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Evaluation of Diagnostic and Treatment Timelines for Ischemic Stroke Patients in the Emergency Department: A Prospective Observational Study

Acil Serviste İskemik İnme Hastalarının Tanı ve Tedavi Sürelerinin Değerlendirilmesi: Prospektif Gözlemsel Çalışma

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ABSTRACT

Background: This study aimed to evaluate the diagnostic and treatment processes of patients presenting with ischemic stroke to the Emergency Department of Eskisehir Osmangazi University Faculty of Medicine Hospital, identify workflow deficiencies, and propose improvement strategies.

Methods: This prospective and observational study included 592 patients aged 18 years or older who were diagnosed with ischemic stroke in the emergency department. Demographic data of patients admitted to the emergency department and diagnosed with ischemic stroke, their backgrounds, vital signs at the time of first presentation to the emergency department, emergency department management processes (electrocardiography, fingerstick blood glucose, consultation calls and completion times, Computed tomography (CT) and CT angiography acquisition and reporting times, treatment (intravenous thrombolytic therapy (IV tPA) and endovascular therapy (EVT) initiation times and transfer times to the stroke unit were recorded.

Results: The mean age of the patients was 68.28±13.09 years, and 53.7% were male. Reperfusion therapy (rtPA and/or EVT) was administered to 25.1% of the patients. The mean door-to-doctor time was 2.00±0.91 minutes, and the mean door-to-CT time was 22.36±16.79 minutes. Diagnostic and treatment processes were significantly faster in patients receiving reperfusion therapy (P<.001). The primary factor delaying rtPA administration was the arrival time of the consultant physician to the emergency department.

Conclusion: Timely and effective management of diagnostic and treatment processes in ischemic stroke patients significantly reduces mortality and morbidity. Coordinated teamwork between emergency and stroke units and process optimization may enhance the success of stroke management.

Keywords: Ischemic stroke, door-to-needle time, thrombolytic therapy, endovascular.

ÖZ

Amaç: Bu çalışmada, Eskişehir Osmangazi Üniversitesi, Tıp Fakültesi Hastanesi Acil Servisi'ne başvuran iskemik inme hastalarının tanı ve tedavi süreçlerinin değerlendirilmesi, süreçlerdeki aksaklıkların belirlenmesi ve iyileştirme önerilerinin sunulması amaçlanmıştır

Yöntemler: Prospektif ve gözlemsel olarak planlanan çalışmaya, 18 yaş üzeri, acil serviste iskemik inme tanısı alan 592 hasta dahil edilmiştir Acil servise başvuran ve iskemik inme tanısı alan hastaların demografik verileri, özgeçmişleri, acil servise ilk başvuru anındaki vital bulguları, acil servis yönetim süreçleri (elektrokardiografi çekimi, parmak ucu kan şekeri, konsültasyon çağrıları ve tamamlanma süreleri, bilgisayarlı tomografi (BT) ve BT anjiografi çekimi ve raporlanma süreleri, tedaviye (intravenöz trombolitik tedavi (IV tPA) ve endovasküler tedavi (EVT) başlama süreleri ile inme ünitesine transfer zamanları kayıt altına alınmıştır.

Bulgular: Çalışmaya katılan hastaların ortalama yaşı 68,28±13,09 yıl olup %53,7'si erkekti. Hastaların %25,1'ine reperfüzyon tedavisi (rtPA ve/veya EVT) uygulandı. Kapı-doktor süresi ortalama 2,00±0,91 dk, kapı-BT süresi 22,36±16,79 dk olarak saptandı. Reperfüzyon tedavisi uygulanan hastalarda tanı ve tedavi süreçleri anlamlı şekilde daha hızlıydı (P<.001). rtPA uygulama süresini en çok etkileyen faktör konsültan hekimin acil servise gelme süresi olarak belirlendi.

