

Predicting Outcome of IV Thrombolysis-Treated Ischemic Stroke Patients: The Dragon Score

Jagadish Kumar Ch¹, S Saravanan², Ravi K S³

¹Senior Resident, Department of Neurology, Tirunelveli Medical College, Tirunelveli, Tamil Nadu

²Professor and HOD, Department of Neurology, Tirunelveli Medical College, Tirunelveli, Tamil Nadu

³Assistant Professor, Department of Neurology, Tirunelveli Medical College, Tirunelveli, Tamil Nadu

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Corresponding Author: Dr. Jagadish Kumar Ch

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Abstract:

Introduction: All acute ischemic stroke patients won't respond to IV Thrombolysis, as only half of the patients achieve recanalization. A reliable scoring for prediction of outcome of acute ischemic stroke patients treated with IV alteplase would be useful for following reasons: 1) early estimation of prognosis and 2) early identification of patients who have a very high likelihood for a poor outcome despite IV thrombolytic treatment. One such reliable scoring system is DRAGON score. Our aim is to predict outcome in acute ischemic stroke patients who have been thrombolysed using DRAGON SCORE which is simple, fast and cost-effective.

Objective: To assess the reliability of the DRAGON score in predicting the functional outcomes in ischemic stroke patients treated with intravenous (IV) alteplase.

Methodology: This cross-sectional analytical study included 44 patients with acute ischemic stroke who were treated with IV thrombolysis at the Department of Neurology, TVMCH, between April 2022 and October 2023. Key pre-treatment variables such as computed tomography (CT) findings, baseline National Institutes of Health Stroke Scale (NIHSS), age, blood glucose levels, and onset-to-treatment time were evaluated to derive the DRAGON score. The primary outcome was the modified Rankin Scale (mRS) score at discharge, which was correlated with the initial DRAGON score to predict functional outcomes.

Results: The DRAGON score, a 10-point scale based on CT findings, NIHSS, and other clinical parameters, demonstrated a significant correlation with functional outcomes at discharge. Patients with lower DRAGON scores (<4) were associated with favourable outcomes (mRS ≤3), while those with higher scores (>7) were more likely to experience poor recovery or death. The area under the curve (AUC) for predicting favourable outcomes was 0.768, with a sensitivity and specificity of 75%.

Conclusion: The DRAGON score is a simple, quick, and cost-effective tool for predicting the outcome of ischemic stroke patients treated with IV alteplase. It can help in early decision-making, particularly in identifying patients who may benefit from additional interventions like mechanical thrombectomy. Further studies with larger sample sizes are necessary to validate these findings and assess long-term outcomes.

Keywords: IV Alteplase, National Institutes of Health Stroke Scale (NIHSS), modified Rankin Scale (mRS) score, DRAGON score.

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Introduction

All acute ischemic stroke patients won't respond to IV Thrombolysis, as only half of the patients achieve recanalization. Approximately 50% will have a good outcome (independence in activities of daily life and modified Rankin Scale [mRS] score 0–2). The efficacy of IV alteplase decreases substantially with increasing onset-to-treatment time (OTT). Other factors influencing final functional outcome after IV alteplase include baseline NIH Stroke Scale (NIHSS) score, patient age, and blood glucose level on admission, all of which are available shortly after patient admission i.e before alteplase administration. In some patients, events such as reocclusion, recanalization with insufficient

reperfusion, recanalization causing hemorrhage, recanalization in a vascular territory that is already infarcted may be the reasons for poor recovery. A reliable scoring for prediction of outcome of acute ischemic stroke patients treated with IV alteplase would be useful for following reasons: 1) early estimation of prognosis and 2) early identification of patients who have a very high likelihood for a poor outcome despite IV thrombolytic treatment. One such reliable scoring system is DRAGON score. The DRAGON score is a 10-point scoring system based on computed tomography (CT) findings of hypo Density or a dense cerebral artery sign, Prestroke modified Rankin Scale (mRS), Age,

Glucose level on admission, Onset-to-treatment time, and initial National Institutes of Health Stroke Score (NIHSS). Patients with high DRAGON score will be further proceeded with CTA/MRA to plan

mechanical thrombectomy. Our aim is to predict outcome in acute ischemic stroke patients who have been thrombolysed using DRAGON SCORE which is simple, fast and cost-effective.

