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1.1. The Australian Stroke Clinical Registry (AuSCR)

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BACKGROUND

The Australian Stroke Clinical Registry (AuSCR) has been operational since 2009. It is currently based at the Florey Neuroscience Institute and is led by Professor Dominique Cadilhac. The goal of AuSCR is to provide reliable and representative national data on patients admitted to hospital with acute stroke or transient ischemic attack (TIA) in order to inform improvements to the health system.

The AuSCR

- Adheres to the Australian national guidelines for best-practice in clinical quality registries
- Operates in both public and private hospitals
- Includes both adult and pediatric cases
- Requires participating hospitals to have ethics approval
- Utilizes an “opt-out” model for patient inclusion is used, in addition to a waiver of consent for people who die while in hospital

In the AuSCR, data are collected on the provision of evidence-based therapies, supplemented with clinical and demographic patient information, to provide an indication of the quality of acute stroke care received. Staff from participating hospitals can enter these data on all eligible patients either manually via the web tool, by using a data import process, or a combination of both. Each hospital has access to their own data and summary “live” reports that the staff can download to enable regular reviews of hospital performance.

OUTCOME MEASURES

Patient outcomes are ascertained with a questionnaire (including age-appropriate-paediatric questions) at follow-up, 90 to 180-days after admission. The AuSCR Office staff, with the assistance of the Stroke Foundation, are responsible for follow up of registrants who are known to be alive and have not refused follow-up or have “opted-out” of the Registry. For registrants unable to be contacted, survival status is determined using annual data linkage with the National Death Index (NDI) made available, through an ethically approved process, by the Australian Institute of Health and Welfare (AIHW).

FACTS

- The AuSCR is a clinical quality registry designed to facilitate the promotion, monitoring and improvement of acute care for stroke and transient ischemic attack.
- All hospitals require ethics approval to participate in the AuSCR. The AuSCR Office has established processes to assist hospital staff in progressing these applications.

- An opt-out model for patients or proxies has been ethically approved, including a waiver of consent for patients who die in hospital or for patients with cognitive impairment who have no declared proxy (current opt-out rate is 2.6%).
- Hospital staff are trained in the use of the AuSCR data management system (now operating within the Australian Stroke Data Tool [AuSDaT]) including how to export their own data and access live reports which include benchmarked information against all other AuSCR sites.
- Hospitals are responsible for the data they submit into the online system, based on their nominated program. The data can be entered manually, via an automated data upload process, or a combination of both.
- A data linkage to Ambulance Victoria to include variables from prehospital care is currently being investigated.

DATA QUALITY CHECKING PROCEDURES

- Audit of medical records for a sample of randomly selected registrants after the first 50 cases and every two years thereafter (dependent on funding availability) to assess data quality.
- Regular data cleaning and case ascertainment processes to ensure the integrity of data. Hospitals are provided data quality reports to enable them to address missing or inconsistent data.

COMMUNITY FOLLOW-UP REGISTRANTS

- AuSCR office follows up eligible patients 90-180 days post-stroke: 1st attempt – mailed survey to registrant; 2nd attempt – mailed survey to registrant and/or proxy; 3rd attempt – telephone follow-up.
- Survival status on all registrants is obtained annually using linkage to the National Death Index.
- Hospitals are able to view individual follow-up data for their patients, as well as conduct a bulk export of their own follow-up data collected by the AuSCR Office.
- National and state-level reporting
- AuSCR annual reports are produced each year using the aggregated national data (acute care plus 90 to 180 days health outcomes) as well as ID-coded site data for the clinical indicators.
- State governments that fund the AuSCR program also request additional reports (e.g. stroke service/CEO reports) to inform quality improvement planning.
- Journal publications: produced by writing committees that may include several active site investigators.

1.2. Linking a hospital registry to prehospital data in England

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The Sentinel Stroke National Audit Programme (SSNAP) has been collecting data on processes and outcomes of stroke care after admission to hospital and post discharge in England, Wales and Northern Ireland since 2013. Achieving case ascertainment rates of about 95% and high data quality it has been shown to be a powerful tool for change. Over 80,000 records are added each year and the data are reported to clinicians, commissioners and the public (www.strokeaudit.org)).

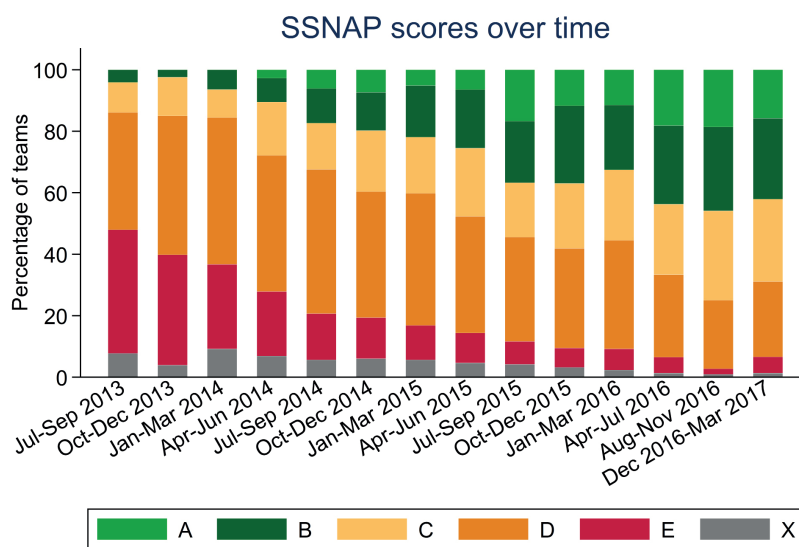


Figure 1. Overall performance on SSNAP over the last 5 years for all hospitals in England, Wales and Northern Ireland showing improving performance over time. A= best performing hospitals. E= worst performing hospitals. X = no data submitted

BACKGROUND

Stroke services in England are undergoing major reconfigurations, centralizing acute stroke care in a smaller number of larger units. This provides advantages through better use of a limited number of stroke physicians and more efficient delivery of care when patients arrive in the unit. However, the price paid is often longer travel times from the patient's home to the hospital and this will become a bigger issue for patients that may need thrombectomy. What is important for the patient is the stroke call-to-treatment time because this will determine the effectiveness of treatment. Until now, data collected by emergency medical services has not been linked to the hospital data. This has previously prevented planning services that fully address the entire patient pathway from onset of symptoms to delivery of treatment.

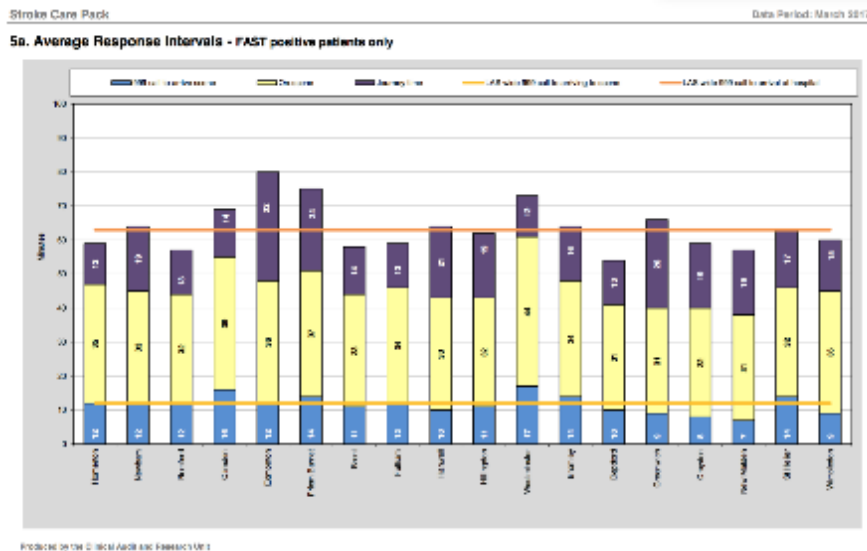


Figure 2. Example of prehospital data from London showing time spent getting top scene, time on scene and time to hospital

PLANS

However, to bridge this gap, funding has been provided from NHS England to link the two data sets at the individual patient level and agreement has been reached covering the information governance issues. All 11 ambulance providers in England have agreed to participate, the data definitions have been agreed upon and the data set is currently being piloted and the webtool developed. We anticipate that data will be published monthly from April 2019 reporting the variables shown in Fig 3.

Figure 3. Selected data items to be reported

- Time of emergency call to time connected to ambulance service
- Date and time of emergency vehicle arrival at patient location
- Time of departure from patient location
- Time of arrival outside hospital
- Was the patient recorded as FAST positive by the paramedics?
- Time first assessed by stroke clinician
- Time of first scan
- Time of onset of thrombolysis/thrombectomy
- Time arrival on the stroke unit

HOW WILL DATA BE USED?

It is hoped that individual ambulance services and hospital trusts will use the data to identify areas where time can be saved. It is already clear from prehospital data that a long time is spent on scene; with better awareness of metrics, "scene time" may be reduced. The data can be used to determine where reconfiguration of services can be justified by demonstrating reduced door-to-needle times despite longer call-to-hospital times. It will enable peer comparisons of care for quality improvement of inpatient stroke care, and most importantly will encourage emergency medical services and hospital emergency departments to work more collaboratively to deliver better patient care.

1.3. The Norwegian Stroke Registry

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BACKGROUND

The Norwegian Stroke Registry was established in 2015. It is a statutory national quality register for stroke treatment, aiming to characterize and improve the quality of stroke treatment and care. All 51 hospitals providing stroke treatment in Norway report to the Registry, for which ethics approval is not required.

Norwegian Stroke Registry Facts:

- Data tracking captures the patient's course from symptom onset to final outcome. This includes prehospital data capture of the time of stroke onset (or last known well), time of EMS call and time of admission to the hospital.
- Details of hospital treatment and outcome are added and supplemented with hospital-derived clinical and demographic information.
- Patient functional status before admission and at hospital discharge or upon transfer to rehabilitation care along with the level of rehabilitation care are specified.
- Patient follow-up is also obtained at three months following the stroke event, ideally during an outpatient clinic evaluation.
- Socio-demographic factors and rehabilitation strategy, activities of daily living and functional outcome are also recorded. From these parameters, the quality of acute stroke treatment, rehabilitation and patient outcome can be estimated.
- From 2019 onwards, the Registry was expanded to include endovascular therapy, tracking technical and clinical details of the endovascular interventions performed.
- Each hospital has access to their own data, including regular reports of their performance and progress, compared to that the composite of other hospitals participating in the registry.
- Regular reports display pre-specified key performance indicators for individual hospitals, permitting adjustment and corrective measures if required. Taken together, these measures serve to characterize the national stroke burden along with where and how efforts are best directed toward its management.

DIRECT BENEFITS OF THE REGISTER

1. Accurate estimation of stroke incidence and prevalence
2. Feedback on current performance in key performance indicators
3. Facilitates identification of areas in need of improvement
4. Analysis of quality improvements and their efficacy is made feasible and easy
5. Facilitates building a culture of comparison and accountability
6. Facilitates cooperation and sharing of data
7. Facilitates identification of patients and patient groups for clinical trials
8. Provides a pool of information facilitating analyses of epidemiology, treatments, clinical outcomes, and disease progression.

1.4. Improving stroke care through the implementation of a low-budget stroke registry in New Zealand

Contact person: A/Prof Anna Ranta, Associate Professor, Head of Medicine, University of Otago Wellington , email: anna.ranta@otago.ac.nz, website: www.strokenetwork.org.nz

BACKGROUND

It is challenging to monitor rates of acute stroke treatment, door-to-needle times, and complications because administration of IV thrombolysis and door-to-needle times are not routinely captured by health administrative data. Monitoring these performance measures is important because it allows stroke centers to benchmark their performance against other sites, assess the impact of quality improvement initiatives on processes of care, and provides reassurance to clinicians regarding the safety of acute stroke treatments by monitoring for complication rates.

INTERVENTION

In 2015 the New Zealand National Stroke Network implemented a mandatory national thrombolysis register that has recently expanded to include thrombectomy. Results are consistently visible at local levels for monitoring the effects of quality improvement efforts. The stroke leads from around New Zealand gather annually at a National Stroke Reperfusion Data & Quality Meeting to review each hospital and region's results, monitor progress, and assess complication rates. As part of the day, exemplar hospitals show-case their innovations and there is an opportunity to present complex cases for discussion and shared learning. Stroke clinicians, ambulance staff, and emergency physicians are amongst the group of regular attendees.

RESULTS

- A National Acute Stroke Audit completed in 2009 found that only 3% of ischemic stroke patients admitted to New Zealand Hospitals received IV thrombolysis
- Some progress had been made through the introduction of national key performance indicators, but progress had been slow until 2015
- After the introduction of the register, treatment rates have steadily increased to over 10% and the national median door-to-needle time has dropped from 77 to 58 minutes.

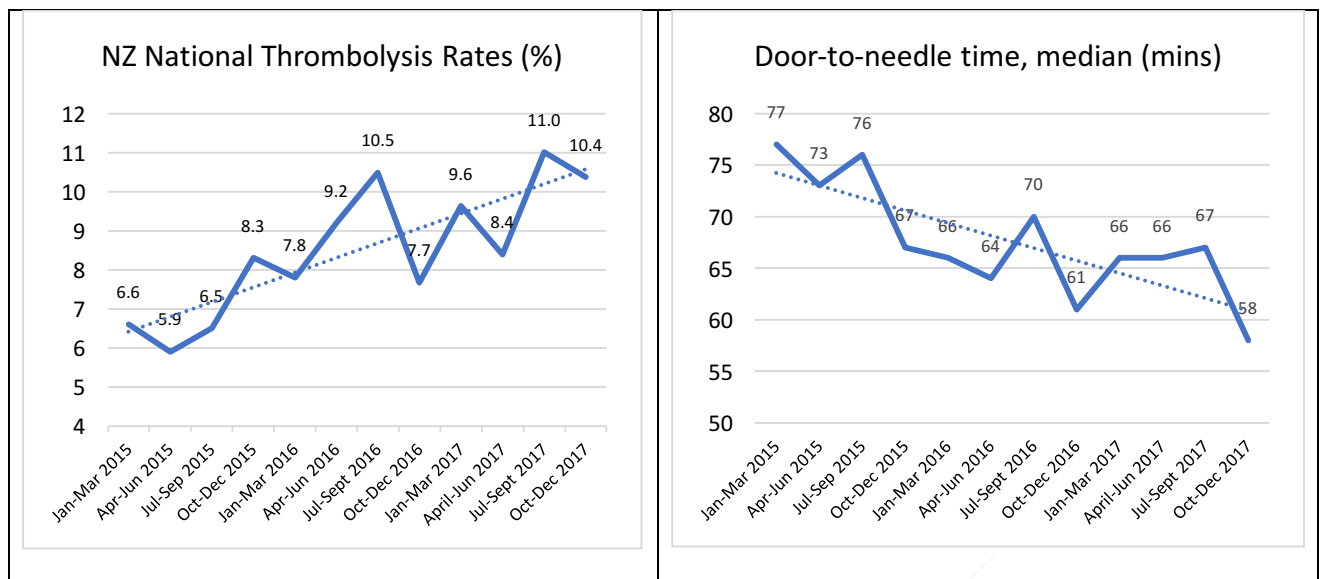


Figure 1: Thrombolysis rates and Door-to-Needle times mapped over time 2015 through 2017

- An additional benefit of the register's implementation and the annual quality meetings has strengthened the New Zealand stroke community through a shared sense of purpose.
- Every hospital, no matter how small, participates and feels engaged.
- The symptomatic intracerebral hemorrhage rate for 2017 was 2.8%, which is well below reported rates from clinical trial data.
- Openly sharing and publishing complication rates has provided reassurance to the wider sector around patient safety.

OBSTACLES

Lack of Funding: In 2011 the Ministry of Health set up a National Stroke Network with coordination support (~30 hours a week) and in 2014 appointed a Clinical Leader (1 day a week). The original register received no additional funding support and consisted of an Excel spreadsheet template completed by stroke services, collated by the Network coordinator, and analysed by the Clinical Leader. This system was sufficient to get started but was not an adequate long-term solution. In 2017 the Ministry of Health provided NZ\$50,000 to transition the register to a proper database platform with further development to facilitate improved data integrity, analysis, reporting, and to incorporation of thrombectomy data. The new and much improved REDcap database was rolled out in January 2017.

Pre-Hospital to Hospital Data Linkage: A second challenge is the lack of linkage to pre-hospital data beyond time of symptom onset. Time to call, dispatch, on-scene, and scene-to-hospital time all important aspects of the pathway that need to be monitored to achieve the shortest onset-to-needle times and better patient outcomes. Integration of the two data sources is currently under discussion.

SUMMARY

Starting a reperfusion register is possible with very limited resources and, even when rudimentary, can yield fantastic service improvement results with active stakeholder engagement. The collaborative, all-inclusive, and bottom-up approach with some modest funding support from the government has succeeded in New Zealand

1.5. Get With the Guidelines Stroke (GWTG). American Heart Association (AHA) National Stroke Database

Contact person: Christine Rutan, National Director, Quality and Health IT, American Heart Association, Christine.Rutan@heart.org

BACKGROUND

Initiated in 2003, GWTG-Stroke is an in-hospital program for improving stroke care by promoting consistent adherence to the latest treatment guidelines. Participating hospitals submit data to a web based reporting tool and receive real time feedback on adherence to evidence-based guidelines. The GWTG-Stroke dataset includes information on care processes during acute hospitalization, medical history, labs, interventions, therapies, patient status at the end of admission and post-discharge follow-up. Participants receive QI consultation from dedicated American Heart Association Field Staff, access to education and resources, and the opportunity to be recognized for performance on Achievement and Quality measures. This award-winning program has a proven track record of success with more than 2,200 hospitals participating and nearly 6 million patients enrolled. Additionally, this vast data resource allows the AHA to support research, publication, and quality improvement initiatives, keeping the program participants on the leading edge of innovation.

