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Research Article

STEPSS and PEDSS Scores for Predicting Short-Term Outcome in Children with Febrile Status Epilepticus: A Prospective Observational Study

Dr. Akalya R[1], Dr. Madhumathi R[2*], Dr. B. Jane Amala Sebasty[3], Dr. M. Sowmiya[4]
[1]MBBS, MD Paediatrics, Assistant Professor, Department of Paediatrics, Government Chengalpattu Medical College and Hospital, Chengalpattu, Tamil Nadu, India.
[2*]MBBS, MD Paediatrics, Assistant Professor, Department of Paediatrics, Government Chengalpattu Medical College, Chengalpattu, Tamil Nadu, India.
[3]MBBS, MD Paediatrics, Assistant Professor, Department of Paediatrics, Government Medical College and Hospital, Tiruppur, Tamil Nadu, India.
[4]MBBS, MD Paediatrics, Medical Officer, TT Mottur PHC, Vellore, Tamil Nadu, India.
Corresponding Author: Dr. Madhumathi R
Email: i_madhumathi@yahoo.in
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ABSTRACT
Background: Febrile status epilepticus (FSE) is a high-priority paediatric emergency because prolonged seizures may be followed by delayed neurological recovery, seizure recurrence, or death. Early, bedside prognostication is particularly useful in busy public-sector emergency units where escalation decisions have to be made quickly.
Objective: To assess the predictive value of the Status Epilepticus Pediatric Severity Score (STEPSS) and Pediatric Early Determinants of Status Score (PEDSS) for short-term outcome in children with FSE, and to examine their relationship with electroencephalographic findings, magnetic resonance imaging findings, drug refractoriness, seizure semiology, and Pediatric Cerebral Performance Category Scale (PCPCS)-based outcome assessment.
Methods: This prospective observational study was conducted over 12 months, from May 2024 to May 2025, in the Paediatric Emergency Room of Government Chengalpattu Medical College, Tamil Nadu, India. Children aged 6 months to below 5 years presenting with FSE were enrolled consecutively after informed consent. STEPSS was calculated at admission and PEDSS within 48 hours. EEG, MRI, treatment response and short-term outcome until discharge or death, with 7-14 day post-event follow-up where applicable, were recorded. Descriptive statistics, chi-square/t-test associations and multivariable analysis were used.
Results: Among 100 children, 58% were boys and the largest age group was 1 to below 3 years (52%). Generalized tonic-clonic seizures were observed in 78%, seizure duration exceeded 60 minutes in 32%, refractory status epilepticus occurred in 20%, and super-refractory status epilepticus in 5%. EEG abnormalities were present in 68%, while MRI abnormalities were seen in 42%, most commonly hippocampal signal change (14%). Favourable outcome, unfavourable neurological outcome and mortality occurred in 68%, 26% and 6%, respectively. Lower STEPSS and PEDSS categories were associated with better outcome. Multivariable analysis identified refractory status epilepticus (OR 8.4), STEPSS >3 (OR 6.2), PEDSS >=3 (OR 5.8), hippocampal MRI abnormality (OR 4.3), and EEG background slowing (OR 3.6) as independent predictors of poor outcome.
Conclusion: STEPSS and PEDSS were practical predictors of short-term outcome in children with FSE. STEPSS may support early emergency triage, while PEDSS adds value after EEG, treatment response and systemic severity become available. Children with high scores, refractory seizures, background EEG slowing or hippocampal MRI change require early escalation, close counselling and structured neurodevelopmental follow-up.

Keywords: Febrile Status Epilepticus, STEPSS, PEDSS, Paediatric Status Epilepticus, EEG, MRI, PCPCS, Refractory Status Epilepticus.

INTRODUCTION

Status epilepticus (SE) is no longer viewed merely as a long seizure. The International League Against Epilepsy defines it as a condition arising from failure of seizure termination or from mechanisms that produce abnormally prolonged seizures, with time-dependent risk of neuronal injury and network alteration.[1] In children, this definition carries particular urgency because the clinical window

for reversal is short, the developing brain is vulnerable, and delayed seizure control can convert a treatable emergency into a neurocritical illness.

