Experience from Today for the Stroke Care of the Future

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A B S T R A C T

Time is of the essence to prevent brain damage in the context of acute ischaemic stroke, yet most patients do not receive specialist care or early reperfusion therapy in the setting of acute ischaemic stroke. In order to increase the number of patients treated in stroke-ready hospitals and optimise the quality of treatment in all existing stroke centres, the ANGELS (Acute Networks Striving for Excellence in Stroke) Initiative was established in 2015. This article summarizes the experiences of different countries in stroke unit planning and quality monitoring presented at a symposium at the 4th European Stroke Organization Conference (ESOC) in May 2018 in Gothenburg, Sweden.

Key words: ischaemic stroke, ANGELS, stroke centres

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INTRODUCTION

The onset of acute ischaemic stroke is characterised by sudden loss of focal brain function; therefore, time is of the essence to prevent brain damage and the most important factor in successful reperfusion therapy is early intervention. Yet, in Europe, most patients do not receive specialist care in the setting of acute ischaemic stroke, and, indeed, fewer than one third of stroke patients are currently treated in a dedicated stroke centre. In order to increase the number of patients treated in stroke-ready hospitals and optimise the quality of treatment in all existing stroke centres, the Angels (Acute Networks Striving for Excellence in Stroke) Initiative was established in 2015. Funded by Boehringer Ingelheim, the Angels network currently involves a global community of more than 1,300 stroke centres and stroke-ready hospitals in which 175,244 patients are treated annually. The initiative supports quality data collection and monitoring easy via the Registry of Stroke Care Quality (ResQ) and is endorsed by 12 national stroke societies as well as other professional societies in Europe. This article summarizes the experiences of different countries in stroke unit planning and quality monitoring, presented at a symposium at the 4th European Stroke Organization Conference (ESOC) in May 2018 in Gothenburg, Sweden.

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THE AUSTRIAN EXPERIENCE

Approximately 25,000 cases of stroke occur each year in Austria, which has a population of approximately 8.5 million. Currently, there are 39 stroke units located within 37 hospitals across the country. Stroke units comprised of four to eight beds are located within neurology departments, which are equipped to handle 1-6 stroke admissions per day. These units provide access to a range of services associated with comprehensive stroke care, including ECG and EEG monitoring, therapists (one therapist per four beds) and specialized nurses (four per four beds). Cerebral angiography is available within 30 minutes of transfer, and stroke units have specialized neuroradiological, neurosurgical, and vascular surgical consultation available within 60 minutes of transfer. Rehabilitation is integrated with the neurological department. In addition, there are 10 intervention centres that provide access to mechanical thrombectomy, which has been shown to be of benefit to most patients caused by occlusion of the proximal anterior circulation, irrespective of patient characteristics or geographical location.[1]

The geographic distribution of Austria's stroke units is such that nationwide, most patients can be admitted to a stroke unit within 45 minutes of the index event. Almost 1,943 communities have access to a unit within 45 minutes or less; 130 have access in under 60 minutes, and 42 have access in under 75 minutes. Healthcare responsibilities are shared between the federal administration and the nine federal states with their municipalities. Since 1997, in-patient stroke care has been remunerated by case rates financed through nine regional health funds.

In 2003, the Austrian Stroke Society launched the Austria Stroke Unit Registry to establish minimum and target quality indicators and to develop benchmarks. This quality registry comprehensively documents all patients admitted to one of the 39 stroke units via follow-up questions about outcome indicators 3 months after admission. Minimum target levels for quality indicators were established in 2005 (Table 1).

