

Mobile Stroke Unit News

News magazine of the PRE-hospital Stroke Treatment Organization

Volume 1, No. 1

The Rapidly Expanding Field of Prehospital Stroke Care

By Klaus Fassbender, MD
and Shrey Mathur, MD

Dear PRESTO Community,

Welcome to the inaugural issue of the official newsletter for the PRE-hospital Stroke Treatment Organization (PRESTO). We hope that the newsletter will provide you with valuable updates on our rapidly growing organization and Mobile Stroke Units.

It certainly is a great time for Mobile Stroke Units and prehospital stroke care in general. It has been exciting to see the Mobile Stroke Unit concept grow and develop from the first MSU in Homburg on the road 10 years ago to new MSUs in the last months in San Mateo County, Indianapolis, Atlanta, Rochester, Lehigh Valley, New York City, Southend, Coimbatore, Bangkok and Zhengzhou. Taken together, there are more than 30 active and planned MSU projects worldwide.

We are proud to announce that we have founded PRESTO as a professional organization and legal entity as the primary spokes group for MSU-based pre-hospital stroke treatment and



Klaus Fassbender, MD
PRESTO President



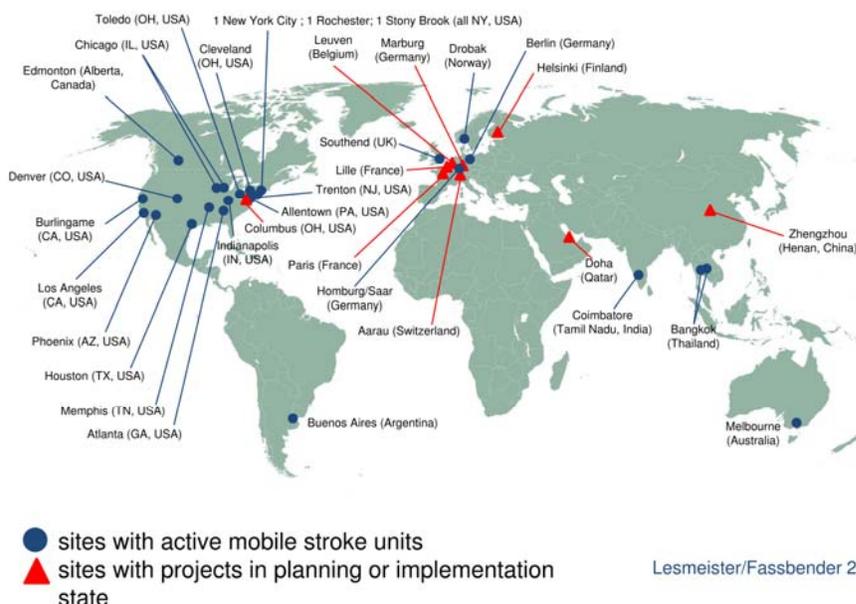
Shrey Mathur, MD
PRESTO Secretary

related issues. PRESTO exists for and is dedicated to the following purposes:

- To improve stroke outcomes by supporting research and advocacy for pre-hospital stroke treatment in Mobile Stroke Units (MSUs).
- To provide a platform to enhance collaborative research across the spectrum of prehospital stroke care.

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Medical Centers with Ambulance-Mounted Stroke Brain Imaging



Mobile Stroke Units May Help Increase and Speed Intra-arterial Thrombectomy

By Amanda Jagolino, MD; Alexandra Czap, MD; and James C. Grotta, MD

The ongoing BEST-MSU study is a randomized (by week) evaluation of Acute Ischemic Stroke (AIS) management in tPA eligible patients on a MSU compared to standard management by emergency medical services (EMS). The study includes patients going on to have Intra-arterial Thrombectomy (IAT) at the destination hospital. During MSU management, several steps leading to



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IAT are completed in the prehospital setting: CT of the brain, neurologist assessment, screening for eligibility of tPA, tPA treatment when applicable,

baseline labs, and ED pre-notification. In addition, MSU management can potentially increase IAT eligibility if patients are appropriately triaged to stroke centers with IAT capability, and present to their EDs prior to establishment of large infarction that can preclude IAT. A BEST-MSU sub-study

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Note From the Editor

By Robert G. Kowalski, MD, MS



With this issue we launch the first newsletter of the PRE-hospital Stroke Treatment Organization, or PRESTO. We hope this will be the first of many years of newsletters to help chronicle developments in this new paradigm of care of acute stroke, with an international scope.

