

Spectrum of Critically Ill Neurological and Neurosurgical Patients Admitted to a Level 3 Intensive Care Unit in Nepal: Analysis by Diagnosis, Clinical Profile, and Outcome

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ABSTRACT

Background

Neurocritical conditions significantly contribute to disease burden in low-income and middle-income countries (LMICs) like Nepal, where epidemiology and outcomes data are limited. This study analyzes the spectrum of neurocritical patients admitted to a level 3 intensive care unit (ICU) in Nepal, focusing particularly on diagnosis, age distribution, and clinical outcomes.

Objective

To describe the demographic and clinical profile of patients and determine the factors associated with outcomes in the neuro-intensive care unit.

Method

A retrospective, single-center, observational study was conducted over three years (January 2021 to December 2023) in the Neuro-intensive care unit of Nepal Medcity Hospital. Patients were categorized based on their primary diagnosis. Data from 820 patients were analyzed using descriptive statistics for demographics, diagnoses, duration of intensive care unit stay, mechanical ventilation, and outcomes (survival, mortality, survival, mortality, and leave against medical advice withdrawal of treatment). Data were extracted using the National Intensive Care Unit Registry maintained by NICRF (Nepal Intensive Care Research Foundation).

Result

A total of 820 cases were analyzed. Males constituted 65.9% of admissions. The most preponderant patient population was aged ≥ 61 years, with cerebrovascular diseases (47.2%), being the leading diagnosis, followed by trauma (19.8%). Mechanical ventilation was required in 32.8% of cases. Overall ICU survival was 71.3%, with 28.7% mortality. Older age, lower admission Glasgow Coma Scale, vascular diagnosis, and mechanical ventilation were independent predictors of ICU mortality.

Conclusion

Cerebrovascular diseases and trauma are the primary drivers of Neuro-intensive care unit admissions. Prioritizing stroke prevention and trauma reduction programs may reduce mortality in neurocritical care.

KEY WORDS

Intensive care unit, Mortality, Neurocritical care, Outcome

INTRODUCTION

Neurocritical care is an evolving subspecialty of critical care medicine that combines expertise in neurology, general critical care management, and evidence-based practices to treat patients with brain or spinal cord injuries.¹ This field emerged from the understanding that an already affected brain (primary injury) is greatly influenced by systemic alterations that may adversely affect its function (secondary injury).²

Acute neurologic illnesses (ANI) contribute significantly to the global burden of disease and cause disproportionate death and disability in low-income and middle-income countries (LMICs) where neurocritical care resources and expertise are limited.³ Subspecialized Neurocritical care is associated with improved survival and functional outcomes for critically ill adults with brain injury.⁴ Globally, neurocritical care accounts for 10–15% of ICU admissions, with stroke and TBI representing the most common diagnoses.⁵ There is substantial heterogeneity in the availability of neurocritical care beds across the world (83% in US hospitals vs 56% in other countries).⁶ The knowledge of patient characteristics, common diagnoses, and outcomes in a neurocritical unit aids in planning resource allocation, optimizing resource utilization, and guiding focused training and education.⁷

This study, therefore, aims to address this knowledge gap through a retrospective epidemiological evaluation of neurocritical conditions managed in a tertiary-level ICU in Nepal. The patients were categorized by diagnosis, age group, and treatment outcomes to identify the pattern of healthcare delivery. These findings are critical for implementing targeted interventions, better resource utilization, and overall improvement in the care and treatment of neurological and neurosurgical emergencies in Nepal.

METHODS

A retrospective, observational study was conducted in the Neuro Intensive Care Unit of the tertiary hospital, Nepal Medciti Hospital at Lalitpur. The study included all patients admitted to 12-bedded semi-closed neuro-ICU over three years period from January 2021 to December 2023. Following ethical approval from the Institutional Review Committee (IRC-RP-2081/82-15), the primary data were extracted from the National ICU registry system maintained by Nepal Intensive Care Research Foundation (NICRF). Baseline admission variables included age groups (≤ 20 years, 21–40 years, 41–60 years, and ≥ 61 years), gender, surgical status, need for mechanical ventilation, and need for vasopressors. Patients were then categorized based on their primary diagnosis as: stroke, trauma, infection, tumor, seizure, demyelinating, and others. Diagnostic classification was based primarily on neuroimaging findings (CT/MRI) supplemented by clinical expertise.

