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Original Research Paper

Application of Prognostic Nutritional Index in predicting the prognosis of Acute Ischemic Stroke patients

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ABSTRACT:
Introduction: Stroke is a leading cause of mortality and disability worldwide, with ischemic stroke accounting for 70% of cases. Malnutrition is a common complication, increasing susceptibility to infections and worsening outcomes. The Prognostic Nutritional Index (PNI), based on serum albumin and lymphocyte count, is a promising tool for assessing nutritional and inflammatory status in stroke patients. This study evaluates the prognostic utility of PNI in acute ischemic stroke (AIS) patients. **Methods**: A hospital-based cross-sectional study was conducted at Sri Manakula Vinayagar Medical College and Hospital, Pondicherry, over 12 months. Eighty-two AIS patients meeting the inclusion criteria were enrolled. PNI was calculated as [(10 × serum albumin) + (0.005 × total lymphocyte count)]. Logistic regression and ROC curve analysis assessed PNI's predictive value for clinical outcomes. **Results**: The mean age of participants was 60.5 ± 11.8 years, with a male predominance (65.9%). Low PNI was significantly associated with unfavourable clinical outcomes (OR: 0.797, 95% CI: 0.68-0.935, p = 0.005). ROC analysis demonstrated good predictive accuracy (AUC = 0.816, p < 0.001), with a PNI cut-off of 46.165 (sensitivity: 84.21%, specificity: 66.67%). **Discussion**: Lower PNI correlated with increased stroke severity, infection risk, and mortality, consistent with prior studies. However, variations in PNI cut-off values across studies suggest further validation is needed. **Conclusion**: PNI is a valuable prognostic tool in AIS, aiding in early risk stratification and guiding nutritional interventions. Future longitudinal studies are needed to confirm its clinical applicability.

Keywords: Prognostic Nutritional Index (PNI), Acute Ischemic Stroke, Malnutrition, Stroke Prognosis, Stroke Outcomes

INTRODUCTION:

Stroke is a major global health burden on patients and society as a whole, being to the leading causes of death and permanent disability.[1–4] The pathophysiology of stroke is significantly influenced by an increased inflammatory burden.[5] Ischaemic stroke accounts for 70% of all strokes. A disruption in the cerebral blood supply results in ischaemic stroke, a clinical syndrome characterised by brain necrosis and cranial nerve dysfunction. Seventy to eighty percent of cerebrovascular diseases are ischaemic strokes, which are common and often occur.[6] About 70% of stroke patients may also have varying degrees of cognitive and physical dysfunction.[7]

Malnutrition is a common complication of stroke and an independent risk factor for poor prognosis of stroke. It can occur in both the acute and convalescent stages of stroke, with an incidence rate ranging from 6.1% to 62%. About 25% of patients suffer from malnutrition in the first few weeks after stroke. Malnutrition causes deterioration in the immune system causing a decrease in resistance to pathogenic microorganisms, which results in an increase in treatment resistance. This increases the risk of developing an infection in stroke patients.[8]

Stroke-related infections are common and serious complications. The incidence of SRI is between 5 and 65%. Infectious complications are lung infections, urinary system infections, and infections of other systems. Therefore, early diagnosis and treatment of SRI are very important. Effective assessment techniques are crucial for the prevention of SRI in the early period.[9]

The Prognostic Nutritional Index (PNI) is a widely used nutritional and immune index based on serum albumin (ALB) levels and total lymphocyte count in peripheral blood which can simultaneously evaluate the overall inflammation and nutritional conditions of the patients with stroke.[10] Recent studies have shown that PNI can be used to effectively assess the

nutritional status of elderly stroke patients, and it has certain prognostic value for stroke in elderly patients.[11]

While PNI has been widely studied in oncology and critical care, its application in acute ischemic stroke remains relatively novel. Limited studies have investigated the role of PNI in predicting stroke outcomes, and existing research lacks standardized cut-off values and robust validation across diverse patient populations.

This study aims to bridge this gap by evaluating the prognostic utility of PNI in AIS patients, assessing its correlation with functional outcomes, mortality, and recurrence risk. By integrating PNI into conventional risk stratification, this research has the potential to improve early prognostic assessment and guide targeted nutritional interventions in stroke management.

OBJECTIVE:

To correlate the prognostic nutrition index in proven ischemic stroke patients for predicting prognosis and outcome of the disease.