Table 1: Dragon score (0-10points) for prediction of outcome at discharge in ischemic stroke patients undergoing intravenous alteplase.

DRAGON score (0–10 points)	
Hyper Dense cerebral artery sign or early infarct signs on admission CT head scan	
None	0
Either of them	1
Both	2
mRS score >1, prestroke	
No	0
Yes	1
Age	
<65 y	0
65–79 y	1
>80 y	2
Glucose level on admission	
<8 mmol/L (144 mg/dL)	0
>8 mmol/L (144 mg/dL)	1
Onset to treatment time	
<90 min	0
>90 min	1
NIHSS score on admission	
0–4	0
5–9	1
10–15	2
>15	3

Objective: To predict outcome in ischemic stroke patients treated with IV alteplase based on immediate pretreatment parameters -DRAGON score.

Materials and Methods

After Institutional Ethical Committee approval, A cross-sectional analytical study was conducted at the TAEI ward, Tirunelveli medical college and hospital. Enrolling patients who met the eligibility criteria for IV thrombolysis. A total of 44 patients were included in the study between April 2022 and October 2023.

Inclusion and Exclusion Criteria:

Inclusion: Patients with acute ischemic stroke presenting within the thrombolysis window period and meeting the eligibility criteria for thrombolysis.

Exclusion: Patients outside the thrombolysis window period or with contraindications to thrombolysis.

Methodology

Upon admission, patients with acute ischemic stroke in window period were assessed for eligibility criteria for IV thrombolysis. DRAGON score, NIHSS score were measured at admission. mRS score was measured before stroke, at admission and at the time of discharge.

Baseline routine investigations such as ECG, Random blood sugar were done. CT brain was done and observed for early infarct signs like hypodensity comprising less than one-third of the middle cerebral artery territory, loss of basal ganglion outline, loss of insular ribbon, or effacement of sulci. MRI brain was done for all patients. Onset to treatment time was recorded.

Informed consent was obtained from all patients (or patient's relatives) for study. Neurologic outcome based on mRS at the time of discharge was correlated with DRAGON score at admission to know that DRAGON score is predictor of outcome after i.v. thrombolysis. Good outcome was defined as mRS \leq 3.

Statistical Analysis:Data was assessed using SPSS 23.0 software. Univariate analysis for predictors of outcome were determined using the χ^2 and Student's t-test. Means were compared using the Student's t-test (two-tailed), and percentages were compared using the χ^2 test. P values \leq 0.05 were considered significant.

Results

Table 2: Base line characteristics of patients

Characteristics		All patients (n=44)	N %
Age group	<40	5	11.4%
	41-50	13	29.5%
	51-60	7	15.9%
	61-70	15	34.1%
	>71	4	9.1%
Gender	F	12	27.3%
	M	32	72.7%
CT brain score	0	17	38.6%
	1	21	47.7%
	2	6	13.6%
mRSscore>1 ,prestroke	0	44	100.0%
RBS@admission	0	15	34.1%
	1	29	65.9%
NIHSS score subgroups	<5	2	4.5%
	5-9	14	31.8%
	10-15	17	38.6%
	>16	11	25.0%
Dragon score	2	1	2.3%
	3	4	9.1%
	4	18	40.9%
	5	7	15.9%
	6	9	20.5%
	7	5	11.4%
Dragon score subgroups	<4	23	52.3%
	5-6	16	36.4%
	>7	5	11.4%

During the study period, a total of 44 patients out of 2657 acute ischemic stroke patients met the inclusion criteria [Table 2]. The mean patient age was 62.7 years (range 33 – 82), and the mean National Institutes of Health Stroke Scale (NIHSS)

score was 12.8 (range 4–21). In our study population, DRAGON score of patients on admission was within the range of 2-7. Mean DRAGON score was 4.8. There were no patients with a DRAGON score of 0-1 and 8–10.

