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Improving Outcomes Achieved by a New Stroke Program in Hungary

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Key Words

Stroke · Thrombolysis · Stroke team · Stroke center · Public education

Abstract

Background: Stroke is a devastating disease with increasing incidence and prevalence due to population aging. Even with the best care, a proportion of patients dies or is left with significant neurological and cognitive disability. Organization of stroke centers markedly improved outcomes worldwide. We initiated a 'lysis alarm' program in September 2013 at our medical center. **Methods:** This is a retrospective review of electronic data from patients with acute ischemic stroke before (October 2012–June 2013) and after (October 2013–June 2014) the 'lysis alarm' program was introduced at our medical center. **Results:** Prior to the introduction of the stroke program, there were only 19 thrombolysis procedures in 777 acute stroke patients in 9 months, while this figure rose to 32 thrombolysis procedures in 737 acute stroke patients after the initiation of the program. The 'door-to-needle' time decreased from 88 to 71 min when the two study periods were compared. These changes were associated with decreased stroke mortality in patients receiving thrombolytic treatment (16% prior to the program and 9% during the program). In 2013, there were 1,439 thrombolysis procedures, representing 3.2% of all stroke cases throughout Hungary. After the introduction of the 'lysis alarm' program, we have reached a 4% thrombolysis rate at our medical center. **Conclusions:** Our thrombolysis rate is higher than the national average, but still low compared to the rates of Western European countries. We are continuously working to enhance our stroke program. Here, we discuss those components that need to be further refined in order to improve stroke intervention and outcome.

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Background

‘Time is brain!’ ‘Be fast!’ These well-known international slogans emphasize the importance of quick action in acute stroke [1]. After a few minutes of circulation arrest, the brain tissue pathology cannot be reversed: neurons die. According to the literature, in patients with a typical large-vessel acute ischemic stroke, 120 million neurons, 830 billion synapses, and 714 km of myelinated fibers are lost each hour [2]. However, early thrombolysis may markedly reduce the ischemic core by increasing reperfusion in patients with penumbra [3]. This is why immediate stroke care, including early recanalization of the occluded blood vessel, is so important.

National census data showed that Hungary had a population of 9,877,365 people at the end of 2013. Vas County in western Hungary comprised a population of 257,688 people, 77,566 of whom resided in the county’s administrative center, Szombathely. The Markusovszky University Teaching Hospital (MUTH) provides tertiary care services for the entire Vas County and is affiliated with the University of Pécs. During the last few years, the medical center has undergone extensive infrastructural improvements and quality upgrades in its several comprehensive programs. Presently, the MUTH maintains one of the active intravenous (i.v.) thrombolysis centers in the Western Transdanubia region of Hungary.

The prehospital care of stroke patients has been improved in the country by providing more optimal treatment based on protocols on site and during transport as well [4]. The cooperation between prehospital ambulance care and stroke centers is vital to secure an optimal care for stroke patients [5].

According to WHO data, the number of new stroke events in Europe is projected to rise from 1.1 to 1.5 million per year from 2000 to 2025, largely due to population aging [6]. Currently, 1.4 million deaths are caused by stroke each year in Europe. In Hungary, the number of acute stroke patients is estimated at 40,000–50,000 per year [7–9]. The acute stroke mortality rate in the age group below 50 years is 8–10/100,000 residents in Western European countries. In Hungary, this number is 40/100,000 for women and 60/100,000 for men [10, 11]. Stroke patients in Hungary are 5–10 years younger than those in the developed industrial countries, and every fourth patient is under 60. Besides being the third leading cause of death, stroke is the first leading cause of disability and the second cause of dementia [9–12]. The proportion of all stroke cases receiving i.v. thrombolytic therapy was 18% in 2011 (4.9% in 2003) in Austria [13, 14], and 16.7% in 2014–2015 in France [15], while this figure was only 3.2% in 2013 in Hungary, even though the number of thrombolysis procedures doubled between 2008 and 2013 [16, 17]. The 3.2% thrombolysis rate was derived from 1,439 thrombolysis procedures performed at 37 active thrombolysis centers in 2013 across Hungary [16–18]. In the same year, 145 i.v. thrombolysis procedures were performed in the Western Transdanubia region, and the number of thrombolysis had most rapidly increased in Szombathely and Zalaegerszeg. At our medical center (MUTH), in 2014, we achieved a 4% thrombolysis rate with 32 thrombolysis procedures during a period of 9 months.

