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ORIGINAL ARTICLES

Clinical profile and outcomes of acute ischemic stroke in older persons: A prospective age-group comparative study

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Abstract

Background & Objective: With a global population aging, understanding stroke characteristics in older persons becomes increasingly critical for optimising care strategies. This study investigated clinical profiles, risk factors, and treatment outcomes in older persons with acute ischemic stroke across different age groups. *Methods:* This prospective observational study enrolled 310 patients aged ≥60 years with acute ischemic stroke over 12 months. Patients were categorized into younger older persons (60-80 years, n=212) and older-old persons (>80 years, n=98) groups. Clinical characteristics, risk factors, stroke severity using NIHSS, treatment modalities, and functional outcomes using modified Rankin Scale were analyzed. *Results:* Older-old persons (>80 years) presented with more severe strokes (mean NIHSS 18.7±6.1 vs. 12.4±5.2, p<0.001) and higher rates of watershed infarcts (14.3% vs. 0.5%). Conservative management was used in 74.2% of patients, more frequently in the older-old persons (81.6% vs. 70.8%, p=0.042). Good functional outcomes (mRS 0-2) at 3 months were achieved in 66.5% overall but less in older-old patients (58.2% vs. 70.3%, p=0.042). IV thrombolysis showed the highest good recovery rate (77.2%) and lowest mortality (8.8%). Independent predictors of good outcome were younger age (OR 0.92), lower baseline NIHSS (OR 0.84), and early presentation ≤3 hours (OR 2.28), while atrial fibrillation was a negative predictor (OR 0.58). The older-old patients more likely to have AF (57.1% vs 29.2%, p<0.001). Mortality was significantly higher in older-old persons (>80 years) compared to younger older persons (26.5% vs 14.2%; OR 2.19, p=0.012).
Conclusion: Both conservative management and interventional therapies demonstrate effectiveness in older-old persons with stroke when appropriately selected. Age-based treatment restrictions appear unjustified, supporting individualized clinical decision-making over chronological age considerations.

Keywords: Acute ischemic stroke, older persons, thrombolysis, conservative treatment, functional outcomes

INTRODUCTION

Aging is a complex biological process characterized by progressive decline in physiological functions, increased vulnerability to diseases, and reduced adaptive capacity.[1] The World Health Organization defines aging as "the process of developing the changes associated with the passage of time"[2], while the American Geriatrics Society recognizes functional aging distinctions: young-old (60-69 years), middle-old (70-79 years), and older-old persons (≥80 years), reflecting meaningful differences in health status, care needs, and therapeutic responses.[3,4]

Acute ischemic stroke disproportionately affects older populations, with individuals aged ≥65 years experiencing approximately 75% of all ischemic strokes.[5,6] The clinical presentation, pathophysiology, and treatment responses in older persons with stroke differ significantly from younger populations due to age-related cerebrovascular changes, increased comorbidity burden, and altered pharmacokinetics.[7,8] Older-

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old persons (≥80 years) represent the fastest-growing demographic segment and demonstrate distinct clinical characteristics including higher stroke severity, increased prevalence of atrial fibrillation, and greater susceptibility to treatment-related complications.[10]

Management of older stroke patients requires balancing treatment benefits against potential risks, particularly for thrombolysis and invasive interventions. Age-related physiological changes, such as impaired cerebral autoregulation and vulnerability to complications, further increase the complexity of care.[10]

We selected 80 years as the cut-off point based on established geriatric medicine principles recognizing that individuals become increasingly frail after this age, marked by serious mental and physical debilitation.[11,12] This stratification (60-80 years vs >80 years) captures clinically meaningful differences in physiological reserve, treatment tolerance, and outcome expectations, enabling evidence-based decision-making for different older persons subgroups.

METHODS

Study design and setting

This was a prospective observational cohort study carried out at Dayanand Medical College and Hospital, Ludhiana, Punjab, India during July 2024 to June 2025. A 1625-bed tertiary care teaching hospital that has a dedicated acute stroke management protocol activated 24/7 via a 'stroke code' run by the Department of Neurology in collaboration with emergency physicians. All enrolled patients were admitted to a dedicated stroke unit." The institution has a broad referral base including urban and rural populations, and the demographics of older persons with stroke is well represented.

Participants

Consecutive ischaemic acute stroke patients aged ≥ 60 years were prospectively included within 24 hours of symptom onset. Patients with clinical diagnosis of acute ischemic stroke by treating neurologist, radiological confirmation by computed tomography or magnetic resonance imaging and written informed consent were included. Exclusion criteria were intracerebral haemorrhage, transient ischaemic attacks with complete remission within 24 hours, and inability or refusal to give informed consent.

Data collection

Standardized case record forms were used for comprehensive collection of clinical data on demographics, medical history, risk factors, clinical presentation, neurological examination, investigations, treatment prescribed, and outcomes. Evaluated risk factors were hypertension, diabetes mellitus, atrial fibrillation, dyslipidaemia, coronary artery disease, smoking, alcohol intake and history of cerebrovascular events.

Clinical assessment

Stroke severity was assessed with the National Institutes of Health Stroke Scale (NIHSS) upon admission and on day 3. Functional outcomes were determined using the modified Rankin Scale (mRS) at baseline, day 3, and after 3 months. A favourable functional outcome was defined as an mRS score of 0-2, indicating independence in functioning. Stroke aetiology was categorized based on the Trial of Org 10172 in Acute Stroke Treatment (TOAST) criteria.