Sonuç: İskemik inmeli hastalarda tanı ve tedavi süreçlerinin zamanında ve etkin yürütülmesi mortalite ve morbiditeyi azaltmaktadır. Acil servis ve inme ekiplerinin koordineli çalışması ve süreç optimizasyonu, inme yönetiminde başarıyı artırabilir.

Anahtar Kelimeler: İskemik inme, kapı-iğne süresi, trombolitik tedavi, endovasküler tedavi.

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INTRODUCTION

Stroke is an acute neurological condition associated with high morbidity and mortality rates, and it is recognized globally as a significant public health concern. According to data from the World Health Organization (WHO), approximately 15 million individuals experience a stroke each year, of whom 5 million die and another 5 million continue their lives with permanent sequelae. In the United States, stroke ranks as the third leading cause of death after cardiovascular diseases and malignancies, and it is also a primary cause of long-term physical and cognitive disabilities.[1]

From a pathophysiological standpoint, stroke is a clinical syndrome that develops as a result of the sudden disruption of cerebral circulation. Etiologically, it is classified into two main categories: ischemic (85–87%) and hemorrhagic (13–15%). The most common type, ischemic stroke, typically results from thromboembolic events leading to occlusion of cerebral arteries.[2] Symptoms are usually of sudden onset and are characterized by neurological deficits that vary depending on the affected cerebral region.

In acute ischemic stroke, early and effective intervention not only reduces mortality but also significantly improves patients' quality of life. In this context, the principle of "time is brain" emphasizes that every minute is critical.[3] The guidelines of the American Heart Association and the American Stroke Association recommend that intravenous (IV) recombinant tissue plasminogen activator (rtPA) therapy be administered within the first 4.5 hours following the onset of symptoms. Furthermore, in eligible patients, the initiation of endovascular therapy (EVT) within the first 6 hours has been shown to reduce both mortality and morbidity.[4] In order to facilitate rapid access to treatment, specific target timeframes have been defined in the guidelines. One such benchmark, the "door-to-needle time" (DTN), refers to the time interval between the patient's arrival at the emergency department and the initiation of IV thrombolytic therapy. It is recommended that this duration be under 60 minutes, and that at least 50% of patients receive treatment within this timeframe.[5] Achieving these targets necessitates timely diagnosis, prompt neurological and radiological evaluations, effective multidisciplinary teamwork, and the optimization of in-hospital protocols. Particularly in centers where a radiologist is not available at all times, the use of teleradiology systems is encouraged by the U.S. Food and Drug Administration (FDA). The objective of this study is to evaluate the diagnostic and therapeutic processes of patients presenting to the emergency department with suspected stroke, to analyze the functioning of the current system, and to identify any deficiencies in order to propose improvements.

MAIN POINTS

- In patients receiving reperfusion therapy, diagnostic and interventional processes progressed significantly faster.
- Although a time analysis of the diagnostic and treatment processes showed compliance with guidelines in some phases, significant delays were observed particularly in steps such as consultation duration.
- Initial diagnostic procedures are conducted promptly following hospital admission, whereas radiological evaluations and their reporting consume substantial time

MATERIAL AND METHODS

Study Design and Ethical Approval

This study is prospective and observational in nature and was conducted in the Emergency Department of Eskişehir Osmangazi University Faculty of Medicine Hospital. The study protocol was approved by the university's ethics committee (Date: June 7, 2018; Decision No: 12). Although initially planned to span one year, the study was terminated early as the targeted sample size (n = 592, power = 0.95) was reached within nine months.

Study Center and Patient Management Protocol

Eskişehir Osmangazi University Faculty of Medicine Hospital has been authorized by the Ministry of Health as a stroke center since 2009. In this context, a standardized protocol is implemented for the management of acute stroke, and EVT has been actively performed since 2012.

Patient Selection and Data Collection

Inclusion criteria for the study were: being 18 years of age or older, receiving a diagnosis of ischemic stroke following evaluation in the emergency department, and obtaining written informed consent from the patient or a first-degree relative. Exclusion criteria included patients under the age of 18, pregnant individuals, trauma patients, and those diagnosed with hemorrhagic stroke.