The time-sensitive nature of cerebrovascular events has been increasingly appreciated in the last few years in Hungary. The new national stroke campaign of the Hungarian Stroke Society was launched in 2009. The organization of stroke centers required careful coordination in patient care with well-defined work flow and standard operating procedures [19, 20]. As a result, our stroke center at the MUTH has been providing gradually improving acute stroke care, although still lagging behind that of Western European countries [15, 21–23].

Methods

Patients

These analyses of stroke patients' data were approved by the Institutional Ethics Committee. Documentations of 51 patients who received i.v. thrombolysis were reviewed in detail out of 1,514 patients with acute stroke at the MUTH in the two study periods (1) from October 2012 to June 2013, prior to the initiation of the 'lysis alarm' program, and (2) from October 2013 to June 2014, with the 'lysis program' in place. We used the National Institute of Health Stroke Scale (NIHSS) to assess neurological impairment and to monitor outcome.

The 'Lysis Alarm' Program

The 'lysis alarm' program was launched in September 2013 at the MUTH. It aims to increase the number of acute stroke patients treated with i.v. thrombolysis and to decrease the 'stroke-to-door' and the 'door-to-needle' time. This required the development of prehospital care, the organization of stroke teams and the proper coordination of patients within the hospital. When our 'lysis alarm' program started, we began collecting data of patients who received thrombolysis.

In the 'lysis alarm' operation, the patient is taken to our hospital by the National Ambulance Service. As soon as possible, the Ambulance Center informs the Triage desk and the emergency physician, who alerts the neurologist and the radiologist about the impending arrival of an acute stroke patient. When the patient arrives, the team of specialists as well as the CT service is prepared. After being examined by the emergency physician and the neurologist, the patient is sent for cranial computed tomography (CT) imaging and CT angiography (CTA). If the diagnosis of acute ischemic stroke is confirmed based on the history, physical examination, laboratory tests, and CT/CTA, and the patient qualifies for i.v. thrombolysis based on the guidelines by the Ministry of National Resources and the relevant medical regulations, i.v. recombinant tissue plasminogen activator, alteplase (Actilyse, Boehringer Ingelheim International), is infused at a rate of 0.9 mg/kg/60 min following the 10% bolus injection in the patient unit of the Emergency Department (ED) [11, 18]. The patient is monitored for 24 h after the intervention in the ED and then transferred to the Department of Neurology or, if needed, to the Intensive Care Unit. In the scenario when an acute stroke patient is brought to the hospital by a family member or by ambulance service without an advance notification to the ED stroke team, the patient may still receive the above services and the i.v. thrombolysis intervention (if the criteria are met).

Statistical Analysis

The analyses were performed using the Statistical Package of Social Sciences (SPSS) version 19.0 software. We used a statistical significance level of $p < 0.05$.

Results

In the first study period (October 2012–June 2013), 777 patients were admitted with acute ischemic stroke. Nineteen of the 777 patients (2%) received i.v. thrombolysis. Their average age was 57 years, there were 10 men and 9 women, and 9 had left-hemisphere, 6 had right-hemisphere, and 4 had brainstem strokes (table 1). Following thrombolysis, the conditions of 10 out of the 19 thrombolized patients improved based on the NIHSS scores. Of these 19 patients, 4 were younger than 45 years.

During the second period (October 2013–June 2014), 737 patients were admitted with acute ischemic stroke, and 32 (4%) received i.v. thrombolysis. The average age of patients

Table 1. Demographic data of patients and treatment characteristics during the two study periods

	From October 2012 to June 2013	From October 2013 to June 2014
Number of all patients admitted with AIS	777	737
Number of patients who received i.v. thrombolysis	19	32
Average age of thrombolized patients, years	57±15	66±11
'Door-to-needle' time, min	88±25.17	71±27.87
'Stroke-to-needle' time, min	168±42.26	151±56.14
Head CT time of thrombolized patients, min	13±7.39	14±12.13

AIS = Acute ischemic stroke.

