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Paramedic Global Impression of Change During Prehospital Evaluation and Transport for Acute Stroke

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Abstract

Background and Purpose: The prehospital setting is a promising site for therapeutic intervention in stroke, but current stroke screening tools do not account for the evolution of neurological symptoms in this early period. We developed and validated the Paramedic Global Impression of Change (PGIC) Scale in a large, prospective, randomized trial.

Methods: In the prehospital Field Administration of Stroke Therapy-Magnesium (FAST-MAG) randomized trial conducted from 2005 to 2013, EMS providers were asked to complete the PGIC Scale (5-point Likert scale values: 1-much improved, 2-mildly improved, 3-unchanged, 4-mildly

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Authors Contributions:

KS and SSch performed data acquisition, statistical analysis, drafting, writing and revision of manuscript. EB assisted with manuscript writing and data analysis. SH contributed to study design, statistical analysis, and revision of manuscript. SSta, ME, SStr, FP, LA, DL contributed to study design, data acquisition, and revision of manuscript. RC contributions included funding and oversight. JLS and NS contributed to study design, data acquisition, statistical analysis, writing and revision of the manuscript.

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worsened, 5-much worsened) for neurological symptom change during transport for consecutive patients transported by ambulance within 2h of onset. We analyzed PGIC concurrent validity (compared with change in Glasgow Coma Scale, Los Angeles Motor Scale), convergent validity (compared with NIH Stroke Scale severity measure performed in the Emergency Department) and predictive validity (of neurologic deterioration after hospital arrival and of final 90-day functional outcome). We used PGIC to characterize differential prehospital course among stroke subtypes.

Results: Paramedics completed the PGIC in 1691 of 1700 subjects (99.5%), among whom 635 (37.5%) had neurologic deficit evolution (32% improvement, 5.5% worsening) during a median prehospital care period of 33 (IQR 27–39) minutes. Improvement was associated with diagnosis of cerebral ischemia rather than intracranial hemorrhage, milder stroke deficits on ED arrival, and more frequent nondisabled and independent 3-month outcomes. Conversely, worsening on the PGIC was associated with intracranial hemorrhage, more severe neurological deficits on ED arrival, more frequent treatment with lytics, and poor disability outcome at 3 months.

Conclusions: The PGIC scale is a simple, validated measure of prehospital patient course that has the potential to provide information useful to emergency department decision-making.

Clinical Trial Registration Information: ClinicalTrials.gov NCT00059332

Many interventions for acute stroke are most effective when initiated as soon as possible after symptom onset. Delays in initiating such care can lead to further progression of neurologic deficits, a common complication. [1–5] Ultra-early neurologic deterioration (U-END) occurs in 1 in 8 ambulance-transported acute cerebrovascular disease patients and is associated with markedly reduced functional independence and increased mortality. [6] Recent studies estimate that 50–60% of acute stroke patients present to hospitals using ambulances, highlighting the critical role of EMS systems in acute stroke care. [7–11] During evaluation and transport, paramedics and emergency medical services (EMS) personnel are tasked with the timely assessment of suspected stroke patients. Additionally, information including relevant medical history and last known well time are gathered in the field to help expedite evaluation in the emergency department (ED). [12] To assist with patient evaluation in the field, several prehospital stroke identification instruments and prehospital stroke severity rating scales have been validated for prehospital use. [13–18] However, current prehospital stroke tools do not document stroke symptom changes that may occur during evaluation and transport. This information is useful and can help guide treatment decisions made upon hospital arrival.

Demonstration that mechanical thrombectomy is an efficacious treatment for acute ischemic stroke has contributed to organized systems of stroke care that include prehospital triage of suspected large vessel occlusion acute stroke patients with more patients transported directly to Comprehensive Stroke Centers (CSC). [19–22] Bypassing Primary Stroke Center (PSC) for CSC may mean longer transport times and the need for more robust deficits progression documentation before the first ED encounter. In addition, a growing number of trials are testing paramedic-delivered neuroprotective therapies to acute stroke patients in the field and prehospital change scales are useful to capture an early response to intervention. [23–26]

There is a growing need for scales to document evolution of stroke deficits during the prehospital encounter. We devised the Paramedic Global Impression of Change (PGIC)

Scale, a single item, 5-point Likert instrument, to assess for improvement, stability, or worsening of neurologic deficits from the time of paramedic arrival on scene to subsequent delivery of patient to the receiving emergency department (Table 1). We quantified the concurrentand predictive validity of the PGIC compared with existing instruments. We used the PGIC to characterize the frequency of changes in neurological symptoms during transport and assessed the association of worsening neurologic deficits with stroke subtype (ischemic vs hemorrhagic), initial deficit severity in the field, and long-term 3-month functional outcome.

METHODS

Study design and setting

The main FAST-MAG trial database and materials have been made publicly available at the NIH-NINDS Archived Clinical Research Datasets and can be accessed at https://www.ninds.nih.gov/Current-Research/Research-Funded-NINDS/Clinical-Research/Archived-Clinical-Research-Datasets. Supplementary data on clinically-recorded, ED-arrival GCS in FAST-MAG are available from author JLS (jsaver@mednet.ucla.edu) upon reasonable request.

