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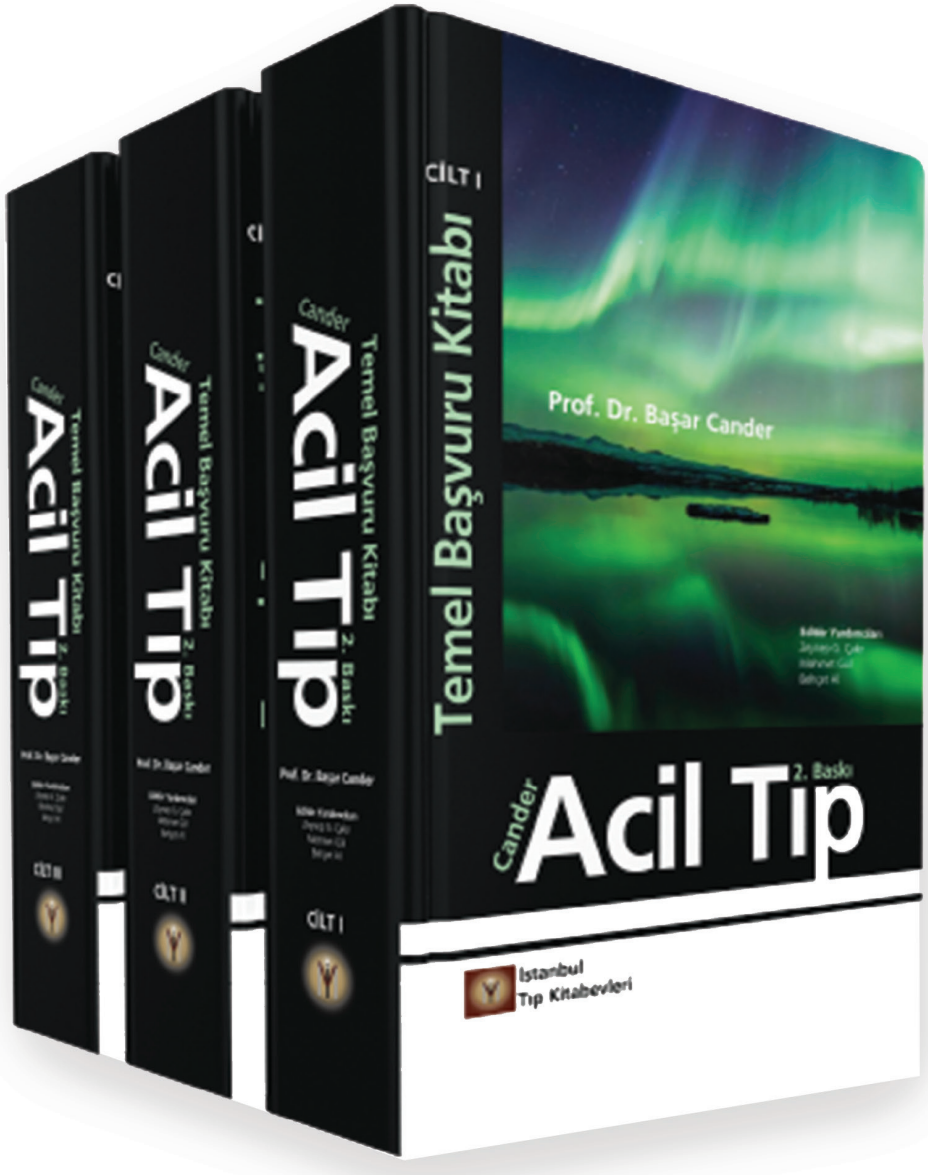

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EURASIAN JOURNAL OF EMERGENCY MEDICINE
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Association between Inflammatory Markers Measured at Emergency Admission and In-Hospital Mortality Among Patients with Acute Ischemic Stroke

Tarun Sharma

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Keywords: Ishchemic stroke, inflammation, albumin,vascular, prognosis

Stroke remains a leading cause of mortality and disability world-wide, with its incidence projected to rise in the coming years. Blood biomarkers have demonstrated their value in disease identification and monitoring. While stroke severity is a key determinant of prognosis and recurrence risk, research on relevant blood biomarkers remains limited. Given that stroke pathophysiology involves a complex interplay of ischemia-driven inflammatory and immune responses, evaluating an immune-related biomarker panel in relation to stroke severity holds significant potential. Inflammatory markers have now been well studied as prognostic markers in acute ischemic stroke (AIS). Most research on inflammation in atherosclerotic disease has centered on cardiac conditions. While stroke shares certain pathophysiological similarities with ischemic heart disease, key distinctions warrant its independent investigation. Ischemic stroke exhibits greater etiological diversity compared to coronary artery disease. Additionally, stroke patients tend to be older on average and present with distinct risk factor profiles compared to those with cardiac disease. The role of these inflammatory markers starts in the vascular compartment immediately after arterial blockage (1). The pathophysiology of AIS is intricate and influenced by multiple factors. Scientific research has established a connection between inflammation and AIS, demonstrating its role in disease onset, progression, and outcomes (2,3). In the early phase of ischemic stroke, various peripheral immune cells such as neutrophils, monocytes, T cells, and macrophages migrate into the brain parenchyma followed by a rise of inflammatory markers (4). Consequently, evaluating inflammatory markers can provide valuable prognostic insights for AIS. Numerous inflammatory biomarkers, including albumin, interleukin, high-sensitivity C-reactive protein, tumour necrosis factor, and homocysteine, have been closely linked to AIS (5,6). Beyond these individual indicators, composite inflammatory markers have also been utilized to predict AIS prognosis. One such marker, the neutrophil-to-lymphocyte ratio (NLR), which represents the balance between circulating neutrophils and lymphocytes, has shown a strong correlation with short-term functional outcomes in AIS patients (7). Post-ischemic inflammatory responses cause blood brain barrier disruption leading to haemorrhagic transformation, and subsequently worse prognosis of patients with AIS (8).

Another marker, the platelet-to-lymphocyte ratio (PLR), is a significant prognostic marker for AIS, offering insight into platelet activation driven by inflammation-coagulation interactions and other mechanisms (9,10). Similarly, the systemic Immune-Inflammation index (SII) has been linked to poor AIS outcomes, highlighting its role in thrombotic and immune dysregulation. Once cerebral ischemia occurs, an excessive oxidative stress response follows, leading to structural and functional brain damage. Inflammation and oxidative stress, two early hallmarks of ischemic brain injury, are deeply interconnected. Choi et al. (11) highlights albumin level as an independent predictor of in-hospital mortality in AIS patients. While inflammatory indices such as NLR, and PLR offer valuable.

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Initial insights into the consistent significance of albumin underscores its clinical utility for risk stratification. Routine albumin assessment in emergency settings can facilitate early risk evaluation and guide treatment strategies in patients with AIS.

Conclusion

Neutrophils, the first immune responders in ischemic stroke, have been clinically associated with poor functional outcomes. Approximately 12 hours after stroke onset, they infiltrate the brain parenchyma, triggering neuronal death through the release of elastase, matrix metalloproteinase-1, interleukin-1β, and reactive oxygen species. These processes compromise the blood-brain barrier and exacerbate damage in the ischemic region (12). Additionally, neutrophils express inducible nitric oxide synthase, an enzyme responsible for nitric oxide production, which has been linked to larger infarcts in cases of middle cerebral artery occlusion. The increase in neutrophils thus plays a pivotal role in ischemic brain injury. Platelets also contribute to thrombotic inflammation and stroke pathogenesis by interacting with neutrophils. Like neutrophils, activated platelets engage with the endothelium and release inflammatory mediators that amplify the post-stroke immune response, further intensifying inflammation.

Prediction of stroke outcomes requires a high degree of precision, which can be gained by a combination of clinical judgement, validated scales, neuroimaging and laboratory findings. The number of specific blood biomarkers is still low but these markers might play an important role in prognostic scales or even machine-based algorithms, which have already proven to outperform conventional scores in stroke and cardiovascular risk assessment.

Inflammatory markers play a crucial role in predicting the prognosis of AIS by reflecting the extent of immune activation and tissue damage. Biomarkers such as albumin, NLR, PLR, and systemic SII have shown promise in assessing stroke severity and outcomes. Future research should focus on integrating these markers into clinical practice through standardized panels and AI-driven predictive models. Additionally, novel inflammatory biomarkers and targeted immunomodulatory therapies could enhance stroke management, offering personalized treatment approaches. Advancing our understanding of inflammation in AIS may improve early risk stratification and therapeutic strategies.

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Opinions of Emergency Medicine Physicians on the Subspecialty of Emergency Medicine Critical Care: A Pilot Study

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Abstract

Aim: In December 2023, the Medical Specialization Board of Japan recommended granting emergency medicine as a primary specialty the right to undergo a subspecialty examination in critical care. This decision was subsequently published in the Official Gazette in May 2024, and it was officially entered into force. While Emergency Medicine Specialization Societies welcomed this decision with great enthusiasm, Critical Care Specialization Societies reacted negatively. Through this survey study, we aimed to determine the opinions of emergency medicine physicians regarding the Critical Care Subspecialty and to reflect on the current debate within the emergency medicine community.

Materials and Methods: This cross-sectional survey study involved physicians working at the Emergency Medicine Clinic of a City Hospital. After obtaining the necessary permissions, a 22-question survey was prepared using Google Forms and administered to 52 emergency medicine physicians who agreed to participate out of the 75 physicians working in the clinic. Descriptive statistics were obtained from the survey results, and categorical variables were presented as frequencies and percentages.

Results: 29% of the physicians had over 10 years of experience in emergency medicine, whereas 27% had 1-2 years of experience. All participants agreed that the critical care subspecialty is appropriate for emergency medicine, supported the recommendation, and desired the right to enter this subspecialty. Additionally, 92% of the physicians viewed the efforts of emergency medicine specialty societies regarding critical care subspecialty positively, whereas 96% considered the opposing statements from other specialty societies to be unjustified.

Conclusion: There is widespread consensus among emergency medicine physicians regarding the need for subspecialty training. Granting the right to enter the critical care subspecialty will likely result in many emergency medicine specialists occupying positions within this field, despite the potential drawbacks.

Keywords: Emergency medicine, critical care, subspecialty

Introduction

In Türkiye, the first general intensive care units were established by anesthesiology and reanimation specialists under the name "Reanimation Units" starting from the 1960s. These intensive care units were incorporated into the scope of the newly established intensive care subspecialty after publication of the Medical Specialization Regulations in 2002. The concept of "general intensive care" of this new discipline was planned to provide health services to all critical patients and to operate as units defined in three different levels. The implementation of subspecialty training programs was also defined at protocol level. In 2012, student intake for subspecialty training began. According to the Regulation on Medical and Dental Specialization Education, the duration of intensive care subspecialty training is 3 years, and the main specialties that can be selected for this subspecialty are anesthesiology and reanimation, general surgery, chest diseases, internal medicine, infectious diseases and clinical microbiology, and neurology, which total six specialties (1-3).

The emergency medicine specialty was officially established in our country in 1993. It was included in the Emergency

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Medicine Specialist Training Core Curriculum published in 2013 under the five recommended subspecialties (pediatric emergency, toxicology, critical care, disaster medicine, trauma and emergency surgery, international emergency medicine). However, this section was removed from the 2016 curriculum. Emergency medicine associations have occasionally applied to relevant authorities to enable emergency medicine specialists to take the intensive care subspecialty exam. The Turkish Emergency Medicine Foundation also has an application in this regard (4).

In the final days of the year, on December 28, 2023, the Board of Medical Specialties issued a recommendation allowing emergency medicine specialists to take the subspecialty exam for intensive care, which caused a significant stir both within the emergency medicine and the anesthesiology and reanimation communities. The Emergency Medicine Physicians Association of Turkey (EPAT) and the Emergency Medicine Association of Turkey (EMAT) announced this news as a positive development. EPAT shared it on their website under the title "fruit of a 25-year struggle: intensive care subspecialty", while EMAT posted an infographic titled "a journey started 20 years ago" on social media. This post emphasized that the association has been making necessary applications in this field since 2004. However, in the anesthesiology and reanimation community, there were statements that opposed this development. The Turkish Society of Intensive Care and the Turkish Society of Intensive Care Specialists have articulated their arguments against this development in their statements. Anesthesiology associations have made statements opposing the granting of intensive care subspecialty admission rights to emergency medicine departments. Anesthesia associations argue that allowing emergency medicine specialists to begin intensive care training while the number of emergency medicine specialists in all emergency departments remains insufficient could create a shortage of emergency service specialists. Another argument they present is that the current practice, in which physicians from six different specialties are already receiving intensive care training, could lead to a lack of uniformity in the training process, and the inclusion of emergency medicine specialists as the seventh specialty might negatively impact this process. (5-7). Ultimately, the intense efforts of the Emergency Medicine Associations bore fruit, and the Law regarding the designation of intensive care as a subspecialty was published in the Official Gazette on March 1, 2024, with issue number 32476, and came into effect (8).

With this survey, we aimed to determine the opinions of emergency medicine physicians, including residents, specialists, and academics, working in the Emergency Medicine Clinic of a Tertiary Care City Hospital regarding intensive care subspecialty. Our goal was to shed light on current debates within the emergency medicine community and to reflect the views of professionals in the field.

Materials and Methods

This cross-sectional study included physicians working in the Emergency Medicine Clinic of a City Hospital. Ethical approval was obtained from the KTO-Karatay University Clinical and Non-Clinical Research Ethics (decision number: E-41901325-200-79454, date: 16.02.2024) and necessary permissions were also obtained from the Hospital Education Planning Committee. Data collection took place over a period of 2 months from April 5, 2024, to June 5, 2024. A survey form was developed to evaluate the opinions of physicians working in the Emergency Medicine Clinic of the City Hospital regarding intensive care subspecialty. The survey comprised 22 questions, including 3 questions about demographic characteristics and 19 questions about subspecialty training and intensive care subspecialty. Forms were prepared electronically using Google Forms and shared with physicians working in the clinic. Reminders were sent at regular intervals. During the data collection phase, the purpose of the research was explained to the physicians, verbal consent was obtained, and those who agreed clicked on the relevant link to answer the survey. 52 out of 75 physicians working in the clinic, 52 participated in the study, accounting for 69%. Physicians who did not want to participate in the study were excluded. No specific reason was identified for the group that did not wish to participate in the study, and we believe their non-participation was due to an aversion to completing the survey.

Statistical Analysis

Statistical analysis of the data was performed using the Jamovi Statistical Package program, and categorical variables were presented in frequency and (%) format. This study was presented as an oral speech at WACEM 2024, Rome, Italy, in November 2024.

Results

A total of 52 physicians participated in the survey. Of these individuals, 4 were academicians, 12 were specialists, and 36 were resident physicians (Figure 1). The three most common responses of the participants to the question querying the total duration of work in the emergency medicine specialty were 10 years or more, with 15 participants (29%), followed by 1-2 years with 14 participants (27%), and 2-3 years with 6 participants (11%), as well as 4-5 years with 6 participants (11%) (Figure 2). Responses to single-choice questions are given in Table 1.

Regarding whether they had experience in intensive care, 50% (n=26) of the respondents answered "Yes." All participating

physicians (n=52) answered yes to the question "Should any subspecialty be defined for the emergency medicine specialty?". A total of 168 responses were received from the 52 participating physicians regarding the question "Which subspecialties should be defined?". The most common choice was intensive care/critical care (27%, followed by toxicology 25%, trauma and emergency surgery 21%). The option of disaster medicine was selected 26 times (16%), and pediatric emergency was selected 18 times (11%) (Figure 3).

For the question "Which subspecialty would you like to choose?", a total of 82 responses were received from the participants in the survey. The most common choice was intensive care/critical care (39%, followed by toxicology 37%, and trauma and emergency surgery 17%). Disaster medicine was selected 6 times, while pediatric emergency was not chosen (Figure 4).

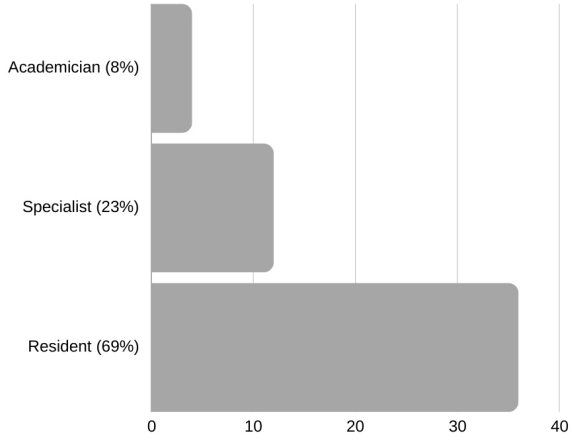

Figure 1. Role in emergency medicine

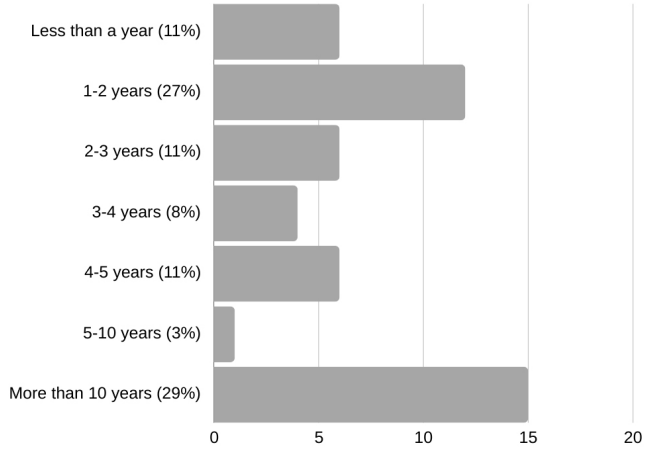

Figure 2. Total duration of work in the emergency medicine specialty

Participants evaluated the recommendation decision regarding intensive care subspecialty training for the emergency medicine specialty as 100% positive. All respondents to the survey (n=52) believed intensive care subspecialty is suitable for emergency medicine. Furthermore, all physicians (n=52) expressed their desire for the emergency medicine specialty to be granted access to intensive care subspecialty training.

Ninety-six percent of the physicians expressed that they found the statements made by Intensive Care Specialty Associations unjustified the recommendation decision to grant intensive care subspecialty rights to the emergency medicine specialty, while 2 participants (4%) stated that they found these statements justified. When asked whether they wanted to pursue any subspecialty training after completing their emergency medicine training, 81% answered "Yes." When asked whether they wanted to apply for intensive care subspecialty training if given the opportunity, 69% of the participants (n=36) answered yes, while 6 physicians responded no (12%) and 10 physicians (19%) were undecided.

