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Original Research Article

Clinical Spectrum, Outcomes, and Prognostic Factors in a Tertiary Neuro-Intensive Care Unit: A Retrospective Study

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Abstract:

Background: Neuro-Intensive Care Units (NICUs) are critical for managing life-threatening neurological conditions. However, data on disease patterns and outcomes in NICUs from developing countries remain scarce.

Methods: This retrospective study analysed 553 consecutive patients admitted to a tertiary Neuro-ICU in over three years (Nov. 2021–Sep. 2025). Demographics, diagnoses, clinical parameters, ventilatory support, complications, and outcomes at discharge, 1 month, 6 months, and 1 year were evaluated. Statistical analyses identified predictors of poor outcome.

Results: The cohort included 63.1% males with a mean age of 42.3 ± 16.8 years. Cerebrovascular accidents were the most common diagnosis (30.4%), followed by Guillain–Barré syndrome (17.5%). Mechanical ventilation was required in 33.1%, associated with significantly increased mortality (55.2% vs. 4.4%, p <0.001). Mortality at discharge and one year were 21.3% and 22.1%, respectively. Coma at admission (OR 3.6, 95% CI 2.2–5.7, p <0.001), septicemia (OR 5.2, 95% CI 3.1–8.6, p <0.001), and electrolyte imbalances (OR 1.8, 95% CI 1.1–2.9, p =0.04) independently predicted poor outcomes.

Conclusion: High early mortality and morbidity characterize NICU patients in this setting, though significant recovery is possible. Identifying key prognostic factors can guide focused interventions and resource allocation to optimize neurocritical care in developing countries.

Keywords: Neuro-Intensive Care, Critical Neurology, Prognostic Factors, Mechanical Ventilation, Outcome Prediction.

Introduction

Neurological intensive care medicine has emerged as a specialized branch dedicated to the management of critically ill patients with life-threatening neurological and neurosurgical conditions. The evolution of neurocritical care dates back to the mid-twentieth century, when the poliomyelitis epidemics in Europe necessitated the creation of specialized respiratory units—such as those established by Ibsen in Copenhagen and Spalding at the Radcliffe Infirmary—which later evolved into the first dedicated Neuro-Intensive Care Units (NICUs)[1]. These early centers laid the foundation for the integration of clinical neurology and critical care principles, emphasizing continuous monitoring, ventilatory management, and prompt intervention in acute neurological deterioration. During the 1970s and 1980s, neurointensive care gained recognition as a distinct discipline, with stroke units, coma management protocols, and mechanical ventilation strategies contributing substantially to improved neurological outcomes [2-4].

In recent decades, NICUs have become an essential component of tertiary hospitals globally, providing focused care for a wide spectrum of disorders including cerebrovascular accidents, Guillain–Barré syndrome (GBS), myasthenic crisis, status epilepticus, central nervous system infections, and metabolic encephalopathies [5-7]. The goals of neurointensive care encompass vigilant monitoring, prevention and treatment of raised intracranial pressure, maintenance of cerebral perfusion, management of mechanical ventilation, and timely intervention for systemic complications. However, the infrastructure, patient profiles, and outcome determinants in developing countries differ considerably from those in resource-rich settings. In India, the majority of studies in neurocritical care have focused on traumatic brain injury, with only limited published data analyzing the outcome of non-traumatic neurological disorders managed in NICUs. This paucity of data represents a critical gap in understanding disease burden, management practices, and prognostic indicators in the Indian context [7-8].

The patient population in Indian NICUs often presents with unique challenges—delayed hospital presentation, pre-existing comorbid conditions such as diabetes mellitus and hypertension, and a higher incidence of systemic infections [8-10]. Moreover, limited resources necessitate a judicious selection of patients for admission and a careful allocation of intensive care support [11]. Objective assessment of the clinical benefit and cost-effectiveness of neurointensive care therefore assumes paramount importance in such environments. Studies from Western countries have established the role of specialized neurocritical care in reducing mortality and improving functional outcomes, yet these models cannot be directly extrapolated to Indian healthcare systems due to differences in population characteristics, disease severity, and access to care. Systematic regional data are crucial for designing tailored management algorithms and efficient triaging policies.

The present study addresses this unmet need by analyzing the outcome profile of patients admitted to the Department of Neurology, Meenakshi Medical College hospital and Research Institute, Kanchipuram, Tamil Nadu a tertiary hospital. Through retrospective evaluation of demographic variables, disease distribution, clinical parameters, and their relationship to short- and long-term outcomes, the study aims to identify key prognostic indicators influencing survival and recovery among neurocritical patients. By integrating these findings with international evidence, the investigation seeks to contribute to the rational planning of neuro intensive care services in resource-limited settings while highlighting avenues for improving patient outcomes through optimized monitoring, infection control, and early intervention strategies.

