Section: General Medicine

Original Research Article

ASSOSCIATION OF PERIPHERAL BLOOD MONOCYTES COUNT WITH STROKE SEVERITY AND FUNCTIONAL OUTCOMES IN ACUTE ISCHAEMIC STROKE

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ABSTRACT

Background: Inflammation plays a key role in the pathophysiology of acute ischemic stroke, with monocytes contributing to post-ischemic injury and repair. Simple and accessible biomarkers are needed for early prediction of stroke severity and outcomes. **Materials and Methods:** This prospective observational study included 40 patients with acute ischemic stroke admitted to Basaveshwara Medical College and Hospital between April 2024 and September 2025. Stroke severity was assessed using the National Institutes of Health Stroke Scale (NIHSS) at admission. Peripheral monocyte count was measured from blood samples obtained at presentation. Functional outcome was evaluated using the Modified Rankin Scale (mRS) at discharge. Poor outcome was defined as mRS ≥3. Correlation analysis, logistic regression, and receiver operating characteristic (ROC) curve analysis were performed. **Results:** The mean age of the patients was 62.4 ± 10.8 years, with a male predominance (65%). Higher monocyte counts were observed in patients with severe stroke compared to those with mild to moderate stroke (0.74 ± 0.16 vs. 0.55 ± 0.14 $\times 10^9$/L; $p < 0.05$). Monocyte count showed a positive correlation with NIHSS score ($r = 0.48$, $p = 0.002$). Patients with poor functional outcomes had significantly higher monocyte levels than those with favorable outcomes (0.71 ± 0.17 vs. 0.51 ± 0.13 $\times 10^9$/L; $p < 0.01$). On multivariate analysis, elevated monocyte count was an independent predictor of poor outcome (OR 2.3; 95% CI 1.2–4.5; $p = 0.01$). ROC analysis demonstrated moderate predictive ability (AUC = 0.74). **Conclusions:** An increased peripheral blood monocyte count correlates with acute ischemic stroke severity and adverse functional outcomes. As an inexpensive and easily accessible inflammatory biomarker, it holds promise for incorporation into early risk stratification models and prognostic assessment.

INTRODUCTION

Stroke continues to be a leading cause of death and long-term disability worldwide, with ischemic stroke accounting for approximately 80–85% of all cases. Despite advances in reperfusion therapies and supportive care, a substantial proportion of patients experience significant neurological deficits and poor functional recovery. Early risk stratification is therefore essential to guide management decisions and improve outcomes. In this regard, there is increasing interest in identifying simple, cost-effective biomarkers that can reliably predict stroke severity and prognosis.

Inflammation plays a central role in the pathogenesis of acute ischemic stroke. Following cerebral ischemia, a cascade of immunological events is initiated, characterized by activation of peripheral immune cells, release of pro-inflammatory cytokines, and disruption of the blood–brain barrier. Monocytes are key mediators in this process and are integral to the innate immune response. These cells migrate rapidly to the site of ischemic injury, where they contribute to neuronal damage through the release of

inflammatory mediators, as well as to tissue repair and remodeling.[1]

Experimental and clinical studies have demonstrated that monocyte counts increase in the acute phase of stroke and may serve as a marker of systemic inflammatory activity.[2] Elevated peripheral monocyte levels have been associated with increased stroke severity, higher National Institutes of Health Stroke Scale scores, and worse functional outcomes.[3] In addition, various inflammatory indices derived from monocytes, including the lymphocyte-to-monocyte ratio and monocyte-related biomarkers, have been shown to have prognostic significance in acute ischemic stroke.[4]

However, despite these observations, the practical utility of monocyte count as an independent and easily accessible prognostic marker remains unclear. Many previous studies have been limited by retrospective designs, small sample sizes, and variability in study populations, which may affect the reproducibility of findings. Furthermore, data from resource-limited settings are scarce.

Therefore, the present study was designed to evaluate the association between peripheral monocyte count at admission and stroke severity, and to determine its role in predicting clinical outcomes in patients with acute ischemic stroke.

MATERIALS AND METHODS

1. Study Design

This was a prospective observational study conducted to evaluate the association between peripheral monocyte count, stroke severity, and clinical outcomes.

2. Study Setting

The study was carried out at Basaveshwara Medical College and Hospital over a period of 18 months, from April 2024 to September 2025. Ethical clearance was obtained from the Institutional Ethics Committee, and informed consent was taken from all participants.

3. Study Population

A total of 40 patients with acute ischemic stroke were included.

Inclusion Criteria

- Age ≥18 years
- Clinically and radiologically confirmed acute ischemic stroke
- Presentation within 72 hours of onset

Exclusion Criteria

- Hemorrhagic stroke
- Active infection at admission
- Autoimmune or inflammatory diseases
- Malignancy
- Patients on immunosuppressive therapy

4. Sample Size

A sample size of 40 patients was included based on feasibility and availability of eligible cases during the study period.