Table 1. Quality Indicators and Minimum Target Levels

		Target
Number of patients admitted to SU (4 beds)	250	400
% of pats. admitted within 3 hours	50%	70 %
Admission - brain imaging <30 min <60 min	 30 % 60 %	 50 % 80 %
Admission – imaging brain supplying vessels (24 h)	50 %	80 %
Rate of thrombolysis (all ischaemic strokes)	5 %	15 %
Rate of thrombolysis (18 – 80 yrs, ODT <120 min and NIHSS Score >3)	30 %	60 %
Door-to-needle time (60 min)	all	––
Participation in clinical trials (% of pts.)	3 %	––
Secondary prevention (ischaemic stroke)	95 %	––
Follow up (3 months)	60 %	90 %

Currently, comprehensive documentation of each case has been achieved for at least 40% of indicators, with five units achieving 90% documentation of outcome indicators (Figure 1). Data analysis is quality assured by a registry statistician. By April 2018, the registry had documented 171,944 patients, 139,378 cases of stroke, and 122,588 cases of ischaemic stroke.

Figure 1. Austrian Stroke Unit Registry Patient Documented Outcome Indicators

The quality initiative also uses online benchmarking via peer-to-peer exchange on experience and benchmark meetings. Stroke unit personnel are able to compare anonymised data on the rate of thrombolysis for patients with ischaemic stroke in their own unit against the anonymised data of other units.

Process Management is Key to Improving Functional Outcomes

Treatment with intravenous recombinant tissue plasminogen activator (rtPA) within 4.5 hours of clearly defined symptom onset is the mainstay of treatment for acute ischemic stroke.[2] National guidelines currently recommend a door-to-needle time (DNT) of ≤60 minutes as an optimal window for treatment. However, analysis of registry data in the United States (US) and Eastern Europe has shown that approximately one third of patients are not treated with rtPA within an appropriate onset-to-treatment time (OTT).[3,4] Moreover, various small studies indicate that the earlier the patient arrives at the hospital, the longer it takes to administer intravenous thrombolysis.[5,6]

In Austria, acute stroke care is associated with shorter OTT and lower mortality than other non-Austrian centers in the SITS registry, with a DNT of 48 minutes for a high proportion of patients.[7] Nonetheless, considerable variability in DNT persists between stroke units.[8] It is known that multiple patient- and disease-related factors can increase DNT, such as older age, female sex, low or very high stroke severity, and presence of prior stroke.[6] In order to further examine inter-variability between centers, Julia Ferrari MD, PhD, of the Department of Neurology, Hospital Barmherzige Brueder in Vienna, and colleagues examined factors that influenced the DNT with a particular focus on process management. The team analysed Austrian Stroke Unit Registry case level data and, via a questionnaire, asked each stroke unit questions about process measures, such as how patients arrived at the hospital, where they were admitted (i.e. straight to stroke unity or via emergency department), and routine choice of imaging prior to thrombolysis. Multivariate analysis showed that the highest in-hospital delays were associated with imaging, especially when the radiology department was distant from the location of stroke treatment.[8] Laboratory analyses delayed DNT, and time delays were also caused by the architectural structure of the hospital, which in many cases include a 'pavilion' system separated from each pavilion. The type of transport used to deliver patients (e.g., helicopter, ambulance, ambulance with emergency physician) also contributed to time delays.

Austrian Stroke Unit Registry data show that outcome indicators have improved over time. Approximately 50% of patients have an onset-to-door time (ODT) of <90 mins; the proportion of patients with a DNT <30 mins has increased; and the thrombolysis rate has also improved. A key lesson learned by the Austrian network is that continuous quality assessment and process management are crucial to reducing OTT and improving functional outcomes for patients with stroke. Regular lively intra- and inter-centre discussion of effective strategies can help to optimise processes and patient care. Data from other stroke management initiatives in Austria affirm that comprehensive standardisation of the pathway from stroke onset to patient rehabilitation has the potential to increase the thrombolysis rate and improve clinical outcomes.[9]

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THE CZECH EXPERIENCE

Clinical practice guidelines clearly endorse the positive correlation between quality management and improved clinical outcomes in stroke care. Yet, it can be challenging for physicians identify which indicators to monitor in their own practice setting. The Czech Republic experience of participating in the Angels initiative shows that a gradual approach to quality monitoring can be rewarded by significant improvements in stroke care. Stroke care in the Czech Republic, which has a population of over 10 million spread over 78,866 km^2, is centrally organised with no large regional differences. Stroke centres were initially accredited by the Stroke Society, but, since 2009, have been accredited by the Ministry of Health and scientific societies. The Czech government and European Union structural funds supported the establishment of the specialized stroke network, which is comprised of 45 stroke centres. These are distributed throughout the Czech Republic and are regulated by strict requirements for personnel and equipment.

