

7-1-2017

## DRAGON Score Predicts Functional Outcomes in Acute Ischemic Stroke Patients Receiving Both Intravenous Tissue Plasminogen Activator and Endovascular Therapy

Arthur Wang  
*New York Medical College*

N Pednekar

R Lehrer

Akira Todo  
*New York Medical College*

Ramandeep Sahni  
*New York Medical College*

*See next page for additional authors*

Follow this and additional works at: [https://touro scholar.touro.edu/nymc\\_fac\\_pubs](https://touro scholar.touro.edu/nymc_fac_pubs)



Part of the [Medicine and Health Sciences Commons](#)

---

### Recommended Citation

Wang, A., Pednekar, N., Lehrer, R., Todo, A., Sahni, R., Marks, S., & Stiefel, M. (2017). DRAGON Score Predicts Functional Outcomes in Acute Ischemic Stroke Patients Receiving Both Intravenous Tissue Plasminogen Activator and Endovascular Therapy. *Surgical Neurology International*, 8, 149.  
<https://doi.org/10.4103/2152-7806.210993>

This Article is brought to you for free and open access by the Faculty at Touro Scholar. It has been accepted for inclusion in NYMC Faculty Publications by an authorized administrator of Touro Scholar. For more information, please contact [touro.scholar@touro.edu](mailto:touro.scholar@touro.edu).

---

## Authors

Arthur Wang, N Pednekar, R Lehrer, Akira Todo, Ramandeep Sahni, Stephen Marks, and Michael Stiefel

## Original Article

# DRAGON score predicts functional outcomes in acute ischemic stroke patients receiving both intravenous tissue plasminogen activator and endovascular therapy

Arthur Wang, Noorie Pednekar<sup>1</sup>, Rachel Lehrer, Akira Todo<sup>1</sup>, Ramandeep Sahni<sup>1</sup>, Stephen Marks<sup>1</sup>, Michael F. Stiefel<sup>2</sup>

Departments of Neurosurgery, <sup>1</sup>Neurology, Westchester Medical Center, New York Medical College, Valhalla, New York, <sup>2</sup>Capital Institute for Neurosciences, Stroke and Cerebrovascular Center, Capital Health System, Trenton, New Jersey, USA

E-mail: \*Arthur Wang - wanga@wcmc.com; Noorie Pednekar - pednekarn@wcmc.com; Rachel Lehrer - lehrer@wcmc.com; Akira Todo - todaa@wcmc.com; Ramandeep Sahni - sahnir@wcmc.com; Stephen Marks - markss@wcmc.com; Michael F. Stiefel - mstiefel@capitalhealth.org

\*Corresponding author

Received: 05 November 16 Accepted: 18 December 16 Published: 18 July 17

## Abstract

**Background:** The DRAGON score, which includes clinical and computed tomographic (CT) scan parameters, predicts functional outcomes in ischemic stroke patients treated with intravenous tissue plasminogen activator (IV tPA). We assessed the utility of the DRAGON score in predicting functional outcome in stroke patients receiving both IV tPA and endovascular therapy.

**Methods:** A retrospective chart review of patients treated at our institution from February 2009 to October 2015 was conducted. All patients with computed tomography angiography (CTA) proven large vessel occlusions (LVO) who underwent intravenous thrombolysis and endovascular therapy were included. Baseline DRAGON scores and modified Rankin Score (mRS) at the time of hospital discharge was calculated. Good outcome was defined as mRS  $\leq 3$ .

**Results:** Fifty-eight patients with LVO of the anterior circulation were studied. The mean DRAGON score of patients on admission was 5.3 (range, 3–8). All patients received IV tPA and endovascular therapy. Multivariate analysis demonstrated that DRAGON scores  $\geq 7$  was associated with higher mRS ( $P < 0.006$ ) and higher mortality ( $P < 0.0001$ ) compared with DRAGON scores  $\leq 6$ . Patients with DRAGON scores of 7 and 8 on admission had a mortality rate of 3.8% and 40%, respectively.