The demographic data, medical history, vital signs at the time of initial presentation to the emergency department, and emergency department management processes (ECG, capillary blood glucose, consultation requests and their completion times, computed tomography (CT) and CT angiography (CTA) imaging and reporting times, initiation times of IV tPA and EVT treatments, and transfer times to the stroke unit) of patients who presented to the emergency department and were diagnosed with ischemic stroke were recorded.

Statistical Analysis

Statistical analyses were performed using IBM SPSS Statistics for Windows, Version 21.0 (IBM Corp., Armonk, NY).

Continuous quantitative data were expressed as number (n), mean, and standard deviation. Categorical variables were grouped accordingly. The Chi-square test was used to compare categorical variables. To compare means between groups, the Shapiro-Wilk test was initially performed to assess the normality of data distribution. A p-value less than 0.05 in the Shapiro-Wilk test was interpreted as indicating that the data did not follow a normal distribution. In such cases, the non-parametric Mann-Whitney U test was used for comparisons between two groups, and the Kruskal-Wallis test was used for comparisons among more than two groups. A p-value of less than 0.05 was considered statistically significant in the analyses performed.

RESULTS

During the study period, a total of 592 patients diagnosed with ischemic stroke presented to the emergency department. Of these patients, 77 received rtPA, 72 underwent EVT, and the remaining 443 patients were treated conservatively.

The distributions and comparisons of patients according to age, medical history, National Institutes of Health Stroke Scale (NIHSS), and vital signs at admission, based on treatment options, are presented in Table 1.

Table 1: Comparison of different parameters on response to thrombolytic treatment, complications and mortality

Parameter	Only rtPA $\bar{x} \pm$ SD	Interventional Treatment $\bar{x} \pm$ SD	Conservative Treatment $\bar{x} \pm$ SD	P
Age	72.38±12.54	62.88±14.68	68.28±13.09	<.001
NIHSS (median)	8.00	15.00	2.00	<.001
Chronic Heart Failure (%)	11.7	6.9	6.5	.274
Coronary Artery Disease (%)	28.6	16.7	26.6	.164
Chronic Renal Failure (%)	7.8	4.2	4.5	.448
Hypertension (%)	70.1	50.0	57.8	.038*
Diabetes mellitus (%)	33.8	20.8	33.6	.092
Pulse (pulse/min)	86.75±17.14	81.43±13.55	82.18±14.98	.278
Fever (°C)	36.25±0.43	36.22±0.49	36.25±0.43	.101
Respiratory Rate (respiration/min)	20.99±2.19	21.11±2.92	20.60±2.19	.093
sPO2 (%)	93.71±1.59	93.47±2.28	94.58±1.93	<.001
Systolic Blood Pressure (mmHg)	161.09±27.75	157.65±32.41	154.01±28.77	.122
Diastolic Blood Pressure (mmHg)	87.34±15.02	86.88±16.21	84.31±14.71	.195

Since 11 patients presented with non-contrast cranial CT already performed at an external center, the evaluation was conducted based on 581 patients. CTA was not performed in 70 patients due to the current creatinine elevation and/or the absence of major vessel occlusion. The time intervals from emergency department admission to subsequent procedures for all patients are presented in Table 2.

Table 2: Time Intervals from Emergency Department Admission to Performed Procedures

Procedure	n	$\bar{x} \pm$SD (min)	Min-Max (min)
Door-Doctor	592	2.00±0.91	1-10
ECG Examination	592	5.13±1.56	1-15
CBG	592	4.70±1.84	1-12
Consultation Request	592	29.49±23.31	3-150
Referred by the Consultant	592	63.08±49.30	9-260
Door-CT	581	22.36±16.79	1-120
Door-CT Evaluation	581	24.00±17.56	2-121
Door-CTA	522	41.74±52.98	5-390
Door-CTA Evaluation	522	43.59±53.49	3-395

When the time intervals of procedures performed from the time of admission were compared between patient groups, it was found that there was no statistically significant difference in the time to ECG acquisition between those who received reperfusion therapy and those who did not (P=.128); however, statistically significant differences were observed in the time to physical examination, capillary blood glucose measurement, consultation request, consultant arrival, BBT acquisition, BBT evaluation, CTA acquisition, and CTA evaluation (Table 3).