This study was performed in consecutive patients enrolled in the Field Administration of Stroke Therapy: Magnesium (FAST-MAG) study, a phase 3, NIH-NINDS-sponsored, randomized, double-blinded, placebo-controlled trial to evaluate prehospital initiation of magnesium sulfate as a neuroprotective agent in the treatment of acute stroke. The study was approved by Institutional Review Board (IRB) review at the leading institution and participating hospital sites. Explicit informed consent was obtained via cellphone conversation between on scene patients or legally authorized representatives and off-scene enrolling physician-investigators, or under exception from informed consent regulations. The methodology and primary results of the FAST-MAG study have been previously published. [24–2627] Inclusion criteria included screening positive for likely stroke on the modified Los Angeles Prehospital Stroke Screen and a last known well time within two hours of paramedic start of study agent. Consecutive patients were enrolled from January 2005 – December 2012 in Los Angeles and Orange counties in a network including 315 ambulances, 40 EMS agencies, 60 receiving hospitals, and 2988 paramedics trained in study procedures.

Prehospital assessment scales

At time of enrollment, paramedics rated: patient baseline stroke-related motor deficit severity using the Los Angeles Motor Scale (LAMS) (ranging from 0, indicating no face, arm, or grip weakness, to 10, indicating complete, bilateral weakness); and the patient baseline degree of impaired level of consciousness using the Glasgow Coma Scale (GCS). Then, upon arrival to the receiving hospital and completion of the transport, EMS providers were asked to use the Paramedic Global Impression of Change (PGIC) scale to rate the degree of change in patient neurological status from their first arrival on scene to emergency department arrival (scene to door). The PGIC is a 5-point Likert scale with the following

values: 1-much improved, 2-mildly improved, 3-unchanged, 4-mildly worsened, 5-much worsened (Table 1).

Comparator measurements

For this study, PGIC scores were compared with several additional post-arrival measures routinely collected in the FAST-MAG Trial. Early measures of stroke severity assessed by study nurse coordinators soon (median 70 minutes) after patient ED arrival included repeat scoring of the LAMS and GCS and first study performance of the NIH Stroke Scale, a detailed measure of stroke deficit severity. From the prehospital and early post-arrival measures, the following deficit change measures were derived: 1) change in motor deficit from prehospital to early in the ED course - delta LAMS (P-EDC), and 2) change in level of consciousness from prehospital to early in the ED course - delta GCS (P-EDC).

While the time period covered by the PGIC was confined to the prehospital course, the time period covered by the delta LAMS (P-EDC) and delta GCS (P-EDC) included both the prehospital course and the early post-ED arrival course. In a subset of patients, a clinically obtained arrival GCS was available from the medical record. For this subset, an additional deficit change measure was derived: change in level of consciousness from prehospital to ED arrival - GCS (P-EDA).

For dichotomized analyses of early course, early deterioration in level of consciousness was defined as a decrease on the GCS by 2 points or more, as in prior studies, [28] and early deterioration in motor deficits was defined as an increase on the LAMS by 2 points or more.

In addition, certified raters, blinded to treatment assigned, rated final functional outcome at day 90 on the modified Rankin Scale, a global functional outcome scale assessing impairment, disability, and handicap. [29]

Patient final diagnoses were adjudicated by a central committee as cerebral ischemia (subtypes transient ischemic attack and ischemic stroke), intracranial hemorrhage, and cerebrovascular mimic.

Data Analysis

Comparisons between outcome scales were performed with Kruskal-Wallis tests for ordinal scales and one-way Analysis of Variance (ANOVA) for continuous scales (assumptions for normality, homogeneity of variance, absence of strongly influential outliers were met). Pairwise comparisons were performed with Wilcoxon rank-sum tests (Mann-Whitney U-test) and Chi-square test for ordinal and skewed continuous scales and Student’s t-tests for normally distributed continuous scales.

There was no gold standard comparator to assess the concurrent validity of the PGIC, for three reasons. First, the two available measures, delta LAMS (change in LAMS from field to hospital) and delta GCS (change in GCS from field to hospital), are both known to be imperfectly insensitive to global change due to the narrow focus of the LAMS on motor deficits and the GCS on level of consciousness. Second, the GCS is known to be insensitive to improvements in acute cerebral ischemia patients, as even patients with major initial focal

deficits typically have no impaired level of consciousness and a ceiling GCS score of 15. Third, the delta GCS P-EDC and delta LAMS (P-EDC) in the entire study population covered not only the prehospital time period but also the early post-ED arrival time period, while the PGIC covered only the prehospital time period. Concurrent validity of the PGIC was explored by comparing PGIC scores with delta GCS and delta LAMS scores using Spearman's, correlation coefficients. Strength of correlations were classified as: 0.8 to 1.0 – Strong; 0.6 to 0.79 – Moderately strong; 0.5 to 0.59; Moderate; 0.3 to 0.49 – Fair; 0 to 0.29 – Poor. [30] Predictive validity of the PGIC for early outcome was assessed by comparing PGIC scores with the first, post-arrival NIHSS using Spearman's correlation coefficient. Predictive validity of the PGIC for final outcome was assessed by correlating PGIC scores with 3-month ordinal mRS functional outcome score, and binary non-disabled (mRS 0–1) and independent (mRS 0–2) 3-month outcomes.

RESULTS

Characteristics of study patients

From January 2005 to December 2012, 1700 patients were enrolled in the FAST-MAG trial. Paramedics completed the PGIC for 1691 (99.5%), who compromise the study group, with mean age 69 years (standard deviation (SD) 13.5), 42.5% female, 23.7% Latino, and 12.8% African American.(Table 2) Symptom onset to paramedic on-scene time was a median of 23 minutes (interquartile Range (IQR) 14–42). Subjects arrived at the hospital a median of 58 minutes (IQR 48–79) after last known well. First study nurse evaluation early in the ED course was 70 minutes (IQR 45–95.5) after ED arrival. The final diagnosis was acute cerebral ischemia (ACI) in 1241 (73.3%), intracranial hemorrhage (ICH) in 384 (22.7%) and stroke mimic in 66 (3.9%).