**Conclusions:** The DRAGON score can help predict better functional outcomes in ischemic stroke patients receiving both IV tPA and endovascular therapy. This data supports the use of the DRAGON score in selecting patients who could potentially benefit from more invasive therapies such as endovascular treatment. Larger prospective studies are warranted to further validate these results.

### Access this article online

**Website:**

[www.surgicalneurologyint.com](http://www.surgicalneurologyint.com)

**DOI:**

10.4103/2152-7806.210993

**Quick Response Code:**

This is an open access article distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 3.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as the author is credited and the new creations are licensed under the identical terms.

For reprints contact: [reprints@medknow.com](mailto:reprints@medknow.com)

**How to cite this article:** Wang A, Pednekar N, Lehrer R, Todo A, Sahni R, Marks S, et al. DRAGON score predicts functional outcomes in acute ischemic stroke patients receiving both intravenous tissue plasminogen activator and endovascular therapy. *Surg Neurol Int* 2017;8:149.

<http://surgicalneurologyint.com/DRAGON-score-predicts-functional-outcomes-in-acute-ischemic-stroke-patients-receiving-both-intravenous-tissue-plasminogen-activator-and-endovascular-therapy/>

**Key Words:** Endovascular thrombectomy, ischemic stroke, large vessel occlusion, tissue plasminogen activator

## INTRODUCTION

Intravenous tissue plasminogen activator (IV tPA) has been shown to improve functional outcomes in patients with acute ischemic strokes secondary to large vessel occlusions (LVO).<sup>[6]</sup> Despite this, IV tPA has a low rate of recanalization, and patients with LVO can further benefit from endovascular therapy.<sup>[3]</sup> To this end, the DRAGON score was designed to prognosticate patient outcomes after IV tPA therapy, as well as to identify patients who could benefit from further endovascular treatment.<sup>[4,12]</sup>

The DRAGON score is a 10-point scoring system based on computed tomography (CT) findings of hypoDensity or a dense MCA sign, prestroke modified Rankin Scale (mRS), Age, Glucose level on admission, Onset-to-treatment time, and initial National Institutes of Health Stroke Scale (NIHSS).<sup>[12]</sup> The score has shown good performance in predicting poor patient outcomes despite administration of IV tPA.<sup>[13]</sup>

Recent randomized clinical trials using modern endovascular techniques have demonstrated the efficacy of endovascular stroke therapy for treating patients with acute ischemic strokes from LVO.<sup>[1,7,11]</sup> At present, there is no data to suggest that the DRAGON score can predict functional outcome in stroke patients receiving both IV tPA and endovascular therapy. We sought to assess the utility of the DRAGON score in predicting functional outcome in anterior circulation stroke patients receiving both IV tPA and endovascular therapy.

## MATERIALS AND METHODS

Institutional Review Board approval was obtained prior to study initiation. A retrospective chart review was conducted among anterior circulation ischemic stroke patients treated with IV tPA and endovascular therapy, with either the ADAPT technique or stent-trieter. The major inclusion criteria were anterior circulation LVO seen on computed tomography angiography (CTA) and age  $\geq 18$ . Anterior circulation LVO was defined as occlusions of the internal carotid artery (ICA) and M1 and/or M2 segment of the middle cerebral artery (MCA). Baseline DRAGON scores [Table 1], details of the treatment, and clinical outcome at time of hospital discharge were determined.

All endovascular interventions were performed on a flat detector-based biplane angiographic system under general anesthesia. Endovascular treatment included mechanical thrombectomy with or without intraarterial thrombolysis (intraarterial tissue plasminogen activator). Mechanical thrombectomy was defined as a stentrieter and/or direct

aspiration via a large-bore ( $\geq 5$  Fr) intracranial reperfusion catheter. The degree of recanalization (Thrombolysis in Cerebral Infarction, TICI score) was determined at the end of the case by an endovascular surgeon.

The primary clinical outcome was the modified Rankin Scale (mRS) score at discharge. All mRS scores were reported on physical therapy progress notes and reviewed by stroke neurologists. Good outcome was defined as a mRS score 0–3 and poor outcome as mRS 4–6 (death or dependency).