The Czech quality system initially focused on monitoring annual values that were reported to the Ministry of Health and various professional societies (e.g., for neurosurgeons, radiologists, and emergency room physicians). Monitoring has expanded to annually collect individualized data for all recanalized patients and for all stroke patients two months out of each half year. Figure 2 summarises the summary indicators that are currently collected.

Figure 2. Czech Republic Annual Quality of Care Indicators

1x Emergency medical services
Rejected admission
4x Stroke epidemiology/coverage of care
Centre admissions primary and secondary catchment area, mortality, length of hospitalisation
3x Recanalisation therapy
% IVT, DTN time <60% endovascular
1x Rehabilitation
Acute direct PT ward admissions
3x Neuroradiology/neurosurgery
Brain vascular surgery/interventions, cerebral vessels CAS/CEA

To date, Czech Republic stroke centres are treating >26,000 patients per year (95% of all stroke cases). Data point to an increased trend in recanalization, although it is unclear whether this trend is due to the reorganisation of stroke care. Almost 25% of all admitted patients are thrombolysed and the rate of thrombectomy is increasing (6% of all admitted cases).

Since 2016, monthly data have been reported for each center on recanalization, focused on the following metrics: onset to hospital, door-to-imaging (DTI), door-to-needle (DNT), primary centre entry to secondary centre, and door-to-groin (DTG). All centres are currently reporting data. The reports are colored green for the median time for recanalization which has decreased from <30 minutes to a median of <20 minutes. One outcome from this benchmarking has been that in each quarter time the mean DNT has decreased and is lower compared with other RES-Q countries. Analysis of these quality indicators also help to identify gaps in the stroke care process in different regions, at different times in the day or the week, and differences across age groups, and gender. Each stroke centre can also see their own data and compare with other centres.

This centrally organised accredited network with compulsory national stroke triage for emergency medical services (EMS) has been critical in improving outcomes, including time to treatment, rates of recanalisation therapy, and admissions to stroke centres. Moving forward, personnel at stroke centres have signaled a desire to monitor quality indicators twice per year and collect data on other aspects of stroke care.

Figure 3. Interventions for Successful Quality Monitoring

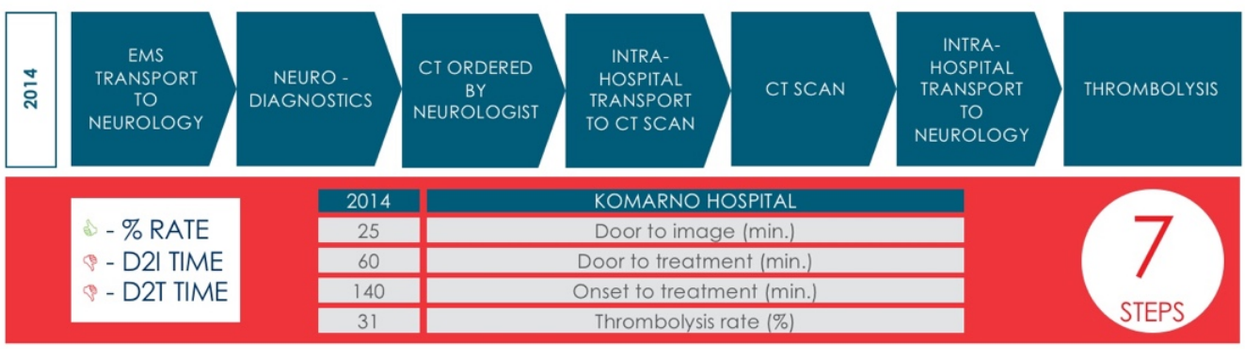
- Establish and continuously refine realistic, well-defined targets
- Give awards to centres achieving targets
- Set penalties for centres not achieving targets (e.g., reduced funding)