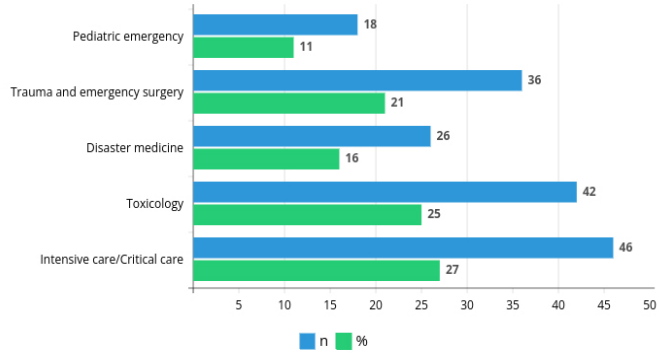

Figure 3. Responses to the question "Which subspecialties should be defined for Emergency Medicine?"*

*Multiple responses are possible for this question

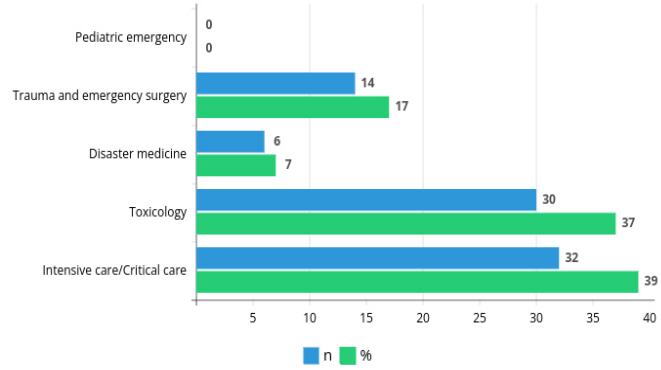

Figure 4. Responses to the question "Which subspecialty training would you like to pursue after completing your emergency medicine training?" *

*Multiple responses are possible for this question

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Table 1. Responses to single-choice questions in the survey (n=52)			
Question	**Response options**	**n**	**%**
Do you have experience in intensive care?	Yes	26	50
	No	26	50
Should a subspecialty be defined for the emergency medicine specialty?	Yes	52	100
	No	0	0
Would you like to pursue a subspecialty training after emergency medicine residency?	Yes	42	81
	No	2	4
	I'm undecided	8	15
How do you evaluate the recommendation for the entry right to Intensive Care Medicine Subspecialty training for Emergency Medicine?	Positive	52	100
	Negative	0	0
	I'm undecided	0	0
Is emergency Medicine related to Intensive Care?	Yes	52	100
	No	0	0
	I'm undecided	0	0
Is the Intensive Care Fellowship suitable for the emergency medicine specialty?	Yes	52	100
	No	0	0
	I'm undecided	0	0
Do you think entry to the Subspecialty Board Exam should be granted for the Emergency Medicine specialty?	Yes	52	100
	No	0	0
	I'm undecided	0	0
How do you evaluate the efforts of the Emergency Medicine Specialty Associations regarding the Intensive Care Subspecialty?	Positive	48	92
	Negative	2	4
	I'm undecided	2	4
How do you evaluate the statements of other specialty associations opposing Emergency Medicine Physicians' access to the Intensive Care Subspecialty Board Exam?	Agree	2	4
	Disagree	50	96
	I'm undecided	0	0
Would you consider applying for the Intensive Care Subspecialty Board Exam if given the opportunity?	Yes	36	69
	No	6	12
	I'm undecided	10	19
Would you consider preparing for the Intensive Care Subspecialty Board Exam?	Yes	34	65
	No	8	15
	I'm undecided	10	20
What is your view on long-term patient care?	I want	22	42
	I do not want	10	19
	I'm undecided	20	39
What is your opinion on the requirement for a third compulsory service?	I can do it	8	15
	I can not do it	30	58
	I'm undecided	14	27
What is your opinion on working outside of shifts?	I can do it	20	39
	I can not do it	12	22
	I'm undecided	20	39
What is your opinion on working on-call?	I can do it	32	62
	I can not do it	12	23
	I'm undecided	8	15

When evaluating their willingness to study for the intensive care subspecialty exam, 65% of the participants answered "Yes," while 20% remained undecided.

It is essential that patient care in emergency departments does not exceed 8 hours. However, in many cases, especially due to bed shortages, the length of stay in the emergency department often exceeds 24 hours. This situation is referred to as long-term care. In response to the question "What is your view on long-term patient care?" 42% of the physicians answered "I would like to", while 39% remained undecided. Regarding the question "What is your opinion on a third mandatory service?" 58% of the physicians answered "I cannot do it", while 27% remained undecided. For the question "What is your view on the working schedule outside of shifts?" responses were 39% yes, 38% undecided, and 23% no. Regarding the question "What is your view on the call duty system?" 62% answered "Yes", and 15% were undecided.

A multiple-choice question was posed to the participants regarding the reasons for their desire to pursue specialization training, yielding a total of 66 responses. The most common response, at 46%, was "To pursue an academic career," followed by 24% selecting "To escape the emergency department environment," and 12% choosing "To change specialties" (Figure 5). Another multiple-choice question was asked to assess the positive aspects of specialization training, obtaining a total of 78 responses. The most frequent response, at 51%, was "To specialize in a specific field," followed by 23% each for "To acquire new knowledge" and "To gain new skills" (Figure 6). Furthermore, a multiple-choice question was posed to examine the negative aspects of specialization training, and 86 responses were received. The most common response, at 51%, was "To potentially undergo mandatory service again," followed by 23% each for "To undergo three years of training" and "To potentially experience a decrease in monthly income". The concept of a third compulsory service refers to the mandatory assignment by the Ministry following subspecialty training that physicians in Türkiye are required to undertake after completing their general practitioner and specialty training (Figure 7).

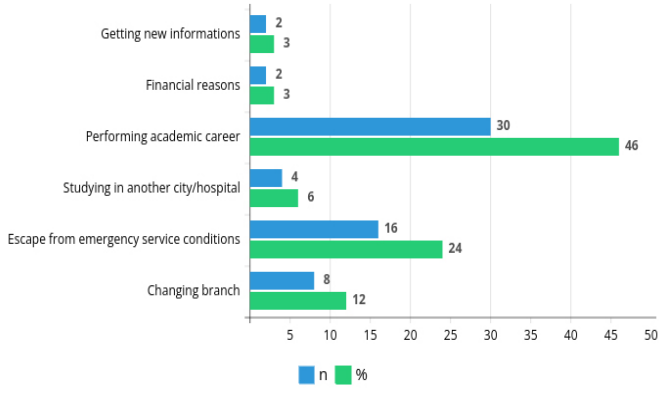

Figure 5. Responses to the question "What could be the reason(s) for wanting to pursue subspecialty training?"*

*Multiple responses are possible for this question

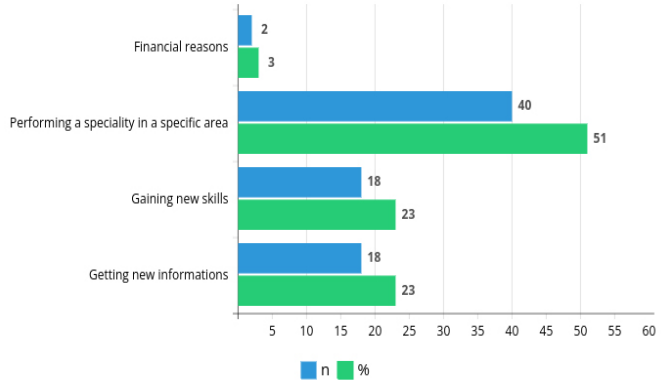

Figure 6. Responses to the question "What could be the positive aspects of subspecialty training?"*

*Multiple responses are possible for this question

Discussion

Academic emergency medicine education in Türkiye began in 1993 and has since evolved to the point where emergency medicine specialization training is now offered in almost every university and training hospital across Türkiye. With approximately 1200 specialists and 4000 residents involved in educational activities, emergency medicine education continues to rapidly progress with the development of specialty competency boards (9).

Emergency medicine specialization training is a rigorous four-year program. In addition to theoretically understanding all major emergency topics in medical education, emergency medicine physicians undergo numerous procedural interventions during their residency training, allowing them

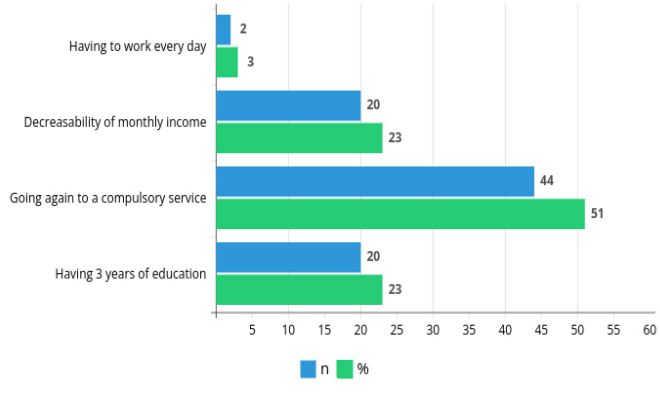

Figure 7. Responses to the question "What could be the negative aspects of subspecialty training?"*

*Multiple responses are possible for this question

to learn and master these procedures firsthand. Furthermore, emergency medicine specialization training includes rotations in various major branches, providing resident physicians with the opportunity to gain experience in these fields. Throughout their residency training and professional careers, emergency medicine physicians follow many critically ill patients and participate in their diagnosis, treatment, and even discharge processes. Due to the high occupancy rates of services and intensive care beds in our country, many critically ill patients experience extubation after being intubated in emergency departments once their treatment is complete. This situation can be considered an expression of the fact that emergency medicine physicians, contrary to common belief or expectation, are also involved in long-term patient follow-up.

It was found that half of the physicians participating in our study had intensive care experience. Intensive care experience refers to the care services provided by emergency physicians to patients who require intensive care admission but are monitored in the emergency department due to bed unavailability during their daily practice. The concept of intensive care is closely related to emergency medicine in daily practice. Critically ill patients diagnosed and treated in the emergency department are admitted to intensive care beds if available. For many emergency physicians, the first question they ask at the beginning of their shift is often about the occupancy rates of intensive care beds in the hospital. With the concept of intensive care being so intertwined with emergency medicine practice, Intensive Care Specialty, which is one of the subspecialties entered through the Specialty Qualification Examination, has naturally attracted the attention of the emergency medicine community for a long time in our country. All participants agreed that subspecialty training should be defined for emergency medicine. A significant number of emergency medicine physicians are willing to pursue subspecialty training after completing their emergency medicine education.

The discussions regarding subspecialty training for emergency medicine are not new, and this effort has a history of at least 20 years. Throughout this process, repeated requests have been made to relevant authorities for emergency medicine specialists to grant them the right to apply for intensive care subspecialty training. As a result of this process, on December 8, 2023, the Specialty Board of Medicine issued a recommendation to grant emergency medicine specialists the right to take the intensive care subspecialty board examination. This recommendation has been positively received by the emergency medicine community. Both of the emergency medicine specialty associations in our country have announced this as a positive development. Additionally, the Türkiye Emergency Medicine Foundation expressed similar sentiments. However, on the other side of the scale, in the field of Anesthesiology, Reanimation, and intensive care, this development has been met with negativity and even significant backlash; the specialty associations in these fields have made statements opposing this development.

In the literature, the characteristics of an intensive care unit (ICU) responsible physician are as follows: "Being able to diagnose, monitor, and treat patients at risk; managing hemodynamic instability, heart failure, arrhythmias, respiratory failure, acute neurological events, acute and chronic renal failure, acute endocrine and metabolic disorders, drug reactions, coagulation disorders, severe infections, nutrition, liver failure, acid-base and fluid-electrolyte balance." Additionally, the ICU-response physician should be knowledgeable about poisonings and able to make necessary interventions. These conditions are part of the routine daily practice of emergency medicine physicians. Similarly, in the same literature, the interventions that an ICU responsible physician should know are listed as follows: "Airway management and care, placement of intravascular catheters and hemodynamic monitoring, temporary pacemaker, cardiopulmonary resuscitation, chest tube insertion, bronchoscopy, percutaneous tracheostomy, renal replacement therapy." Almost all interventions are already performed by emergency medicine residents and specialists in emergency departments in today's practice (9).

In one study, the knowledge of physicians regarding cardiopulmonary resuscitation was evaluated according to their specialties. In this survey, the mean number of correct answers was determined to be 7.71±1.93, with only emergency medicine and cardiology specialties exceeding the threshold of 10 correct answers. In another study, emergency physicians used echocardiography more than anesthesiologists and intensivist (10,11).

According to the survey results, the most preferred subspecialty branch desired by emergency medicine physicians was intensive care/critical care. In addition, intensive care/critical care was the most frequently chosen subspecialty department by emergency medicine physicians. All participants agreed that the intensive care subspecialty is suitable for emergency medicine, deemed the recommendation decision correct, and expressed a desire for access to the intensive care subspecialty. While 92% of physicians found the efforts of emergency medicine specialty associations regarding the intensive care subspecialty to be positive, 96% considered the opposing statements of other specialty associations to be unjustified. These findings underscore the justified rationale behind the efforts made by emergency medicine associations to date and highlight the appropriateness of achievement in the intensive care subspecialty.

In recent years, healthcare policies have been claimed to have led to defensive medicine practices, which also affect physicians' specialization preferences. Emergency medicine is considered a high-risk field. According to the "Regulation on Principles and Procedures Regarding Institution Contribution to Compulsory Financial Liability Insurance for Medical Malpractice" published in the Official Gazette dated July 21, 2010, No. 27648, when examining the risk groups of medical specialties, the emergency medicine specialty is placed in the 4th, i.e., the highest-risk group. Although specialties in the 4th risk group obtained placement with scores significantly below the general average in the Turkish Medical Specialty Examination in 2007, this gap widened even further compared with other specialties in 2015 (12).

When examining the years of experience in the emergency medicine specialty among the physicians who answered our survey questions, it was observed that approximately one-third of the physicians had been working for more than 10 years, while another one-third had been working for 1-2 years. This indicates that the experiences of physicians in the emergency medicine specialty are heterogeneously distributed. Therefore, the opinions regarding the Intensive Care Medicine Subspecialty belong to both physicians who are new to emergency medicine and those who have been in this field for more than 10 years.

Emergency physicians' desire to pursue a subspecialty may reflect an attempt to escape the chaotic environment of the emergency department. Emergency departments are among the healthcare settings where incidents of "violence in healthcare" have been increasingly prevalent in recent years. Additionally, the chaotic environment of the emergency department can lead to feelings of burnout and contribute to depression among staff. In one study, depression scales were compared between emergency medicine residents and physicians in other internal medicine specialties, revealing higher scores indicating "mild mood disorder" and "borderline clinical depression" among emergency department physicians. Another study examined burnout and job satisfaction among emergency department staff and found that physicians exhibited higher levels of emotional exhaustion and depersonalization than other emergency department workers (13,14). The fact that 24% of respondents in our study cited "escaping the emergency department environment" as a reason for wanting to pursue subspecialty training supports this notion. However, the most common response to this question, cited by 46% of the participants, was "pursuing an academic career," indicating that the primary motivation behind emergency physicians' desire for subspecialty training lies in academic aspirations.

Study Limitations

This study was conducted at a single emergency medicine clinic; therefore, caution should be exercised when generalizing the results. Replicating the study in a broader sample of emergency medicine physicians may enhance the generalizability of the findings.

Conclusion

In conclusion, the field of emergency medicine is inherently intertwined with the concepts of intensive care and critical care. Emergency physicians routinely provide care to critically ill patients and perform all necessary interventions. There is broad consensus among emergency physicians, particularly those specializing in intensive care. Granting access to intensive care subspecialty training for emergency medicine specialists will likely result in many emergency medicine experts occupying positions within these subspecialty fields, despite the potential drawbacks.

Ethics

Ethics Committee Approval: Ethical approval was obtained from the KTO-Karatay University Clinical and Non-Clinical Research Ethics (decision number: E-41901325-200-79454, date: 16.02.2024) and necessary permissions were also obtained from the Hospital Education Planning Committee.

Informed Consent: During the data collection phase, the purpose of the research was explained to the physicians, verbal consent was obtained, and those who agreed clicked on the relevant link to answer the survey.

Footnotes

Authorship Contributions

Concept: Y.Y., Design: Y.Y., M.K.Y., Data Collection or Processing: Y.Y., M.K.Y., Analysis or Interpretation: Y.Y., M.K.Y., Literature Search: Y.Y., Writing: Y.Y., M.K.Y.

Conflict of Interest: The authors declare that they have no conflict of interest.

Financial Disclosure: There are no financial conflicts of interest to disclose.

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The Predictive Impact of The PECARN Score in Pediatric Patients with Minor Head Trauma

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Abstract

Aim: Head trauma is a leading cause of emergency department visits in children, with an annual incidence of 1.850 per 100.000. Computed tomography (CT) scans are the standard for diagnosing head trauma but involve risks like sedation, radiation exposure, and high costs. This raises the question of CT necessity for children with a Glasgow Coma Scale (GCS) score of 14 or above. The Pediatric Emergency Care Applied Research Network (PECARN) rules, introduced in 2009, aim to identify low-risk patients to reduce unnecessary CT scans and associated risks.

Materials and Methods: This retrospective observational study reviewed patients under 18 with minor head trauma from January 1 to December 31, 2022. Inclusion criteria were a GCS score of 14 or higher and presentation within 24 hours of injury. Patients were evaluated using PECARN criteria and divided into two groups: Group A (age >2 years) and Group B (age ≤2 years). These groups were further categorized into low, medium, and high-risk levels. Clinically important traumatic brain injury was defined by criteria including death, surgery requirement, intubation, or hospitalization for two or more days. Data collected included patient age, gender, symptoms, and CT scan results. Statistical analyses were conducted using SPSS software.

Results: The study found that 95.8% of low-risk patients under 2 years and all low-risk patients over 2 years had normal CT scans, supporting the PECARN criteria's effectiveness in identifying patients unlikely to benefit from CT imaging.

Conclusion: Implementing PECARN guidelines can enhance patient safety, reduce radiation exposure, and optimize resource use in emergency settings.

Keywords: Trauma, score, pediatric

Introduction

Head trauma is one of the most common reasons for children to visit the emergency department, with an estimated annual incidence of 1850 per 100.000 (1). Approximately 90% of these cases are minor head trauma. Minor head trauma can be defined as caused by an external force in which the patient shows few or no symptoms. The question of whether there is a serious traumatic brain injury (TBI) resulting from minor head trauma is of great importance (1,2). Computed tomography (CT) scanning is the gold standard for the evaluation and management of patients with head trauma (3). However, CT scans involve certain clinical challenges such as risks associated with sedation, exposure to carcinogenic ionizing radiation, and cost. It is estimated that brain tomography results in a fatal malignancy in 1 in 1000 to 1 in 5000 cases, with the risk increasing as the child gets (4). Therefore, weighing the potential benefits of tomography when a child experiences head trauma is crucial. Guidelines agree that CT is recommended for children with moderate or severe head trauma or a Glasgow Coma Scale (GCS) score of ≤13. The question arises about the necessity of CT imaging for children with a GCS of 14 and above.

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The Pediatric Emergency Care Applied Research Network (PECARN) published an age-based rule in 2009. These rules aim to identify low-risk patients, thereby reducing unnecessary CT scans and associated radiation exposure. It was developed for patients under 18 years old with a GCS score of 14-15 who presented within 24 hours of head trauma. Six criteria exist for children under 2 years old: (altered mental status, palpable skull fracture, loss of consciousness ≥5 seconds, scalp hematoma excluding frontal area, severe mechanism of injury, and abnormal behavior according to parents). For children over 2 years old, there are six criteria (altered mental status, vomiting, amnesia, severe mechanism of injury, clinical signs of basilar skull fracture, and severe headache) (5).

We aim to investigate compliance with PECARN rules in CT scanning decisions for pediatric patients with minor head trauma who present to the emergency department.

Materials and Methods

Study Design and Patients

Patients under the age of 18 who presented to the emergency department with minor head trauma between January 1, 2022, and December 31, 2022, were included. The study was conducted retrospectively and observationally, adhering to the principles of the Declaration of Helsinki. Since it is a retrospective study, Ethical Committee Approval from Bezmialem Foundation University Rectorate Technology Transfer Office was obtained, but patient consent was not obtained (decision number: 2022/113, date: 26.04.2022). Patients with a GCS score of 14 or above who presented within the first 24 hours after head trauma were included. Only falls and falls from heights were included in the study. There was no specific internal protocol applied during the study period. Clinicians independently utilized various guidelines reported in the literature. Patients with a GCS score of 13 or below, those with severe head trauma, those presenting to the emergency department more than 24 hours after trauma, and those who had neuroimaging at another hospital were excluded from the study. Additionally, patients who did not wait for the evaluation or refused clinical observation, those over 18 years of age, and those with incomplete data were also excluded. The patient flow chart is shown in Figure 1.

Clinical Protocol

We applied PECARN criteria to patients under two years old and over two years old included in the study. Patients were divided into two groups: Group A (age >2 years) and Group B (age ≤2 years). In our study, we applied the PECARN criteria separately to patients younger than two years old and those older than two years old, as these age groups have distinct evaluation protocols under the PECARN guidelines. All patients in the groups under and over two years old were further subdivided into three groups: low, medium, and high risk. We defined clinically important traumatic brain injury (ciTBI) by the presence of any of the following criteria (5): death following TBI, requiring brain surgery, intubation, or hospitalization for two days or more. We defined a lesion found on CT scan but not fitting the definition of "ciTBI" as an "abnormal CT finding."

Data Collection

The records of the patients included in the study were reviewed using the hospital automation system, including age, gender, loss of consciousness, headache, vomiting, abnormal behavior according to parents, amnesia, seizure, concern for non-accidental trauma, mechanism of trauma, abnormal mental status, signs of skull fracture, GCS, neurological deficit, follow-up, and CT scan results. Data were collected by emergency medicine physicians through a form specifically developed for the study.

Statistical Analysis

The quantitative variables were described using measures of central tendency and variance: mean ± SD. Fisher's exact test and chi-squared test were used to determine differences in proportions or relationships between categorical variables. To demonstrate behavioral differences in group means, the Kruskal-Wallis H-test was used when assumptions of normality and homoscedasticity were not met. The Bonferroni post hoc correction method was used for multiple comparisons between groups. Statistical significance for all cases was set at p=0.05. Statistical analyses were performed using IBM SPSS (Statistical Package for the Social Sciences for Windows, Version 21.0, Armonk, NY, IBM Corp.).