MATERIALS AND METHODS:

Study Setting: The study will be carried out in the department of General medicine of Sri Manakula Vinayagar medical college and hospital (SMVMCH), which is a tertiary care hospital in rural Pondicherry, India.

Study design: The study design employed is a Hospital based cross sectional study

Study duration: The study will be done over a period of 12 months after approval by SMVMCH Research Committee and Institutional Ethics Committee, from December 2023 to January 2024.

Sample size:

Patient who are diagnosed as stroke patients visiting as both outpatients and inpatient of Sri Manakula Vinayagar Medical College and Hospital, Pondicherry satisfying the inclusion criteria. Based on the 70% prevalence of malnutrition in study named as The Effect of Prognostic nutritional index on infection in acute ischemic stroke patients conducted by Sebnem Nergiz et al.[11] with 95% Confidence Interval, 10% Absolute precision was calculated to 82.The sample size was calculated using the formula:

Sample size n = [DEFF*Np(1-p)]/ [$(d^2/Z^2_{1-\alpha/2}$*(N-1)+p*(1-p)]

Study Participants: Patients included in this study are those who are diagnosed with Acute ischemic stroke.

Inclusion criteria:

1. Patients diagnosed with Acute ischemic stroke
2. Patients whose CT/MRI brain imaging confirmed the diagnosis of acute stroke
3. Age > 18 years

Exclusion criteria:

1. Patients with previous history of stroke
2. Stroke patients with haemorrhagic transformation
3. Patients with acute infection
4. Patients with any malignancy
5. Patients with end stage renal failure and hepatic failure

Sampling:

The study was done in patients admitted under general medicine at S.M.V.M.C.H. during the given span of time, after getting the informed written consent from the patient and clearance from Research and Ethics Committees. All patients who fulfilled the inclusion and exclusion criteria were taken up for the study. Samples are selected in consecutive sampling method

Study procedure:

Samples for the study is derived from collecting data from medical records of already proven Acute ischemic stroke patients and excluding the patients based on the exclusion criteria, the Nutritional prognostic index was calculated. The outcomes and prognosis of these patients were determined based on the calculated scores.[12]

PNI: [(10 × serum albumin (g/dL)) + (0.005 × total lymphocyte count)].

Methodology:

After identifying acute ischemic stroke patients based on the clinical findings and imagings, the various parameters like serum albumin, total lymphocyte count were measured. We were using the study materials (CT brain / MRI brain) from the proven acute ischemic stroke patients. Samples collection done based on patients personal data, case history, clinical findings, blood samples collected from these patients to determine PNI and CT/MRI brain records were collected from previous medical records of already proven acute ischemic stroke patients after excluding the exclusion criteria. The obtained study materials were used only for interpreting the results required for this study. Blood samples will be withdrawn from patients after getting consents.

Flowchart illustrating the standard operating procedure of the study:

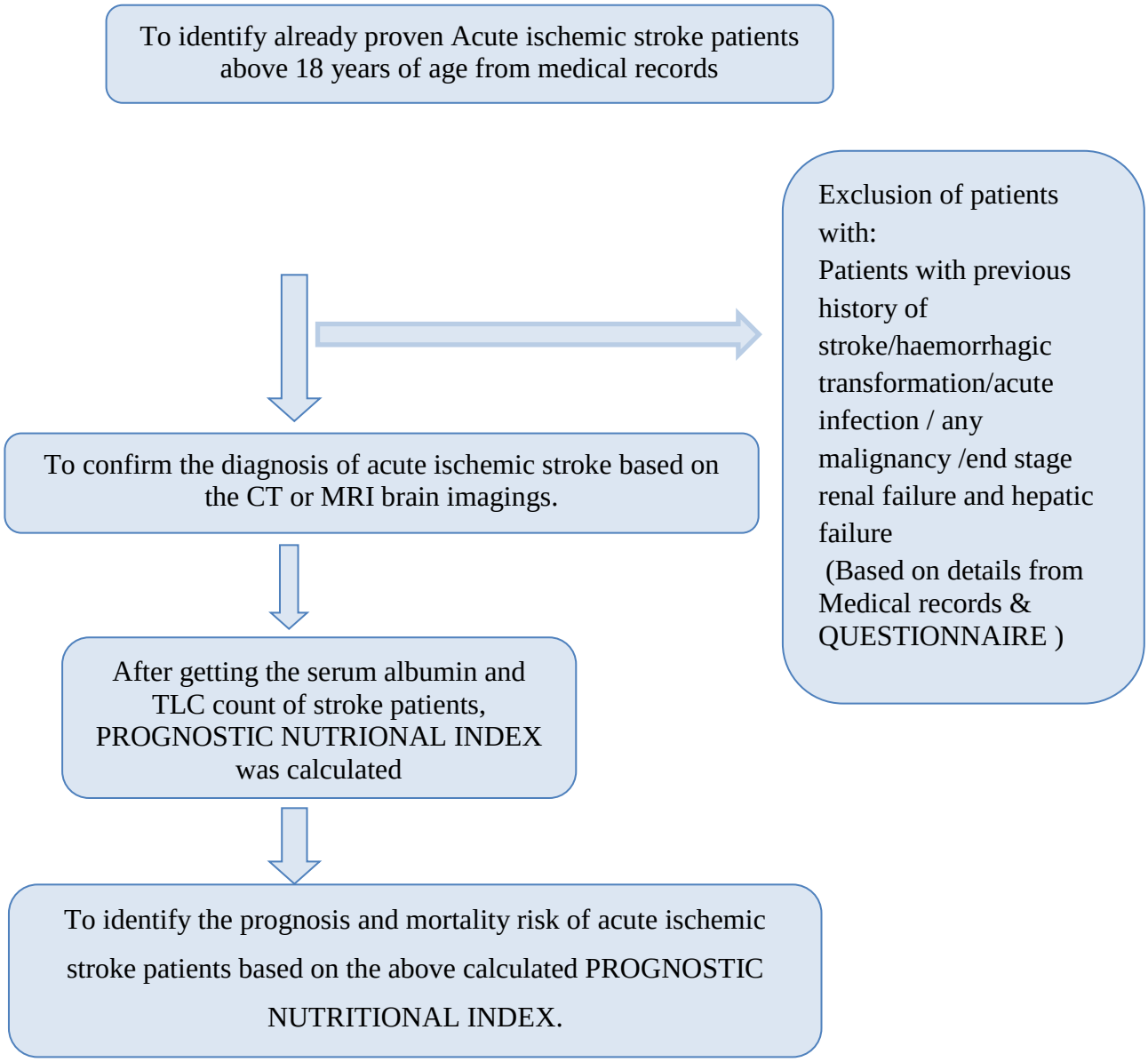

Table 1: Demographic characteristics and laboratory findings of eligible patients (N=82)

Characteristics	n (%)
Age in years , Mean (S.D)	60.5 (11.8)
Gender	
Male	54 (65.9)
Female	28 (34.1)
BMI	
Normal	25 (30.5)
Overweight	40 (48.8)
Obese	17(20.7)
Occupation	
Unemployed	15(18.3)
Skilled workers	27(32.9)
Sales Person	1 (1.2)
Unskilled Workers	39(47.6)
Comorbidities	
No comorbidities	19 (23.2)
Systemic Hypertension	49(59.6)
Type 2 Diabetes Mellitus	39(47.6)
Coronary Artery Disease	9 (11)
Others	6 (7.3)
History of Smoking	
Yes	42 (51.2)
No	42(48.8)
History of Alcohol	
Yes	48(58.5)
No	34(41.5)
Laboratory findings	
Total Leukocyte count as cells per microlitre, Mean (S.D)	1974(844)
Total serum albumin(g/l),Mean (S.D)	4.03(0.442)

The demographic details and lab results of the study participants (N=82) are shown in Table 1. The participants' average age was 60.5 ± 11.8 years, and they were primarily male (65.9% male, 34.1% female). In terms of BMI, 20.7% were obese, 48.8% were overweight, and 30.5% had a normal BMI. In terms of occupation, there were 18.3% unemployed people, 32.9% skilled workers, 1.2% salespeople, and 47.6% unskilled workers. In contrast to 23.2% who had no comorbidities, 59.6% had systemic hypertension, 47.6% had type 2 diabetes mellitus, 11% had coronary artery disease, and 7.3% reported other conditions. With 51.2% reporting a history of smoking and 58.5% reporting alcohol use, smoking and alcohol consumption were both common. According to laboratory results, the mean total serum albumin level was 4.03 ± 0.442 g/L, and the mean total leukocyte count was 1974 ± 844 cells per microlitre. These results offer an in-depth analysis of the study population's health profile.