THE SLOVAKIA EXPERIENCE

Prehospital healthcare is a crucial link between stroke onset, the timing of patient arrival at a stroke-ready hospital, and access to treatment. In Slovakia, (population 5 million), seven EMS providers with 280 EMS crews are in service 24/7, each operating a compact area. There are 87 ambulances with three crew members each, including physicians, seven helicopter crews with physicians on board, and 186 paramedic-only ambulances staffed by two crew members. Two thirds of the responding to acute stroke in the field are comprised of paramedic crews, who are mandated to respond within two minutes of the emergency call. About 40 hospitals are equipped to provide thrombolytic treatment and five hospitals provide thrombectomy.

Matej Polák reported on the experience of Komarno, a city experience with a population of 34,000. There is one thrombolysis centre for the region, servicing 103,000 people, located in an old-era hospital with many buildings distributed around the hospital complex. Computer tomography (CT) is located almost 500 metres away from the neurology department and the intra-hospital transportation capabilities are suboptimal. Until 2014, the stroke protocol was that EMS personnel diagnosed stroke in the field, which neurologists confirmed or rejected following more comprehensive evaluation. After a diagnosis of stroke, the neurologist ordered a CT scan and intra-hospital transfer. After CT diagnosis, the patient was transferred back to the neurology department and thrombolysis, if indicated, was administered in the neurology department. Although many steps were involved in this protocol, the thrombolysis rate was considered reasonable (Figure 3).

Figure 3. Thrombolysis Rate with a Seven-Step Stroke Protocol



However, in 2014, the local hospital and ZaMED (corresponding EMS provider) adopted a plan to significantly shorten the time needed to diagnose and to treat stroke patients. This revised protocol focused on defining what EMS crews should do in-field; ensuring a clear distribution of patient management tasks between the EMS and hospital crews; and establishing communication channels between the hospital and EMS. The revised protocol also addressed other issues, such as periodic training of EMS crews by hospital neurologists.

According to the protocol, the in-field goals for EMS crews are to diagnose stroke, rapidly initiate treatment, and collect relevant medical history, including the onset of symptoms, current medications, and stroke history (Table 2). A stroke card was also developed for use as a tool to provide guidance for paramedics and introduced to every EMS ambulance. Patient management tasks were delineated between EMS and Neurology department (Table 3).

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Table 2. EMS Tasks in the Field

Rapid diagnosis and administer treatment
Maintain oxygen saturation (above 95%)
Treat the hypotension or hypertension (especially above 220 mmHg sys.)
Secure the IV access (preferably 2 large bore IV access)
Measure and correct the glucose level
ECG diagnosis (search for atrial fibrillation)

Table 3. Distribution of Patient Management Tasks

EMS	**Neurology**
Choose the right hospital (with available CT, Neurology department)	Check the availability of CT scanner and pre-order
Pre-notify hospital and provide estimated time of arrival	Inform EMS crew in-field about the availability of the CT scanner
Route the patient to the right department (CT / NEURO/ICU)	Pre-admit the patient
Wait with the patient in hospital in case subsequent urgent transport is needed	Wait for the EMS crew and the patient at the CT

A communications protocol stipulated that the on-duty neurologist should always carry a stroke cellphone to receive calls from EMS crews in-field. Furthermore, a stroke android application was introduced in 2017 nationwide that EMS can use to report to the on-duty neurologist that they have a stroke patient. The hospital to which EMS is taking the patient also receives a pre-notification that patient is being routed there. Whilst the EMS crew is on route to hospital, the on-duty neurologist in the hospital arranges for a CT scan and waits for the arriving EMS crew with the patient directly at the CT department, where the patient is immediately handed over from EMS to neurologist. This streamlined process eliminated 3 of the 7 steps (Figure 4) and has improved all quality indicators over time (Table 4).