Results

Out of a total of 243 patients included in the study, 136 (56%) were classified as PECARN low risk, 78 (32.1%) as medium risk,

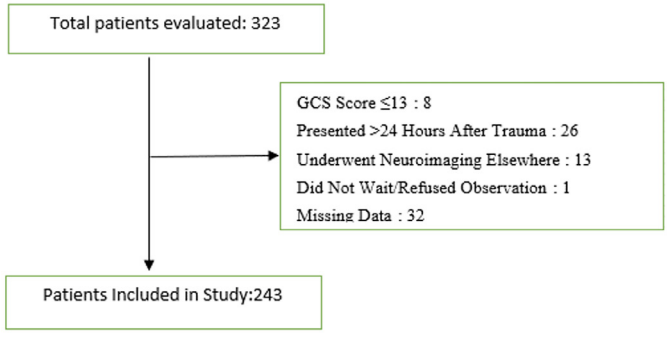

Figure 1. The patient flow chart
GCS: Glasgow coma scale

and 29 (11.9%) as high risk. The gender and age averages for Group A (>2 years) and Group B (≤2 years) are shown in Tables 1, 2. In Group A, all low-risk patients had normal CT scans. Among the medium-risk patients, 98.2% had normal CT scans, and among the high-risk patients, 60% had normal CT scans ($p<0.05$). In Group B, 95.8% (23 patients) of low-risk patients, 95.2% (20 patients) of medium-risk patients, and 66.7% (6 patients) of high-risk patients had normal CT scans (33.3% of high-risk patients had CT abnormalities) ($p<0.05$).

In Group A, 59.8% (67 patients) of the low-risk patients experienced simple falls, and 20.5% (23 patients) fell from a height greater than 1.5 meters. In Group B, 83.3% (20 patients) of the low-risk patients experienced simple falls. Among the medium-risk patients, 57.1% (12 patients) experienced simple falls, and 19% (4 patients) fell from a height greater than 90 cm. Among the high-risk patients, 66.7% (6 patients) fell from a height, and 22% (2 patients) rolled down stairs (at least 5 steps) (Tables 1, 2). The mechanisms of trauma for both groups are detailed in Tables 1,2.

Table 1. Group A

PECARN		Low	Medium	High	p	p^1	p^2	p^3
Age (year)		6.23±3.96	6.02±3.95	6.62±4.90	0.793(k)	1	1	1
CT result	Normal	112 (100.0%)	56 (98.2%)	12 (60.0%)	<0.001**	1	<0.001	<0.001
	Abnormal	0 (0.0%)	1 (1.8%)	8 (40.0%)				
Gender	Male	91 (81.2%)	16 (28.1%)	3 (15.0%)	<0.001*	<0.001	<0.001	1
	Female	21 (18.8%)	41 (71.9%)†	17 (85.0%)				
Mechanism of trauma	Simple falls	67 (59.8%)	25 (43.9%)	2 (10.0%)	<0.001**	0.012	<0.001	0.051
	Traffic accident	11 (9.8%)	2 (3.5%)	1 (5.0%)				
	Falling from high	23 (20.5%)	22 (38.6%)	12 (60.0%)				
	Falling off the stairs	1 (0.9%)	5 (8.8%)	5 (25.0%)				
	Head impact	10 (8.9%)	3 (5.3%)	0 (0.0%)				
Scalp hematoma	Nope	78 (69.6%)	12 (21.1%)	2 (10.0%)	<0.001**	<0.001	<0.001	0.018
	Frontal	19 (17.0%)	14 (24.6%)	3 (15.0%)				
	Temporal	0 (0.0%)	5 (8.8%)	10 (50.0%)				
	Parietal	9 (8.0%)	13 (22.8%)	3 (15.0%)				
	Occipital	6 (5.4%)	13 (22.8%)	2 (10.0%)				
Palpable fracture	Nope	112 (100.0%)	57 (100.0%)	16 (80.0%)	<0.001**	1	0.001	0.011
	Yes	0 (0.0%)	0 (0.0%)	4 (20.0%)				
Amnesia	Nope	109 (97.3%)	50 (87.7%)	18 (90.0%)	0.056**	0.096	0.495	1
	Yes	3 (2.7%)	7 (12.3%)	2 (10.0%)				
Loss of consciousness	Nope	112 (100.0%)	54 (94.7%)	13 (65.0%)	<0.001**	0,111	<0.001	0.007
	Yes	0 (0.0%)	3 (5.3%)	7 (35.0%)				
Abnormal behavior	Nope	112 (100.0%)	48 (84.2%)	20 (100.0%)	<0.001**	<0.001	1	0.306
	Yes	0 (0.0%)	9 (15.8%)	0 (0.0%)				
Vomiting	Nope	94 (83.9%)	15 (26.3%)	4 (20.0%)	<0.001*	<0.001	<0.001	1
	Yes	18 (16.1%)	42 (73.7%)	16 (80.0%)				
Seizure	Nope	112 (100.0%)	51 (89.5%)	14 (70.0%)	<0.001**	0.004	<0.001	0.203
	Yes	0 (0.0%)	6 (10.5%)	6 (30.0%)				
Headache	Nope	97 (86.6%)	22 (38.6%)	10 (50.0%)	<0.001*	<0.001	0.001	1
	Yes	15 (13.4%)	35 (61.4%)	10 (50.0%)				
Skin laceration	Nope	76 (67.9%)	52 (91.2%)	19 (95.0%)	<0.001**	0.002	0.040	1
	Yes	36 (32.1%)	5 (8.8%)	1 (5.0%)				
Treatment	Discharge	2 (1.8%)	8 (14.0%)	3 (15.0%)	0.007**	0.012	0.098	1
	Observation	103 (92.0%)	48 (84.2%)	17 (85.0%)				
	Leave without permission	7 (6.2%)	1 (1.8%)	0 (0.0%)				
Severe brain injury	Nope	112 (100%)	57 (100%)	20 (100%)	1*	1	1	1

Stats: n (%), *Pearson chi-squared test, **Fisher's exact test, Mean ± SD/Median (min-max), (k) Kruskal-Wallis H-test, p^1: Low vs. medium, p^2: Low vs. high, p^3: Medium vs. high, CT: Computed tomography, PECARN: Pediatric emergency care applied research network

Table 2. Group B								
PECARN		**Low**	**Medium**	**High**	**p**	**p[1]**	**p[2]**	**p[3]**
Age (year)		10.58±5.7	9.1±5.73	10.56±5.	0.647(k)	1	1	1
CT result	Normal	23 (95.8%)	20 (95.2%)	6 (66.7%)	0.051**	1	0.157	0.207
	Abnormal	1 (4.2%)	1 (4.8%)	3 (33.3%)				
Gender	Male	13 (54.2%)	11 (52.4%)	6 (66.7%)	0.872**	1	1	1
	Female	11 (45.8%)	10 (47.6%)	3 (33.3%)				
Mechanism of trauma	Simple falls	20 (83.3%)	12 (57.1%)	0 (0.0%)	**<0.001****	0.909	**<0.001**	**0.009**
	Traffic accident	0 (0.0%)	0 (0.0%)	1 (11.1%)				
	Falling from high	2 (8.3%)	4 (19.0%)	6 (66.7%)				
	Falling off the stairs	1 (4.2%)	3 (14.3%)	2 (22.2%)				
	Head impact	1 (4.2%)	2 (9.5%)	0 (0.0%)				
Scalp hematoma	Nope	19 (79.2%)	6 (28.6%)	2 (22.2%)	**<0.001****	**0.011**	**0.003**	0.065
	Frontal	3 (12.5%)	9 (42.9%)	0 (0.0%)				
	Temporal	0 (0.0%)	2 (9.5%)	1 (11.1%)				
	Parietal	1 (4.2%)	3 (14.3%)	2 (22.2%)				
	Occipital	1 (4.2%)	1 (4.8%)	4 (44.4%)				
Palpable fracture	Nope	24 (100.0%)	20 (95.2%)	8 (88.9%)	0.159**	1	0.819	1.000
	Yes	0 (0.0%)	1 (4.8%)	1 (11.1%)				
Loss of consciousness	Nope	24 (100.0%)	19 (90.5%)	3 (33.3%)	**<0.001****	0.636	**<0.001**	**0.009**
	Yes	0 (0.0%)	2 (9.5%)	6 (66.7%)				
Abnormal behavior	Nope	19 (79.2%)	17 (81.0%)	3 (33.3%)	**0.023****	1	**0.033**	**0.030**
	Yes	5 (20.8%)	4 (19.0%)	6 (66.7%)				
Vomiting	Nope	20 (83.3%)	7 (33.3%)	0 (0.0%)	**<0.00****	0.003	**<0.001**	0.213
	Yes	4 (16.7%)	14 (66.7%)	9 (100.0%)				
Seizure	Nope	24 (100.0%)	20 (95.2%)	4 (44.4%)	**<0.001****	1	**0.002**	0.014
	Yes	0 (0.0%)	1 (4.8%)	5 (55.6%)				
Headache	Nope	24 (100%)	21 (100%)	9 (100%)	1	1	1	1
	Yes	23 (95.8%)	16 (76.2%)	8 (88.9%)	0.127**	0.249	1	1
Skin laceration	Nope	1 (4.2%)	5 (23.8%)	1 (11.1%)				
	Yes	3 (12.5%)	3 (14.3%)	0 (0.0%)	0.051**	1	0.136	0.267
Treatment	Discharge	19 (79.2%)	17 (81.0%)	6 (66.7%)				
	Observation	0 (0.0%)	1 (4.8%)	3 (33.3%)				
	Leave without permission	2 (8.3%)	0 (0.0%)	0 (0.0%)				
Severe brain injury	Nope	24 (100.0%)	20 (95.2%)	7 (77.8%)	1	1	1	1

Stats: n (%), *Pearson chi-squared test, ** Fisher exact test, Stats: Mean ± SD/Median (Min-Max), (k) Kruskal-Wallis H-test, p[1]: Low vs. medium, p[2]: Low vs. high, p[3]: Medium vs. high, CT: Computed tomography, PECARN: Pediatric emergency care applied research network

Discussion

Minor head traumas constitute a significant portion of childhood injuries. Over 80% of patients presenting to the emergency department with head trauma have minor head injuries (6). Studies indicate that male children are more frequently subjected to head trauma, with incidences reported to be four times higher in males than females (7). In our study, 85% of high-risk patients over 2 years old were male, while this proportion was 66.7% in those under 2 years old. It is essential to recognize the higher risk of head trauma in male children and implement preventive health measures targeting this group (8,9). High-risk head trauma in both age groups primarily resulted from falls from heights, consistent with findings from similar studies.

The clinical decision-making process for children with minor head trauma is challenging. Although CT is the gold standard for diagnosing TBI, its use in minor head trauma remains controversial due to associated risks (10). PECARN criteria provide a safe evaluation method for pediatric patients without the need

for CT. In our study, only 11.9% of patients undergoing CT were classified as high-risk by PECARN criteria, while 88.1% were low to moderate risk, yet still underwent CT. Previous research has shown that a high percentage (94.8%) of CT scans performed for minor head trauma are normal (11,12). Osmond et al. (13) found pathology in only 4.9% of CT scans for minor head trauma in children. In our study, 95.8% of patients under 2-year-old classified as low-risk by PECARN had normal CT results. All CT scans were normal for low-risk patients over 2 years old. For high-risk patients, CT showed TBI in 33% and 40% of those under and over 2 years old, respectively (14). Non-frontal scalp hematomas are considered a risk factor for TBI (15). Burns et al. (15) associated the highest rates of TBI with temporal/parietal and occipital scalp hematomas. In our study, the presence of a scalp hematoma was indicative of high-risk status. When scalp hematomas were absent, PECARN criteria classified 69.6% and 79.2% of patients in the low-risk group for younger than 2 years old and older, respectively. Among high-risk patients, 50% over the age of 2 had temporal scalp hematomas, while 44% under the age of 2, had occipital hematomas as the most common finding. The incidence of skull fractures following head trauma in children ranges from 2% to 20%, with a higher prevalence in those under 2 years old. Bressan et al. (17) reported a 13.3% incidence of skull fractures on CT in the high-risk group. Similarly, in our study, all patients over 2 years old with palpable fractures were high-risk, while this was true for only 50% of those under 2 years old. Despite nearly half of the infants under 2 years old with palpable fractures not being classified as high-risk, the presence of a palpable fracture suggests a potential for significant injury (18). Infants with intracranial injuries can often be asymptomatic. In our study, the presence or absence of amnesia did not show a statistically significant difference in risk classification in the over-2-year-old group. Amnesia may not be adequately assessed in acute settings, highlighting the importance of thorough evaluation in emergency management. Seizures are a recognized complication of TBI and often indicate more severe injuries. Approximately 5-7% of hospitalized TBI patients experience at least one Seizure (19). Post-traumatic seizures occur in about 18% of children aged 2 years and under (20). In our study, the presence of seizures correlated with higher PECARN risk levels, suggesting the necessity of CT in such cases. Even if CT results are normal, this information is valuable for safely discharging patients from the emergency department. Vomiting is a common side effect of head trauma, with a general incidence of 7% in adults and 15% in children Dayan et al. (21) reported TBI in only two out of 815 patients with isolated post-traumatic vomiting (22,23). In our study, all patients under 2 years old with vomiting were classified as high-risk. Applying PECARN rules in children presenting to the emergency department with head trauma can reduce the rate of CT scans. Many studies have demonstrated that PECARN rules have high sensitivity and specificity for identifying serious brain injuries (24). These guidelines provide a systematic and reliable approach for evaluating pediatric head trauma, enhancing patient safety, and optimizing resource use in emergency settings.

Study Limitations

The retrospective nature and the small number of patients are the limitations of the study

Conclusion

PECARN criteria provide a reliable framework for the evaluation and management of pediatric head trauma in emergency settings. Implementing these guidelines can enhance patient safety, optimize the use of medical resources, and reduce unnecessary radiation exposure. Future studies should continue to refine these criteria and explore additional factors that may influence risk stratification and clinical decision-making.

Ethics

Ethics Committee Approval: Since it is a retrospective study, Ethical Committee Approval from Bezmialem Foundation University Rectorate Technology Transfer Office was obtained, but patient consent was not obtained (decision number: 2022/113, date: 26.04.2022).

Informed consent: Retrospective study.

Footnotes

Authorship Contributions

Concept: A.D.D., Design: A.D.D., A.N.D., B.T., Data Collection or Processing: A.D.D., U.E., Analysis or Interpretation: A.D.D., U.E., B.T., Literature Search: A.D.D., A.N.D., U.E., Writing: A.D.D.

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Evaluation of Demographic Characteristics and Quality Indicators of Patients Aged 65 and Above Who Present to The Emergency Department Due to Non-Traumatıc Reasons

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Abstract

Aim: Elderly patients have higher morbidity and mortality rates, and emergency department (ED) management of them is difficult. We aimed to evaluate the demographic characteristics of patients aged 65 and above who present to the ED for non-traumatic reasons and to assess parameters that may be significant in determining the quality of care for them.

Materials and Methods: Patients over 65 who presented to the ED of a tertiary care hospital for non-traumatic reasons between September and November 1, 2021, were prospectively included. The patients' age, gender, transfer method, social life status, Identification of Seniors at Risk (ISAR) score, tests requested, blood product requested, use of urinary catheters, restriction need, abuse/neglect status, the diagnosis, consultations requested and durations, outcomes, length of stay, and those who re-applied in 72 hours were recorded.

Results: Two thousand five hundred twenty-nine patients were included. The mean age was 74.4±7.5, and 47.8% were female. The median ISAR score was 2. The most common diagnosis was infection. 70.4% of the patients were discharged, 20.4% were admitted to a ward, and 9% were admitted to the intensive care unit. The median length of stay was 220 minutes, and the median time for consultation was 119 minutes. In multivariate analysis, consultation request and type of admission were statistically significant independent variables in predicting hospitalization. Additionally, patients who needed blood products, had restrictions, and had high ISAR scores had significantly higher hospitalization rates.

Conclusion: In conclusion, planning EDs by evaluating the characteristics of the geriatric population will increase the quality of patient care.

Keywords: Emergency department, geriatric patient, elderly patient, quality indicators, seniors health

Introduction

According to the World Health Organization, old age is defined chronologically as beginning at the age of 65 (1). According to the data from the Turkish Statistical Institute (TUIK), the proportion of the elderly population within the total population was 8.2% in 2015, and it increased to 9.5% in 2020. It is projected that the proportion of the elderly population within the total population will be 11% in 2025, 12.9% in 2030, 16.3% in 2040, 22.6% in 2060, and 25.6% in 2080 (2). With this increase, it is expected that the demand for the emergency department (ED) among the elderly will rise (3).

One out of every three patients admitted to the ED is over 65 years of age (4). ED care refers to the process of deciding on the admission or discharge of an elderly patient from the hospital and defines the care and costs associated with this process (5). The admission and mortality rates, as well as the costs of ED visits, are higher for the elderly population compared to young adults (6). The mortality rate of patients aged 60 and above admitted from the ED is 21% (7). Research has shown that the increasing number

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of ED visits contributes to a decline in patient care quality, delays in the initiation of treatment, longer hospital stays, less adherence to accepted clinical guidelines, and an increase in overall costs (8).

The increase in the elderly population and the higher rate of healthcare visits compared to other age groups, along with their tendency to present with multiple chronic conditions and the risk of inappropriate medication and polypharmacy as well as their complex social and physical challenges, pose challenges for healthcare systems. Elderly patients have unique disease presentations, needs, tendencies, and outcomes (8).

The development of geriatric emergency medicine, which started in the 1990s, continued to progress with a series of studies. Geriatric EDs were first established in the United States in 2008, and their numbers have gradually increased (9).

In geriatric patient care, appropriate triage assessment, trained healthcare personnel, equipment designed for specific needs, special planning, and procedures/protocols applied to these patients are essential. This approach will allow for more durable assessments, diagnoses, and treatments tailored to the individual patient, ensuring that they benefit from healthcare services effectively and appropriately, and preventing unnecessary healthcare expenditures (9). For example, the Identification of Seniors at Risk (ISAR) is a screening tool developed to identify elderly individuals at high risk for adverse health outcomes in the ED, including death, hospitalization, or a decline in functional status. It includes six self-report questions about functional dependency (pre-illness acute changes), recent hospitalization, impaired memory and vision, and polypharmacy. Scores of 2 or higher are associated with hospitalization and mortality (10-12).

Although criteria are being developed globally to improve the quality of care, there are no defined quality indicators for elderly patients in our country. As a result, patient profiles vary between countries, and we believe that defining our elderly population and identifying their needs will enhance the quality of care.

It has been shown that high-quality care is associated with better survival and health outcomes for elderly patients (13). Therefore, the quality of care provided to elderly patients in the ED and the consideration of the special needs of elderly individuals are essential. The development of a comprehensive set of quality indicators will help improve the quality of geriatric patient care in the ED.

The aim of our study, is to evaluate the demographic characteristics of patients aged 65 and above who visit our hospital ED due to non-traumatic reasons, and to assess parameters that may be significant in determining the quality of care for these patients.

Materials and Methods

Study Design and Patient Selection

This study was conducted prospectively in the Emergency Medicine Department of our hospital from 01.09.2021 to 01.11.2021, after obtaining ethical approval from the Clinical Research Ethics Committee of Health Sciences University Antalya Training and Research Hospital (decision number: 13/10, approval date: 02.09.2021).

Patients aged 65 and above who presented to the Emergency Department of Health Sciences University Antalya Training and Research Hospital for non-traumatic reasons were prospectively enrolled in the study after obtaining verbal and written consent from them or their relatives. The study's exclusion criteria were determined as patients under 65 years of age, trauma-related admission, and those with inaccessible data.

The study protocol did not interfere with the patients' therapeutic and diagnostic procedures or cause any delay.

Data Collection

The study form recorded the following data concurrently: patient age, gender, method of transfer, social living status, waiting time for examination after registration (in minutes), ISAR score (described in Table 1) requested tests in the ED, whether blood products were requested, whether the patient was followed with a foley catheter, whether any restrictions were applied, abuse/neglect status, diagnoses made in the ED, requested consultations, consultation completion time, and ED outcome.