Table 2: Relationship between PNI and Clinical parameters (N=82)

Variables	Correlation coefficient (r)	P-value
BMI	-0.031	0.781
Age	-0.197	0.076
Gender	-0.063	0.572
Hypertension	-0.042	0.709

Table 2 shows the correlations between various factors and PNI (Prognostic Nutritional Index) show weak inverse relationships. Age and PNI have a negative correlation of -0.197, indicating that as age increases, PNI slightly decreases. The correlation between sex (male = 1, female = 0) and PNI is also negative (-0.063), suggesting that being male is weakly associated with a lower PNI score. Similarly, the relationship between hypertension (HTN = 1) and PNI is weakly negative (-0.042), with individuals with hypertension tending to have slightly lower PNI scores. The correlation between BMI and prognosis outcome is very weak at -0.031, indicating that BMI has almost no effect on the prognosis. However, all these values were found to be statistically insignificant.

Table 3: Logistic regression model with predictors of unfavorable clinical outcome (N=82)

Variables	Unadjusted OR (95%CI)	p-value	Adjusted OR (95%CI)	p-value
Age	0.975 (0.911-1.044)	0.470	-	-
HTN	3.429(0.590 -19.932)	0.170	-	-
DM	0.949 (0.180-5.001)	0.951	-	-
Smoking	1.054 (0.2-5.5)	0.951	-	-
Alcohol	0.261 (0.29-2.339)	0.230	-	-
Albumin	0.014 (0.001-0.220)	0.002	-	-
Lymphocyte count	0.999 (0.998-1)	0.249	-	-
Low PNI	0.797(0.68-0.935)	0.005	1.008 (0.721-1.411)	0.961

Table 3 presents the logistic regression model for predicting an unfavorable clinical outcome (N=82). In the unadjusted model, none of the variables, including age, hypertension (HTN), diabetes (DM), smoking, alcohol use, albumin and lymphocyte count, showed significant associations with the outcome, except for albumin and low PNI, which had a strong association with statistical significance. In the unadjusted model, low PNI remained a significant predictor, with an odds ratio of 0.797 (95% CI: 0.68-0.935, p = 0.005), suggesting that a lower PNI score is associated with a higher likelihood of an unfavorable clinical outcome. The adjusted odds ratio (OR) for low PNI is 1.008 (95% CI: 0.721-1.411), with a p-value indicating that it is not statistically significant. This suggests that, after adjusting for other factors, low PNI is not strongly associated with an unfavorable clinical outcome.

Figure 1: Receiver operating characetristic curve (ROC) of the prognostic nutritional index (PNI) for prediction of 1 month outcomes in acute ischemic stroke patients

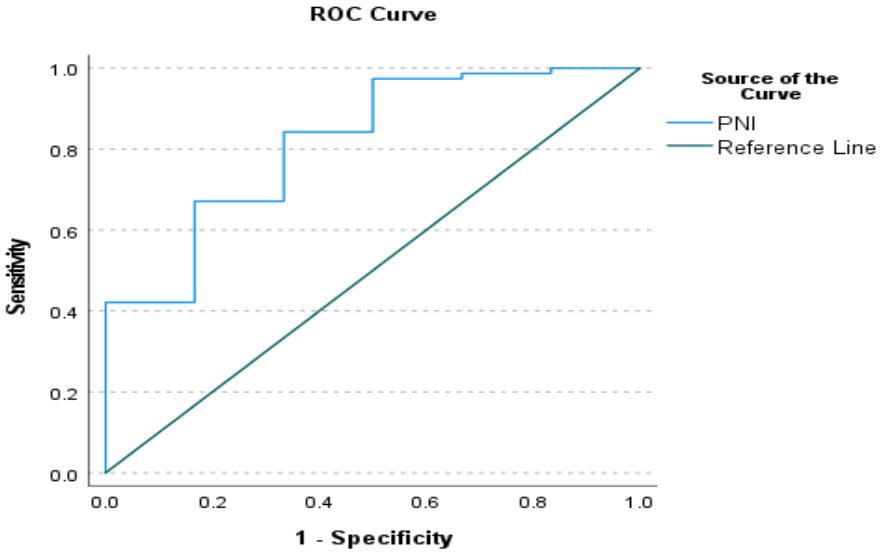

Figure 1 shows the Receiver Operating Characteristic (ROC) curve for the Prognostic Nutritional Index (PNI) in predicting 1-month outcomes in acute ischemic stroke patients. The area under the curve (AUC) for PNI is 0.816 (95% CI: 0.64-0.992, p < 0.001), indicating that PNI has a good ability to discriminate between favorable and unfavorable outcomes. A higher AUC value (close to 1) reflects better predictive accuracy. The cutoff value for PNI was found to be 46.165, with a sensitivity of 84.21% and specificity of 66.67%. This suggests that PNI is a relatively accurate tool for predicting outcomes in this patient group, with good sensitivity (ability to correctly identify those with unfavorable outcomes) and moderate specificity (ability to correctly identify those with favorable outcomes).