Patient outcome variables that were considered in the study were length of stay (LOS), mortality, and leave against medical advice (LAMA). Only patients with complete clinical documentation, diagnostic imaging records, and documented ICU outcomes (survival/mortality) were included. Patients who were admitted for non-neurological or non-neurosurgical conditions were excluded from the study. Cases with incomplete records (e.g., lack of ventilation status or unclear disposition) were excluded.

The collected data were entered into Excel sheets and analyzed using SPSS software (version 31.0). Continuous variables were expressed as mean $\pm$ standard deviation (SD) if normally distributed, or median with interquartile range (IQR) if skewed. Categorical variables were summarized as counts and percentages. Normality of distributions was assessed using the Shapiro–Wilk test. For group comparisons, Student's t-test or Mann–Whitney U test was used for continuous variables, and the chi-square test (or Fisher's exact test, where appropriate) for categorical variables. Correlation analyses were performed to explore relationships between continuous variables. Pearson's correlation coefficient was used for variables with approximately normal distributions and linear relationships. Spearman's rank correlation coefficient was applied when variables were ordinal, non-normally distributed, or when the relationship was monotonic but not linear. Multivariate logistic regression was used to identify independent predictors of ICU mortality, with variables included based on clinical relevance and significance in univariate analysis ($p < 0.1$). A two-tailed $p < 0.05$ was considered statistically significant. Analyses were conducted using SPSS v.31.

RESULTS

Out of 910 patients, 90 patients had incomplete or missing data. A total of 820 patients were analyzed and incorporated into the study (Fig. 1).

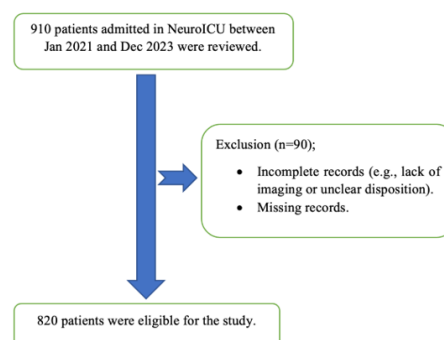


Figure 1. STROBE diagram depicting the review of Neurological and Neurosurgical patient's records

The mean age was 49.9 ± 21.6 years (range 18–95), with 540 (65.9%) males. The most common diagnosis subtype was vascular (47.2%), followed by trauma (19.8%), tumor

(12.2%), seizure (10.1%), infection (7.1%), demyelinating (2.6 %), and others (1.1 %) (Fig. 2). The median admission GCS was 11 (IQR 3–15). The median ICU length of stay (LOS) was 12 days (IQR 6–22). Mechanical ventilation was required in 32.8% of patients. The overall ICU mortality was 28.7% (n = 235) (Table 1).

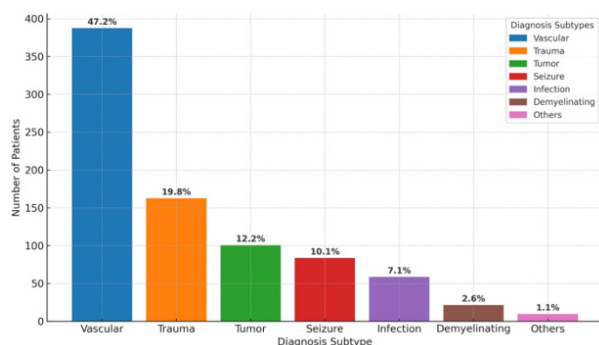


Figure 2. Distribution of Diagnosis subtypes (n=820)

Table 1. Baseline Demographics and Clinical Characteristics

Variable	Value	n (%)
Age (years)		
≤ 20 years		89 (10.90%)
21–40 years		181 (22%)
41–60 years		255 (31.10%)
≥ 61 years		295 (36%)
Male sex		540 (65.9%)
Admission GCS	Median 11 (IQR 3–15)	
Diagnosis subtype		
Vascular		387 (47.2 %)
Trauma		162 (19.8 %)
Tumor		100 (12.2 %)
Seizure		83(10.1 %)
Infection		58 (7.1 %)
Demyelinating		21 (2.6 %)
Others		9 (1.1 %)
Postoperative status (Yes)		239 (29.1%)
Vasopressor requirement (Yes)		72 (8.8%)
Mechanical ventilation (Yes)		269 (32.8%)
ICU LOS (days)	Median 12 (IQR 6–22)	
Mortality (Yes)		235 (28.7%)
Left against medical advice (LAMA)		42 (5.1%)

Non-survivors were significantly older than survivors (61.3 ± 15.2 vs. 50.8 ± 17.9 years, $p < 0.001$) and had lower admission GCS (7 [IQR 4–10] vs. 12 [IQR 8–15], $p < 0.001$). Vascular and infectious diagnoses were over-represented among non-survivors ($p < 0.001$). Mechanical ventilation was more frequent in non-survivors (63.0% vs. 22.3%, $p < 0.001$). Median LOS was longer among survivors (13 vs. 8 days, $p < 0.001$) (Table 2).