Figure 4. Thrombolysis Rate with a Four-Step Stroke Protocol

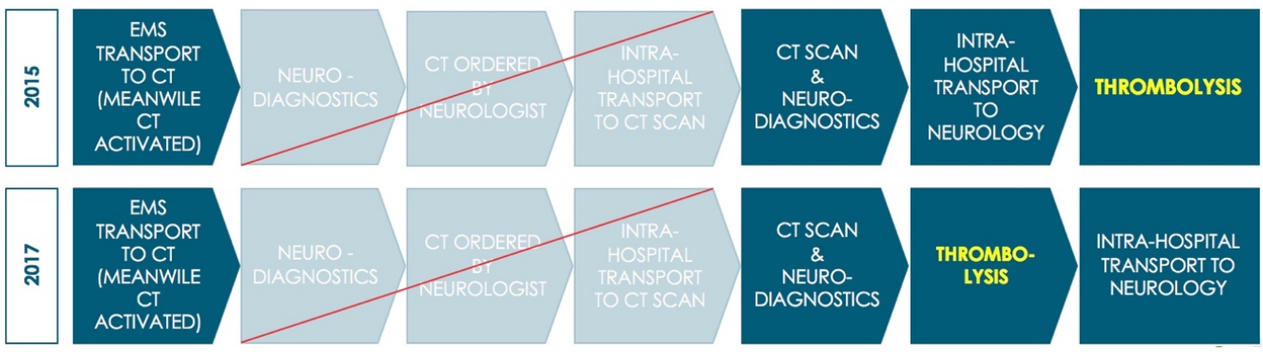

Table 4. Quality Indicators for Komarno EMS

Indicator	2014	2015	2017
Door to image (min)	25	12	8
Door to treatment (min)	60	28	15
Onset to treatment (min)	140	120	97
Thrombolysis rate (%)	31	39	44

Subsequently, the protocol was amended so that thrombolysis could be administered in the CT room resulting in further improvement for stroke patients arriving at hospitals via EMS. The thrombolysis rate and door-to-treatment times reached by this change of the protocol are now among the best in Europe. Moving forward, the model is being introduced nationwide, the STROKE cards are now digitalized for use with electronic tablet devices, and the protocol is considering strategies to streamline communication by using electronic data flow from EMS to hospitals.

SIMULATION TRAINING

Simulation is a powerful tool for training and clinical practice that, according to David Gaba, who first introduced the simulation training in healthcare, provides guided experiences that evoke or replicate substantial aspects of the real world in a fully interactive manner. Based on the principle of 'learning by doing' or by teaching others, simulation in healthcare can enhance three major domains of professional behavior, namely: the decision-making process, critical thinking, and clinical judgement.[10] These principles employ reflective and deliberate practices that involve repetition to achieve mastery, rigorous assessment of psychomotor and procedural skills, specific informative feedback, and improved skills performance in a controlled setting.

As reiterated by Paola Santalucia of the IRCCS Neurolesi Centre Bonino-Pulejo Piemonte Hospital in Messina, Italy, stroke is a time-dependent emergency associated with complex patient management tasks. The decision-making processes are typically challenging, real-world patients differ significantly from patients in clinical trials, and guideline recommendations can be difficult to incorporate to clinical practice. In contrast, simulation builds skills in managing acute stroke patients in a safe context without inducing risk and/or harm. This learning modality establishes a "safety attitude" by reinforcing the potential for error at every step and promoting reflective and deliberate practice. Learners can participate in different scenarios as many times as necessary in order to achieve the pre-specified level of competence