5. Data Collection

Baseline demographic details including age and sex were recorded. Clinical variables and vascular risk factors such as hypertension, diabetes mellitus, smoking, and dyslipidemia were documented at admission.

6. Stroke Assessment

Stroke severity at presentation was assessed using the National Institutes of Health Stroke Scale (NIHSS). Baseline NIHSS score was used to categorize severity, as it is a validated predictor of stroke outcomes.

7. Laboratory Parameters

Peripheral venous blood samples were collected at admission. Monocyte count was measured using automated hematology analyzers as part of complete blood count. Additional parameters such as total leukocyte count and derived inflammatory indices (if available) were also recorded.

8. Outcome Measures

Functional outcome was assessed using the Modified Rankin Scale (mRS) at discharge. Mortality and in-hospital complications, including infections, were documented.

9. Definitions

- Severe stroke: NIHSS score ≥16
- Poor outcome: mRS score ≥3

10. Statistical Analysis

Statistical analysis was performed using SPSS software (version XX). Continuous variables were expressed as mean ± standard deviation, and categorical variables as frequencies and percentages. Correlation between monocyte count and stroke severity was analyzed using Pearson or Spearman correlation tests. Logistic regression analysis was used to identify independent predictors of poor outcome. Receiver operating characteristic (ROC) curve analysis was performed where applicable to determine predictive value. A p-value of <0.05 was considered statistically significant.

RESULTS

A total of 40 patients with acute ischemic stroke were included in the study. The mean age of the study population was 62.4 ± 10.8 years, with a male predominance (65%). The most common risk factors were hypertension (60%), diabetes mellitus (45%), and smoking (35%). Baseline demographic and clinical characteristics of the study population are summarized in Table 1.

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Table 1: Data are presented as mean ± SD or number (percentage). NIHSS denotes National Institutes of Health Stroke Scale

Variable	Value
Age (years), mean ± SD	62.4 ± 10.8
Male sex, n (%)	26 (65%)
Hypertension, n (%)	24 (60%)
Diabetes mellitus, n (%)	18 (45%)
Smoking, n (%)	14 (35%)
Dyslipidemia, n (%)	16 (40%)
NIHSS score at admission, mean ± SD	12.6 ± 5.4
Severe stroke (NIHSS ≥16), n (%)	14 (35%)
Monocyte count (×10⁹/L), mean ± SD	0.62 ± 0.18

The mean National Institutes of Health Stroke Scale (NIHSS) score at admission was 12.6 ± 5.4. Based on NIHSS, 14 patients (35%) had severe stroke (NIHSS ≥16), while the remaining 26 patients (65%) had mild to moderate stroke. Comparison of monocyte count according to stroke severity is shown in Table 2."

Table 2: Data are presented as mean ± SD. NIHSS denotes National Institutes of Health Stroke Scale. P values were calculated using independent t-test

Variable	Mild–Moderate Stroke (n = 26)	Severe Stroke (n = 14)	p-value
NIHSS score (mean ± SD)	9.2 ± 3.1	18.4 ± 2.6	<0.001
Monocyte count (×10⁹/L)	0.55 ± 0.14	0.74 ± 0.16	0.01

The mean peripheral monocyte count at admission was 0.62 ± 0.18 ×10⁹/L. Patients with severe stroke had significantly higher monocyte counts compared to those with mild to moderate stroke (0.74 ± 0.16 vs. 0.55 ± 0.14 ×10⁹/L; $p < 0.05$). A positive correlation was observed between monocyte count and NIHSS score ($r = 0.48$, $p = 0.002$), indicating that higher monocyte levels were associated with increased stroke severity.

Figure 1: Correlation Between Monocyte Count and Stroke Severity.

Scatter plot showing the relationship between admission monocyte count and NIHSS score.

Functional outcomes assessed using the Modified Rankin Scale (mRS) at discharge showed that 22 patients (55%) had a poor outcome (mRS ≥3), while 18 patients (45%) had a favorable outcome. The association between monocyte count and functional outcome is presented in Table 3

Patients with poor outcomes had significantly higher mean monocyte counts compared to those with favorable outcomes (0.71 ± 0.17 vs. 0.51 ± 0.13 ×10⁹/L; $p < 0.01$).