PGIC scores and comparator measures

The distribution of PGIC scores in all patients and within the major diagnostic category subtypes is shown in Tables 2 and 3. Overall, paramedics rated 635 subjects (37.5%) as having global neurologic deficit evolution during transport. Improvement in neurologic deficits was more common, present in 540 (31.9%) than was worsening, present in 95 (5.6%).

Patient demographic and clinical features univariately associated with neurological status change on the PGIC scale were age, severity of initial prehospital focal motor deficits, and diagnostic category subtype (Table 2). The pattern of change on the PGIC differed by diagnostic category. Acute cerebral ischemia patients were more likely to improve (36.0%) than worsen (3.2%), while intracranial hemorrhage patients were equally likely to improve (16.4%) and worsen (13.0%) (Table 3, Figure 1).

In the exploratory assessments of concurrent validity, PGIC showed fair correlationg with delta LAMS (P-EDC) ($R=0.31$, $P<0.001$) and poor correlation with delta GCS (P-EDC) ($R=0.20$, $P<0.0001$). Among the subset of 961 patients with a clinically documented ED arrival GCS score, the PGIC showed poor correlation with the delta GCS (P-EDA) ($R=0.15$, $P<0.0001$). However, this reflected the GCS' insensitivity to improvements. In analysis by

binary categories of worsening or no worsening, worsening on the PGIC predicted was associated with deterioration by 2 or more points on the GCS (P-EDA) with sensitivity 96% %, specificity 26%, and positive predictive value 93%, negative predictive value 74%, and overall accuracy 90%. (Figure 2).

In the assessment of early predictive validity, the relation was analyzed of the PGIC score to the NIHSS score assessed by a study nurse early in the ED course. Mean NIHSS score at the time of study nurse evaluation was 11.3 (SD 9.9). There was a graded relation between prehospital change PGIC scores and early post-arrival NIHSS scores. Patients with a PGIC "much improved" rating had NIHSS 4.5 (SD 0.9); PGIC "mildly improved" had NIHSS 9.0 (SD 1.7); PGIC "unchanged" had NIHSS 12.6 (SD 9.7); PGIC "mildly worsened" had PGIC had NIHSS 14.8 (SD 5.0); and PGIC "much worsened" had NIHSS 25.4 (SD 12.5). The PGIC score showed moderate correlation to the full range of the early ED course NIHSS, $r=0.31$. $p<0.001$. In addition, PGIC scores were associated with receipt of intravenous tPA upon hospital arrival. Among patients with initial prehospital intermediate deficit severities on the LAMS of 3–4, those with subsequent worsening on the PGIC more often received IV tPA than those with subsequent improvement, 50.0% vs 25.2%, $p=0.03$.

In the assessment of long-term predictive validity, the relation was analyzed of the PGIC score to 3-month modified Rankin Scale global disability outcome scores. The mean 3-month mRS was 2.69 (SD 2.1). There was a graded relation between prehospital change PGIC scores and 3-month mRS scores. Patients with a PGIC "much improved" rating had 1.76 (SD 0.6); PGIC "mildly improved" had mRS 2.04 (SD 0.5); a PGIC "unchanged" had mRS of 2.93 (SD 0.25); a PGIC "mildly worsened" had mRS 3.05 (SD 0.9); and a PGIC "much worsened" had mRS 4.23 (SD 2.0). The PGIC score weakly correlated with the entire range of the 3-month mRS ($P<0.0001$ by ANOVA, $r=0.22$. Considering binary 3-month outcomes, there was a graded relation with PGIC trajectory. Nondisabled (mRS 0–1) outcomes among patients with improved, stable, and worsened PGIC courses were 48.1% vs 30.4% vs 22.1%, respectively, $p<0.0001$. Functional independence (mRS 0–2) outcomes among patients with improved, stable, and worsened PGIC courses were 63.0% vs 47.1% vs 41.1% respectively, $p<0.0001$) (Table 4).

DISCUSSION

This study found that paramedics were successfully able to implement a simple Likert-scale questionnaire to identify evolution of neurological deficits among suspected stroke patients during EMS evaluation and transport with very high compliance. The Paramedic Global Impression of Change Scale identified a change in neurological status during EMS on-scene care transport in more than one-third of patients, with improvement being more common, occurring in nearly 1 in 3 patients, than worsening, occurring 1 in 20 patients.

The PGIC provided insight into differences in hyperacute course among stroke subtypes, showing that worsening in the field was much more common anong intracranail hemorrhage than acute cerebral ischemia patients, and improvement much more common among acute cerebral ischemia patients. In hyperacute intracerebral hemorrhage, the hematoma in mnay patients is actively continuing to expand during the period of care in the field, prior to first

imaging. In acute cerebral ischemia, early improvement in the field likely often reflects spontaneous recanalization, which is more likely to occur in the hyperacute phase before thrombus orgaanization is completed. The high frequency of prehospital neurological deterioration in intracranial hemorrhage highlights the desirability of effective treatments that could be initiated at the earliest possible moment, at time of first paramedic contact, in advance of ultra-early neurolodic deterioratio. [31] In the current study, more than 1 in 8 patients with intracranial hemorrhage experienced some deterioration of neurologic status during transport on the PGIC. These findings are consistnet with studies of early post-arrival course in intracerebral hemorrhage patients which have found that 18–36% of intracrebral hemorrhage patients experience an expansion of hemorrhage volume within the first 3 hours of symptom onset, which is associated with a worsening of neurologic status and an increased risk of morbidity. [31–35] In the current study, worsening of symptoms during transport, as indicated by the PGIC, similarly was associated with worse levels of disability 3 months after stroke.

