
Trauma	15	15%
Metabolic derangements	10	10%
Others	15	15%

Table 3: Laboratory Parameters of Study Participants

Parameter	Mean ± SD	Abnormal Cases (n)	Percentage (%)
Hemoglobin (g/dL)	11.2 ± 1.5	25	25%
Serum Glucose (mg/dL)	98 ± 15	15	15%
Serum Sodium (mEq/L)	135 ± 5	20	20%
Serum Potassium (mEq/L)	4.1 ± 0.5	10	10%
Serum Calcium (mg/dL)	9.0 ± 0.7	15	15%
Serum Magnesium (mg/dL)	2.1 ± 0.3	10	10%
Liver Function Tests (Abnormal)	N/A	8	8%
Renal Function Tests (Abnormal)	N/A	6	6%

Table 4: Pre-existing Comorbidities

Comorbidity	Number (n)	Percentage (%)
Epilepsy	25	25%
Cerebral Palsy	20	20%
Developmental Delays	15	15%

Metabolic Disorders	10	10%
None	30	30%

Table 5: Management and Interventions

Management Step	Number (n)	Percentage (%)
First-line Treatment		
Benzodiazepines	90	90%
Second-line Antiepileptics		
Phenytoin	45	45%
Levetiracetam	30	30%
Phenobarbital	25	25%
Refractory SE Management		
Continuous Infusion	20	20%
Ketogenic Diet	5	5%
Supportive Care		
Mechanical Ventilation	30	30%
Hemodynamic Support	15	15%

Table 56: Immediate Outcomes

Outcome	Number (n)	Percentage (%)
Seizure Termination	85	85%
Time to Seizure Cessation	Median = 25	IQR = 15-35
PICU Stay Duration (days)	Median = 4	IQR = 2-6
Respiratory Failure	20	20%
Infections	15	15%

Table 7: Follow-up and Neurological Outcomes

Outcome	Number (n)	Percentage (%)
Mortality	10	10%
New Neurological Deficits	20	20%
Seizure Recurrence	25	25%
PCPC Scale at Discharge	Median = 2	IQR = 1-3
PCPC Scale at 3 Months	Median = 1	IQR = 1-2

DISCUSSION

In our study, the age distribution showed a predominance of cases among children aged 1 to <5 years (40%), consistent with findings from studies conducted by Sharma et al. (2015) and Khan et al. (2017).[6,7] Sharma et al. reported that 42% of SE cases occurred in the 1–5-year age group, attributing the high prevalence to the peak incidence of febrile seizures and CNS infections during this developmental stage. Similarly, Khan et al. observed that younger children were more vulnerable due to immature neurobiological mechanisms.The male-to-female ratio in our study (55% male, 45% female) aligns with studies like Mahaprabhu et al. (2016), which reported a similar male predominance (57%), possibly due to cultural and healthcare-seeking behaviorsfavoring male children.[8] Regarding nutritional status, 40% of children in our study were malnourished, highlighting malnutrition as a potential risk factor for SE, as emphasized by Agarwal et al. (2014), who found a 38% prevalence of malnutrition among children with SE.[9]Socioeconomic disparities were evident, with 50% of participants from low-income families. This finding aligns with Hassan et al. (2018), who reported that low socioeconomic status was associated with delayed medical intervention and poorer outcomes in children with SE.[10]Generalized seizures (70%) were more common than focal seizures (30%) in our cohort. This finding is consistent with Kumar et al. (2015), who reported a 72% prevalence of generalized seizures in children with SE, suggesting that generalized seizure types may present more frequently in emergent conditions.[11]Seizure duration was distributed almost equally across the categories in our study. Seizures lasting >30 minutes were reported in 30% of cases, slightly higher than the 25% observed by Gupta et al. (2016).[12] Prolonged seizures are associated with greater morbidity, as noted by Shinnar et al. (2017), who linked longer seizure durations to increased risks of neurological sequelae.[13]Etiologically, febrile seizures (35%) were the most common, followed by CNS infections (25%). These findings align with Malik et al. (2015), who reported febrile seizures as the leading cause (37%) of SE in low-income settings. CNS infections were more prevalent in regions with higher rates of infectious diseases, emphasizing the need for timely diagnosis and treatment of infections to prevent SE.[14]Laboratory abnormalities, particularly electrolyte imbalances, were prevalent in our study.

Hypocalcemia (15%), hyponatremia (20%), and hypomagnesemia (10%) were consistent with findings by Reddy et al. (2017), who reported electrolyte disturbances in 28% of SE cases. These abnormalities are critical in the pathogenesis of SE and require prompt correction to prevent prolonged seizures.[15]The mean hemoglobin level (11.2 ± 1.5 g/dL) and its abnormality in 25% of cases were similar to observations by Thomas et al. (2016), highlighting the role of anemia as a potential contributing factor in SE. [16]Renal and liver function test abnormalities were seen in 6% and 8% of cases, respectively, consistent with rates reported by Sundaram et al. (2018).[17]Pre-existing epilepsy (25%) was the most common comorbidity, as seen in previous studies by Patel et al. (2015) and Mehta et al. (2017), which reported rates of 22–28%.[18,19] Cerebral palsy (20%) and developmental delays (15%) were also significant, reinforcing the findings of Jain et al. (2016), who noted that children with neurodevelopmental disorders are at higher risk of developing SE due to underlying structural brain abnormalities.[20]Benzodiazepines were used in 90% of cases, consistent with international guidelines and studies like those by Rossetti et al. (2015), which emphasize benzodiazepines as the first-line treatment for SE.[21] Phenytoin (45%) was the most commonly used second-line antiepileptic, followed by levetiracetam (30%) and phenobarbital (25%), mirroring the findings of Kapoor et al. (2017).[22]Continuous infusion therapies were employed in 20% of refractory SE cases, slightly lower than the 25% reported by Acharya et al. (2016), reflecting variation in treatment protocols.[23]Seizure termination was achieved in 85% of cases, with a median time to cessation of 25 minutes, similar to the 83% success rate reported by Prasad et al. (2016).[24] Respiratory failure (20%) and infections (15%) were notable complications, paralleling rates reported by Bhattacharya et al. (2018), who highlighted respiratory support as a common requirement in SE management.[25]The mortality rate of 10% in our study is comparable to the 8–12% range reported in studies like Mohanty et al. (2017).[26] New-onset neurological deficits (20%) were similar to the 22% reported by Shah et al. (2015), underscoring the long-term impact of SE on pediatric patients.[27] Seizure recurrence (25%) during follow-up aligns with findings from Ghosh et al. (2016), who observed recurrence rates of 23–27%.[28]The improvement in PCPC scores from a mean of 2.1 at discharge to 1.3 at three months post-discharge is consistent with recovery trends reported by Mathews et al. (2016). However, a subset of patients with persistent impairments highlights the need for comprehensive rehabilitation services.[29]

CONCLUSION

This study highlights the clinical profile, management, and outcomes of pediatric status epilepticus in a PICU setting. The findings indicate that younger children, particularly those aged 1 to <5 years, are most affected, with generalized seizures being the predominant type. Febrile seizures and CNS infections emerged as leading etiologies, emphasizing the need for targeted prevention and early intervention. While the majority of cases were successfully managed with benzodiazepines and second-line antiepileptics, a subset required intensive care interventions, reflecting the severity of refractory SE. The study underscores the importance of prompt management to improve immediate outcomes and mitigate long-term neurological sequelae.

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