Born approximately a decade ago through the work of Prof. Klaus Fassbender and colleagues at Saarland University Medical Center, in Homburg, Germany, the mobile stroke concept originated with placement of a specialized head CT scanner on an ambulance for brain imaging in the field. The Saarland center's mobile stroke truck now includes a point-of-care laboratory, stroke medication, and telemedicine technology for transmission of real-time videos (<https://www.mobile-stroke-unit.org/the-msu-concept>).

Since its inception, the concept has gained acceptance at multiple centers in Europe, the Americas, Asia and Australia. These include active mobile stroke operations in at least three German cities, the UK, Norway, Canada, Argentina, Thailand, India and Australia. In the U.S., mobile stroke units are now operating in at least 14 cities, with more in implementation stages. Others are planned for France, Switzerland, Belgium and Finland.

In October 2018, a group of MSU pioneers including Prof. Fassbender; James Grotta, MD of the University of Texas, Houston; Heinrich J. Audebert, MD of Charite Universitat, Berlin, German; and Stephen David MD of the University of Melbourne, Australia, gathered during the World Stroke Congress in Montreal, Canada, for the

first official meeting of the newly formed PRE-hospital Stroke Treatment Organization, PRESTO. Prof. Fassbender was selected as the group's founding President. Members of the PRESTO Board will be chosen in coming months.

Future issues of the Mobile Stroke Unit News will include recurring features on topics of interest related to pre-hospital stroke care.



William J. Jones, MD, a stroke Neurologist who heads the stroke service at the University of Colorado School of Medicine, and was instrumental

in establishing the Mobile Stroke Unit in Colorado (one of the first three in the United States), will edit the clinical trials section of the newsletter. This will feature results from ongoing trials and studies as they are available and published, as well as provide updates on new clinical trials under consideration utilizing the mobile stroke platform.



Anne Alexandrov, PhD, RN, will write recurring articles on the issue of reimbursement for mobile stroke units, a subject that is being watched intently as centers attempt to

arrange financial support and justification for the MSU model. Dr. Alexandrov is Mobile Stroke Unit chief nurse practitioner and professor in the College of Nursing at the University of Tennessee Health Science Center.

The newsletter welcomes submission of articles on any topic related to mobile stroke.

Robert G. Kowalski, MD, MS is Director of Clinical Neurology Research at the Henry Ford Hospital, in Detroit MI, and is leading research on the Mobile Stroke Unit at the University of Colorado School of Medicine.

Mobile Stroke Unit Improves Imaging and Reporting Times



By Eric Nyberg, MD

Despite being the mainstay of treatment for acute ischemic stroke (AIS) since its FDA approval over 20 years ago, only 3-5% of patients suffering from

AIS receive tPA. One of the main reasons for this shortcoming is the limited time window, historically 4.5 hours, during which it can be administered. Furthermore, the effectiveness of tPA in improving functional outcomes is exquisitely sensitive to expediency of drug delivery, with a 20% decrease in the likelihood of positive outcome for every 30-minute delay in reperfusion according to one study (Mazighi 2013). Mobile stroke units (MSU) aim to address this shortfall by bringing the personnel and technology necessary for thrombolytic therapy to the patient in the field, thus eliminating the delay in treatment incumbent in the transportation time of the patient to the hospital and repeat examination on arrival.

One of the key technological developments that enables this is made possible by the CT scanner on board. Our MSU is a new generation ambulance equipped with a Ceretom CT scanner. Images are acquired in the field and transmitted to our hospital based PACS via a HIPAA compliant 4G cloud-based system (Figure 1). The image transfer process typically takes about a minute. As a neuroradiologist, I was interested in analyzing the imaging component of the MSU. The 'Stroke Alert' protocol for patients presenting to the Emergency Department with suspected AIS is already highly optimized. Radiologists are notified by phone when Stroke Alert patients arrive in the CT suite, prompting us to walk to the scanner to review images as soon as they are acquired and discuss preliminary results and potential

additional imaging with the stroke neurologists. Very little time is wasted in this process leaving very little opportunity for further improvement. However, from the patient's perspective, this misses the broader picture.