In order to identify elderly people at risk, the Original ISAR screening tool was published in Canada in 1999. This screening tool is a 6-item questionnaire that measures early (30 days) and late (180 days) mortality, transition to nursing home, and decline in functional life activities in patients over the age of 65 who apply to the ED (Table 1). According to the ISAR screening questionnaire, frailty can be predicted if two or more questions are answered "yes" (10-12).

The patients' diagnoses, in addition to the final diagnosis, were classified as follows; cardiovascular system, neurological system, respiratory system, gastrointestinal system, renal system, infectious diseases, genitourinary system, oncology, hematological system, metabolic diseases, and others. Patient cost data were recorded as the median amount, based on the patient invoices sent to the Social Security Institution and registered in the Hospital Information Management System (HIMS).

The length of hospital stay and the rate of readmission after seventy-two hours were obtained using the Ministry of Health's e-Nabız system, the Death Information System, and the HIMS.

Primary Outcome

The primary outcomes for patients included discharge from the ED, death in the ED, or admission to a ward or intensive care unit (ICU) from the ED.

Statistical Analysis

The study data were analyzed with SPSS (Statistical Package for the Social Sciences) 23.0 and MedCalc 23.110 programs. Numerical data were expressed as mean ± standard deviation and median, while frequency data were expressed as percentage. The Mann-Whitney U test was used to compare two independent groups for numerical data, and the Pearson chi-square and Fisher's exact tests were used for frequency data. Normality analysis was performed with the Kolmogorov-Smirnov test. Logistic regression analysis was used. All hypotheses were formulated as two-tailed tests, and the alpha critical value was accepted as 0.05.

Results

Sociodemographic Characteristics of The Patients

A total of 6597 geriatric patients presented to the ED during the study period. A total of 4068 patients were excluded from the study due to meeting exclusion criteria, missing data, and unavailability, leaving 2529 patients included in the study (Figure 1). The mean age of the patients was 74.4±7.5 years. 52.2% (n=1319) of the patients were male and 47.8% (n=1210) were female (Table 2).

Eighty-point-eight percent (n=2044) of the patients presented as outpatients. Of the patients included in the study, 89.4% (n=2260) lived with their family, 9.4% (n=237) lived alone, and 1.3% (n=32) resided in a nursing home (Table 2).

ISAR Score of The Patients

The median ISAR score of the patients was found to be 2 [interquartile range (IQR): 1-4]. The distribution of the items of the ISAR scores of the study patients is presented in Table 1. The most commonly requested tests in the patients included in the study were complete blood count (80.5%; n=2036) and biochemistry (80.4%; n=2033), followed by an electrocardiogram (59.9%; n=1514). The most frequently requested cultures were urine (5.4%; n=136) and blood (4.5%; n=113) cultures.

Examinations and Imaging Performed in The ED

The most frequently requested imaging methods were non-contrast (38.6%; n=977) and ultrasonography (20.7%; n=524). Blood product replacement was performed in 2.8% (n=72) of the patients.

The number of patients monitored with a Foley catheter in the ED among those aged 65 and above, who presented due to non-traumatic reasons, was 386 (15.3%), (including those who had a catheter inserted in the ED and those who arrived with a Foley catheter in place), urinary tract infection (UTI) associated with Foley catheter use was observed in 42 (1.7%) of the patients included in the study. Restrictions were applied to 1.3% (n=32) of the patients, with the most commonly used method being physical restraint (93.8%).

The Diagnosis

When examining the diagnoses received by patients aged 65 and above who presented to the ED due to non-traumatic reasons, the most common diagnoses were infections (26.5%; n=670), followed by cardiovascular system pathologies (20.13; n=514), gastrointestinal system pathologies (14.4%; n=365), neurological problems (7.1%; n=180), and respiratory system diseases (5.4%; n=137) (Table 3). Among infections, the most common was UTI (10.4%; n=262), followed by pneumonia (6%; n=153).

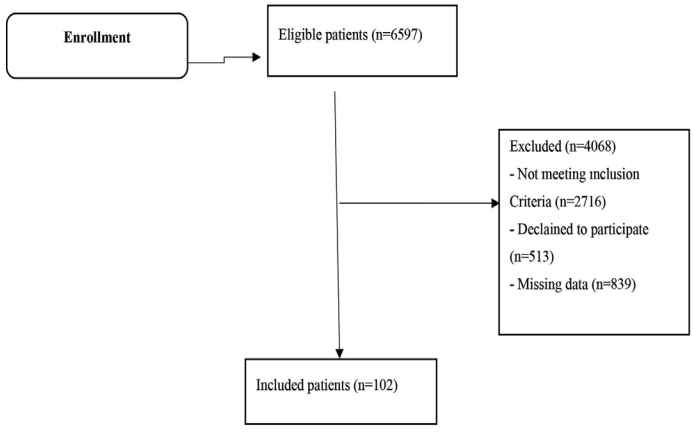

Figure 1: Patiens flow chart
n: Number of patients

Table 1. Identification of Seniors at Risk screening survey questions

Identification of Seniors at Risk screening tool	Yes	No
Did you need help from someone in your daily life before the illness or injury that brought you to the emergency room?	1	0
Have you needed more support in your own care since the illness or injury that brought you to the emergency room?	1	0
Have you been hospitalized for 1 or more nights in the last 6 months? (excluding emergency room stays)	1	0
Is your vision good in general?	0	1
Do you experience significant problems with your memory in general?	1	0
Do you take 3 or more medications per day?	1	0

Consultations

In the study, 51.6% (n=1304) were terminated without a consultation in the ED. Some of the patients were discharged from the ED without a consultation, while 48.2% (n=1225) a consultation was requested for them. The most frequently requested consultations were in the following departments: general internal medicine (14.6%; n=370), cardiology (14.6%; n=369), neurology (10.3%; n=260), and infectious diseases (9.9%; n=251). The total time spent on consultations in the ED was 119 minutes (IQR: 60-228) (Table 4).

Table 2. Sociodemographic data of the study patients

Variable	Mean ± SD
Age	74.4±7.5
	n (%)
Gender	
Male	1319 (52.2)
Female	1210 (47.8)
Transfer method	
By themselves	2044 (80.8)
With 112 ambulance service	484 (19.1)
Social life status	
Lives with his/her family	2260 (89.4)
Lives alone	237 (9.4)
Living in a nursing home	32 (1.3)
Abuse or neglect	5 (0.2)
ISAR score	
ISAR-1	853 (33.7)
ISAR-2	1330 (52.6)
ISAR-3	763 (30.2)
ISAR-4	668 (26.4)
ISAR-5	505 (20)
ISAR-6	1593 (63)
Total ISAR Score (Median-IQR)	2 (1-4)

SD: Standard deviation; n: Number, ISAR: Identification of Seniors at Risk, IQR: Interquartile ratio

Table 3. Diagnoses of study patients and distribution of related organ systems

Variable	n (%)
Infectious diseases	670 (26.5)
Urinary tract infection	262 (10.4)
Pneumonia	153 (6)
Soft tissue infection	133 (5.3)
Central nervous system infection	14 (0.6)
Upper respiratory tract infection	40 (1.6)
Catheter infection	10 (0.4)
Other infections	58 (2.3)
Cardiovascular system	514 (20.3)
Atypical chest pain	192 (7.6)
Heart failure	109 (4.3)
Acute coronary syndrome	82 (3.2)
Dysrhythmias	50 (2)
Hypertension	49 (1.9)
Acute arterial occlusion	18 (0.7)
Deep vein thrombosis	11 (0.4)
Aortic dissection	3 (0.1)
Neurological problems	180 (7.1)
Ischemic stroke	129 (5.1)
Hemorrhagic stroke	12 (0.5)
Seizure	29 (1.1)
Others	10 (0.4)

n: Number

Outcomes

Of the patients included in the study, 70.4% (n=1781) were discharged from the ED, 20.4% (n=516) were admitted to a ward, and 9% (n=228) were admitted to the ICU. Four (0.2%) patients died in the ED. 4.5% (n=115) of the discharged patients reapplied to the ED within 72 hours. The median length of stay of the hospitalized patients was 6 (IQR: 3-11) days. The median waiting time for examination after registration was 4 (IQR: 0-30) minutes, and the median length of stay in the ED was 220 (IQR: 110-375) minutes. The median ED costs of the patients included in the study were 151 (IQR: 75-277) Turkish Liras (Table 5).

Table 4. Consultation data of geriatric patients in the emergency department

Variable	n [%]
Number of consultations	
No consultation	1304 [51.6]
1 consultation	645 [25.5]
2 consultation	303 [12]
3 consultation	135 [5.3]
4 consultation	59 [2.3]
5 consultation	32 [1.3]
6 consultation	25 [1]
7 consultation	11 [0.4]
8 consultation	9 [0.4]
9 consultation	4 [0.2]
10 consultation	1
11 consultation	1
Department and number of consultations	
Internal medicine	370 [14.6]
Cardiology	369 [14.6]
Neurology	260 [10.3]
Infectious diseases	251 [9.9]
Pulmoner diseases	151 [6]
General surgery	130 [5.1]
Anesthesia and reanimation	86 [3.4]
Urology	55 [2.2]
Cardiovascular surgery	52 [2.1]
Orthopedics and traumatology	40 [1.6]
Neurosurgery	33 [1.3]
Eye diseases	17 [0.7]
Medical oncology	16 [0.6]
Ear, nose and throat diseases	11 [0.4]
Thoracic surgery	7 [0.3]
Hematology	3 [0.1]
Nephrology	2 [0.1]
Psychiatry	1 [0.1]
Endocrinology	1
Median time (minutes) [median-IQR]	119 [60-228]

IQR: Interquartile range, n: Number

Statistical Analysis

In the univariate analysis conducted to compare the characteristics of hospitalized and discharged patients, no significant differences were found in terms of gender and social living status, while the hospitalization rate was significantly higher in patients who had blood products requested (44.4% vs. 29.1%; p=0.05) and consultation (60.4% vs. 0.6%; p=0.00) in the ED compared to those who did not. Additionally, patients who arrived at the ED in an ambulance had a higher hospitalization rate compared to those who arrived by themselves (55% vs. 23.6%, p=0.00), and patients who had restrictions applied had a higher hospitalization rate compared to those who did not (59.4% vs. 29.2%, p=0.00). A statistically significant difference was found between the mean ages of hospitalized and discharged patients (75 vs. 73; p<0.001). Additionally, the ISAR scores (3 (IQR: 2-4) vs 2 (IQR: 1-3); p=0.00) and length of stay in the ED for hospitalized patients [334.5 (IQR: 210-556) vs 180 (IQR: 90-300); p=0.00] were significantly higher compared to those who were discharged (Table 6).

Table 5. Outcomes of study patients and time and costs from emergency department to hospitalization

Variable	n (%)
Outcome from emergency department Discharged Service admission Intensive care unit admission Exitus	 1781 (70.4) 516 (20.4) 228 (9) 4 (0.2)
Readmission after 72 hours	115 (4.5)
	Median (IQR)
Waiting time between admission and examination (minutes)	4 (0-30)
Duration of stay in the emergency department (min)	220 (110-375)
Hospital stay (days)*	6 (3-11)
Emergency department cost (Turkish Lira)	151 (75 -277)

n: number, IQR: interquartile ratio, *Post-emergency period

Table 6. Univariate analysis of variables determining hospitalization

Variable	Hospitalization n (%)	Discharge n (%)	p value
Gender Female Male	 353 (29.2) 395 (29.9)	 857 (70.8) 924 (70.1)	0.67
Social life status Living alone Living with family Living in a nursing home	 73 (30.8) 661 (29.2) 14 (43.8)	 164 (69.2) 1599 (70.8) 18 (56.3)	0.18
Blood product requirement Yes No	 32 (44.4) 716 (29,1)	 40 (55.6) 1741 (70,9)	0.00
Consultation requirement Yes No	 740 (60.4) 8 (0.6)	 485 (39.6) 1296 (99.4)	0.00
Transfer method By themselves With 112 Ambulance Service	 482 (23.6) 266 (55)	 1563 (76.4) 218(45)	0.00
Restriction requirement Yes No	 19 (59.4) 729 (29.2)	 13 (40.6) 1768 (70.8)	0.00
	Median (IQR)	**Median (IQR)**	
Age	75 (69-81)	73 (68-79)	0.00
ISAR score	3 (2-4)	2 (1-3)	0.00
Staying time in emergency room	334.5 (210-556)	180 (90-300)	0.00

n: Number, IQR: Interquartile ratio, ISAR: Identification of Seniors at Risk

Table 7. Logistic regression analysis to determine the independent variable effective in predicting hospitalization			
Variable	**Odds ratio**	**95% Confidence interval**	**p value**
Age	1	0.98-1.01	0.73
ISAR score	1	0.94-1.09	0.63
Staying time in emergency department	0.99	0.99-1.00	0.11
Social life status Lives alone Lives in a nursing home	 1.2 0.93	 0.80-1.78 0.38-2.27	 0.37 0.87
Consultation requirement	233	114-477	0.00
Transfer method	1.66	1.27-2.15	0.00
Restriction requirement	1.33	0.57-3.1	0.50
ISAR: Identification of Seniors at Risk			

In the logistic regression analysis conducted to identify the independent variables effective in predicting hospitalization for patients aged 65 and above, who presented to the ED due to non-traumatic reasons, consultation request [odds ratio (OR): 233.95% confidence interval (CI): 144-477] and transfer method (OR: 1.66; 95% confidence interval CI: 1.27-2.55) were found to be statistically significant independent variables (Table 7).

Discussion

According to the 2021 data from the TUIK, women make up 44.3% of the population aged 65 and above. In Antalya province, this rate is 53.63% (2). In a multicenter study conducted in our country by Ergin et al. (14) in 2015, the average age of 1299 patients was recorded, focusing on those aged 65 and older across different provinces. In another study conducted by Yıldırım et al. (15) in 2016, a retrospective analysis of geriatric patients presenting to the ED was conducted. In the same study, the mean age of the patients was reported as 76.1±7 years, and 47.7% of them were women. In another study conducted by Tanderup et al. (16) on geriatric patients, the mean age was 78 years and 56.2% were women. Our study's findings are consistent with other studies in the literature.

This study showed that 89.4% of patients aged 65 and above who presented due to non-traumatic reasons lived with their family, while 9.4% lived alone. According to data published by TUIK in 2021, 24.1% of households in our country have at least one individual aged 65 and above. The proportion of households consisting of individuals aged 65 and above living alone constitutes 6.2% of the entire population, with 74.9% of these individuals being women. In Antalya province, 20.9% of households have at least one individual aged 65 and above, while 5.5% of all households consist of individuals aged 65 and above living alone (2). In a study conducted by Tekten et al. (17), which examined the follow-up of geriatric patients in the ED, it was found that 97.5% (n=236) of the patients lived with their family, while 2.5% lived alone. There are insufficient data in the national literature on this topic, and in the study conducted by Tekten et al. (17), the proportion of elderly patients presenting to the ED living with their family is higher than the finding identified in our study, although it is close. Since there are no official statistical data regarding the living conditions of all elderly individuals in our country, it has not been possible to compare the living conditions of elderly patients identified in our study with geriatric patients in our country.

According to the results of this study, 80.8% of patients aged 65 and above visit the ED through outpatient visits, while 19.1% arrive by 112 emergency medical services ambulances. In a study conducted by Lee et al. (18), the ED visits of individuals aged 65 and above were evaluated. It was found that 38% of the 3230 patients presented to the hospital with ambulance assistance, and the number of ambulance admissions increased with the rise in patients' mean age. In the study conducted by Tekten et al. (17), 56.6% of geriatric patients presented to the ED on their own, while 43.4% arrived in an ambulance. In the study conducted by Benedict and Adefuye (19), 63.5% of the patients presented to the ED through outpatient visits. In another study conducted by Burt et al. (20), the rate of ambulance usage for ED visits was found to be 14.2%, with 39% of these visits made by elderly individuals. In our study, the rate of outpatient visits by elderly patients to the ED exceeded that in other studies in the literature, while the rate of ambulance admissions was lower than that in other studies. These differences may be attributed to factors such as the ambulance usage habits of the population in the study region, the proportion of elderly individuals living with their family, alone, or in a nursing home, the hospital level, and the types of patients it primarily serves.

This study showed that the median ISAR score for patients aged 65 and above who presented to the ED due to non-traumatic

reasons was 2. In a study by Loddo et al. (21), an ISAR score above 2 was found in 72.4% of 421 geriatric patients who presented to the ED. In a study conducted by Chakroun-Walha et al. (22) in Tunisia, it was reported that 38% of the patients had an ISAR score above 1. In a study conducted by Bahadırlı et al. (23) in [Country Name], an ISAR score was found to be negative (<2) in 162 out of 473 patients who presented to the ED. The results of this study regarding the ISAR scores of geriatric patients are generally consistent with the findings reported in the literature.

Another finding of this study is that the most common diagnosis in geriatric patients presenting due to non-traumatic reasons was infections, followed by cardiovascular system pathologies. UTI and pneumonia are the most common infections observed in this age group. In a study conducted by Yıldırım et al. (15), the most common pathologies identified in the geriatric patient group were respiratory, cardiac, and neurological conditions. In another study conducted by Ergin et al. (14), 19.5% of the patients were diagnosed with cardiovascular system issues, 17.6% with gastrointestinal system problems, and 15.2% with pulmonary system conditions. In a single-center study conducted by Dundar and Ayranci (24), 10.692 geriatric patients were examined, and the most common symptoms for ED visits in this group were dyspnea at a rate of 18.5%, followed by abdominal pain at a rate of 12.4% and chest pain at a rate of 8.3%. Since studies on geriatric patients presenting to the ED follow different methods in classifying the existing pathologies of this patient group, a direct comparison between the findings of our study and the literature is not possible. For example, unlike the literature, geriatric patients in our study were not classified according to their symptoms; and pneumonia, which could be classified under respiratory conditions, was instead evaluated as an infection.

In a study conducted in our country, that followed individuals aged 65 and above in the ED, biochemical tests were requested for 90.9% of the patients, direct radiographs for 86.4%, computed tomography (CT) for 23.4%, and microbiological tests for 6.5% (25). In a retrospective study by Celiński et al. (26) examining 1200 geriatric patients presenting to the ED, biochemical tests were requested for 73.8% of the patients, direct radiographs for 38.4%, ultrasound for 11.5%, and CT for 23.4%. While the findings related to blood tests in our study are consistent with the literature, in the two studies referenced above, direct radiographs were the most frequently requested imaging method in the elderly patient group. This may be related to the study populations. While our study focused on non-traumatic visits, the two studies mentioned above also included patients who presented due to trauma.

According to the results of this study, 15% of geriatric patients were followed with a Foley catheter. Of the 13,215 geriatric patients studied by Fakih et al. (27), 6.7% received bladder catheterization in the ED. Compared to the other two studies, the rate of bladder catheterization is higher in our study. This difference may be due to variations in the patient population and in treatment approaches.

In this study, 1.3% of the geriatric patients had restrictions applied in the ED. In a two-year retrospective study conducted by Swickhamer et al. (28), 83 patients were examined, and physical and chemical restraints were applied to 42.2% of the patients. In a study conducted by Eltaliawi et al (29). in Egypt with 287 patients, the prevalence of all restraint methods was found to be 11%, while the frequency of physical restraint alone was 3.2%. Studies in the literature report varying rates of patient restraints, and the restraint rate identified in our study is considerably lower than other studies. This may be due to differences in the patient populations of the studies, or it could be a result of some of the data being collected retrospectively.

According to the results of this study, at least one consultation was requested for 48.4% of geriatric patients presenting for non-traumatic reasons, and the most frequently requested consultations were in the departments of internal medicine, cardiology, neurology, and infectious diseases. In a study conducted by Kapçı et al. (25), 70% of patients aged 65 and above who presented to the ED were consulted with at least one department. The most frequently requested consultations were in the departments of internal medicine, pulmonology, and neurology. In another study conducted by Loğoğlu et al. (30) in our country, a consultation was obtained for 43.4% of the geriatric population presenting to the ED. The most frequently requested consultations were in the departments of cardiology, internal medicine, and pulmonology (7). In a cohort study conducted by Celiński et al. (26) covering the years 2016-2018, 1200 geriatric patients were examined, and the consultation rate was found to be 64.9%. While there are differences in the consultation rates among studies in the literature, the departments for which consultations are requested show similarities. The differences in consultation rates may stem from the patient selection criteria between studies, as well as variations in the emergency medicine systems across countries or even within the same country. Consultation rates may also vary depending on factors such as whether the hospital where the study was conducted is a teaching and research hospital, a lower-level hospital, or a public or private hospital.

