

The mobile stroke unit and management of acute stroke in rural settings

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In patients with suspected acute stroke, immediate brain imaging, most frequently with computed tomography (CT), is essential to distinguish between an ischemic lesion and a hemorrhage.¹ In ischemic stroke, timely treatment with intravenous tissue plasminogen activator or thrombectomy results in substantial clinical improvement.^{1,2} The treatment is time dependent with a 5% decrease in mortality for every 15-minute reduction in door-to-needle times.³

Although access to cranial CT scanners poses few problems in urban areas, this may be challenging in rural settings. The recent installation of portable scanners in ambulances (i.e., mobile stroke unit) facilitates rapid evaluation and treatment of patients with acute stroke.⁴ The portable scanners are typically small, simple to use and images can be transferred to distant sites for interpretation.⁵ In most models of care using these mobile stroke units, the ambulance operates within city limits and provides acute medical care at the site of the ictal event as a first responder rather than at a hospital. These units also have the potential to be used in rural and remote communities to improve the quality of care provided for patients with acute stroke.

How does a mobile stroke unit work?

The standard practice of suspected stroke management involves transfer via ambulance to a CT-equipped hospital, clinical assessment and brain imaging. Once hemorrhage has been excluded, intravenous tissue plasminogen activator may be offered as the standard of care in appropriate cases. The CT-equipped stroke ambulance — the mobile stroke unit — allows brain imaging to be completed at the patient's location, bringing the "hospital to the patient"⁴⁻⁷ (Figure 1). The mobile stroke unit, staffed with paramedics, a stroke fellow (in our program) and a radiology technologist, links the stroke physician (usually at a tertiary hospital) to the patient via a telemedicine connection. After completion of the telestroke evaluation and brain imaging, the stroke fellow can start treatment with intravenous tissue plasminogen activator, if appropriate, in the ambulance while the patient is being transferred to the stroke centre.

In urban settings, the mobile stroke unit is deployed to where the patient is located. In rural settings, for speed and rapid

KEY POINTS

- Brain imaging is essential in the evaluation of patients with suspected stroke.
- Thrombolysis and thrombectomy are major therapeutic advances in the management of acute stroke and can be offered only once computed tomography rules out a brain hemorrhage; the treatment is time dependent.
- Mobile stroke units improve time to treatment with intravenous tissue plasminogen activator.
- Although mobile stroke units are most commonly used in urban areas, they have potential for use in rural settings.

access, an ambulance from the rural site brings the patient toward the outbound mobile stroke unit (in our program, within a 250 km radius of the university hospital) (Figure 2).⁸ The ambulances meet at predetermined rendezvous sites, and the patient is transferred to the mobile stroke unit for further management. Depending on the clinical diagnosis and the treatment offered, the patient may stay in the mobile stroke unit and be transferred to the tertiary care facility or, if appropriate, sent back to the local hospital for further care (Box 1).

What are the benefits?

A mobile stroke unit has both the medical expertise and imaging technology to evaluate patients with suspected stroke rapidly and accurately. The most important benefit of the mobile stroke unit is rapid diagnosis of the stroke type, allowing hemorrhage to be ruled out and treatment with intravenous tissue plasminogen activator to be started quickly if appropriate. At present, such patients are referred to a hospital with CT imaging and a stroke (or telestroke) program.

Another benefit is that the neurology consultation is done at the rendezvous site. Patients can be sent back to the local hospital if they do not require care at a tertiary centre, thus reducing unnecessary transfer to emergency departments. (In our experience, one-third of patients are sent back to the referring site.)

The unit can also be helpful in the assessment of other neurologic emergencies, including suspected head trauma.⁹

What are the possible harms?

The CT images obtained in the mobile stroke units are of lower quality than those produced by standard scanners in hospitals (Figure 3); however, we believe that they are sufficient to make

treatment decisions in the field. To our knowledge, there are no reports of harm resulting from the quality of the imaging in mobile stroke units.

Telemedicine and transfer of CT images require the availability of fast wireless Internet; poor wireless connectivity may be



Figure 1: The mobile stroke unit based at the University of Alberta Hospital in Edmonton (left photo). The ambulance (right photo) is equipped with a computed tomography scanner (grey arrow), “point-of care” laboratory (analyzer model poch-100i, Sysmex Canada; black arrow) and telemedicine equipment (white arrow).