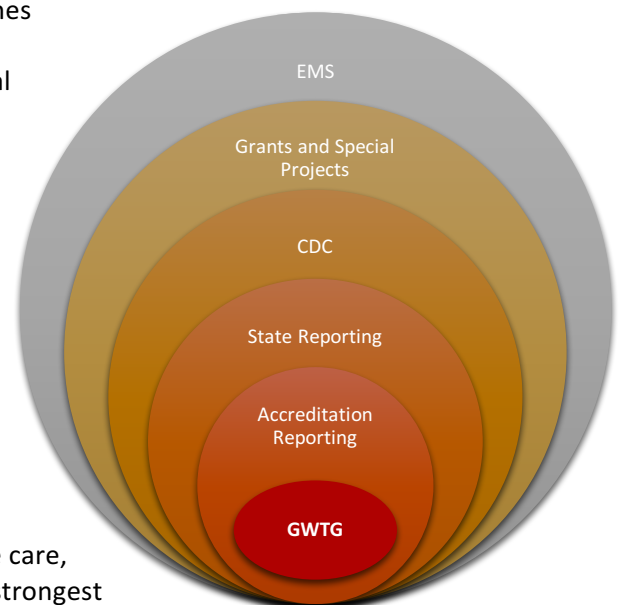
Layered application fulfills multiple reporting requirements

KEY COMPONENTS

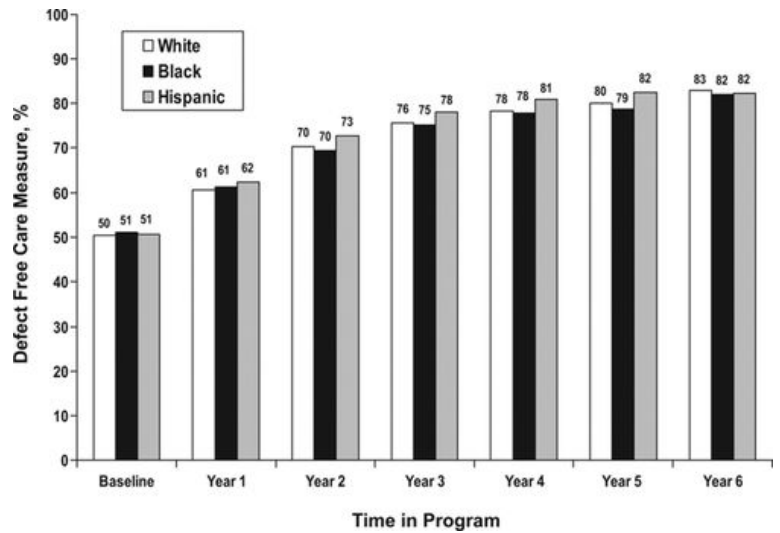
- Web based platform with real-time reporting
- Evidence-based measures with strong process outcomes link
- ~ 90 Quality Improvement field staff providing hospital consultation
- Hospital and EMS recognition for adherence to guidelines
- 2,200 hospitals a participating
- Nearly 6 million patient records
- Robust research process and pipeline with more than 120 published manuscripts
- Layered form supports participation in a variety of initiatives, including hospital accreditation

RESULTS

- The program has shown rapid and sustained improvement year over year in evidence-based stroke care, especially in Achievement measures, which have the strongest process outcome link.

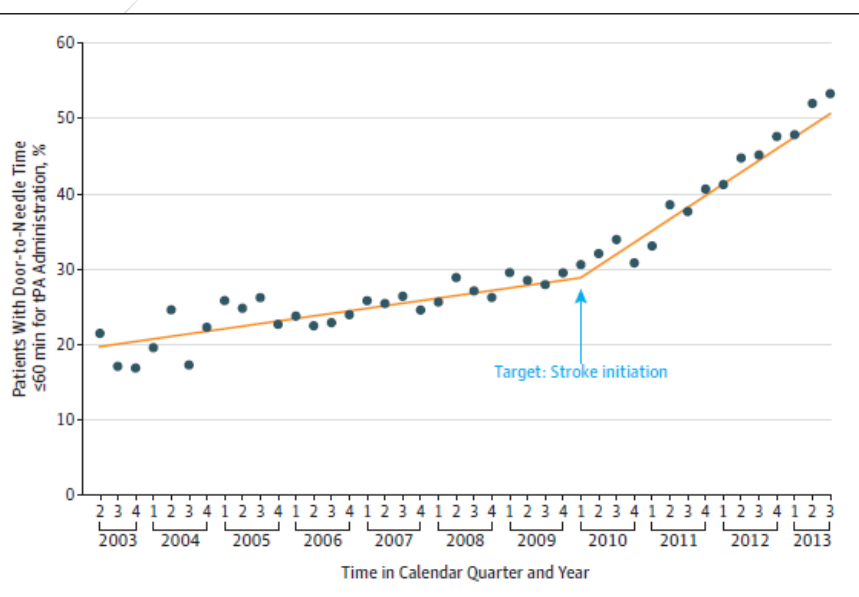


- GWTG focuses on care standardization and the consistent application of evidence-based guidelines in all patients. Hospital improvements in stroke care have been observed over time in all race/ethnic groups (see figure).
- A study comparing 366 GWTG-Stroke hospitals with non-participating hospitals showed accelerated reductions in 30-day and one-year mortality and sustained reductions over 18 months.



FOCUSED IMPROVEMENT CAMPAIGNS

- GWTG-Stroke also deploys focused improvement programs, where program data demonstrates a clear gap in treatment.
- Over 9 years, AHA found only 25% of cases met the door-to-needle (DTN) guideline (60 min).
- In 2010, Target: Stroke launched with the goal of doubling the number of eligible patients who receive Alteplase within the 60-minute DTN timeframe.
- 1200 hospitals enrolled and deployed best practice strategies associated with shorter Door-to-needle times.
- Resources, including focused education and sample protocols as well as a recognition program were provided.
- In 2013-14, this goal was reached. Today, 75% of patients are treated within the 60min time



FUTURE PLANS

Reducing symptom onset to treatment is critical to continue to improve stroke outcomes. GWTG-Stroke has extended efforts beyond hospital treatment times, focusing on systems of care that include the public awareness, partnership with EMS and referral hospitals, to reduce pre-hospital times and improve the efficiency of the whole system. While EMS data has been captured by some hospitals, GWTG-Stroke is working to automate data transfer between EMS and the registry. Additionally, with the increasing role of endovascular therapy in acute stroke care, future improvement efforts, including Target: Stroke Phase III will focus on timely endovascular treatment.

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2.1. Singapore National Stroke Awareness Campaign

Contact person: Deidre Anne De Silva, Head and Senior Consultant, Head of Neurology, Singapore General Hospital Campus, National Neuroscience Institute, email: gnrdsd@sgh.com.sg

BACKGROUND

Time-critical hyperacute stroke treatment such as acute thrombolysis (IV tPA) and endovascular clot retrieval (ECR) are proven to reduce post-stroke disability. The utilization of hyperacute treatments remains low in Singapore, mainly due to delayed hospital arrival stemming from failure to recognize stroke symptoms and the urgency of the situation. A 2014 survey led by a team of students from the National University of Singapore (NUS) Yong Loo Lin School of Medicine found that fewer than 50 % of Singapore residents could accurately name one stroke symptom and 40 % did not know the number to dial for an emergency ambulance in Singapore.

FIRST NATIONAL STROKE AWARENESS CAMPAIGN IN SINGAPORE in 2016

The Singapore National Stroke Awareness Campaign was first held in 2016 with funding support from the Ministry of Health, Singapore. The campaign focused on stroke symptom recognition and the appropriate emergency action of calling 995 for an ambulance.

Some key strategies used in the campaign include:

- 1) Employment of the F.A.S.T. acronym message
- 2) Use of multiple platforms include a production of a video, posters and social media
- 3) Translation into all national languages

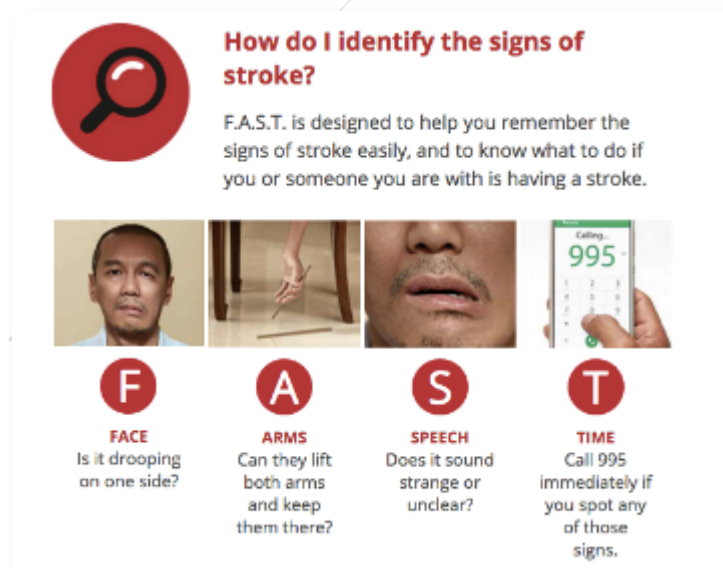


Figure 1: Graphics from 2016 campaign

IMPACT AND RESULTS OF SINGAPORE NATIONAL STROKE CAMPAIGN

The National Neuroscience Institute (NNI) conducted a research project which aimed to evaluate the impact of the stroke-related campaign by studying the presentation patterns of stroke patient pre-

and post-campaign of 2016 in both Tan Tock Seng Hospital (TTSH) campus and Singapore General Hospital (SGH) campus. Patients arriving to the hospital within 3.5 hours (in the window to be considered for IV tPA) increased from 28% to 41%. The proportion of patients arriving within 7 hours (within the window of consideration for ECR) increased from 42% to 58%. However, there was no significant change in ambulance utilization.

CAMPAIGN IN 2017

As a result of the demonstrable improvement in public awareness after the first national campaign, funding for a subsequent campaign was approved. For the 2017 national stroke awareness campaign, an icon was designed to illustrate the FAST message in a simple and effective manner. This was used to create visual and video material to promote stroke awareness. There were also advertisements with these images in the subway system and at bus-stops as well as an online social media campaign.

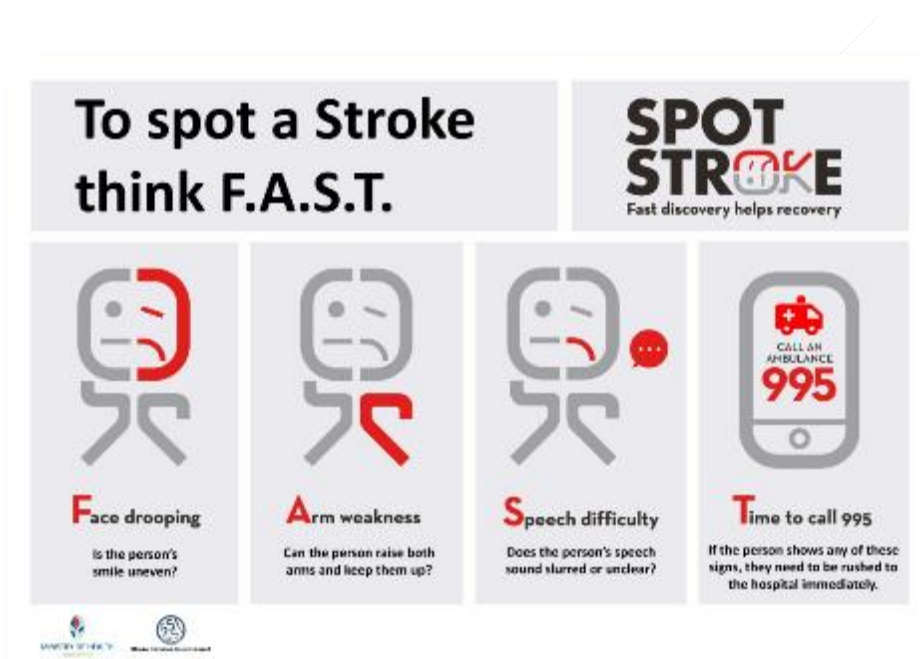


Figure 2: Graphics from 2017 campaign

CAMPAIGN IN 2018

In 2018, the emphasis of the campaign was to call for an ambulance. Using the same icon, there was a strong call to action message with the tagline "How F.A.S.T you act makes a difference". To contextualize this, there were visual and video graphics created to convey the message that appropriate action can make a difference. Advertisements were featured on buses, taxis, within the subway trains, on online platforms, in newspapers and on the radio.

SPOT \ **ACT** \ **CALL**
STROKE \ **F.A.S.T.** \ **995**



Figure 3: Graphics from 2018 campaign

2.2. Increasing Stroke Awareness and Emergency Medical Service System Responsiveness. A Seattle-King County, Washington Case Report

Contact person: Peter Kudenchuk, Professor of Medicine/Cardiology, University of Washington Medical Center, Seattle, WA, USA, e-mail: kudenchu@u.washington.edu

BACKGROUND

In May 2017, the governor of the state of Washington issued a proclamation declaring as “Stroke Awareness Month”. All citizens were encouraged to “take action to reduce their risk of stroke, know the signs and symptoms, and act FAST,” referring to the F.A.S.T. acronym to identify an acute stroke (Figure 1). The campaign stressed the time-critical nature of stroke, and the importance and benefits of calling the emergency access number (911) to activate emergency medical service responders who were specially trained on stroke assessment and rapid hospital triage. It marked the start of an ongoing effort to reduce death and disability from stroke.

INTERVENTION

While encouraging acute stroke recognition, this program was also aimed toward preventing stroke used the following methods:

- Emphasis on healthy lifestyles -- diet, physical activity, weight loss, smoking cessation, control of blood sugar and cholesterol and hypertension.
- Directed the public to a state-wide free public service available through this toll-free telephone number that was also linked to a database of community resources addressing various disease conditions including stroke and providing assistance to access these services.
- Encouraged supportive care for persons who had previously suffered a stroke, and access to rehabilitation services to improve function and quality of life, and importantly, prevent a second event.

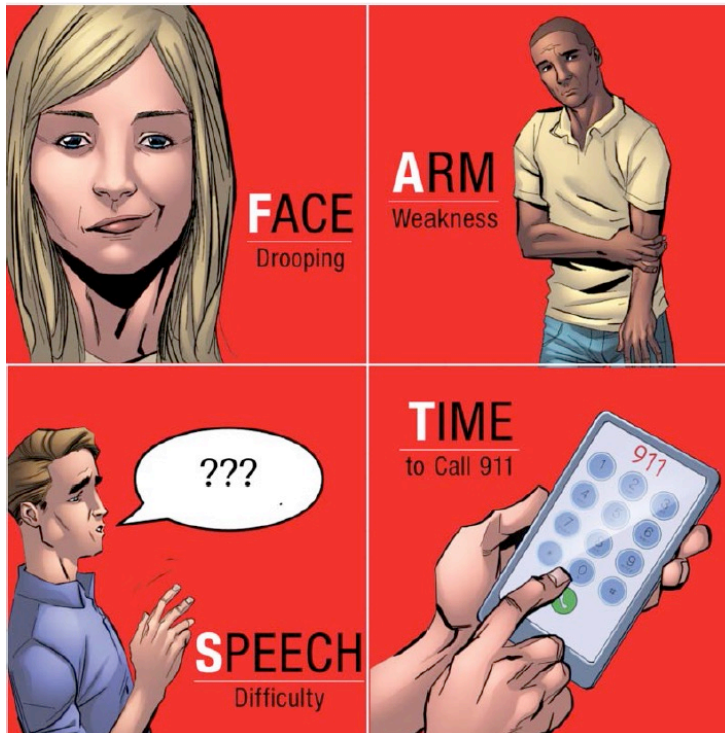


Figure 1 Components of the FAST acronym

At about the same time Emergency Medical Services (EMS) of King County Washington also implemented a revised prehospital stroke triage strategy:

- Employed tools to better identify patients suspected of having a severe stroke (a large vessel occlusion, potentially treatable with endovascular clot retrieval).
- Incorporated FAST and if positive, the Los Angeles Motor Scale (LAMS) tool by first EMS responders.
- A LAMS score of ≥ 4 (indicative of acute hemiparesis) along with a stroke symptom onset interval of ≤ 6 hours (more recently expanded to ≤ 24 hours), prompted immediate EMS transport to a Comprehensive Stroke Center (CSC) for potential thrombolytic and/or endovascular clot retrieval.
- The limited number and geographical distribution of these centers required accurate identification and triage of appropriate thrombectomy candidates by EMS, given that all were located in urban Seattle, a distance of 25 miles or more from more remote patient catchment areas.

RESULTS

Under this program, in 2017 approximately 2,400 patients with EMS-suspected stroke or transient ischemic attacks were evaluated. Of these, 185 patients were identified as meeting triage criteria by FAST and LAMS field assessment and were transported to a CSC. The median age of these patients was 70 years, and nearly half were women. A quarter of these severe cases presented at night and about one-third on a weekend day. Among these 185 triaged cases, 91% had a hospital diagnosis of stroke with the remaining 9% being stroke mimics. In all, 127 of the 185 patients (69%) identified by this means had ischemic strokes, 81 of whom (64%) had a large vessel occlusion stroke appropriate for treatment at a CSC. Of these, 56% received tPA and 73% had endovascular clot retrieval.

SUMMARY

Given the importance of treatment times in acute stroke, expeditious activation of EMS, EMS in-field care and triage, and hospital evaluation are each critical. The timeline in Figure 2 indicates the measured median time intervals required for each of these components of care. On average, the time from last known well to completed thrombectomy was 3 hours, with a median time from EMS activation (emergency call) to arrival at a CSC of 52 minutes. Based on these preliminary findings, this effort has resulted in a good number of the sickest stroke patients being triaged to a CSC for care, the majority of whom had had favorable outcomes. Going forward, we continue to engage the public in stroke prevention and treatment, encouraged by what we see can be accomplished through planning and programmatic implementation.