Table 3: Age, mRS score at discharge and % outcome of 44 patients

		mRSscore @discharge subgroups				P value
		mRS \leq 3		mRS \geq 4		
		No of patients	%Good outcome	No of patients	%Miscerable outcome	
Age group	<65 (32)	16	50.0%	16	50.0%	0.164
	66-79(8)	4	50.0%	4	50.0%	
	>80(4)	4	100.0%	0	0.0%	

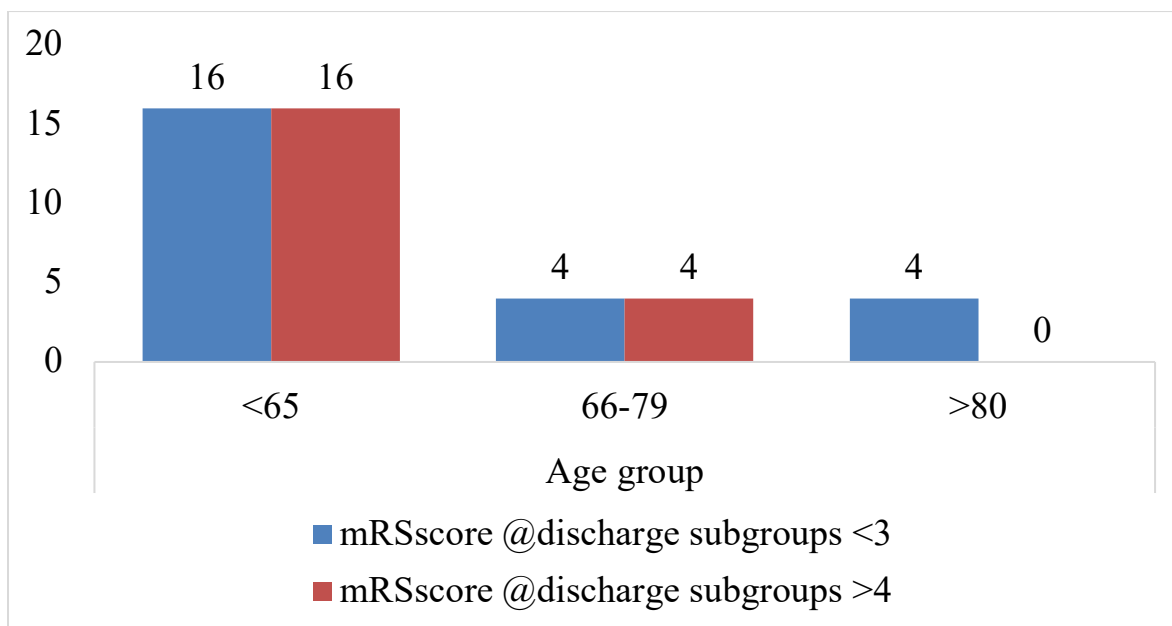


Figure 1:

Among patients aged less than 65, 50.0% had mRS scores less than 3, while another 50.0% had scores greater than 4 at discharge. In the 66-79 age group, both mRS subgroups comprised 50.0% of the patients at discharge. Among patients aged over 80,

all four patients had mRS scores less than 3 at discharge, and none had scores greater than 4. P value was 0.164 which is statistically not significant.

Table 4: Dragon score, mRS at discharge and % of Good outcome of the 44 patients

		mRSscore @discharge subgroups				P value
		mRSscore ≤3		mRSscore >3		
		No of patients	N %	No of patients	N %	
Dragon score	2	1	100.0%	0	0.0%	0.028
	3	4	100.0%	0	0.0%	
	4	13	72.2%	5	27.8%	
	5	2	28.6%	5	71.4%	
	6	2	22.2%	7	77.8%	
	7	2	40.0%	3	60.0%	