Table 3: Data are presented as mean ± SD. mRS denotes Modified Rankin Scale; NIHSS denotes National Institutes of Health Stroke Scale. P values were calculated using independent t-test

Variable	Favorable Outcome (mRS <3) (n = 18)	Poor Outcome (mRS ≥3) (n = 22)	p-value
Monocyte count (×10⁹/L)	0.51 ± 0.13	0.71 ± 0.17	0.002
NIHSS score (mean ± SD)	8.6 ± 3.2	15.8 ± 4.1	<0.001

On logistic regression analysis, elevated monocyte count was found to be an independent predictor of poor functional outcome (odds ratio [OR]: 2.3; 95% confidence interval [CI]: 1.2–4.5; $p = 0.01$), after adjusting for age, sex, and baseline NIHSS score. Independent predictors of poor functional outcome are shown in Table 4.

Table 4: Odds ratios are adjusted for variables included in the multivariable model. TLC denotes total leukocyte count, and ESR erythrocyte sedimentation rate

Variable	Odds Ratio (OR)	95% Confidence Interval	p-value
Age	1.04	0.98 – 1.10	0.12
Male sex	1.3	0.5 – 3.4	0.56
NIHSS score	1.25	1.08 – 1.44	0.003
Monocyte count	2.30	1.20 – 4.50	0.01

In-hospital mortality was observed in 6 patients (15%), all of whom had higher baseline monocyte counts and severe stroke. Additionally, complications such as infections were more common in patients with elevated monocyte levels. Clinical outcomes and in-hospital complications are summarized in Table 5.

Table 5: Data are presented as number (percentage). mRS denotes Modified Rankin Scale

Outcome	Value
Poor functional outcome (mRS ≥3), n (%)	22 (55%)
Mortality, n (%)	6 (15%)
Infections, n (%)	10 (25%)

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Receiver operating characteristic (ROC) curve analysis demonstrated that monocyte count had moderate predictive value for poor outcome, with an area under the curve (AUC) of 0.74.

Figure 2. Receiver Operating Characteristic (ROC) Curve for Monocyte Count Predicting Poor Functional Outcome.

The ROC curve shows the ability of admission monocyte count to predict poor functional outcome (modified Rankin Scale score ≥3) in acute ischemic stroke. The area under the curve indicates discriminatory performance. The diagonal line represents no discrimination.

DISCUSSION

In this prospective observational study, higher peripheral monocyte counts at admission were significantly associated with increased stroke severity and poor functional outcomes. A positive correlation was observed between monocyte count and NIHSS score, and elevated monocyte levels independently predicted unfavorable outcomes. These findings suggest that monocyte count may serve as a useful prognostic biomarker in acute ischemic stroke.

2. Comparison with Previous Studies

Our findings are consistent with previous studies demonstrating an increase in circulating monocytes following acute ischemic stroke. Monocytes have been shown to contribute to post-ischemic inflammation and lesion expansion.[1] Furthermore, elevated monocyte counts have been associated with greater stroke severity and poorer clinical outcomes.[2] Similar observations have been reported with inflammatory indices such as the lymphocyte-to-monocyte ratio (LMR), where lower ratios correlate with worse prognosis.[3] More recently, the monocyte-to–high-density lipoprotein ratio (MHR) has also emerged as a predictor of adverse outcomes in stroke patients.[4]

3. Pathophysiological Explanation

The association between monocyte count and stroke severity can be explained by underlying inflammatory mechanisms. Following cerebral ischemia, monocytes are rapidly recruited to the ischemic region, where they release pro-inflammatory cytokines and chemokines, contributing to neuronal injury.[1] These inflammatory mediators disrupt the blood–brain barrier, leading to increased permeability and edema. Additionally, monocyte activation promotes infarct progression and secondary brain damage through sustained inflammatory responses.[5]

4. Clinical Implications

Monocyte count, as part of a routine complete blood count, represents a simple, inexpensive, and readily available biomarker. Its association with stroke severity and outcomes makes it a valuable tool for early risk stratification. Incorporating monocyte count into clinical assessment may help identify high-risk patients who require closer monitoring and aggressive management.

5. Strengths of the Study

The strengths of this study include its prospective design and the use of standardized clinical scoring systems such as NIHSS and mRS. Additionally, the study provides data from a real-world clinical setting, contributing to the limited literature in this population.

6. Limitations

This study has several limitations. The sample size was relatively small, and the study was conducted at a single center, which may limit generalizability. Potential confounding factors influencing inflammatory markers could not be completely eliminated. Moreover, serial measurements of monocyte count were not performed.

7. Future Directions

Further large-scale, multicentric studies are required to validate these findings. Future research should also focus on the role of monocyte subtypes and dynamic changes in monocyte levels in predicting stroke outcomes, which may provide deeper insights into stroke pathophysiology and therapeutic targets.

CONCLUSION

Elevated admission monocyte count is significantly associated with increased stroke severity and poorer functional outcomes in acute ischemic stroke. Although it demonstrates moderate predictive accuracy, its simplicity, low cost, and wide availability make it a potentially useful biomarker for early risk stratification in clinical practice.

Note: Further large-scale studies are required to validate these findings.

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