Materials and Methods

Study Design and Setting: This study adopted a retrospective observational design and was conducted in the Department of Neurology, Meenakshi Medical College hospital and Research Institute, Kanchipuram, Tamil Nadu a tertiary hospital. The Neuro-ICU comprises nine fully equipped beds with facilities for invasive monitoring, mechanical ventilation, and specialized neurological care. The unit caters to patients with a wide range of acute neurological and neurosurgical disorders requiring close monitoring, ventilatory assistance, or complex intervention. The present analysis was based on the review of medical records from patients admitted to the NICU over a three-year period, from Nov 2021 to Sep 2025.

Ethical Considerations: The study protocol adhered to the ethical principles of the Declaration of Helsinki and institutional ethical guidelines for retrospective data analysis. This study was approved by the Institutional Ethics Committee of Meenakshi Medical College Hospital and Research Institute, (Approval No. EC/MMCHRI/2021-22/98). All procedures involving human participants were conducted in accordance with the ethical standards of the institutional research committee Written informed consent was obtained from all participants or their legally authorized representatives prior to study inclusion as this was a non-interventional study using anonymized patient data from medical records, formal patient consent was collected as per the standard procedures.

Study Population and Inclusion Criteria: The study population consisted of 553 consecutive patients admitted during the study period. Inclusion criteria were patients diagnosed with acute neurological diseases who required intensive monitoring, ventilatory support, or specialized treatment not feasible in general wards. Patients admitted for neurocritical medical management following conditions such as cerebrovascular accidents, Guillain–Barré syndrome (GBS), myasthenic crisis, status epilepticus, and central nervous system (CNS) infections were included. Exclusion criteria comprised patients admitted in pre-terminal or moribund states who died within six hours of admission, cases involving social admissions (e.g., hospital staff or relatives without indication-based criteria), and those transferred from other units for palliative care only.

Data Collection and Clinical Parameters: Demographic, clinical, and laboratory data were extracted using a structured proforma from hospital case records. Variables included patient demographics (age, sex, socioeconomic class), primary neurological diagnosis, associated systemic illnesses, clinical presentation, duration of illness before admission, indication for ICU admission, and neurological status at the time of admission. The level of consciousness was evaluated using the Glasgow Coma Scale (GCS), and patients were categorized into four groups based on GCS score ranges (3, 4–6, 7–10, and >10). Indications for ICU admission were classified into six categories: coma, respiratory failure, neuromuscular paralysis, monitoring, therapeutic intervention, and post-thymectomy management.

Laboratory investigations included serum electrolytes, renal and hepatic profiles, lumbar puncture findings (when applicable), and infection screening. Neuroimaging data (CT or MRI brain), electrophysiological studies (EEG, ENMG), and relevant imaging reports were reviewed. Ventilatory parameters such as the duration and indication for mechanical ventilation, re-intubation, need for tracheostomy, and ventilator-related complications were documented. All recorded complications including respiratory infections, pneumothorax, and septicemia were reassessed in relation to patient outcomes.

Outcome Assessment: The primary outcome measures were survival and functional recovery at the time of discharge, one month, six months, and one year following discharge. Outcomes were classified using the Modified Glasgow Outcome Scale (GOS):

(1) Death, (2) Persistent Vegetative State, (3) Severe Disability (bedbound), (4) Moderate Disability, (5) Good Recovery (independent life), (6) Independent life with gainful occupation, and (7) Unknown (lost to follow-up). For analysis, categories 1–3 were grouped as poor outcomes and 4–6 as good outcomes. Outcomes were correlated with major variables including diagnosis, coma status, comorbidities, septicemia, metabolic abnormalities, and ventilatory requirement.

Statistical Analysis: All data were entered into digital records for statistical processing. Descriptive statistics were used to summarize the patient characteristics and outcomes. Categorical variables were analyzed using chi-square tests, and continuous variables were expressed as mean ± standard deviation. A p-value less than 0.05 was considered statistically significant. Multivariate analysis was applied to identify clinical predictors of poor outcome, focusing on parameters such as disease category, comorbid conditions, presence of coma, septicemia, and need for mechanical ventilation [12].