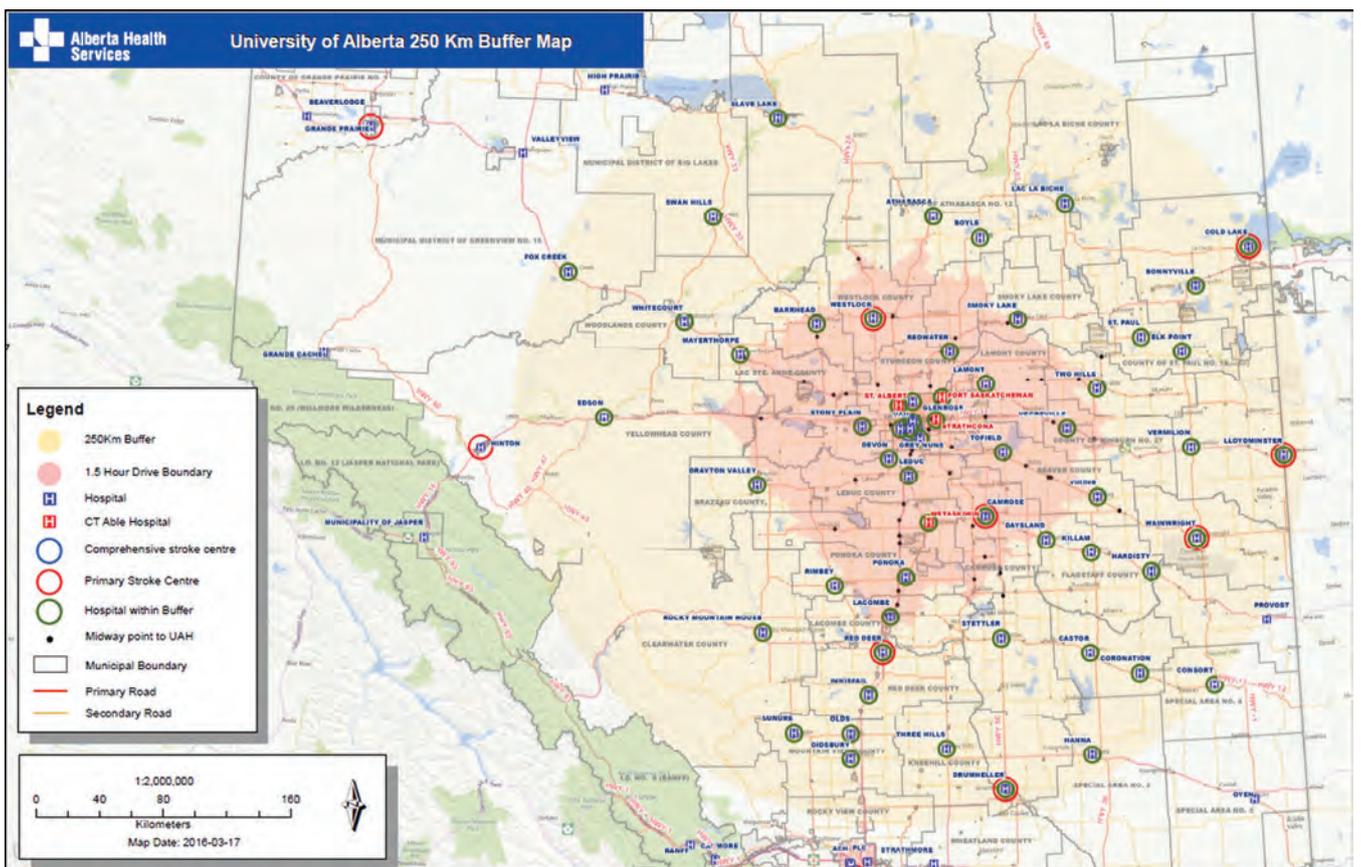


Figure 2: The catchment area for the mobile stroke unit in northern Alberta. This is within a 250 km radius of the University of Alberta Hospital (UAH). The legend shows the available hospitals with computed tomography (CT) (i.e., primary stroke centres) and without CT scanners within the region. Reproduced from [Mobile stroke unit triage of patients with a suspected stroke: a novel solution to reducing suspected stroke admissions in busy emergency departments, Shuaib A, et al. *BMJ Innovations*, Vol. 4, p. 54-9, copyright © 2018]® with permission from BMJ Publishing Group Ltd.

Box 1: Use of the mobile stroke unit at the University of Alberta Hospital, Edmonton

In February 2017, Edmonton Stroke Program introduced the mobile stroke unit in Canada to focus on a rural setting (Figure 1). The catchment area for the mobile stroke unit is within a 250 km radius of the University of Alberta Hospital in Edmonton (Figure 2).

