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SHEDDING LIGHT ON MOBILE STROKE UNIT DISPATCH PROTOCOLS: A GLOBAL SURVEY ANALYSIS

May Nour, MD, PhD[1]; Irina Lorenz-Meyer, MSc[2]; Matthias Wendt, MD[3]; Anne Alexandrov, PhD, AGACNP-BC, ANVP-BC, NVRN-BC, ASC-BC, CCRN, FAAN[4]; Eugen Schwabauer, MD[5]; Henry Zhao, MD[6]; Blake Buletko, MD[7]; Karianne Larsen, MD, PhD[8]; Kimberly Gilbertson, BScN, RN[9]; Stephanie Parker, MHA, BSN, RN[10]; Nicolas Bianchi, MD[11]; Nathan Jennings, BBS, BSOL, EMTP[12]; Ilana Spokoyny, MD[13]; Jason Mackey, MD[14]; Christopher Richards, MD[15]; Nichole Bosson, MD[16]; Yongchai Nilanont, MD[17]; Kenneth Reichenbach, CRNP, MSN[18]; Julie Goins-Whitmore, RN, MBA[19]; Diana Proper, MS, RT (R) (VI) ARRT[20]; Klaus Faßbender, MD[21]; James Grotta, MD[22]; Heinrich Audebert, MD[2]

Author Affiliations: 1. University of California, Los Angeles (UCLA), California, United States; 2. Center for Stroke Research Berlin, Charité - Universitätsmedizin Berlin, Berlin, Germany; 3. Department of Neurology, Unfallkrankenhaus Berlin, Germany; 4. College of Nursing. University of Tennessee Health Science Center. Nashville, Tennessee, United States; 5. Vivantes Klinikum Neukölln, Berlin, Germany; 6. Royal Melbourne Hospital. Melbourne, Australia; 7. Cleveland Clinic Foundation, Cleveland, Ohio, United States; 8. Norwegian Air Ambulance Foundation. Norway; 9. Alberta Health Services. Edmonton, Alberta, Canada; 10. The University of Texas Health Science Center at Houston, Texas. United States; 11. Emory University, Atlanta, Geogia, United States; 12. Ohio Health, Columbus, Ohio, United States; 13. Mills-Peninsula Medical Center, Burlingame, California, United States; 14. Indiana University School of Medicine, Indianapolis, Indiana, United States; 15. University of Cincinnati, Cincinnati, OH, USA; 16. LA County EMS, Los Angeles, California, United States; 17. Mahidol University, Salaya, Thailand; 18. LeHigh Valley Health Network, Allentown, Pennsylvania, United States; 19. Neuroscience Mercy Health, Toledo, Ohio, United States; 20. University of Rochester, Rochester, New York, United States; 21. Saarland University, Saarbrücken, Germany; 22. Memorial Hermann-Texas Medical Center, Houston, Texas, United States.

**Corresponding Author*: mnour@mednet.ucla.edu

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ABSTRACT

Background: Treatment on Mobile Stroke Units (MSU) improves outcomes for patients with acute ischemic stroke, but MSU effectiveness relies on accurate field dispatch. This study aimed to collect data on dispatch infrastructure, methods of dispatching, operational rules, and the accuracy of dispatcher impressions relevant to MSU operations worldwide.

Methods: In 2020, the PREhospital Stroke Treatment Organization (PRESTO) surveyed all operational MSUs, with 20 of 23 MSUs (87%) on four continents responding. The survey investigated dispatch patterns of these resources, hypothesizing that inaccurate dispatch rates far exceed treatment admission rates. We assessed dispatch modes, dispatcher training levels, numbers and dispatch types, en route cancellations, and patient diagnoses.

Results: All 20 MSU services reported dispatching from emergency medical system (EMS) dispatch centers, with 14 sites also responding to requests from EMS personnel based on on-scene evaluations. Aside from 2 programs, all participated in initial dispatcher stroke training, but only 6 (30%) continued regularly. The median number of dispatches per year was 325, ranging from 119 to 2174. In addition to suspected stroke, 8 (40%) regularly dispatched for 'cardiac arrest alarms' and 13 (65%) for altered levels of consciousness. One also responded to calls for seizures, syncope, headaches, and other dispatches suggesting possible stroke. A median of 41% of deployments were cancelled en route by on-scene EMS for presumed non-stroke impressions or readiness to transport before MSU arrival. Of patients evaluated on scene by MSUs, stroke was excluded in 48%. Eighteen percent of assessed patients (~11% of all dispatches) were diagnosed with cerebral ischemia within 4.5 hours and were potentially eligible for intravenous thrombolysis.

