Doctors in Training Grant

FINAL REPORT

The launch of the Melbourne Mobile Stroke Unit. From left: Shane Foster (Ambulance Victoria), Francesca Langenberg (RMH Radiology Lead), Andrea Wyatt (Ambulance Victoria), Skye Coote (RMH Nursing Coordinator) and myself (RMH Medical Coordinator)

Dr Henry Zhao

Doctor of Philosophy (PhD) in Clinical Acute Stroke Medicine

University of Melbourne and Melbourne Health
Melbourne, Australia

I am excited to provide my Final Report on my work on the Australian-first Melbourne Mobile Stroke Unit and my research in pre-hospital stroke care.

It has been quite a journey since I joined the Melbourne Mobile Stroke Unit project around two years ago as a junior stroke fellow, just as the concept was crystallising. The first Mobile Stroke Units around the world were still in their infancy, with the very first one operating in 2008 in a rural city of Homburg in southern Germany. The German team had been exploring how a CT scanner could be transported in a vehicle (the first version was an old lorry), and finally managed to fit a small CereTom™ CT scanner in a normal ambulance. The CereTom™ was a portable scanner in use in many neuro-intensive care units around the world and could actually be wheeled around. The scanner also had its own battery backup power supply, but needed to be recharged if it was taken outside of the hospital. This was made possible by using an inverter connected to the ambulance's motors to provide on-the-road power.

Following the success of the Homburg team, the concept was taken up by Berlin, Germany who used a far bigger vehicle to house the CereTom™ scanner and a mobile laboratory. The Berlin Mobile Stroke Unit (also called STEMO) became immediately fully integrated into the Berlin Fire Department (ambulance and fire services are integrated in many parts of USA and Europe) and was so widely dispatched that a further two units are now being put into service. The concept then spread across the Atlantic and soon Houston, Texas began their own mobile stroke service. This led to intense interest in many other US cities who began to roll out their own projects, including Cleveland, Ohio who ran the first telemedicine only service, and Memphis, Tennessee who were the first to use a hospital grade CT scanner in a vehicle the size of a truck (everything is bigger in the American southwest as the idiom goes).

I was lucky enough to be able to see and ride on the Mobile Stroke Units firsthand in Berlin and Houston in June 2016 along with a representative of Ambulance Victoria. These services utilised a specialised team of a stroke neurologist, radiographer or radiologist, stroke nurse and paramedics to respond to patients with suspected stroke in the community.

Instead of a hospital bed, patients were examined in their homes, many literally in their own beds. They were then carried out to the Mobile Stroke Unit ambulance and scanned, which allowed important drugs such as clot-dissolvers to be given then and there.

There were no extraneous administration processes and no wait for a CT scan or a hospital bed like in the emergency department. You could easily see why internationally there was a reported 45 minutes time saving to initiation of potentially life saving stroke treatments compared to taking the patient to hospital.

Dr Henry Zhao
University of Melbourne
and Melbourne Health

1. The very first Mobile Stroke Unit in Homburg, Germany
2. Our very own Melbourne Mobile Stroke Unit in production
3. The interiour of the Melbourne Mobile Stroke Unit in production
4. The finished Melbourne Mobile Stroke Unit

Back in Australia, we set out to work on our Melbourne Mobile Stroke Unit, the first in Australia and Oceania. Our design needed to be quite different from models overseas to comply with Australian regulations (which we found out are the harshest in the world) and Ambulance Victoria operation procedures. We selected a vehicle model that Ambulance Victoria also use for other complex care purposes (Mercedes™ Sprinter 5 series) as it was important for build and maintenance reasons that our engineers were familiar with the vehicle. With international help from the manufacturer, our Australian engineers in Penguin, Tasmania installed the CT scanner and a contrast injector. As the CT weighed about half a tonne, it was critical for the safety of staff and patients that it received proper fixation (to 20G as per regulations) during ambulance transport. This was solved by engineering a multistep locking system. Next, the power supply system was installed to allow the CT scanner to charge via a power cable at base and an inverter while out on the road.

As it was our eventual plan that the project would move to telemedicine, we engaged a company to install telemedicine hardware that would be capable of beaming CT images and relay audio-visual information between the vehicle and the hospital via 4G. Next came the seats – three at the back and two in the front cabin for the crew. Finally, the vehicle was finished by adding a fridge, contrast warmer, air-conditioner/heater, storage spaces, radio communications and clinical care items (oxygen, suction, IV poles, etc).