Paediatric convulsive SE has an estimated incidence of 17-23 episodes per 100,000 children per year in prospective population-based work, and prolonged febrile seizures form a major proportion of first-ever episodes in neurologically healthy children.[2] Febrile status epilepticus occupies the severe end of the febrile seizure spectrum. It is encountered most often between 6 months and 5 years of age, the same period in which fever-triggered seizures are common and parents may initially interpret convulsions as an extension of a febrile illness rather than a neurological emergency.[3,4]

The short-term course after FSE is heterogeneous. Many children recover well, but a smaller group develops persistent altered sensorium, focal deficits, refractory seizures, intensive care requirement, or death.[4] Neuroimaging studies from the FEBSTAT cohort demonstrated that acute hippocampal injury can follow FSE in a subset of children, and longer follow-up has strengthened the link between early hippocampal T2 hyperintensity, hippocampal sclerosis and later temporal lobe epilepsy.[5,6] Such observations make early risk stratification more than an academic exercise. It influences monitoring, counselling and follow-up intensity.

Electroencephalography adds another layer to risk assessment. Acute EEG abnormalities after FSE, particularly slowing or epileptiform activity, may indicate ongoing cortical irritability or more diffuse cerebral dysfunction.[7] Functional outcome scales are also important because mortality alone is an inadequate endpoint in paediatrics. The Pediatric Cerebral Performance Category Scale (PCPCS), adapted for paediatric critical care outcomes, provides a pragmatic way to document cognitive and neurological status before and after a critical illness.[8]

Adult-derived scores such as STESS and EMSE have informed prognostication in SE, but they do not map cleanly onto children. Age weighting, comorbidity burden and adult functional scales are not developmentally neutral. STEPSS was therefore proposed as a child-focused bedside score using sensorium, seizure type, age and previous seizure history.[9] PEDSS was developed more recently as a broader paediatric score that integrates premorbid PCPCS, EEG abnormality, seizure semiology, drug refractoriness and systemic critical illness, thereby capturing both neurological and systemic severity.[10]

In Tamil Nadu and similar Indian public healthcare settings, a score that can be applied early and interpreted without sophisticated modelling has obvious practical value. Children may reach tertiary care after home treatment attempts, peripheral referral, transport delays or late recognition of refractory seizures. The present study evaluated STEPSS and PEDSS in children with FSE and examined how these scores correlated with EEG findings, MRI abnormalities, drug refractoriness, seizure semiology and short-term outcome.

MATERIALS AND METHODS

Study Design and Setting

This was a prospective observational study conducted in the Paediatric Emergency Room of Government Chengalpattu Medical College, Tamil Nadu, and India. The study period extended from May 2024 to May 2025. The study was designed to assess the prognostic utility of STEPSS and PEDSS in children presenting with febrile status epilepticus.

Study Population

Children aged 6 months to below 5 years who presented with febrile status epilepticus were included. FSE was defined as seizure activity lasting 30 minutes or longer, or recurrent seizures without return to baseline consciousness, in the presence of fever and without an acute structural central nervous system lesion or metabolic derangement explaining the event.

Inclusion Criteria

Children were eligible if they were aged 6 months to below 5 years, fulfilled the clinical definition of FSE, and were admitted to the Paediatric Emergency Room during the study period.

Exclusion Criteria

Children with pseudoseizures, newborns or infants below one month of age, and children with severe pre-existing disability, defined as premorbid PCPCS score >=4, were excluded.

Data Collection

Eligible children were enrolled consecutively after written informed consent from parents or legal guardians. Demographic details, fever duration, seizure duration, seizure semiology, sensorium at presentation, previous seizure history, developmental baseline, treatment administered and response to therapy were recorded. Neurological examination was

performed at admission and during short-term outcome assessment.