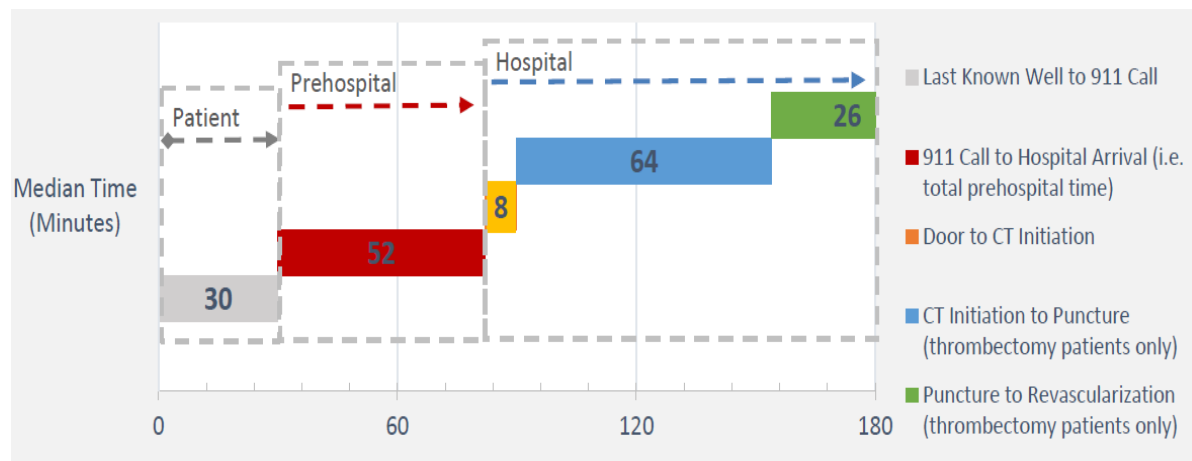


Figure 2. Timeline for EMS-suspected severe stroke cases in Seattle and King County (Jan 15, 2017 – Jan 14, 2018), depicted by the time interval from last known well to assessment and therapy.

2.3. Stroke 1-2-0 special task force promoting stroke awareness in China

Contact person: Dr. Renyu Liu, e-mail: renyu.liu@upjs.upenn.edu, official website: www.stroke112.org

BACKGROUND

The stroke awareness in China is improved by Stroke 1-2-0, a novel stroke educational tool, with the strong efforts of the Stroke 1-2-0 Special Task Force of the Chinese Stroke Association (CSA) formed in 2017.

BARRIERS

Although intravenous thrombolytic therapy is available in China, Stroke is still the leading cause of death and disability in China.(1) A recent study indicated that only 1.6–4.0 % of ischemic stroke patients received thrombolytic therapy because of significant pre-hospital delays. Median time of the prehospita! delay was 15 hours despite the “FAST” (Face, Arm, Speech, and Time) campaign being used in China for over a decade. To address this, a novel stroke awareness educational program, Stroke 1-2-0, was engineered and promoted in China to improve rapid stroke recognition and reduction of pre-hospital delay.

DESCRIPTIN OF PROGRAM

China's medical emergency phone number (1-12) to transform stroke signs into numbers to transcend language and enhance recall (Figure 1A). 1 represents “First, look for an uneven face,” 2 represents “Second, examine for arm weakness”, and 0 represents “Zero (absence of) clear speech.” In the Chinese version, the pronunciation of zero is “ling,” which has the same meaning as “ting” (hearing) as indicated in figure 1B.



Figures 1A and B. Stroke 1-2-0 program promotional materials. **Figure 1A**, the original image published in English in *Lancet Neurology*; **Figure 1B** is another example of material in China endorsed by Chinese Stroke Association, China National Health Commission, the Stroke 1-2-0 Special Task Force, the Sino-China Stroke 1-2-0 Research Studio.

After its publication in *Lancet Neurology* in 2016, Stroke 1-2-0 was immediately adopted and supported by a special task force under the leadership of Dr. Jing Zhao from Fudan University and Renyu Liu from University of Pennsylvania. A series of Stroke 1-2-0 educational animation videos were produced; one of which was translated into 10 different local dialects by experts in their specific regions. Stroke 1-2-0 was introduced through various media platforms including a special introduction in China Central Television (CCTV), *Lancet Neurology*, the *Lancet Neurology* twitter account, Tencent (Tengshun) Video, Wechat, and other platforms. These educational materials are widely distributed in hospitals, and are visible in buses, metros, bus stops, billboards, and civic squares across the nation.

RESULTS AND CHALLENGES

- As a policy, Stroke 1-2-0 has been highly recognized and promoted nationwide by the State Health and Construction Commission through recommendations and guidelines.
- Stroke 1-1-2 has been added to the National Emergency Rescue Map for stroke patients, initially developed by Dr. Lijie Ren from Shenzhen.
- Received support from various academic societies including Chinese Stroke Association, Chinese Medical Association, Chinese Society of Geriatrics, Chinese Society of Anesthesiology, the Chinese Surgical Society. Stroke 1-2-0 is now included in 3 relevant Guidelines.

- The Stroke 120 special task force was well supported by experts across China. More than 1,000 hospitals along with more than 16,000 medical volunteers from 30 provinces and cities across China have joined the special task force to improve stroke awareness in their region.
- In a recent National Survey (15145 participants) Stroke 1-2-0 was considered more suitable for Chinese than FAST (82% vs 8%) Stroke 1-2-0 was well accepted across all ages and educational backgrounds.
- Centers promoting Stroke 1-2-0 experience twice as many thrombolytic therapies and prehospital delay compared to pre-campaign. So far, only 12 provinces have established Stroke 1-2-0 special task forces, though similar initiatives will need to be adopted throughout other provinces.

FUTURE PLANS

- Produce more relevant educational videos suitable for various ages and cultural background using various popular media formats
- Establish more local special task forces
- Continue to generate Stroke 1-2-0 related educational materials
- Continue multidisciplinary efforts and encourage more volunteers to join the Stroke 1-2-0 special task force
- Host national and international meetings to produce new approaches and guidelines to improve stroke awareness and reduce prehospital delays.

2.4. Stroke 112, a Universal Stroke Awareness Program, introduced in Taiwan and Macau

Contact person: Dr. Jing Zhao (email: zhaojingssmu@163.com) and Dr. Renyu Liu (email: liur@uphs.upenn.edu), website: www.stroke112.org

SUMMARY

To improve stroke awareness and reduce prehospital delays, we modeled a simple but potentially powerful universal stroke educational tool, Stroke 1-1-2, to overcome language barriers and improve stroke recognition and response times to call the emergency number, 112. This initiative has been well accepted in Taiwan where 1-1-2 is used as an emergency phone number.

BACKGROUND

Although thrombolytic therapy has been available since 1996, stroke is the second leading cause of death worldwide, with the highest mortality and disability rates in non-English speaking countries and regions. This is partly due to significant prehospital delays (1-3). The FAST (Face, Arm, Speech, and Time)(4) stroke awareness educational tool has made great strides in over 28 countries resulting in a drop in prehospital delays, though predominantly in English-speaking areas(5). However, English as the primary language accounts for only 4.4-4.8% of the global population. A universal stroke awareness program for non-English speaking countries and regions needs to be developed.

PROGRAM DESCRIPTION

- We developed, Stroke 1-1-2, as a novel stroke awareness educational tool (1-1-2 is the universal emergency number in over 70 countries and regions)
- The numbers imply an emergency and correspond to the 3 stroke recognition signs used in FAST (Face, Arm, Speech, and Time): 1 uneven face (crooked mouth); 1 weak arm (arm weakness); 2 incoherent lips (slurred speech) as indicated in Figure 1 and presented in various languages(6)
- To determine whether the new tool would be well accepted in a non-English speaking country, we translated the English version (Fig. 1A) into Traditional Chinese used in Taiwan (Fig. 1B)
- Online surveys were performed to examine the acceptance of the Stroke 112 program compared with that of FAST in Taiwan on 2 separate occasions: an initial estimation of the acceptance of Stroke 112 in August 2017, and 2 weeks after the official STARS-Taiwan (Stroke Treatment and Research Society-Taiwan) promotion of Stroke 112 (Fig. 2A) in March 2018.

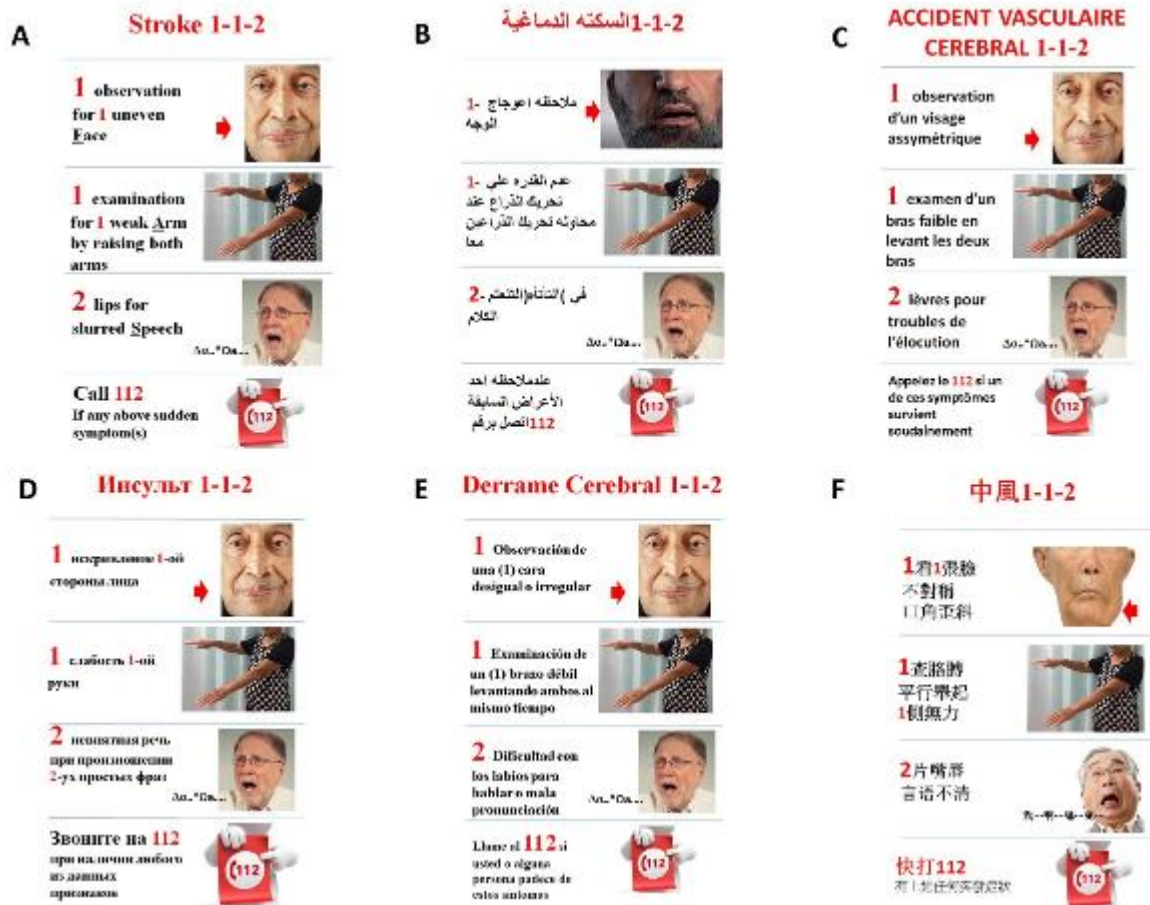


Figure 1. Stroke 1-1-2 presented in 6 different United Nation official languages. A, English; B, Arabic; C, French; D, Russian; E, Spanish; and F, traditional Chinese. It is important to note that instead of literal translation in the Russian version, pragmatic culturally-oriented translation was used. Particularly, "2 lips for slurred Speech" was described as "2 phrases for slurred speech" in Russian. A similar approach could be used in other languages if there is any culture-related concern or language-specific mnemonic.

RESULTS

- We received 465 survey responses to the initial survey
- The results indicated that Stroke 112 was easier to remember for people in Taiwan than FAST (54.6%vs 41.2%)
- After Stroke 112's official release in Taiwan, a second survey of 610 individuals, found that Stroke 112 was much easier to remember than FAST (66.4% vs. 28.6%), a significant improvement from the initial survey (P=0.0001)
- In addition, among neurologists (130) responding to the second survey, a greater acceptance of Stroke 112 (74.6%) was found compared to FAST (16.4%) (P=0.0001)
- This initial study demonstrated the acceptance of Stroke 112 in one non-English speaking region
- The next step is to determine its effectiveness
- We have also introduced the program in Macau (Fig. 2B); however, further promotion needs to be implemented

- Our early findings strongly suggest that Stroke 112 should be introduced and promoted in the countries and regions where 112 is used as an emergency number.



Figure 2. Introducing Stroke 112 program in Taiwan (A) and Macau (B).

FUTURE PLANS

- 1) Produce relevant educational videos suitable for various ages and cultural backgrounds
- 2) Identify new test sites in promoting Stroke 112.
- 3) Establish local special task forces to promote Stroke 112
- 4) Host national and international meetings to arrive at new approaches and guidelines to improve stroke awareness and reduce prehospital delays globally.

2.5. The FAST/VITE public education campaign for stroke symptom recognition: The Heart and Stroke Foundation of Canada

Contact person: Thalia Field, Assistant Professor, University of British Columbia, Stroke Neurologist, Vancouver Stroke Program, e-mail: thalia.field@ubc.ca

BACKGROUND

Since 2014, the Heart and Stroke Foundation of Canada (HSFC) has delivered a multimodal public campaign to teach the public to recognize signs of stroke and to activate emergency medical services immediately using the “FAST” acronym in English and the VITE acronym in French.

INTERVENTIONS

- The campaign includes an impactful and routinely shown television commercial from the point of view of a man’s wife and daughter witnessing him experiencing an acute stroke, and with his family members performing a “FAST” assessment and calling emergency health services.
- Ambulances in several regions across the country are emblazoned with large FAST decals.
- The HSFC has branded the month of June as “Stroke Month” and local stroke experts across the country in addition to patients and family members with lived experience are recruited for media appearances on radio and television to promote stroke awareness and to reinforce the FAST campaign.



RESULTAS

- Each year, a simultaneously released Stroke Report emphasizes a specific aspect for public awareness each year (for example, the 2017 campaign “Stroke At Any Age” included the message that young people may also experience strokes and FAST assessments still apply). <https://www.youtube.com/watch?v=1i3nMJHXk5A>
- The 2017 FAST/VITE campaign in Quebec found that following the campaign, 71% of respondents knew at least one of the three cardinal signs of stroke, 37% knew 2 or 3 signs, and 13% knew all three signs, as compared with 54%, 22% and 5% pre-campaign.

4.1. Recognition of stroke mimics in United Kingdom

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SUMMARY

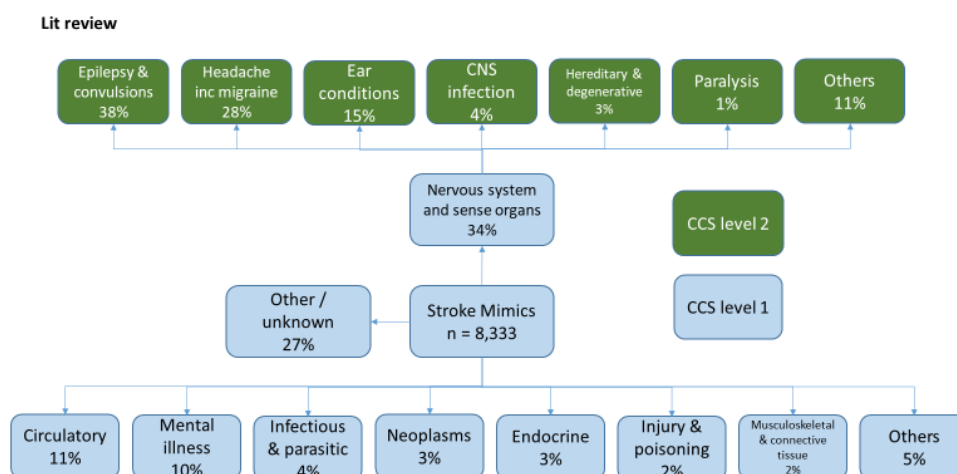
The Newcastle University Stroke Research Group in conjunction with the North East Ambulance Service NHS Foundation Trust (NEAS), investigated whether it was possible to improve the ambulance identification of stroke patients by reducing the Stroke Mimic rate using routinely collected information. This project was supported by a Stroke Association post graduate fellowship.

PROBLEM

- Due to evidence favoring centralized specialist stroke care, ambulances may bypass local hospitals in order to access Hyper Acute Stroke Units (HASUs) with suspected stroke patients.
- Pre-hospital identification of stroke in the UK is based on the FAST test which is moderately sensitive for stroke but lacks specificity.
- Similar to other stroke identification tools used by Emergency Medical Services (EMS), this results in a high rate of suspected stroke cases with stroke mimic conditions (typically 30-40% of cases) being transported directly to HASUs.

PROGRAM DESCRIPTION

- This project sought to develop a pragmatic tool to be used by EMS to identify stroke mimic patients.
- Mixed methods were used including a survey of UK paramedics, systematic review of stroke mimic characteristics and regression analysis of a dataset linking EMS suspected stroke with hospital diagnoses.
- Focus groups with paramedics and hospital clinicians were used to refine the stroke mimic identification tool and explore its applicability by EMS.



Taxonomy of stroke mimics using Clinical Classification Software (CCS) codes.

RESULTS

- Data from 5,645 suspected stroke patients transported by EMS to four acute hospitals in the North East of England were linked to final hospital diagnoses.
- The overall stroke mimic rate in this population was 38%. Stroke mimics were younger and more likely to be female than stroke patients.
- Common stroke mimics identified in the EMS data included seizures, sepsis, syncope and migraine.
- A simple tool based on six characteristics easily observable by EMS was developed which prioritized simplicity and specificity known as STEAM.
- STEAM included the following characteristics: systolic blood pressure <90mmHg; temperature >38.5°C with heart rate >90; seizures with previously diagnosed epilepsy; age <40 years; headache with previously diagnosed migraine; and FAST negative.
- STEAM identified stroke mimic patients with 6% sensitivity, 99% specificity and a positive predictive value (PPV) of 91%.

BARRIERS

- Linking EMS data with hospital episode statistics from multiple hospitals in order to determine the stroke mimic rate and develop the tool were major hurdles.
- The risk of a stroke patient having their assessment and treatment delayed concerned paramedics and hospital clinicians.
- Quantifying how stroke mimic identification by EMS would benefit patients, EMS and hospitals was difficult as stroke mimic patients would still be transported to hospital and it was unclear how much influence SM identification by EMS would have on hospital processes.
- Although the tool would be quick to deploy and simple to use, it would only identify a small number of stroke mimic cases.