Improvement during transport was associated with lower NIHSS scores upon emergency department arrival and increased chance of functional independence at 90 days. Patients with improving scores on PGIC had an average nearly 5 point lower early ED course NIHSS compared to stable prehospital course patients in this study. Some of these patients are likely to have initial stroke severity scores in the field indicating transport directly to thrombolytic-capable and thrombectomy-capable receiving stroke centers, but to improve to minimal deficits no longer warranting intervention by the time of hospital arrival.[36]

The PGIC provides information on patient prehospital neurologic course that complements that provided by existing instruments. Current prehospital deficit severity measures, like the GCS and the LAMS, are generally narrow in the scope of neurologic functions they address, while the PGIC is intrinsically an encompassing, global assessment. In addition, current instruments, like the GCS and LAMS, are static assessments of patient status at one time point, while the PGIC provides a dynamic assessment of patient trajectory over time. Comparison of the changes on static measures, like the delta GCS and the delta LAMS, do capture change over time, but in regular practice to be paramedic-administered measures these would require repetition of paramedic assessments at the time of hospital arrival, which could slow acute stroke patient care and also prolong paramedic care time. The PGIC efficiently provides a paramedic assessment of patient prehospital course at a global level. As is desirable, it showed statistically significant, but fair to weak, correlation with the delta GCS and delta LAMS, indicating that it is sensitive to the changes noted on those more focused instruments but also capturing other patient aspects as well. The biologic importance of PGIC scores is confirmed by their predictive validity in showing association with with nondisabled (mRS 0–1) and functionally independent (mRS 0–2) long-term outcome outcome at 3-months.

In the clinical setting, it is often helpful to have scales that provide efficient, quantitative depictions of patient state or course, in addition to more nuanced, but less efficiently conveyed, detailed qualitative descriptions. With regard to a patient's broad neurologic deficits, for example, the NIHSS has found a useful role in practice as a brief numeric indicator, complementing the more nuanced, expansively described findings of full

neurologic examination. With regard to level of consciousness, the GCS has found a useful role in practice as a brief numeric indicator, complementing the more nuanced, expansively described detailed neurologic evaluation of alertness. Similarly, the PGIC could serve a useful role as a brief, numeric indicator of patient prehospital neurologic course, complementing more nuanced, expansively described paramedic verbal reports of evolution of findings. In the research setting, the PGIC provides a numeric indicator of patient course that can be incorporated into prognostic and treatment-response models in a manner that verbal descriptions cannot provide. Changes in the PGIC scores could potentially help in assessing the effect of innovations in prehospital stroke care, such as longer patient routing directly to Comprehensive Stroke Centers and patient care and transport in Mobile Stroke Units equipped with CT scanners compared with standard ambulances. This study has several limitations. All patients were enrolled in a clinical trial. Although entry criteria in the FAST-MAG trial were broad in age, stroke severity, and comorbidities, the study did exclude patients with pre-stroke disability, systolic blood pressure higher than 220, and other uncommon features. These patients may have different frequencies of symptom worsening and improvement. Because only one paramedic was present with the patient observing the course continuously throughout transport in the back of the ambulance, the PGIC was completed by tht single paramedic rater in each subject, precluding formal assessment of inter-rater reliability. As the PGIC is a qualitative scale that has potential for subjective variation among raters, assessment of inter-rater reliability is desirable in a future study.

In conclusion, the PGIC is an easily administered addition to current stroke-screening assessments with high degree of compliance. A substantial portion of patients do experience a change in neurologic deficits during transport. Stroke cases exhibiting significant deterioration en route to the hospital may require for more rapid evaluation and aggressive intervention where available and that should be accounted for as it can help further delineate patient destination decisions and appropriate therapeutic intervention.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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References

1. Carcel C, Wang X, Sato S, Stapf C, Sandset EC, Delcourt C, et al. Degree and timing of intensive blood pressure lowering on hematoma growth in intracerebral hemorrhage: Intensive blood pressure reduction in acute cerebral hemorrhage trial-2 results. Stroke. 2016;47:1651–1653 [PubMed: 27143274]
2. Emberson J, Lees KR, Lyden P, Blackwell L, Albers G, Bluhmki E, et al. Effect of treatment delay, age, and stroke severity on the effects of intravenous thrombolysis with alteplase for acute

ischaemic stroke: A meta-analysis of individual patient data from randomised trials. Lancet (London, England). 2014;384:1929–1935