Scoring Systems

STEPSS (Status Epilepticus Pediatric Severity Score)

The STEPSS score was assessed at admission. The total score ranged from 0 to 6 and was assigned using four bedside parameters: sensorium, seizure type, age and previous history of seizures.

Component	Scoring Criteria
Sensorium	Alert/somnolent/confused = 0; stuporous/comatose = 1
Type of seizure	Simple or complex partial, absence, or myoclonic seizure = 0; generalized convulsive seizure = 1; non-convulsive status epilepticus in coma = 2
Age	>=2 years = 0; <2 years = 2
Previous history of seizures	Yes = 0; No = 1

Interpretation: scores <3 were considered favourable; scores 3-4 indicated an unfavourable risk category; and scores >4 denoted higher mortality risk.

PEDSS (Pediatric Early Determinants of SE Severity Score)

The PEDSS score was calculated within 48 hours of admission. It combined premorbid neurological function, EEG abnormality, drug refractoriness, critical illness and seizure semiology into a composite short-term prognostic score.

Component	Scoring Criteria
Premorbid PCPCS	Score 1-2 = 0; score 3-5 = 1
EEG abnormality	Absent = 0; present = 1
Drug refractoriness	Responsive to first-line treatment = 0; benzodiazepine-resistant SE = 1; refractory SE = 2
Critically sick	No shock, intubation or MODS = 0; any one present = 1
Seizure semiology	Focal seizure = 0; generalized seizure = 1

Interpretation: scores <3 indicated good prognosis, scores >=3 indicated poor prognosis, and a score of 6 represented high mortality risk.

Investigations

Each child underwent EEG and MRI brain as close as feasible to the seizure episode. EEG findings were classified as normal, epileptiform activity, or non-epileptiform abnormality, including background slowing or disorganized rhythms. MRI findings were categorized as normal, hippocampal signal change, cortical/subcortical edema, structural malformation, inflammatory/infectious change, or other documented abnormality. Etiology was assigned from clinical, laboratory, EEG and imaging findings and grouped as infectious, structural, genetic, metabolic, inflammatory/autoimmune, post-vaccination, unknown, or presumed viral febrile illness when no specific cause was identified.

Outcome Assessment

Children were followed until discharge or death. Short-term outcome was categorized as favourable, unfavourable neurological outcome, or mortality. PCPCS was used to document premorbid functional status and short-term neurological status, including follow-up between day 7 and day 14 when applicable.

Ethical Considerations

Institutional Ethics Committee approval was obtained from Government Chengalpattu Medical College before commencement of the study. Written informed consent was obtained

from parents or legal guardians. Confidentiality was maintained throughout the study.

Statistical Analysis

Data were entered in Microsoft Excel and analysed using SPSS version 21.0. Frequencies and percentages were used for categorical variables. Mean or median values were used for continuous variables where applicable. Associations were tested using chi-square test or t-test as appropriate. Multivariable analysis was performed to identify independent predictors of poor outcome, and results were expressed as odds ratios (ORs) with 95% confidence intervals (CIs). A p-value <0.05 was considered statistically significant.

RESULTS

A total of 100 children with febrile status epilepticus were included. Boys constituted 58% of the cohort. The highest representation was in the 1 to below 3 years age group, which accounted for 52 children, followed by the 3 to below 5 years group (28%) and the 6 months to below 1 year group (20%). Generalized tonic-clonic seizures were the commonest clinical presentation. Seizure duration exceeded 60 minutes in nearly one-third of the cohort, and 20 children progressed to refractory status epilepticus. The demographic and clinical profile is summarized in Table 1 and Figure 1.