FUTURE PLANS

- This study clearly described the suspected stroke population identified by EMS services which was only possible by creating a linked dataset.
- Developing a tool which identifies stroke mimic patients with sufficient accuracy to be clinically applicable is difficult using the observations that are commonly used by EMS.
- Further research is needed into improving EMS stroke identification and point of care diagnostics for stroke, so patients can be appropriately triaged to specialist services and unnecessary admissions to distant HASUs can be reduced.

4.2. Improving emergency identification and ambulance response in acute stroke in United Kingdom

Contact person: Stephanie Jones, Senior Research Fellow, University of Central Lancashire, e-mail: sjones10@uclan.ac.uk

BACKGROUND

For every minute that a large-vessel ischemic stroke is untreated, the average patient loses 1.9 million neurons. The stroke chain of survival relies heavily on the accuracy and speed with which the Emergency Medical Services (EMS) can identify suspected stroke, attend the patient on scene and convey them to a specialist center. However, identifying 'true stroke' from an EMS call is challenging; emergency medical dispatch sensitivity and positive predictive value (PPV) for identifying stroke is typically less than 50%. In the UK, emergency medical dispatchers (EMDs) are not health professionals by background and receive in-service training to enable them to use decision-based computerized algorithms to provide the most appropriate response.

PROBLEM

With the increasing availability and importance of time-dependent hyperacute stroke care, such as thrombolysis, failure by EMDs to recognise stroke in up to 50% of cases was leading to potentially avoidable delays in treatment. Although the FAST acronym was established, it was only used if the EMD already suspected stroke. The diverse and sometimes non-stroke-specific nature of presenting stroke symptoms also made correct identification difficult.

The overall aim of the programme was to develop and test methods to facilitate recognition of stroke by EMDs.

PROJECT

- In this programme of research, we firstly explored the interaction between the public and the EMS during emergency calls for stroke, including a retrospective records review; qualitative exploration of callers' experiences; and identification of the key words used by the public to describe stroke.
- We then developed and evaluated the effectiveness of an online training package for EMDs in order to increase their ability to recognise stroke.
- The research programme ran from 2008-2012.

RESULTS

Phase 1:

- Analysis of EMS call data found that EMDs correctly identified 48.3% of stroke patients
- For patients with a final diagnosis of stroke, facial weakness and speech problems were consistently associated with dispatch and ambulance diagnosis of stroke
- The time from call to arrival at hospital was shorter when the dispatch code was stroke compared with not stroke

- Content analysis of EMS call recordings showed that of callers stating that the patient was having a stroke, 85.5% were correct
- Less than a third of calls in which the final diagnosis was stroke included mention of any of the FAST items; often, stroke was reported and coded as a 'collapse or fall'

Phase 2:

- We incorporated these research findings in an online training package with the help of an expert committee
- The training package was initially delivered to EMDs within one control center.
- Almost all EMDs reported an increase in stroke symptom knowledge and a high level of satisfaction with the training.
- The training package was then implemented and evaluated across a regional ambulance service using an interrupted time series design over an 18-month period
- Training significantly improved the recognition of stroke by EMDs (see figure 1) and there was also a small non-significant reduction in time from call to arrival of the ambulance on scene.

FUTURE PLANS

The training package has been rolled out nationally and internationally and has been taken up in more than 8 countries. It is owned by the University of Central Lancashire, it has been endorsed by the UK Stroke Forum Education and Training and is free to access online.

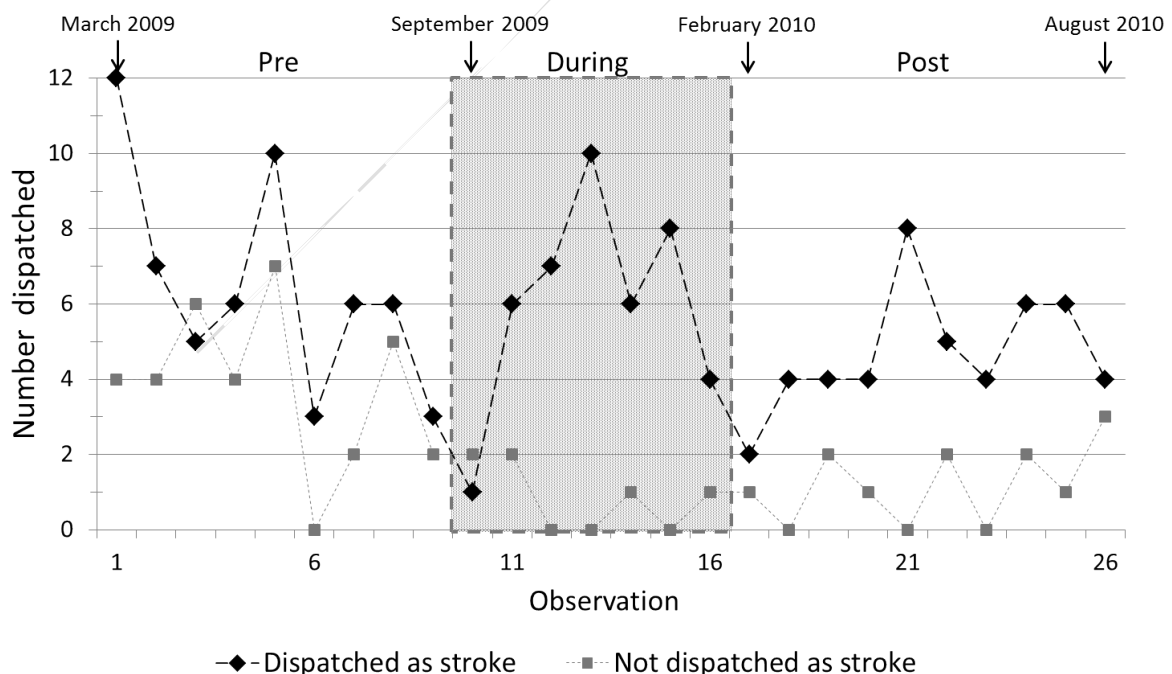


Figure 1. Weekly numbers of patients with final diagnosis of stroke dispatched as stroke and not stroke

4.3. The Stroke Prehospital Delay Summary Statement: A Global Battlefield

Contact person: Dr Renyu Liu, e-mail: renyu.liu@uphs.upenn.edu

BACKGROUND

Jing Zhao and colleagues published a report of an international meeting, mainly attended by Chinese clinicians involving over 11,000 participants to discuss how stroke patients could be managed more effectively in order to deliver high quality acute stroke care. Data were reviewed from India, China, Japan and Korea where median delay to arriving in hospital range from 11-20 hours, even in urban areas.

PROBLEMS

The main factors identified for delay in these countries were:

- Poor public awareness. The lack of an effective awareness/educational tool is recognised. Although the FAST tool is widely used its effectiveness may be reduced because of linguistic issues
- Reluctance to call emergency services. For example, less than 15% of patients in India use EMS and even in some well-developed countries use is below 60%
- Poor Emergency Medical Services. Many low and middle-income countries have a paucity of functional ambulances. Services are often fragmented with a range of different emergency numbers and there is variable access to qualified EMS personnel
- Poor knowledge of hospital stroke care capability. This is especially true in rural areas and results in delays to treatment because of the need for secondary transfers
- Inability to diagnose stroke in a timely manner perhaps due to lack of experienced clinicians or lack of diagnostic equipment
- Poor traffic conditions
- Inadequate government support
- Consent requirement. In some countries and regions, e.g. India and China, thrombolytic therapy required formal consent, often leading to long delays in thrombolysis administration



Figure 1. An advertisement for stroke management on the side of the highway. The portion outlined in red indicates the 11 digits of the emergency phone number. It is not an uncommon practice in China for many local hospitals to have their own specific emergency phone numbers, even though 120 as a standard specific medical emergency phone number has been implemented for many years.

SOLUTIONS

- Implement of novel stroke awareness campaigns particularly focusing on non-English speaking countries. The Stroke 120 programme was felt to be a significant advance and has been shown to improve services in China
- Educate people about the need to use ambulance services
- Avoid using medical jargon in public education
- Educate the younger generation. Do not just focus education on the older at-risk population
- Educate community physicians and family doctors
- Improve EMS education for both staff and dispatchers while encouraging the use of tools such as the Cincinnati Prehospital Stroke Scale
- Focus on in-hospital stroke education during initial stroke admission to identify stroke risk factors and importance of activating Stroke 120 for any future events
- Appoint stroke educators
- Remove the need to obtain family member consent before giving thrombolytic therapy
- Develop a stroke center capability map for each region (in China known as the stroke emergency map), which combined with a stroke activation protocol setting, would guide EMS to the nearest appropriate stroke center in the event of stroke. Such stroke maps have been implemented in many areas in China with a resultant increase in thrombolysis rates
- Develop telemedicine networks, particularly in remote rural areas
- Develop support systems to enable patients and families to be able to afford the cost of drugs and other treatment after discharge

5.1. Adherence to a regional UK pre-hospital stroke pathway

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BACKGROUND

Since 2015, Greater Manchester (GM) has operated a centralized care pathway for stroke patients that is similar to the London hub and spoke model of delivery. The pathway comprises of 3 Hyper Acute Stroke Units (HASU) and 6 District Stroke Centers (DSC) serving around 3.2 million people. The region's Neuroscience Centre at Salford Royal Hospital serves as the pathway's Comprehensive Stroke Centre (CSC) and is open 24 hours a day, serving the whole region overnight. The unit is the largest by far in the UK and sees ~2200 strokes per year. Two additional HASUs in the north and south of the city, termed Primary Stroke Centers (PSC), are open for extended hours (06.45-22.45).

CURRENT STATE

FAST test positive patients are taken directly by ambulance to the nearest, open HASU which can mean bypassing a local hospital. If the patient's time of onset is > 48 hours ago and/or the patient is too unstable for transfer to a HASU (based on pre-specified pathway exclusions) they are diverted to the nearest Emergency Department. Emergency Medical Service (EMS) clinicians therefore have to take into account a number of factors when deciding which hospital to take a patient with a suspected stroke, including:

- Accurate FAST status
- Are the FAST symptoms resolved/resolving? (indicating a probable Transient Ischemic Attack)
- Are any pathway exclusions present?
- Time of onset?
- Current medications taken by the patient?
- HASU or local hospital? If HASU, which is nearest and is it open? Can they get there before closure if a PSC?
- Length of time on scene?
- Use of pre-alert to inform the incoming hospital?
- If unsure, is there timely access to Ambulance Clinical Support Hub for advice?

CONTENT STATE PROBLEMS

- This complexity can complicate decision making, which is compounded by the potential for confusion with other local care pathways, such as major trauma
- The GM pathway is shared locally with all EMS staff via email and clinicians are expected to print a paper copy for their own use, although it is likely this is not always followed through by staff

- If the pathway is not readily available to ambulance crews when out on the road then clinicians can call an Advanced Paramedic for advice, however, they may have to wait for a call back
- This potentially adds delay which is undesirable as time is brain in stroke, and rapid transfer to an appropriate hospital is critical for better outcomes.
- Local intelligence highlighted a potential issue with inappropriate attendances by ambulance crews with suspected stroke patients at HASUs, especially the CSC.
- lack of knowledge and understanding of the pathway by EMS clinicians was suspected to be key issue in compliance

INITIAL INTERVENTION AND RESULTS

- Identifying the Problem: Prior to designing a solution, local EMS staff took part in a scoping exercise where this was evaluated. Staff rated their confidence in their own stroke pathway knowledge at a median of 7/10. However, only 44% correctly stated the opening hours of the CSC/PSCs with almost no one knowing how many pathway exclusions there were and just 19% knowing the nearest HASU when presented with a postcode.
- Proposed Solution: Following on from this work, a GM Connected Health Cities (CHC) project was established with an aim of describing pathway compliance.
- It investigated a large retrospective dataset of consecutive patients conveyed by ambulance to the CSC over an 18-month period (01/09/2015-28/02/2017)
- 4216 suspected stroke patients had data extracted from the ambulance Patient Report Form (PRF) and the hospital Electronic Patient Record (EPR).
- 2571 patients were transferred to the CSC rather than their nearest ED. Of these, 183 (7.1%) or 348 (13.5% - when including FAST- arrivals) had a pathway exclusion and thus should have been conveyed to their local hospital rather than the CSC
- It was also found that another 5% of patients arrived and potentially should have been taken to another open HASU, as likely to have been closer

In summary, this analysis suggests that up to 500 patients may have been conveyed incorrectly by ambulance to the CSC in breach of the pre-hospital stroke pathway. This number is likely to be an underestimate as compromised airway patient or those with a time of onset of >48 hour were not included.

SOLUTION AND FUTURE PLANS

A smartphone application (app) to support and improve pathway decision making was developed and piloted to ensure local EMS clinicians take patients to the “right place at the right time for the right care”.

The smartphone app aimed to:

- Reproduce the GM pre-hospital stroke pathway in a simple to use, accessible electronic format that could be easily disseminated to crews and updated remotely should the pathway change
- Ensure the appropriate assessments were carried correctly out by EMS clinicians
- Direct EMS staff in a robust and accurate way to the most appropriate hospital

- Correctly prompt a pre-alert in line with the pathway (< 4-hour onset and/or anticoagulated patients)
- Pilot Trial: During a 2-month period in the summer of 2017, a beta version of the app was tested and named the Pre Hospital Pathway Aid (PHPA)
- Clinicians volunteered to test it and users included a range of EMS staff
- A live mode was available for actual cases and a demo mode for functionality user testing were embedded in the app
- During the pilot there were 74 live uses and on 32 occasions (43%) the user was prompted to take the patient to the nearest ED based on the pathway rules rather than a HASU
- Pilot Results: The pilot strongly suggested that the PHPA app will improve pathway compliance by EMS clinicians.

NEXT STEPS

In early 2019, the digital aid will be launched by the local ambulance service, with it made available to all GM EMS clinicians through installation on their emergency vehicle mobile phones.

The potential impacts of the app are:

- Reduction in the number of inappropriate attendances at GM HASUs due to non-compliance of the pre-hospital pathway – this will increase capacity at these units to treat actual suspected strokes rather than “mimics”
- Reduction in unsafe transfers of patients to HASUs where they should not bypass their nearest ED
- Increase in selection of the correct nearest HASU for crews with poor local geographical knowledge
- Reduction in calls to Ambulance Clinical Support Hub when crews are uncertain of the pathway resulting in reduced time on scene and improved hospital conveyance times
- Reduction in the number of additional ambulance transfers (repatriations) back to their local hospital for patients brought to a HASU inappropriately

The app has received very positive user feedback and been reviewed by the Stroke Network’s Patient and Career Group, with the chair commenting: *“The app comes across as a brilliant, simple and effective idea that reduces the need for paramedics to carry around pieces of paper and allows them to instantly decide on the most appropriate place of care. Having experienced a stroke myself, I vividly remember the paramedic on that day trying to work out and discuss where he should take me.*

This app would have made that decision clearer and faster for them”.

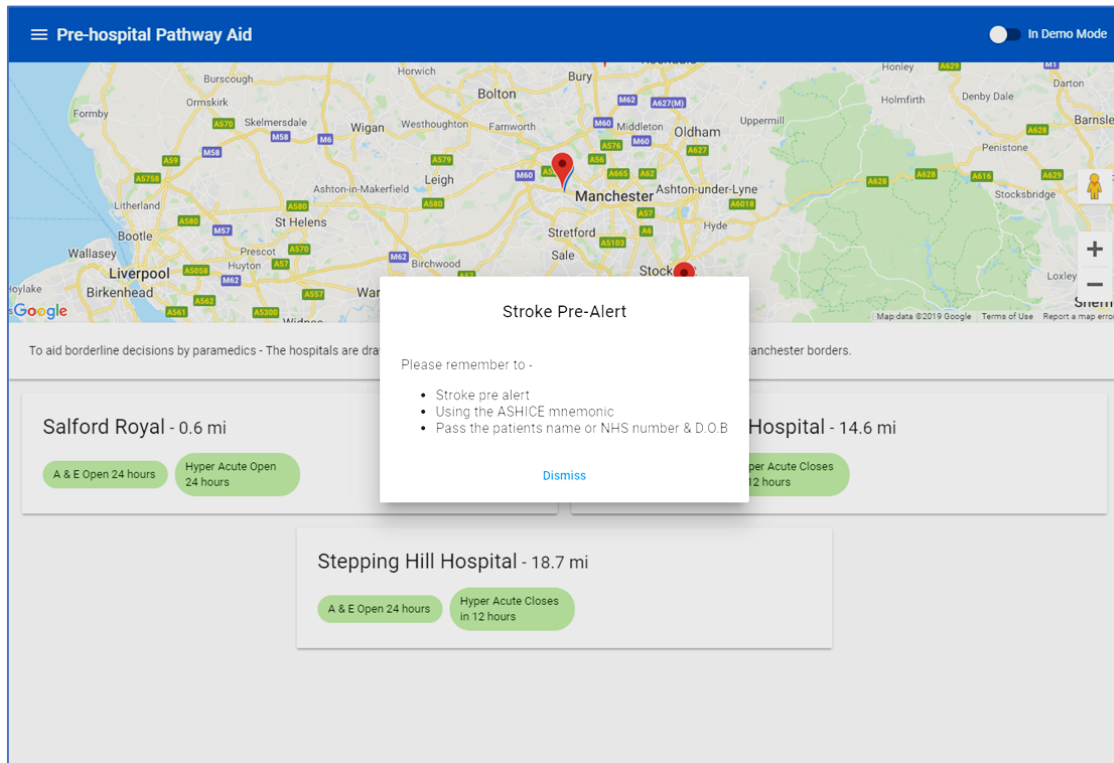


Figure: Screenshot of the Pre-Hospital Pathway Aid (PHPA) mobile phone app highlighting the pathway instructions and nearest Hyper Acute Stroke Units (HASU), both prompted once the user has completed the flowchart of buttons built within the app.