Table 3: Comparison of different parameters on response to thrombolytic treatment, complications and mortality

Procedure	rtPA $\bar{x} \pm$SD (n)	EVT $\bar{x} \pm$SD (n)	Conservative Treatment $\bar{x} \pm$SD	P
Examination Time	1.82±0.62 (77)	1.72±0.58 (72)	2.07±0.97 (443)	.005*
ECG	4.91±0.90 (77)	4.71±1.16 (72)	5.23±1.69 (443)	.128
CBG	4.32±1.55 (77)	4.29±1.55 (72)	4.83±1.92 (443)	.046*
Consultation Request	15.44±6.63 (77)	12.78±6.45 (72)	34.65±24.61 (443)	<.001*
Referred by the Consultant	26.62±8.47 (77)	23.43±8.89 (72)	75.86±50.72 (443)	<.001*
CT	12.55±5.46 (76)	12.44±5.95 (68)	25.62±17.94 (437)	<.001*
CT Evaluation	13.79±5.49 (76)	13.56±5.69 (68)	27.40±18.78 (437)	<.001*
CTA	18.60±14.70 (73)	17.03±8.52 (65)	50.32±59.04 (384)	<.001*
CTA Evaluation	20.25±15.01 (73)	18.28±8.66 (65)	52.30±59.59 (384)	<.001*

In the analysis of delays in the administration of recombinant tPA beyond the guideline-recommended timeframe (>60 minutes), factors were examined as categorical and continuous variables using logistic regression analysis with Spearman's rho. The logistic regression analysis using Spearman's rho revealed a direct association between consultant arrival time and rtPA administration time (P=.05, OR: 0.094, 95% CI: 0.88–1.00) (Table 4).

Table 4: Door intervention time (min)

Procedure	N	Mean (min)	Minimum	Maximum
rtPA	77	67.09±17.14	30	111
EVT	72	76.69±30.59	17	158

DISCUSSION

Stroke ranks as the second leading cause of death worldwide. In recent years, significant advancements have been achieved in the management and treatment of acute ischemic stroke, in parallel with technological progress. The initiation of IV rtPA use and the implementation of EVT techniques have transformed the paradigm in this field. Nonetheless, the process involves a race against time to preserve brain tissue. Therefore, early diagnosis of stroke and timely initiation of effective treatment are critically important for patient prognosis. Additionally, specialized care during the acute phase in intensive care or stroke units can improve overall outcomes.[6]

In our study, the rate of female patients was 46.3%, and male patients 53.7%. This difference suggests that stroke incidence may vary based on social, demographic, and geographic factors. Accordingly, a large-scale study including 33,530 patients with ischemic stroke reported the rate of male patients as 59.4%.[7]

When assessed in terms of comorbidities, hypertension (58.4%), diabetes mellitus (32.1%), coronary artery disease (25.7%), prior cerebrovascular event (24.0%), chronic heart failure (7.3%), and chronic kidney disease (4.9%) were the most commonly accompanying conditions. These findings are consistent with studies in the literature reporting that hypertension, cardiovascular diseases, and heart failure are the most frequent comorbidities associated with acute ischemic stroke.[8]

In the time analysis of diagnostic and treatment processes in the emergency department, the time from admission to examination was found to be an average of 2.00±0.91 minutes. In another study conducted in a neurology outpatient clinic, this time was reported as 35.00±11.9 minutes.[9] This difference indicates that intervention processes proceed more rapidly in emergency departments. In our study, the shorter examination time in patients who received reperfusion therapy was found to be statistically significant; however, this difference is not clinically meaningful. During the diagnostic process, ECG acquisition and capillary blood glucose measurements were carried out in a manner that did not interfere with imaging or treatment procedures.