Figure 1: Selected CT image of a patient presenting with aphasia. Despite motion artifact around the periphery, a dense left MCA sign is evident.



Figure 2: Selected CT image of a patient with symptoms referable to the right MCA territory. Despite mild motion artifact, there is evidence of loss of the gray-white differentiation in the right frontal lobe.

picture. The patients' encounters with medical care begins when they reach out to EMS.

Thus we sought to analyze the effect of the mobile stroke unit on imaging times; specifically, the difference between the time elapsed from the time at which the patient calls EMS to the times that images are available in PACS (PACS time) and the time that results are verbally conveyed to the stroke neurologist (Report time), compared with the already highly streamlined Stroke Alert process for patients presenting via the conventional pathway, which follows the current 'pre-hospital stroke alert' guidelines. Our MSU operates locally every other week, with alternate weeks spent operating in a neighboring metropolitan area. This 'on-off' schedule provided optimal conditions for prospective cohort and control data gathering.

Ninety-seven patients presenting from January through September 2016 were included, including 47 consecutive patients imaged in the MSU and 50 control patients presenting through the conventional pathway. Mean times of dispatch to images viewable in PACS were 21 minutes and 44 minutes for MSU and conventional pathways, respectively ($p < 0.001$). Mean times from EMS dispatch to the provision of an actionable report were 34 minutes and 54 minutes for the MSU and conventional pathways, respectively ($p < 0.001$) (Table 1, Nyberg 2018).

Other key imaging metrics were also improved in the MSU cohort. These patients benefited from the provision of an actionable report within the initial 60 minutes since contacting EMS, the so called 'golden hour', 100% of the time, compared with only 78% of cases in the conventional pathway ($p < 0.001$), and in less than 30 minutes in 40% of MSU patients compared with only 4% of controls ($p < 0.001$).

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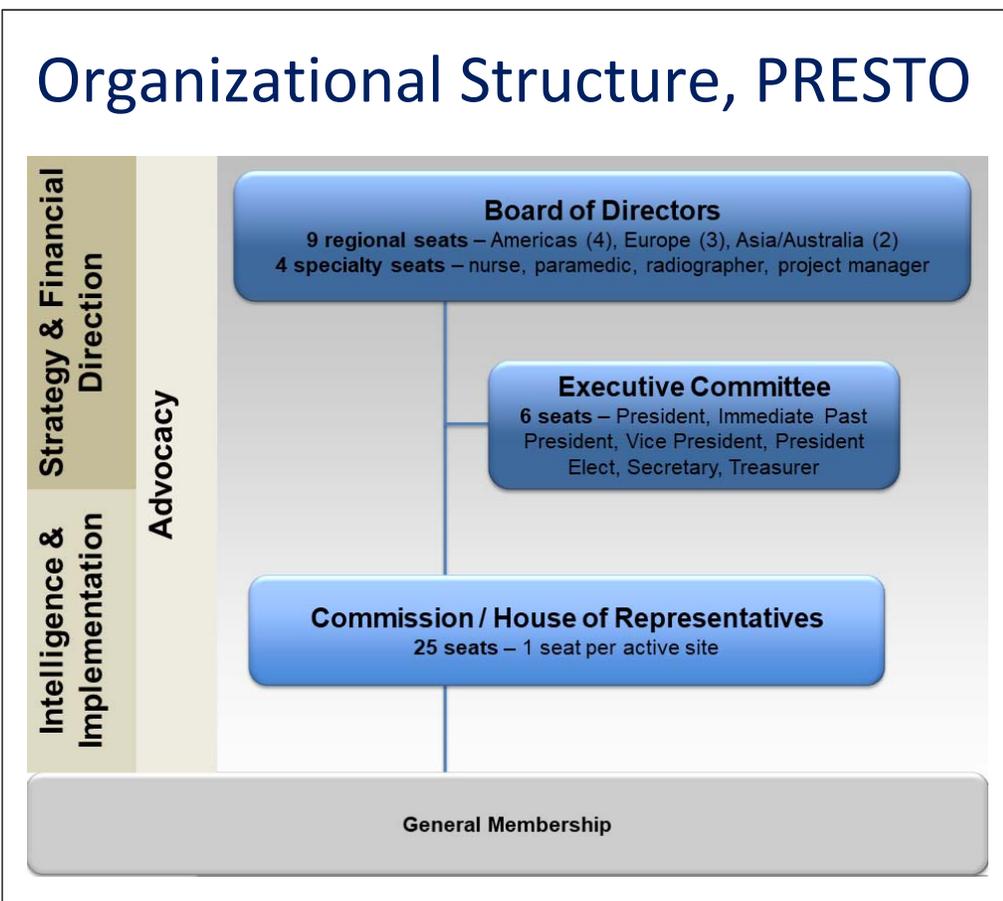
Stroke Treatment Advancing with Ambulance-Mounted Brain Imaging

