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ORIGINAL ARTICLE / ÖZGÜN ARAŞTIRMA MAKALESİ

The Effect of Stroke Units on The Management of Ischemic Stroke Patients in the Emergency Department: A Retrospective 5-Year Study

Acil Serviste İskemik İnme Hastalarının Yönetimine İnme Ünitesinin Etkisi: 5 Yıllık Geriye Dönük Tarama

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ABSTRACT

Aim: Ischemic stroke is one of the leading causes of morbidity and mortality Worldwide. It is recommended to treat stroke patients in specialized care centers known as stroke units (SU). The aim of this study is to investigate the impact of the stroke unit on the treatment of stroke patients in the emergency department (ED).

Material and Methods: This retrospective observational study was performed in the emergency department of Dokuz Eylül University Faculty of Medicine Hospital. Patients aged 18 years and over with a diagnosis of ischemic stroke were included in the study. A comparison was made between the demographic characteristics, treatments given, length of stay in the emergency department and hospital, and mortality rates before and after the SU was introduced.

Results: A total of 1,546 patients were included in this study; 583 of the patients were admitted before the SU was established, and 963 were admitted after. The majority of stroke patients (56%) were male. The mean age of patients before the SU was 72±12.4 years and after SU it was 70±12.9 years. The highest number of admissions was observed in the 71-80 age group. The most common symptoms for hospital admission were weakness in arms and legs and dysarthria. Thrombolytic treatment was administered to 1.2% of ischemic stroke patients before the SU and 5.5% after the SU (p=0.00). The mean hospital length of stay was 10.7±8.3 days before the SU and 9.4±8.3 days after. Mortality was 8.6% before the SU and 6.7% after.

Conclusion: The establishment of the Stroke Unit (SU) resulted in an increased rate of thrombolytic treatment. In this study SU had no effect on mortality. Despite the increase in the number of patients, there was no change in the length of stay in the ED; however, hospital length of stay was shortened.

Keywords: Emergency department, stroke, stroke unit, ischemic stroke, thrombolytic treatment

ÖZ

Amaç: İskemik inme dünya genelinde önemli bir morbidite ve mortalite nedenidir. Tedavi sürecinin inme ünitesi olarak adlandırılan özelleşmiş bakım merkezlerinde yapılması önerilmektedir. Bu çalışmanın amacı, inme ünitesinin (İÜ) acil servisteki inme hastalarının tedavisine etkisini araştırmaktır.

Gereç ve Yöntemler: Bu retrospektif gözlemsel çalışma Dokuz Eylül Üniversitesi Tıp Fakültesi Hastanesi Acil Servisinde yapıldı. İskemik inme tanısı alan 18 yaş üstü hastalar çalışmaya dahil edildi. İnme ünitesi öncesi ve sonrası dönemde hastaların demografik özellikleri, verilen tedaviler, acil serviste ve hastanede kalış zamanı karşılaştırıldı.

Bulgular: Bu çalışmaya 1546 hasta dahil edildi. Hastaların 583'ü İÜ öncesi, 963 tanesi İÜ sonrası dönemde hastaneye kabul edildi. İnme geçiren hastaların çoğunluğu (%56) erkekti. İÜ açılmadan önceki hastaların yaş ortalaması 72±12,4 yaş; İÜ açıldıktan sonraki yaş ortalaması 70±12,9 yaş bulundu. En çok başvurunun 71-80 yaş grubunda olduğu görüldü. Hastaların hastaneye başvuru nedenleri arasında en sık kol ve bacakta güç kaybı ve konuşma bozukluğu yer almaktadır. İÜ öncesi iskemik inme hastalarının %1,2'sine, İÜ sonrası ise %5,5'ine trombolitik tedavi verilmişti. (p=0,00). İÜ öncesi ve sonrası dönemde hastanede kalış süreleri sırasıyla 10,7 ±8,3 gün ve 9,4±8,3 gün bulunmuştur. Mortalite İÜ öncesi dönemde %8,6 iken İÜ sonrası dönemde %6,7 bulundu.

Sonuç: İÜ açılmasıyla trombolitik tedavi verilme oranında artış olmuştur. İÜ'nin mortaliteye üzerine etkisi olmamıştır. Hasta sayısının artmasına rağmen hastaların acil serviste kalış süresinde değişiklik olmamış fakat hastanede kalış süresi kısalmıştır.