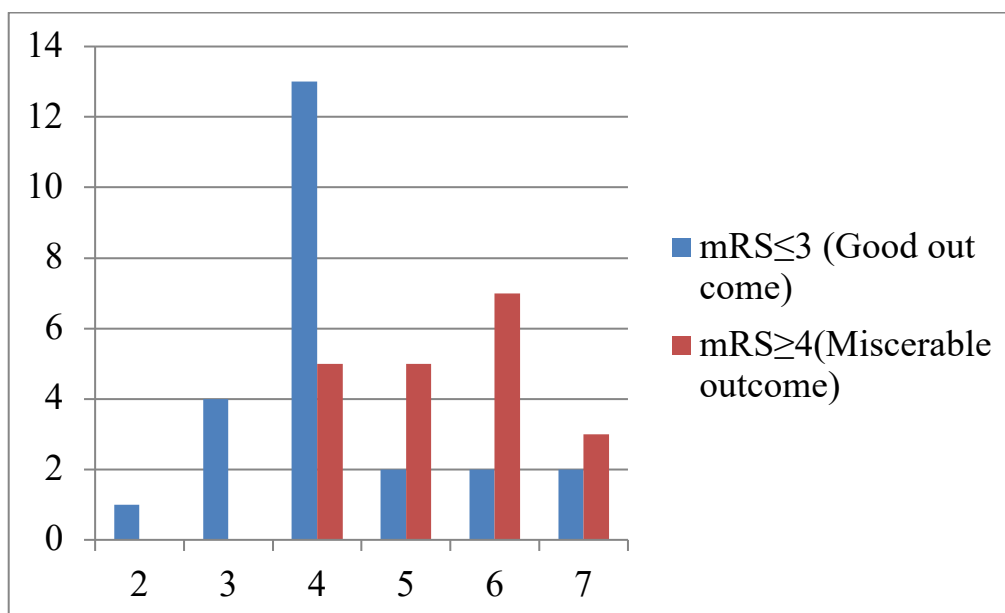


Figure 2: Dragon Score, Average Mrs at Discharge and % of Good Outcome of the 44 Patients

Patients with Dragon score 2 had 100.0% favorable outcomes (mRS < 3) at discharge. Patients with Dragon score 3 also had 100.0% favorable outcomes at discharge.

Among patients with Dragon score 4, 72.2% had mRS scores less than 3, and 27.8% had scores greater than 4 at discharge. Patients with Dragon score 5 showed a split distribution, with 28.6% having mRS scores less than 3, and 71.4% having scores greater than 4 at discharge. Among patients

with Dragon score 6, 22.2% had mRS scores less than 3, while 77.8% had scores greater than 4 at discharge. Patients with Dragon score 7 had 40.0% favorable outcomes (mRS < 3) at discharge, and 60.0% had scores greater than 4.

Highest and lowest percentage of good outcomes (mRS ≤ 3) was found in patients with dragon score of 2,3 and 6,7 respectively. The p-value of 0.028 indicates a significant difference in mRS outcomes within this Dragon score subgroup.

Table 5: Dragon score group, Mean mRS at discharge and % of Good outcome of the 44 patients

		mRSscore @discharge subgroups						P value
		Mean		mRS≤3		mRS>3		
				No of patients	N %	No of patients	N %	
Dragon score subgroups	≤4(23)	2.57	1.20	18	78.3%	5	21.7%	0.004
	5-6(n=16)	4.38	1.54	4	25.0%	12	75.0%	
	>7(n=5)	4.00	1.87	2	40.0%	3	60.0%	

DRAGON scores were sub-grouped into high (≥7), intermediate (5-6) and low (≤4) score groups