Table 2. Summary results of thrombolysis before and during the 'lysis alarm' study periods

	Patients with improved symptoms, %	Patients died, %	Bleeding complications, %	Patients released home, %	Patients sent on rehabilitation, %
From October 2012 to June 2013	52.6	16	21	32	37
From October 2013 to June 2014	71.8	9	9	47	37.5

receiving thrombolysis was 66 years, there were 19 men and 13 women, and 15 had left-hemisphere, 14 had right-hemisphere, and 3 had brainstem strokes (table 1). The NIHSS scores of 20 out of the 32 thrombolized patients improved. One of the 32 patients was younger than 45 years.

The numbers of patients who underwent thrombolytic treatment increased by 2% between the first and second study periods (χ^2 test, $p = 0.041$).

The average 'door-to-needle' time decreased by 17 min (table 1), but it was still above the accepted maximum time period of 60 min [1, 17]. The number of bleeding complications decreased from 21 to 9% (table 2).

The number of successful thrombolysis procedures markedly increased in the second compared to the first period. The number of patients with improvement increased from 52.6 to 71.8%. In addition, the number of asymptomatic patients also rose, while the number of patients who died after thrombolysis decreased (fig. 1; table 2) [24]. These results show an improving trend, but did not reach statistical significance.

We also looked at the thrombolysis outcomes in NIHSS-based severity subgroups of patients and found that in the period before 'lysis alarm', there were no successful lysis procedures in the group of stroke patients with serious neurological symptoms, while the success rate was 50% in the group of patients with moderate symptoms and 78% in the group of patients with mild symptoms. In the period after launching 'lysis alarm', the success rate was 50% in the serious symptoms group, 57% in the moderate symptoms group, and 81% in the mild symptoms group (fig. 2).

In the first period, all thrombolysis procedures were successful in the <45-years age group, while all thrombolysis procedures were unsuccessful in the ≥ 70 -years age group. The success rate was 50% in the middle-aged group. During the 9-month period after launching the 'lysis alarm', we observed a significant improvement, with an 83% success rate of thrombolysis in the middle-aged group and a 54% success rate in the oldest age group (fig. 2).

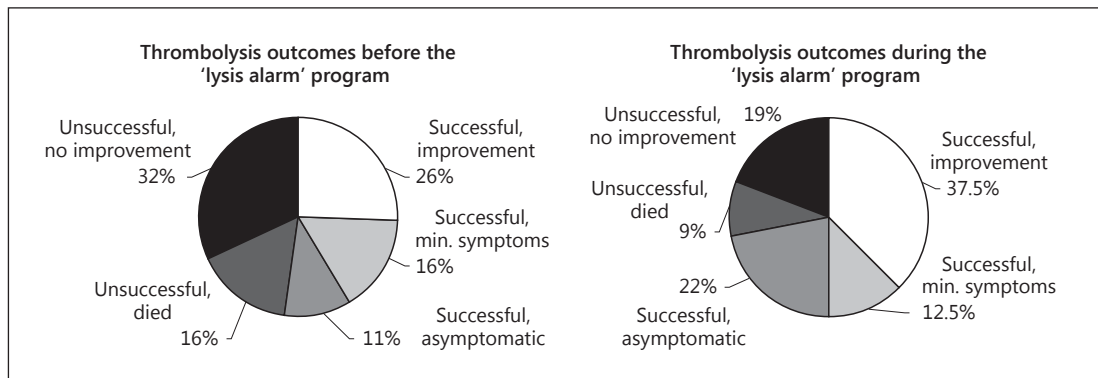


Fig. 1. Thrombolysis outcomes before and during the 'lysis alarm' program showing the rates of successful and unsuccessful thrombolysis procedures. Successful interventions are marked with lighter shades (proportion of asymptomatic patients and patients with improvement based on the NIHSS scores). The proportion of unsuccessful interventions (including patients without improvement, worsening or death) is marked with darker shades.