Anahtar Kelimeler: Acil servis, inme, inme ünitesi, iskemik inme, trombolitik tedavi

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Introduction

According to the 2022 Global Stroke Fact Sheet by the World Stroke Organization (WSO), approximately 12.2 million new stroke cases occur worldwide yearly. Of these, 7.6 million (62%) are ischemic strokes, resulting in 3.3 million stroke-related deaths annually (1). Stroke is the second leading cause of death and the third leading cause of disability globally. In Türkiye, as per the 2019 World Health Organization (WHO) report, stroke is the second most common cause of death among women and the third among men (2). In 2017 alone, 38,099 deaths in Türkiye were attributed to stroke (3).

The WHO defines stroke as the interruption of blood flow to the brain, typically caused by the rupture or blockage of blood vessels (4). The primary goal in the treatment of ischemic stroke is to eliminate the clot causing the stroke. Different treatment options, including thrombolytic, anticoagulants, antiplatelet therapy, and mechanical thrombectomy, are available (5). Thrombolitic treatment is an effective option for ischemic stroke. Intravenous recombinant tissue plasminogen activator (tPA) was approved by the United States (US) Food and Drug Administration (FDA) for the treatment of ischemic stroke in 1996(5). In Türkiye, rtPA began to be administered following its approval in 2006. Thrombolytic therapy, which requires close monitoring and carries a risk of serious complications, dedicated stroke units (SU) are necessary for its use (5). The concept of specialized SU was first proposed in the 1950s, and studies demonstrating their effectiveness in stroke care began to emerge in the 1980s (6,7). A landmark 1991 study comparing general intensive care units (ICUs) to SUs found that stroke patients benefitted more from care in SU (8). Further research comparing general and specialized ICU services revealed that patients receiving care in SUs experienced reduced mortality both during their ICU stay and in the following 18 months (9,10). Numerous meta-analyses and reviews have since confirmed that SU reduce mortality, shorten hospital stays, and improve recovery outcomes for ischemic stroke patients (10,11).

Stroke units developed earlier in other parts of the world, and their implementation in Türkiye occurred later. After the approval of rtPA in Türkiye, a SU was established in 2007 within the Neurology Clinic of Dokuz Eylul University.

The aim of this study is to assess the impact of the Stroke Unit at Dokuz Eylul University Facult of Medicine on the management of stroke patients in the ED.

Material and Methods

In this study, patients admitted to the Emergency Department of Dokuz Eylül University Hospital with a diagnosis of ischemic stroke and hospitalized in neurology, stroke unit, or intensive care unit were included. Ethical approval date and number are: Dokuz Eylul University Hospital, Izmir, 13.01.2011; 2011/01-08. A retrospective screening method was used for a total of 5 years. 19.05.2007, the date of admission of the first patient admitted to the ED as the opening of the Stroke Unit was taken as the midpoint, data was collected 2.5 years before and 2.5 years after this date. For this purpose, patients were admitted to the ED between 01.01.2005 and 31.12.2009 and were hospitalized with a diagnosis of ischemic stroke were collected. Patients admitted to the ED with ischemic stroke between 01.01.2005 and 18.05.2007 were classified as the "before SU" group; whereas patients admitted between 19.05.2007 and 31.12.2009 were classified as the "after SU" group. Hospital information of both groups of patients was retrospectively obtained from patients electronic and physical archive files. Patients' age, gender, presenting complaint, treatments given, length of stay in the emergency department, length of hospitalization, and outcome information were recorded on previously created forms. The recorded data were divided into before-SU and after-SU periods, those periods were compared. Length of stay in the emergency department was the primary outcome, with length of hospital stay, thrombolytic treatment rate and mortality were secondary outcomes.

Inclusion criteria:

i) Over 18 years old

ii) Patients admitted to the emergency department with ischemic stroke (based on diffusion-weighted MRI) between 01.01.2005 and 31.12.2009

Exclusion criteria:

i) No evidence of ischemic stroke on diffusion-weighted MR imaging,

ii) Those with missing data in their file were excluded from the study.

Statistical Analysis

The SPSS 15.0 Evaluation version was used for statistical calculations. Descriptive statistics were given as numbers and percentages for categorical variables and mean, standard deviation, median, minimum, and maximum for numerical variables. Continuous variables were compared using Student's t-test for normally distributed variables and categorical variables were compared using Chi-square (X^2) test and $p < 0.05$ was considered statistically significant.

