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Dosing Tissue Plasminogen Activator on a Mobile Stroke Unit: Comparison Between Estimated and Hospital-Measured Weights

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ABSTRACT

BACKGROUND: Prehospital tissue plasminogen activator dosing in a mobile stroke unit (MSU) is estimated by the paramedic and nurse. We aimed to determine the accuracy of the estimated weight method compared with the actual weight of patients treated with tissue plasminogen activator on the MSU. **METHODS:** We prospectively collected the estimated weight used on the MSU for treatment and the first-documented hospital-measured weight (bed scale) within 24 hours of hospital arrival. Median absolute and percent difference in weights were calculated; less than 10% of difference in weights was considered acceptable. To compare the estimated and measured weights, we conducted a Wilcoxon signed rank test and Fisher exact test to explore the association between weight difference of greater than 10% and patient outcomes. **RESULTS:** Among 337 patients, median estimated and hospital-measured weights were 79.0 kg (interquartile range [IQR], 66.0–94.5) and 78.5 kg (IQR, 65.0–91.7), respectively. The median of the absolute value of the difference in estimated versus measured weight was 2.7 kg (IQR, 0.6–7.6; $P < .0001$). The median percent difference in weight was 3.6% (IQR, 0.8%–9.4%). The median difference between the tissue plasminogen activator dosage administered on the MSU and the recommended dose based on the actual weight was 1.3 mg (IQR, 0.06–4.8) in absolute value. In 56 patients (16.6% of the entire sample) with overestimation of weight by greater than 10%, there were no symptomatic intracerebral hemorrhages. There was no association between weight difference and discharge modified Rankin score ($P = .59$). **CONCLUSION:** Weight estimation on an MSU can lead to similar tissue plasminogen activator dosing for 83.4% of subjects compared with if dosing were determined based on actual weight. Weight overestimation or underestimation had no detected impact on tissue plasminogen activator outcomes.

Keywords: emergency medical services, ischemic stroke, mobile stroke, tissue plasminogen activator, transport nursing, weight

Tissue plasminogen activator is a highly effective treatment of acute ischemic stroke,[1] and early stroke treatment is associated with better outcomes in stroke patients.[2] Mobile stroke units (MSUs) are under evaluation for improving short- and long-term outcomes in stroke patients. The purpose of MSUs is to expedite stroke care by treating patients in a prehospital setting, where obtaining a measured body weight, critical for accurate prehospital tissue plasminogen activator dosing, is challenging.

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The Benefits of Stroke Treatment Using a Mobile Stroke Unit is a multicenter, prospective, cluster-randomized comparative effectiveness study of tissue plasminogen activator–eligible patients managed on an MSU versus emergency medical services.[3] In May 2014, the first MSU was established in the United States. The MSU is a standard 12-ft ambulance equipped with a computed tomography (CT) scanner and point-of-care laboratories. The MSU team includes a vascular neurologist, a registered nurse, a paramedic, and a CT technologist. All nurses and paramedics on board the unit have extensive prehospital and/or acute inpatient experience with at least 8 years of service. The paramedic and nurse on the MSU subjectively assess the weight of patients to calculate the required tissue plasminogen activator dosages.

This study aimed to assess the accuracy of the estimated weight of stroke patients by the paramedic and nurse on the MSU compared with the weight measured by a calibrated weight device upon arrival at the hospital. We hypothesized that the weight obtained by the MSU staff would have high reliability, thereby helping save time to treatment.

Methods

The Benefits of Stroke Treatment Using a Mobile Stroke Unit study was institutional review board approved, and consent was obtained from all patients. The inclusion criteria for evaluation on the MSU are last seen normal within 4.5 hours of symptom onset, history and neurological examination consistent with acute stroke, and no contraindications for tissue plasminogen activator per guidelines. Once the CT on the MSU rules out a hemorrhage, tissue plasminogen activator is administered in the unit and the patient is transferred to the nearest stroke center.

Data were prospectively collected for MSU tissue plasminogen activator–treated patients. During the course of transferring the patient onto the MSU gurney and positioning the patient for the CT scan, the MSU nurse and paramedic estimated the patient's weight to the best of their ability and previous experiences. Patients and family members could be asked to estimate the weight, and this information could be used by MSU staff in their final estimate. Tissue plasminogen activator (0.9 mg/kg) was administered intravenously to patients on the MSU based on the estimated weight. For patients with an estimated weight higher than 100 kg, the maximum dosage (90 mg) was administered. We compared the estimated weight used on the MSU with the first documented hospital-measured weight (bed scale) within 24 hours of hospital arrival.