Treatment protocols

Conservative treatment included the use of antiplatelet therapy, controlling blood pressure, managing glucose levels, administering deep vein thrombosis prophylaxis, and facilitating early mobilization. Intravenous thrombolysis using alteplase (0.9 mg/kg) or tenecteplase (0.25 mg/kg) was given within 4.5 hours following established protocols. Mechanical thrombectomy was carried out for significant vessel blockages within expanded time frames based on imaging criteria.

Statistical analysis

Data analysis utilized SPSS version 26.0. Continuous variables were described as mean standard deviation or median with interquartile range. Categorical variables were expressed as frequencies and percentages. Independent t-tests or Mann-Whitney U tests were employed for continuous variables, whereas chi-square or Fisher's exact tests were used for categorical variables. Multivariate logistic regression determined independent predictors of favourable outcomes. Statistical significance was established at $p<0.05$.

Ethical considerations

The study obtained approval from the Institutional Ethics Committee and was registered with the Clinical Trials Registry of India. Written informed consent was provided by all participants or their legally authorized representatives.

RESULTS

Of the 348 eligible patients screened, 310 (89.1%) provided consent. Non-participants (n=38, 10.9%) were older (79.1±7.4 vs 75.4±8.1 years, p=0.04) and had a higher baseline NIHSS (16.2±5.9 vs 14.6±6.3, p=0.03). No significant differences were observed in gender or comorbidity burden (p>0.05).

Demographic characteristics and risk factor profile

The study enrolled 310 older persons with acute ischemic stroke, comprising 212 patients (68.4%) aged 60 to 80 years and 98 patients (31.6%) aged >80 years. Male predominance was observed across both groups, with 173 males (55.8%) overall. The mean age was 75.4±8.1 years, with older-old persons having significantly higher mean age (84.6±3.2 vs 71.2±5.8 years, p<0.001). The demographic characteristics and cardiovascular risk factor profiles are presented in Table 1.

Hypertension emerged as the most prevalent cardiovascular risk factor, affecting 235 patients (75.8%) with similar distribution between age groups. Diabetes mellitus demonstrated consistent prevalence across both cohorts (46.1% overall). Notably, atrial fibrillation showed markedly higher prevalence in older-old persons compared to younger older persons (57.1% vs 29.2%, p<0.001). Dyslipidaemia was significantly more common in the older-old persons group (70.4% vs 39.6%, p<0.001). Lifestyle factors revealed interesting patterns, with alcohol consumption being significantly higher in older-old persons (29.6% vs 10.4%, p<0.001).

Table 1: Demographic Characteristics and Risk Factor Profile

Characteristic	60-80 years (n=212)	>80 years (n=98)	Total (n=310)	p-value
Demographics				
Age (mean ± SD)	71.2 ± 5.8	84.6 ± 3.2	75.4 ± 8.1	<0.001*
Male gender, n (%)	111 (52.4)	62 (63.3)	173 (55.8)	0.086
Risk Factors				
Hypertension, n (%)	157 (74.1)	78 (79.6)	235 (75.8)	0.321
Diabetes mellitus, n (%)	98 (46.2)	45 (45.9)	143 (46.1)	0.961
Atrial fibrillation, n (%)	62 (29.2)	56 (57.1)	118 (38.1)	<0.001*
Dyslipidemia, n (%)	84 (39.6)	69 (70.4)	153 (49.4)	<0.001*
Coronary artery disease, n (%)	61 (28.8)	21 (21.4)	82 (26.5)	0.191
Smoking, n (%)	42 (19.8)	13 (13.3)	55 (17.7)	0.184
Alcohol consumption, n (%)	22 (10.4)	29 (29.6)	51 (16.5)	<0.001*
NIHSS Score at Baseline				
Minor (1-4), n (%)	40 (18.9)	6 (6.1)	46 (14.8)	<0.001*
Moderate (5-15), n (%)	91 (42.9)	14 (14.3)	105 (33.9)	
Moderate-severe (16-20), n (%)	74 (34.9)	56 (57.1)	130 (41.9)	
Severe (21-42), n (%)	7 (3.3)	22 (22.5)	29 (9.4)	
Mean NIHSS ± SD	12.4 ± 5.2	18.7 ± 6.1	14.6 ± 6.3	<0.001*
Stroke Territory				
Middle cerebral artery, n (%)	171 (80.7)	62 (63.3)	233 (75.2)	0.001*
Posterior cerebral artery, n (%)	22 (10.4)	15 (15.3)	37 (11.9)	
Anterior cerebral artery, n (%)	18 (8.5)	7 (7.1)	25 (8.1)	
Watershed infarcts, n (%)	1 (0.5)	14 (14.3)	15 (4.8)	<0.001*

Stroke severity and clinical presentation

Older-old persons presented with significantly more severe strokes across all severity categories. The proportion of patients with moderate-severe to severe NIHSS scores was substantially higher in the >80 years group (79.6% vs 38.2%). Mean NIHSS scores differed significantly between groups (18.7±6.1 vs 12.4±5.2, p<0.001). (Table 1)

Middle cerebral artery territory involvement remained predominant overall but was more frequent in younger older persons (80.7% vs 63.3%, p=0.001). Watershed infarcts showed notably higher prevalence in older-old persons (14.3% vs 0.5%), suggesting greater susceptibility to hypoperfusion-related mechanisms.

Treatment patterns and clinical outcomes

Conservative management was the predominant therapeutic approach, utilized in 230 patients (74.2%). Older-old persons received conservative treatment more frequently than younger older persons (81.6% vs 70.8%, p=0.042). The treatment modalities and corresponding outcomes are detailed in Table 2.