Results

In this study a total of 1546 patients were admitted to the hospital with diagnosis of ischemic stroke. Of these, 583 (37.7%) were admitted before SU was established and 963 (62.3%) were admitted after. Of all patients diagnosed with ischemic stroke, 56% (n=867) were male and 44% (n=679) were female. There was no significant difference between groups in terms of gender before and after the establishment of the SU. 57.1% (333) males and 42.9% (250) females were admitted before SU, and 55.5% (534) males and 44.5% (429) females were admitted after SU; p=0.53). The mean age of ischemic stroke patients before and after the SU was 72±12.4 years (range: 31–103 years) and 70±12.9 years (range: 22–106 years), respectively. There was no difference in mean age between the two groups(p=0.32). The highest number of patients are in the 71-80-year age group, and there is no difference between the before and after SU groups (Figure 1).

The majority of symptoms related to ischemic stroke was associated with motor skills. The most common symptoms were limb weakness and speech impairment. The most frequent sensory symptoms were imbalance and loss of sensation. The most prevalent cognitive symptoms were altered consciousness, nausea, and vomiting. (Table 1) The distribution of symptoms and clinical findings remained similar before and after establishing the Stroke Unit (Figures 2, 3, 4).

Pathologic Findings/Complaints	Before SU, n (%)	After SU, n (%)
Motor Signs	370 (64.4)	659 (68.9)
Weakness in the arm	33 (5.7)	46 (4.8)
Weakness in the leg	14 (2.4)	21 (2.2)
Weakness in both arm and leg	143 (24.5)	287 (29.8)
Inability to walk	3 (0.5)	2 (0.2)
Inability to swallow	1 (0.2)	0 (0.0)
Facial asymmetry	31 (5.3)	48 (5.0)
Dysarthria, motor aphasia	133 (22.8)	235 (24.4)
Loss of vision, diplopia	12 (2.1)	20 (2.1)
Sensory signs	114 (19.8)	177 (18.5)
Numbness, loss of sensation	32 (5.5)	65 (6.7)
Aphasia	16 (2.7)	15 (1.6)
Dizziness, loss of balance	66 (11.3)	97 (10.1)
Cognitive signs	91 (15.8)	121 (12.6)
Alteration of conscious	69 (11.8)	93 (9.7)
Amnesia	1 (0.2)	0 (0.0)
Somnolence	1 (0.2)	3 (0.3)
Nausea, vomiting	12 (2.1)	13 (1.3)
Seizure	1 (0.2)	6 (0.6)
Arrest	0 (0.0)	1 (0.1)
General condition disorder	5 (0.9)	2 (0.2)
Syncope	2 (0.3)	3 (0.3)

Table 1. Clinical Symptoms
SU: Stroke Unit

Overall, 26.3% (403) of ischemic stroke patients were admitted to the hospital within the first three hours. Of these patients, 66.1% (1030) exhibited motor symptoms, 20.4% (316) presented with sensory symptoms, and 12.1% (187) with cognitive symptoms. Among those with motor symptoms who presented within three hours, 41.6% had limb weakness, and 36.8% had speech impairment. Of those presenting with sensory findings in the first three hours, 50.8% had dizziness and imbalance, while 29.8% experienced sensory loss. Among patients with cognitive symptoms presenting within the first three hours, 82.8% exhibited altered consciousness.

In our study, 90.8% (1393) of ischemic stroke patients received antiplatelet therapy, 5.3% (82) received anticoagulant treatment, and 3.9% (60) received thrombolytic therapy. The administration of thrombolytic therapy increased significantly after SU. Before the SU was established 1.2% (7) of ischemic stroke patients received thrombolytic therapy whereas it raised to 5.5% (53) after SU. The increase in this rate was found to be statistically significant ($\chi 2=21.352$, p=0.00) (Figure 5).