Delays in consultation requests may be attributed to factors such as late notification of the stroke team, the presence of a single on-call consultant, and physical distance. In the literature, the average consultation time following emergency admission has been reported as 28 minutes.[10] When cranial CT acquisition times are examined, one study indicated that in hospitals with a dedicated stroke team, the average CT acquisition time was 63 minutes, whereas it was 100 minutes in hospitals without such teams.[10] In our study, the door-to-CT time largely complied with the ≤20-minute CT acquisition and interpretation timeframe recommended in the guidelines.[4] However, these durations could be further improved through measures such as enhancing pre-hospital notification systems, establishing stroke teams, and directing patients directly to imaging areas. Although delays during off-hours have been reported in some centers, studies have shown that these timeframes do not vary in stroke centers with well-defined protocols.[11]

Intravenous alteplase therapy, which is administered to improve functional outcomes, has been shown in randomized controlled trials to significantly reduce mortality and morbidity when initiated within 4.5 hours.[12-14] However, because this efficacy decreases over time, rapid diagnosis and treatment are essential. In this context, increasing awareness and protocol training among healthcare personnel is recommended.[4]

Intervention was performed in 25.1% of the patients, consisting of rtPA alone (51.7%) and interventional treatment (48.3%). According to our study, patients who underwent intervention received earlier examination, capillary blood glucose measurement, consultation requests and consultant arrival, CT acquisition and evaluation, and CTA acquisition and evaluation from the moment of admission.

Interventional treatment is currently a recommended evidence-based approach for major acute ischemic strokes. In the ESCAPE trial, modern endovascular techniques were reported to significantly reduce both morbidity and mortality.[15] In our study, it was also observed that patients who received interventional treatment were managed more rapidly due to the structured stroke protocol, which contributed to the favorable clinical outcomes reported in the literature.

In our study, among patients who received only rtPA, the time to rtPA administration was found to be associated with the consultant arrival time. It was determined that the initiation of antihypertensive treatment for elevated blood pressure did not delay this period. To improve intervention times, large vessel occlusion scales (such as C-STAT, FAST VAN, RACE) are being developed. For patients with positive findings in these scales, the initiation of early stroke protocols is recommended. This study demonstrates that timely implementation of diagnostic and treatment procedures in acute ischemic stroke patients is a key determinant of prognosis. Emergency department teams should be structured to improve stroke-specific diagnostic and management processes; stroke protocols should be updated to ensure that patients receive appropriate treatment within 60 minutes of arrival. In this context, multidisciplinary quality improvement teams should be established, and evidence-based practices in stroke management should be sustained.

CONCLUSION

Ischemic stroke is a neurological condition that causes significant morbidity and mortality and requires urgent intervention. In well-organized stroke centers operating in accordance with current guidelines, timely management of diagnostic and treatment processes can significantly reduce both mortality and morbidity rates. Therefore, it is of utmost importance that stroke patients are transferred as quickly as possible to designated and functional stroke centers.

To further shorten diagnostic and treatment times, training programs should be organized for healthcare professionals and updated regularly. For effective stroke management, early activation systems should be established, stroke teams should be formed, and these teams should work in coordination. Additionally, efficient communication and collaboration between emergency physicians and neurology teams should be developed to ensure rapid assessment and timely implementation of the most appropriate treatment.

Ethics Committee Approval: Ethics committee approval was received for this prospective study from the Clinical Research Ethics Committee of Eskişehir Osmangazi University (Date: June 7, 2018; Decision No: 12). The study was conducted in accordance with the principles of the Declaration of Helsinki.
Informed Consent: Signed informed consent was obtained from all cases.
Peer-review: Externally peer-reviewed.
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