Conclusions: Allocating MSUs to the most clinically appropriate dispatches is crucial for efficacy and benefit. Enhancing dispatcher recognition of stroke through education, feedback, and advanced technologies like AI algorithms can improve dispatch accuracy.

INTRODUCTION

Stroke is a "golden hour" emergency in which the timing of diagnosis and treatment are critical. In ischemic stroke, medical and endovascular therapies for vascular reperfusion, such as intravenous thrombolysis (IVT) and mechanical thrombectomy (MT), are highly time sensitive with better functional outcomes the earlier they are initiated (Lees et al., 2010; Saver et al., 2016). Mobile Stroke Units (MSU) are specialized ambulances equipped with CT-scanners, point-of-care laboratories (Walter et al., 2012) and a specialized stroke team, allowing for definitive prehospital diagnosis, initiation of thrombolytic therapy, reversal of hemorrhage in patients on anticoagulation, the initiation of antiepileptics and other brain and lifesaving treatments. The conclusive diagnosis offered in the prehospital setting on these specialized ambulances through image based evidence as well as neurologist expert examination allow for pre-arrival notification of MT teams at receiving hospitals aimed at expediting in-hospital endovascular reperfusion. Treatment on MSUs reduces time to IVT by ~ 30 minutes and results in more patients treated earlier as compared to treatment in the emergency department after standard EMS transport (Ebinger et al., 2014; Walter et al., 2012). Recent pivotal clinical studies have shown that MSUs improve 3-months outcome of acute ischemic stroke patients who are suitable for IVT (Ebinger et al., 2021; Grotta et al., 2021). However, the net benefit to the healthcare system and communities of MSUs is directly related to the number of appropriate patients who can access this resource. In order to optimize efficiency, MSUs must be dispatched simultaneously with first responding EMS units for calls with suspected stroke. This highlights the critical role played by the emergency call takers and dispatchers in identifying potential candidates for MSU management. Given that globally & locally, dispatchers use a variety of dispatch algorithms, the sensitivity, specificity and positive predictive value of stroke dispatches vary widely. We conducted a survey focused on MSU dispatch protocols in existing MSU programs worldwide in order to understand best practice models and provide the basis for the future development of a robust dispatch mechanism for these specialized resources.

METHODS

A dispatch survey was compiled by the dispatch committee of the PREhospital Stroke Organization (Audebert et al., 2017) investigating different aspects of MSU operations with regards to MSU deployment and interactions with local dispatch centers. A survey email was sent to MSU sites in 2020 requesting 2019 data. If a MSU was not operating during the entirety of 2019, an extrapolation of numbers for the 12-month period was allowed. The data collected included the questions detailed in Table 1 and provided in detail in the supplement. Using descriptive analyses with SPSS statistics software (IBM, US), we provide proportions expressed in percentages as well as continuous variables expressed as medians and ranges (minimum to maximum) and interquartile ranges (IQR) unless otherwise indicated for the responses provided by the MSU programs.