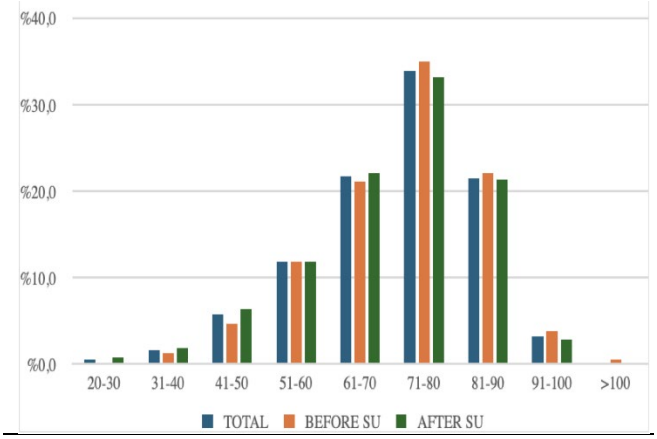

Figure 1. Ischemic stroke percentage distribution by age group

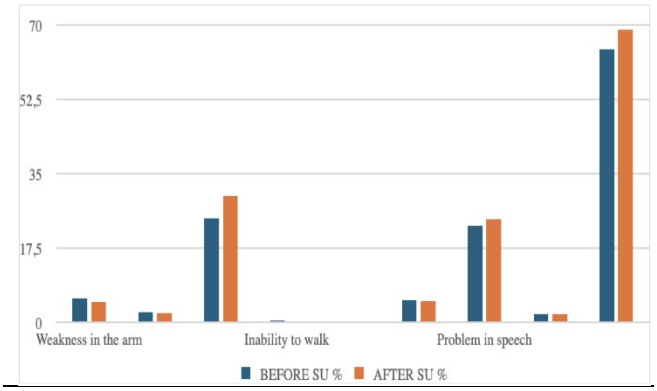

Figure 2. Motor signs before SU and after. SU:SU: stroke unit

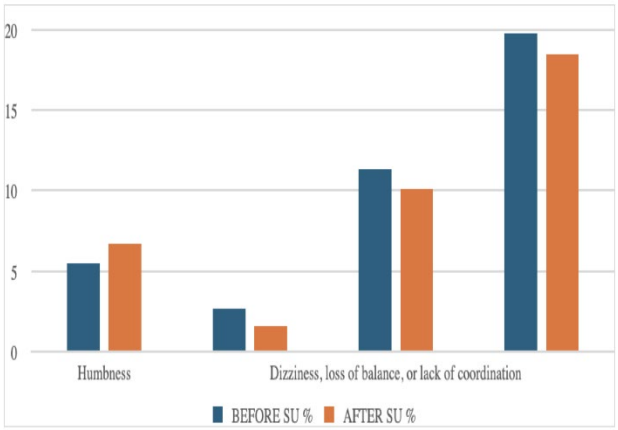

Figure 3. Sensorial signs before SU and after SU. SU: stroke unit

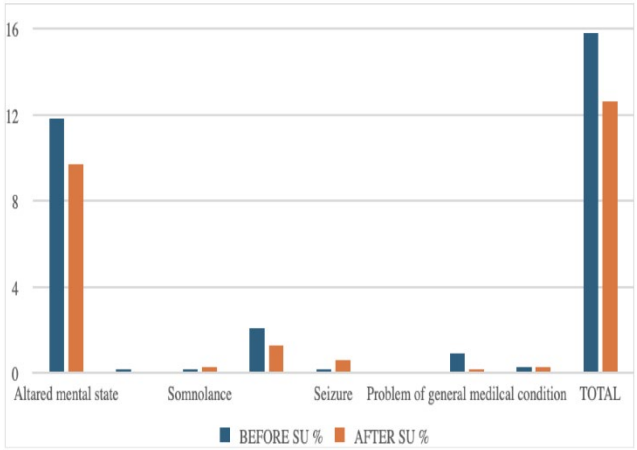

Figure 4. Cognitive signs before SU and after SU. SU: Stroke Unit

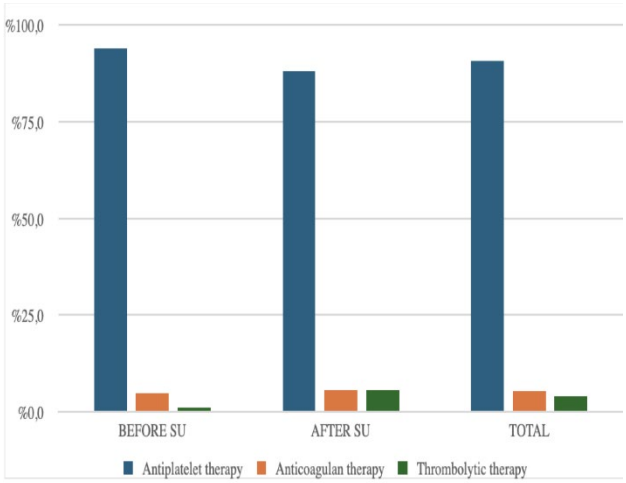

Figure 5. Treatment Before SU and After SU. SU: stroke unit

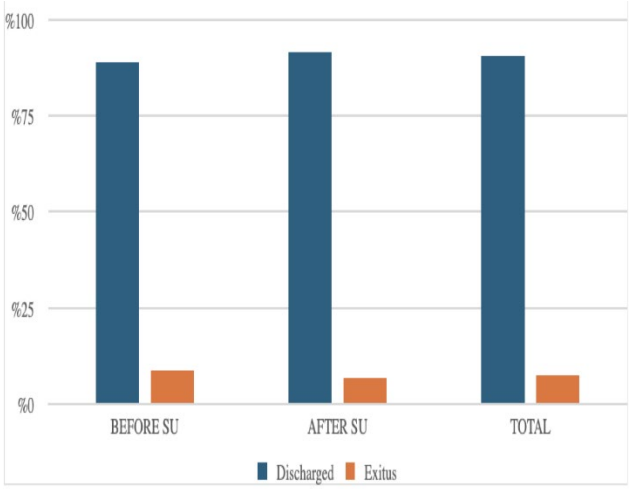

Figure 6. Before SU and after SU, hospital death and discharge rates. SU: stroke unit

Ischemic stroke patients stayed in the ED for a mean of 15.7±20.6 hours (min: 0.3; max: 360 hours). ED length of stay is 15.6±22.7 hours (min: 0.3; max: 360 hours) before SU, 15.7±19.2 hours (min: 0.7; max: 240 hours) after SU, and there was no statistical difference (p=0.93). The mean length of stay in the ED was 15.7±18.8 hours for patients receiving antiaggregant therapy, 20.5±42.5 hours for anticoagulant therapy, and 10.8±12.5 hours for thrombolytic therapy. The mean length of stay in the ED of patients receiving thrombolytics was statistically shorter than that of patients receiving anticoagulant therapy (p=0.03). The mean length of stay in the hospital for patients receiving antiplatelet therapy, anticoagulant therapy, and thrombolytic therapy was 9.8±8.2 days, 11.3±10.2 days, and 8.5±6.3 days, respectively. The differences between treatment modality and length of stay were not statistically significant (p=0.26). The mean hospital stay of the patients before SU was 10.7±8.3 days and 9.4±8.3 days after SU. The length of stay in the hospital was significantly shorter after SU (p=0.00).