According to the results of this study, 70.4% of geriatric patients presenting with non-traumatic conditions were discharged from the ED, 20.4% were admitted to a ward, 9% were admitted to the ICU, and 0.2% died in the ED. In a study conducted by Kapçı et al. (25), the ED visits and subsequent outcomes of patients aged 65

and above were investigated. In the study, which retrospectively evaluated a total of 536 patients, 47.4% were discharged from the ED, 36.4% were admitted to a ward, 10.8% required ICU admission, and three patients died. In an analysis conducted by Loğoğlu et al. (30), it was reported that 75% of patients aged 65 and above who presented to the ED were discharged. In another study, 18.46% of the patients were admitted to a ward, 2.54% were admitted to the ICU, and 0.4% died in the ED. In the study conducted by Keskinoğlu et al. (31), it was found that 90% of geriatric patients presenting to the ED were discharged within a few hours. 19% of the patients were admitted to a ward, 3.5% were admitted to the ICU, and 0.023% died. In a study conducted by Ergin et al. (14), it was reported that 67.5% of patients aged 65 and above who presented to the ED were discharged, 21.7% were admitted to a ward, and 10.8% were treated in the ICU. In another study conducted by Lumjeaksuwan et al. (32) in Thailand, the discharge rate from the ED for geriatric patients was 58%, while a study by Latham and Ackroyd-Stolarz (33), it was reported to be 71.6%. The discharge and admission rates of geriatric patients reported in the literature are generally consistent with the findings of our study. As previously mentioned, the differences in results reported by other studies may be attributed to variations in patient populations and emergency medical services systems.

According to the results of this study, the median length of stay of elderly patients in the ED is 220 minutes. In the study conducted by Latham and Ackroyd-Stolarz (33), the mean length of stay for geriatric patients in the ED was 7.87±95 hours. In a study by Salvi et al. (10), the length of stay for geriatric patients in the ED was found to be 10.3±8 hours. In a study by Lağoğlu et al. (30), the mean length of stay in the ED for discharged patients was 162.7 minutes, while for hospitalized patients, it was 220.6 minutes. Similarly, in a study conducted by Kapçı et al. (25), the mean length of stay in the ED was found to be 213±192 minutes. The resemblance of our study to those conducted in our country may be related to the likeness of our healthcare system.

This study showed that patients with a high ISAR score had significantly higher hospitalization rates than other patients. In a meta-analysis conducted by Galvin et al. (11), ISAR scores and hospitalization rates were compared. For the 30-day hospital admission rate, the sensitivity was 0.83 and the specificity was 0.26, while for the 3-month hospital admission, the sensitivity was 0.80 and the specificity was 0.38. In a study conducted by Salvi et al. (10), a comparison was made between ISAR scores and the mortality rates of patients in the ED. A significant difference was found in the 6-month mortality follow-up between the normal and frail populations, and this was shown to have a correlation with the patients' ISAR scores. In a study conducted by Di Bari et al. (12), a comparison was made between the ISAR scores and the mortality rates occurring during hospital or ED admissions. As a result, an increase in the ISAR score is associated with an increased mortality rate.

This study showed that patients who arrived at the hospital by ambulance had significantly higher hospitalization rates than others. In a study by Strum et al. (34), 35% of geriatric patients who called 911 emergency services presented to the ED under paramedic care, while 7.5% presented to the ED independently. Among patients who presented to the ED with paramedic assistance, 40.2% were classified as urgent, while among those who presented on their own, 18.9% were classified as urgent. In a study conducted by Parker et al. (35) the hospitalization rate of patients who arrived via private patient transport was found to be significantly higher compared to that of others. According to the study conducted by Sun et al. (36), patients who arrived at the ED in an ambulance were 1.7 times more likely to be hospitalized than patients who came on their own.

This study showed that 4.5% of the discharged patients were re-admitted to the ED within 72 hours. In a study conducted by Millhouse et al. (37), the readmission rate to the ED within 72 hours was found to be 5.45%. In the study conducted by Dinh et al. (38) and Robinson and Lam (39), the rate of readmission to the ED within 72 hours was found to be 4.9%. In the study conducted by Aslaner (40), the rate of readmission to the ED within 72 hours was found to be 6%. The rate of readmission to the ED within 72 hours after discharge is consistent with those reported in the literature.

According to the results of this study, the median cost of patients treated in the ED is 151 TL, which is approximately $8.4. In another study conducted in our country, which defined the expenditures of patients presenting to the ED in 2011, the cost of patients directly discharged from the ED was 115.1±89.9 TL (calculated at $72.3 for that year), the cost of patients admitted to a ward was 146.5±87.5 TL (calculated at $92.1 for that year), and the cost of patients admitted to the ICU was 179.2±122.2 TL (calculated at $112.7 for that year). In the same study, the cost for patients who were deceased was 432±222.6 TL (calculated as 271.6$ for that year), and the cost of patients transferred to another hospital was 216.1±121.5 TL (calculated as 135.9$ for that year) (25). In a study conducted by Hwang et al. (41) in the United States, which examined the cost analysis of geriatric patients in two different hospitals, the average age of the patient groups was approximately 81. The average treatment cost for the first group was 2436 USD, while for the other group it was 2905 USD. The cost findings identified in our study are consistent with another study conducted in our country by Kapçı et al. (25), but they are quite different from the figures reported from the United States. It is normal for ED patient care costs to vary depending on the study country, and the figures will differ based on the country's

economic conditions and healthcare policies. Even within the same country, there can be significant differences in patient care costs between public and private hospitals.

Study Limitations

This study has several limitations. Lifestyles of geriatric patients are affected by many factors. For example, factors such as the elderly care culture of the country where the study was conducted, the region where the study took place within the same country, and whether the data were collected from urban or rural areas, can all lead to differences in the lifestyle of the elderly and variations in hospital admissions.

Another factor that could contribute to differences in the study population is that this study was conducted in a tertiary care ED. When examining admissions to primary and secondary care hospitals as well as private hospitals, differences in the admissions of geriatric patients can be observed. Therefore, it would be more accurate to classify the results of our study as third-level care admissions rather than extrapolating them to all geriatric admissions.

In this study, the cost calculation derived from the healthcare expenses of geriatric patients may vary significantly depending on the hospital, the city where the study was conducted, and the country. The distinction between private and public hospitals causes significant differences in hospital fees, and the healthcare policies and economic conditions of countries lead to considerable disparities in the pricing of healthcare services. The financial data obtained in this study should be evaluated specifically for third-level public hospitals in our country.

Conclusion

According to the current findings of the study, parameters such as social living status, method of hospital transfer, ISAR score, procedures performed in the emergency department, physical restraints, need for blood products, time markers, cost, consultation, and readmission may be useful for geriatric patients, just as other ED quality indicators are. Furthermore, patients who require blood products and consultations, those brought to the ED by 112 emergency services, those subjected to restraints, and those with a high ISAR score, have significantly higher hospitalization rates compared to other patients. Additionally, the need for consultation and being brought to the ED by 112 emergency services was identified as effective independent variables in predicting hospital admission.

Ethics

Ethics Committee Approval: Ethical approval was obtained from the Clinical Research Ethics Committee of Health Sciences University Antalya Training and Research Hospital (decision number: 13/10, approval date: 02.09.2021).

Informed Consent: This study was conducted prospectively.

Footnotes

Authorship Contributions

Concept: A.A., A.G., M.K., Design: A.A., A.G., M.K., Data Collection or Processing: A.A., A.G., D.K., Analysis or Interpretation: D.K., Literature Search: A.G., M.K., Writing: A.A., A.G., M.K.

Conflict of Interest: The authors declare that they have no conflict of interest.

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Turkish Women Authors in Emergency Medicine

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Abstract

Aim: A large number of articles are published in the field of Emergency medicine in Türkiye every year. This study aims to evaluate the number and quality of publications in the field of emergency medicine in Türkiye and to determine the effect of female authors on publication quality.

Materials and Methods: A total of 32 international journals were identified. All articles published in these journals between January 01, 2015, and December 31, 2020 were reviewed, and publications by Turkish researchers were included in the study.

Results: Most of the publications are case reports and series (35.7%), but the numbers of systematic reviews (0.4%) and meta-analyses (0.3%) are low. The median count of authors of the articles was 5 (1-32) [for women: 1 (0-16); for men: 4 (0-16); $p<0.001$]. There is at least one woman author in 66.9% of the publications included in the study. 173 (22.5%) of the publications had female corresponding authors, while 192 (25%) of the publications had female first authors; moreover, 149 (19.4%) of the studies had both female first and corresponding authors. There was also no significant difference in the gender of the first authors and corresponding authors across years ($p>0.05$).

Conclusion: The number of women authors was found to be statistically significant lower than the number of men authors. However, there was no gender difference in the distribution of first authors and corresponding authors. This showed that although the number of women was small, they were in an influential position.

Keywords: Emergency medicine, women authors, publications, researcher

Introduction

According to the 2022 data, there are 16.834 (38% women) academic staff in university hospitals and training and research hospitals in Türkiye; of which, 335 are in the field of emergency medicine and 25.6% of this is women (1). United States data has shown that more than 50% of healthcare workers are women (2). Although the working rate of women in Türkiye is 28%, more than half of the health workers are women (3,4). However, it has been reported that the majority of female health workers are nurses, midwives, and caregivers, and only 40% of doctors are women (4). Even though women work more in the field of health than men, the fact that they are fewer academics is attributed to different reasons (such as race, gender discrimination, unwanted sexual behaviors, motherhood, and female role in society) (5-8).

One of the important indicators and tools of academic progress is the publication of international scientific articles. In many countries, academic advancement depends on tenure and/or the number of publications and citations to those publications (9). Although the conditions for academic promotion vary from country to country, researchers are expected to publish in journals with high impact factors (IF), and these publications are expected to be cited (10-12). Although the number of publications on emergency medicine in our country increases every year, the data

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on the number and citations of these studies are limited (13,14). One of the criteria for academic promotion in our country is to have publications in international journals such as those indexed in the Social Sciences Citation Index, Science Citation Index, Science Citation Index Expanded, or Arts and Humanities Citation Index. Additionally, papers may be published in journals listed in other indices (15).

Before this study, we had some questions in mind. To answer these questions, we designed this study.

1) Do female researchers sufficiently participate in the studies conducted in the field of emergency medicine in our country?

2) Does the presence of female researchers affect the number of citations of the publications?

For this purpose, the publications of the journals published in the field of emergency medicine between the years 2015-2020 were examined.

Materials and Methods

Study Design

The retrospective observational study that did not include human subjects, and therefore ethics committee approval was not required.

Workflow

Emergency medicine journals were searched on the LetPub-Scientific Journal Selector website (https://www.letpub.com/index.php?page=journalapp), which provides quality editorial service. Journals titled emergency medicine were taken to increase visibility. A total of 32 international journals were identified. All articles published in these journals between January 01, 2015, and December 31, 2020, were reviewed, and publications by Turkish researchers were included in the study. The genders of the authors in the articles were determined by looking at the pictures on the websites of the institutions they work at and/or on public social media accounts (ResearchGate, LinkedIn, Twitter, Instagram, etc,) (16). The website https://tez.yok.gov.tr/UlusalTezMerkezi/, where the national thesis data is available, was checked to determine whether these publications are the subject of a master's thesis or not.

Inclusion Criteria

Articles meeting the following criteria were included in the study.

- Being published in Emergency medicine journals

- To be written in English

- Full text available

- Be written on the specified dates

- Including studies based in Türkiye

Included Journals

Advanced Journal of Emergency Medicine, African Journal of Emergency Medicine, Anatolian Journal of Emergency Medicine, Archives of Academic Emergency Medicine, BMC Emergency Medicine, Case Reports in Emergency Medicine, Clinical and Experimental Emergency Medicine, Clinical Practice and Cases in Emergency Medicine, Emergency Medicine International, Emergency Medicine: Open Access, Eurasian Journal of Emergency Medicine, Hong Kong Journal of Emergency Medicine, International Journal of Emergency Medicine, Iranian Journal of Emergency Medicine, Italian Journal of Emergency Medicine, Journal of Education and Teaching Emergency Medicine, Journal of Emergency and Internal Medicine, Journal of Emergency Medicine Case Reports, Journal of Emergency Medicine, Trauma and Acute Care, Journal of Pediatric Emergency and Intensive Care Medicine, Open Access Emergency Medicine, Open Journal of Emergency Medicine, Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine, Turkish Journal of Emergency Medicine, Western Journal of Emergency Medicine, World Journal of Emergency Medicine

Emergency Medicine Journal, Shock, Resuscitation, Academic Emergency Medicine, Annals of Emergency Medicine, and The Journal of Emergency Medicine were included in the study.

Measurements

For each article researched, the name of the journal, the IF of the journal, the number of issues for every year, and whether it has Open Access were identified.

The total number of the author, the number of men/woman authors, whether or not it is a master's thesis, the date of publishing, the number of centers (single/multicenter), type of study (meta-analysis, systematic review, randomized controlled trial, cohort study (prospective observational study), case-control study, cross-sectional study, case reports and series, ideas, editorials, opinions, animal research studies, retrospective analysis, others), subject of study (resuscitation; analgesia, anesthesia, and interventional sedation; emergency wound care and management; cardiovascular, respiratory, digestive, renal and genitourinary, obstetrics and gynecological, pediatrics, geriatrics, infectious diseases, toxicology, environmental, endocrine, hematological and oncological, neurology, eye, ear, nose, and throat, dermatological, trauma, imaging, prehospital, education, psychiatry, abuse, management, others), and the number of citations was examined for each study.

Statistical Analysis

The adherence of the data to normal distribution was examined with the Kolmogorov-Smirnov test. The Mann-Whitney U test was used to compare the features that were not normally distributed in two independent groups, and the Kruskal-Wallis and Dunn tests was used to compare more than two independent groups. Relationships between numerical variables were tested with the Spearman correlation coefficient. As descriptive statistics, mean ± standard deviation and median (min-max) values for numerical variables, number and % values are given for categorical variables. SPSS Windows version 23.0 package was used for statistical analysis, and $p<0.05$ was considered statistically significant.

Results

A total of 768 articles published by researchers working in Türkiye between 2015 and 2020 in these journals were investigated. 63.8% of the journals were Open Access; the average IF was 1.63±0.74; and the annual average issue was 7.14±4.07. The journal in which the articles were published the most was the Eurasian Journal of Emergency Medicine (28.4%), while the journal in which they were published the least was the Journal of Emergency Medicine. The highest number of publications appeared in 2016 (22.4%), and most of them were performed as single-center studies (79.0%). The total number of authors of the articles was 3846. The total number of male authors was approximately three times higher than that of female authors, with 2877 males (74.8%) and 969 females (25.2%), respectively. The median count of authors of the articles was 5 (1-32) (for women: 1 (0-16), for men, 4 (0-16) [$p<0.001$)]. The average number of citations received by the published articles was 4.85±9.36, and 1.77% of the articles consisted of studies obtained from master's theses. Most of the publications are case reports and series (35.7%), but the numbers of systematic reviews (0.4%) and meta-analyses (0.3%) are low (Table 1). Study subjects were mostly focused on imaging, cardiovascular,

Table 1. Descriptive data on publications

Parameter	Value	p value
Number of publications	768	-
Year n (%) 2015 2016 2017 2018 2019 2020	 155 (20.2) 172 (22.4) 117 (15.2) 104 (13.5) 123 (16.0) 97 (12.7)	0.001
Open access n (%) Yes No	 490 (63.8) 278 (36.2)	0.001
Number of citation [mean ± SD (M) min-max]	4.85±9.36 (2) (0-140)	-
Number of centers n (%) Multicenter Single center	 161 (21.0) 607 (79.0)	0.201
Number of authors [median (min-max)] Total (n=3846, 100%) Men (n=2877, 74.8%) Women (n=969, 25.2%)	 5 (1-32) 4 (0-16) 1 (0-16)	<0.001
Type of publication n (%) Case reports and series Retrospective study Cohort study (prospective observational) Randomized controlled trial Ideas, editorials, opinions Cross-section Case-control Systematic review Meta-analysis Animal research studies Others	 274 (35.7%) 145 (18.9%) 145 (18.8%) 80 (10.4%) 46 (6.0%) 35 (4.6%) 16 (2.1%) 3 (0.4%) 2 (0.3%) 5 (0.7%) 17 (2.2%)	0.001

[p was obtained from Mann-Whitney U or Kruskall-Wallis tests within each colom, different letters superscript indicate significant differences ($p<0.05$) according to the Dunn test SD: Standard deviation, M: Median]

and trauma (12.3%; 11.1%; 9.2%, respectively) and focused least on otolaryngology, abuse, and emergency wound care and management.

There was no significant correlation between the article being a thesis and its number of citations, or between the number of study centers and the number of citations it received (p=0.613, p=0.201, respectively). It was determined that the number of citations of publications in Open Access journals was significantly lower than that in subscription journals. (p=0.001). The older the study, the higher the number of citations it received (p=0.001). case-control studies and randomized controlled trials had a higher number of citations compared to other studies (p=0.001).

A positive correlation was found between the yearly number of publications and the IF of the journals (r=0.647, p=0.001). A statistically significant very weak positive correlation was found between the IF and the total number of authors (r=0.120, p=0.001). A positive correlation was found between the IF and the number of citations it received (r=0.468, p=0.001). There were statistically significant weak relationships involving the number of yearly publications, the total number of authors, and the number of citations received. Positive and statistically significant weak correlations were found between the number of authors and the number of citations (r=0.209, p=0.001).

In only 24 (3.1%) articles, all authors were women, while in 254 (33.1%) articles, all authors were men. There is at least one woman author in 514 (66.9%) of the publications included in the study. 173 (22.5%) of the publications had female corresponding authors, while 192 (25%) of the publications had female first authors [149 (19.4%) of the studies had both female first and corresponding authors]. There was also no significant difference between the genders of the first authors and corresponding authors across years (p>0.05) (Table 2) (Figure 1).

Publications that included at least one female author were compared with others. It was observed that there was no difference in the Journal IF or the number of citations received (p>0.05) (Table 3).

Discussion

The American College of Physicians emphasizes the importance of gender equality in academia (17). In different studies, it has been determined that women are not sufficiently included as authors of original research articles in medical journals, and the proportion of female authors in some journals has decreased over time (16,18).

Hart and Perlis (16) examined the articles in journals with the highest IF between 2008 and 2018. They found a continued

Table 2. The situation of the women authors

Parameter	Women n (%)	Men n (%)	p value
Number of corresponding authors			
Total	173 (22.5%)	595 (77.5%)	
2015	35 (22.5%)	120 (77.5%)	
2016	35 (20.3%)	137 (79.7%)	0.826
2017	25 (21.4%)	92 (78.6%)	
2018	24 (23.1%)	80 (76.9%)	
2019	27 (21.9%)	96 (78.1%)	
2020	27 (27.8%)	70 (72.2%)	
Number of first authors			
Total	192 (25%)	576 (75%)	
2015	43 (27.7%)	112 (72.3%)	
2016	40 (23.3%)	132 (76.7%)	
2017	28 (23.9%)	89 (76.1%)	0.899
2018	24 (23.1%)	80 (76.9%)	
2019	30 (24.4%)	93 (75.6%)	
2020	27 (27.8%)	70 (72.2%)	

p was obtained from chi-squared test, significant differences p<0.05.