6.1. Centralization of acute stroke services in London and Greater Manchester

Contact person: Angus I. G. Ramsay, Senior Research Associate, Department of Applied Health Research, University College London, e-mail: angus.ramsay@ucl.ac.uk

BACKGROUND

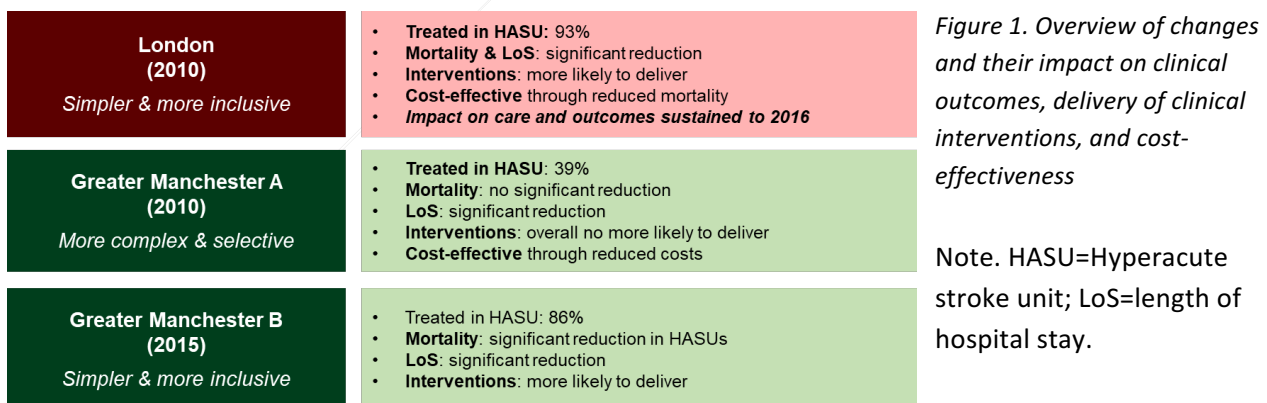
The centralizations

In 2019, to address unwarranted variations in care and outcomes, two large metropolitan areas in the UK - London (population 8.2 million) and Greater Manchester (GM, 2.7 million) - centralized their hospital stroke services. Both areas developed 'hub and spoke' systems with hyperacute stroke units (HASUs) offering rapid access to specialist assessment, brain imaging, and thrombolysis if appropriate. The systems implemented differed in several ways.

- **London (2010).** Eight 24/7 (HASUs) were designated; all patients were eligible for HASU treatment. Once stable, patients were transferred to the community or one of 24 acute stroke rehabilitation units.
- **GMA (2010).** Three HASUs were designated: one operated hyperacute services 24/7 and two operated 7am-7pm, Monday-Friday. Only patients reaching hospital within 4h were eligible for HASU treatment; 11 District Stroke Centers treated patients arriving after 4h and provided ongoing acute rehabilitation.
- **GMB (further centralization in 2015):** all patients eligible for HASU treatment; in-hours HASUs extended operation to 7am-11pm, 7 days per week.

RESULTS

Independent mixed-methods research studied the impact of these changes, using the rest of England as a control (Figure 1):



- **London (2010):** length of hospital stay (LoS) and mortality reduced significantly (estimated additional 96 lives saved annually); services were significantly more likely to deliver evidence-based interventions; 93% patients were treated in HASU; changes were cost-effective due to improved outcomes. The impact on outcomes and delivery of care was sustained long-term.

- **GM (2010):** LoS reduced significantly, but there was no significant effect on mortality or delivery of care. GM HASUs delivered interventions as effectively as London HASUs, but treated only 39% of stroke patients; changes were cost-effective, due to reduced LoS.
- **GM (2015):** LoS reduced significantly, and delivery of clinical interventions was significantly better than the rest of England. Mortality reduced significantly among patients treated in HASUs (estimated additional 68 lives saved annually); 86% patients treated in HASUs.

BARRIERS

There are clear benefits of centralized service models where all stroke patients are eligible for HASU treatment in urban settings. However, implementing such changes is complex and controversial.

Independent qualitative research on the London and GM changes identified lessons on planning, implementing, and sustaining such complex changes:

- Combining system-wide and clinical leadership can help enable change. It is important to involve all relevant stakeholders (including hospital and ambulance services, patients and carers, payers, and politicians) throughout planning and implementation.
- Simpler, more inclusive service models promote clear understanding of the new system.
- Service standards help ensure that services can provide appropriate care; providers benefit from hands-on facilitation; ongoing achievement of standards should be linked to financial incentives.
- Phasing of implementation should be minimized, and timings of changes clearly communicated.

FUTURE PLANS

These lessons are being used by those planning acute stroke service reorganizations across the English, Welsh, Scottish, and Northern Irish National Health Services. www.learningfromstroke.com

6.2. The Saskatchewan Acute Stroke Pathway in Canada

Contact person: Michael E. Kelly, Professor of Neurosurgery, University of Saskatchewan, e-mail: m.kelly@usask.ca, web-site: <http://www.sasksurgery.ca/provider/acutestroke.html>

SUMMARY

There was great disparity in acute stroke care across the province of Saskatchewan, Canada. To address this disparity, the Heart and Stroke Foundation Canadian Stroke Best Practice Recommendations (CSBPRs) were applied to the entire health system. This application resulted in marked improvement in access to stroke care as determined by Canadian Best Practice performance metrics. Additionally, there was a dramatic increase in endovascular cases over the four years after implementation.

BACKGROUND AND PROBLEM TO BE SOLVED

The province of Saskatchewan, Canada represents a large geographic territory of 651,900 km² with 1.2 million residents. Over 2000 Saskatchewan residents are hospitalized per year with stroke at various acute care facilities. There was disparity noted in stroke care at these center that were identified during a 2011 audit. Therefore, the Saskatchewan Acute Stroke Pathway (ASP) was implemented. The process involved applying CSBPRs province-wide for acute stroke along with the collection of performance metrics.

DESCRIPTION OF THE PROJECT

Recommendations implemented included: creation of primary and comprehensive stroke centers, expansion of emergency medical service stroke alert bypass window, increased use of telehealth technologies, twenty-four-hour access to computer tomography and angiography, and standardized assessment, diagnostic and treatment tools that integrate best practice guidelines into workflow. Additionally, all stroke centres were required to report key metrics which assisted in understanding successful implementation of CSBPRs and identified quality improvement initiatives.

RESULTS

A significant improvement in access to acute stroke care was achieved. Eight primary stroke centres (PSC) and 1 comprehensive stroke centre (CSC) were established and a 12-hour EMS bypass window was implemented. EMS adopted the FAST tool to correctly identify stroke patients 78% of the time. 68% of patients arrived at the stroke centre within 4.5 hours of symptom onset. The median provincial door to needle time decreased from 82 minutes to 66 minutes. Prior to pathway implementation, 20 patients received endovascular clot retrieval. This increased to 70 patients per year within a 4-year period.

Although standard processes were adopted by all stroke centres to ensure that there were significant improvements in the continuity of stroke treatment regardless of facility, lower volume centres continue to experience challenges in meeting CSBPRs resulting in ongoing improvement work. Transfer of patients requiring endovascular therapy has improved provincial endovascular clot retrieval access to 58 patients per 1 million population from 24 patients per 1 million. Further improvement work is focusing on increasing this access to 100 patients per 1 million population. Metrics continue to show provincial work as a whole and allow for all stroke centers to be accountable for care being provided.

FUTURE WORK

Continued provider engagement across the spectrum of acute stroke care is required. Further improvements to thrombolytic and endovascular stroke care is needed to improve overall patient access. Further work will include analysis of cost and patient outcomes.



Figure: Average door to imaging time improvements seen in a Saskatchewan Primary Stroke Centre after implementation of the Saskatchewan Acute Stroke Pathway protocol

6.3. PreSS – Prehospital Stroke Score, improved recognition of stroke in the prehospital setting in Denmark

Contact person: Per Sabro, EMS, Central Denmark Region, Hovedpostkasse@ph.rm.dk

BRIEF SUMMARY

A newly developed screening tool, the Prehospital Stroke Score (PreSS), uses a two-step validated approach to suspected stroke patients, helping to identify symptoms of stroke and to distinguish more versus less severe strokes. PreSS will facilitate timely referral of patients for thrombolysis and thrombectomy.

PreSS is a combination of a score for stroke screening, and a severity score. Several scores/scales have been suggested in recent years and are similar with respect to choice of symptoms, and overall performance. Adopting one enables the cost-effective development of e-learning material, development of standard operational procedures and facilitates additional training, experience sharing and comparison.

PROBLEM TO BE SOLVED

Every year 12,000 Danes experience a stroke, with the majority being ischemic. Delivery of effective stroke therapy requires timely recognition and, in turn, timely intervention.

In the Central Region of Denmark, thrombolysis is performed at two hospitals (Regional Hospital Holstebro and University Hospital Aarhus), while thrombectomy is only performed at the University Hospital. Early identification and transport to the most appropriate centre is essential for optimal patient outcomes but have presented a challenge in the prehospital setting.

PROGRAM DESCRIPTION

This improvement effort is done in the under the auspices of the national LKT Stroke (Learning and Quality Team). LKT Stroke has two identified areas for improvement:

- Optimization and quality assurance of the prehospital care and transport of stroke patients
- Diagnosis and treatment of stroke patients with atrial fibrillation/flutter

The LKT Stroke project will run for two years. The goals of the project have been defined by an expert group of neurologists, prehospital physicians, cardiologists and experts in quality improvement.

The aims of the prehospital initiative include early detection of stroke and use of PreSS to identify candidates for thrombolysis and thrombectomy.

The projects benchmarks to date include:

- Defining and validating the screening tool – PreSS
- Development of an iPad platform for documentation and data collection
- Development dissemination of an E-learning programme for the education of the ambulance staff
- New stroke guidelines for the Danish prehospital organization
- Identification of data elements and an approach to their documentation and communication

- Revision of the 'Danish Index', a decision support tool used in the EMSN Control Center, incorporating input from neurologist

CHALLENGES AND FUTURE PLANS

The largest challenge has been to collecting real time data. Next steps include after work meetings for GPs on stroke for education regarding time frames for stroke treatment and, methods of treatment. Development of e-learning material for GPS is also underway.

Components of the PreSS score

PreSS part 1 (CPSS + other)		
Symptoms	Yes	No
Facial droop		
Arm weakness		
Speech		
Other*		

≥ 1 point = suspicion of stroke

* e.g. sudden onset of: Loss of balance or co-ordination, visual field defects, diplopia, numbness and/or leg weakness

PreSS part 2 (PASS)		
Symptoms	Yes	No
Incorrect month and/or age		
Gaze palsy and/or deviation		
Arm weakness		

≥ 2 points = high suspicion of "LVO" stroke

*LOV: Large vessel occlusion

6.4. Training system for emergency stroke care for paramedic personnel in Japan

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SUMMARY

We have developed two half-day training courses: Prehospital Stroke Life Support (PSLS) and Immediate Stroke Life Support (ISLS), which are management systems for Prehospital and ED settings, respectively. The PSLS algorithm consists of seven steps, from on scene assessment to action in an ambulance. The ISLS algorithm consists of primary and secondary programmes, including “Drip, Ship and Retrieve”. Despite lacking high-level outcome evidence, these systems are widely used in Japan. We feel that these training systems will contribute to spreading good practice in stroke care across regions in Japan.

CHALLENGES

In Japan fewer than 10% of patients with acute ischemic stroke are treated with intravenous thrombolytic therapy or endovascular clot retrieval. One reason may be related problems before the patient arrives at the hospital.

TRAINING COURSES

To increase the number of ischemic stroke patients treated with intravenous thrombolytic therapy or endovascular clot retrieval, we developed training courses for emergency stroke care for paramedic personnel and medical staff of the emergency department (ED) in a hospital in Japan. The Japan Resuscitation Council (JRC) released the JRC Resuscitation Guidelines in 2010, in which Neuro-resuscitation (NR) was Chapter 6 and revised the Guidelines in 2015. NR is neurocritical care focused on resuscitation of the central nervous system. Based on the JRC guidelines, we considered stroke as a core of NR, and developed the relationship between stroke care, neurocritical care and internal medicine, and between prehospital care and the ED. From there we developed half-day training courses with training manuals. Prehospital Stroke Life Support (PSLS) and Immediate Stroke Life Support (ISLS) are management systems for prehospital case and ED, respectively. PSLS and ISLS also cover the first five or six steps of the “D’s of Stroke Care” from the American Heart Association. We recognize that emergency stroke care may act in parallel with other emergency care, such as for cardiac arrest, acute coronary syndrome or trauma. PSLS consists of seven steps from scene assessment to the action in ambulances. ISLS is an initial management system for suspected stroke patients in the ED. Its algorithm consists of a primary survey and secondary survey, which the same as for trauma care. The ISLS guidebook was revised this year according to “Drip, Ship and Retrieve”. Figure 1 shows recent scenes from the courses and lists the course content. We use a “case-map” method to denote of training scenarios in these courses. Case-maps have a tabular form consisting of two axes: the horizontal axis as algorithm, and the vertical axis as medical practices. This method can represent scenarios of patients with hemorrhagic or ischemic stroke in the same form. We feel these courses could contribute to sharing common regional systems for stroke care.

FUTURE PLANS

We intend to link these systems to care systems for patients with acute impaired consciousness or other systemic conditions, and to provide stroke education for lay citizens in the near future.

PSLS



PSLS course content					
Items	Length	K	S	A	Methods
Lecture	30 min.				Projector
CPSS & KPSS	50 min.				Acting by trainees
Demonstration	20 min.				Acting by staff
Training for seven steps	50 min.				Acting by trainees
Case study (total steps)	50 min.				Several scenarios

ISLS



ISLS course content					
Items	Length	K	S	A	Methods
GCS, ECS & FOUR score	50 min.				Acting by staff
NIHSS	50 min.				
Management of general condition	50 min.				Human simulator
Case study	50 min.				Group work

Figure 1. Content and scenes of PSLs and ISLS training courses. Abbreviations: PSLs: Prehospital Stroke Life Support. ISLS: Immediate Stroke Life Support. GCS: Glasgow Coma Scale. ECS: Emergency Coma Scale. CPSS: Cincinnati Prehospital Stroke Scale. Kurashiki Prehospital Stroke Scale. NIHSS: National Institute of Health Stroke Scale. K: knowledge, S: skill, A: attitude.

6.5. Reducing death after intracerebral hemorrhage: The 'ABC' hyperacute care bundle

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THE PROBLEM

Intracerebral hemorrhage (ICH) causes 1 in 10 strokes. It has a high 30-day case fatality of 30-40% and over half of survivors remain dependent on others for day-to-day care. There is now evidence that reversal of anticoagulants, rapid lowering of blood pressure, neurosurgery and care on a high dependency unit can improve outcomes.

The ABC care bundle: We sought to improve implementation of hyperacute ICH care by combining guideline-recommended interventions in to the 'ABC care bundle':

- A – rapid reversal of Anticoagulants
- B – intensive Blood pressure lowering
- C - Care pathway to ensure timely referral to neurosurgery and critical care

We implemented this in 2015-16 at our large Greater Manchester Hyperacute Stroke Unit (HASU; Salford Royal Hospital) and 30-day case fatality fell by a third.

SCALE UP IN GREATER MANCHESTER

The ABC bundle was launched at two other Greater Manchester HASUs in April 2017. In the three months prior to launch, local teams identified and addressed barriers to ABC bundle delivery, secured executive leader and clinician buy-in, and planned and delivered launch meetings at their hospitals. Teams from the three HASUs met every quarter for collaborative learning sessions, along with the lead Neurosurgeon.

One HASU demonstrated marked improvements in care processes, including a reduction in median door-to-needle time for anticoagulant reversal and door-to-target time for intensive blood pressure lowering (Fig 1). The same HASU had a reduction in 30-day case fatality from 34.3% to 26.8%. Challenges with implementation at the other HASU meant that care processes did not significantly improve, and no improvement was seen in 30-day case fatality.

ABC-ICH APP AND DASHBOARD

We have now designed, developed and implemented at Greater Manchester HASUs a tablet app to be used by acute stroke teams to guide delivery of the care bundle and capture key process data automatically, for display in a linked dashboard (Fig 2). Based on learning from this pilot launch, version 2 of the app is currently being developed.

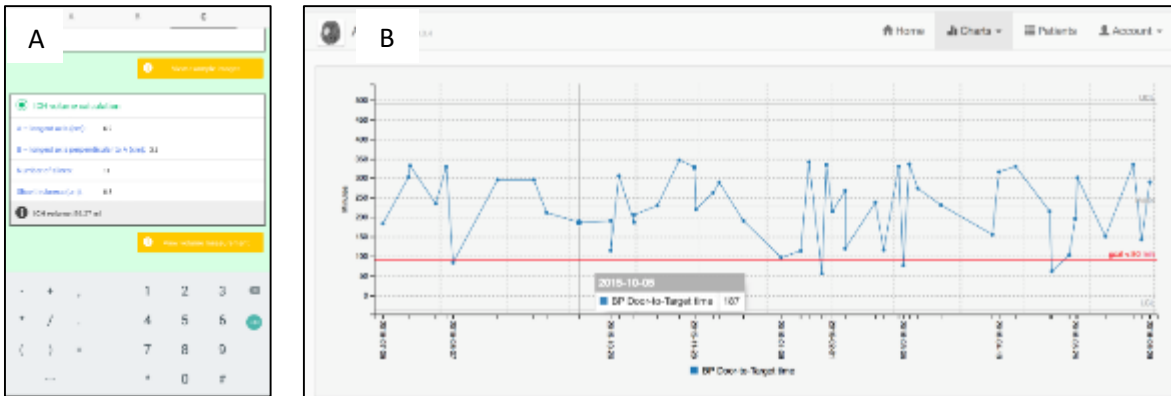


Figure 2: (A) Screenshot of the ABC-ICH app showing ICH volume calculator, which is used to inform the decision to refer to neurosurgery. (B) Screenshot of linked dashboard with an example of a door-to-target time run chart.

NEXT STEPS

Building on work in Greater Manchester, we are now planning to launch the bundle in three other UK regions, supported by V2 of the ABC-ICH app and dashboard. A parallel quantitative and qualitative evaluation will determine the impact of the care bundle on death and disability after ICH and ensure the implementation strategy is further optimized for a full national scale up.