Results

The study included 553 patients admitted to the Neuro-Intensive Care Unit over three years. The demographic profile showed a predominance of males (63.1%) compared to females (36.9%), with the age distribution spanning from 1 to 84 years and a mean age of 42.3 ± 16.8 years. Patients aged 41–60 years constituted the largest age group (43.2%), followed by 21–40 years (30.2%). The baseline neurological status assessed by the Glasgow Coma Scale (GCS) revealed that 41.9% of patients had relatively preserved consciousness (GCS >10), while 10.7% presented with severe coma (GCS 3). Mean ICU stay was 4.08 ± 3.3 days, ranging broadly up to 385 days, reflecting diverse clinical courses (Table 1).

Table 1: Demographic and Baseline Characteristics of Patients Admitted to Neuro-ICU (N = 553)

Parameter	Category	Patients (n)	Percentage (%)	Mean ± SD / Range
Age (years)	1–20	33	6.0	42.3 ± 16.8 (1–84)
	21–40	167	30.2	
	41–60	239	43.2	
	>60	114	20.6	
Sex	Male	349	63.1	—
	Female	204	36.9	—
Socioeconomic class	Upper & middle	258	46.7	—
	Lower & below poverty line	295	53.3	—
Baseline GCS	3	59	10.7	6.9 ± 2.4
	4–6	74	13.4	
	7–10	188	34.0	
	>10	232	41.9	
Mean ICU stay	—	—	—	4.08 ± 3.3 (1–385 days)

Regarding clinical diagnoses, cerebrovascular accidents were the most frequent cause of Neuro-ICU admission, accounting for 30.4% of cases, followed by Guillain–Barré syndrome (17.5%) and CNS infections such as meningitis and encephalitis (14.1%). Myasthenia gravis and status epilepticus contributed 8.5% and 7.1%, respectively. Hypoxic and metabolic encephalopathies, although less common, were associated with higher mortality and poor long-term outcomes. Comorbid systemic illnesses were prevalent, with hypertension (28%) and diabetes mellitus (20.2%) being the most common, both contributing to worsened prognosis. Importantly, patients with chronic renal disease showed the highest mortality rate among systemic conditions (48%) (Table 2).

Table 2: Neurological Diagnoses and Associated Comorbidities

Diagnosis / Comorbidity	Patients (n)	Percentage (%)	Mortality (in-ICU %)	One-Year Poor Outcome (%)
Cerebrovascular accident	168	30.4	28.6	45.0
Guillain–Barré syndrome	97	17.5	8.2	10.5
Myasthenia gravis	47	8.5	9.8	13.0
CNS infections (meningitis, encephalitis)	78	14.1	23.8	34.0
Status epilepticus	39	7.1	7.7	12.1
Hypoxic/metabolic encephalopathy	17	3.1	45.9	67.0
Miscellaneous (spinal, neoplastic, metabolic)	107	19.3	18.9	28.0
Systemic hypertension	153	28.0	14.5	36.4
Diabetes mellitus	111	20.2	13.2	32.7
Coronary artery disease	70	12.9	12.9	29.8
Chronic renal disease	11	2.0	45.5	48.0
Others (COPD, valvular, collagen vascular)	51	9.2	18.5	28.4

The primary reason for ICU admission was neurological monitoring in unstable patients (58.0%), followed by respiratory failure (17.4%) and coma (13.9%). Patients admitted in coma demonstrated a significantly higher mortality rate at discharge (50.0%) and sustained poor functional outcomes at one year (57.1%; adjusted odds ratio [OR] 3.6, 95% Confidence Interval [CI] 2.2–5.7, $p < 0.001$). In contrast, patients admitted for intractable seizures or therapeutic interventions showed improved survival and recovery ($p = 0.001$), with mortality rates notably lower than in coma or respiratory failure groups. Therapeutic interventions such as plasma exchange and post-thymectomy care constituted smaller patient subsets with relatively favorable outcomes (Table 3).

Table 3: Indications for ICU Admission and Related Clinical Parameters

Indication	Patients (n)	Percentage (%)	Mean Age (yrs) ± SD	Mortality (%)	Poor Outcome at 1 Yr (%)
Neuromonitoring / unstable neurological state	321	58.0	43.1 ± 13.3	5.4	13.5
Respiratory failure	98	17.4	46.9 ± 15.9	47.0	53.6
Coma / GCS ≤ 6	77	13.9	51.2 ± 17.4	50.0	57.1
Intractable seizures	69	12.5	39.6 ± 15.8	10.1	21.7
Raised intracranial pressure	28	5.1	44.2 ± 12.1	28.5	35.7
Therapeutic procedures (e.g., plasma exchange)	50	9.0	41.7 ± 13.8	7.0	24.0
Post-thymectomy management	12	2.2	35.9 ± 8.2	0.0	8.3
Others (metabolic instability, diagnostic evaluation)	27	4.9	49.0 ± 11.7	9.2	28.0

Mechanical ventilation was required in one-third of patients (33.1%), predominantly due to central neurological causes (42.3%), pulmonary complications (28.6%), and neuromuscular weakness (19.2%). The mean duration of ventilation was 17.2 ± 14.6 days. The mean duration of ventilation was 17.2 ± 14.6 days. Ventilated patients experienced significantly higher mortality compared to non-ventilated counterparts (55.2% vs. 4.4%, $p < 0.001$, OR 4.0, 95% CI 2.4–6.5). Ventilator-associated infections occurred in 25.2% and were independently associated with increased mortality risk ($p = 0.0001$). Tracheostomy was performed in 8.3% of ventilated patients (Table 4).