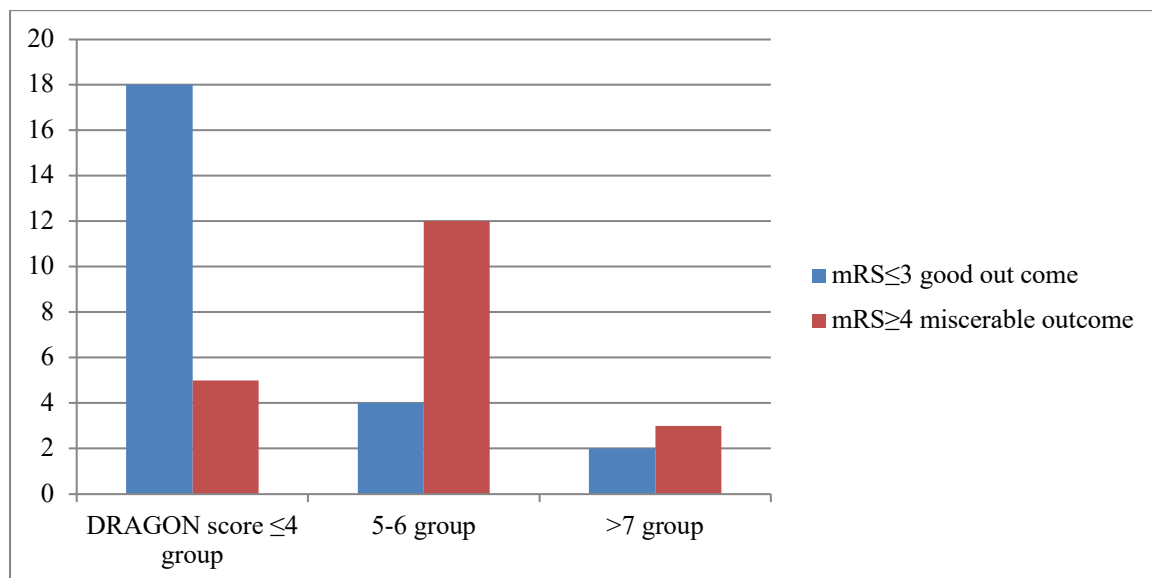


Figure 3: Dragon score group ,Mean mRS at discharge and % of Good outcome of the 44 patients

18 out 23 (78.3%) patients with Dragon scores less than 4, had favorable outcomes (mRS < 3), while 5 (21.7%) had less favorable outcomes (mRS > 4) at discharge.

Among patients with Dragon scores between 5 and 6, 4 out of 16(25.0%) had mRS scores less than 3, while a larger majority 12 (75.0%) had scores greater than 4 at discharge. In patients with Dragon

scores greater than 7, 40.0% had mRS scores less than 3, while 60.0% had scores greater than 4 at discharge.

P value 0.004 which is statistically significant. High and intermediate DRAGON scores were associated with higher mRS scores compared with low mRS scores and were also associated with higher mortality

Table 6: Dragon score sub group, and mortality of 44 patients

		Mortality				P value
		No		Yes		
		No of patients	N %	No of patients	N %	
NIHSS score	<4	2	100.0%	0	0.0%	0.284

	5-9	10	71.4%	4	28.6%	
	10-15	16	94.1%	1	5.9%	
	>16	8	72.7%	3	27.3%	
DRAGON score sub group	<4	22	95.7%	1	4.3%	0.030
	5-6	10	62.5%	6	37.5%	
	>7	4	80.0%	1	20.0%	