The mobile stroke unit has a portable computed tomography (CT) scanner (CereTom, Samsung), telestroke equipment (LifeBot) and a “point-of care” laboratory to perform complete blood cell count, glucose and international normalized ratio (pocH-100i, Sysmex Canada) tests. The mobile stroke unit team consists of a stroke fellow, a CT technologist, a registered nurse, a primary care paramedic and an advanced care paramedic.

The mobile stroke unit is dispatched by the hospital telestroke neurologist after telephone consultation with the rural emergency department physician or a prehospital emergency medical services crew. The mobile stroke unit travels toward the presenting hospital — about half the distance — and meets up at a predetermined rendezvous location with the inbound ambulance.

The patient is transferred into the mobile stroke unit for a CT scan of the brain, and the images are transmitted to the hospital telestroke neurologist for review in real time. Management options include treatment with intravenous tissue plasminogen activator in the mobile stroke unit and transport to the university hospital, supportive care and transport to the university hospital if necessary or transfer back to the local referring hospital.

Our preliminary experience has shown that the mobile stroke unit can serve as an excellent triage mechanism for patients with suspected stroke, before transport to a tertiary care centre. Since project implementation, 68 patients have been evaluated. Seventeen patients received thrombolysis and were transported to the university hospital for further management. Twenty-three patients were transferred back to the local hospital because they did not require any further immediate evaluation. An additional 28 patients were evaluated by the mobile stroke unit and transferred to the university hospital without thrombolysis. These included 12 patients with stroke mimics, two with transient ischemic attacks, five with intracranial hemorrhage, one with cerebral contusion secondary to trauma and eight with strokes outside the window for thrombolysis.

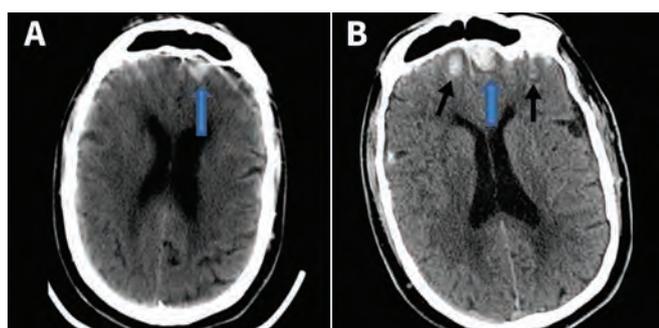


Figure 3: Comparison of a set of cranial computed tomography (CT) scans done in the mobile stroke unit (A) and upon arrival at the hospital (B). The cerebral hemorrhage (contusion) is better defined on the conventional hospital CT scanner (blue arrows). Additional areas of smaller contusions are also identified with the hospital scanner (black arrows).

problematic in rural areas. The training of personnel to staff the mobile stroke units has not been an issue and exposure to CT-related radiation is minimal. However, the cost-effectiveness of the mobile stroke unit, particularly in the rural setting, requires further study and is an important part of our current ongoing research program.

What is the evidence so far?

There is now considerable experience with mobile stroke units in Europe, North America, Asia and Australia where currently more than 20 units are operational and several more such units are planned.⁶ In one randomized controlled trial in an urban setting ($n = 100$), treatment with intravenous tissue plasminogen activator was started within an average of 38 minutes from alarm in 53 patients seen by the mobile stroke unit, compared with 73 minutes for those in the control group ($n = 47$) who received usual care; there was no increase in the risk of intracranial hemorrhage when the mobile stroke unit was deployed.⁴

The small number of patients in preliminary studies of mobile stroke units does not allow for determination of better clinical outcomes, nor are there studies of their use in rural settings. Larger studies of patients with stroke who were treated in emergency departments show clearly, however, that early treatment of stroke is associated with better outcomes.³

What can we expect in the future?

There continues to be considerable interest in the use of mobile stroke units in the care of patients with suspected stroke. An international collaboration has been established to coordinate programs worldwide.¹⁰

Although the emphasis is currently on the evaluation and management of acute stroke, the mobile stroke unit may be used in the management of other neurologic and neurosurgical emergencies.^{6,9} The number of personnel in the mobile stroke unit will likely be reduced to paramedics only. Currently, the Cleveland Clinic’s mobile stroke unit operates without a physician in the unit itself.¹¹

Portable CT technology continues to improve. Introduction of CT angiography and CT perfusion into mobile stroke units will allow for detection of major arterial occlusions in patients with acute stroke, allowing for diversion to specialized hospitals that offer thrombectomy services.¹²

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