Table 2. Univariate Comparison of Survivors vs. Non-survivors

Variable	Survivors (n=543)	Non-survivors (n=235)	p-value
Age (years)	50.8 ± 17.9	61.3 ± 15.2	<0.001
Admission GCS	12 (8–15)	7 (4–10)	<0.001
LOS (days)	13 (8–22)	8 (4–14)	<0.001
Mechanical ventilation	121 (22.3%)	148 (63.0%)	<0.001
Vascular diagnosis	263 (48.4%)	124 (52.8%)	<0.001

Correlation analysis was done among age, GCS, and length of stay. Age negatively correlated with GCS ($\rho = -0.28$, $p < 0.001$). GCS negatively correlated with LOS ($\rho = -0.19$, $p < 0.001$) (Fig. 3). Age positively correlated with LOS ($\rho = 0.21$, $p < 0.001$).

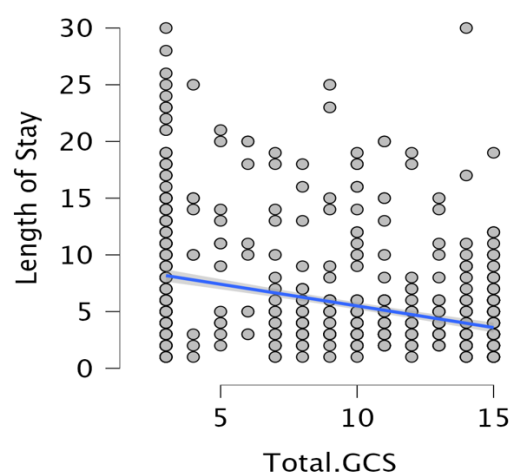


Figure 3. Scatter plot depicting correlation between Total GCS and Length of Stay (LOS)

On logistic regression, older age (OR 1.04 per year, 95% CI 1.02–1.05, $p < 0.001$), lower GCS at admission (OR 0.94 per point, 95% CI 0.90–0.98, $p < 0.001$), vascular diagnosis (OR 1.7, 95% CI 1.2–2.5, $p = 0.004$), and mechanical ventilation (OR 4.2, 95% CI 2.7–6.4, $p < 0.001$) were independent predictors of ICU mortality. Gender and LOS were not independent predictors (Table 3).

Table 3. Multivariate Logistic Regression: Predictors of Mortality

Variable	Odds Ratio	95% CI	p-value
Age (per year)	1.04	1.02–1.05	<0.001
Admission GCS (per point)	0.94	0.90–0.98	<0.001
Vascular diagnosis	1.70	1.20–2.50	0.004
Mechanical ventilation	4.20	2.70–6.40	<0.001
Gender (male)	1.10	0.80–1.50	0.45
ICU LOS	1.01	0.99–1.03	0.32

DISCUSSIONS

This study provides a comprehensive epidemiological analysis of critically ill patients admitted to the neurointensive care unit of a level 3 hospital. As the

first longitudinal characterization of neurocritical care epidemiology in Nepal, this 3-year cohort study establishes baseline demographic profiles, disease patterns, and clinical outcomes for severe neurological disorders in a resource-limited tertiary care setting.

In this large cohort of 820 patients admitted to the neuro-ICU, we identified several independent predictors of poor outcome, including advanced age, lower admission Glasgow Coma Scale (GCS), vascular etiology, and the need for mechanical ventilation. These findings underscore the importance of early risk stratification in neuro-ICU patients and also provide unique insights from our regional population.