Table 3. Comparison of publications with female authors with others

	Publications without women (n=254) M [Q1 Q3]	Publications with women (n=514) M [Q1 Q3]	Total (n=768) M [Q1 Q3]	p value
Impact factor	12.20 [2.50 12.47]	12.20 [2.50 12.47]	12.20 [2.50 12.47]	0.369
Number of citation	2 [0-5]	2 [0-6]	2 [0-6]	0.367

M: Median, p value was obtained from Mann-Whitney U test

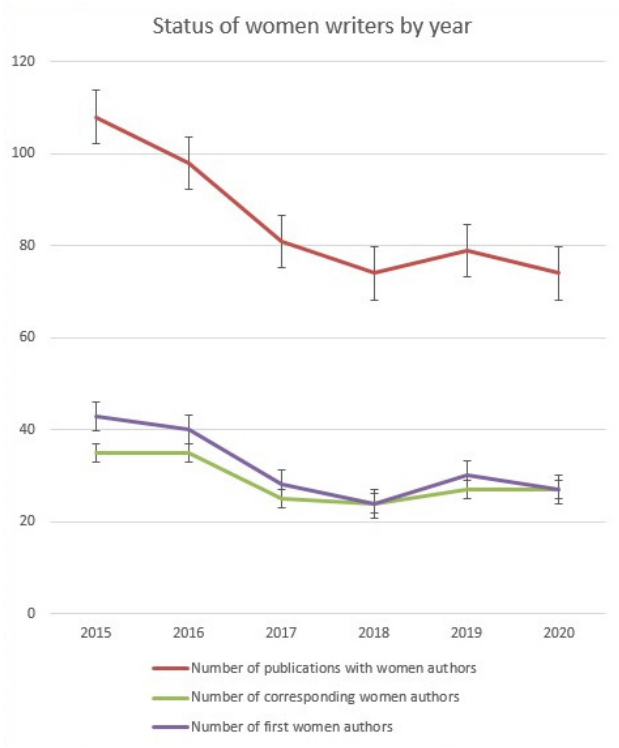

Figure 1. Status of women writers by year

increase in the representation of women in academic publications but demonstrated that disparity still exists, especially in the last author's position. Silver et al. (19) reviewed the four journals with the highest IF in pediatrics. They showed that women were underrepresented as first writers (41.7%). They showed that the first author was also underrepresented as co-author and final author, regardless of gender. Andersen et al. (20) reviewed articles on COVID-19 and identified authors of USA origin. The articles originating from the USA in the journals included in the study increased by 61% during the COVID-19 epidemic compared to the number of articles published in 2019 (20). Despite this, the proportion of women was found to be lower in COVID-19-related articles compared to articles published in 2019 (first authorship was 19% lower, last authorship was 5% lower, and the overall rate was 8% lower per article). The COVID-19 pandemic has affected almost everyone's work and family life, and this justifies the concern that women are more affected (20). Reza et al. (21) reviewed the publications included in the Class I recommendations in heart failure guidelines. It was shown that there were 20% female authors in the United States guidelines and 14% in the European guidelines. The ratio of female first/senior authors in studies on heart failure was 11%. This distribution did not change significantly over time (data from 2001 to 2016). This situation is similar to what occurs when case report authors are examined (22).

Vural et al. (17) reviewed publications in three major emergency medicine journals between 2000 and 2019. 72.5% of the publications had at least one female author. However, the rate of the first author was 25.8%; the rate of the senior author was 18.7%; and the rate of the corresponding author was (21.6%). As the number of authors in the articles increased, the number of female authors also increased.

In this study, unlike other studies, we tried to evaluate not only the journals with the highest impact value in the field of emergency medicine, but also all journals. There was at least one female author in one-third of the articles published in Türkiye. In only 3.2% of the articles, the authors are all women. Although the number of male authors [median: 4 (0-16)] is higher than the number of female authors [median: 1 (0-16)] ($p<0.001$), it was observed that women did not lag behind men both as first author and as the corresponding author ($p>0.05$). The publications that included women were not different from the othersaccording to journal IFs and citation counts.

Study Limitations

- Not including journals indexed in different databases.
- The date interval is limited to five years.
- Although it was not difficult to reach Turkish authors, special software could be used for gender determination [Genderize.io (https://genderize.io)] (3).
- Even in this study, there is only one female author.

Conclusion

The number of women authors was found to be statistically significantly lower than the number of men authors. However, there was no gender difference between the number of the first author and the corresponding author. This showed that although women were few in number, they were in an influential position.

Ethics

Ethics Committee Approval: All information collected from this study was from open accessed LetPub-Scientific Journal Selector website, ResearchGate, LinkedIn, Twitter, and Instagram accounts. All this data is publicly available. Therefore, ethics committee approval was not required.

Informed Consent: The retrospective observational study that did not include human subjects, and therefore ethics committee

approval was not required. Authors declare that human rights were respected according to the Declaration of Helsinki.

Footnotes

Authorship Contributions

Surgical and Medical Practices: M.S., Concept: M.S. M.B., Design: M.S. M.B., Data Collection or Processing: A.H. M.E.K., A.A., F.B., Analysis or Interpretation: M.B., H.G., Literature Search: A.H., M.S.K., A.A., F.B., Writing: M.B., A.A., M.S.

Conflict of Interest: The authors declare that they have no conflict of interest.

Financial Disclosure: There are no financial conflicts of interest to disclose.

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The Effect of Stretcher Level and Angle on Successful First-Pass Orotracheal Intubation

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Abstract

Aim: Careful and appropriate preparation is essential for a successful intubation. In order to increase the success rate of orotracheal intubation (OTI), it is very significant to position the patient appropriately before intubation. There is no standard approach about stretcher positions in the guidelines. In this study, we aimed to investigate the optimal stretcher height and angle for a successful intubation in first attempt.

Materials and Methods: The study was planned as randomized, controlled and prospective. In the study, 3 different stretcher levels pelvic (P), umbilical (U) and epigastric level and 2 different stretcher angle positions (head angle of 0° and head angle of 30°) were used. OTI success and duration, glottic view and number of attempts to intubate were noted by an independent observer.

Results: As a result, a total of 284 participants, 65.1% (n=185) paramedic and 34.9 % (n=99) medical students, participated in the study voluntarily. Of these, 57.4% (n=163) were women. Of the 284 intubation attempts, 88.7% (n=252) were successful and 11.3% (n=32) were unsuccessful. The groups were examined in terms of intubation success. The most successful group was the U30° group with 96.1%; followed by P30° (94.2%), U0° (90.9%) and P0° (89.6%), respectively (p=0.002).

Conclusion: Checking different stretcher levels and stretcher head positions to establish optimum standards in intubation increases the success of first entry in OTI. This will also reduce OTI complications. Studies on this subject can contribute to updates in OTI standardizations.

Keywords: Stretcher, angle, level, successful, intubation, orotracheal

Introduction

Orotracheal intubation (OTI) is a very common method used in in-hospital and out-of-hospital arrests, emergency departments, and operating rooms to provide airway and respiratory care. Careful and appropriate preparation is essential for successful intubation. To increase the success rate of OTI, it is important to position the patient appropriately before intubation (1,2). During the preparation phase, it is recommended to elevate the patient to the operator's xiphoid level (3). Optimal patient positioning plays a critical role in the success of intubation. The primary goal of laryngoscopy is to align the pharyngeal and laryngeal axes, thereby providing an unobstructed direct view of the glottis and facilitating the passage of the endotracheal tube through the vocal cords. Almost all airway management guidelines recommend the sniffing position or jaw thrust (for trauma patients) to achieve a direct view of the glottis. Elevating the head to an optimal height and ensuring that it is sufficiently raised without obstructing blade insertion enhances the laryngeal view and minimizes the need for repositioning during intubation. Although there are many studies about positioning the patient properly, there are not enough studies on the effect of the angle and height of the stretcher on intubation success. A study by Lee BJ et al. (4) reported that 25° of elevation of the head of the stretcher provides a superior laryngeal view of the patient compared with the non-elevated stretcher (patient laying in supine position). In cases where the patient cannot be placed in the supine position (obesity, scoliosis, mass, ankylosing spondylitis, etc.), it may be necessary to secure the airway by changing the angle of the stretcher (5). The position of the patient during OTI may affect both the available oxygen volume of the patient (6,7) and the time required for intubation (4,8), thereby increasing the risk of hypoxemia and decreasing the intubation success rate. Although many studies have investigated optimal positioning of

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the head of the patient during rapid intubation, the uncertainty of the optimal stretcher height and angle remains (9,10). In this study, we aimed to investigate the optimal stretcher height and angle for successful intubation in the first attempt.

Materials and Methods

Study Design, Setting and Participants

Approval for this study was obtained from the Ethics Committee of Istanbul Medipol University (decision number: E-10840098-772.02-6120, date: 30.11.2021). The study was planned to be randomized, controlled, and prospective. The subjects included in the study were students of Istanbul Medipol University Faculty of Medicine (6th grade) and First and Emergency Aid (Paramedics 2nd grade) who wanted to be involved in the study voluntarily. Students who had experienced OTI or previous OTI lessons were not included in this study. Individuals who declined to participate in the study and those exhibiting anatomical incompatibilities that prevented appropriate adjustment of the stretcher height and angle (such as individuals with insufficient or excessive body length relative to the stretcher) were excluded from the study. An informed voluntary consent form was obtained from those who wanted to be included in the study. One hour of theoretical and practical OTI training was given to participants included in the study. The training was provided to the participants by an instructor who is an active educator in medical education and has 5 years of experience in the emergency department. The instructor used the Tintinalli's Emergency Medicine A Comprehensive Study as the training resource (3). In the study, 3 different stretcher levels [pelvic (P), umbilical (U) and epigastric (E) level] and 2 different stretcher angle positions (head angle of 0° and head angle of 30°) were used (Figure 1,2).

The Determination of P, U and E Levels Involves the Identification of Specific Anatomical Landmarks

E Level: The E region is centered above the umbilicus and below the costal margins, approximately over the xiphoid process.

U Level: This corresponds to the midpoint of the U region, which is aligned with the umbilicus and the approximate midpoint of the abdomen.

P Level: This is centered in the hypogastric (or pubic) region, located below the U region, near the pubic symphysis, and in line with the intertubercular line.

These levels provide standardized reference points for clinical and anatomical studies (11).

The Stretcher Angle is Determined

The stretcher angle is determined by measuring the inclination of the stretcher relative to the horizontal plane.

This Was Achieved Using the Following Steps

Initial Positioning: The stretcher was placed on a flat surface to provide an accurate reference point.

Angle Adjustment: The backrest or surface of the stretcher was adjusted to the desired angle. The stretcher angle was set to 30°, which is also recommended for preoxygenation (4).

Measuring Tool: A protractor with a built-in angle measurement function was used to measure the angle between the inclined surface of the stretcher and the horizontal plane.

Recording the Angle: The exact angle was noted in degrees for documentation and use in clinical or study protocols.

Data Collection and Management

The stretcher levels and stretcher head positions determined for randomization were written on papers by a secretary who was not aware of the study and were placed in sealed envelopes. Two closed boxes were prepared, and the stretcher levels and the stretcher head angle positions were placed by the secretary. Each subject included in the study randomly selected two envelopes from two separate boxes for the stretcher level and head position. The stretcher level and head position were adjusted by an independent personnel. The Muka LC-5100 stretcher and Laerdal

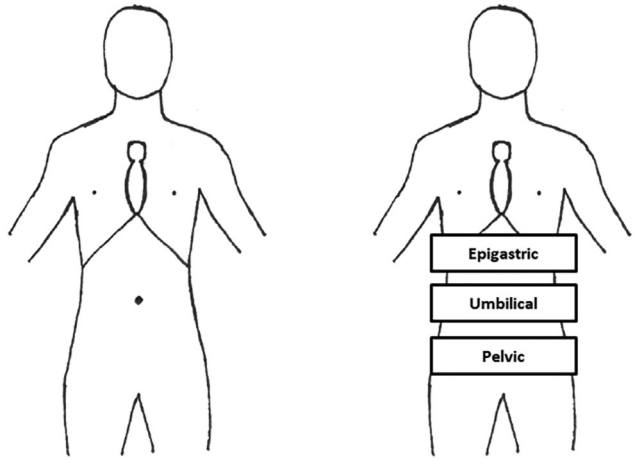

Figure 1. Body anatomy and stretcher levels

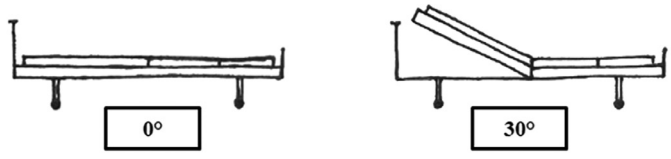

Figure 2. Stretcher angle positions

Megacode Kelly (Laerdal Nursing Adult Full Body CPR Intubation Airway Management Manikin) model were used in this study. Each participant attempted OTI on the manikin, and OTI success was evaluated by tracheal opening of the anterior neck of the manikin. The success and duration of OTI, glottic view, and number of attempts to intubate were noted by an independent observer.

First and Emergency Aid (Paramedic) Students

Paramedics are health personnel who are able to provide basic and advanced life support based on current medical guidelines in the prehospital emergency health system; able to take the medical history of the sick/injured person with appropriate communication skills; able to recognize all kinds of system trauma; and able to transfer the sick/injured person safely by ambulance to target hospitals. The educational period in Türkiye is two years.

Medical Faculty Students

Medical faculty students in Türkiye take emergency medicine lessons during their fifth year (theory and practice). Final year students (6^{th} grade) only take a practical emergency medicine internship for 2 months. The aim of the emergency medicine internship program is to train physicians who can provide differential diagnosis, emergency interventions, and necessary treatments and prevent and monitor diseases defined within the scope of the national core education program (NCEP) in primary care and emergency services at the levels specified in the NCEP.

Cormack-Lehane Classification

It is very useful to anticipate patients who will be difficult to intubate, but preoperative testing is not sufficient to identify most cases. In 1984, Cormack RS and Lehane J (12) described a four-grade scoring system for laryngeal appearance using direct laryngoscopy to predict difficult intubation. This scoring system is widely used in clinical trials and clinical practice to aid the subsequent management of patients who are intubated with difficulty (13).

Statistical Analysis

The descriptive statistics were presented in Mean±SD for the quantitative variables and as frequencies and percentages for the categorical variables. The frequencies of categorical variables were compared using Pearson's chi-square and Fisher's exact test as appropriate. Groups were formed according to the stretcher position and head angle. In the comparison of these 6 groups, 2x2 tables were obtained by the select case process. Since the minimum expected count values of the cells were appropriate (less than 25% of them were less than 5), the p value of the Pearson's chi-square test was used. A total of 15 subgroup analyses were conducted for 6 groups. To prevent type 1 error, Bonferroni's correction was used, and a p value <0.0033 was considered statistically significant in the subgroup analysis. Outliers were analyzed using the box-plot test. Shapiro-Wilk tests and Q-Q plot tests were used to evaluate normality. The homogeneity of variances was analyzed using Levene's test. After evaluating these prerequisites, Welch ANOVA and Games-Howell post-hoc tests were applied to compare the intubation times among the groups. All the analyses were 2-sided with an alpha of 0.05 (except subgroup analyses with Bonferroni's correction) and were performed using SPSS statistical software (IBM SPSS Statistics for Windows, version 26.0. Armonk, NY: IBM Corp.).

Results

The stretcher level could not be adapted to some participants (53 people, especially at the E level, where the stretcher level could not be raised in accordance with the practitioner's height). As a result, a total of 284 participants, 65.1% (n=185) paramedic and 34.9 % (n=99) medical students, participated in the study voluntarily. Of these, 57.4% (n=163) were women. Intubation success was analyzed according to the gender of the participants, type of education, stretcher height, and head angle on 6 different subgroups. There was no difference between intubation success and failure according to sex and education type ($p>0.05$ for both) Table 1.

Of the 284 intubation attempts, 88.7% (n=252) were successful and 11.3% (n=32) were unsuccessful. Six different groups were formed by adjusting the stretchers at 3 levels as P, U, and E and two different stretcher head angles (0° and 30°) for each stretching level. The groups were examined in terms of intubation success. The most successful group was the U30° group (96.1%; followed by the P30° (94.2%), U0° (90.9%), and P0° (89.6%) groups, respectively. The E0° (83.3%) and E30° (73.8%) groups were found to be more unsuccessful than the other groups. The mean number of trials was determined as 2.3±1.30 in total. The U30° group had the least attempts with 1.9±1.02, followed by the E30° group with 2.0±1.06. At the E level, more interventions were required in both head positions (0° and 30°) than at other levels (2.7±1.41 and 3.3±1.57, respectively). The mean time to successful intubation attempts was 29.4±21.1 seconds. The longest intubation duration occurred at the E level group (34.9±22.4 seconds for E0° and 43.6±26.4 seconds for E30°). Participants were asked to evaluate their effort by scoring between 1 and 10, with the mean effort was found to be 4.8±2.9. It was determined that the participants expended more effort at the E level compared to the other positions (5.8±2.8 for E0°, 7.1±2.9 for E30°). In total, 42 (14.8%) patients used the external laryngeal maneuver (ELM) while intubating. The number of participants in each group, Cormack-Lehane classification,

intubation success, number of attempts, time, effort, and need for ELM, all variables according to the groups are shown in Table 1.

A statistically significant difference was found between the intubation success of the 6 groups formed according to the stretcher position and the stretcher head angle (p=0.010). To identify which groups/groups caused the difference, subgroup analysis was performed by comparing the groups one by one. Accordingly, there was a significant difference between the U30° group, which had the highest success rate of 96.1%, and the E30° group. p=0.002; a total of 15 subgroup analyses were performed among 6 groups. For these results, p value <0.0033 was considered statistically significant (Bonferroni correction); there was no significant difference between the U30° group and the other groups (p>0.0033 for all). The second group, the P30° group, was the second most successful group (94.2%, but there was no significant difference between the other groups (p>0.0033 for all). The results of the analysis of variables and subgroup analyses according to intubation success are presented in Table 2.

Subgroups were also compared according to intubation time (unsuccessful attempts were excluded in this analysis). There was a significant difference between the U30° group, which had the shortest intubation time period, and the E0° and E30° groups (p=0.046, <0.001, respectively). The P30° and U0° groups also showed significantly faster values than the E30° group (p=0.003, p=0.006; respectively). No significant difference was found in the other subgroup comparisons in terms of intubation time (p>0.05 for all) (Table 3).

Discussion

The effectiveness of stretcher level and angle during OTI application was investigated. The participants were recruited from a population of particularly inexperienced practitioners. Therefore, the effect of experience on the success rate in the first attempt during the OTI application was removed. First-pass success in performing OTI in the emergency department has been associated with reduced intubation-related complications (14). In fact, international guidelines emphasize the importance of advanced airway management in out-of-hospital cardiac arrests and emphasize the effects of the number of intubation attempts on poor neurological outcomes (15). In this regard, although studies can be found widely in the literature to better visualize the glottic angle during OTI, no study has been conducted on the stretcher angle and height. There is no standard approach to stretcher positions in the guidelines. There have been studies on the ramp and sniffing positions in previous publications (16,17). Studies have also been conducted on intubation in the lateral position (18). This study is the first to investigate the relationship between different stretcher levels and angles and successful OTI attempts.

The primary outcome of the study was OTI success. The most successful stretcher levels were determined as U30° and P30°. In this study, we found that the OTI application at the U30° stretcher level was the most successful. There was a statistically significant difference between U30° and E30°. However, no significant differences were observed between the other groups. We believe that the lower success rate at the E level is due to less laryngeal vision and more effort.

Table 1. Classification of results according to stretcher position and stretcher head angle

Position	Total, n (%)	Pelvic		Umbilical		Epigastric	
Head-angle		0°	30°	0°	30°	0°	30°
Number of participants	284	48 (16.9)	52 (18.3)	55 (19.4)	51 (18.0)	36 (12.7)	42 (14.8)
C-L classification, n (%)							
1	159 (56.0)	29 (18.2)	33 (20.8)	35 (22.0)	38 (23.9)	15 (9.4)	9 (5.7)
2	96 (33.8)	15 (15.6)	17 (17.7)	16 (16.7)	12 (12.5)	16 (16.7)	20 (20.8)
3	27 (9.5)	3 (11.1)	2 (7.4)	3 (11.1)	1 (3.7)	5 (18.5)	13 (48.1)
4	2 (0.7)	1 (50.0)	0	1 (50.0)	0	0	0
Successful intubation rate (%)	252 (88.7)	43 (89.6)	49 (94.2)	50 (90.9)	49 (96.1)	30 (83.3)	31 (73.8)
Failed attempt, n (%)	32 (11.3)	5 (10.4)	3 (5.8)	5 (9.1)	2 (3.9)	6 (16.7)	11 (26.2)
Number of attempts, Mean±SD	2.3±1.30	2.1±1.13	2.0±1.06	2.1±1.17	1.9±1.02	2.7±1.41	3.3±1.57
Time, sec.* Mean±SD	29.4±21.1	30.5±24.4	26.1±18.1	27.1±17.7	21.3±13.9	34.9±22.4	43.6±26.4
Effort, 1-10 points, Mean±SD	4.8±2.9	5.1±2.7	4.1±2.5	4.5±2.9	3.1±2.3	5.8±2.8	7.1±2.9
Need for ELM, n (%)	42 (14.8)	5 (11.9)	6 (14.3)	8 (19.0)	5 (11.9)	6(14.3)	12 (28.6)

C-L: Cormack-Lehane curve, SD: Standard deviation, sec: Seconds, ELM: External laryngeal maneuver, *Failed attempts were excluded from the time assessment

We predicted that providing the appropriate angle to the stretcher head would increase the visualization of the glottic angle without requiring the practitioner's physical posture, thus increasing the success of the first OTI entry. In this context, we found that the laryngeal visual angle (Cormack-Lehane classification) was better with U30° than U0°; we also found that P30° provided better laryngeal vision than P0°. With this result, the angulation of the stretcher showed that better laryngeal viewing angle was provided compared to the 0° position of the stretcher, which supports the suggestion of Lee BJ et al. (4) Lee HC et al. (19), on the other hand, did not find any difference in laryngeal view in their study with different stretcher levels in the supine position, and this was not compatible with our study.