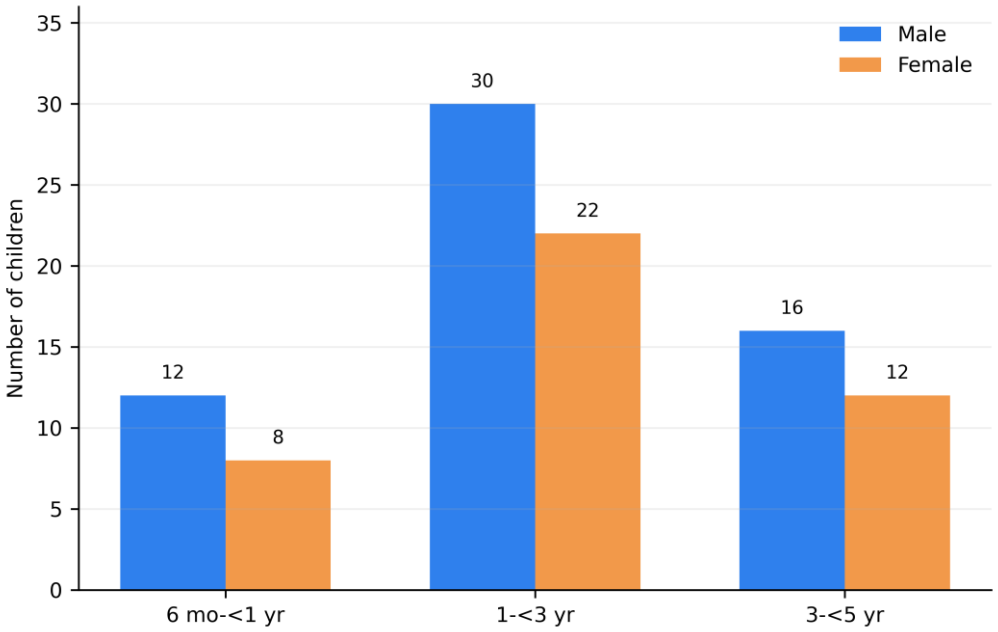

Figure 1. Age and Gender Distribution of Children with Febrile Status Epilepticus

Table 1. Baseline Demographic and Clinical Profile of the Study Population (N=100).

Variable	Frequency, n (%)
Age group: 6 months-<1 year	20 (20.0%)
Age group: 1-<3 years	52 (52.0%)
Age group: 3-<5 years	28 (28.0%)
Male sex	58 (58.0%)
Female sex	42 (42.0%)
Generalized tonic-clonic seizures	78 (78.0%)
Focal seizures	18 (18.0%)
Myoclonic/atypical seizures	4 (4.0%)
Seizure duration >60 minutes	32 (32.0%)
Refractory status epilepticus	20 (20.0%)
Super-refractory status epilepticus	5 (5.0%)

Febrile illness of presumed viral origin was the leading etiological category, observed in 42% of children. CNS infection accounted for 16%, while 24% remained etiologically unclassified after available clinical and laboratory evaluation. Genetic/metabolic,

inflammatory/autoimmune and structural categories were less frequent, but clinically relevant because they often demanded closer monitoring and broader diagnostic work-up. The etiological profile is displayed in Figure 2. *Donut chart shows percentage distribution and corresponding counts in the legend.*

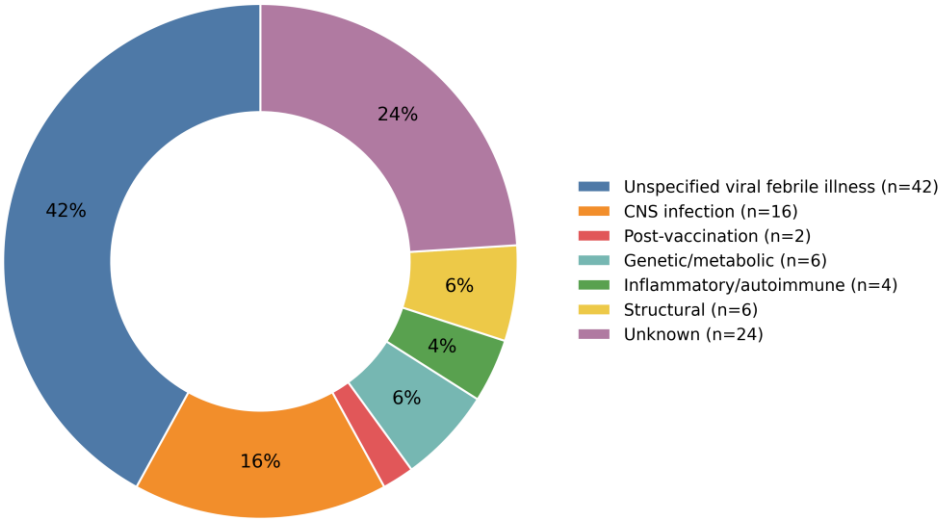

Figure 2. Etiological Classification of Febrile Status Epilepticus in the Study Cohort.