It was determined that 7.4% (115) of the patients died in the hospital and 90.6% (1431) were discharged or transferred from the hospital. The mortality rate was 8.6% (50) before SU and 6.7% (65) after. There was no statistical difference between mortality rates ($\chi 2=1.71$, p=0.19; OR:1.29 RR:1.27) and discharge rates before and after SU (χ 2=0.35, p=0.55) (Figure 6).

Discussion

Many studies have shown that SUs have positive effects on the treatment of ischemic stroke patients, the degree of dependency after discharge, and the cost of stroke (6,10) One of these specialized stroke units was established in May 2007 within the Department of Neurology at Dokuz Eylul University Hospital.

In our study, patients who applied to the Dokuz Eylül University Emergency Department and were diagnosed with ischemic stroke between January 2005 and December 2009 were retrospectively examined. It was determined that 0.6% of the patients were diagnosed with ischemic stroke and were admitted to the neurology department, intensive care unit or stroke unit. A similar rate of ischemic stroke was diagnosed and treated in the before and after SU periods.

The mean age of patients admitted due to stroke was 71.2±12.7 years in our study. There was no difference between the mean age of patients who had a stroke before and after SU. It was observed that most of the patients with ischemic stroke were between the ages of 60-90 years, in which risk factors for ischemic stroke are common. The mean age was 62 years in Kumral et al., 67.2 years in Bousser et al., and 73.2 years in Bornstein et al (12-14). In our study, the highest number of patients is in the 70-80 age group. Bousser and Hennerici et al. observed that the stroke frequency was concentrated in the age range of 65-75 years, and the results were similar to those of our study (13,14). The frequency of ischemic stroke increases with advancing age.