Median difference and median absolute percent difference between the weight estimated on the MSU and the actual weight measured in the hospital were calculated. Less than 10% of difference in the weights was considered acceptable. Because the weight differences were not clinically relevant when both weights were greater than 100 kg and the patient received the same maximum tissue plasminogen activator dosage, the differences were set to 0 for these patients. Wilcoxon signed rank test was used to assess the significance of difference in the weights. Tissue plasminogen activator dosage administered on the MSU was compared with the recommended dosage based on the actual weight of the patients. Fisher exact test was used to explore association between weight difference of greater than 10% and patient outcomes, including incidence of symptomatic hemorrhage and discharge modified Rankin score (mRS) less than 2. All analyses were conducted using R version 2.13.1 (R Foundation for Statistical Computing).

Results

Three hundred thirty-seven consecutive MSU tissue plasminogen activator–treated patients were included. The average age of the patients was 67.8 years (SD, 15.6 years), and 47.5% of them were male. Median estimated and median hospital-measured weight were 79.0 kg (interquartile range [IQR], 66.0–94.5) and 78.5 kg (IQR, 65.0–91.7), respectively. The median absolute value of the difference in estimated versus measured weight was 2.7 kg (IQR, 0.6–7.6; $P < .0001$). The median percent difference in weight was 3.6% (IQR, 0.8%–9.4%). The median difference between the tissue plasminogen activator dosage administered on the MSU and the recommended dose based on the actual weight was 1.3 mg (IQR, 0.06–4.8) in absolute value. Fifty-eight patients (17.2%) had both estimated and actual weights of 100 kg or greater. Among the 279 patients whose estimated and hospital-measured weights were not both 100 kg or greater, 174 (62.4%, or 51.6% of the entire sample) had weight difference of less than 5%, 49 (17.6%, or 14.5% of the total sample) had weight differences between 5% and 10%, and 56 (20.1%, or 16.6% of the entire sample) had weight difference greater than 10% (Fig 1). There were no symptomatic intracerebral hemorrhages in patients with overestimation of weight by greater than 10%.

There were 16 patients whose estimated weights were greater than 10% less than the actual weight, and 4 of them (25.0%) had discharge mRS of 0 or 1. Among the rest of 321 patients, 109 (34.0%) had discharge mRS of 0 or 1. There was no association between weight difference and discharge mRS less than 2 ($P = .59$).

Discussion

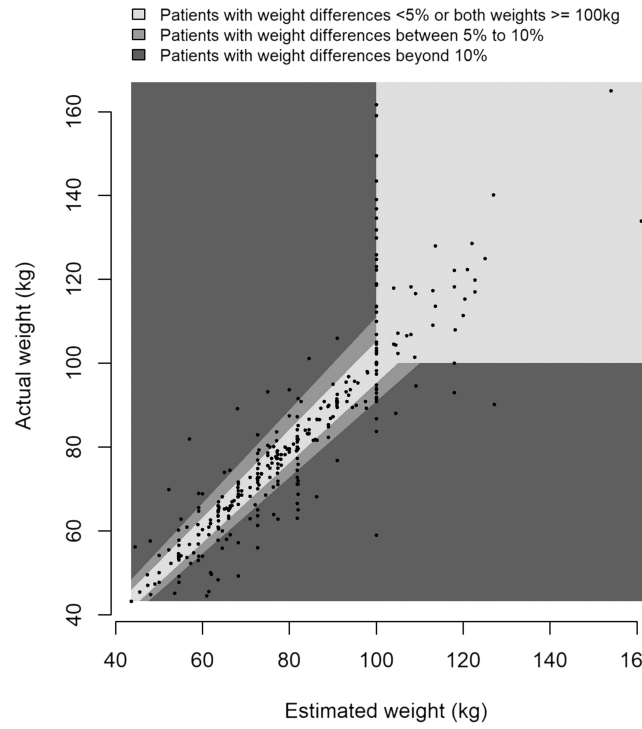
Our study, consistent with previous reports,[4,5] showed that estimating a patient's weight by experienced caregivers is reasonably accurate. A difference of more than 10% between the estimated and measured weights,

occurring in 16.6% of cases, did not lead to adverse outcomes with tissue plasminogen activator treatment. Our findings can be compared with a recent single-center study that reported 14% of acute ischemic stroke patients treated with tissue plasminogen activator in the study received an incorrect thrombolytic dose because of a mean of 9.5% divergence of weight estimate compared with actual weight. In our study, we found a mean divergence of 7.0%. In both studies, a misdose was not associated with either poor outcomes or a higher risk of hemorrhage.[6] The differences in weights in our study led to an undertreatment or overtreatment of, on average, 3.5 mg of tissue plasminogen activator. Keeping this in context, this would represent a dose of 0.86 to 0.94 mg/kg (or variability of 0.04 mg/kg) for an 81-kg patient. Considering that "low-dose" tissue plasminogen activator considered equivalent in some countries is 0.6 mg/kg, or 0.3 mg/kg lower than the "full" dose,[7] and that doses used in the pilot studies to determine the dose for the pivotal National Institute of Neurological Disorders and Stroke trial differed by 0.1 mg/kg,[8] the underdosage or overdosage occurring as a result of estimating the patients' weight seems rather modest.