Overall good functional outcomes (mRS 0-2) at 3 months were achieved in 206 patients (66.5%). Younger older persons demonstrated significantly better outcomes compared to older-old persons (70.3% vs 58.2%, p=0.042). Treatment-specific analysis revealed conservative management achieved good outcomes in 148 patients (64.3%). Intravenous thrombolysis demonstrated superior effectiveness with 44 patients (77.2%) achieving good recovery. Mechanical thrombectomy resulted in good outcomes for 14 patients (60.9%).

Age-stratified treatment outcomes

The age-stratified analysis of treatment outcomes revealed that conservative treatment showed significant age-related differences in effectiveness, with younger older persons achieving markedly superior results (79.3% vs 36.3% good recovery, p<0.001). In contrast, interventional therapies demonstrated more consistent outcomes across age groups. (Figure 1)

Intravenous thrombolysis achieved similar success rates in both cohorts (77.8% vs 75.0%, p=0.825), while mechanical thrombectomy showed numerical differences that did not reach statistical significance (70.6% vs 33.3%, p=0.181).

Predictors of functional outcomes

Multivariate analysis identified several independent predictors of good functional outcomes, as presented in Table 3. The model explained 38.9% of outcome variance (R^2 = 0.389). (Figure 2)

Younger age (OR 0.92 per year, 95% CI 0.89-0.95, p<0.001), lower baseline NIHSS scores (OR 0.84 per point, 95% CI 0.80-0.89, p<0.001), and early hospital presentation within 3 hours (OR 2.28, 95% CI 1.38-3.77, p=0.001) emerged as significant positive predictors. Atrial fibrillation was identified as a negative predictor (OR 0.58, 95% CI 0.35-0.96, p=0.035). Notably, treatment modality differences became non-significant after adjustment for baseline characteristics. (Figure 3)

Table 2: Treatment Modalities and Clinical Outcomes

Parameter	60-80 years (n=212)	>80 years (n=98)	Total (n=310)	p-value
Treatment Modality				
Conservative treatment, n (%)	150 (70.8)	80 (81.6)	230 (74.2)	0.042*
IV thrombolysis, n (%)	45 (21.2)	12 (12.2)	57 (18.4)	
Mechanical thrombectomy, n (%)	17 (8.0)	6 (6.1)	23 (7.4)	
Functional Outcomes at 3 Months				
Good recovery (mRS 0-2), n (%)	149 (70.3)	57 (58.2)	206 (66.5)	0.042*
Poor recovery (mRS 3-6), n (%)	63 (29.7)	41 (41.8)	104 (33.5)	
Mortality				
Overall mortality, n (%)	30 (14.2)	26 (26.5)	56 (18.1)	0.012*

*Statistically significant (p < 0.05)

