Organizational models for thrombolysis in acute ischemic stroke
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General Discussion
Reorganizing acute stroke care – shifting focus to the pre-hospital phase

The key determinants of underuse of thrombolysis are encountered before the patient reaches the hospital. Of all stroke patients only between 14 to (in some settings) 48% arrives at the hospital within two hours. As a consequence a substantial proportion of patients arrive too late to benefit from acute therapies such as thrombolysis. A Get with the Guidelines stroke program showed that the proportion arriving within two hours of symptom onset did not increase significantly between 2003 to 2009. Current efforts to improve thrombolysis delivery have shifted, in part, from the organization within the hospitals towards a focus on pre-hospital stroke management, as supported by a recent review article. A central component herein is that all links in the pre-hospital pathway matter and must be studied for improvement. Important determinants of pre-hospital delay are the delay in seeking medical attention by patient and/or bystander and characteristics of EMS triage and transport. As such this may be considered an example of integrated care in which the patient, and professionals from various healthcare organizations work together closely to achieve optimal patient care.

As early recognition and rapid response to symptoms are crucial for improving access to thrombolysis, the effects of educational campaigns on stroke knowledge and help seeking behavior have been evaluated. Although some of these studies have been successful in raising awareness of stroke symptoms and risk factors, they did not translate in the appropriate changes in behavior – that is calling 911 immediately. In addition, the effects of these publicity campaigns are highly variable and wane over time. Future public campaigns should be tailored to a more specific subpopulation. For example, minorities and stroke victims who are at high risk of stroke such as male sex and old age. Most important is that public campaigns convey a clear message and specific action, such as an immediate 911 call. In educating the public to recognize a stroke, the symptoms should be well known. For example, the Face Arm Speech Time (FAST) test should be distributed among the whole society so that everyone knows the major symptoms such as speech disorders and limb weakness.

Centralized organization models vs. decentralized organization models

In Chapter 3 we demonstrated a 50% greater likelihood and up to 22% overall treatment rate with thrombolysis in a centralized model of acute stroke care compared to decentralized care at community hospitals. In the Netherlands, the incidence of stroke is expected to rise to 2.6 per 1,000 persons in 2020, leading to 44,200 stroke admissions per year on an estimated 17 million inhabitants. With a 1% increase in thrombolysis rate this would result in 442 additional patients treated every year. Should hospitals be able to treat 22% as in our study, around the 10,000 would be treated with thrombolysis leading to a rise of 10% in the number of patients
achieving independent functional outcome\textsuperscript{8}. In addition substantial reductions in healthcare costs may be expected due to less patients requiring long-term (nursing) care. As acute stroke care settings and distances to hospitals that offer thrombolysis may differ, attempts should be undertaken to replicate the findings obtained in this thesis in other regions of the Netherlands and beyond. Appointing regional stroke champions to promote the benefits of centralized care and communication with GPs and EMS may be deployed to support such initiatives. This way the benefits of a centralized organizational model, as supported by the findings published in this thesis and international stroke guidelines\textsuperscript{9}, may be realized more quickly in clinical practice and used to further improve thrombolysis delivery.

Attempts to further centralize acute stroke care in regions other than ours should be accompanied by promotional activities in the region, which can be carried out by a regional stroke champion. For example, inform patients to call 911 immediately in case of suspected stroke, and explain that centralization of care is in their own best interest because it leads to an increase in quality of care\textsuperscript{10}. The delay occurring by first contacting the GP may be substantial. Approximately 50\% of all stroke patients, including those potentially eligible for thrombolysis, first contact their GP following the onset of stroke symptoms. More effort should be undertaken to scrutinize data collected at the GP offices, because time delays to ambulance calls are significantly longer for stroke patients when the GP is first contacted\textsuperscript{11}. In particular, triage of suspected stroke patients and subsequent actions; i.e. direct transport to the hospital by ambulance or not should be further studied. Unpublished experiments using our simulation model\textsuperscript{12} suggest that the proportion of patients treated with thrombolysis may be increased by 1-8\% when all patients would immediately contact 911 following stroke onset. Also EMS dispatch operators and ambulance personnel should be continuously trained in recognizing stroke symptoms and the use of scales for stroke recognition such as the FAST test and how to act. Finally, it is important that prenotification of the receiving hospitals is used allowing the hospital to prepare for the arrival of the patient and to have immediate access to the CT scan. With prenotification it is possible to achieve a door-to-needle time of 20-25 minutes at different settings, as shown in previous studies\textsuperscript{13,14}. The hospitals in which thrombolysis is no longer provided may be further trained in providing optimal stroke care after the acute phase. Of course factors such as driving distance and driving time to hospitals providing thrombolysis are important. However, we demonstrated in Chapter 3 that additional driving time for patients treated with thrombolysis in case of centralized stroke care can be largely compensated by a shorter door-to-needle time of 12 minutes (35 versus 47 for decentralized care).
Exploiting simulation models in improving thrombolysis delivery