The Angels initiative has adopted an *in-situ* simulation. This approach safely recreates highly realistic scenarios in the workplace that require complex decision-making and involve multiple personnel in their own workplace setting. The goals of *in situ* simulation are to identify existing and latent knowledge gaps or potential process loop-holes and to provide opportunities for clinicians to rehearse high-risk clinical scenarios and "stress" the system. There are many advantages to in this approach. First, in situ simulation provides immersive learning that includes cognitive, emotional, and psychomotor domains. This modality emphasizes learning in a working environment with routine equipment, and, therefore, uses existing logistical, organisational and operational resources, thus bypassing the need for a permanent physical location. Simulation also ensures an interdisciplinary learning experience by involving and evaluating the whole team for human factors as well as technical performance, clinical competency, teamwork, and communication behaviours. Finally, an *in situ* simulation learning modality can be used to incorporate new protocols and resources (e.g., checklists, flow charts, and algorithms) to practice, evaluate their impact on promoting patient safety, and nudge clinical culture toward continuous progress monitoring and support.

To date, there have been approximately 200 *in situ* simulations in Angels stroke centres which reduced DNT by more than 20 minutes from the first to the second simulation. Following simulation, four key actions derived from Helsinki measures to reduce in-hospital delay in stroke thrombolysis have subsequently been implemented to reduce DNT (Figure 4):

- Prenotification
- Priority to blood sample with Angels stickers
- Stroke bag to start simulation at CT
- Direct to CT

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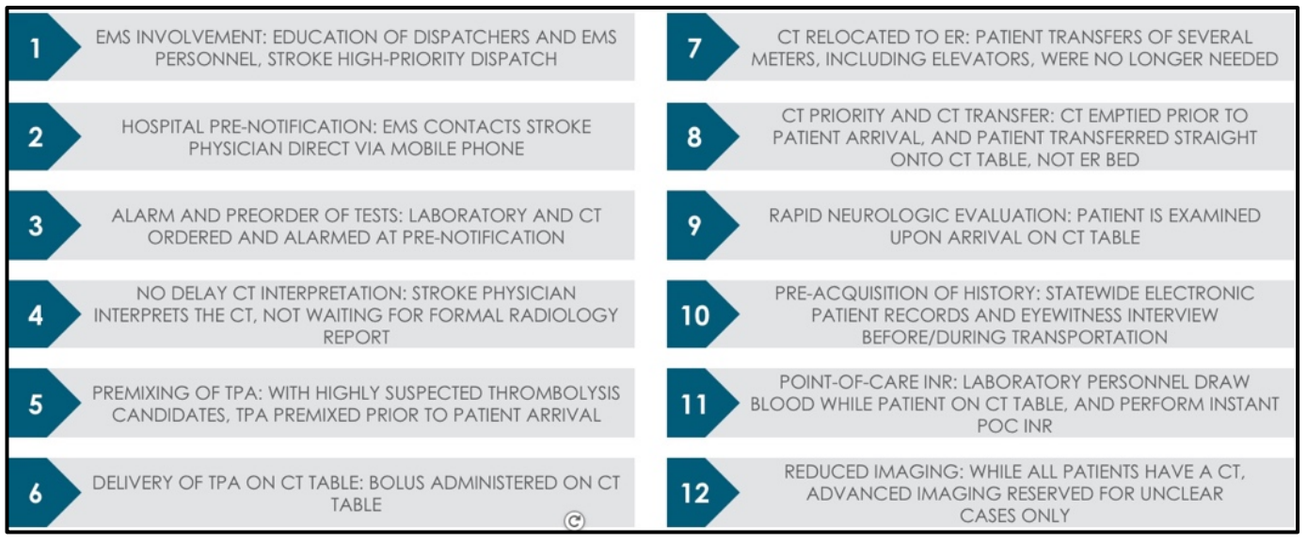
Figure 4. 12 Measures to Reduce Treatment Delays



CONCLUSION

These presentations affirm the value of the ANGELS Initiative and the substantive changes to clinical practice that are possible with multiple, concurrent, quality monitoring and improvement strategies, the adoption of effective processes and protocols, and point-of-care education modalities, such as *in situ* simulation. More importantly, analysis of registry and other quality data show that these changes are improving outcome indicators and patient safety in acute stroke settings.

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