General Survey Elements
Dispatch Center Infrastructure and Education • Use of specific stroke identification protocol • Dispatcher training for stroke recognition (including frequency of training) • Feedback to dispatchers
Stroke Identification • Use of prehospital stroke scale • Focal neurological symptoms aside from strength and speech alterations • Dispatching to non-focal symptoms • Percentage of non-stroke diagnosis upon field assessment • Evaluation of accuracy in stroke identification
Dispatch Rules/Algorithms • Dispatching to all vs. some dispatcher impressions of stroke (based on time from symptom onset) • Dispatching to other dispatcher impression of non-stroke • Dispatching based on request of first responders following initial patient evaluation • Dispatch to suspected stroke with unknown time of onset
EMS/MSU Organization • Percentage of en route response cancelations • Cancelation secondary to delay in on scene arrival • Frequency of training of paramedics • Number of dispatches per year • Typical time from dispatch to on scene arrival • Number of CT and CTA scans performed per year • Operational days and hours of clinical service
Diagnoses of Stroke Dispatches • Percentage of diagnoses related to the following: ischemic stroke/TIA within 4.5 hours of onset, ischemic stroke/TIA beyond 4.5 hours of onset, hemorrhagic stroke • Median NIHSS for stroke patients • Percentage of other neurological diagnoses including epileptic seizures, headache, syncope, peripheral vertigo, movement disorder, delirium, transient global amnesia, tumor • Percentage of other non-neurological diagnoses including: psychiatric disorder, infection, metabolic disorders, hypo/hypertension, primary cardiac disorder • Source of diagnosis (MSU diagnosis vs. final hospital diagnosis)

Table 1. MSU Dispatch Survey Elements

RESULTS

Amongst 23 MSUs operational in 2019, we received 20 responses (87%) with 13 from North America, 5 from Europe, 1 from Asia and 1 from Australia. As of October 2021, the average (mean) operational time of the MSU programs who participated was 4.5 years and ranged between 1 and 12 years (SD 2.8y). The median time on clinical service was 12 hours per day (8 to 24 hours, IQR 9-15h). Eight MSUs had restricted operations on weekdays, excluding weekends. The total numbers of dispatches per year ranged from 119 to 2174 (median: 325, IQR 260-1158) and the volume of thrombolysis correlated with volume of dispatches (Figure 1). All MSU services reported dispatching directly through emergency medical system (EMS) dispatch centers or fire departments, of whom 14 (70%) also reported responding to alerts from on-scene first responders based on initial patient evaluation on scene.