In this thesis we stress the potential of simulation for improving acute stroke care. Use of simulation implies alternative study modes for assessing the impact of proposed interventions for optimizing the stroke pathway (Chapter 5), those studies seeking to explain differences among organizational models (Chapter 6), and studies investigating the effects of reorganizing organizational models on short-term costs and travel time (Chapter 7). Other interesting uses include a-priori assessment of improvement approaches prior to investments in clinical research. Apart from its use for research purposes concerning organization models and the stroke pathway, simulation models may also be used for practical implementation purposes, assuming a region by region optimization of acute stroke care, thereby accounting for regional differences. Ideally, such use of simulation should go together with a project approach, detailing steps to undertake, and its management. Examples are available in the engineering domain, but require tailoring for their application for acute stroke care.

The potential of simulation models in future stroke research may include implementation of improvement approaches suggested by simulation studies to investigate whether comparable results may be achieved in clinical practice. Implementation should be supported by face validity of the simulation model as offered by domain experts, patient-focused outcomes, and literature observations to overcome potential organizational inertia. To expand future use of simulation in stroke and healthcare, a generic model should be pursued in which local variations can be easily accounted for, so that future attempts to improve thrombolysis may be deployed regardless of regional differences in stroke care set-up. This may include studying the effects of centralizing stroke care in other parts of the Netherlands. For example, the consequence of increases in ambulance transport time may be modeled and quantified in terms of clinical outcomes such as thrombolysis rates and patient outcome (Chapter 7). In addition, cost-effectiveness of interventions may be performed.

Emerging technologies

In the future, the pre-hospital emergency teams may be involved in thrombolysis treatment themselves. Developments indicate that it is possible to improve pre-hospital stroke management by transfer of all diagnostic and therapeutic measures already to the pre-hospital phase of stroke management. This way diagnosis and treatment of ischemic stroke patients is already available at the emergency site, as shown in recent trials. For example, by using a Mobile Stroke Unit (MSU), that is an ambulance which includes everything needed for the diagnosis and treatment of acute stroke such as a CT scanner, a POC diagnostic device, and telemedicine connection to the hospital, time to thrombolysis treatment can be reduced by 50%. However, medical
benefits and best setting still have to be further explored. For example, distances to hospitals offering thrombolysis in the Netherlands are relatively short compared to, for example, to regions in the United States of America or Australia. Therefore the feasibility of MSUs has to be studied per region prior to implementation. Also, cost-effectiveness of the MSU is unclear and has to be further studied.

Cost of centralizing thrombolysis treatment in decentralized stroke care settings

The cost analysis performed in Chapter 7 suggests that it would be more efficient in terms of resource and personnel utilization to centralize acute stroke therapies such as thrombolysis. In addition, it is made plausible that raising acute stroke care at low volume community hospitals to the level of specialized hospitals places a great strain on limited hospital budgets and may not be sustainable in the long run. To facilitate future economic evaluations, standard registration of the EQ-5D questionnaire should be considered. This way utility values can be obtained a-priori and used to make accurate calculations of the costs and benefits associated with proposed improvement approaches. Together with making improvements along the stroke pathway, the question is warranted whether the time has come for broad implementation of centralized acute stroke care in other parts of the Netherlands and beyond. This way a larger proportion of patients may receive state-of-art stroke treatment in the future.

References


