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Original Research Article

Role of Encephalitis, Non-Convulsive Status Epilepticus, Diazepam (Benzodiazepine) Resistance, Imaging, Tracheal Intubation Score (End-It Score) in the Prediction of Mortality and Morbidity of Children with Clinical Status Epilepticus – A Prospective Observational Study

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Abstract

Background: Status epilepticus is a life-threatening pediatric neurological emergency associated with significant mortality and long-term neurological disability. Early prediction of outcome is essential for appropriate management. The Encephalitis, Non-convulsive status epilepticus, Diazepam resistance, Imaging, and Tracheal intubation (END-IT) score is a simple clinical tool designed to predict functional outcomes in patients with status epilepticus.

Aim: To evaluate the role of the END-IT score in predicting mortality, neurological morbidity, and duration of hospital stay among children with clinical status epilepticus.

Materials and Methods: This prospective observational study included 100 children aged 1 month to 18 years admitted with clinical status epilepticus to the Emergency Department and Pediatric Intensive Care Unit of Indira Gandhi Institute of Child Health, Bengaluru. END-IT scores were calculated at admission and modified after neuroimaging when required. Neurological outcomes were assessed using the Pediatric Overall Performance Category (POPC) score at discharge and three months after discharge. Statistical analysis was performed using SPSS version 25.0, and correlations were evaluated using Pearson's correlation coefficient.

Results: Most patients were infants (36%), and 61% were males. The majority reached the hospital more than two hours after seizure onset. The most common END-IT score was 0 (29%). Hospital stay increased significantly with increasing END-IT score ($r=0.547$, $p<0.001$). Significant positive correlations were observed between END-IT score and neurological outcome at discharge ($r=0.729$, $p<0.001$) and at three months ($r=0.653$, $p<0.001$). Eighty-four percent of children were discharged, 11% died, and 5% were discharged against medical advice.

Conclusion: The END-IT score demonstrated excellent prognostic value in predicting mortality, neurological outcome, and duration of hospital stay among children with status epilepticus. Its routine use at admission may facilitate early risk stratification, timely management, efficient resource utilization, and improved counselling of caregivers.

Keywords: Status Epilepticus, END-IT Score, Pediatric Overall Performance Category, Neurological Outcome, Mortality, Morbidity, Pediatric Intensive Care, Prognosis.

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Introduction

Status epilepticus (SE) is a life-threatening neurological emergency in children characterized by prolonged or recurrent seizures without complete recovery of consciousness between episodes. It is associated with significant mortality, neurological morbidity, prolonged hospitalization,

and considerable psychosocial and economic burden on affected children and their families. Early recognition and prompt treatment are essential to prevent irreversible neuronal injury and improve clinical outcomes. [1]

The International League against Epilepsy (ILAE) defines status epilepticus as a condition resulting either from the failure of mechanisms responsible for seizure termination or from the initiation of mechanisms leading to abnormally prolonged seizures. [2] The ILAE operational definition emphasizes time-dependent therapeutic intervention, as prolonged seizure activity increases the risk of permanent neurological damage and systemic complications. [3] Standardized management guidelines therefore recommend rapid stabilization, timely administration of antiseizure medications, and identification of the underlying etiology to improve survival and neurological recovery. [4]

Several clinical factors influence the prognosis of pediatric status epilepticus, including encephalitis, non-convulsive status epilepticus (NCSE), resistance to benzodiazepines, abnormal neuroimaging findings, and the requirement for tracheal intubation. These variables are independently associated with prolonged seizure duration, refractory status epilepticus, intensive care admission, and poor neurological outcomes. [5]

To facilitate early prognostic assessment, Gao et al. developed the Encephalitis, Non-convulsive status epilepticus, Diazepam resistance, Imaging, and Tracheal intubation (END-IT) score, a simple bedside scoring system that incorporates these five clinically relevant parameters. The END-IT score has demonstrated good predictive accuracy for functional outcome in patients with status epilepticus and has been proposed as a practical tool for identifying high-risk patients requiring intensive management. [1] Subsequent validation by Kapoor et al. confirmed the usefulness of the END-IT score in children, demonstrating its ability to predict mortality, neurological disability, and prolonged hospitalization in pediatric status epilepticus. [2]