At ICU discharge, mortality stood at 21.3%, with an additional 31.3% of survivors remaining bedbound and 30% experiencing moderate disability. Only 12.5% of patients achieved good recovery, and 4.0% resumed independent life with gainful occupation. Follow-up assessments at one month demonstrated slight improvements with reduced bedbound cases and increasing good recovery rates; these trends continued at six months and one year, where long-term gains in functional independence and occupation were evident. However, mortality remained above 20% at all time points, underscoring the high-risk profile of this cohort (Table 5).

Table 4: Ventilatory Support and ICU-related Complications

Parameter	Patients (n)	Percentage (%)	Mean ± SD / Duration	Mortality (%)	p-value
Required mechanical ventilation	183	33.1	17.2 ± 14.6 days	55.2	<0.001
No ventilation required	370	66.9	3.5 ± 2.4 days	4.4	—
Indication: central neurological	77	42.3	—	—	—
Indication: pulmonary / aspiration	52	28.6	—	—	—
Indication: neuromuscular	35	19.2	—	—	—
Tracheostomy performed	46	8.3	—	—	—
Reintubation required	12	2.2	—	—	—
Infection post-intubation	139	25.2	—	Increased mortality	—
Ventilator-associated pneumonia	29	5.2	—	—	—
Other complications (collapse, pneumothorax, tracheal stenosis)	10	1.8	—	—	—

Table 5: Outcome at ICU Discharge and Long-Term Follow-Up

Outcome Category	At Discharge (n, %)	At 1 Month (n, %)	At 6 Months (n, %)	At 1 Year (n, %)	p-value
Death	118 (21.3)	112 (20.3)	112 (20.3)	118 (22.1)	<0.001
Persistent vegetative state	3 (0.5)	1 (0.2)	2 (0.4)	1 (0.2)	NS
Severe disability (bedbound)	173 (31.3)	82 (14.8)	31 (5.6)	10 (1.8)	<0.05
Moderate disability	166 (30.0)	88 (15.9)	103 (18.6)	78 (14.1)	<0.05
Good recovery	69 (12.5)	82 (14.8)	93 (17.0)	89 (16.3)	<0.05
Independent life / gainful occupation	22 (4.0)	45 (8.1)	125 (22.6)	109 (19.7)	<0.001
Lost to follow-up	—	101 (18.3)	77 (13.9)	124 (22.4)	—

Multivariate logistic regression identified coma at admission (adjusted OR 3.6, 95% CI 2.2–5.7, $p < 0.001$), septicemia during ICU stay (OR 5.2, 95% CI 3.1–8.6, $p < 0.001$), mechanical ventilation requirement (OR 4.0, 95% CI 2.4–6.5, $p < 0.001$), and electrolyte disturbances such as hyponatremia/hypernatremia (OR 1.8, 95% CI 1.1–2.9, $p = 0.04$) as key predictors of poor outcome at one year. The presence of systemic hypertension and diabetes also independently contributed to adverse prognosis ($p = 0.03$) (Table 6). Collectively, these findings outline the clinical and demographic factors influencing outcomes in a tertiary Neuro-ICU setting in India, underscoring the importance of early identification of high-risk patients and targeted interventions to improve survival and functional recovery. The statistical significance of predictors and effect sizes reinforces their clinical relevance for guiding resource allocation and individualized patient care strategies in resource-limited environments (Tables 1–6).