EEG was abnormal in 68 children: 40 had epileptiform discharges and 28 had background slowing or other non-epileptiform abnormalities. MRI brain was abnormal in 42 children, with hippocampal signal change being the most frequent specific finding. STEPSS and PEDSS distributions showed that a substantial minority fell into higher-risk categories. The neurodiagnostic and score distributions are presented in Table 2.

Table 2. Neurodiagnostic Findings, Premorbid PCPCS and Severity Score Distribution (N=100).

Finding/Category	Frequency, N (%)
EEG normal	32 (32.0%)
EEG epileptiform activity	40 (40.0%)
EEG slowing/non-epileptiform abnormality	28 (28.0%)
MRI normal	58 (58.0%)
MRI hippocampal signal change	14 (14.0%)
MRI cortical/subcortical edema	10 (10.0%)
MRI structural malformation	8 (8.0%)
MRI inflammatory/infectious change	6 (6.0%)
MRI other abnormality	4 (4.0%)
Premorbid PCPCS 1	74 (74.0%)
Premorbid PCPCS 2	16 (16.0%)
Premorbid PCPCS 3	10 (10.0%)
STEPSS 0-2	46 (46.0%)
STEPSS 3-4	38 (38.0%)
STEPSS >4	16 (16.0%)
PEDSS <3	52 (52.0%)
PEDSS 3-5	40 (40.0%)
PEDSS 6	8 (8.0%)

Overall, 68 children had a favourable short-term outcome, 26 had an unfavourable neurological outcome, and six died. A clear gradient was seen across both STEPSS and

PEDSS categories. Children with STEPSS 0-2 had overwhelmingly favourable outcomes, whereas mortality was concentrated among children with STEPSS >3. PEDSS showed a similar pattern: all deaths occurred in children with PEDSS >=3. The score-outcome relationships are shown in Table 3 and Figure 3.

Table 3. Association of STEPSS and PEDSS Categories with Short-Term Outcome (N=100).

Score category	Favourable	Unfavourable	Mortality
STEPSS 0-2	44 (44.0%)	2 (2.0%)	0 (0.0%)
STEPSS 3-4	20 (20.0%)	16 (16.0%)	2 (2.0%)
STEPSS >4	4 (4.0%)	8 (8.0%)	4 (4.0%)
PEDSS <3	48 (48.0%)	4 (4.0%)	0 (0.0%)
PEDSS 3-5	18 (18.0%)	18 (18.0%)	4 (4.0%)
PEDSS 6	2 (2.0%)	4 (4.0%)	2 (2.0%)

Stacked bars show favorable outcome, unfavourable neurological outcome and mortality within each score category.