7.1. New Zealand National Stroke Clot Retrieval Improvement Programme

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THE PROBLEM

Endovascular Clot Retrieval is a highly effective intervention that improves stroke outcomes. However, the procedure is complex and time sensitive, requiring specialist expertise with relatively low case volumes, making the procedure challenging to implement in areas with low population density.

DESCRIPTION OF THE PROJECT

In New Zealand (NZ) a National Stroke Network supported by the Ministry of Health has been operational since 2011 and with dedicated clinical leadership time since 2014. After the publication of the pivotal endovascular therapy trials in 2015, the network organized a working party to develop a New Zealand-wide clot retrieval implementation strategy. This document mapped projected patient volumes across NZ as well as estimated flight times to transport patients from smaller to larger centres. The strategy also considered requisite case volumes for interventionists to maintain competence and what might be considered sustainable and safe clinician rosters (i.e. on-call frequencies). This resulted in the designation of three clot retrieval centres in NZ: Auckland, Wellington, and Christchurch; evenly distributed across the country. In addition, the network applied for the set-up of a standalone National Stroke Clot Retrieval Service Improvement Programme to assist with service implementation in an effort to achieve national equity of access, optimal service provision, consistency, and a robust monitoring system.

RESULTS

The strategy was received and supported by the Ministry of Health and distributed to all NZ hospitals. Clot retrieval services are now operational at the three named centres although full staff recruitment to roll-out sustainable 24/7 regional services is still ongoing. The strategy has helped significantly with gaining buy-in from hospital managers and regional health authorities resulting in swifter business case approval and implementation.

The application for a National Stroke Clot Retrieval Service Improvement Programme was approved by the Ministry of Health in April 2018 with project management in place, a clinical leader being currently recruited, and an initial sector wide stakeholder engagement workshop being held on 22 August in Wellington. This workshop allowed representatives from every NZ hospital and clinical specialty, as well as health care consumers, a voice in what we want and should achieve. One outcome from this workshop was the development of the new official NZ terminology of 'Stroke Clot Retrieval' as it was seen as highly descriptive, without any extraneous or jargon words, and was thus deemed to be highly patient focused; a passion of NZ stroke services.

Current barriers identified included radiology and interventionist access/workforce, access to advanced imaging, pre- and intra-hospital transport delays, and ongoing gaps in stroke expert support to some provincial hospitals to aid with rapid decision-making. A detailed five-year work-plan will be prepared by December 2018, with anticipated sign-off from the Ministry of Health to allow a national mandate to

implement high quality and quality assured clot retrieval services that will be reachable by as many New Zealanders as possible by 2023.

CHALLENGES

While equity of access is at the forefront of clinicians' and policy makers' minds in our publicly funded health system, resource constraints are a major challenge because of constantly competing demands. Despite being "cost-effective"-clot retrieval is expensive to set up and maintain in low volumes centres and even some of our tertiary units will struggle. Alternative models of care for interventionists and initial rapid radiology assessments may present potential solutions. Some of the geographic challenges may be impossible to overcome and even once we have fully implemented the current three-centre model, some very rural New Zealanders are still likely to be excluded (see Figure 1). However, with the roll out of advanced imaging to all NZ CT-capable hospitals, we hope that this can at least be partially mitigated. Telestroke services and close hospital/ambulance sector collaboration will be key components to success. Unfortunately, immediate hospital diversion or mobile stroke units are not very feasible options in most of New Zealand due to our significant rurality making initial transport to the nearest CT-capable hospital the first step likely for many years to come. Transporting the interventionist to the patient is being discussed, but nearly all of the affected hospitals lack the angiography infrastructure to support such an initiative.

CONCLUSIONS

We face significant challenges around the implementation of nationwide equitable clot retrieval services, but we have put measures into place that have started us on a firm trajectory to achieving our goal.

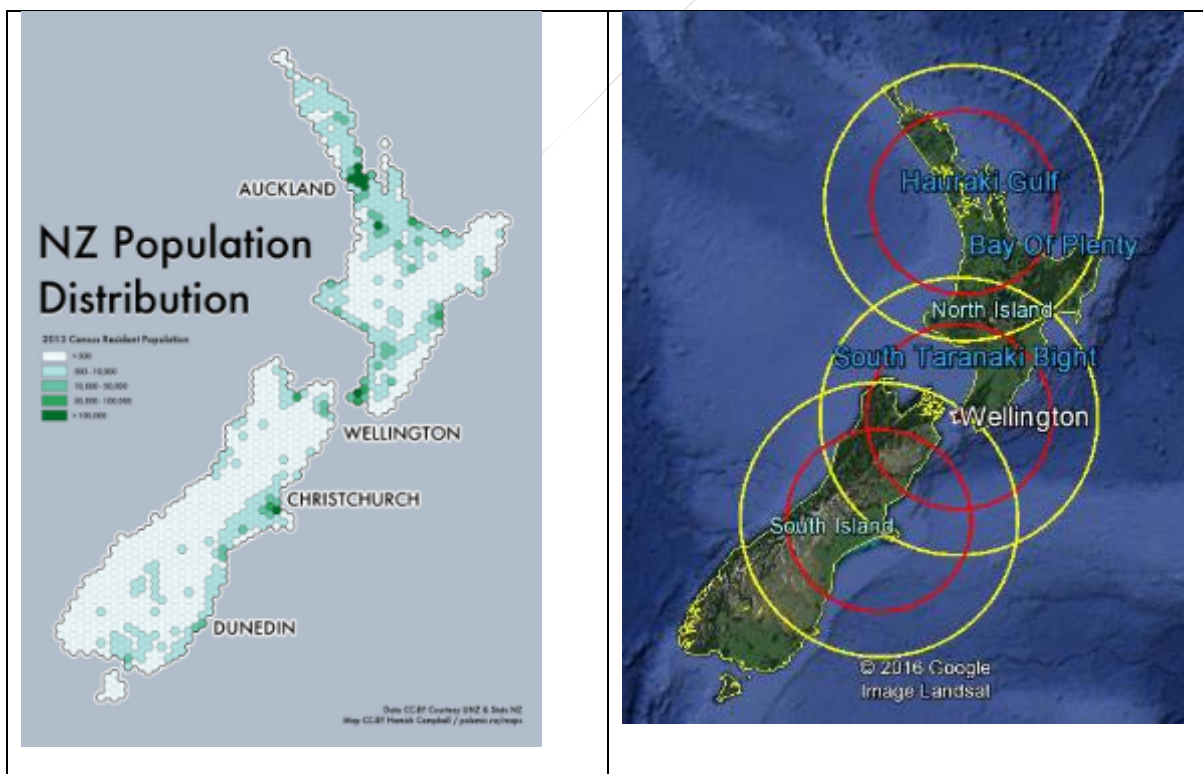


Figure 1. New Zealand population distribution and a map of estimated transport times to the three-clot retrieval centres (red rings = 90 minutes and yellow rings = 120 minute transport times).

7.2. Door-to-needle Initiative at the Regional Hospital Bispebjerg, Denmark

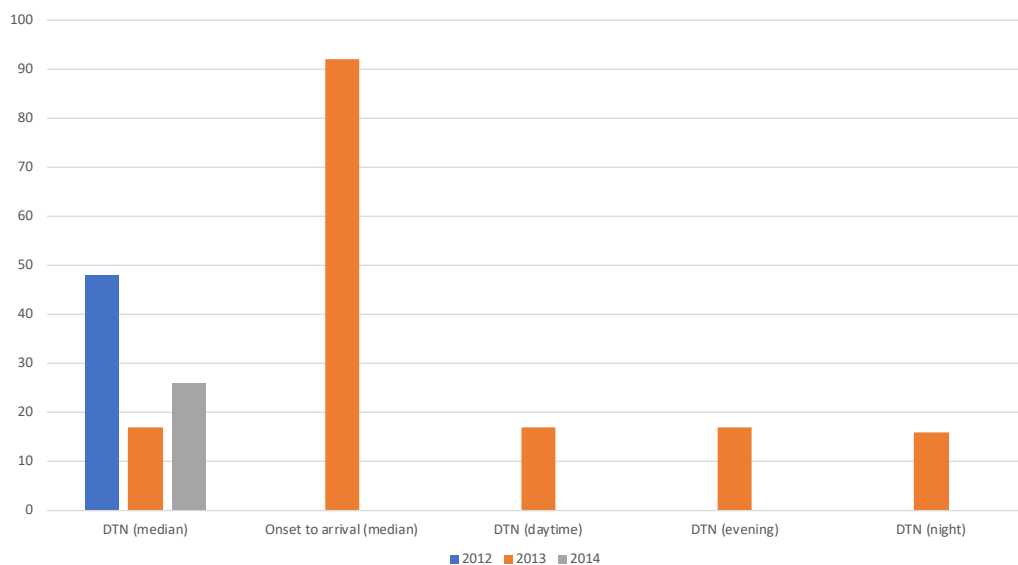
Contact person: Hanne Christensen, Professor of Neurology with special focus on stroke, University of Copenhagen, e-mail: hanne.krarup.christensen@regionh.dk

Before the initiative in 2013, door-to-needle (DTN) time was below one hour. Patients were admitted to the acute neurological ward for neurological examination, general preparation, blood samples and ECG. Patients were only taken to the Department of Radiology – 8 minutes away – if meeting the criteria for IVT evaluation.

Inspired by the Helsinki model presented at the ESC in 2012 documenting a reduction of DTN to 20 minutes, the team of stroke doctors decided that we could do that too. We were granted resources from the Capital Region for an implementation project. This was conducted as a consensus-based, bottom-up project.

A task force including a stroke neurologist, a stroke nurse, a radiologist, a radiology technician and a hospital porter documented the present patient pathway and excluded systematically unnecessary steps. The principles of the new model included admitting patients directly to a designated room in the Radiology Department equipped for acute treatment at the level of an ER, pre-notification of Radiology and hospital porter before arrival of patient, pre-registration of the patient, delegation of vital values to the hospital porter, reduction of numbers of blood samples and faster analyses of crucial tests, and creating a detailed description of all team members assigned tasks. Patients are examined in bed or on the ambulance carrier as decided by the stroke neurologist. IVT is administered in the scanner between non-contrast CT and CT-angiography. All patients are attended to by a specialized neurologist.

The new model was presented to all team members and improved according to feedback, through several staff meetings.



The DTN is monitored by the National Stroke quality registry, where data including DTN in individual hospitals are available. The DTN in Bispebjerg Hospital has stayed at 20 minutes in patients worked up with CT, however, increasing implementation of MRI has increased times by approximately 10 minutes. The number of patients receiving IVT has increased without affecting DTN.

New staff are trained by an experienced staff member before working alone (neurologists, radiologists, nurses). Neurologists are NIHSS-certified, and radiologists must complete an e-learning series in CT-angiography before being on call. The stroke neurologists' group has monthly meetings where challenges are solved.

Increasing implementation of MRI – Choice of imaging modality is at the discretion of the treating neurologist, based on individual patient factors. DTN in MRI patients is increased by approximately 10 minutes. An 8-minute IVT-MRI protocol has been developed to speed treatment, but the need for MRI in IVT is a continued discussion. Further, “wake-up strokes” pose a challenge given the need for more advanced imaging to identify candidates for acute therapy.

Our success is and has been based on the bottom-up and multi-disciplinary approach, which has resulted in long term engagement of all involved staff. One example is the training of hospital porters in measuring vital signs (e.g. blood pressure, heart rate, body temperature, oxygenation), which has turned this group into true health care team members. This importance of acute stroke care is also stressed by all team members providing acute care independent of seniority. We also think that finding local solutions to challenges is needed, there is no one-size-fits-all, both as to culture and infrastructure; in our case, how to provide modern, efficient health care in historic buildings

7.3. Quality Improvement and Clinical Research (QuicCR) in Alberta, Canada

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PROBLEM TO BE SOLVED

Ischemic stroke is debilitating disease; however, there has been an effective medical treatment for this disease since 1995 with IV alteplase (tissue plasminogen activator, tPA), which was initially approved in Canada in 1999. However, this treatment is highly time dependent, as 1.9 million neurons die every minute with a persisting arterial occlusion in an average ischemic stroke.

There have been calls to reduce treatment times, or door-to-needle (DTN) times, at hospitals to a median of 45 minutes by the US Target Stroke initiative and SITS WATCH, and to a median of 30 minutes by Canadian neurologists and the Canadian Best Practice Recommendation for Hyperacute Stroke Care.

However, DTN times remain high: the *Target-Stroke* initiative was able to reduce DTN times to 67 minutes and the Safe Implementation of Thrombolysis in Stroke – Monitoring Study (SITS-MOST) is a cohort of the SITS-ISTR, and it captured data on alteplase treated patients within the EU, which had 285 hospitals, and the initial results with 6483 patients showed that the median DNT was 68 minutes.

There are 17 hospitals in Alberta that are designated stroke centres. All of these hospitals provide stroke treatment. EMS will by-pass the closest hospital and take suspected stroke patients directly to the closest stroke centre.

DESCRIPTION OF THE PROJECT

We aimed to reduce treatment times across the entire province of Alberta. Our goal was to reduce the time from arrival at a hospital to the start of treatment to a median of 30 minutes, and to have 90% of all patients treated within 60 minutes.

A modified version of the Institute for Healthcare Improvement's "Improvement Collaborative" methodology was used. All stroke centres formed interdisciplinary teams with paramedics, emergency physician, emergency nurses, diagnostic imaging technicians, neurologist and radiologists. All teams participated in three face-to-face learning sessions and one face-to-face closing celebration. In between these face-to-face workshops, sites implemented changes using Plan-Do-Study-Act (PDSA) cycles. Additionally, they were supported by site visits and webinars. All sites submitted data through a central QuicCR registry.

The key changes that we assisted teams to implement included: pre-notification of an incoming acute stroke patient by paramedics; activating the stroke team once pre-notification is received; rapid registration of the patient; moving the patient directly to the CT scanner on the EMS stretcher; not waiting for laboratory results unless indicated; using a rapid telestroke process (if applicable); and administering alteplase in the scanner or telestroke bay.

Provincially we are now treating patients with alteplase within 36 minutes (median). All sites have been able to treat within 30 minutes. The number of ischemic stroke patients receiving treatment has increased

significantly and the proportion of ischemic stroke patients that received alteplase went up from 9.35% (pre-period) to 15.73% (post period).

FUTURE PLANS

We are now working to ensure that stroke patients can access endovascular treatment (EVT) from our primary stroke centres. Fifteen out of 17 of the stroke centres only provide thrombolysis, and EVT candidates need to be urgently transferred to one of two comprehensive stroke centres that offer EVT. Therefore, it is critical to have short Door-In-Door-Out (DIDO) times. We are currently working to reduce DIDO times by working with our EMS (Emergency Medical Services) and transfer services along with our specialists at the Comprehensive Stroke Centres.

8.1. Mobile Stroke Units – a perspective for future prehospital stroke care

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Fredrik Naumann/Felix Features

BACKGROUND

The concept of Mobile Stroke Units (MSU) for prehospital diagnosis and treatment of patients with acute stroke was first presented in 2003 by Fassbender and colleagues. The first MSU was established in 2008 in Germany, and to date approximately 25 sites worldwide are using MSU and more centres are planning the use of MSU systems.

An MSU is a specially equipped ambulance car with a computerized tomography scanner (CT) capable of performing brain scans and with laboratory equipment for bloodwork include analysis coagulation and other necessary parameters. In addition, there is a wireless data connection to a comprehensive stroke centre. This data connection enables the MSU crew to transfer the CT scan images to the stroke centre and provides a two-way audio video connection between the MSU crew and the receiving hospital. This MSU concept has been used to start intravenous thrombolytic treatment earlier by establishing relevant clinical findings on-site and excluding intracerebral hemorrhage and other contra-indications. Further, MSUs can be used for the diagnosis of large vessel occlusions (LVO) in the brain allowing triage of the patients to thrombectomy-capable centres.

There is international consensus that IV thrombolysis and endovascular clot retrieval should be administered to eligible stroke patients as early as possible. The first 60 minutes after symptom onset are defined as the “golden hour” for stroke treatment. Patients treated in this timeframe have the highest probability of disability-free survival. The MSU concept can increase the number of patients treated in the first hour after symptom onset by 10 times and facilitates a reduction of the time between stroke symptom onset and definitive treatment.

MSUs are established both in urban and rural environments. The use and catchment area of an MSU has to be adapted to the local emergency medical response system (EMS). The local geography, hospital infrastructure, dispatch call-out procedures and collaboration with other EMS units (from different providers and municipalities) should be decided before implementation of a MSU system. Close collaboration with all in-hospital stroke treatment units is important for successful implementation of an MSU. Adherence to local and national safety, health and privacy is required.

Today there are several staffing concepts in use in different MSU locations over the world. The crew configuration ranges from usual EMS teams (emergency medical technicians (EMT) and paramedics) augmented with specialised nurses or nurse practitioners to MSUs crews where the ambulance is staffed with EMTs, paramedics, a radiology technician and a vascular neurologist. In general, there is reliable

telemedicine support to a vascular neurology expert and a radiologist at the hospital when these competencies are not available on the MSU itself.

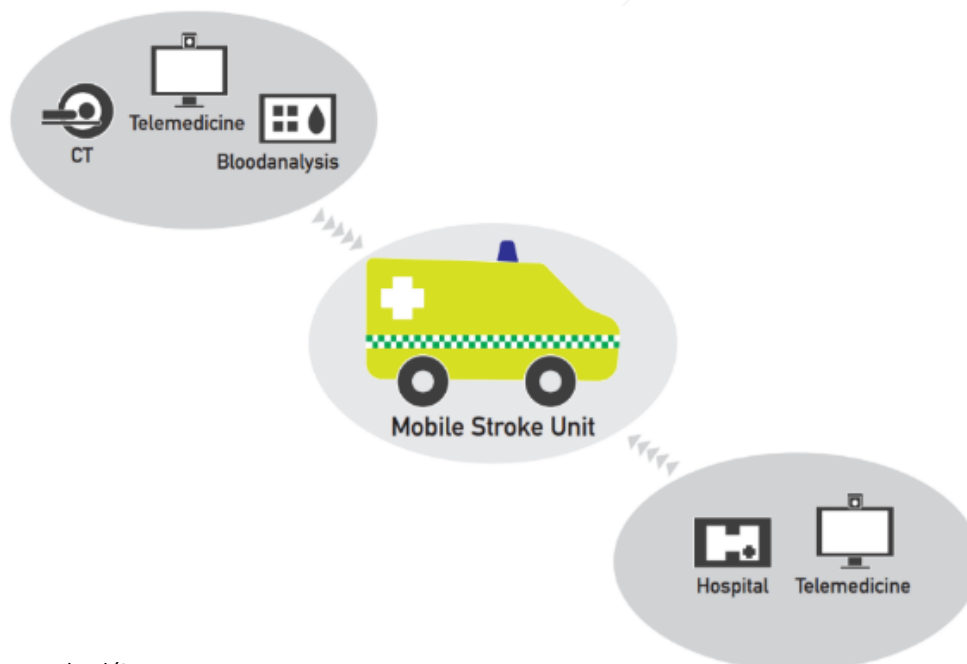
FUTURE PLANS

There is ongoing research to determine the best usage for MSUs. To date, both the geographic catchment area in which an MSU should be established and the crew configuration that should be chosen is unclear.