Univariate analysis for predictors of outcome were determined using the  $\chi^2$  and Student's *t*-test. Means were compared using the Student's *t*-test (two-tailed), and percentages were compared using the  $\chi^2$  test. *P* values  $\leq 0.05$  were considered significant. Statistical analysis was performed using NCSS Statistical Software Inc V10.0 (Salt Lake City, Utah).

## RESULTS

During the study period, a total of 58 patients met the inclusion criteria [Table 2]. The mean patient age was 61.4 years, and the mean National Institutes of Health Stroke Scale (NIHSS) score was 15.6 (range 6–36). In our study population, there were no patients with a DRAGON score of 0–2 and 9–10. There was no significant difference in age or NIHSS between patients with good clinical outcomes (mRS  $\leq 3$ ) and those with poor clinical outcomes (mRS  $\geq 4$ ). Pretreatment DRAGON scores and percentage of good outcomes at discharge are shown in Table 3.

**Table 1: The DRAGON score**

Variable	Category	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 years	0
	65–79 years	1
	$\geq 80$ years	2
Glucose level on admission	$\leq 8$ mmol/L (144 mg/dL)	0
	> 8 mmol/L (144 mg/dL)	1
Onset-to-treatment time	$\leq 90$ min	0
	> 90 min	1
NIHSS on admission	0–4	0
	5–9	1
	10–15	2
	> 15	3

CT: Computed tomography, mRS: Modified Rankin Score, NIHSS: National Institutes of Health Stroke Scale

The highest and lowest percentage of good outcomes ( $mRS \leq 3$ ) was found in patients with a DRAGON score of 3 and 8, respectively. With increasing DRAGON scores, worse clinical outcome ( $mRS \geq 4$ ) was observed [Figure 1]. Mortality rates of 3.8% and 40% were observed in patients with DRAGON scores of 7 and 8, respectively.

The association between subgroups of DRAGON scores and mRS and mortality rate is shown in Figure 2. DRAGON scores were grouped into high (score of 7–8), intermediate (score of 5–6), and low (score of 3–4) subgroups. High DRAGON scores were associated with higher mRS scores (average  $4.8 \pm 0.3$ ;  $P < 0.006$ )

**Table 2: Baseline characteristics of patients**

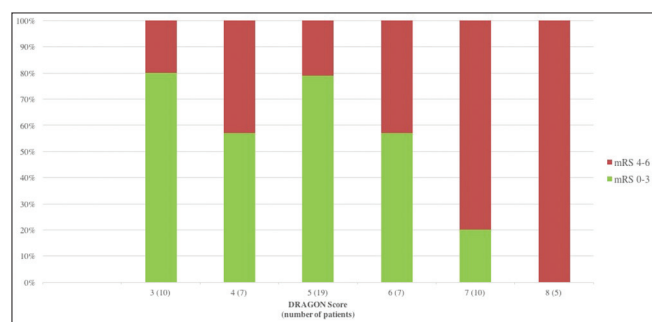
Characteristic	All patients (n=58)	mRS $\leq 3$ (n=33)	mRS $\geq 4$ (n=25)	P
Age, mean (range)	61.4 (32-85)	57.8	66.2	0.018
NIHSS, mean (range)	15.6 (6-36)	14.1	17.5	0.019
DRAGON Score				
0-2	0	-	-	
3	10 (17%)	8	2	
4	7 (12%)	4	3	
5	19 (33%)	15	4	
6	7 (12%)	4	3	
7	10 (17%)	2	8	
8	5 (9%)	0	5	
9-10	0	-	-	

mRS: Modified Rankin Score at discharge, NIHSS: National Institutes of Health Stroke Scale

**Table 3: DRAGON Scores, average mRS at discharge, and % good outcome of the 58 patients**

DRAGON Score	Average mRS	% Good outcome*
3	2.1	80
4	2.3	57
5	2.6	79
6	2.9	57
7	4.8	20
8	4.8	0

mRS: Modified Rankin Score, % Good outcome (defined as  $mRS \leq 3$  at time of discharge)