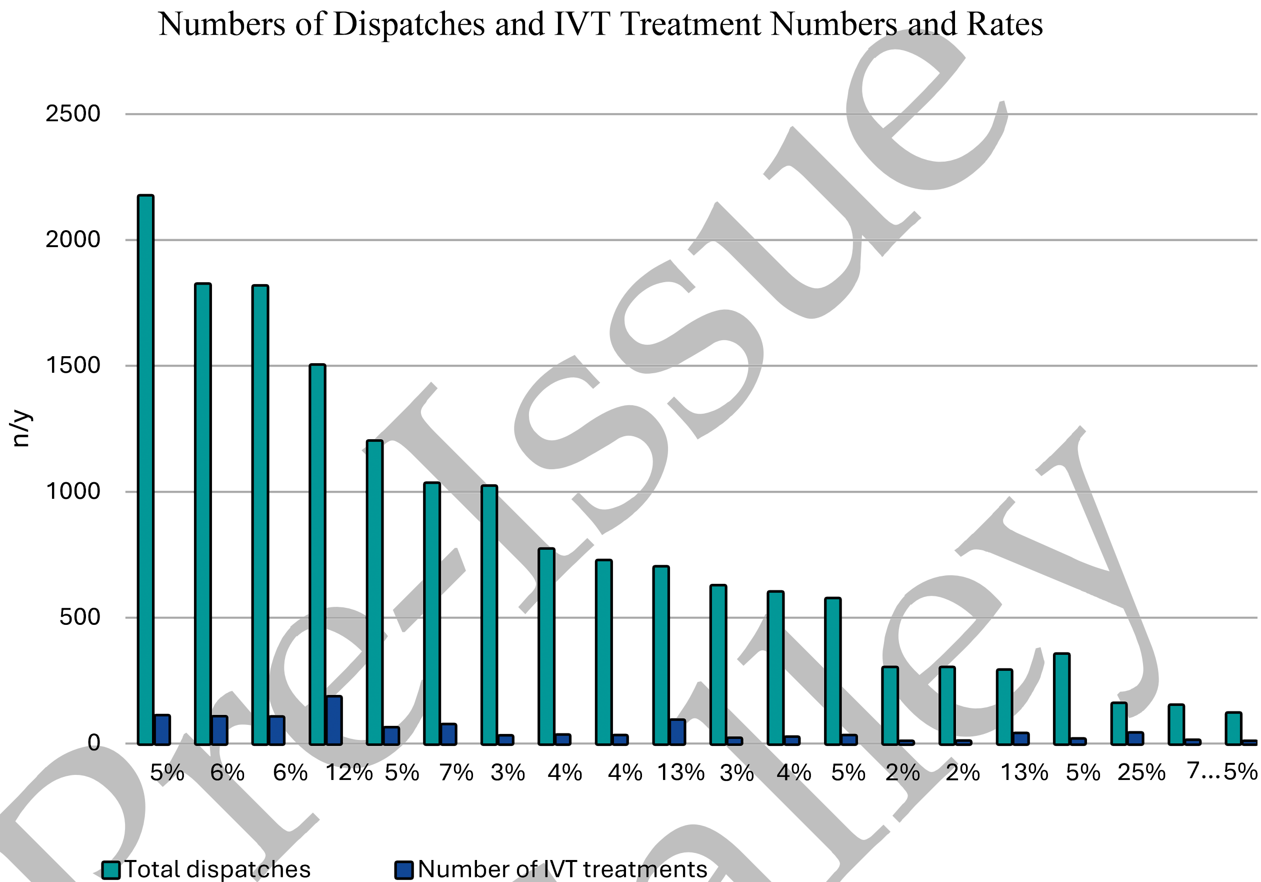

Figure 1: Number of Dispatches and tPA Treatments Numbers and Rates in 2019. Total numbers of dispatches at different MSU sites and respective numbers of intravenous thrombolytic (IVT) treatments per year. Proportion (%) of dispatches leading to prehospital IVT from all dispatches

Stroke Identification At Dispatch Level

Seventeen of 20 (85%) dispatch centers used specific stroke identification protocols/algorithms while the remaining 3 (15) relied on stroke identification by experienced dispatchers. A wide variety of dispatch systems were used, with 5 (25%) MSUs using the Medical Priority Dispatch System (MPDS, International Academies of Emergency Dispatch), others using a variety of commercial programs, dispatch algorithms made locally by their medical directors, or a combination thereof. With the exception of 2 (10%) programs, all reported participating in initial stroke identification/recognition training for EMS dispatchers in their system of care, however, only 6 (30%) programs followed that with routine (1 training/year).

Dispatch Regulations for MSUs

In the majority of MSUs, deployments were restricted by symptoms time since onset or patient last-seen-well time ranging from 4 to 24 hours, while 7 (35%) programs did not restrict their attachment to calls by a knowledge of the patient last known well time ahead of dispatch. Apart from dispatches for suspected stroke, 8 (40%) MSUs also attached to calls of 'cardiac arrest alarms' and 13 (65%) deployed to altered level of consciousness dispatches. One (5%) US-based MSU program responded to other call types including 'seizure', 'syncope', 'headache', 'sick person' if thought to be suspicious for stroke.

MSU Operational Rules, Number of Stroke Evaluations and Treatments

With the exception of 5 (25%) MSUs, all programs operated under a protocol of concurrent dispatch with first responding units. A median of 41% (IQR 25-61%) of MSU deployments were cancelled en-route by the first responders on-scene due either to a provider impression of non-stroke or much less frequently to readiness to transport ahead of MSU arrival. Fourteen (70%) MSU programs operated within a maximum (calculated) distance-to–scene time with a median of 20 (IQR 15-25) minutes, ranging from 10 to 160 minutes, the latter in a rural area.

The median number of CT scans was 171, ranging from 23 to 402 (IQR 20-91). Eight (40%) MSUs did not use CT-angiography (CTA) on board while the remaining MSUs performed on average (median) 42 CTAs per year (range: 12 to 402, IQR 20-91). After large vessel occlusion (LVO) diagnosis, pre-notification of in-hospital neurointerventional teams responsible for mechanical thrombectomy and delivery to the angiography suite was the preferred route. The median number of IVT treatments was 29 times per year ranging from 6 to 184 times (IQR 17-70).