It is assumed that earlier treatment of stroke patients will lead to lesser disability after stroke and hence gains in quality adjusted life years (QALYs). There are only few studies looking at the cost effectiveness of MSUs. In addition, costs per QALY depend on the health care and will influence prioritization and implementation.

CONCLUSION

MSUs have shown the capacity to reduce the time interval between symptom onset and treatment for stroke patients. MSUs provide better triage possibilities for stroke patients with LVOs or hemorrhage. More research is needed especially regarding patient outcomes, crew composition and cost effectiveness. New diagnostic tools like decentralised CT scanners, microwaves or ultrasound examination and other structural changes in prehospital health care may change the impact and necessity of MSUs.



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Medical technical equipment content of a MSU and telemedical communication connection to the receiving hospital

8.2. Implementation of a New Zealand telestroke service to achieve tertiary level stroke thrombolysis intervention rates in rural and provincial communities.

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CHALLENGE

Stroke thrombolysis is a key intervention to help reduce stroke related disability. In New Zealand, with the introduction of a mandatory national thrombolysis register, we noted some disparities in rates of stroke thrombolysis provision across the country. While the larger tertiary centres consistently achieve thrombolysis rates of up to 15-25% of admitted ischemic stroke patients, we noted consistently lower thrombolysis rates (0-6%) and also longer door-to-needle times at smaller rural and provincial hospitals. This raised concern around poor equity of access and we hypothesized that the difference was largely due to insufficient 24/7 expert thrombolysis decision support at these smaller centres.

INTERVENTION

Telestroke uses videoconferencing (VC) technology to allow off-site experts to provide stroke thrombolysis decision support to less experienced front line clinicians. In 2016 a telestroke network was implemented in the Central Region of New Zealand involving a tertiary 'hub' hospital and several small regional 'spoke' hospitals.

RESULTS

The introduction of telestroke was associated with a significant increase in thrombolysis rates and a reduction in door-to-needle time in provincial hospitals: Among participating provincial hospitals 6.1% were thrombolysed in the 6-months prior to telestroke implementation, and 15.7% during the 6-months following implementation of telestroke (OR 2.86, 95% CI 1.68-4.89); $p=0.0001$. Overall, mean (SD) regional hospital door-to-needle times were reduced from 79.6 (31.4) to 62.7 (23.3) minutes ($p=0.015$).

OBSTACLES

The first main challenge was achieving funding support. The Ministry of Health provided a modest amount of seed funding of NZ\$250,000 that supported purchase of the initial 5 telestroke units, clinician iPads, and some project management and clinical leadership time. These components were crucial to achieve initial set-up and complete a pilot phase. During the pilot phase the clinicians volunteered their time in exchange for installation of a telestroke unit at the tertiary centre as well meaning they no longer had to drive into the hospital at night. Once the success was demonstrated, additional hospitals readily purchased their own equipment and paid for ongoing service fees. A second challenge was clinician buy-in. There were some trust issues at the smaller centres that were overcome through hospital visits by the clinical lead and full up-front stakeholder engagement and a co-design process. Similarly there were some concerns at the tertiary clinician end due to the increase in out-of-hour call burden on top of already busy workloads. To address this concern a regional collaborative effort among hospital CEOs and funders resulted in the introduction of a new funding model that utilizes a subscription model where hospitals contribute an annual fee based on their patient population base. The total revenue funds extra neurologist resources

allowing them a four hour rest period the morning after being on call over-night and a stroke fellow to assist with the service and ensure workforce sustainability.

CONCLUSION

The introduction of telestroke has had a dramatically positive impact on acute stroke service access and quality and these benefits have been sustained 2 years after implementation. Since the introduction of the New Zealand Central Region telestroke network the network has sequentially added more and more participating sites and two additional networks are being implemented aiming for full coverage of rural New Zealand by 2020.

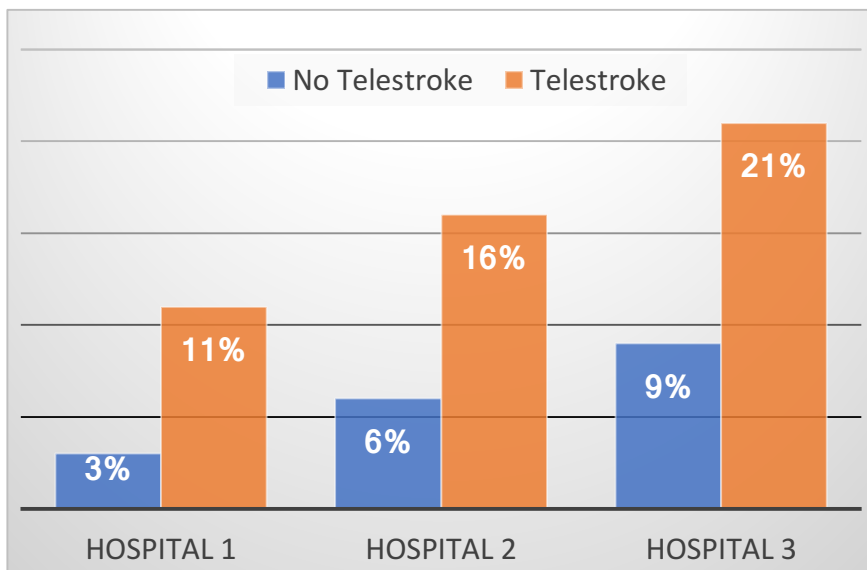


Figure 1. Thrombolysis rates pre- and post-introduction of telestroke (rates are calculated as cases thrombolysed/patients admitted with non-haemorrhagic stroke)



Figure 2. Telestroke from patient (left) and from neurologist end (right).

8.3. Victorian Stroke Telemedicine in Australia

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BACKGROUND

The Victorian Stroke Telemedicine (VST) program commenced in 2013 with funding support from the Australian Government, and initially operated through the Florey Institute of Neuroscience and Mental Health (the Florey). In 2018 the VST service transitioned into Ambulance Victoria. VST has a wide range of collaborators and stakeholders including the Victorian Government Department of Health, Monash University, Ambulance Victoria, and the Stroke Foundation amongst many others. More recently, new collaborations with international companies were also developed including Meytec (Germany), Pulsara (USA), and Promedicus (Australia/Germany). The VST Director is Prof Christopher Bladin, with research linkages through the Florey and Monash University.

DESCRIPTION OF PROGRAMME

VST enables clinicians to collaborate across organizational boundaries to deliver the best care possible to patients with stroke, irrespective of the patient's location. VST is operational across 16 hospitals in regional Victoria and has recently expanded the service to outer-metro Melbourne. The core component of VST is a clinical service which links rural and regional Victorian hospitals to a network of Melbourne-based neurologists who can provide treatment advice on patients who present to the Emergency Department (ED) within 4.5 hours of their stroke symptoms commencing. Real time audio-visual communication and viewing of brain imaging is possible, allowing the rapid assessment of those patients presenting with symptoms of suspected stroke. The service is available 24 hours a day, 365 days a year. Through the use of telemedicine, the aims of the VST Program are to:

- Increase equity of stroke care in rural and regional hospitals
- Reduce delays in diagnosis and treatment
- Improve access to reperfusion therapies such as stroke thrombolysis and endovascular clot retrieval.



VST has utilized modern digital technologies to streamline communication and the assessment of patients. All hospitals call a single 1300 number to access the on-call stroke neurologist. Clinical decision-making is then undertaken using real time audiovisual clinical consultation with patients, family, and medical staff. The neurologist has rapid access to brain images using state-of-the-art PACS software including automated analysis of brain blood flow maps. The stroke neurologist is then able to make an initial diagnosis – in other words, to determine if the patient is having a stroke, or has one of the many conditions that can mimic a stroke (e.g. migraine, seizure etc.). Decisions can then be made regarding the use of therapies such as stroke thrombolysis or endovascular clot retrieval.

An important component of VST is standardized stroke data collection and regular review of clinical data for quality assurance purposes. Data is collected using the Australian Stroke Clinical Registry (AuSCR) with 3-month patient follow-up which allows for PROMs (patient reported outcome measures – these assess the quality of care delivered to patients, from the patient perspective). There are well-defined governance processes to report these results back to clinicians, hospitals, and relevant Government Depts.

RESULTS

With VST more patients with ischemic stroke arriving within 4.5hrs of symptom onset received stroke thrombolysis (37%), with some smaller regional hospitals commencing stroke thrombolysis for the first time. A VST consult resulted in a significantly more accurate diagnosis of ischemic stroke (90% with VST vs. 57% without VST), and significant reduction in diagnosis of TIA (2% vs 14%). There were significant improvements in key processes of stroke care, including reduced door to CT time (by approx. 10 mins), and reduced door to needle time for stroke thrombolysis (by approx. 30mins). There was a significant 4-fold reduction in the occurrence of symptomatic intracerebral hemorrhage (sICH) after thrombolysis down to 4%. Logistic regression indicated that use of VST resulted in a 2-fold increase in stroke thrombolysis, with a 3-fold increase in treatment < 60 mins.

In summary, the data shows that VST delivers stroke care, faster, and more safely, with outcomes comparable to metro hospital standards. Stroke investigations and treatment are faster (including door to CT brain, door to needle time) and also safer, with less haemorrhagic complications. VST also demonstrates excellence in research translation – new evidence and treatment guidelines can be quickly implemented. For example, new data on patient selection for endovascular clot retrieval can be integrated into practice within weeks to months (rather than years) of publication.

8.4. FAST-ED app (Field Assessment Stroke Triage for Emergency Destination) in Atlanta

Contact person: Ed Jauch, Professor, Department of Emergency Medicine, Medical University of South Carolina, e-mail: edward.jauch@msj.org

BACKGROUND

Modern acute stroke care focuses on timely reperfusion. EMS transport of patients with suspected stroke to the most appropriate hospital is critical to maximize timely reperfusion therapies and to optimize likelihood of recovery. With various levels of hospital capabilities and geographic distributions, a singular prehospital care static algorithm cannot meet the needs of every geographic region nationally.

THE PROGRAMME

The FAST-ED (Field Assessment Stroke Triage for Emergency Destination) smartphone application combines the prehospital large vessel occlusion (LVO) scale, FAST-ED, with a database of regional stroke system of care in order for Emergency Medical Services (EMS) to triage a potential stroke patient to the most appropriate hospital based on last known well time, the likelihood of a large vessel occlusion, eligibility criteria for receiving intravenous (IV) alteplase, the proximity of local stroke care hospitals, and current traffic patterns. This app-based intervention includes the FAST-ED stroke screen and score for LVO, and then determines, based on regional facilities and the patient's location, the most appropriate transport destination based on real-time GPS information and hospital capacity.

The FAST-ED app is based on a built-in automated decision-making algorithm that relies on 1) a brief series of questions assessing patient's age, anticoagulant usage, time last known normal, motor weakness, gaze deviation, aphasia, and hemineglect; 2) a database of all regional stroke centers according to their capability to provide IV alteplase and EVT; and 3) Global Positioning System technology with real-time traffic information to compute the patient's eligibility for IV alteplase or EVT as well as the distances/transportation times to the different neighboring stroke centers in order to assist EMS professionals with the decision about the most suitable destination for any given patient with acute ischemic stroke (Figure 1).

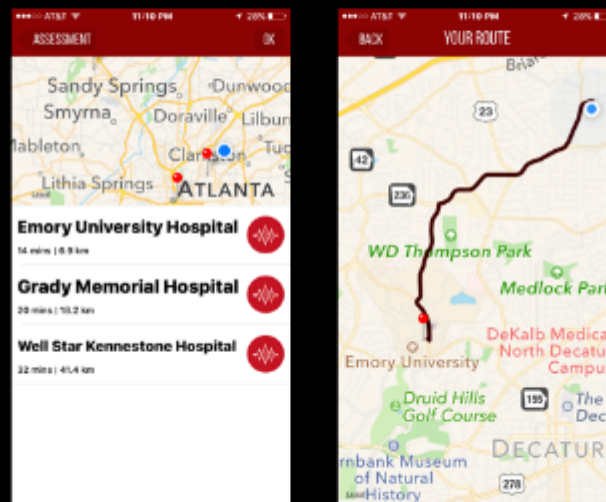
RESULTS AND FUTURE PLANS

There are several prehospital LVO scores in use at the present time. In initial studies, the FAST-ED score has a "high degree of accuracy" in predicting patients with LVO. To be maximally effective, the database used in the application must be maintained for current regional stroke capabilities. The algorithm can be adjusted to vary the desired bypass time/distance according to local preference. Ongoing studies will help better understand the performance of the scores in various practice settings and the impact on reperfusion administration and patient outcomes.

An agreement was made with all parts involved to provide the App to EMS and other users free of charge (Freeware). Several states and regions in the US have endorsed FAST-ED as the recommended prehospital screen/score of choice for EMS.

FAST ED Smartphone App: Output

The algorithm calculates the best options for Stroke Centers (CSC vs. closest center) in order of arrival time/traffic/distance



FAST-ED lists up the closest stroke centers or CSCs, depending on the algorithm assessment, in order of time distance, with the closest one first based on the ambulance location.

Figure 1. Screen shots of FAST-ED application and recommendation based on patient characteristics, likelihood of a large vessel occlusion, and real time regional stroke resources and traffic patterns

8.5. e-STROKE – Image interpretation by artificial intelligence in England

Contact person: Dr George Harston, Chief Medical and Innovation Officer, Brainomix Limited, e-mail: gharston@brainomix.com, web-site: www.brainomix.com

BACKGROUND

Every 30 minutes a stroke patient who could have been saved, dies or remains permanently disabled. The care of patients with acute stroke is time critical and early intervention saves lives and reduces disability. Key stages in the patient pathway include fast and confident diagnosis, consistent and reliable identification of the right patients for the right treatments and specialist care, and appropriate selection for transfer of patients who need clot retrieval (endovascular clot retrieval) in a neuroscience centre.

Imaging is a key component patient evaluation, informing diagnosis and stratifying patients for the right treatment. The interpretation of the brain scans is one of the main areas of variability and uncertainty that is causing delays in the acute treatment decision. To address these problems, Brainomix has developed e-STROKE SUITE, a clinically validated comprehensive imaging software (e-ASPECTS, e-CTA, e-Mismatch) that integrates into the hospital system and provides artificial intelligence driven decision support for clinicians.

IMPACT

The comprehensive nature of the e-STROKE SUITE and the consistency that it provides has the potential to standardize the care of stroke patients across a stroke network, or wider region, improving transfer and treatment decisions. Artificial intelligence allows patients presenting to any hospital to benefit from the standard of care that is otherwise only found in specialist centres. In this way stroke care is democratized, and even non-specialist clinicians are empowered to make fast and confident decisions with a common language across a region.

e-STROKE SUITE

The e-STROKE SUITE resides within the hospital network, taking images directly from the CT or the MR scanner and outputting the results in under 2 minutes, not only into the hospital imaging viewing platform (PACS), but also sending alerts to the mobile phones of key clinicians and being available for real-time interaction on the web viewer. The e-STROKE SUITE uses artificial intelligence to leverage the maximum amount of information from simple and readily accessible imaging.

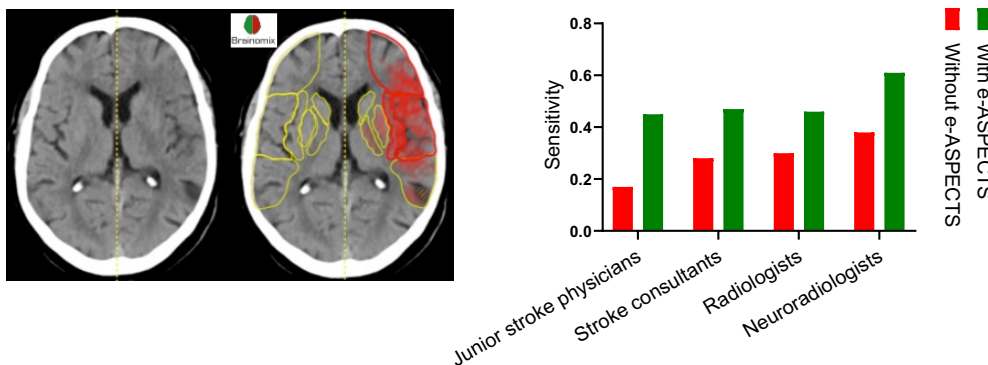


Figure 1 - Automated delineation of early ischemic change (red overlay) with automated e-ASPECT scoring (involved regions outlined in red). Graph demonstrates the sensitivity of different clinician groups to ischemia with and without e-ASPECTS support.

- **e-ASPECTS** supports the interpretation of routinely available non-contrast CT imaging. Machine learning algorithms delineate the acute ischemic changes and highlight these for the attending clinicians (Figure 1). The software increases the sensitivity of all clinicians to ischemic change regardless of experience and expertise, thus bringing real world value across the entirety of stroke networks. The e-STROKE SUITE software uniquely quantifies the volume of damage both in milliliters and using the ASPECT score, allowing objective decisions about patient transfer to be made in real time.
- **e-CTA** supports the interpretation of CT angiograms, the routine test for identifying patients with the most severe strokes and who need to be transferred to a specialist centre immediately. e-CTA uses deep learning algorithms to identify occlusion of the proximal arteries feeding the brain and alerts the clinician to this critical finding. The software also uses the scans to define the prevalence of collateral blood vessels (Figure 2). Collateral blood flow maintains blood flow to the brain pending treatment, essential if treatments are to be effective.