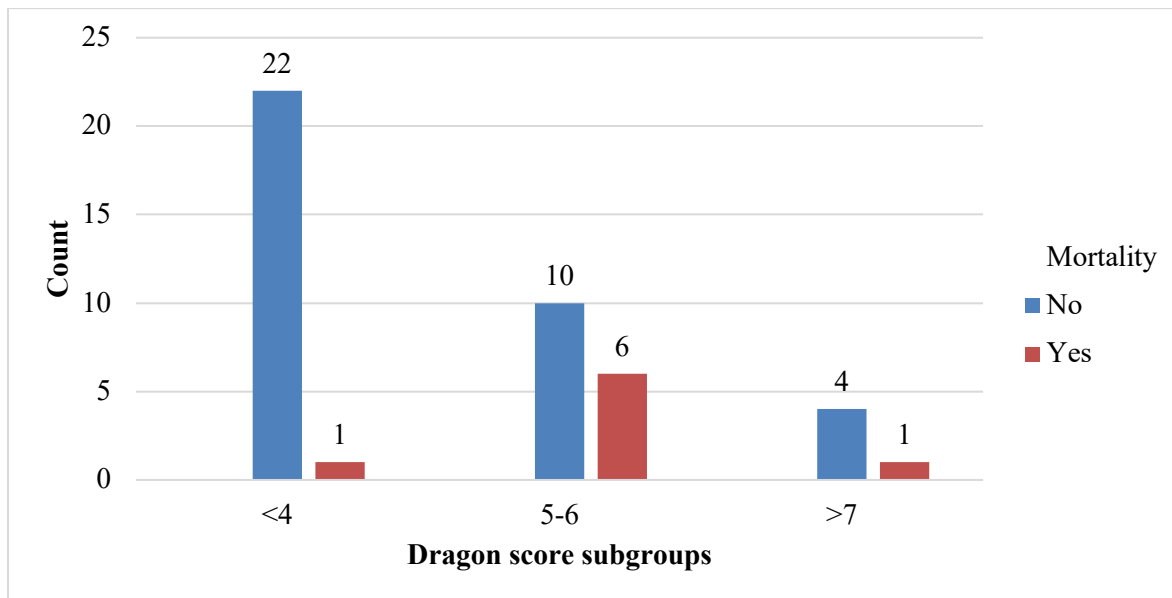


Figure 4: Dragon score sub group, and mortality of 44 patients

The Dragon score appears to have a statistically significant association with mortality. The mortality rates increase as the Dragon score increases. Notably, the P value is 0.030, indicating a significant relationship between Dragon score and mortality.

ROC Curve

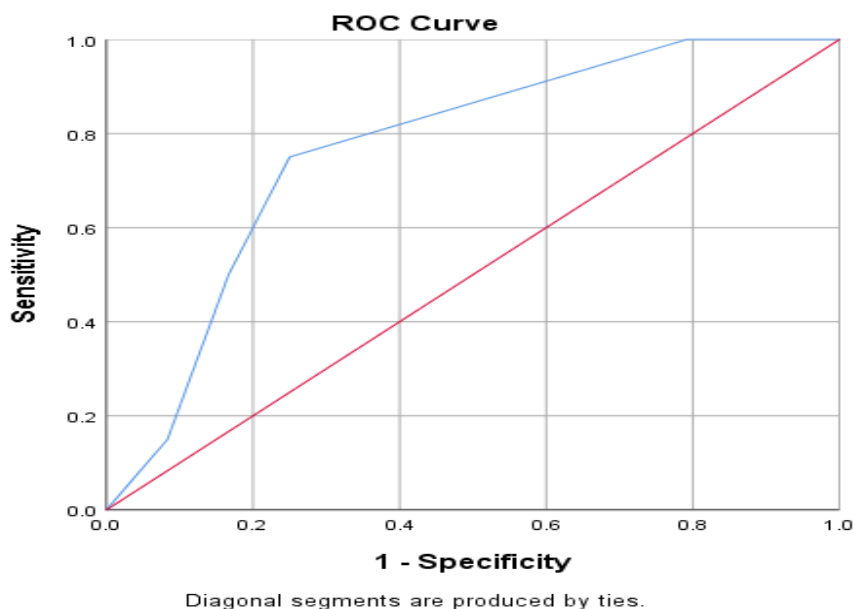


Figure 5: ROC Curve

Table 7:

Dragon score			
Cut-off value	4.5		
AUC	0.768		
P value	0.002		
Sensitivity	75.00%		
Specificity	75.00%		
PPV	71.43%		
NPV	78.26%		
Accuracy	75.00%		
	mRSScore @discharge subgroups		
	>4	<3	
Dragon score	>4.6	15	6
	<4.5	5	18

Area under the Curve (AUC): The AUC (Figure 5) of 0.768 suggests that the Dragon score has a moderately good ability to discriminate between patients with good and poor outcomes.

P Value: The low p-value of 0.002 indicates that the association between the Dragon score and predicting a good outcome is statistically significant, providing evidence that the Dragon score is informative in this context.

Sensitivity: With a sensitivity of 75.00%, the Dragon score correctly identifies 75.00% of patients who actually have a good outcome. This metric reflects the ability of the Dragon score to avoid false negatives.

Specificity: The specificity of 75.00% indicates that the Dragon score correctly identifies 75.00% of patients who do not have a good outcome. This metric reflects the ability of the Dragon score to avoid false positives.

Positive Predictive Value (PPV): The PPV of 71.43% means that, among patients predicted to have a good outcome by the Dragon score, 71.43% actually do.

Negative Predictive Value (NPV): The NPV of 78.26% means that, among patients predicted not to have a good outcome by the Dragon score, 78.26% actually do not.

Accuracy: The overall accuracy of 75.00% signifies the proportion of correct predictions made by the Dragon score in identifying patients with good outcomes.