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- To facilitate the appropriate proliferation and distribution of MSUs by providing a forum for professional scientific and medical communication, resource for public education, and stimulus for governmental, industrial, and philanthropic support.

To facilitate collaboration in the growing PRESTO community, we have compiled a directory of email addresses and maintained an updated mailing list. We have seen this list grow to well over a hundred recipients. It has been great to see the collaboration and exchange of ideas, problems and solutions based on this email list. We are encouraged by such an active and engaged community. We developed a website for PRESTO (PRESTO-MSU.org) to provide a portal for resources and information for those interested in MSUs and the PRESTO community. On the website you will find information about PRESTO as an organization, including the background, our mission, governance (including downloadable bylaws), research collaborations, advocacy and education. Further, we provide general information about Mobile Stroke Units, and details for past and upcoming meetings (including minutes), and a platform for news (the PRESTO newsletter, Mobile Stroke Unit News) and publications.

Importantly, you can become a member through the website (prestomsu.org/membership). More than 200 members from more than 100 institutions have signed up through the website and in person. We hope that the website provides you with easily accessible and useful information which you will be able to share in your networks. We also have an active



Twitter (@PRESTO_MSU) where we encourage you to continue to engage.

At the European Stroke Organization Conference in Gothenburg in May 2018, the Bylaws Committee met and clarified the structure of the organization. We worked to ensure a democratic, representative and transparent structure rooted in the bylaws of the ESO and WSO.

In October 2018, we held our first official PRESTO meeting in Montreal in parallel with the World Stroke Congress. Thank you to all of you who attended and presented at the PRESTO meeting in Montreal. During this meeting, we were able to update on the progress of MSU programs worldwide, gain historical and personal perspective on mobile

imaging development, learn about large trials, thrombectomy campaigns and exciting program experiences (both challenges and successes, e.g. in India and Norway). We further discussed pressing issues including reimbursement and organizational structure.

Based on the discussions and consensus at the meeting in Montreal, we voted for an amendment of the bylaws and governance structure. This new governance structure will provide a voice for different geographical regions (Americas, Europe, Asia/Australia) and also for active and integral members of MSU teams (nurses, paramedics, radiographers, project managers). In addition, we created an advisory committee which will allow each active MSU program to

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have a representative to engage with the Board and Executive.

Looking forward, we will be holding elections for the Board of Directors by email soon. We are striving to represent the diversity of voices in the MSU community and encourage you to take part.

I am honored to serve as the founding president during this stage and am grateful to the many individuals who have been active, vocal and engaged to help make this organization what it is and what it will be.

Klaus Fassbender, MD is Professor and Chairman of Neurology, Saarland University Medical Center, Homburg, Germany. He is the founding President of the PRE-hospital Stroke Treatment Organization (PRESTO).

Shrey Mathur, MD is Scientific Assistant, Department of Neurology, Saarland University Medical Center, Homburg, Germany. He is Secretary of the PRESTO organization.



Mobile Stroke Unit, Saarland University Medical Center, Homburg, Germany

Mobile Stroke Platform Permits Rapid Imaging in Field for Acute Stroke Care

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The tighter standard deviations in both PACS and Report times in the MSU arm also suggest decreased variability and greater reliability of imaging and reporting during a given timeframe.

Thus the MSU made a considerable impact on local key imaging and reporting time metrics, and we expect to find commensurate improvements

in expediency of thrombolytic therapy and improved outcomes, however these data are still being analyzed. However, we may find that there to be a greater benefit in rural areas, where travel times to the nearest stroke center may be considerably more formidable.