3. Kuramatsu JB, Gerner ST, Schellinger PD, Glahn J, Endres M, Sobesky J, et al. Anticoagulant reversal, blood pressure levels, and anticoagulant resumption in patients with anticoagulation-related intracerebral hemorrhage. Jama 2015;313:824–836 [PubMed: 25710659]
4. Saver JL, Fonarow GC, Smith EE, Reeves MJ, Grau-Sepulveda MV, Pan W, et al. Time to treatment with intravenous tissue plasminogen activator and outcome from acute ischemic stroke. Jama 2013;309:2480–2488 [PubMed: 23780461]
5. Saver JL, Goyal M, van der Lugt A, Menon BK, Majoie CB, Dippel DW, et al. Time to treatment with endovascular thrombectomy and outcomes from ischemic stroke: A meta-analysis. Jama 2016;316:1279–1288 [PubMed: 27673305]
6. Shkirkova K, Saver JL, Starkman S, Wong G, Weng J, Hamilton S, et al. Frequency, predictors, and outcomes of prehospital and early postarrival neurological deterioration in acute stroke: Exploratory analysis of the fast-mag randomized clinical trial. JAMA neurology. 2018;75:1364–1374 [PubMed: 30039165]
7. Acker JE 3rd, Pancioli AM, Crocco TJ, Eckstein MK, Jauch EC, Larrabee H, et al. Implementation strategies for emergency medical services within stroke systems of care: A policy statement from the american heart association/american stroke association expert panel on emergency medical services systems and the stroke council. Stroke. 2007;38:3097–3115 [PubMed: 17901393]
8. Ekundayo OJ, Saver JL, Fonarow GC, Schwamm LH, Xian Y, Zhao X, et al. Patterns of emergency medical services use and its association with timely stroke treatment: Findings from get with the guidelines-stroke. Circulation. Cardiovascular quality and outcomes. 2013;6:262–269 [PubMed: 23633218]
9. Lacy CR, Suh DC, Bueno M, Kostis JB. Delay in presentation and evaluation for acute stroke: Stroke time registry for outcomes knowledge and epidemiology (s.T.R.O.K.E.). Stroke. 2001;32:63–69 [PubMed: 11136916]
10. Prabhakaran S, O'Neill K, Stein-Spencer L, Walter J, Alberts MJ. Prehospital triage to primary stroke centers and rate of stroke thrombolysis. JAMA neurology. 2013;70:1126–1132 [PubMed: 23817961]
11. Schroeder EB, Rosamond WD, Morris DL, Evenson KR, Hinn AR. Determinants of use of emergency medical services in a population with stroke symptoms: The second delay in accessing stroke healthcare (dash ii) study. Stroke. 2000;31:2591–2596 [PubMed: 11062280]
12. Kamel H, Navi BB, Fahimi J. National trends in ambulance use by patients with stroke, 1997–2008. Jama 2012;307:1026–1028 [PubMed: 22416095]
13. Chenkin J, Gladstone DJ, Verbeek PR, Lindsay P, Fang J, Black SE, et al. Predictive value of the ontario prehospital stroke screening tool for the identification of patients with acute stroke. Prehospital emergency care : official journal of the National Association of EMS Physicians and the National Association of State EMS Directors. 2009;13:153–159
14. Kidwell CS, Starkman S, Eckstein M, Weems K, Saver JL. Identifying stroke in the field. Prospective validation of the los angeles prehospital stroke screen (lapss). Stroke. 2000;31:71–76 [PubMed: 10625718]
15. Kimura K, Inoue T, Iguchi Y, Shibazaki K. Kurashiki prehospital stroke scale. Cerebrovascular diseases (Basel, Switzerland). 2008;25:189–191
16. Kothari RU, Pancioli A, Liu T, Brott T, Broderick J. Cincinnati prehospital stroke scale: Reproducibility and validity. Annals of emergency medicine. 1999;33:373–378 [PubMed: 10092713]
17. Llanes JN, Kidwell CS, Starkman S, Leary MC, Eckstein M, Saver JL. The los angeles motor scale (lams): A new measure to characterize stroke severity in the field. Prehospital emergency care : official journal of the National Association of EMS Physicians and the National Association of State EMS Directors. 2004;8:46–50
18. Perez de la Ossa N, Carrera D, Gorchs M, Querol M, Millan M, Gomis M, et al. Design and validation of a prehospital stroke scale to predict large arterial occlusion: The rapid arterial occlusion evaluation scale. Stroke. 2014;45:87–91 [PubMed: 24281224]