**Figure 1: Clinical outcome at discharge according to the DRAGON score**

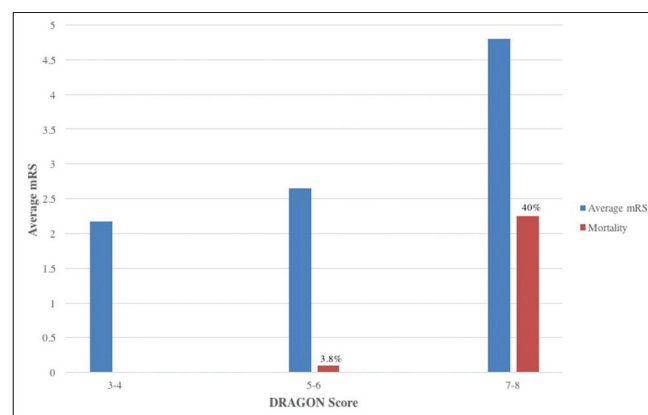
compared with intermediate scores (average mRS  $2.6 \pm 0.4$ ) and low scores (average mRS  $2.2 \pm 0.5$ ). High DRAGON scores (7–8) were also associated with higher mortality (40%;  $P < 0.0001$ ) compared with intermediate and low DRAGON scores (3.8% and 0%, respectively).

## DISCUSSION

The DRAGON score was originally proposed as an easy way of identifying patients who should be given additional therapeutic interventions (i.e., endovascular, hypothermia) due to poor functional outcomes after IV tPA.<sup>[12]</sup> The score takes into account various initial prognosticating factors (age, initial NIHSS, time from onset, CT image findings, and blood sugar levels) and provides relevance based on multivariate logistic regression. Strbian *et al.* showed the predictive value of their scoring system by demonstrating that patients with DRAGON scores of 8 and 9–10 carried a 70% and 100% proportion of miserable outcomes ( $mRS \geq 5$ , bedridden, incontinent, requiring constant nursing care, or dead), respectively, compared to patients with lower DRAGON scores.<sup>[4]</sup> These patients could be suitable for additional rescue therapies such as endovascular intervention.

Although the DRAGON score has been validated by several centers across the world, there are no studies investigating the utility of the score in predicting functional outcomes of patients receiving both IV tPA and endovascular therapy.<sup>[2,4,9,13]</sup> The results of our study show that patients with a DRAGON score of 7–8 had significantly worse clinical outcomes ( $mRS \geq 4$ ) and higher mortality compared to patients with DRAGON scores  $\leq 6$ . This demonstrates that the DRAGON score can predict patient clinical outcomes after treatment with IV tPA and endovascular therapy. In addition, the score can be used to select patients who could benefit from endovascular intervention.

There exist a few scoring systems in the literature that have shown promise in predicting the clinical outcome,



**Figure 2: Correlation between DRAGON score and mRS and mortality**

and thus, appropriately select patients for endovascular therapy. The CTA collateral score, based on the degree of collateral circulation on pretreatment CTA, has been shown to predict smaller infarct volumes and better clinical outcomes in patients after recanalization with endovascular intervention.<sup>[5]</sup> The Capillary Index Score, based on a preintervention cerebral angiogram, can predict favorable outcomes in patients with ischemic strokes.<sup>[8]</sup> Similarly, the PRE (Pittsburgh Response to Endovascular therapy) score, which incorporates age, admission NIHSS, and ASPECT score on head CT, can predict outcomes and facilitates selection for patients who could benefit from endovascular intervention.<sup>[10]</sup>

Compared with other scoring systems, the DRAGON score is (1) fast to obtain, (2) consists of parameters known at admission, and (3) has a low cost; free.<sup>[2,4,9,13]</sup> Our study results show that the DRAGON score can in fact be applied to endovascular patients who have already received IV tPA.