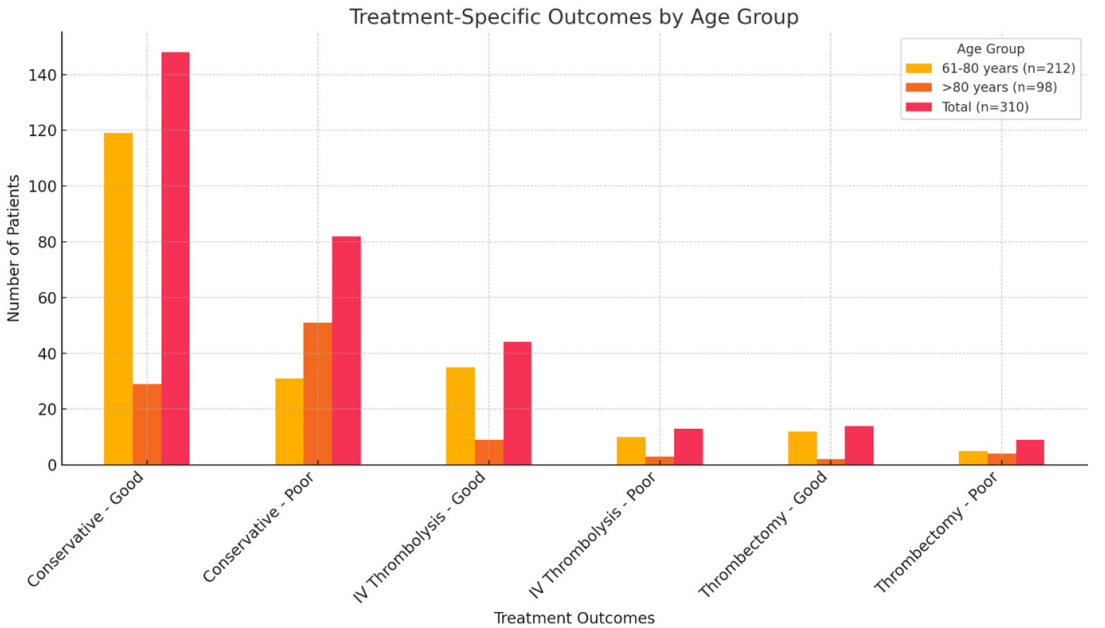

Figure 1. Treatment-specific outcomes by age group

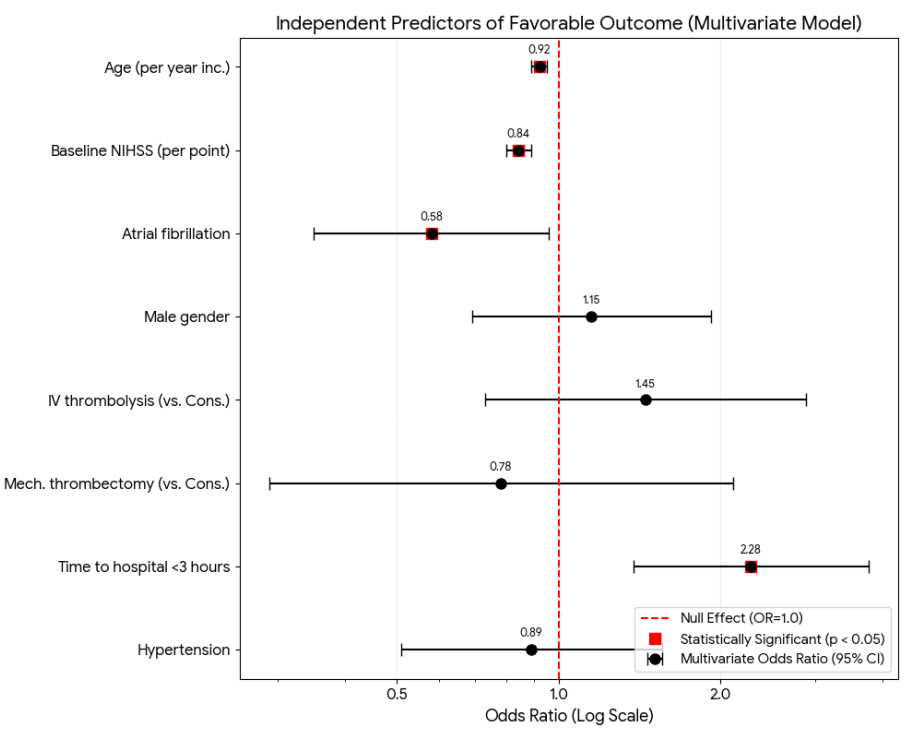

Figure 2. Multivariate predictors of good functional outcome

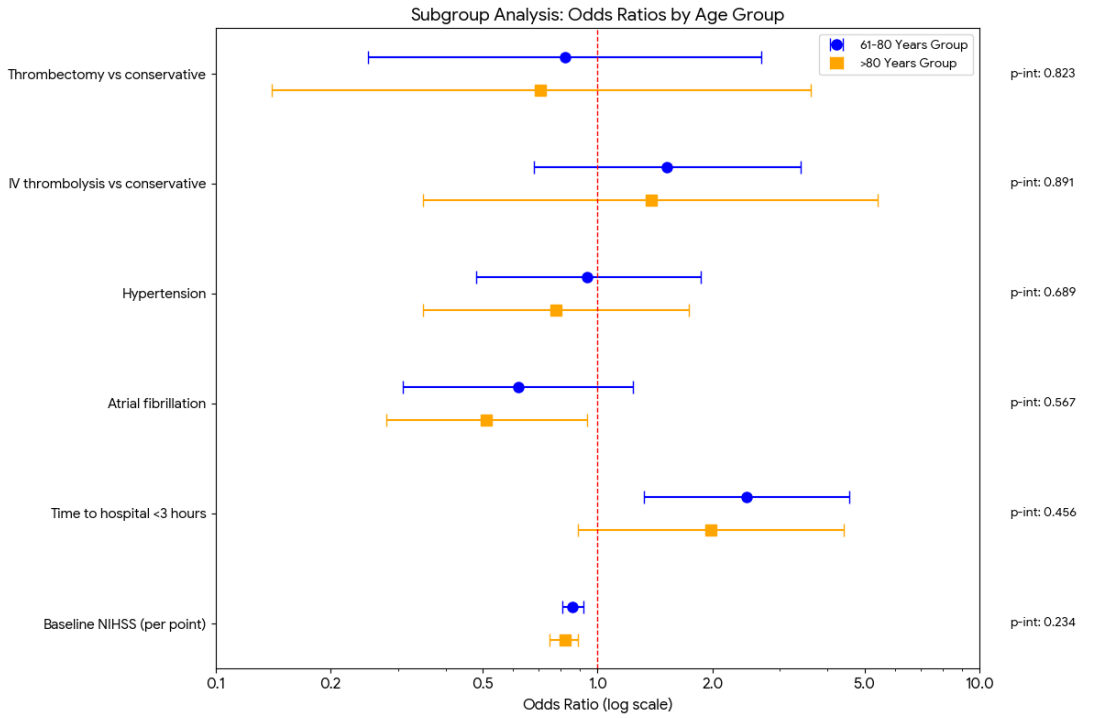

Figure 3. Age-specific predictors of good outcome

Age-stratified multivariate analysis

Age-Stratified Multivariate Analysis was shown in Table 5.

Mortality analysis

Overall mortality was 18.1%, with significantly higher rates in older-old persons (26.5% vs 14.2%, p=0.012). Interventional therapies demonstrated numerically lower mortality rates, with intravenous thrombolysis showing the lowest overall mortality (8.8%).