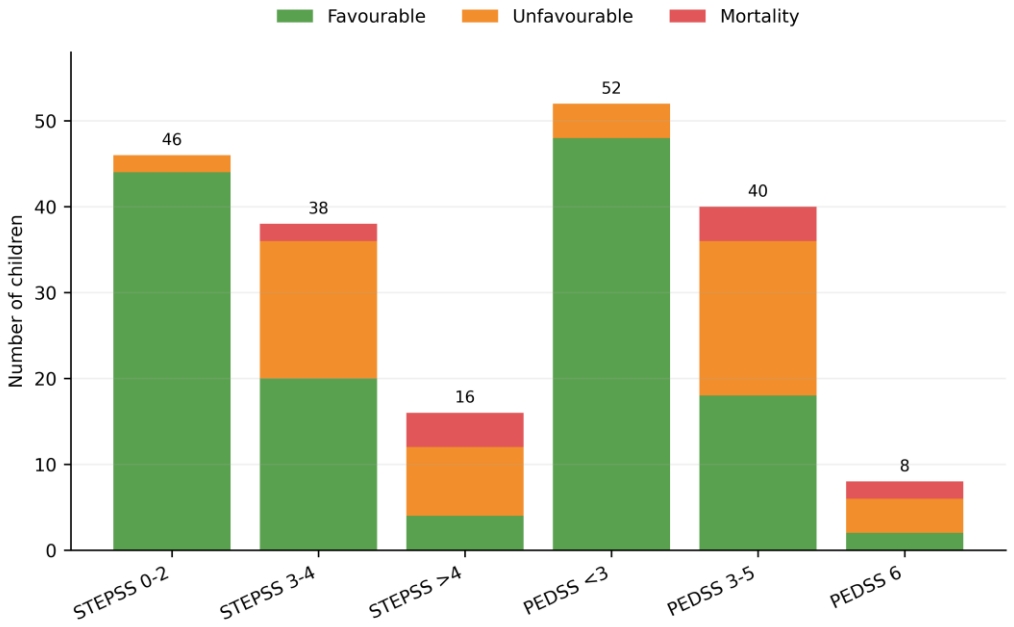

Figure 3. STEPSS and PEDSS Categories According To Short-Term Outcome.

When STEPSS and PEDSS were cross-tabulated, 44 of 46 children with STEPSS 0-2 had PEDSS <3. Conversely, all children with STEPSS >4 had PEDSS >=3, indicating strong concordance between the two tools in identifying high-risk children. This pattern supports a stepwise approach in which STEPSS is applied at presentation and PEDSS is calculated after early EEG, systemic severity and treatment response are known.

Table 4. Multivariate Predictors of Poor Outcome, Defined as Unfavourable PCPCS-Based Outcome or Mortality.

Predictor	Odds Ratio	95% CI	P-Value
Refractory status epilepticus	8.4	2.8-25.0	<0.001
STEPSS >3	6.2	2.1-18.1	<0.001
PEDSS >=3	5.8	1.9-17.4	<0.001
Hippocampal MRI abnormality	4.3	1.2-15.6	0.024
EEG background slowing	3.6	1.1-11.8	0.038

On multivariable analysis, refractory status epilepticus was the strongest independent predictor of poor outcome (OR 8.4, 95% CI 2.8-25.0; p<0.001). STEPSS >3, PEDSS >=3, hippocampal MRI abnormality and EEG background slowing also independently predicted unfavourable outcome or mortality. These predictors are listed in Table 4 and illustrated in Figure 4.

Forest plot displays odds ratios with 95% confidence intervals on a logarithmic scale.