The participants exerted greater effort in the E30° and E0° positions. This was attributed to the necessity of applying significant muscle strength to elevate the shoulders and arms to a higher level, as well as the challenges encountered during intubation due to the reduced laryngeal view angle. The prolonged elevation of the shoulders and arms during intubation may also contribute to physiological fatigue. Additionally, the weight of the laryngoscope was thought to be a contributing factor. Lee HC et al. (19) reported that OTI was less painful at a high stretcher level. This situation partially contradicts our study. When we go up from the P level to the U level, the amount of effort spent decreases, but the level of effort increases at the E level.

Semler MW et al. (16) reported that the ramp position during OTI caused a higher number of attempts it contradicts our study. Except for the E level, a 30° angle was found to provide a smaller number of attempts compared with a 0° angle of the stretcher head.

Semler MW et al. (16) reported that the ramped position during OTI resulted in a higher number of attempts, which contradicts the findings of our study. In our study, except at the E level, a 30° angle reduced the number of attempts compared with a 0° angle of the stretcher head.

Table 2. Analysis of variables associated with intubation success

Variables	Succeeded	Failed	p value
Gender			
Female	144 (88.3)	19 (11.7)	0.810*
Male	108 (89.3)	13 (10.7)	
Education type			
Paramedic student	163 (88.1)	22 (11.9)	0.649*
Medical student	89 (88.9)	10 (10.1)	
Position-angle[α]			
Pelvic-0°	$43_{a, b}$ (89.6)	$5_{a, b}$ (10.4)	**0.010***
Pelvic-30°	$49_{a, b}$ (94.2)	$3_{a, b}$ (5.8)	
Umbilical-0°	$50_{a, b}$ (90.9)	$5_{a, b}$ (9.1)	
Umbilical-30°	49_{b} (96.1)	2_{b} (3.9)	
Epigastric-0°	$30_{a, b}$ (83.3)	$6_{a, b}$ (16.7)	
Epigastric-30°	31_{a} (73.8)	11_{a} (26.2)	
Subgroup analysis[β]			
Pelvic-0°-Pelvic-30°			0.475**
Pelvic-0°-Umbilical-0°			1.000**
Pelvic-0°-Umbilical-30°			0.259**
Pelvic-0°-Epigastric-0°			0.517**
Pelvic-0°-Epigastric-30°			0.051*
Pelvic-30°-Umbilical-0°			0.717**
Pelvic-30°-Umbilical-30°			1.000**
Pelvic-30°-Epigastric-0°			0.151**
Pelvic-30°-Epigastric-30°			0.006*
Umbilical-0°-Umbilical-30°			0.440**
Umbilical-0°-Epigastric-0°			0.333**
Umbilical-0°-Epigastric-30°			0.025*
Umbilical-30°-Epigastric-0°			0.061**
Umbilical-30°-Epigastric-30°			**0.002***
Epigastric-0°-Epigastric-30°			0.310**

[α]Each subscript letter denotes a subset of position-angle categories whose column proportions do not significantly differ from each other at the p<0.05 level. [β]Subgroup analysis was calculated by obtaining 2x2 tables by case selection process. A total of 15 subgroup analyses were performed among 6 groups. A p value <0.0033 was considered statistically significant for these results (Bonferroni's correction). *Pearson chi-square test, **Fisher's exact test

Table 3. Comparison of the subgroups in terms of intubation time

Subgroups	Mean difference (seconds)	p value**
Pelvic-0°-Pelvic-30°	4.41	0.930
Pelvic-0°-Umbilical-0°	3.29	0.970
Pelvic-0°-Umbilical-30°	9.18	0.255
Pelvic-0°-Epigastric-0°	-4.42	0.942
Pelvic-0°-Epigastric-30°	-13.10	0.070
Pelvic-30°-Umbilical-0°	-1.12	1.000
Pelvic-30°-Umbilical-30°	4.78	0.852
Pelvic-30°-Epigastric-0°	-8.83	0.416
Pelvic-30°-Epigastric-30°	-17.51	**0.003**
Umbilical-0°-Umbilical-30°	5.89	0.697
Umbilical-0°-Epigastric-0°	-7.71	0.566
Umbilical-0°-Epigastric-30°	-16.39	**0.006**
Umbilical-30°-Epigastric-0°	-13.61	**0.046**
Umbilical-30°-Epigastric-30°	-22.29	**<0.001**
Epigastric-0°-Epigastric-30°	-8.68	0.550

*Failed attempts were excluded from the time assessment, **ANOVA (Fisher) and Tukey's post-hoc test. The mean difference was significant at the p<0.05 level

The management of trauma patients should be conducted with careful consideration of possible spinal cord injury. Until proven otherwise, the continuous use of spinal boards and cervical collars is essential to ensure spinal cord stability. Although the findings of our study conflict with those of Semler, it must be noted that adjusting the stretcher angle may not be suitable for patients with suspected spinal trauma. The effect of 30° stretcher angle on spinal cord loading and spinal stability should be investigated in future studies.

If it is determined that the stretcher angle has no negative impact on the spinal cord, then the stretcher height and angle, as suggested by our findings, can be utilized to achieve optimal positioning for successful intubation in trauma patients.

Study Limitations

The recommendations of this study for trauma patients, especially those with spinal injury (especially at the P level), can be evaluated within the scope of limitations. In addition, information on OTI complications was not available because everything was performed on a manikin.

In clinical practice, the variability in intubation difficulty among patients (as assessed by the Mallampati classification, Cormack-Lehane classification, and the LEMON method) suggests that the findings of our study may yield different results when applied to real patient populations. However, the use of a single-type mannequin to ensure standardization in the study eliminated the potential negative effects of variations in anatomical structures.

Therefore, the criterion for evaluating the success of OTI was the number of attempts and first-pass success.

Current Knowledge

The stretcher should be raised to the xiphoid level of the surgeon performing the intubation. Although intubation and ventilation are traditionally performed with the patient in the supine position, aligning the external ear with the sternal notch may also help visualize the glottic.

The Contributions of This Paper

For successful first-pass intubation, the best results were achieved when the stretcher was placed at the level of the umbilicus and the stretcher angle was set to 30°.

Conclusion

Checking different stretcher levels and stretcher head positions to establish optimum standards for intubation can increase the success rate of the first entry in OTI. This will also reduce OTI complications. We recommend that these studies be included in updates to OTI standardizations and include direct recommendations for integrating this technology into clinical guidelines or training programs.

Ethics

Ethics Committee Approval: Approval for this study was obtained from the Ethics Committee of Istanbul Medipol University (decision number: E-10840098-772.02-6120, date: 30.11.2021).

Informed Consent: An informed voluntary consent form was obtained from those who wanted to be included in the study.

Footnotes

Authorship Contributions

Surgical and Medical Practices: M.Ş., Concept: M.Ş., B.G., Design: M.Ş., H.İ.Ç., B.G., Data Collection or Processing: M.Ş., H.İ.Ç., G.E.Y., Analysis or Interpretation: S.B., B.G., Literature Search: M.Ş., Writing: M.Ş.

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Patient Satisfaction in 112 Emergency Health Services: Scale Development and Validation

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Abstract

Aim: Despite its critical importance, no standardized scale specifically adapted to measure patient satisfaction with all aspects of 112 Emergency Healthcare Services is available. We aimed to develop a scale to measure patient satisfaction with 112 Emergency Healthcare Services.

Materials and Methods: This study was conducted in accordance with the Declaration of Helsinki. First, studies on patient satisfaction were reviewed, and then a questionnaire inventory consisting of 40 items was created to measure the desired domain. We sent the inventory to 10 experts in the field and asked them to evaluate the appropriateness of the items for the purpose of the study. The content validity index was calculated, and the items that should remain in the measurement tool. After conducting the pilot test, using these results, data were collected from 400 patients/patient relatives who applied to 112 Emergency Health Services in Aksaray province between 27.05.2015 and 30.06.2015 using the survey technique, and the collected data were analyzed by Kaiser-Meyer-Olkin test, Bartlett test, exploratory factor analysis, and confirmatory factor analysis.

Results: The scale, which was determined to consist of 26 items based on the analyses, consists of 4 sub-dimensions: ambulance personnel, call answering personnel, on-scene service provision, and ambulance technical equipment. The Cronbach's alpha coefficient of the developed scale was 0.907, and the goodness-of-fit measures were excellent.

Conclusion: A reliable scale for measuring patient satisfaction in 112 Emergency Health Services, which may be suitable for health managers, health professionals, and researchers interested in this field, has been introduced to the literature.

Keywords: Emergency medical services, transportation of patients, patient satisfaction, scale development

Introduction

Health is one of the most critical service areas that directly impacts the quality of life of humans. To enhance the effectiveness of the healthcare system and improve patient satisfaction, assessing and continuously improving the quality of healthcare services are essential. Among the key indicators for evaluating healthcare quality, patient satisfaction is one of the most significant. This reflects the extent to which patients' expectations are met and the overall experiences of the patients are positive. Patient satisfaction serves not only as a measure of healthcare providers' performance but also guides the improvement of patient-centered care. Furthermore, it positively influences patient loyalty and health outcomes, making it an essential focus for healthcare organizations aiming to elevate their quality management and care standards.

Patient satisfaction is commonly defined as the comparison between patients' expectations and the benefits they perceive before and after receiving healthcare services (1). Performance measurement in healthcare aims to foster continuous improvement in service delivery, emphasizing patient satisfaction as a key priority. Generally, patient satisfaction is influenced by whether the healthcare service meets or exceeds expectations

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and whether it is perceived positively. From the initial visit to a healthcare institution to diagnosis, treatment, and the final outcome, patient satisfaction serves as a vital indicator of service quality throughout the care process (2).

Measuring patient satisfaction is integral to ensuring the provision of quality healthcare and tailoring services to meet patients' needs and expectations (2). While numerous studies have explored patient satisfaction in various healthcare settings- such as private hospitals, primary, secondary, and tertiary care institutions, and among inpatients- there is a notable gap in the literature regarding satisfaction levels within 112 Emergency Healthcare Services. Existing research in this area is limited and predominantly relies on surveys as the primary evaluation method.

To address this gap, this study aimed to develop a comprehensive, valid, and reliable measurement tool specifically designed to evaluate patient satisfaction with 112 Emergency Healthcare Services. By identifying key dimensions critical to improving the quality of these services, this research contributes to the literature by providing a robust framework for assessing patient satisfaction in emergency care.

Enhancing patient satisfaction in emergency healthcare not only improves individual patient experiences and strengthens the overall public health outcomes and sustainability of healthcare services. Therefore, policymakers and healthcare providers must prioritize service quality and adopt a patient satisfaction-focused approach.

Compared to existing scales, such as the Emergency Department Patient Satisfaction Scale and the Patient Satisfaction with Emergency Medical Services survey, our approach offers a more comprehensive assessment. While these scales focus on overall satisfaction elements, our instrument includes different subdimensions. Furthermore, our scale is specifically designed to assess prehospital care and fills a gap in the literature by addressing factors critical to the 112 emergency care experiences, such as communication with dispatchers and paramedic evaluations.

Materials and Methods

Study 1: Inventory Creation

Procedure

National and international studies on the subject were reviewed to determine the construct to be measured by examining all dimensions of the subject. A pool of 40 items was created to cover all dimensions of the construct to be measured. The question pool included questions on the dimensions of telephone access to the 112 emergency call number, ambulance arrival time, level of knowledge of employees and service delivery method, technical equipment, patient privacy, process of delivering the patient or injured person to the health institution, and general satisfaction level. The developed scale is a five-item Likert-type scale. The answers are listed as 1- strongly disagree, 2- disagree, 3- neutral, 4- agree, and 5- strongly agree. The respondent answers the items by marking one of the options.

Sample and Analysis Method

After creating the item pool, experts were consulted to assess the appropriateness of the items in terms of content and scope. For this purpose, 10 experts were selected and asked to evaluate the relevance of the items in the question pool to the aim of the study. The experts provided their opinions for each item as "absolutely necessary," might be necessary but not essential," or "not necessary". The experts' responses were evaluated by calculating the content validity ratio (CVR), as expressed in Davis's technique (3). The CVR index was calculated using the formula [CVR=N_G/(N/2)-1], where N represents the total number of participating experts and N_G represents the number of experts who marked the "absolutely necessary" option (4). According to Yurdugül (4), statistically significant CVRs are shown in Table 1 below ($p<0.05$).

In this study, we calculated the CVR index of each item in the 40-item question pool sent to 10 experts. From the calculations, 8 items with a CVR index below 0.62 were removed from the inventory, and the remaining 32 items were obtained (Appendix 1).

Study 2: Scale Development and Validation

Procedure

The present study used a cross-sectional analytical survey design. The quantitative data were collected between 27.05.2015 and 30.06.2015 via face-to-face interviews and questionnaires by conducting interviews with either patients or their relatives who received services from 112 Emergency Health Services. Care was taken to ensure that the participants were not under pressure while filling out the questionnaire. It took an average of 5 minutes to complete the questionnaires. Before the developed scale was applied to the entire sample, a pilot study was conducted with 20 patients and their relatives who had used

Table 1. Acceptable values for the content validity index (4)

Number of experts	Min. value	Number of experts	Min. value
5	0.99	8	0.78
6	0.99	9	0.75
7	0.99	10	0.62

Min.: Minimum

Aksaray 112 Emergency Health Services. At the end of the pilot study, the comprehensibility of the scale and the questions were tested, and it was decided that it would be applicable.

Sample and Analysis Method

The study population consisted of patients and their relatives who received Aksaray 112 Emergency Health Services during the study period at the Aksaray Province Center. The provincial health directorate reported that approximately 15.000 people used the 112 Emergency Health Services in Aksaray Province on relevant dates. Because it was impossible to reach this population, the required sample size was calculated to be 375 people with a 95% confidence interval using the PASS 11 software. However, according to Büyüköztürk (5), since it is recommended that "the sample size in scale development studies should be at least 10 times the number of questions", it was decided that the sample size should be 400 people; therefore, there were 40 items in the first question inventory. Within the scope of the research, the contact information of 400 patients and their relatives who received services, registered in the database of the Aksaray Provincial Health Directorate 112 Command Control Center, was obtained via a simple sampling selection method. The participants were informed about the research, and data were collected from the volunteers via face-to-face surveys. Participants were allowed only one answer per person. The inclusion criteria were to be a patient or a relative of a patient who used 112 Emergency Health Services on the relevant dates and not to be an unconscious patient. The exclusion criterion was being an unconscious patient. Participants were provided with detailed information about the purpose, scope, and nature of the study before their participation. They were explicitly informed that their responses would be used solely for research and that their participation was voluntary. Written consent was obtained from all participants, who were assured of the confidentiality and anonymity of their data. For participants who were relatives of unconscious patients, the same process of information dissemination and consent was followed. Ethical approval for the study was obtained from the relevant institutional ethics committee, which ensured that the research adhered to ethical guidelines and standards. Demographic and situational factors such as age, gender, health status, cultural background, previous experiences, and urgency may have influenced participants' responses. In addition, factors such as the conditions under which emergency services are provided and waiting times may also influence satisfaction levels. The study was conducted in accordance with ethical rules at all stages and adhered to the COPE guidelines. Ethical approval was obtained from the Non-Interventional Clinical Research Ethics Committee of Selçuk University Faculty of Health Sciences (decision number: 05, date: 27.05.2015). Additionally, written permission to conduct the study was obtained from the Aksaray Provincial Directorate of Health.

Statistical Analysis

Descriptive statistical analyses, Cronbach's alpha (α) reliability coefficient, the Kruskal-Meier method, and Bartlett's test were used to analyze the data. Exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) were used to evaluate the construct validity of the scale, after which goodness-of-fit values were calculated. In EFA, varimax rotation and principal component analysis were used. Items with factor loadings below 0.30, which is an acceptable value for social sciences, were removed from the scale. Analyses were conducted using SPSS 22.0 and AMOS 23.0 software.

Results

The mean age of the participants in the sample group was 44.74±14.99 years, and 196 were female. In the sample group, 176 of the participants were primary school graduates, 116 secondary school graduates, 108 higher education graduates, and 284 were married.

Validity and Reliability Analysis

After discarding 8 items with a CVR index below 0.62 from the initial 40-item question pool, we applied the following analyses and stages to the 32-item inventory to develop a valid and reliable measurement tool:

First, the Cronbach's α value of the scale in our study was calculated as 0.907, indicating that the scale was reliable. EFA and CFA were used to assess the validity of the scale. In EFA, the appropriateness of the data was examined using the Kaiser-Meyer-Olkin test (KMO) coefficient and Bartlett's test of sphericity (BTS). According to the EFA results, the BTS of the scale was significant. The KMO value was 0.636, and it was decided that the data were suitable for factor analysis (χ^2: 10133.638; df: 435; p=0.000) (Table 2).

Table 2. Cronbach's Alpha, KMO and Bartlett's test results of the developed scale

Cronbach's alpha, KMO and Bartlett's test results		
Cronbach alpha coefficient (α)		0.907
Kaiser-Meyer-Olkin measure of sampling adequacy		0.636
Bartlett's test of sphericity	Approximate chi-square	10133.638
	DF	435
	p	0.000

KMO: Kaiser-Meyer-Olkin, DF: Degrees of freedom

Table 3 presents the common variance. Common variance is the amount of variance that each variable in the scale shares with other variables. In our research, items with factor loadings of 0.30 were included in the analysis. According to these results, 2 more items were removed from the scale, and a scale of 30 items was obtained (6,7).

After determining the number of items, the number of factors is determined. The aim of factor selection is to obtain a small number of factors that best represent the relationships between the items. As shown in Table 4, the factors in this study were identified using the principal component method, and the number of significant principal components was determined to be 4. The cumulative variance explained by the four factors constituted 54.85% of the total variance. The findings presented in Table 4 were obtained by rotating the factor loadings of each item. The rotation was performed using the Varimax method. The lower cut-off point of the items was set at 0.30, and each factor was given a name derived from the factor matrix. The first factor was labeled the "Ambulance Staff Dimension", the second factor was labeled the "Call Answering Staff Dimension", the third factor was labeled the "Incident Scene Service Delivery Dimension", and the fourth factor was labeled the "Ambulance Technical Equipment Dimension". In factor analysis, if the structure is unidimensional, the first factor should explain at least 40%

Table 3. Common variance table

Items	Factor loadings
When I called 1-1-2, I reached the staff on duty quickly and easily.	0.309
The staff who answered the phone listened to me carefully.	0.702
The staff member who answered the phone understood what I was saying.	0.304
The staff who answered the phone was respectful towards me.	0.474
I trusted the staff who answered the phone.	0.643
The ambulance arrived at the address I gave without any delay.	0.309
The ambulance staff asked questions about the patient's/injured person's complaints.	0.658
Ambulance staff listened to the patient's/injured person's complaints.	0.509
Ambulance staff applied the necessary intervention to the patient/injured at the scene.	0.686
Ambulance staff gave explanatory information about the patient/injured.	0.651
Ambulance staff showed enough care for the patient/injured.	0.328
Ambulance staff brought all the devices they will use to the scene.	0.454
Ambulance staff gave morale to the patient/relative.	0.604
I trusted the professional knowledge of the ambulance staff.	0.661
I was generally satisfied with the demeanor of the ambulance staff.	0.553
Ambulance staff were in uniform.	0.375
Ambulance staff paid attention to hygiene rules.	0.308
I found the teamwork of the ambulance staff good.	0.688
Ambulance staff did their best for us.	0.581
Ambulance staff paid attention to the privacy of the patient/injured.	0.477
Ambulance staff were friendly.	0.493
Ambulance staff gave clear answers to our questions.	0.532
Ambulance staff explained the necessary procedures.	0.539
The devices brought by the ambulance staff worked smoothly.	0.668
Ambulance staff explained clearly why the patient/injured should be transferred/not transferred to the hospital.	0.527
Ambulance staff delivered the patient/injured person to the hospital as soon as possible.	0.647
The ambulance was adequately equipped for all kinds of interventions.	0.642
The interior of the ambulance was suitable for weather conditions.	0.755
The interior of the ambulance was quiet, noiseless and comfortable.	0.688
The ambulance provided safe transportation to the hospital.	0.687

of the total variance. On the other hand, for multifactor structures, the total variance explained is expected to be 40% (8). Therefore, this value was taken as a reference in the scale developed in the study, and it was concluded that the scale met the necessary conditions.