Assessment of neurological outcome following status epilepticus is equally important for evaluating long-term prognosis. The Pediatric Overall Performance Category (POPC) score is a validated functional outcome measure that objectively assesses neurological recovery and disability in critically ill children. The use of prognostic scores such as END-IT together with standardized outcome assessment facilitates risk stratification, guides clinical decision-making, and assists in counselling parents regarding expected outcomes. [6] Despite improvements in pediatric intensive care and epilepsy management, prospective studies evaluating the prognostic value of the END-IT score in Indian children remain limited. Clinical profiles, etiological patterns, and treatment responses differ across populations, highlighting the need for regional validation of prognostic models. Previous Indian studies have also emphasized the importance of identifying predictors of unfavorable neurological outcome and prolonged hospitalization in children with status epilepticus. [7,8] Therefore, the present study was undertaken to assess the role of the END-IT score in predicting mortality and neurological morbidity among children with clinical status epilepticus using the Pediatric Overall Performance Category (POPC) score at discharge and three months after discharge.

Materials and Methodology

Study Design: This was a prospective observational study.

Study Setting: The study was conducted in the Emergency Department (ED) and Paediatric Intensive Care Unit (PICU) of Indira Gandhi Institute of Child Health, Bengaluru.

Study Duration: The study was conducted over a period of 18 months, from October 2022 to March 2024.

Sample Size: A total of 100 children with clinical status epilepticus were included in the study. Although the calculated minimum sample size was 85, 100 eligible children were enrolled consecutively during the study period.

Study Population: Children aged 1 month to 18 years presenting with clinical status epilepticus and admitted to the ED or PICU were screened for eligibility.

Inclusion Criteria

- Children aged 1 month to 18 years.
- Clinical status epilepticus as defined by the International League against Epilepsy (ILAE).
- Written informed consent obtained from parents or legal guardians.
- Child assent obtained whenever applicable.

Exclusion Criteria

- Medicolegal cases.
- Intracranial tumors.
- Neurodegenerative disorders.
- Developmental epileptic encephalopathies.

Study Procedure: Eligible children were enrolled consecutively after confirming the inclusion and exclusion criteria. Baseline demographic characteristics, seizure history, clinical presentation, duration and number of seizures, pre-hospital treatment, time taken to reach the

healthcare facility, underlying etiology, laboratory investigations, neuroimaging findings, electroencephalography (EEG), and treatment details were recorded using a structured proforma.

Each child was assessed using the END-IT score at admission. If neuroimaging was unavailable initially, the score was updated after CT or MRI findings became available.

Components of the END-IT Score

Encephalitis

- Yes = 1
- No = 0

Non-convulsive Status Epilepticus (NCSE)

- Yes = 1
- No = 0

Diazepam (Benzodiazepine) Resistance

- Yes = 1
- No = 0

Imaging

- Normal = 0
- Unilateral lesion = 1
- Bilateral lesions/Diffuse cerebral edema = 2

Tracheal Intubation

- Yes = 1
- No = 0

The maximum attainable END-IT score was 6.

Definitions

Encephalitis: Acute onset of fever with altered mental status and/or new-onset seizures together with cerebrospinal fluid or neuroimaging evidence of central nervous system inflammation.

Non-convulsive Status Epilepticus (NCSE): Persistent alteration in consciousness associated with epileptiform EEG activity without prominent motor manifestations.

Benzodiazepine Resistance: Failure of seizure termination following adequate first- or second-line benzodiazepine therapy within 10 minutes of administration or recurrence within 30 minutes.

Outcome Assessment: Neurological outcome was assessed using the Pediatric Overall Performance Category (POPC) score at:

- Discharge
- One week
- One month
- Three months after discharge

POPC scores were categorized as:

- **Favorable outcome:** POPC score 1–2
- **Unfavorable outcome:** POPC score 3–6

Children with pre-existing developmental delay were considered to have a favorable outcome if they returned to their baseline functional status.

Outcome Measures

Primary Outcome

- To determine the role of the END-IT score in predicting mortality and neurological outcome among children with status epilepticus.

Secondary Outcomes

- To assess the relationship between END-IT score and duration of hospital stay.
- To evaluate the association between individual END-IT components and mortality.
- To determine neurological outcome at discharge and three months following discharge.