19. A systems approach to immediate evaluation and management of hyperacute stroke. Experience at eight centers and implications for community practice and patient care. The national institute of neurological disorders and stroke (ninds) rt-pa stroke study group. Stroke. 1997;28:1530–1540 [PubMed: 9259745]
20. Alberts MJ, Latchaw RE, Jagoda A, Wechsler LR, Crocco T, George MG, et al. Revised and updated recommendations for the establishment of primary stroke centers: A summary statement from the brain attack coalition. Stroke. 2011;42:2651–2665 [PubMed: 21868727]
21. Powers WJ, Rabinstein AA, Ackerson T, Adeoye OM, Bambakidis NC, Becker K, et al. 2018 guidelines for the early management of patients with acute ischemic stroke: A guideline for healthcare professionals from the american heart association/american stroke association. Stroke. 2018;49:e46–e110 [PubMed: 29367334]
22. Schwamm LH, Pancioli A, Acker JE 3rd, Goldstein LB, Zorowitz RD, Shephard TJ, et al. Recommendations for the establishment of stroke systems of care: Recommendations from the american stroke association's task force on the development of stroke systems. Stroke. 2005;36:690–703 [PubMed: 15689577]
23. Ankolekar S, Fuller M, Cross I, Renton C, Cox P, Sprigg N, et al. Feasibility of an ambulance-based stroke trial, and safety of glyceryl trinitrate in ultra-acute stroke: The rapid intervention with glyceryl trinitrate in hypertensive stroke trial (right, isrctn66434824). Stroke. 2013;44:3120–3128 [PubMed: 24003041]
24. Saver JL, Starkman S, Eckstein M, Stratton S, Pratt F, Hamilton S, et al. Methodology of the field administration of stroke therapy - magnesium (fast-mag) phase 3 trial: Part 1 - rationale and general methods. International journal of stroke : official journal of the International Stroke Society. 2014;9:215–219 [PubMed: 24444116]
25. Saver JL, Starkman S, Eckstein M, Stratton S, Pratt F, Hamilton S, et al. Methodology of the field administration of stroke therapy - magnesium (fast-mag) phase 3 trial: Part 2 - prehospital study methods. International journal of stroke : official journal of the International Stroke Society. 2014;9:220–225 [PubMed: 24444117]
26. Saver JL, Starkman S, Eckstein M, Stratton SJ, Pratt FD, Hamilton S, et al. Prehospital use of magnesium sulfate as neuroprotection in acute stroke. The New England journal of medicine. 2015;372:528–536 [PubMed: 25651247]
27. Sanossian N, Starkman S, Liebeskind DS, Ali LK, Restrepo L, Hamilton S, et al. Simultaneous ring voice-over-internet phone system enables rapid physician elicitation of explicit informed consent in prehospital stroke treatment trials. Cerebrovascular diseases (Basel, Switzerland). 2009;28:539–544
28. Qureshi AI, Suarez JI, Yahia AM, Mohammad Y, Uzun G, Suri MF, et al. Timing of neurologic deterioration in massive middle cerebral artery infarction: A multicenter review. Critical care medicine. 2003;31:272–277 [PubMed: 12545028]
29. Saver JL, Filip B, Hamilton S, Yanes A, Craig S, Cho M, et al. Improving the reliability of stroke disability grading in clinical trials and clinical practice: The rankin focused assessment (rfa). Stroke. 2010;41:992–995 [PubMed: 20360551]
30. Chan YH. Biostatistics 104: Correlational analysis. Singapore medical journal. 2003;44:614–619 [PubMed: 14770254]
31. Kazui S, Minematsu K, Yamamoto H, Sawada T, Yamaguchi T. Predisposing factors to enlargement of spontaneous intracerebral hematoma. Stroke. 1997;28:2370–2375 [PubMed: 9412616]
32. Broderick J, Connolly S, Feldmann E, Hanley D, Kase C, Krieger D, et al. Guidelines for the management of spontaneous intracerebral hemorrhage in adults: 2007 update: A guideline from the american heart association/american stroke association stroke council, high blood pressure research council, and the quality of care and outcomes in research interdisciplinary working group. Circulation. 2007;116:e391–413 [PubMed: 17938297]
33. Brott T, Broderick J, Kothari R, Barsan W, Tomsick T, Sauerbeck L, et al. Early hemorrhage growth in patients with intracerebral hemorrhage. Stroke. 1997;28:1–5 [PubMed: 8996478]
34. Davis SM, Broderick J, Hennerici M, Brun NC, Diringer MN, Mayer SA, et al. Hematoma growth is a determinant of mortality and poor outcome after intracerebral hemorrhage. Neurology. 2006;66:1175–1181 [PubMed: 16636233]

35. Kazui S, Naritomi H, Yamamoto H, Sawada T, Yamaguchi T. Enlargement of spontaneous intracerebral hemorrhage. Incidence and time course. Stroke. 1996;27:1783–1787 [PubMed: 8841330]

36. Powers WJ, Derdeyn CP, Biller J, Coffey CS, Hoh BL, Jauch EC, et al. 2015 american heart association/american stroke association focused update of the 2013 guidelines for the early management of patients with acute ischemic stroke regarding endovascular treatment: A guideline for healthcare professionals from the american heart association/american stroke association. Stroke. 2015;46:3020–3035 [PubMed: 26123479]

