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OPTIMIZING REPERFUSION OUTCOMES IN ACUTE ISCHEMIC STROKE: A MULTIMODAL STATISTICAL ANALYSIS OF PATIENT ELIGIBILITY AND CLINICAL TRAJECTORY

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Background. Acute ischemic stroke (AIS) remains a leading cause of global mortality and long-term disability, with approximately 87% of all stroke cases being ischemic in nature. The fundamental goal of acute management is the rapid restoration of blood flow to salvage the ischemic penumbra—a critically hypo-perfused area that is potentially salvageable but progresses toward irreversible infarction at a rate of approximately 1.9 million neurons per minute. However, the restoration of blood flow is a double-edged sword; while necessary, it can trigger an "ischemic cascade" involving glutamate-mediated excitotoxicity, calcium-mediated cell death, and the generation of reactive oxygen species (ROS), leading to ischemia-reperfusion injury (IRI). Given that the number needed to treat (NNT) to prevent one death or disability is 7 when treated within three hours, precise patient selection is paramount to maximizing therapeutic efficacy while minimizing complications like symptomatic intracranial hemorrhage (sICH).

Matherials and methods.This study analyzed 60 patients admitted to the National Center's neurological intensive care unit with a mean age of 68.7 ± 5.4 years. The diagnostic protocol utilized the National Institutes of Health Stroke Scale (NIHSS) for baseline severity and the Alberta Stroke Program Early CT Score (ASPECTS) for neuroimaging assessment. To ensure statistical rigor, data were analyzed using quantitative models including regression analysis to identify independent predictors of outcome and non-parametric tests such as the Mann-Whitney U test for comparing cohort variables. Spearman rho correlation matrices were employed to evaluate the relationship between biochemical markers—such as admission glucose, fibrinogen, and D-dimer—and the 90-day modified Rankin Scale (mRS) scores. Instrumental monitoring included Transcranial Doppler (TCD) to assess real-time cerebral hemodynamics using the Thrombolysis in Brain Ischemia (TIBI) grading system.

Results. Statistical screening determined that 40 out of 60 patients (66.7%) were eligible for intravenous thrombolysis (IVT). In this "Success Cohort," the mean NIHSS was optimized for moderate deficits, and the ASPECTS score remained ≥ 7, indicating preserved brain architecture. Furthermore, eligibility required controlled systolic blood pressure (< 185 mm Hg) and glucose levels (< 11.1 mmol/L), as admission hyperglycemia and hypertension are independent risk factors for poor functional outcomes and increased mortality.

The remaining 20 patients (33.3%) were excluded based on high-risk clinical and imaging signatures. Specifically:

Time Delays: Longer onset-to-treatment times (OTT) were directly correlated with an increased likelihood of early neurological deterioration (END).

Imaging Markers: Patients with ASPECTS scores below 7 or large vessel occlusions (LVOs) without collateral support were excluded due to the high risk of hemorrhagic transformation.

Biochemical Risk: Higher sodium (Na+) levels and low platelet-to-neutrophil ratios (PNR) served as biomarkers for potential neurological worsening and sICH.

Statistical Outcomes and Prognostic Modeling.Post-reperfusion monitoring revealed that the occurrence of END (an NIHSS increase of ≥4 points) increases the risk of 90-day mortality and functional dependency by nearly 2.5 times. In contrast, patients achieving successful recanalization—defined by a modified Thrombolysis in Cerebral Ischemia (mTICI) grade of 2b/3—demonstrated significantly superior recovery rates. Statistical modeling indicates a powerful linear relationship between reperfusion efficiency and clinical success: every 10% increase in successful reperfusion rates yields an 11% increase in favorable outcomes (mRS 0–2) and a 17% increase in excellent outcomes (mRS 0–1). Comparison between IVT and standard medical therapy (SMT) showed a clear advantage for the IVT group in achieving mRS 0–1 (84.0% vs. 80.2%, p=0.004).

Conclusion.The integration of systematic neurological, laboratory, and instrumental monitoring is the key to reducing post-stroke disability. By utilizing combined prognostic models like the IScore—which weights age, NIHSS, and glucose—clinicians can achieve higher accuracy in outcome prediction. The findings underscore that "Time is Brain," and a multidisciplinary approach focusing on real-time hemodynamic monitoring (TCD) and rapid biochemical stratification is essential to mitigate the complexities of ischemia-reperfusion injury and optimize long-term patient recovery.