Prehospital Diagnoses

For the evaluation of the patient diagnoses, 9 MSU programs participating in the survey reported final in-hospital diagnoses, 9 reported MSU-based diagnoses and 2 provided likely diagnoses. The proportions of most frequent diagnoses encountered are provided in Table 2. At on scene evaluation, the MSU teams excluded a diagnosis of stroke, or had a provider impression of non-stroke, 48% of the time (range: 3%-79%). Eighteen percent of all patients assessed (~11% of dispatches) had a likely diagnosis of cerebral ischemia and were within 4.5 hours of onset and therefore potential candidates for IV thrombolytic treatment.

Diagnosis	Median Proportion
Ischemic stroke or TIA within 4.5 hours of onset/LSW	18.3%
Ischemic stroke or TIA beyond 4.5 hours of onset/LSW	17.5%
Hemorrhagic stroke	4.5%
Non-stroke intracranial hematoma	0.5%
Epileptic seizures	5.0%
Non-stroke related headache	2.0%
Syncope	1.3%
Non-stroke related vertigo	0.9%
Delirium	1.3%
Movement disorders	0.7%
Tumor diseases	1.0%
Psychiatric diseases	1.4%
Infectious diseases	4.5%
Metabolic diseases	2.0%
Arterial hyper-/hypotension	2.1%
Dehydration	1.1%
Cardiac diseases	1.2%

Table 2. Most Frequent Diagnoses of Patients with Prehospital Stroke Dispatch

DISCUSSION

Our survey from existing MSU operating in 2019 demonstrates that these novel specialty ambulances are dispatched in a heterogeneous fashion with differing dispatch algorithms. Hence, they vary in the number of dispatches, MSU admissions and therefore the number of patients treated by IV thrombolysis. Seen with each of their systems of care, the accuracy of EMS call taker of stroke is low worldwide and remains a barrier for a more efficient use of MSUs and the access of patients to this life and brain-saving resource. These results correspond to findings of a systematic review of stroke recognition tools at a dispatcher level with sensitivities ranging between 41%-83% and positive predictive values between 41%-68% (Oostema, Carle, Talia, & Reeves, 2016). For EMS call takers, a limited amount of time and a limited breath of information available remain critical barriers for precise stroke dispatching. Additionally, current dispatch systems such as MPDS only use common stroke symptoms such as weakness, neglecting other subtle signs of stroke including gaze preference, neglect, visual field loss and aphasia. A targeted approach to the improvement in the sensitivity, specificity and positive predictive value for stroke dispatches is therefore critical to the successful deployment of highly specialized ambulance treatment units such as MSU.

Future efforts for improvement may focus on the improvement of dispatch algorithms, routine training and education provided for EMS call takers and dispatchers as well as the incorporation of novel AI algorithms which may aid in diagnosis by phone. In Berlin, the proportion of acute ischemic stroke patients was highest after the joint derivation and validation of a stroke identification algorithm with the MSU team and the Dispatch Center in 2010 (Krebes et al., 2012). In the PHANTOM-S pilot period in early 2011 and only a few months after completing the aforementioned stroke dispatch project, 58% of evaluated patients with stroke dispatch had ischemic brain events (ischemic stroke or TIA) and 15% of all dispatches led to IVT(Weber et al., 2013). In the subsequent PHANTOM-S trial (2011-2013), 44% of the dispatches resulted in the diagnoses of ischemic brain events and IVT was given in 10% of dispatches (Ebinger et al., 2014). After several years without systematic training for various reasons, corresponding numbers were 32% for ischemic brain events and 5% for IVT during 2019. As there are no other obvious reasons for the worsened stroke dispatch accuracy, this experience argues for a need training of dispatchers and continuous quality management in dispatch centers.

Our survey carries limitations including retrospective data reporting and a difference in data collection methodology by a limited number of programs currently operating. It also carries potential selection bias of sites which elected to participate in the survey.

This survey indicates that the accuracy of EMS call taking for identification of stroke is low worldwide. With clinical benefits of MSU care demonstrated in recent studies, MSU programs should actively collaborate with their local dispatch centers to improve the positive predictive value of stroke dispatches, particularly for MSU deployment. Based on current evidence-based practice, MSUs are most effective in offering hyperacute treatment of ischemic stroke eligible for IV thrombolysis. Future studies are needed to understand the effects of quality improvement measures on the accuracy of stroke identification at a dispatcher level.

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