Discussion

Our study analysed that the DRAGON score is a reliable predictor of functional outcomes (mRS scores) and mortality in ischemic stroke patients undergoing thrombolysis. Our findings corroborate previous studies, suggesting that both the DRAGON and NIHSS scores are reliable predictors of post-thrombolysis outcomes, including functional recovery and mortality risk.

DRAGON Score and Functional Outcomes:

Our study observed that patients with DRAGON scores ≤ 4 had significantly better outcomes, with 78.3% of patients achieving favorable outcomes (mRS < 3) at discharge. This finding aligns with previous studies, such as those by Arthur Wang et al., who demonstrated that the DRAGON score effectively predicts functional outcomes in patients receiving rtPA (recombinant tissue plasminogen activator) therapy for ischemic stroke. Specifically, the DRAGON score's sensitivity and specificity (both 75.0%) observed in our study are consistent with other research, reinforcing its utility as a prognostic tool for stroke outcomes.

Moreover, D. Strbian et al. found that higher DRAGON scores were associated with poorer outcomes, mirroring our study's results, where patients with scores ≥ 5 had significantly higher mortality and worse functional recovery. Strbian et al.'s study also highlighted the score's predictive power for poor functional outcomes and death, with an AUC of 0.87, which is comparable to our AUC of 0.768, suggesting moderately good discrimination between favorable and poor outcomes in our cohort as well. [7]

NIHSS and Functional Outcomes: The NIHSS score is another well-established predictor of stroke severity and outcome. In our study, patients with NIHSS scores ≤ 4 had uniformly favorable outcomes, whereas those with NIHSS > 16 had universally poor outcomes (100% with mRS > 4).

This is in line with the findings of previous studies, such as Lou et al., who developed the HAT score to predict hemorrhage post-thrombolysis but also emphasized the prognostic value of NIHSS in predicting both functional outcomes and risks after stroke intervention. [10]

Association between DRAGON Score and Mortality: Our study also highlights the association between higher DRAGON scores and mortality, with a p-value of 0.030 indicating statistical significance. This association has been observed in mul-

multiple studies, including Strbian et al., where the DRAGON score's ability to predict mortality post-thrombolysis was validated. [7] The consistent finding across studies that higher DRAGON scores correlate with increased mortality adds weight to the score's utility in clinical decision-making. The score's ability to predict outcomes was validated by an Area under the Curve (AUC) of 0.768, with a sensitivity and specificity of 75%, indicating a balanced predictive performance. The significant p-value of 0.002 confirms that the DRAGON score is informative for predicting recovery and mortality. These findings align with previous studies, such as Strbian et al., who reported similar correlations between higher DRAGON scores and poor functional outcomes and mortality. [7] Furthermore, the DRAGON score's predictive metrics, including a Positive Predictive Value (PPV) of 71.43% and a Negative Predictive Value (NPV) of 78.26%, further establish its clinical utility.

Clinical Implications: The DRAGON score provides a quick, reliable method for clinicians to assess prognosis early in the management of ischemic stroke patients undergoing thrombolysis. Based on our findings, we recommend its routine use alongside NIHSS to better stratify patients by risk and optimize treatment strategies. Given the strong predictive capacity for mortality and poor functional outcomes in patients with higher scores, the DRAGON score can also help guide discussions about prognosis with patients and families.

Limitations

Our study has limitations including

1. Small sample size
2. We did not include additional baseline confounding variables that can affect patient outcomes.
3. Additionally, the early assessment of mRS at discharge, rather than the standard 90-day follow-up, limits the ability to fully assess long-term outcomes, as functional recovery may continue beyond discharge.

Conclusion

Overall, the DRAGON score demonstrated significant predictive value for both functional outcomes and mortality in ischemic stroke patients treated with thrombolysis. Its combination with the NIHSS score provides a comprehensive risk assessment for stroke prognosis.

Its sensitivity, specificity, and predictive values further validate its use as a prognostic tool. It is a simple, easy score and cost-effective. Patients with high DRAGON score will further be subjected to endovascular therapy. Further studies with larger

patient cohorts and long-term follow-up are necessary to validate these findings and refine the clinical applicability of the DRAGON score.

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