Although gender has not been shown to be a risk factor in ischemic stroke, in our study, men (56%) were more common than women (44%) in patients with ischemic stroke. Although Lloyd-Jones et al. (15), Rey et al. (16), and Bousser et al. (14), reached similar results to our study. However, there are also meta-analyses showing that ischemic stroke is more common in women (17). The different results obtained in the studies suggest that gender is not a risk factor for ischemic stroke.

Ischemic stroke presents with different symptoms and signs depending on the affected area. In our study, the main symptoms in patients admitted and diagnosed with ischemic stroke were loss of strength in arms and legs, speech impairment, altered consciousness, nonsensical speech, seizures, and syncope. (Table 1) As identified by Kim et al. (18), motor symptoms and speech disorders are among the key indicators of neurological impairment. Similarly, Yanagida et al. (19) highlighted the presence of hemiplegia and disartria, while Revathi et al. (20) emphasised the significance of hemiparesis, dysarthria, and dizziness as primary symptoms leading to hospital admission. Although ischemic stroke causes many different symptoms, we thought that patients are admitted to hospital primarily because of symptoms that affect their daily life, such as motor findings and speech disorders.

Approximately 25% of patients were admitted to the hospital within the first three hours. Admission in the first 3 hours, which is essential for the effectiveness of treatment, varies between 29% and 50% (21,22). It was observed that

the rate of early admission to hospitals in our country is higher than the studies in other countries. Keskin et al. (21) found that 50% of the patients, as well as Korkmaz et al. (22) found that 44% of patients were admitted to the hospital within the first 3 hours. In our study, the number of admissions to ED within the first three hours after SU increased by approximately 24% compared to the before SU period, but still, 2/3 of the patients present late and lose the chance of thrombolytic treatment. This first 3-hour period has been extended even further, and although more effective methods such as embolectomy are among the options, access to this treatment is not accessible in all regions across the country.

Antiaggregant therapy was the most commonly used treatment option for ischemic stroke, followed by anticoagulant and thrombolytic therapy. Only 60 of the patients in our study received thrombolytic therapy. Seven (11.7%) patients received thrombolytic therapy before SU, but this increased to 53 (88.3%) after SU. Thrombolytic therapy was administered to 19.3% of patients who came within the first 3 hours. Barber et al. (23) found the admission rate within the first three hours to be 27% and the thrombolytic administration rate to be 4.7%. In our hospital, the number of patients receiving thrombolytic therapy after SU increased approximately eightfold compared to before SU. Lattimore et al. (24) found similar results. The number of patients receiving thrombolytic therapy increased significantly with the opening of the SU, as expected, and this is supporting existing evidence for opening new SU centers.

The mean length of stay of ischemic stroke patients in the ED was 15.7±20.6 hours. No significant change was observed in the length of stay in the ED before and after SU. In addition, the length of stay in the ED was significantly shorter in patients receiving thrombolytic therapy. It would be appropriate to think that the reason for the lack of difference in the mean waiting time before and after the SU period is the increasing number of patients and limited bed capacity. The number of ischemic stroke patients increased approximately two-fold in the after SU period. Hospital length of stay was significantly shorter in the after-SU period; however, it had no effect on ED length of stay.

Limitations

The limitations of our study included the inability to conduct direct observations regarding the patients' medical history, presenting complaints, and physical examinations due to the retrospective nature of the study. Additionally, the changes in the patients' disability levels following their admission to the stroke unit could not be evaluated. Furthermore, the increase in the number of patients admitted to the hospital due to systemic changes in patient admission policies coincided with the period when the stroke unit was opened, which resulted in an increased number of patients being evaluated for the effectiveness of the stroke unit in the emergency department and throughout the hospital.

Conclusion

Following the establishment of the SU at Dokuz Eylul University Hospital, the rate of thrombolytic treatment increased, however, SU had no effect on mortality. Despite the increase in the number of ischemic stroke patients, there was no change in the length of stay in the ED; however, hospital length of stay was shorter.

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Authors' Contribution: CS: Designing the study, data collection, interpretation of data, writing manuscript **SY**: Designing and planning study, performing critical revision **DTS**: Contributing to writing the manuscript, performing critical revision **RA**: Designing and planning study, performing critical revision.

All authors read and approved the final version of the manuscript

Ethical Approval: Ethical approval was obtained from the Dokuz Eylul University Hospital Clinical Research Ethics Committee before the study (Decision No. 2011/01-08).

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