

Mobile Stroke Units

The Next Frontier in Stroke Treatment

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Mobile stroke units (MSUs) are all the rage now in the stroke world, and for good reason. Stroke treatment has always been time-sensitive, with acute treatment being limited by the ability of physicians to assess stroke patients until they arrive in the emergency room. Now these MSUs—ambulances equipped with a portable CT scanner, point-of-care laboratory testing, access to a vascular neurologist, and select medications—allow for acute stroke workup and treatment to start even before the patient gets to the hospital.

Origin of the MSU

The MSU concept was first pioneered by the Hospital of the Saarland University in Germany, where it resulted in a marked reduction in stroke treatment times.¹ The Stroke Emergency Mobile (STEMO) group in Berlin then showed treatment with an MSU led to a tenfold increase in patients treated within the first hour of stroke, with better neurologic outcomes.² MSU patients were more likely discharged home than to a nursing facility. In 2014, Dr. James Grotta and his team at Memorial Hermann Hospital in Houston introduced the first MSU in the United States.³ Dr. Grotta's group started the Benefits of Stroke Treatment Delivered Using a Mobile Stroke Unit (BEST-MSU) study, investigating the effect of MSU treatment on stroke patients and describing other aspects and hurdles to its implementation. In a few years, MSUs have quickly turned into a phenomenon, with operating centers expanding coast to coast. In 2016, the PRE-Hospital Stroke Treatment Organization (PRESTO) was formed to advance MSU research internationally and to explore the application of MSUs in the treatment of other neurologic conditions such as hyperacute intracerebral hemorrhage.⁴

Variations on a Theme

As of this writing, eight centers spanning coast to coast across the United States are operating MSUs in various configurations. All MSUs are equipped with a CT scanner,

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which provides the standard requisite noncontrast head CT needed for stroke treatment. While most use a portable CT scanner to satisfy physical and technical constraints, the University of Tennessee equipped their 14-ton MSU with a full hospital-grade CT scanner replete with gantry, which can provide more sophisticated brain and vascular imaging if needed.⁵ Other centers, such as the Cleveland Clinic, are studying the utility of obtaining CT angiography on-board their MSU.⁶ Another difference among MSUs lies in staffing: onboard staff typically includes emergency medical technicians or paramedics, a radiology technician, and nurse or nurse practitioner, in addition to a vascular neurologist.⁴ Some variants, such as that of the Cleveland Clinic, employ telemedicine consultation with the vascular neurologist. In fact, the Cleveland Clinic group showed that operating their MSU with telemedicine was feasible and had a low technical failure rate.⁷ In addition, Dr. Grotta's team demonstrated that an assessment done through telemedicine was just as reliable as that of an on-board vascular neurologist.⁸

Quality of Care/Preliminary Results

MSUs have already begun to demonstrate benefit toward stroke patients. A preliminary study from the

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Cleveland Clinic found that MSUs reduced time to imaging and treatment.⁷ Another study from the University of California, Los Angeles, suggests that patients who receive intravenous (IV) tissue-type plasminogen activator (tPA) in an MSU setting may benefit from reduced disability compared to those who receive IV tPA after arriving in the emergency department.⁹ Aside from studying patient outcomes, vascular neurologists are also looking at questions regarding the utility of MSUs in certain geographical regions, best models for workflow, and cost–benefit analyses. Preliminary studies suggest that the expense of MSUs will pay off in the long run,¹⁰ although it remains to be seen which conditions are most optimal for supporting an MSU. Results from the PRESTO and BEST-MSU studies will help answer these and other questions.

Future Directions

By effectively extending the reach of the hospital into the prehospital setting, MSUs are poised to help with much more than simply reducing the time to treatment with IV tPA. With the recent advances in endovascular therapy for stroke, there is a renewed focus on how to deliver patients with large vessel occlusions to endovascular-capable stroke centers. MSUs can help in this regard, avoiding the need to transfer between stroke centers while delivering IV tPA to eligible patients. Even if patients do not qualify for these acute therapies, reaching them sooner could help expedite medical treatment, thereby potentially altering their disease course.

The benefit of MSUs is not exclusive to ischemic stroke: the PRESTO and other groups are already using MSUs to study the hyperacute period of diseases such as intracerebral hemorrhage, while offering the ability to treat them with antihypertensives and anticoagulation reversal agents. Other groups have found that MSUs could help benefit other neurologic emergencies, such as subarachnoid hemorrhage and traumatic brain injury. Before the advent of MSUs,

the Field Administration of Stroke Therapy–Magnesium (FAST-MAG) study—employing a network of first responders to study the effect of magnesium as a neuroprotectant for stroke in the prehospital setting—pioneered the idea of conducting stroke research in the prehospital setting.¹¹ Now, with dedicated resources to treat stroke, MSUs are poised to continue that tradition, serving as a new venue for hyperacute stroke research for areas such as biomarkers and advanced imaging software.

Even as their efficacy and implementation are being studied, MSUs are already making an impression on other fields of medicine: it was recently reported that the University of Minnesota is working on a specialized ambulance concept for the treatment of cardiac arrest and heart failure.¹² MSUs are here to stay, and with further study, can be a powerful tool to help expedite treatment of stroke patients. ■

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