Our cohort, with a mean age of 49.9 years and a male predominance (65.9%), reflects a typical neuro-ICU population, which often sees a higher burden of acute neurological injuries in males, potentially due to differences in risk factor profiles and exposure to trauma.⁸⁻¹⁰ The case mix was dominated by vascular etiologies (47.2%), followed by trauma (19.8%) and tumor (12.2%), a distribution consistent with other large registries of neurocritical care patients.^{11,12} The overall ICU mortality rate of 28.7% falls within the range reported in previous studies, which can vary significantly based on case mix and regional practices.^{9,13}

Our univariate analysis identified several factors significantly associated with mortality. Non-survivors were markedly older and presented with a significantly lower median GCS (7 vs. 12), underscoring the well-established prognostic value of age and level of consciousness in neurological injury.^{14,15} The over-representation of vascular and infectious diagnoses among non-survivors is not surprising. Vascular events, specifically severe strokes, are leading causes of death and disability in neuro-ICU settings, often due to irreversible primary injury or devastating complications like cerebral edema and herniation.^{16,17} Similarly, central nervous system infections are associated with high mortality due to sepsis, elevated intracranial pressure, and direct parenchymal damage.¹⁸

The significantly higher rate of mechanical ventilation in non-survivors (63% vs. 22.3%) is likely a marker of illness severity, reflecting a greater degree of neurological dysfunction impairing airway protection, brainstem failure, or the development of systemic complications.¹⁹

The correlation analyses revealed significant, albeit weak-to-moderate, relationships between key variables. The negative correlation between age and GCS ($p = -0.28$) suggests that older patients may present with, or are more susceptible to, a lower level of consciousness for a given pathology. The correlation between GCS and LOS ($p = -0.19$) is interesting. While a lower GCS often predicts worse outcomes, it can also be associated with earlier mortality, truncating the LOS. This is supported by our finding that survivors had a significantly longer median LOS (13 days)

than non-survivors (8 days). The positive correlation between age and LOS ($p = 0.21$) may indicate that older survivors often have longer recovery times and are more susceptible to non-neurological complications that prolong ICU stay, such as pneumonia or weaning failure from ventilation.²⁰

The multivariate logistic regression model provides the most robust insights by identifying independent predictors of mortality while controlling for confounding variables. The model confirmed that older age, lower admission GCS, a vascular diagnosis, and the requirement for mechanical ventilation are all strong, independent risk factors for death. The odds ratio for mechanical ventilation was particularly high (OR 4.2), reinforcing its role as a potent marker of critical illness in this population, though it is important to distinguish it as a marker of severity rather than necessarily a direct cause of mortality.²¹

The finding that a vascular diagnosis retained independent significance after adjusting for GCS and age highlights the inherently high mortality risk of this patient subgroup compared to others, such as those with trauma or seizures.¹⁹ Conversely, male gender and ICU LOS were not independent predictors of mortality. The lack of association with gender suggests that once critically ill, biological sex may not be a primary determinant of outcome in neurocritical care, though social and pre-illness risk factors may explain its prevalence in the cohort.²² The non-significance of LOS is expected in a multivariate model, as LOS is itself an outcome measure heavily influenced by the patient's clinical course rather than a primary predictive variable.

The 5.1% LAMA rate, while lower than some LMIC reports, highlights socioeconomic barriers to long-term care.²³ These findings highlight the need for better patient education, counseling, and support systems to address underlying concerns.^{24,25}

The single-center, retrospective methodology of this study, as well as the possibility of selection bias, restricts its findings. The lack of granular data on comorbidities and socioeconomic status limits further investigation. Future prospective, multi-center studies that include neuro-prognostication tools and long-term functional outcomes are needed.

This study has several limitations that should be considered when interpreting the findings. First, it is a single-center study. This limits the generalization of the results to other healthcare settings both in Nepal and in similar low- and middle-income countries. A multi-center study would give a better epidemiological picture and improve the validity of the results. Additionally, the retrospective observational design depends on available hospital records, that may be incomplete or missing. Lack of any prospective follow-up further limits the assessment of the long-term functional outcomes of patients, thus limiting the overall understanding of patient recovery beyond ICU

discharge. A hybrid design, which combines elements of both prospective and retrospective data collections within a single study framework, with evaluations using validated scales (e.g., Glasgow Outcome Scale-Extended) would better characterize neurorehabilitation needs.

CONCLUSION

Our findings highlight the significant prevalence of cerebrovascular diseases and trauma in neuro-ICUs, particularly among older males and younger adults, respectively. Older age, lower admission GCS, vascular etiology, and the need for mechanical ventilation were independent predictors of death, highlighting their

prognostic significance in this population. These findings emphasize the need for timely identification of high-risk patients to optimize management strategies, allocate resources effectively, and inform discussions with families regarding prognosis. Further multicenter studies are warranted to validate these predictors and explore interventions that may improve survival in this vulnerable group. The study's findings could guide healthcare policy and resource allocation in similar settings.

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