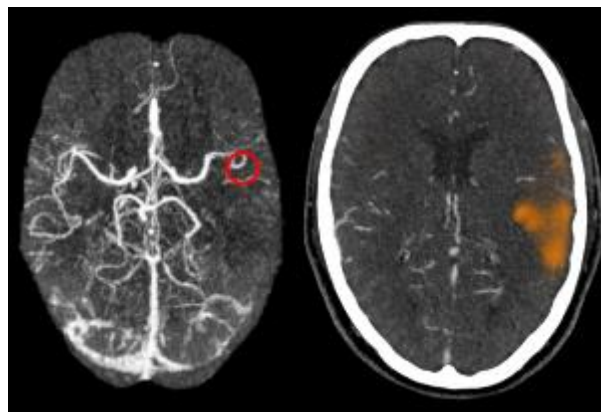


Figure 2. Automated large vessel occlusion detection and localization on CT angiography (left); collateral vessel assessment where a lack of vessel density is highlighted in orange (right)

- **e-Mismatch** automates the interpretation of CT perfusion or MRI scans required for the identification of patients for thrombectomy who have presented outside of the conventional time window for treatment. Easy-to-interpret thresholded maps allow clinicians to make fast and confident decisions about patient treatment.

FUTURE DIRECTIONS

The e-STROKE SUITE is developed in Oxford, in a spin-out company from Oxford University, and the Brainomix team continue to innovate and develop new approaches to image interpretation. Within this year the e-STROKE SUITE will include a tool to automatically identify large vessel occlusion on a simple non-contrast CT scan (i.e. without need for intravenous contrast and specialist expertise). Other features will include automated hemorrhage identification and volume quantification, and interactive communication across the stroke network through the Brainomix mobile app.

9.1. Canadian Stroke Best Practice Recommendations: The companion “Performance Measurement Manual”

Contact person: Thalia Field, Assistant Professor, University of British Columbia, Stroke Neurologist, Vancouver Stroke Program, e-mail: thalia.field@ubc.ca

BACKGROUND

In 2008, the Canadian Stroke Best Practice Recommendations introduced a companion “Performance Measurement Manual” with a suggested list of performance indicator measures for stroke centres as part of the national Canadian Stroke Strategy (CSS). The mission of the CSS is to support all Canadian provinces and territories in developing and implementing integrated stroke strategies by providing national tools to facilitate optimal approaches to service organization, care delivery, evaluation and professional development.

PROGRAMME

An online toolkit, developed by the Canadian Stroke Strategy Information and Evaluation Working Group and the Professional Development and Training Working Group and since under the organization of the Heart and Stroke Foundation of Canada, is updated with each new set of Canadian Best Practice Guidelines.

The performance measures include **benchmarks, targets and thresholds** for performance, in addition to case definitions using ICD-9 and ICD-10 coding for consistent identification of stroke cases, selected comorbidities, and common in-hospital complications, as well as standard codes used for stroke-related clinical investigations. The rationale is that consistent identification of stroke cases in administrative databases will facilitate increased consistency of available data and will enable comparative reporting and benchmarking.

Benchmark: is the performance level which is recognised as the standard of excellence for a specific process of care or outcome and is used for comparisons across groups. Benchmarks provide standard values by which something can be measured, compared, or judged. Benchmarks can be identified through several techniques, including: validated research and statistical methods; identification of top performers; and the past performance of one’s own organization.

Target: is the level of performance that an organization aims to achieve within a specified period of time. It is usually a value between the current actual level of performance and the benchmark, but could be equal to or greater than the benchmark. Target values take into account the resources and constraints with respect to meeting the standard of care.

Threshold: is the minimal acceptable level of performance. Performance rates that fall short of the threshold are considered poor performance and should result in corrective action.

These tools are used by health regions across the country to promote improvement of stroke care. They have also been adopted by Accreditation Canada for their accreditation program for Stroke Distinction, to which stroke centres can voluntarily apply that use “core” indicators from the CSS to determine accreditation. Centres are required to submit data on an ongoing basis every six months to maintain accreditation.

10.1. A collaborative initiative to improve access to stroke reperfusion treatment in provincial New Zealand

Contact person: Dr Bhavesh Lallu, Taranaki District Health Board,
Bhavesh.Lallu@tdhb.org.nz

BACKGROUND

The Taranaki region of New Zealand is sited on a promontory on the West Coast of the North Island. The provincial centre, New Plymouth, is surrounded by rural farmland. The district's 118,000 residents tend to be older than the national average and 16.2% are aged 65 years or older.

In New Zealand, endovascular clot retrieval is undertaken at three comprehensive stroke centres (CSC) which are located in the country's largest cities. Taranaki Base Hospital is equidistant to both the Wellington and Auckland CSC with a road transport time of close to five hours to either destination and a helicopter flight time of 70 minutes. The Wellington centre currently operates only during business hours whereas the Auckland centre provides 24-hour cover through an after-hours on-call system. Endovascular clot retrieval was first performed in New Zealand in March 2011.

In Taranaki, as in other provincial New Zealand locations, standard practice has been to thrombolysate patients in the local intensive care unit after confirmation of ischemic stroke by computed tomography (CT). Even when a large vessel occlusion (LVO) was identified, patients were not transferred to a CSC and often had a poor outcome.

PROGRAMME

Through close and collaborative working relationships between the Emergency Medical Service (EMS) provider and hospital staff, a new strategy has been created in Taranaki to pilot the rapid transfer of patients from the provincial hospital to a CSC. The Thrombectomy Working Group included Intensive Care Paramedics and a hospital team of Emergency Department consultant, medical registrar, CT radiographer and a stroke nurse specialist led by the Geriatrician/Stroke Physician. The protocol requires that as soon as a LVO is suspected, the EMS provider must be notified and will dispatch a flight-credentialed Intensive Care Paramedic under lights and sirens to the Emergency Department. Simultaneously, the helicopter crew at the hospital-sited base adjust the manifest as per a pre-flight checklist. Meanwhile, in hospital, the alteplase bolus is administered in the CT or Emergency Department, the infusion commenced, and the patient prepared for transfer. On arrival of the paramedic, the patient is loaded into the helicopter; in some cases, before the patient has been accepted by the on-call neurologist at Auckland City Hospital. In this case, the patient and family are briefed of the potential for the patient to be declined admission to the CSC and returned to the local hospital.

RESULTS

This approach of early activation of the helicopter, commencement of thrombolysis in the CT department and loading the patient into the helicopter, even before they have been accepted at the receiving hospital, is estimated to save up to 45 minutes with the potential for further time savings with ongoing role refinement. This is in addition to the substantial time-savings gained by flying the patient rather than transporting by road. Helicopter is preferred to fixed wing aircraft where transfers between airfields and hospitals increase the total transport time. [reference in appendix]

Immediately upon acceptance of the patient by the CSC the helicopter lifts off, travelling with priority through controlled airspace and updating the receiving hospital twenty minutes prior to arrival. The neurological intervention team meets the patient in the Emergency Department and they move swiftly to either the angiogram suite or in some cases to CT for further imaging studies.

In the first seven weeks since introduction of the pilot in July 2018 three cases have been transferred under this protocol without in-flight complications. All three patients have had good clinical outcomes and have returned to their homes. The introduction of this protocol epitomizes the Culture of Excellence with visionary staff working collaboratively to improve access to endovascular clot retrieval for provincial stroke patients.



Relevant co-authors

1. Stroke Registry	
1.1. The Australian Stroke Clinical Registry (AuSCR)	
1.2. Linking a hospital registry to prehospital data in England	
1.3. The Norwegian Stroke Registry	Martin Kurz
1.4. Improving stroke care through the implementation of a low-budget stroke registry in New Zealand	
2. Public Awareness	
2.1. Singapore National Stroke Awareness Campaign	Lim W.Y, Chuang D.F, Chue K.M, Lee D.Z, Leong N.J, Ng Z.G, Peng X.Y, Tham Y.N, Wang K.J, De Silva D.A. Stroke Literacy in Singapore: Data From a Survey of Public Housing Estate. <i>AnnAcadMedSingapore</i> 2014;43: 454-63
2.2. Increasing Stroke Awareness and Emergency Medical Service System Responsiveness. A Seattle-King County, Washington	Peter J. Kudenchuk, MD
2.3. Stroke 1-1-2, a Universal Stroke Awareness Program to Reduce Language and Response Barriers	Jing Zhao, MD, PhD; Maryellen F. Eckenhoff, PhD; Wei-Zen Sun, MD; A-Ching Chao, MD, PhD; Han-Hwa Hu, MD, PhD, Yizhun Zhu, MD, PhD; Renyu Liu, MD, PhD
2.4. Stroke 1-1-2, a Universal Stroke Awareness Program, introduced in Taiwan and Macau	Jing zhao, MD, PhD, Zuo Zhang, MD, Anding Xu, MD, PhD, Yongjun Wang, MD, PhD, Renyu Liu, MD, PhD
2.5. The FAST/VITE public education campaign for stroke symptom recognition: The Heart and Stroke Foundation of Canada	
3. Public Education	

4. Early Recognition	
4.1. Recognition of stroke mimics in United Kingdom	
4.2. Improving emergency identification and ambulance response in acute stroke in United Kingdom	
4.3 The Stroke Prehospital Delay Summary Statement: A Global Battlefield	
5. Rapid and Timely Dispatch	
5.1. Adherence to a regional UK pre-hospital stroke pathway	Parry-Jones , The University of Manchester, School of Medical Sciences, Manchester, United Kingdom. C. Sammut-Powell , The University of Manchester, School of Health Sciences, Manchester, United Kingdom, C. Soiland-Reyes & C. O'Donnell , CLAHRC, NIHR Collaboration for Leadership in Applied Health Research and Care, Manchester, United Kingdom. Salford Royal NHS Foundation Trust. D2 Digital, Manchester.
6. Prehospital Stroke Care and Triage	
6.1. Centralization of acute stroke services in London and Greater Manchester	Angus IG Ramsay , Department of Applied Health Research, University College London, Stephen Morris , Department of Applied Health Research, University College London, Naomi J Fulop , Department of Applied Health Research, University College London <i>This report presents independent research commissioned by the National Institute for Health Research (NIHR) Health Services and Delivery Research Programme, funded by the Department of Health and Social Care (study reference 10/1009/09). The views expressed are those of the authors and not necessarily those of the NHS, the NIHR, or the Department of Health and Social Care.</i>
6.2. The Saskatchewan Acute Stroke Pathway in Canada	Michael E. Kelly, K. Ruth Whelan, Lori Latta, Kim Davy, Vivian Onaemo, Lissa Peeling, Gary Hunter Location: Saskatchewan, Canada
6.3. PreSS – Prehospital Stroke Score, improved recognition of stroke in the prehospital setting in Denmark	

List of Authors

6.4. Training system for emergency stroke care for paramedic personnel in Japan	Yasuhiko AJIMI , MD, PhD, Professor, Department of Emergency Medicine, School of Medicine, Teikyo University Hideharu TANAKA , MD, PhD, Professor and Chairman, Graduate school, EMSsystem, Kokusikan UNIV, Research insitute of Disaster and EMS, Kokushikan Hiroshi OKUDERA , MD, PhD, Professor and Chairman, Department of Crisis Medicine, Graduate School of Medicine, University of Toyama. Tetsuya SAKAMOTO , MD, PhD, Director of Teikyo University hospital, Professor and Chairman, Department of Emergency Medicine, School of Medicine, Teikyo University
6.5. Reducing death after intracerebral hemorrhage: The 'ABC' hyperacute care bundle	
7. In-hospital Basic and Advanced Care	
7.1. New Zealand National Stroke Clot Retrieval Improvement Programme	
7.2. Door-to-Needle Initiative at the Regional Hospital Bispebjerg, Denmark	
7.3. Quality Improvement and Clinical Research (QuicCR) in Alberta, Canada	
8. Smart Technologies	
8.1. Mobile Stroke Units – a perspective for the future prehospital stroke care	Thomas W Lindner
8.2. Implementation of a New Zealand telestroke service to achieve tertiary level stroke thrombolysis intervention rates	
8.3. Victorian Stroke Telemedicine in Australia	
8.4. Fast-ED app (Field Assessment Stroke Triage for Emergency Destination) in Atlanta	
8.5. e-STROKE – Image interpretation by artificial intelligence in England	
9. Accountability	
9.1. Canadian Stroke Best Practice Recommendations: The companion "Performance Measurement Manual"	
10. Culture of Excellence	

List of Authors

10.1. A collaborative initiative to improve access to stroke reperfusion treatment in provincial New Zealand

Dr Bronwyn Tunnage, Auckland University of Technology, **Roger Blume**, St John, **Jeanette Langridge**, St John

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6.3. PreSS – Prehospital Stroke Score, improved recognition of stroke in the prehospital setting in Denmark	
6.4 Training system for emergency stroke care for paramedic personnel in Japan	
6.5. Reducing death after intracerebral hemorrhage: The ‘ABC’ hyperacute care bundle	
7. In-hospital Basic and Advanced Care	
7.1. New Zealand National Stroke Clot Retrieval Improvement Programme	
7.2. Door-to-Needle Initiative at the Regional Hospital Bispebjerg, Denmark	
7.3. Quality Improvement and Clinical Research (QuicCR) in Alberta, Canada	
8. Smart Technologies	
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8.2. Implementation of a New Zealand telestroke service to achieve tertiary level stroke thrombolysis intervention rates	
8.3. Victorian Stroke Telemedicine in Australia	
8.4. Fast-ED app (Field Assessment Stroke Triage for Emergency Destination) in Atlanta	
8.5. e-STROKE – Image interpretation by artificial intelligence in England	
9. Accountability	
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Appendix B: List of participants for the First Utstein Meeting on Emergency Stroke Care, June 10-11th, 2018

		EMS LEADERS		
		Europe		
Chair		Pierre Carli	SAMU de Paris, European EMS Leadership Network	FR
		Helge Myklebust	Laerdal Medical	NO
	Steering Committee	Freddy K. Lippert	EMS Copenhagen, The Global Resuscitation Alliance (GRA)	DK
		Asia		
Chair		Sang Do Shin	EMS Seoul, The Global Resuscitation Alliance (GRA)	KO
		Hideharu Tanaka	EMS Tokyo, The Asian Association for EMS (AAEMS)	JP
Chair	Steering Committee	Marcus Ong	Singapore General Hospital and Duke-NUS Medical School Singapore, AAEMS, The Global Resuscitation Alliance (GRA)	SG
		Ramana Rao	GVK Emergency Management Research Institute	IN
		Australia		
Chair	Steering Committee	David Waters	Ambulance New Zealand, The Council of Ambulance Authorities (CAA), The Global Resuscitation Alliance (GRA)	AUS
		Mick Stephenson	Emergency Operations at Ambulance Victoria	AUS
		US		
Chair	Steering Committee	Michael Sayre	Medic One Seattle Fire Department, The Global Resuscitation Alliance (GRA)	US

Chair	Steering Committee	Peter Kudenchuk	University of Washington, King County Medic One, The Global Resuscitation Alliance (GRA)	US
		CANADA		
		Michael E. Kelly	Canadian Ambulance Services	CAN
		ORGANISATIONS		
Chair	Steering Committee	Peter Panagos	Washington University (AHA)	US
Chair		Edward C. Jauch	Medical University of South Carolina (AHA)	US
		Jesper Kjærgaard	Copenhagen University Hospital (DRC)	DK
		Christine Rutan	American Heart Association (AHA)	US

		NEUROLOGISTS		
		Europe		
Chair	Steering Committee	Martin Kurz	Stavanger University Hospital	NO
		Hanne Christensen	Bispebjerg Hospital and University of Copenhagen	DK
Chair	Steering Committee	Anthony Rudd	Kings College London and National Health Service England	UK
		Thomas Lindner	Regional Competence Centre for Emergency Medicine	NO
		Daniel Strbian	Helsinki University Hospital, European Stroke Organisation (ESO)	FI
		Thorsten Steiner	Klinikum Frankfurt Höchst	DE
		Asia		
Chair		Deidre Anne De Silva	Singapore General Hospital	SG
		Thomas Leung	Chinese University of Hong Kong	HK
		Ajimi Yasuhiko	International University of Health and Welfare, Japanese Society of Emergency Medicine (JSEM)	JP
		Australia		
		Chris Bladin	Victorian Stroke Telemedicine Service	AUS
		Anna Ranta	University of Otago	NZ

		US		
		Opeolu Adeoye	University of Cincinnati	US
		CANADA		
Chair		Thalia Field	University of British Columbia	CAN
		FOUNDATIONS		
		Anders Hede	The Danish Foundation TrygFonden	DK
		Tore Lærdal	The Laerdal Foundation	NO
		ORGANISERS		
		Lisbet Schønau	Danish Resuscitation Council (DRC)	DK
		Røskva Winthereig	Danish Resuscitation Council (DRC)	DK

Appendix C**Table 1: Recommendations for data items for an acute stroke care registry**

Type of Data Elements	Core Elements	Add-on Elements
Population/System	<ul style="list-style-type: none">• Baseline patient demographics and prestroke functional state• Baseline stroke characteristics (time onset, severity/NIHSS)	<ul style="list-style-type: none">• Baseline medical history, comorbidity
Process	<ul style="list-style-type: none">• Mode of hospital arrival• Prehospital decision-making elements (prehospital stroke screen use, EMS triage)• Time intervals (onset to EMS, hospital, MD, CT, treatments, disposition, interfacility transfer)	<ul style="list-style-type: none">• Decisions not to treat• Best practice use (prehospital notification, EMS direct to CT)
Outcomes	<ul style="list-style-type: none">• Admission and discharge diagnoses• Rates of acute treatment administration (thrombolytics and endovascular therapies)• Treatment complication rates• Discharge disposition• Early mortality• Post-acute phase patient-centered outcomes (disability and quality of life scores)	<ul style="list-style-type: none">• Outcome quality of life instruments

Appendix D.

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