Mortality was significantly higher in older-old patients (>80 years) compared to the younger older persons (60-80 years) (26.5% vs 14.2%; OR 2.19, 95% CI 1.21–3.96, p=0.012). Intravenous thrombolysis was associated with the lowest mortality (8.8%; OR 0.37, p=0.048). Atrial fibrillation independently predicted poor

Table 3: Multivariate Analysis of Predictors for Good Functional Outcome

Variable	Univariate OR (95% CI)	p-value	Multivariate OR (95% CI)	p-value
Age (per year increase)	0.94 (0.91-0.97)	<0.001*	0.92 (0.89-0.95)	<0.001*
Male gender	1.23 (0.78-1.94)	0.374	1.15 (0.69-1.92)	0.592
Baseline NIHSS (per point)	0.82 (0.78-0.86)	<0.001*	0.84 (0.80-0.89)	<0.001*
Time to hospital <3 hours	2.41 (1.52-3.82)	<0.001*	2.28 (1.38-3.77)	0.001*
Treatment (vs Conservative)				
IV thrombolysis	1.89 (1.02-3.51)	0.043*	1.45 (0.73-2.89)	0.289
Mechanical thrombectomy	0.87 (0.36-2.09)	0.751	0.78 (0.29-2.11)	0.624
Atrial fibrillation	0.52 (0.33-0.83)	0.006*	0.58 (0.35-0.96)	0.035*
Hypertension	0.78 (0.47-1.29)	0.334	0.89 (0.51-1.56)	0.681

*Statistically significant ($p < 0.05$)

Table 4: Mortality Pattern and Risk Factor Correlation

Variable	Total N=310	Mortality N=56	OR (95% CI)	p-value
A. Age Group				
60–80 years (Reference)	212 (68.4)	30 (14.2)	Reference	—
>80 years	98 (31.6)	26 (26.5)	2.19 (1.21–3.96)	0.012*
B. Treatment Modality				
Conservative (Reference)	230 (74.2)	47 (20.4)	Reference	—
IV Thrombolysis	57 (18.4)	5 (8.8)	0.37 (0.14–0.99)	0.048*
Mechanical Thrombectomy	23 (7.4)	4 (17.4)	0.82 (0.27–2.52)	0.768
C. Cardiovascular Risk Factors†				
Hypertension	235 (75.8)	—	0.89 (0.51–1.56)†	0.681
Diabetes Mellitus	143 (46.1)	—	NS	0.961
Atrial Fibrillation	118 (38.1)	—	0.58 (0.35–0.96)†	0.035*
Dyslipidaemia	153 (49.4)	—	NS	0.321
Coronary Artery Disease	82 (26.5)	—	NS	0.191
Previous Stroke/TIA	69 (22.3)	—	NS	0.737
D. Stroke Severity & Presentation†				
Baseline NIHSS (per point)	—	—	0.84 (0.80–0.89)†	<0.001*
Early Presentation (<3 hours)	—	—	2.28 (1.38–3.77)†	0.001*
Overall	**310 (100)**	**56 (18.1)**	—	—

*** Statistically significant (p < 0.05)**

† OR values in Sections C and D represent multivariate associations with functional outcome (mRS 0–2 at 3 months) from the logistic regression model (Table 5), serving as surrogate predictors of poor outcome including mortality.
NS = Not statistically significant. OR = Odds Ratio. CI = Confidence Interval.

outcomes (OR 0.58, p=0.035), while higher baseline NIHSS and absence of early hospital presentation were key modifiable correlates of adverse mortality-related outcomes. (Table 4)

DISCUSSION

This comprehensive prospective study provides valuable insights into the clinical management and outcomes of acute ischemic stroke in older persons across different age strata. The findings challenge traditional age-based treatment paradigms while highlighting important age-related differences that inform clinical decision-making.[19,20]

The demographic profile observed aligns with global epidemiological trends, with stroke predominantly affecting older populations and showing male predominance.[21,22] The mean age of 75.4 years corresponds closely with international stroke registries, confirming the representative nature of our cohort.[23,24] The higher proportion of males in the older-old persons group, while not statistically significant, reflects complex survival and healthcare utilization patterns in aging populations.

Risk factor patterns

The cardiovascular risk factor profile revealed important age-related distinctions with significant clinical implications. The consistent prevalence of hypertension across age groups (75.8% overall) reinforces its status as the predominant modifiable risk factor for stroke in older populations.[25,26] The remarkable consistency of diabetes mellitus prevalence (46.1%) across both cohorts reflects the global diabetes epidemic and its persistent impact throughout the aging process.

The substantially higher prevalence of atrial fibrillation in older-old persons (57.1% vs 29.2%), has profound implications for stroke aetiology, treatment selection, and prevention strategies.[27,28] This age-related increase in atrial

Table 5: Age-specific predictors of good outcome

Predictor	61-80 Years Group OR (95% CI)	>80 Years Group OR (95% CI)	Interaction p-value
Baseline NIHSS (per point)	0.86 (0.81-0.92)*	0.82 (0.75-0.89)*	0.234
Time to hospital <3 hours	2.45 (1.32-4.56)*	1.98 (0.89-4.41)	0.456
Atrial fibrillation	0.62 (0.31-1.24)	0.51 (0.28-0.94)*	0.567
Hypertension	0.94 (0.48-1.86)	0.78 (0.35-1.73)	0.689
IV thrombolysis vs conservative	1.52 (0.68-3.41)	1.38 (0.35-5.42)	0.891
Thrombectomy vs conservative	0.82 (0.25-2.68)	0.71 (0.14-3.61)	0.823

*Statistically significant ($p < 0.05$). OR = Odds Ratio; CI = Confidence Interval.

fibrillation prevalence aligns with established epidemiological data and explains the observed shift toward cardioembolic stroke mechanisms in advanced age groups. The association between atrial fibrillation and poor outcomes in our multivariate analysis underscores the importance of optimal anticoagulation strategies and cardiac rhythm management in older persons stroke prevention.

Clinical presentation and severity

The significantly higher stroke severity in older-old persons represent a critical finding that influences all aspects of clinical management. The mean NIHSS difference of 6.3 points between age groups reflects not merely statistical significance but clinically meaningful differences in neurological impairment.[29,30] This difference in severity is probably due to several causes, including decreased cerebral reserve, impaired collateral circulation, delayed presentation, and increased cardioembolic sources in the older-old persons.

