Clustering and Subgroup Analysis of Acute Ischemic Stroke in 15094 Migraine Patients Using Machine Learning

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Introduction: Migraine is a debilitating condition impacting over 37 million individuals in the United States. This study utilizes machine learning-based clustering algorithms to identify unique clinical profiles in acute ischemic stroke (AIS) patients with migraines, assessing the impact of these profiles on mortality, discharge disposition, and length of stay (LOS).

Methods: The 2015-2021 National Inpatient Sample (NIS) was analyzed using ICD-10 CM/PCS coding for patients with migraines and AIS. Machine learning clustering examined the population based on 49 comorbidities, complications, and clinical covariates. The optimal number of clusters was assessed using the Davies-Bouldin Index (DBI) and Calinski-Harabasz Index (CHI). Multivariate logistic regression evaluated the risk of mortality and non-routine discharge. Kruskal-Wallis H-testing assessed LOS variance across clusters. Statistical analysis was conducted in Python.

Results: A total of 15,094 patients were categorized into five groups based on DBI-CHI scoring, with cluster sizes ranging from 139 to 11,181 patients. Mortality rates varied significantly, from 1.3% in Cluster 1 to 22.61% in Cluster 5. Cluster 5 exhibited the highest prevalence of cerebral edema, cerebral herniation, and mechanical ventilation, correlating with a 28-fold increase in mortality risk AOR 27.89, 95% CI: 17.02–45.71, $p < 0.001$. Kruskal-Wallis H-testing indicated significant differences in LOS among clusters ($p<0.001$), with pronounced differences between Cluster 5 and other groups.

Discussion: Our clustering analysis delineated five distinct AIS and migraine comorbidity profiles. The group characterized by a high prevalence of severe complications corresponded to the highest mortality rate. This machine learning approach enhances understanding of comorbidity interactions, informing tailored clinical decision-making and treatment strategies.

Keywords: Acute ischemic stroke, migraine, machine learning, clustering