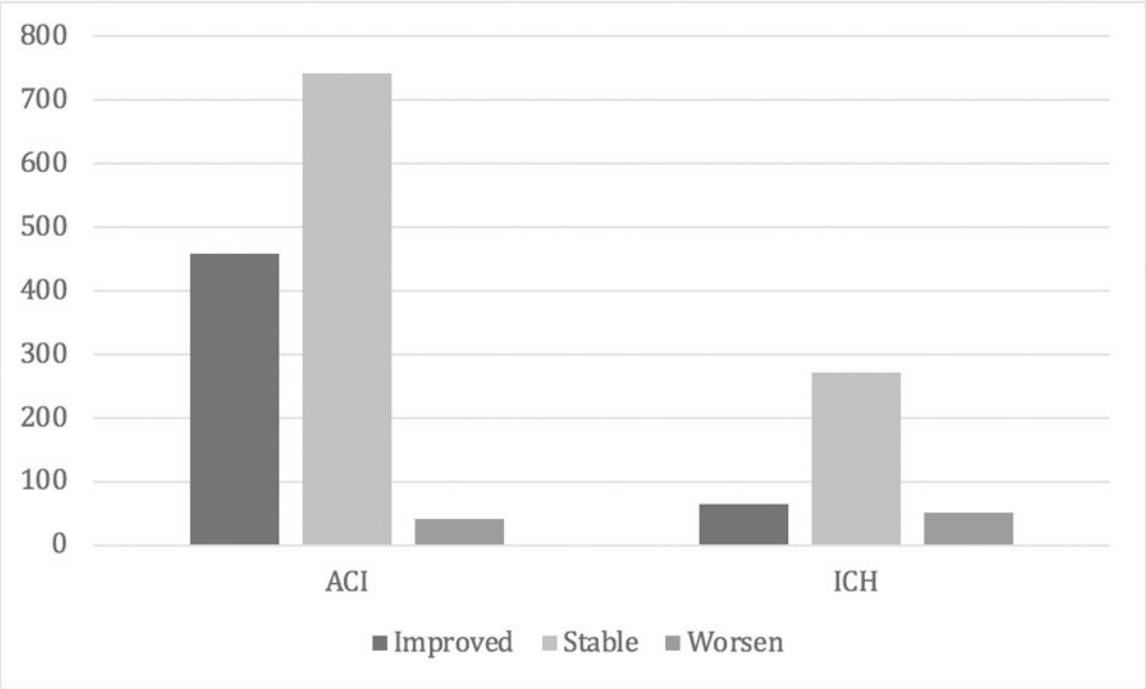

Figure 1.
Trichotomized PGIC scores among ACI and ICH patients

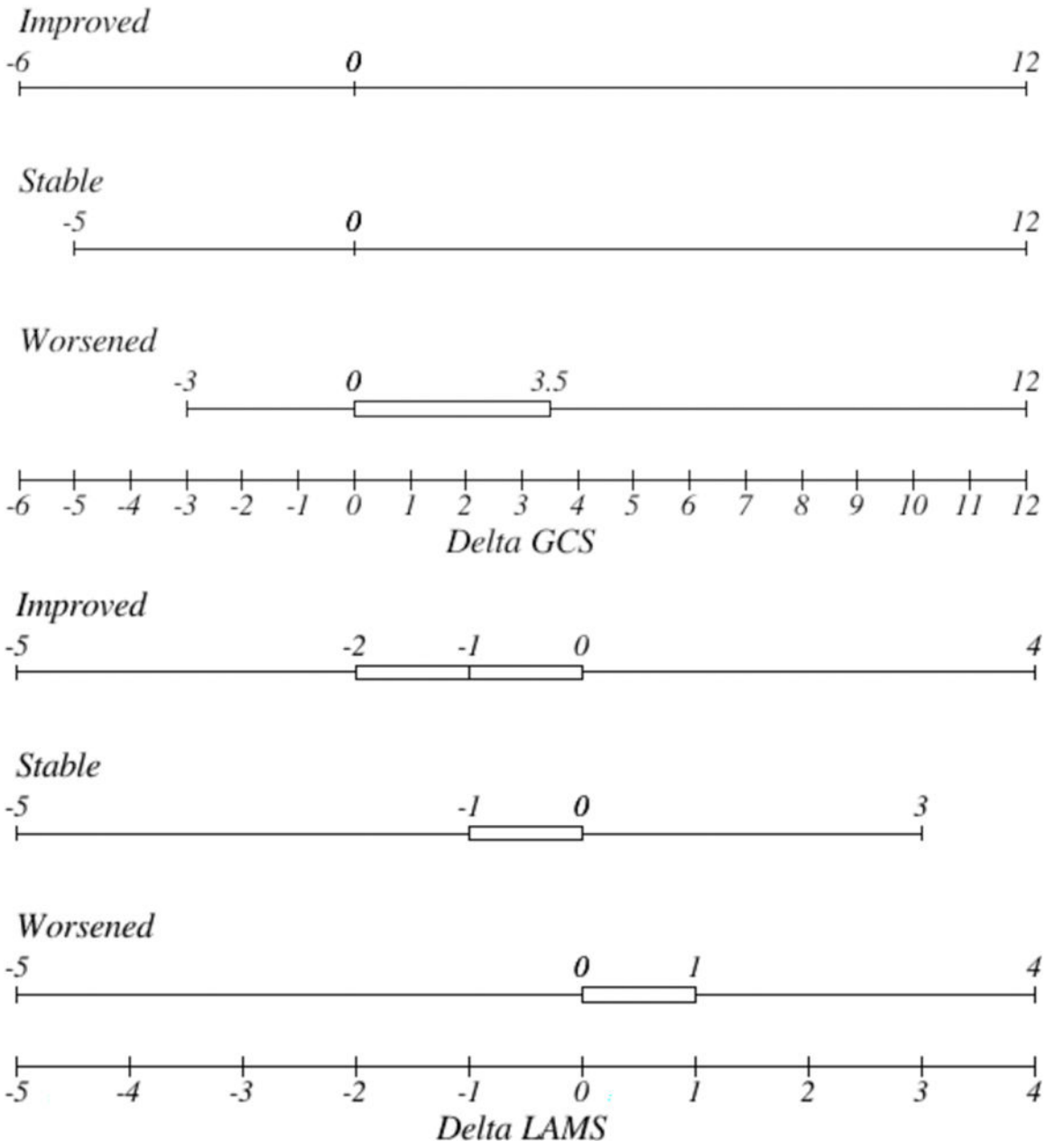

Figure 2.

A, Box and whiskers plot Glasgow Coma Scale (GCS) change based on trichotomized Paramedic Global Impression of Change (PGIC) scale. B, Box and whiskers plot Los Angeles Motor Scale (LAMS) change based on trichotomized PGIC scale.

Table 1:

The Paramedic Global Impression of Change (PGIC) Scale

Description	Score
Much Improved	1
Mildly Improved	2
Unchanged	3
Mildly Worsened	4
Much Worsened	5

Table 2.

Characteristics of Studied Population Overall and by Category of Improvement or Worsening on the Paramedic Global Impression of Change Score