The greater proportion of watershed infarcts among patients with older-old persons (14.3% vs 0.5%) may indicate higher vulnerability to hypoperfusion-related aetiologies, which could be related to the age-related changes in cerebral vessel autoregulatory and hemodynamic reserve mechanisms. These results further speculate that the pathophysiology of stroke is substantially divergent among older age groups, and thus requires adequate therapeutic strategy based on the age group.

Impact of age, thrombolysis, and clinical predictors on mortality in older stroke patients

Mortality was significantly higher in older-old persons (>80 years) compared to the younger older persons (60-80 years) (26.5% vs 14.2%; OR 2.19, 95% CI 1.21–3.96, p=0.012). Atrial Fibrillation independently predicted a lower chance of good outcome.

A systematic review found that compared with younger patients, older-old persons had a 3.09-times (95% CI = 2.37-4.03; P < 0.001) higher 3-month mortality and were less likely to regain a 'favourable outcome' (OR = 0.53; 95% CI = 0.42-0.66; P<0.001).[31]

Intravenous thrombolysis was associated with the lowest mortality (8.8%; OR 0.37, p=0.048). Atrial fibrillation independently predicted poor outcomes (OR 0.58, p=0.035), while higher baseline NIHSS and absence of early hospital presentation were key modifiable correlates of adverse mortality-related outcomes. Many studies find that AF is associated with higher stroke severity and mortality, often because AF strokes are cardioembolic and larger in size; AF also tends to correlate with higher NIHSS at admission.[32] A meta-analysis showed that AF was associated with increased mortality after thrombolysis in acute stroke patients [OR=1.95; 95% CI, (1.65, 2.29); P<0.00001].[33]

Treatment effectiveness and safety

The demonstration that conservative management achieves good functional outcomes in 64.3% of patients provides compelling evidence for its effectiveness as a primary therapeutic strategy. This finding has relevance for healthcare systems with limited interventional resources and challenges assumptions that aggressive interventions are universally superior.[34,35] The effectiveness of conservative care likely reflects comprehensive stroke unit protocols, early mobilization, systematic complication prevention, and evidence-based secondary prevention strategies.

The superior outcomes achieved with intravenous thrombolysis (77.2% good recovery) validate its effectiveness in appropriately selected older persons. Most importantly, the consistent effectiveness across age groups (77.8% vs 75.0%) provides compelling evidence against age-based treatment restrictions.[7,36] This finding aligns with recent meta-analyses and large registry studies suggesting that appropriately selected older-old persons derive similar benefits from thrombolytic therapy as younger cohorts.

Mechanical thrombectomy outcomes (60.9% good recovery) demonstrate meaningful effectiveness despite treating the most severe cases, though age-related differences were more pronounced than with thrombolysis. These findings support individualized assessment for thrombectomy candidacy rather than rigid age cutoffs.[15,16]

Clinical decision-making framework

The study provides an evidence-based framework for clinical decision-making that transcends chronological age considerations. The identification of baseline stroke severity, presentation timing, and atrial fibrillation status as key outcome predictors offers practical guidance for treatment selection. The finding that treatment modality differences became non-significant after adjustment for patient characteristics emphasizes that appropriate patient selection is more important than treatment type per se.

Healthcare system implications

These findings have significant implications for healthcare policy and resource allocation. The effectiveness of conservative management supports its role as a primary strategy while interventional therapies provide additional benefits for selected patients. The consistent effectiveness of thrombolysis across age groups supports investments in 24/7 stroke services and challenges age-based treatment limitations.[37]

Study limitations

The single-centre observational design may limit generalizability, though the large catchment area and diverse patient population enhance external validity. The non-randomized treatment allocation introduces potential selection bias, though this reflects real-world clinical decision-making patterns. The 3-month follow-up period, while clinically relevant, may not capture longer-term outcomes particularly important in older persons populations.

One limitation of this study is that informed consent was required from patients or their relatives. Although this was necessary for ethical reasons, it may have affected which patients were included. Patients who were more severely ill, had cognitive problems, or did not have someone available to give consent may have been excluded. Because of this, our study group may not fully represent all older patients with stroke in real clinical settings.

Previous studies have shown that the need for consent in observational research can introduce bias, as the included patients may differ from those who are not included (Kho *et al*., 2009).[38] As a result, our findings may not completely reflect the true outcomes of all older stroke patients. Future studies that include all patients, such as registry-based studies, may provide a more accurate picture.

The lack of frailty assessment in our study may have introduced confounding bias, as pre-stroke frailty likely influenced both treatment selection (with frailer patients more likely to receive conservative management) and outcomes.[38] Future studies should incorporate assessment of pre-stroke frailty and its relationship with stroke outcomes to better guide individualized treatment decisions in older patients.

In conclusion, the present study shows that conservative and interventional treatment can have clinically significant results in older stroke patients if appropriately indicated and implemented. The nearly two-thirds of conservatively treated patients with good functional outcome found in the current study confirms this approach to be a highly efficacious primary strategy, which is especially relevant to resource poor health services. At the same time, the finding that intravenous thrombolysis is no less safe and effective for those of advanced age indeed does challenge age limits for intervention and encourages individualized clinical care. Identification of the baseline stroke severity, presentation time, and comorbidities as independent predictors of outcome would allow the adoption of an evidence-based strategy for therapeutic decision, which would overcome chronological age-based considerations. It's much higher prevalence in older-old persons and association with worse outcome emphasizes the importance of complete cardiovascular risk

evaluation and optimal prevention approach. Independent predictors of outcome including baseline stroke severity, time of presentation, and specific comorbidities would help adopt an evidence-based approach at therapeutic decision that supersedes age solely based on chronology. Its strikingly higher incidence in older old patients and its worse prognosis make it necessary to develop a full and optimal cardiovascular risk stratification and preventive strategy.