Once the vehicle was built in Tasmania, it made its way across on the Spirit of Tasmania to the World's Most Liveable City. In Melbourne it received final radiation safety testing and given its official livery. From there, it came to rest in its final home at the Royal Melbourne Hospital, where capital works had been carried out to ensure that the vehicle could be parked in a secure area and receive power. Now in our hands, the next weeks were a flurry of activity to train radiographers in use of this novel portable CT scanner and to complete mock training runs prior to treating real patients.

The final operational model of the Melbourne Mobile Stroke Unit was that it would run Monday to Friday, 8am to 6pm (with weekends to be added in future) and would be automatically dispatched to a suspected stroke patient within 20 kilometres of the Royal Melbourne Hospital (although we could rendezvous with a first responding crew that was outside the radius). A five-member crew would be onboard, consisting of a stroke neurologist or fellow, advanced practice stroke nurse, radiographer and two paramedics (one advanced life support, one mobile intensive care), with a plan to eventually relieve the neurologist of having to be onboard using telemedicine. The vehicle carries a complete armamentarium of acute stroke treatments, including thrombolysis (clot-dissolving medications), anticoagulation reversal agents (to reverse bleeding stroke caused by medications such as warfarin), high-blood pressure controlling drugs, anti-seizure medications, as well as new clinical trial drugs (mentioned below). Patients would still be brought to the nearest stroke hospital, however, due to the power of having a CT scanner, patients that require specialised hospital treatment like clot retrieval or neurosurgery can be confidently diagnosed in the community and taken directly to the right hospital, where otherwise they may have arrived at a hospital without these services and require a lengthy inter-hospital transfer.

The efforts of many personnel and institutions finally culminated in the launch of the project by the Victorian Premier Hon Daniel Andrews and Health Minister Hon Jill Hennessy on 12 November 2017. The next day was the first operational day, and I was given the honour of being the first neurologist on the first ever crew on the Melbourne Mobile Stroke Unit.

The first day was eventful, with our service being called into action almost as soon as the day started and performing the very first scan almost immediately.

After a number of jobs, we were called out to a patient who presented with very convincing evidence of a stroke and was within the time window for clot dissolving medications (but was fast going outside that window). We were able to scan her quickly and immediately commence treatment, making her the very first patient to be successfully treated for stroke outside of a hospital in Australia. She subsequently was taken to hospital where she made a good recovery and was able to spend Christmas with her family. It is likely that if the Melbourne Mobile Stroke Unit had not been around, she would have missed the treatment window had she been taken to hospital as per normal.

It is now almost three months into operation and we continue to be very busy, with over 300 dispatch cases over that time. We are able to provide specialised treatment or management to almost half of the stroke patients that are within treatment time windows. The service is received extremely well in the community and by other ambulance crews.

We continue to have many success stories, such as a patient who I attended on the 52nd floor of an apartment block with a severe stroke whom we scanned, started clot dissolving treatment and spoke to the neuro-interventional doctors for expedited clot retrieval surgery. Following successful treatment, his symptoms had essentially completely resolved that same day and was able to be discharged a few days later.

Dr Henry Zhao
University of Melbourne
and Melbourne Health

5. Mobile Stroke Unit team training prior to service launch
6. The Mobile Stroke Unit in active service around Melbourne
7. The very first crew of the Melbourne Mobile Stroke Unit.
   From left counter-clockwise: Myself, Francesca Langenberg, Skye Coote, Peter Norbury, Stephanie Mourad

Though the Melbourne Mobile Stroke Unit is an important clinical asset, it also allows us to perform ground-breaking research. I am coordinating the world's first clinical trial of a drug designed to try to halt bleeding (Tranexamic acid) for patients with a bleeding stroke in a Mobile Stroke Unit. There are otherwise no other treatments available for this devastating condition. This trial would not be feasible in hospital, as patients must be treated within the first few hours of stroke onset, something only the Mobile Stroke Unit can usually achieve. We also have a second important clinical trial of a newer clot dissolving drug (Tenecteplase), which has shown that it has superior effect than the usual drug that is used. This, along with earlier treatment in the community, is hoped to be able to save more brain tissue and improve outcomes for patients.

I would like to especially thank Professor Stephen Davis and Professor Geoffrey Donnan (the co-chairs of the project) for the opportunity to be involved in this innovative and exciting project, as well as Ambulance Victoria and the Royal Melbourne Hospital Stroke Unit for making it all a reality. I wish to finally thank MIGA for providing me with a Doctors in Training Grant, which has helped enable me to carry out a PhD on improving pre-hospital care for stroke patients. Although the PhD is ongoing, the major milestones have been reached and I am immensely proud that we have produced an important service for Melbourne and Melburnians.