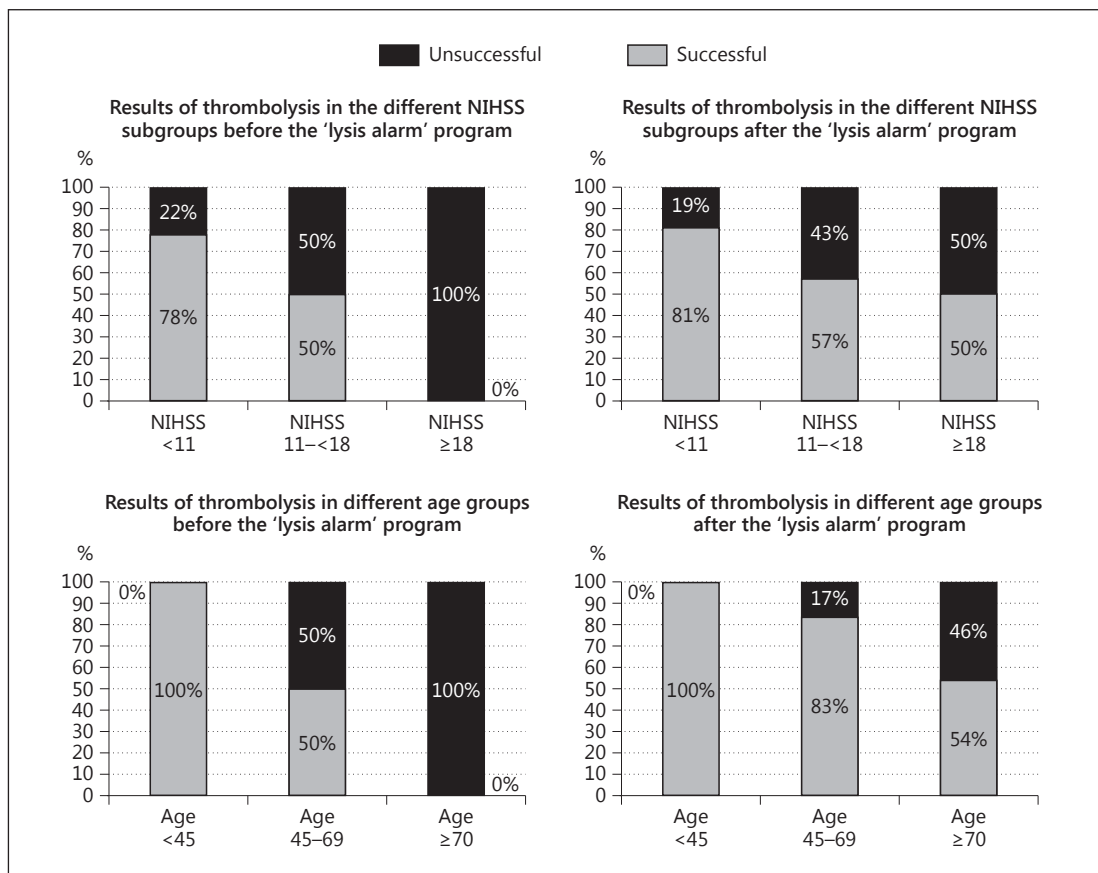


Fig. 2. Thrombolysis outcomes based on NIHSS scores and the patients' ages before and during the 'lysis alarm' program. Patients were divided into 3 groups based on NIHSS scores: patients with mild (NIHSS <11), moderate (NIHSS 11–<18), and serious (NIHSS ≥18) neurological symptoms (upper two panels). As for age distribution, the patients were sorted into 3 groups: the first group includes patients of age 44 or below, the second group includes patients of 45–69 years, and the third group includes patients of 70 years or older (lower two panels).

Discussion

Our ‘lysis alarm’ program resulted in a number of major benefits in acute stroke care. Here, we demonstrate that the number of patients receiving thrombolysis increased and the treatment time decreased with the help of the local Ambulance Service after the inauguration of the ‘lysis alarm’ program. We are still at an early stage of our operation, continuously trying to improve the system by better coordinating the work elements and educating our staff, the primary care doctors, and patients. There is much room for improvement in filtering out patients who do not qualify for the program, further decreasing the ‘stroke-to-needle’ time, and better addressing contraindications of the thrombolysis treatment. Overall, the number of thrombolysis cases at our hospital doubled in 1 year and exceeded the national average, while the treatment time of patients also improved. Thanks to the ‘lysis alarm’ program, we have now more success stories and less bleeding complications associated with thrombolysis. In addition, fewer patients die of stroke after thrombolysis in our Neurology Department, and 47% of patients could be released with mild or no neurological symptoms (table 2). We plan to do more thrombolysis and to introduce neurointerventional procedures in the future, in order to provide a better quality of life for our stroke patients. To reach this goal, we need to further improve the prehospital and hospital care as well as to develop a better health culture in our immediate geographical environment and nationwide [25].

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