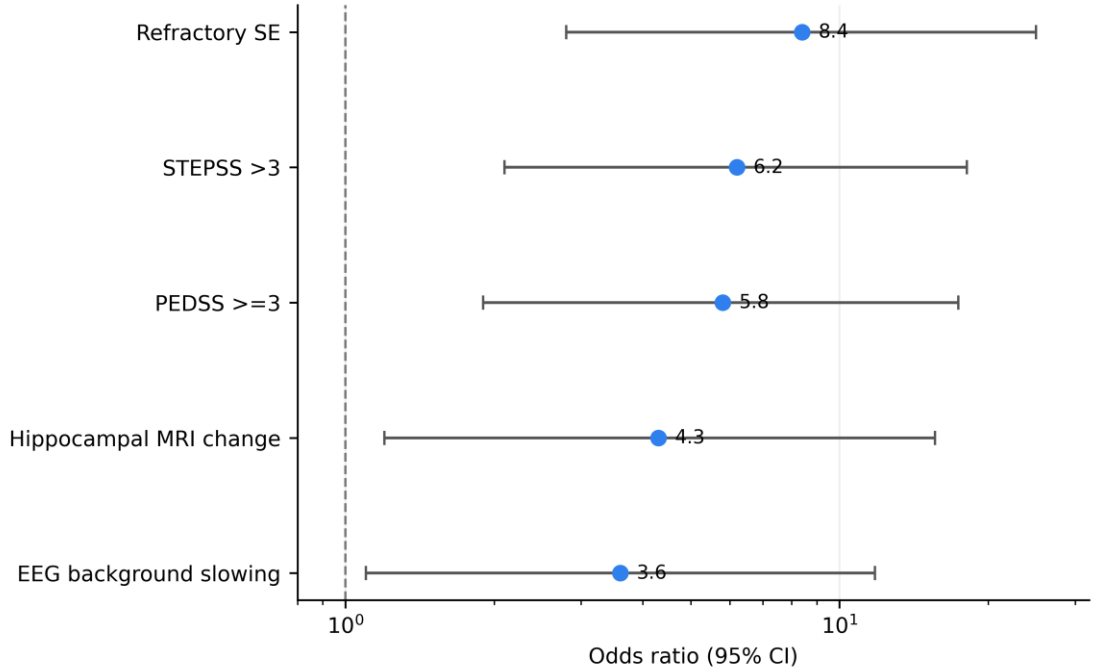

Figure 4. Independent Predictors of Poor Short-Term Outcome.

DISCUSSION

This prospective observational study found that both STEPSS and PEDSS were clinically useful in predicting short-term outcome among children presenting with febrile status epilepticus. The pattern was consistent and clinically intuitive: low STEPSS or PEDSS values were associated with favourable recovery, while higher scores clustered with unfavourable neurological outcome and mortality. This matters because FSE management is time-sensitive, but the first clinician often has limited information. STEPSS, by relying on early bedside variables, offers a workable first screen. PEDSS then refines risk after EEG findings, treatment response and systemic illness severity become available.

The age distribution in the present study closely reflects the biology of febrile seizures. More than half of the cohort belonged to the 1 to below 3 years age group, and all children were below 5 years. Earlier paediatric SE studies have similarly shown that younger children form a large proportion of convulsive SE and FSE presentations.[2,3] Male predominance was also observed. While gender differences are not consistently large across cohorts, the finding is familiar in febrile seizure epidemiology and does not alter the central message: toddlers with fever and prolonged convulsions represent a high-volume emergency group that requires protocol-driven care.

Generalized tonic-clonic seizure was the commonest semiology. This agrees with the expected presentation of febrile convulsive SE, but it also creates a risk of false reassurance when the child appears to stop convulsing but remains encephalopathic. Acute EEG therefore has a practical role beyond documentation. In the present cohort, EEG was abnormal in more than two-thirds of children, and background slowing remained an independent predictor of poor outcome. Acute EEG abnormalities have been reported after FSE in the FEBSTAT study,[7] and electrographic status epilepticus has been associated with mortality and worse short-term outcome in critically ill children.[14] Here, a normal EEG was reassuring, but not a substitute for clinical monitoring.

MRI abnormalities were present in 42% of children, with hippocampal signal change being the most frequent specific finding. The association between hippocampal MRI abnormality and poor outcome is biologically plausible. FEBSTAT demonstrated acute hippocampal injury in a subset of children after FSE,[5] and long-term FEBSTAT follow-up showed that hippocampal T2 hyperintensity can predict hippocampal sclerosis and later mesial temporal lobe epilepsy.[6] For an Indian tertiary-care setting, where families may struggle to return for repeated neuroimaging, the early MRI becomes especially valuable for risk communication and follow-up planning. It should not be treated as a routine checkbox; it is a prognostic investigation when prolonged fever-associated seizures occur.

Refractory SE carried the highest odds ratio for poor outcome in this study. That result is not surprising, but it is important. Refractoriness is a marker of seizure biology, treatment delay, etiology and systemic stress acting together. The American Epilepsy Society guideline emphasizes early benzodiazepine therapy for convulsive seizures lasting at least five minutes, followed by timely escalation when seizures persist.[11] Delayed therapy is also a theme in FEBSTAT emergency management data, where treatment timing was heterogeneous despite prolonged seizures.[13] In the present cohort, all deaths occurred among children with refractory SE, underscoring the need for rapid escalation, airway readiness and early ICU involvement once standard first-line therapy fails.