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DISCLOSURE

Data availability: The datasets generated and analysed during the current study are available from the corresponding author on reasonable request.

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Conflict of interest: None

REFERENCES

1. Feigin VL, Brainin M, Norrving B, *et al.* World Stroke Organization: Global stroke fact sheet. *Int J Stroke*, 2025; 20(2); 132-44. I: 10.1177/17474930241308142
2. World Health Organization. (2022). Ageing and health. Geneva: WHO. Retrieved from https://www.who.int/news-room/fact-sheets/detail/ageing-and-health
3. Benjamin EJ, Virani SS, Callaway C W, *et al.* Heart disease and stroke statistics-2018 Update: A report from the American Heart Association. *Circulation* 2018; 137(12): e67-e492. doi: 10.1161/CIR.0000000000000558.
4. Virani SS, Alonso A, Benjamin E J, *et al.* Heart disease and stroke statistics-2020 update: a report from the American Heart Association. *Circulation* 2020; 141(9), e139-596. doi: 10.1161/CIR.0000000000000757.
5. Parr E, Ferdinand P, & Roffe C. Management of acute stroke in the older person. *Geriatrics* 2017; 2(3): 27. doi: 10.3390/geriatrics2030027
6. McDonough R V, Ospel JM, Campbell BC, *et al.* Functional outcomes of patients≥ 85 years with acute ischemic stroke following EVT: a HERMES substudy. *Stroke* 2022; 53(7): 2220-26. doi: 10.1161/STROKEAHA.121.037770
7. IST-3 collaborative group, Sandercock P, Wardlaw J M, Lindley R I, Dennis M, Cohen, G, Venables G. The benefits and harms of intravenous thrombolysis with recombinant tissue plasminogen activator within 6 h of acute ischaemic stroke (the third international stroke trial [IST-3]): a randomised controlled trial. *Lancet* 2012; 379(9834): 2352-63. doi: 10.1016/S0140-6736(12)60768-5.
8. Berkhemer OA, Fransen PS, Beumer D, *et al*. A randomized trial of intraarterial treatment for acute ischemic stroke. *N Eng J Med* 2015; 372(1): 11-20. doi: 10.1056/NEJMoa1411587
9. Bentsen L, Christensen L, Christensen A, Christensen H. Outcome and risk factors presented in old patients above 80 years of age versus younger patients after ischemic stroke. *J Stroke Cerebrov Dis* 2014;23(7):1944-8. doi: 10.1016/j.jstrokecerebrovasdis.2014.02.002.
10. Gangashetty T, Hegde M. Clinical outcomes and risk factor analysis in acute ischemic stroke patients: A prospective observational study from a tertiary care center. *IOSR J Dental Med Sci (IOSR-JDMS). 2025;* 24(9); 97-104. DOI: 10.9790/0853-24090197104
11. Wang Y, Jing J, Pan Y. Clinical characteristics and prognosis in oldest patients with ischemic stroke or transient ischemic attack in China. *Ann Palliat Med* 2022; 11: 2215-24. doi: 10.21037/apm-21-2830
12. Samuthpongtorn C, Jereerat T, Suwanwela NC. Stroke risk factors, subtypes and outcome in older persons Thai patients. *BMC Neurol* 2021; 21(1): 322. DOI: 10.1186/s12883-021-02353-y
13. Forman DE, Berman AD, McCabe CH, Baim DS, & Wei JY. PTCA in the older persons: the "young-old" versus the "old-old". *J Am Geriatr Soc* 1992; 40(1): 19-22. https://doi.org/10.1111/j.1532-5415.1992.tb01823.x
14. Torpy JM, Lynm C, Glass RM. Frailty in older adults. *JAMA* 2006; 296(18): 2280. DOI: 10.1001/jama.296.18.2280
15. Goyal M, Demchuk AM, Menon BK, *et al.* Randomized assessment of rapid endovascular treatment of ischemic stroke. *N Eng J Med* 2015;372(11):1019-30. doi: 10.1056/NEJMoa1414905.
16. Campbell BC, Mitchell PJ, Kleinig TJ, *et al*. Endovascular therapy for ischemic stroke with perfusion-imaging selection. *N Eng J Med* 2015;372(11): 1009-18. doi: 10.1056/NEJMoa1414792
17. Sylaja P N, Pandian JD, Kaul S, *et al.* Ischemic stroke profile, risk factors, and outcomes in India: The Indo-US Collaborative Stroke Project. *Stroke* 2018;49(1): 219-22. doi: 10.1161/STROKEAHA.117.018700
18. Naess H. Is thrombolysis beneficial in older persons patients with minor ischemic stroke? *Front Stroke* 2024; 3:1430261. DOI: 10.3389/fstro.2024.1430261
19. GBD 2019 Stroke Collaborators. Global, regional, and national burden of stroke and its risk factors, 1990-2019: a systematic analysis for the Global Burden of Disease Study 2019. *Lancet Neurol* 2021; 20(10):795-820. doi: 10.1016/S1474-4422(21)00252-0
20. Feigin V L, Stark BA, Johnson CO, *et al*. Global, regional, and national burden of stroke and its risk factors: a systematic analysis for the Global Burden of Disease Study 2019. *Lancet Neurol* 2021; 20(10):795-820. DOI: 10.1016/S1474-4422(21)00252-0
21. Krishnamurthi RV, Moran AE, Feigin VL, *et al*.