DISCUSSION:

This study evaluated the utility of the Prognostic Nutritional Index (PNI) in predicting outcomes among Acute Ischemic Stroke patients. Our findings suggest that lower PNI values were associated with unfavourable clinical outcomes, including increased risk of infection and mortality. These results align with previous research demonstrating the impact of malnutrition on stroke prognosis.

Low PNI is strongly linked to the development of stroke-related infections (SRI), according to a study by Nergiz et al. In comparison to patients with a PNI > 380, they discovered that patients with an Acute Ischaemic Stroke who had a PNI ≤ 380 had much greater rates of infection, longer hospital stays, and a higher risk of death. Our study also revealed a significant correlation between adverse clinical outcomes and low PNI, highlighting the significance of evaluating nutritional status in the treatment of acute ischaemic stroke.[11]

A Meta-analysis by Chen et al. identified a number of risk factors, such as advanced age, dysphagia, diabetes, and a history of stroke, that contribute to malnutrition in stroke patients. Age and PNI showed a weak inverse correlation in our study, indicating that older patients are more likely to suffer from malnutrition, which can hinder their ability to recover. Our results, however, did not show any significant correlations with other clinical variables, such as diabetes or hypertension.[13]

PNI was found to be an effective prognostic marker for stroke outcomes in a recent review by Di Vincenzo et al., which compared various malnutrition screening tools. According to their research, integrating PNI into routine stroke management could enhance early risk assessment and direct dietary interventions. PNI should be regarded as a useful predictive tool in stroke care, according to our findings, which also show that patients with lower PNI had worse clinical trajectories.[14]

With an AUC of 0.816, the ROC curve analysis of our study showed that PNI had good discriminative ability in predicting one-month outcome. This outcome aligns with research by Xiang et al. that reported the prognostic significance of PNI in stroke patients receiving thrombolysis. The cut-off value of 46.165 in our study yielded a sensitivity of 84.21% and a specificity of 66.67%, making it a practical threshold for clinical use.[8]

Additionally, a study by Ustaalioğlu et al. finds a strong negative correlation between PNI levels and poor clinical outcomes in patients who have had an acute ischaemic stroke. These studies demonstrate that systemic inflammation and malnutrition, which are represented in lower PNI, are major factors in post-stroke recovery difficulties. Nonetheless, some disparities in results are introduced by differences in PNI cut-off values, sample sizes, and outcome measures. For instance, while our study suggests a specific threshold for defining high-risk patients, other studies propose slightly different values, which may be attributed to differences in population characteristics and methodologies.[12]

The findings of our study highlight the significant role of the Prognostic Nutritional Index (PNI) in predicting the prognosis of patients with Acute Ischemic Stroke. Our results demonstrate that lower PNI values are associated with increased stroke severity, higher morbidity, and worse functional outcomes. This aligns with findings from previous studies, including those examined in the literature.

Limitations:

The cross-sectional design prevents us from establishing causality between PNI and stroke outcomes.

Additionally, our study was conducted in a single tertiary care centre, which may limit the generalizability of the findings.

Future research should explore longitudinal studies with larger, more diverse populations to validate PNI as a universal prognostic tool for stroke management.

CONCLUSION:

The Prognostic Nutritional Index (PNI) is a useful tool for predicting clinical outcomes in patients who suffered an acute ischemic stroke, according to this study. Poorer functional outcomes, a higher risk of infection, and a more severe stroke were all substantially correlated with lower PNI values. PNI's possible use in early risk stratification was supported by ROC analysis's strong predictive accuracy.

Generalizability is limited by the single-center study design and differences in PNI cut-off values, despite its apparent utility. To confirm PNI as a universal prognostic tool, more extensive, multicenter, and longitudinal studies are required in the future. PNI integration into standard stroke management may improve patient outcomes, optimize nutritional support, and strengthen early intervention strategies.

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Conflict of Interest: Nil

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