STEPSS and PEDSS should not be seen as competing tools. They answer slightly different questions. STEPSS asks, at the door, whether the child already has bedside markers of severe SE. PEDSS asks, after the first 48 hours, whether the electroclinical course, systemic instability and drug response confirm a high-risk trajectory. The original STEPSS study reported usefulness in predicting outcome and treatment response in children with SE,[9] while the PEDSS derivation study demonstrated high predictive accuracy for mortality and good versus poor outcome at hospital discharge and three months.[10] The present findings are aligned with that logic: all children with STEPSS >4 also had PEDSS >=3, suggesting that high STEPSS is a meaningful early warning rather than an isolated numerical label.

A culturally grounded reading of these findings is necessary. In many Tamil Nadu government hospital pathways, the child first passes through home care, local practitioner care, transport by family or ambulance, and only then reaches a tertiary paediatric emergency room. The same score threshold may therefore carry different operational implications compared with a resource-rich setting where prehospital benzodiazepine use, paediatric transport and continuous EEG are more readily available. Recent real-world work on community-onset paediatric SE also highlights barriers in early treatment and transfer pathways.[16] The practical implication here is simple: once a child with FSE has a high STEPSS, prolonged seizure duration, or early refractoriness, clinicians should not wait for every investigation before escalating care.

The study has limitations. It was conducted at a single tertiary-care teaching hospital, and therefore the findings may reflect referral patterns, treatment delays and case severity typical of this setting. Long-term neurodevelopmental and epilepsy outcomes were not assessed; the follow-up window was short. Continuous EEG was not described as uniformly available, so subclinical seizures may have been missed. In addition, while multivariable analysis identified independent predictors, the sample size and number of deaths limit the precision of effect estimates. Even so, the clinical signal remains coherent: a combined bedside, electrographic, radiological and treatment-response model predicts short-term risk better than any single variable alone.

The immediate clinical value of this study lies in its bedside usability. STEPSS can be documented at admission without waiting for laboratory or imaging reports. PEDSS can be calculated during the early inpatient course and used to guide counselling, ICU monitoring and follow-up prioritization. Children with high scores, refractory seizures, hippocampal MRI signal change or EEG background slowing should be considered for structured neurodevelopmental review after discharge, because early apparent recovery may not exclude later cognitive, behavioural or seizure-related morbidity.[15]

CONCLUSION

STEPSS and PEDSS were effective tools for predicting short-term outcome in children with febrile status epilepticus. STEPSS provided an early bedside risk estimate, whereas PEDSS

strengthened prognostication by incorporating EEG findings, drug refractoriness, systemic critical illness and seizure semiology. Refractory status epilepticus was the strongest predictor of poor outcome, followed by high STEPSS, high PEDSS, hippocampal MRI abnormality and EEG background slowing. Integrating these variables into routine paediatric emergency care may help clinicians identify high-risk children earlier, escalate therapy appropriately and counsel caregivers more clearly. Longer follow-up studies are needed to determine how these early predictors translate into epilepsy, cognitive function and school-readiness outcomes.

Source of Funding
Nil.

Conflict of Interest
None declared.

Ethical Approval
Institutional Ethics Committee approval was obtained from Government Chengalpattu Medical College. Written informed consent was obtained from parents or legal guardians of all enrolled children.

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Abbreviations

SE: status epilepticus
FSE: febrile status epilepticus
STEPSS: Status Epilepticus Pediatric Severity Score
PEDSS: Pediatric Early Determinants of Status Score
PCPCS: Pediatric Cerebral Performance Category Scale
EEG: electroencephalography
MRI: magnetic resonance imaging
RSE: refractory status epilepticus
SRSE: super-refractory status epilepticus
CNS: central nervous system
ICU: intensive care unit
MODS: multi-organ dysfunction syndrome.