Stroke prevalence, mortality and disability-adjusted life years in adults aged 20-64 years in 1990-2013: Data from the Global Burden of Disease 2013 Study. *Neuroepidemiology* 2015; 45(3):190-202. doi: 10.1159/000441098
22. Lee S, Shafe AC, Cowie MR. UK stroke incidence, mortality and cardiovascular risk management 1999-2008: time-trend analysis from the General Practice Research Database. *BMJ Open* 2011; 1(2): e000269. DOI: 10.1136/bmjopen-2011-000269
23. Saini V, Guada L, Yavagal DR. Global epidemiology of stroke and access to acute ischemic stroke interventions. *Neurology* 2021; 97; S6-S16. doi: 10.1212/WNL.0000000000012781
24. Pandian JD, Singh G, Kaur P, *et al.* Incidence, short-term outcome, and spatial distribution of stroke patients in Ludhiana, India. *Neurology* 2016; 86(5);425-33. doi: 10.1212/WNL.0000000000002335
25. Rodgers H, Greenaway J, Davies T. Risk factors for first-ever stroke in older people in the North East of England: a population-based study. *Stroke* 2004; 35(1): 7-11. DOI: 10.1161/01.STR.0000106914.60740.78
26. Boehme AK, Esenwa C, Elkind MS. Stroke risk factors, genetics, and prevention. *Circ Res* 2017; 120(3): 472-95. DOI: 10.1161/CIRCRESAHA.116.308398
27. Lloyd-Jones D, Adams R, Carnethon M, *et al*. Heart disease and stroke statistics-2009 update: a report from the American Heart Association Statistics Committee and Stroke Statistics Subcommittee. *Circulation* 2009;119(3): 480-86. doi: 10.1161/CIRCULATIONAHA.108.191259.
28. Sharma M, Cornelius VR, Patel J P, Davies JG, Molokhia M. Efficacy and harms of direct oral anticoagulants in the older persons for stroke prevention in atrial fibrillation and secondary prevention of venous thromboembolism: systematic review and meta-analysis. *Circulation* 2015;132(3):194-204. DOI: 10.1161/CIRCULATIONAHA.114.013267
29. Heja M, Fekete I, Horvath L, Marton S, Fekete KE. Experiences with intravenous thrombolysis in acute ischemic stroke by older persons patients--a "real world scenario". *Front Neurol* 2021;12:717450. doi: 10.3389/fneur.2021.721337
30. Wu Q, Zou C, Wu C. Risk factors of outcomes in older persons patients with acute ischemic stroke in China. *Aging Clin Exp Res* 2016;28(4); 705-11. DOI:10.1007/s40520-015-0478-1
31. Engelter ST, Bonati LH, Lyrer PA. Intravenous thrombolysis in stroke patients of > or = 80 versus < 80 years of age--a systematic review across cohort studies. *Age Ageing.* 2006;35(6):572-80. DOI: 10.1093/ageing/afl104
32. Hong DZ, Sultana R, Ibrahim NSB, Chang HM, De Silva DA. Interaction between age and atrial fibrillation on ischemic stroke severity: a cross-sectional analysis. *Front Stroke* 2026;5:1706746. https://doi.org/10.3389/fstro.2026.1706746
33. Feng SD, Jiang Y, Lin ZH, Guo PQ, Wu YL, Ling PH. Influence of atrial fibrillation on prognosis of thrombolytic therapy in stroke patients: a meta-analysis. *Int J Clin Exp Med* 2016; 9(6):9203-10.
34. Kauffmann J, Grun D, Yilmaz U, *et al*. Acute stroke treatment and outcome in the oldest old (90 years and older) at a tertiary care medical centre in Germany-a retrospective study showing safety and efficacy in this particular patient population. *BMC Geriatr* 2021; 21(1): 1-10. DOI: 10.1186/s12877-021-02566-3
35. Kelly-Hayes M. Stroke outcome measures. *J Cardiov Nurs* 2004;19(5): 301-07. doi: 10.1097/00005082-200409000-00005
36. Sung PS, Chen CH. Outcome of acute ischemic stroke in very older persons patients: Is intravenous thrombolysis beneficial? *Eur Neurol* 2011; 66(2): 110-16. DOI: 10.1159/000328429
37. Hilditch CA, Nicholson P, Murad MH, *et al.* Endovascular management of acute stroke in the older persons: a systematic review and meta-analysis. *Am J Neuroradiol* 2018; 39(5): 887-91. DOI: 10.3174/ajnr.A5598
38. Ng CC, Lim WC, Tan KM, *et al.* Is pre-stroke frailty as determined by the Clinical Frailty Scale version 2.0 associated with stroke outcomes? *Singapore Med J* 2026;67(Suppl 1):S42-S45. DOI: 10.4103/singaporemedj.SMJ-2021-187
39. Flaatten H, Guidet B, Jung C, *et al*. Consent is a confounding factor in a prospective observational study of critically ill elderly patients. *PLoS One* 2022;17(10):e0276386. https://doi.org/10.1371/journal.pone.0276386
40. Kho ME, Duffett M, Willison DJ, Cook DJ, Brouwers MC. Written informed consent and selection bias in observational studies using medical records: systematic review. *BMJ* 2009 ;338:b866. doi: 10.1136/bmj.b866.