Statistical Analysis: Data were entered into Microsoft Excel and analyzed using SPSS version 25.0. Continuous variables were expressed as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. Associations between categorical variables were analyzed using the Chi-square test or Fisher's exact test. Pearson's correlation coefficient was used to evaluate the relationship between END-IT score, duration of hospital stay, and POPC scores. Receiver operating characteristic (ROC) curve analysis was performed to determine the predictive accuracy of the END-IT score. A p-value <0.05 was considered statistically significant.

Results

A total of 100 children with clinical status epilepticus fulfilling the inclusion criteria were enrolled in the study.

The END-IT score was calculated at admission and modified later based on neuroimaging findings whenever required. Neurological outcomes were assessed using the Pediatric Overall Performance Category (POPC) score at discharge and at 3-month follow-up.

Table 1: Baseline Demographic and Clinical Characteristics of Study Participants (n = 100)

Variable	Number (n)	Percentage (%)
Age Group		
1 month–1 year	36	36.0
>1–5 years	28	28.0
>5–10 years	20	20.0
>10–18 years	16	16.0
Gender		
Male	61	61.0
Female	39	39.0
Time to reach healthcare facility		
≤2 hours	38	38.0
>2 hours	62	62.0
Number of seizures before admission		
1–2	24	24.0
3–5	37	37.0
>5	39	39.0
Duration of each seizure		
5–15 minutes	31	31.0
16–30 minutes	28	28.0
>30 minutes	41	41.0
Pre-existing neurodevelopmental abnormality	23	23.0

Most children (36%) were infants aged 1 month to 1 year, with a male predominance (61%). Nearly two-thirds (62%) reached the hospital more than 2 hours after seizure onset. Thirty-nine percent experienced more than five seizures before admission, while 23% had pre-existing neurodevelopmental abnormalities.

Table 2: Distribution of END-IT Score and Hospital Stay (n = 100)

END-IT Score	Number (n)	Percentage (%)	Mean Hospital Stay (Days)
0	29	29.0	6.1 ± 2.4
1	14	14.0	8.3 ± 3.1
2	16	16.0	11.8 ± 4.5
3	17	17.0	15.7 ± 5.8
4	12	12.0	21.6 ± 6.3
5	8	8.0	28.2 ± 7.1
6	4	4.0	35.3 ± 8.5

Pearson correlation (END-IT score vs. hospital stay): r = 0.547, p-value: <0.001

The majority of children had an END-IT score of 0 (29%), followed by a score of 3 (17%). Mean duration of hospital stay increased progressively with increasing END-IT score, demonstrating a significant positive correlation ($r = 0.547$, $p < 0.001$).

Table 3: Association between END-IT Score and Neurological Outcome at Discharge and Three-Month Follow-up (n = 100)

END-IT Score	Favorable Outcome at Discharge n (%)	Unfavorable Outcome at Discharge n (%)	Favorable Outcome at 3 Months n (%)	Unfavorable Outcome at 3 Months n (%)	Correlation with POPC Score (r)	p-value
0–2 (n=59)	54 (91.5)	5 (8.5)	56 (94.9)	3 (5.1)	At discharge: 0.729	<0.001
3–4 (n=29)	16 (55.2)	13 (44.8)	19 (65.5)	10 (34.5)	At 3 months: 0.653	<0.001
5–6 (n=12)	2 (16.7)	10 (83.3)	3 (25.0)	9 (75.0)	—	—

Children with lower END-IT scores (0–2) had predominantly favorable neurological outcomes at both discharge (91.5%) and three-month follow-up (94.9%).

In contrast, children with higher END-IT scores (5–6) had predominantly unfavorable outcomes at discharge (83.3%) and at three months (75.0%). The END-IT score demonstrated a strong positive correlation with the Pediatric Overall Performance Category (POPC) score at discharge ($r = 0.729$, $p < 0.001$) and at three-month follow-up ($r = 0.653$, $p < 0.001$), indicating that increasing END-IT scores were associated with poorer neurological outcomes.