Table 1: Mean times from dispatch to images viewable on PACS and dispatch to report

Time (min)	MSU		Control		Difference	P Value
	Mean	SD	Mean	SD		
PACS time	21	5.7	44	46.3	23	<.001
Report time	34	8.8	55	47.1	21	<.001

The increased travel time to and from these areas to stroke centers likely results in decreased drug effectiveness, and may preclude some patients from receiving treatment altogether due to time constraints. Thus the MSU, it is hoped, may not only result in improved treatment outcomes locally, but may also represent an important step toward a more equitable distribution of health care delivery services across different demographic populations.

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Mobile Stroke Concept has Potential Role for Thrombectomy and Earlier tPA

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is to compare important IAT workflow metrics and the proportion of patients undergoing IAT in MSU vs EMS patients delivered to our participating EDs. These metrics will include last known normal, alert, and ED arrival to puncture times.

Initiation of the BEST-MSU trial in August 2014 offered a unique opportunity to observe transitions in IAT management during a time of change in standard of care for AIS. One of the most important workflow metrics with both tPA and IAT is ED arrival to treatment time (door-to-puncture-time, DTPT). There have been substantial efforts to improve ED workflow metrics over the four years since IAT has become standard of care. The start of the BEST-MSU study coincided with the adoption of IAT as standard of care. Therefore, as part of the BEST-MSU IAT sub-study, we aimed to examine DTPT in MSU and EMS patients during the first four years of the study. These results will be presented at the International Stroke Conference in Honolulu Hawaii in February 2019.

Identification of possible IAT candidates based on clinical exam, CT or CTA on the MSU should increase the accuracy of triage, increase the number of patients having IAT, and decrease the time from last known normal or alert to puncture. Whether and how much MSU management affects ED workflow as reflected in the DTPT is less logical. Retrospective comparison of DTPT has demonstrated faster IAT metrics in patients first evaluated via an MSU as compared to patients treated at an outside facility prior to transfer to an IAT-capable hospital (Wei et al, Stroke. 2017;48:3295-3300).

In the BEST-MSU study, we will not include patients in the EMS group who were not taken directly to an IAT center but instead were taken to a non-thrombectomy capable PSC and then transferred to a CSC for IAT. Inclusion of these "mis-triaged" patients in the EMS group would substantially inflate



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treatment times for the EMS group. Omission of this group of patients in our analysis will substantially minimize the time gained by appropriate triage of IAT candidates on the MSU.

Understanding the interaction of MSU management and DTPT is important for maximizing the benefit of MSUs. Acceptance of the safety and efficacy of endovascular therapy for select AIS patients has fueled more resources and attention toward restructuring healthcare systems and formulating multidisciplinary teams to streamline and improve IAT metrics after ED arrival. Protocol development and delegation of the complex steps involved in administering timely and appropriate endovascular therapy across disciplines, including emergency, radiology, neurology, anesthesia, and interventional neurology, can improve DTPT by as much as an hour. However, recommendations for IAT workflow and specific time metrics are not yet as widely accepted and monitored as for intravenous tPA. Optimal pre- and post-ED arrival IAT protocols likely vary between different healthcare systems and resource environments as well as among patients.

We suspect that more frequent and extensive pre-hospital notification and interaction with the ED and intervention teams represents an opportunity for further improvement in DTPT as a result of MSU management of potential IAT candidates. When the BEST-MSU study was conceptualized, IAT was not standard of care and the protocol focused mainly on speeding tPA treatment. The study had no standardized protocol for hospital pre-notification and IAT preparation among study sites. Furthermore, once the MSU arrived at the ED, the protocol emphasized that the MSU team should not influence post-arrival care. This has been a lost opportunity for the MSU to speed DTPT. Much of what occurs after arrival in the ED in assessing the patient for IAT duplicates what has already occurred on the MSU, including careful expert neurological exam, scrutiny of the CT scan, and in some cases CTA. Going forward, better pre-hospital and post-arrival communication between the MSU, ED, stroke and endovascular teams might avoid such duplication and allow faster and, in some cases, direct transfer to the endovascular suite.

In summary, while initially conceived as a means to increase and speed tPA treatment, MSUs provide a unique opportunity to provide the same results for IAT. Recent trends in DTPT in MSU and EMS managed patients to be presented at ISC indicate that to maximize the benefit of MSUs on IAT will require close communication and coordination between the MSU, ED and interventional teams to avoid duplication of efforts.

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