	Overall Group (N=1691)	Improved (PCIG= 1–2, n=540)	Unchanged (PGIC=3, n=1056)	Worsened (PGIC=4–5, n=95)	p-value (for I, U, W)
Age (Mean, SD)	69.5 (13.5)	71.2 (13.2) */**	68.8 (13.5) *	66.5 (13.8) **	<0.0001 [1]
Sex Female (N, Percent)	719 (42.5)	224 (41.5)	454 (43.0)	41 (43.2)	0.84 [2]
Diagnosis					
Acute Cerebral Ischemia	1240 (73.4)	457 (84.6) *	743 (70.4) *	40 (42.6) *	<0.0001 [2]
Intracranial Hemorrhage	384 (22.7)	63 (11.7) *	271 (25.7) *	50 (53.2) *	
Stroke Mimic	66 (3.9)	20 (3.7)	42 (4.0)	4 (4.3)	
Race, n (%)					
White	1319 (78.0)	431 (79.8)	812 (76.9)	76 (80.0)	0.47 [2]
Black/African American	217 (12.8)	71 (13.1)	136 (12.9)	10 (10.5)	
Asian	138 (8.2)	36 (6.7)	94 (8.9)	8 (8.4)	
Other	17 (1.0)	2 (0.4)	14 (0.14)	1 (1.1)	
Ethnicity – Hispanic, n (%)	401 (23.7)	122 (22.6)	253 (24.0)	26 (27.4)	0.57 [2]
Medical History					
Hypertension, n (%)	131 (77.8)	420 (77.8)	820 (77.7)	76 (80.0)	0.87 [2]
Diabetes, n (%)	375 (22.2)	117 (21.7)	239 (22.6)	19 (20.0)	0.79 [2]
Hyperlipidemia, n (%)	802 (47.4)	267 (49.4)	489 (46.3)	46 (48.4)	0.48 [2]
Atrial fibrillation, n (%)	368 (21.8)	129 (23.9)	223 (21.1)	16 (16.8)	0.22 [2]
CAD, n (%)	353 (20.9)	112 (22.6)	212 (20.1)	19 (20.0)	0.49 [2]
MI, n (%)	176 (10.4)	57 (10.6)	109 (10.3)	10 (10.5)	0.98 [2]
CABG, n (%)	49 (2.9)	21 (3.9)	26 (2.5)	2 (2.1)	0.25 [2]
Prior Stroke/TIA, n (%)	267 (15.8)	105 (19.4)	148 (13.6)	14 (14.8)	0.68 [2]
Tobacco use, n (%)	294 (17.4)	97 (18.0)	184 (17.4)	13 (13.7)	0.60 [2]
Any alcohol use, n (%)	652 (38.6)	212 (39.3)	393 (37.2)	47 (49.5)	0.06 [2]
Time Intervals (mins), median (IQR)					
Onset to Paramedic Evaluation	23.0 (14.0–42.0)	23.0 (15.0–42.0)	24.0 (14.0–42.0)	20.0 (13.0–43.5)	0.65 [1]
Onset to ED Arrival	58.0 (46.0–79.0)	59.0 (47.0–80.5)	58.0 (46.0–78.0)	57.5 (42.8–79.0)	0.69 [1]
Onset to Study Nurse Evaluation	150 (120–150)	150 (120–180)	150 (125–182)	150 (120–180)	0.89 [1]
Severity Scores					
Prehospital GCS, median (IQR)	15.0 (14.0–15.0)	15.0 (14.0–15.0)	15.0 (14.0–15.0)	15.0 (15.0–15.0)	0.28 [1]

	Overall Group (N=1691)	Improved (PCIG= 1–2, n=540)	Unchanged (PGIC=3, n=1056)	Worsened (PGIC=4–5, n=95)	p-value (for I, U, W)
Prehospital LAMS, median (IQR)	4.0 (3.0–5.0)	3.0 (3.0–5.0) *	4.0 (3.0–5.0) *	4.0 (3.0–5.0) *	<0.0001 3

*/**- indicates significant difference

1- ANOVA was used to establish significance

2- Chi-square test was used to establish significance

3- Kruskal-Wallis statistical test was used to establish significance

Table 3.

Paramedic Global Impression of Change (PGIC) Scale Score and Final Diagnosis

PGIC Score	Acute Cerebral Ischemia (n=1240)	Intracranial Hemorrhage (n=385)	Mimic (n=66)	Total Number (N=1691)	*p-value (ACI vs ICH vs Mimic)
1	136 (11.0) *	6 (1.6) *	5 (7.6) *	147 (8.7)	<0.0001 1
2	321 (25.9) *	57 (14.8) *	15 (22.7) *	393 (23.3)	
3	743 (25.9) *	271 (70.6) *	42 (63.6) *	1056 (62.5)	
4	34 (2.7) *	37 (9.6) *	2 (3.0) *	73 (4.3)	
5	6 (0.5) *	13 (3.4) *	2 (3.0) *	21 (1.2)	

*- indicates significant difference

1- Chi-square test was used to establish significance

Table 4.

Outcomes among trichotomized PGIC scores

	Total (N=1691)	Improved (PCIG= 1–2, n=540)	Unchanged (PGIC=3, n=1056)	Worsened (PGIC=4–5, n=95)	p-value (for I, U, W)
Early Outcomes					
Nurse GCS, median (IQR)	15.0 (14.0–17.0)	15.0 (15.0—15.0) *	15.0 (13.8–15.0) *	15.0 (9.8–15.0) *	<0.0001 1
Nurse LAMS, median (IQR)	3.0 (2.0–5.0)	2.0 (1.0–5.0) */**	4.0 (2.0–5.0) *	4.0 (3.0–5.0) **	<0.0001 2
Nurse NIHSS, mean (SD)	11.3 (9.9)	7.8 (8.4) *	12.6 (9.7) *	17.2 (12.3) *	<0.0001 1
90 Day Outcomes					
mRS 90d 0–1, n (%)	606 (36.2)	264 (48.9) *	321 (30.4) *	21 (22.1) *	<0.0001 3
mRS 90d 0–2, n (%)	878 (52.3)	340 (63.0) *	497 (47.1) *	39 (41.1) *	<0.0001 3
mRS 90d, mean (SD)	2.67 (2.1)	2.1 (2.0) */**	2.9 (2.1) *	3.3 (2.1) **	<0.0001 2
Mortality 90d, n (%)	260 (15.4)	62 (11.5) */**	175 (16.6) *	23 (24.2) **	0.001 3

*/**- indicates significant difference

1- ANOVA was used to establish significance

2- Kruskal-Wallis statistical test was used to establish significance

3- Chi-square test was used to establish significance