A few limitations need to be acknowledged in our current study. First, despite controlling for established stroke outcome predictors, we cannot rule out additional baseline confounding variables that can affect patient outcomes. Second, this study uses data from only one center. Our aim was to apply an already established scoring system towards predicting stroke outcomes rather than investigate a novel prognostic tool. Third, as we only included anterior circulation strokes, our study results cannot be applied to posterior circulation strokes. Further data is needed to determine if the DRAGON score can be adapted for posterior circulation strokes.

## CONCLUSIONS

The DRAGON score is a fast and easy score to obtain that can predict the functional outcomes of acute ischemic stroke patients treated with IV tPA and endovascular therapy. Larger prospective studies and external validation of the score as it applies to both IV tPA and endovascular therapy is warranted.

## Financial support and sponsorship

Nil.

## Conflicts of interest

There are no conflicts of interest.

## REFERENCES

1. Adeoye O, Hornung R, Khatri P, Kleindorfer D. Recombinant tissue-type plasminogen activator use for ischemic stroke in the United States: A doubling of treatment rates over the course of 5 years. *Stroke* 2011;42:1952-5.
2. Baek JH, Kim K, Lee YB, Park KH, Park HM, Shin DJ, et al. Predicting Stroke Outcome Using Clinical versus Imaging-based Scoring System. *J Stroke Cerebrovasc Dis* 2015;24:642-8.
3. Bhatia R, Hill MD, Shobha N, Menon B, Bal S, Kochar P, et al. Low rates of acute recanalization with intravenous recombinant tissue plasminogen activator in ischemic stroke. *Stroke* 2010;41:2254-8.
4. Cooray C, Mazya M, Bottai M, Dorado L, Skoda O, Toni D, et al. External Validation of the ASTRAL and DRAGON Scores for Prediction of Functional Outcome in Stroke. *Stroke* 2016;47:1493-9.
5. Eljovich L, Goyal N, Mainali S, Hoit D, Arthur AS, Whitehead M, et al. CTA collateral score predicts infarct volume and clinical outcome after endovascular therapy for acute ischemic stroke: A retrospective chart review. *J Neurointervent Surg* 2016;8:559-62.
6. Hacke W, Kaste M, Bluhmki E, Brozman M, Dávalos A, Guidetti D, et al. Thrombolysis with alteplase 3 to 4.5 hours after acute ischemic stroke. *N Engl J Med* 2008;359:1317-29.
7. IST-3 collaborative group, Sandercock P, Wardlaw JM, Lindley RI, Dennis M, Cohen G, et al. 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;379:2352-63.
8. Labeyrie PE, Redjem H, Blanc R, Labeyrie MA, Bartolini B, Ciccio G, et al. The Capillary Index Score before thrombectomy: An angiographic correlate of favorable outcome. *J Neurointervent Surg* 2015;2015:1-4.
9. Ovesen C, Christensen A, Nielsen JK, Christensen H. External validation of the ability of the DRAGON score to predict outcome after thrombolysis treatment. *J Clin Neurosci* 2013;20:1635-6.
10. Rangaraju S, Aghaebrahim A, Streib C, Sun CH, Ribo M, Muchada M, et al. Pittsburgh Response to Endovascular therapy (PRE) score: Optimizing patient selection for endovascular therapy for large vessel occlusion strokes. *J Neurointervent Surg* 2015;7:783-8.
11. Saqqur M, Uchino K, Demchuk AM, Molina CA, Garami Z, Calleja S, et al. Site of arterial occlusion identified by transcranial Doppler predicts the response to intravenous thrombolysis for stroke. *Stroke* 2007;38:948-54.
12. Strbian D, Meretoja A, Ahlhelm FJ, Pitkaniemi J, Lyrer P, Kaste M, et al. Predicting outcome of IV thrombolysis-treated ischemic stroke patients: The DRAGON Score. *Neurology* 2012;78:427-32.
13. Strbian D, Seiffge DJ, Breuer L, Numminen H, Michel P, Meretoja A, et al. Validation of the DRAGON Score in 12 Stroke Centers in Anterior and Posterior Circulation. *Stroke* 2013;44:2718-21.