There have been efforts to accurately weigh patients in the prehospital setting using scales designed for emergency medical services gurneys.[9] In that report, the mean difference between a physician estimate and a gurney-scale measurement was 5.7 kg. In our study where experienced nurses and paramedics estimated patient weights, the mean difference was 6.0 kg and the median difference was 2.7 kg in absolute values. This indicates that, if estimated weights are used, it is important that estimates be carried out by caregivers experienced in lifting and transferring patients. Weight measures routinely obtained in clinical care are highly correlated with those obtained by trained research staff and may be used, without statistical correction.[5]

Finally, measured weights themselves may be inaccurate. Although recording an accurate body weight is critical for accurate drug dosage, and inconsistencies in documenting a patient's body weigh can have a negative impact on patient care because of errors in medication dosage, Lees and Allen-Mills[10] found that weighing patients was often delegated to nonregistered health professionals. Furthermore, they found that, in many hospital settings, weighing scales were not calibrated

FIGURE 1 **Distribution of actual weight and estimated weight for stroke patients treated with tissue plasminogen activator in the study. The light gray–shaded area represents the patients with either less than 5% of difference between the actual and estimated weights or both weights were 100 kg or greater. The gray-shaded area represents the patients who had weight differences between 5% and 10% (and both weights not >100 kg). The dark gray–shaded area represents the patients who have weight differences greater than 10% (and both weights not >100 kg).**



properly. An audit of a number of National Health Service organizations found that weighing equipment in regular use in clinical areas was often incorrectly calibrated or of the wrong type.[11,12]

Mobile stroke units are a new, emerging field in nursing. For the last 7 years, the profession has been expanding all over the world, with 23 currently in the United States and growing. Tissue plasminogen activator is a weight-based medication, and nurses do not have access to weigh patients on the MSUs. Therefore, it is crucial for the nurse to obtain information that aids in an accurate weight estimation. Nurses will need to continue to estimate weight in emergency situations where scales are not available yet tissue plasminogen activator has to be administered as fast as possible. Our results provide context on the accuracy of this practice and reassurance that inevitable inaccuracies will not result in poor outcomes and should not deter or delay patient treatment.

Our study has limitations. It was carried out in a single MSU by experienced nurses and paramedics, and results might not be as good as in other settings. In addition, we cannot separate out the relative contribution of input from patients or family on the final estimated weight.

Summary

Estimated weights for tissue plasminogen activator dosing can be accurate and safe.

References

1. The National Institute of Neurological Disorders and Stroke rt-PA Stroke Study Group. Tissue plasminogen activator for acute ischemic stroke. *N Engl J Med*. 1995;333(24):1581–1587.
2. Hacke W, Donnan G, Fieschi C, et al. Association of outcome with early stroke treatment: pooled analysis of ATLANTIS, ECASS, and NINDS rt-PA stroke trials. *Lancet*. 2004;363:768–774.
3. Yamal JM, Rajan SS, Parker SA, et al. Benefits of stroke treatment delivered using a mobile stroke unit trial. *Int J Stroke*. 2018;13(3):321–327.
4. Graves A, Case D, Gupta R, et al. Comprehensive stroke centers: recognizing the need for complex stroke care and interventional radiology's contribution. *Semin Intervent Radiol*. 2013;30(3):325–330.
5. Graves A, VerHage A, Richlik B, et al. Estimated versus actual weight when dosing rt-PA in acute ischemic stroke: is there a difference? *J Neurosci Nurs*. 2013;45(4):180–185.
6. Staszewski J, Dębiec A, Derbich M, et al. Frequency, risk factors, and clinical significance of incorrect dose of alteplase due to weight estimation in acute ischemic stroke patients: a single-center retrospective study. *J Neurosci Nurs*. 2019;51(5):267–272.
7. Jauch EC, Saver JL, Adams HP Jr., et al. 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*. 2013;44(3):870–947.
8. Haley EC, Levy DE, Brott TG, et al. Urgent therapy for stroke. Part II. Pilot study of tissue plasminogen activator administered 91-180 minutes from onset. *Stroke*. 1992;23(5):641–645.
9. Ragoschke-Schumm A, Razouk A, Lesmeister M, Helwig S, Grunwald IQ, Fassbender K. Dosage calculation for intravenous thrombolysis of ischemic stroke: to weigh or to estimate. *Cerebrovasc Dis Extra*. 2017;7(2):103–110.
10. Lees L, Allen-Mills G. Auditing the nursing standard for weighing patients on an acute medical unit. *Nurs Times*. 2009;105(27):12–13.
11. Local Authorities Coordinators of Regulatory Services. *The Weight of the Matter: Interim Report of the LACORS National Medical Weighing Project 2008/9*. London, England: LACORS; 2008.
12. Local Authorities Coordinators of Regulatory Services. *The Weight of the Matter: Final Report of the LACORS National Medical Weighing Project 2008/9*. London, England: LACORS; 2009.