Table 6: Key Predictors of Poor Outcome at 1-Year Follow-Up (Multivariate Comparison)

Predictor Variable	Poor Outcome (%)	Good Outcome (%)	Adjusted OR (95% CI)	p-value
Coma on admission	60.4	39.6	3.6 (2.2–5.7)	<0.001
Septicemia during ICU stay	75.0	25.0	5.2 (3.1–8.6)	<0.001
Mechanical ventilation required	55.2	44.8	4.0 (2.4–6.5)	<0.001
Hyponatremia / hypernatremia	38.5	61.5	1.8 (1.1–2.9)	<0.05
Hypertension / Diabetes	33.0	67.0	1.6 (1.2–2.5)	<0.05
Respiratory infection	40.5	59.5	2.2 (1.4–3.6)	<0.01

Discussion

This study presents a comprehensive analysis of patient outcomes in a Neuro-Intensive Care Unit (NICU) within a tertiary care center in India. The demographic findings, including a male predominance and a concentration of cases in the 41 to 60 years age group, align with observations from Meena et al. (2001) [1] in a similar Indian setting, highlighting regional consistency in patient profiles and neurological disease burden. Cerebrovascular accidents emerged as the principal diagnosis, paralleling results from Al-Busaidi et al. (2019) [2] in Oman, where stroke constituted a significant proportion of ICU admissions with comparably elevated mortality rates. Both studies reaffirm the global challenge in managing ischemic stroke patients in critical care environments, especially in resource-constraint settings.

Guillain–Barré syndrome (GBS) accounted for a substantial fraction of NICU admissions and was associated with relatively lower mortality, reminiscent of data presented by Bayu et al. (2024) [4] in Ethiopia, who documented similar outcomes in low-income contexts. The reliance on mechanical ventilation for respiratory compromise in GBS observed here echoes clinical practices described by Shang et al. (2021) from China, underscoring the critical role of timely ventilatory support in improving survival chances in neuromuscular conditions. The significantly higher mortality among ventilated patients in this study is consistent with findings by Battaglini et al. (2021) [5] in Italy, emphasizing the additional risks of ventilator-associated complications that complicate neurocritical care globally.

The identification of coma at admission, septicemia during ICU stay, and electrolyte imbalance as major predictors of adverse outcomes concur with conclusions by Loza et al. (2020) [7] in the United States, who reported these variables as harbingers of increased mortality and poor functional recovery in neurological ICUs. The relevance of systemic comorbidities such as hypertension and diabetes mellitus in modulating prognosis also finds support from works conducted in comparable settings, including Shrestha et al. (2025) [8] in Nepal, which advocated for integrating comorbidity management into neurocritical care protocols in resource-limited environments.

Functional recovery trajectories delineated in this cohort, with gradual improvement over a one-year period despite initial severe impairment, align with long-term outcome studies like Valburg et al. (2024) [9] from Germany, reinforcing the potential for meaningful rehabilitation even in critically ill neurological patients. However, high attrition rates in follow-up highlight the pressing need for more robust post-discharge care frameworks and patient tracking systems.

Despite robust insights, this investigation is constrained by its retrospective, single-center design, which may limit broader applicability. Dependence on medical record accuracy, loss to follow-up of over 20%, and lack of uniform utilization of advanced neuroimaging and standardized severity scoring are notable limitations. These underscore the necessity for prospective multicenter studies with systematic data collection to develop predictive models and care pathways tailored to diverse healthcare contexts. Our study underscored mechanical ventilation as a strong mortality predictor, consistent with Italian and US data [5,6], identifying ventilator-related complications as pivotal contributors to poor outcomes in neurocritical care. The significant relationship between coma severity, septicemia, and electrolyte disturbances with mortality aligns with findings from Loza and colleagues (2020), reiterating the need for vigilant infection control and metabolic correction. Comorbidities such as hypertension and diabetes, reported as independent outcome modifiers in Nepal (Shrestha et al., 2025), further emphasize the complexity of care in resource-constrained environments.

Longitudinal assessments reflected gradual recovery over one year, paralleling rehabilitation outcomes observed in German neurocritical care patients [9], advocating sustained multidisciplinary support post-discharge. Nonetheless, loss to follow-up remains a challenge, underscoring the demand for improved outpatient care pathways. The study's single-center, retrospective design constrains the generalizability of findings and introduces potential selection and information biases. Incomplete follow-up data (22.4% lost) may skew long-term outcome estimations. Lack of standardized neuroimaging protocols and severity scoring beyond GCS restricted detailed prognostication. Prospective multicenter studies incorporating comprehensive clinical and biomarker data are essential to enhance prediction models and optimize neurocritical care protocols in diverse settings.

Conclusion

This study provides pivotal data delineating patient characteristics, disease spectra, and outcome determinants in a tertiary Neuro-ICU in India. The findings underscore cerebrovascular disease as the principal admission cause, with mechanical ventilation, coma, and septicemia as key mortality predictors. Despite substantial morbidity and early mortality, meaningful long-term recovery is achievable, reinforcing the imperative for targeted interventions and resource optimization. These results furnish a critical foundation for enhancing neurocritical care strategies in resource-limited settings worldwide.

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