Table 4: Final Hospital Outcome of Study Participants (n = 100)

Outcome	Number (n)	Percentage (%)
Discharged	84	84.0
Death	11	11.0
Discharged Against Medical Advice (DAMA)	5	5.0

Most children (84%) were discharged successfully, while 11% died during hospitalization. A small proportion (5%) left against medical advice.

Discussion

The present prospective observational study evaluated the utility of the END-IT score in predicting mortality, neurological morbidity, and duration of hospital stay among children presenting with clinical status epilepticus. The study demonstrated that increasing END-IT scores were significantly associated with prolonged hospitalization, poor neurological outcomes at discharge and three-month follow-up, and higher mortality. These findings support the usefulness of the END-IT score as a practical bedside prognostic tool in pediatric status epilepticus.

The majority of study participants were infants and young children, with a male predominance. Similar demographic patterns have been reported previously, reflecting the greater susceptibility of younger children to prolonged seizures and their neurological consequences. Jafarpour et al. reported that younger children constitute a significant proportion of pediatric status epilepticus cases and emphasized that early recognition and treatment are essential to improve neurological outcomes and reduce long-term disability. [9]

Non-convulsive status epilepticus (NCSE), one of the important components of the END-IT score, has been recognized as an independent predictor of poor prognosis. Hirsch et al. highlighted that NCSE frequently remains undiagnosed without continuous electroencephalographic monitoring and is associated with persistent cerebral dysfunction and unfavorable neurological recovery. [10] Similarly, Tay et al. demonstrated that delayed diagnosis of NCSE contributes to prolonged seizure activity, increased intensive care requirements, and poorer neurological outcomes in children. [11]

Benzodiazepine resistance was another important determinant of adverse outcome in the present study. Chamberlain et al., in a randomized clinical trial comparing lorazepam and diazepam for pediatric status epilepticus, emphasized that failure of initial benzodiazepine therapy is associated with prolonged seizures and the need for second-line anticonvulsant therapy. [12] Likewise, Glauser et al. recommended rapid escalation of treatment in benzodiazepine-resistant status epilepticus to minimize seizure-related neuronal injury and improve survival. [13] The mortality rate observed in the present study was 11%, which is comparable to previous pediatric studies. Chin et al. demonstrated that mortality and neurological disability are determined largely by seizure duration, underlying etiology, and treatment delay rather than seizure occurrence alone. [14] Kravljanac et al. similarly reported that children requiring prolonged intensive care support, mechanical ventilation, and aggressive antiepileptic treatment experienced significantly poorer neurological outcomes and higher mortality. [15]

A significant positive correlation was observed between the END-IT score and duration of hospital stay, indicating that children with higher scores required prolonged hospitalization and intensive care. Sadarangani et al. reported that delayed presentation to healthcare facilities and severe status epilepticus were associated with increased morbidity, longer hospital stay, and higher mortality among children, findings that are consistent with those of the present study. [16]

Neurological outcome assessed using the Pediatric Overall Performance Category (POPC) score showed a strong positive correlation with the END-IT score both at discharge and three months after discharge. Tiwari et al. developed a pediatric outcome prediction model for convulsive status epilepticus and demonstrated that increasing clinical severity scores were strongly associated with unfavorable neurological outcomes, prolonged hospitalization, and increased mortality.[17] The present findings similarly indicate that higher END-IT scores reliably identify children at greater risk of poor functional recovery.

Overall, the findings of the present study validate the clinical utility of the END-IT score as a simple, objective, and easily applicable prognostic tool in pediatric status epilepticus. Early assessment using the END-IT score can facilitate prompt risk stratification, guide therapeutic decision-making, improve parental counselling regarding prognosis, and optimize the utilization of pediatric intensive care resources.

Conclusion

The END-IT score is an effective and reliable bedside prognostic tool for predicting mortality, neurological morbidity, and duration of hospital stay in children with clinical status epilepticus. Higher END-IT scores were significantly associated with prolonged hospitalization, unfavorable POPC scores at discharge and three-

month follow-up, and increased mortality. Early application of the END-IT score can assist clinicians in risk stratification, guide timely therapeutic interventions, improve parental counselling, and optimize critical care resource allocation. Routine incorporation of the END-IT score into the initial assessment of pediatric status epilepticus may contribute to improved clinical decision-making and patient outcomes.

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