The nature of the factors in the scale obtained as a result of EFA, the general structure of the scale, and the extent to which the scale to be obtained explains patient satisfaction were determined by CFA. CFA was conducted on a scale consisting of 4 factors and 30 items developed as a result of EFA. In CFA, regression coefficients between factors and items take values between 0 and 1, and it is desirable that these coefficients are as close to 1 as possible. In the literature, items with regression coefficients below 0.40 are recommended to be excluded from the analysis (8). Therefore, items with regression coefficients below 0.40 were excluded from the analysis. After each item was removed, the analysis was repeated. The regression coefficients of items 1 and 2 under the second factor and items 1 and 13 under the first factor were found to be below 0.40. Therefore, these four items with low regression coefficients were removed from the scale because they did not represent the latent variables well. Finally, CFA was applied to the scale consisting of 26 items and 4 factors (Figure 1). In CFA, three covariances were created after the four items were removed from the analysis. This was done to improve the fit index values obtained while preparing the research model diagram in AMOS. When creating covariances between items, it is recommended to create covariances between items using the same factor. In this context, covariances were created between items 2 and 3 and items 11 and 12 under the first factor and between items 5 and 6 under the third factor. After each covariance correction, the calculation was repeated and the fit index values were recalculated. The final calculated fit index values of the developed scale are presented in Table 5. The values obtained were within acceptable limits. Therefore, the factors identified by EFA and the items' loading on the factors were confirmed by CFA.

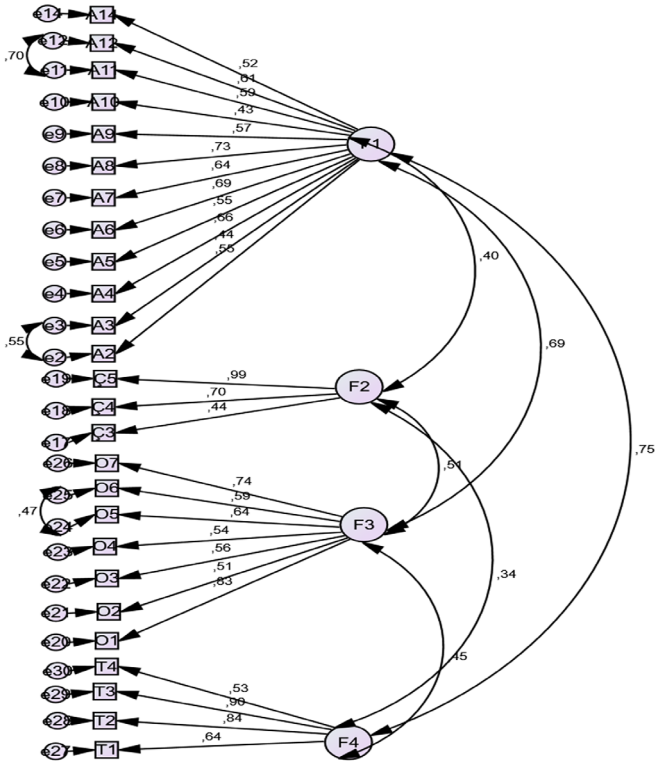

Figure 1. Output of the confirmatory factor analyses

Discussion

The main characteristics of a quality measurement tool are validity and reliability. The validity is the degree to which the scale used can measure the phenomenon. Reliability is the consistency between all questions in the measurement tool and its ability to measure in the same way each time it is used (9). The content validity of the developed scale was evaluated using the CVR index, and internal consistency reliability was calculated using Cronbach's alpha coefficient. Cronbach's alpha coefficient is an indicator of the homogeneity and internal consistency of items in a scale. This coefficient is calculated between 0 and 1, and it is desirable for it to be as large as possible. The larger the Cronbach's alpha coefficient, the more consistent are the items on the scale with each other. For Likert-type scales, Cronbach's alpha coefficient should be as close to 1 as possible (10). A Cronbach's alpha coefficient >0.50 is considered the minimum acceptable value for internal consistency (11). For factor analysis, it is first necessary to assess whether the available data are suitable for factor analysis. For this purpose, a correlation matrix is first created, and variables with strong correlations are identified. Variables with strong correlations are typically grouped under the same factor. Then, Bartlett's test was performed to determine whether the data were suitable for factor analysis. If the Bartlett test value is $p<0.05$, the data are considered suitable for factor analysis. Finally, sampling adequacy was measured using the KMO test, and the KMO value was expected to approach 1. In the literature, the values found in the KMO test are considered unacceptable if they are below 0.50; poor if they are 0.50; moderate if they are 0.60; good if they are 0.70; very good if they are 0.80; and excellent if they are 0.90 (12).

The construct validity of the developed scale was analyzed by EFA and CFA. Factor analysis is a multivariate statistical analysis based on the relationships among data, providing a more concise presentation of it (13). The main purpose of factor analysis is to group a large number of variables, determine whether they can

Table 4. Distribution of items according to the Varimax method				
Items/dimensions	**Factors**			
Ambulance staff dimension	**1**	**2**	**3**	**4**
The ambulance arrived at the address I provided without delay.	0.510			
The ambulance staff asked questions about the patient's/injured person's complaints.	-0.654			
Ambulance staff listened to the patient's/injured person's complaints.	-0.685			
Ambulance staff gave explanatory information about the patient/injured.	0.709			
Ambulance staff paid enough attention to the patient/injured person.	-0.370			
Ambulance staff gave morale to the patient/relative.	0.345			
I trusted the professional knowledge of the ambulance staff.	0.536			
I was generally satisfied with the demeanor of the ambulance staff.	0.529			
Ambulance staff were in uniform.	0.539			
Ambulance staff paid attention to hygiene rules.	0.460			
I found the teamwork of the ambulance staff good.	0.808			
Ambulance staff did their best for us.	0.716			
Ambulance staff explained clearly why the patient/injured person should be transported/not be transported to the hospital.	0.557			
Ambulance staff delivered the patient/injured person to the hospital as soon as possible.	0.578			
Explained variance.	29.775%			
Call answering staff dimension	**1**	**2**	**3**	**4**
When I called 1-1-2, I reached the staff on duty quickly and easily.		0.454		
The staff who answered the phone listened to me carefully.		0.828		
The staff member who answered the phone understood what I was saying.		0.521		
The staff who answered the phone was respectful towards me.		0.567		
I trusted the staff who answered the phone.		0.436		
Explained variance.	9.465%			
On-scene service delivery dimension	**1**	**2**	**3**	**4**
Ambulance staff applied the necessary intervention to the patient/injured at the scene.			0.684	
Ambulance staff brought all the devices they will use to the scene.			0.676	
Ambulance staff paid attention to the privacy of the patient/injured.			0.573	
Ambulance staff were friendly.			0.414	
Ambulance staff gave understandable answers to our questions.			0.593	
Ambulance staff explained the necessary procedures.			0.676	
The devices brought by the ambulance staff worked smoothly.			0.727	
Explained variance.	80.365%			
Ambulance technical equipment dimension	**1**	**2**	**3**	**4**
The ambulance was adequately equipped for any kind of intervention.				-0.473
The interior of the ambulance was suitable for weather conditions.				-0.816
The interior of the ambulance was quiet, noiseless and comfortable.				-0.652
The ambulance provided safe transportation to the hospital.				0.732
Explained variance.	7.244%			
Total explained variance.	54.848%			

Table 5. Fit indices of the model*

Concordance indices	p	CMIN	DF	CMIN/DF	IFI
Standard model	0.000	1139.70	290	3.93	0.922
Concordance indices	**CFI**	**RMSEA**	**GFI**	**RMR**	**AGFI**
Standard model	0.950	0.080	0.854	0.049	0.957

*AGFI, CMI, DF which is the difference between the number of observed data points and the number of estimated parameters. RMSEA refers to the which evaluates model fit in structural equation modeling. RMR stands for the, indicating the average residual error in the model. CFI or the, compares the fit of a target model to an independent baseline model. GFI is the assessing how well the model reproduces observed data. Lastly, IFI stands for the evaluating model improvement over a baseline model. AGFI: Adjusted goodness of fit index, CMIN: Chi-square minimum value, DF: Degrees of freedom, RMSEA: Root mean square error of approximation, RMR: Root mean square residual, CFI: Comparative fit index, GFI: Goodness of fit index, IFI: Incremental fit index

be expressed as factors, and identify which factor the items in the scale should belong to. In this way, the researcher can easily interpret the meaning of the relevant factor by examining the items included in the grouped factors (14).

In the second stage, EFA was performed. EFA is a type of analysis that divides a large number of variables into different groups and transforms the groups into new variables by maximizing the relationships within a group and reducing the links between groups. These new variables are called factors. This strategy aims at reducing the number of variables and revealing new constructs by exploiting the relationships between variables (15). The rotated factor matrix is then created. Correlation coefficients or factor loadings are examined to determine which factor each independent variable falls under. In addition, the researcher can subject factors to axis rotation for factor analysis. The factor rotation does not affect the basic mathematical properties of the solution. As a result of axis rotation, the loading of items in one factor increases, whereas the loading in other factors decreases. Thus, factors have high correlation with each other and can be interpreted more easily. The varimax, quartile, and equamax rotation methods are most commonly used. In the final stage, the resulting factors are labeled and each factor is given a name. In the third stage, CFA was conducted. CFA is an analysis that aims to verify the model used in scale development and validity analyses of a previously created model. CFA evaluates the compatibility of the factors created by EFA with the items under them. In structural equation models, the conceptual model is assessed using data. CFA is generally used in scale development and validity analysis and aims to determine the accuracy of a predetermined structure (16). Fit statistics quantify how well the pre-built models describe the data. The model fit is evaluated using various fit statistics. The fit statistics were used to evaluate the suitability of the parameters of the suggested models and the statistics derived from the sample data. A model cannot be accepted if it does not suit the data (17).

As a result of the analyses conducted in line with the study's purpose, factors were identified, and a valid and reliable measurement tool was developed using EFA and CFA. The EFA and CFA revealed that the scale developed in the research consists of 4 dimensions and 26 items. The dimensions consisted of questions about the following: the ambulance staff; the call-answering staff; on-scene service provision; and the technical equipment of the ambulance (18).

We have introduced a valid and reliable measurement tool that can handle all subdimensions of the subject in detail in the literature. The KMO analysis result was 0.636, and Bartlett's test result was 10133.638, which was found to be significant ($p<0.01$) (19). The factor structure was analyzed using principal component analysis and the Varimax rotation method. The factor loading values of the items ranged from 0.304 to 0.755 (20). In the present study, we included those with a factor loading value greater than 0.30. As a result, a scale with three dimensions and 30 items was obtained. The total variance explained by the 30 items in the four dimensions was 58.848%. After CFA was performed on the data, four additional items with low regression coefficients were removed from the scale (20). A valid and reliable measurement tool consisting of 4 dimensions and 26 items was introduced to the literature from the finalized scale model, with fit indices within acceptable limits (Appendix 2).

The developed scale has significant implications for both practical applications and healthcare policy. By providing a validated and reliable tool specifically tailored for 112 Emergency Healthcare Services, this scale bridges an essential gap in the literature. The multidimensional structure allows for a comprehensive evaluation of service quality, addressing critical aspects such as ambulance staff, call-answering personnel, on-scene service provision, and technical equipment. These dimensions not only facilitate the assessment of current service standards and provide actionable insights to guide improvements in emergency healthcare delivery. Furthermore, the scale's robust psychometric properties ensure its applicability across various settings, supporting its use in broader healthcare policy initiatives to enhance patient satisfaction and service efficiency. By segmenting key points and highlighting their potential contributions, this study underscores the novelty and practical value of the proposed measurement tool.

Study Limitations

Unconscious patients who received services from 112 Emergency Health Services during the study dates constitute a limitation of this study, because the questionnaire could not be applied. The

relatives of these patients were interviewed and included in the study.

Conclusion

The findings of this study provide an appropriate and reliable tool to measure all aspects of patient satisfaction with 112 Emergency Health Services. As a result of this study, the necessary validity and reliability analyses were performed, and the 112 Patient Satisfaction in Emergency Health Services Scale consisting of 4 sub-dimensions and 26 items was developed. The 112 Patient Satisfaction in Emergency Health Services Scale is a valid and reliable measurement tool that measures patient satisfaction with 112 Emergency Health Services. The developed scale is a tool that can be used by health managers, health professionals, researchers, and related people to measure the level of satisfaction with 112 Emergency Health Services. For each item in the scale, an increase in the total score indicates an increase in satisfaction, and a decrease in the total score indicates a decrease in satisfaction.

Ethics

Ethics Committee Approval: The study was conducted in accordance with ethical rules at all stages and adhered to the COPE guidelines. Ethical approval was obtained from the Non-Interventional Clinical Research Ethics Committee of Selçuk University, Faculty of Health Sciences (decision number: 05, date: 27.05.2015). Additionally, written permission to conduct the study was obtained from the Aksaray Provincial Directorate of Health.

Informed Consent: Written consent was obtained from all participants, who were assured of the confidentiality and anonymity of their data. For participants who were relatives of unconscious patients, the same process of information dissemination and consent was followed.

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Footnotes

Authorship Contributions

Concept: E.K, Y.E.Ö, Design: E.K, Y.E.Ö, Data Collection or Processing: E.K, Analysis or Interpretation: E.K, Y.E.Ö, Literature Search: E.K, Writing: E.K.

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Appendix 1: Satisfaction with Emergency Health Services Scale				
Inventory	**Not required**	**Possible but not necessary**	**Absolutely necessary**	**KGO Index**
When I called 112, I reached the staff on duty quickly and easily.	0	1	9	0.80
The staff member who answered the phone listened to me carefully.	0	0	10	1
The staff member who answered the phone explained what I needed to do in a way I could understand and informed me.	0	0	10	1
The staff member who answered the phone understood what I was saying.	0	1	9	0.80
The staff member who answered the phone was respectful to me.	0	1	9	0.80
I trusted the staff member who answered the phone.	0	1	9	0.80
I was generally satisfied with the staff who answered the phone.	0	0	10	1
The ambulance arrived at the address I gave without any delay.	0	1	9	0.80
The ambulance staff asked questions about the patient's/injured person's complaints.	0	1	9	0.80
Ambulance staff listened to the patient's/injured person's complaints.	0	1	9	0.80
Ambulance personnel applied the necessary intervention to the patient/injured at the scene.	0	0	10	1
Ambulance personnel gave explanatory information about the patient/injured.	0	0	10	1
Ambulance personnel showed enough care for the patient/injured person.	0	1	9	0.80
Ambulance personnel brought all the devices they would use to the scene.	0	1	9	0.80
Ambulance personnel gave morale to the patient/relative.	0	1	9	0.80
I trusted the professional knowledge of the ambulance personnel.	0	0	10	1
I was generally satisfied with the demeanor of the ambulance personnel.	0	1	9	0.80
Ambulance personnel were in uniform.	0	1	9	0.80
Ambulance personnel paid attention to hygiene rules.	0	0	10	1
I found the teamwork of the ambulance personnel good.	0	0	10	1
Ambulance personnel did their best for us.	0	0	10	1
Ambulance personnel paid attention to the privacy of the patient/injured.	0	0	10	1
Ambulance personnel were friendly.	0	1	9	0.80
Ambulance staff gave understandable answers to our questions.	0	1	9	0.80
Ambulance staff explained the necessary procedures.	0	0	10	1
The devices brought by the ambulance staff worked smoothly.	0	1	9	0.80
Ambulance personnel explained clearly why the patient/injured person should be transported/not be transported to the hospital.	0	1	9	0.80
Ambulance personnel delivered the patient/injured person to the hospital as soon as possible.	0	0	10	1
The ambulance was adequately equipped for all kinds of interventions.	0	0	10	1
The interior of the ambulance was suitable for weather conditions.	0	0	10	1
The interior of the ambulance was quiet, noiseless and comfortable.	0	1	9	0.80
The ambulance provided safe transportation to the hospital.	0	1	9	0.80

Appendix 2. Satisfaction with Emergency Health Services Scale					
Items/dimensions	**Strongly disagree**	**Disagree**	**Undecided**	**I agree**	**Absolutely agree**
Ambulance staff dimension					
1. Ambulance personnel asked questions about the patient's/injured person's complaints.	1	2	3	4	5
2. Ambulance personnel listened to the complaints of the patient/injured.	1	2	3	4	5
3. Ambulance personnel gave explanatory information about the patient/injured.	1	2	3	4	5
4. Ambulance personnel showed enough care for the patient/injured person.	1	2	3	4	5
5. Ambulance personnel gave morale to the patient/relative.	1	2	3	4	5
6. I trusted the professional knowledge of the ambulance personnel.	1	2	3	4	5
7. I was generally satisfied with the demeanor of the ambulance personnel.	1	2	3	4	5
8. Ambulance personnel were in uniform.	1	2	3	4	5
9. Ambulance personnel paid attention to hygiene rules.	1	2	3	4	5
10. I found the teamwork of the ambulance staff good.	1	2	3	4	5
11. Ambulance personnel did their best for us.	1	2	3	4	5
12. Ambulance personnel delivered the patient/injured person to the hospital as soon as possible.	1	2	3	4	5
Call answering staff dimension					
13. The staff member who answered the phone understood what I was saying.	1	2	3	4	5
14. The staff member who answered the phone was respectful to me.	1	2	3	4	5
15. I trusted the staff member who answered the phone.	1	2	3	4	5
On-scene service delivery dimension					
16. Ambulance personnel applied the necessary intervention to the patient/injured at the scene.	1	2	3	4	5
17. Ambulance personnel brought all the devices they will use to the scene.	1	2	3	4	5
18. Ambulance personnel paid attention to the privacy of the patient/injured.	1	2	3	4	5
19. Ambulance personnel were friendly.	1	2	3	4	5
20. Ambulance personnel gave understandable answers to our questions.	1	2	3	4	5
21. Ambulance personnel explained the necessary procedures.	1	2	3	4	5
22. The devices brought by the ambulance personnel worked smoothly.	1	2	3	4	5
Ambulance technical equipment dimension					
23. The ambulance was adequately equipped for all kinds of interventions.	1	2	3	4	5
24. The interior of the ambulance was suitable for weather conditions.	1	2	3	4	5
25. The interior of the ambulance was quiet, noiseless and comfortable.	1	2	3	4	5
26. The ambulance provided safe transportation to the hospital.	1	2	3	4	5

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Identifying Key Inflammatory Markers of Mortality in Acute Ischemic Stroke Using Logistic Regression Analysis

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Abstract

Aim: This study evaluates the prognostic significance of inflammatory markers in predicting in-hospital mortality among acute ischemic stroke (AIS) patients and constructs a logistic regression model to identify the most relevant predictors.

Materials and Methods: A retrospective analysis was conducted on 259 AIS patients. Laboratory findings were analyzed to compare survivors and non-survivors. To address potential multicollinearity, a correlation matrix and variance inflation factor analysis were applied to identify the most relevant inflammatory markers for logistic regression.

Results: Non-survivors exhibited significantly higher levels of C-reactive protein (CRP), CRP/albumin ratio (CAR), white blood cell count, neutrophil count, neutrophil/lymphocyte ratio, and platelet/lymphocyte ratio, while lymphocyte and albumin levels were lower. Univariable analysis identified albumin and CAR as key predictors, with albumin significantly associated with increased mortality risk [odds ratio (OR): 1.16, 95% confidence interval (CI): 1.081-1.253, $p<0.001$], whereas CAR was associated with reduced mortality (OR: 0.729, 95% CI: 0.589-0.902, $p=0.004$). However, in the final multivariable model, only albumin remained statistically significant (OR: 1.137, 95% CI: 1.043-1.240, $p=0.03$), suggesting its independent prognostic value.

Conclusion: Careful selection of variables for inclusion in the logistic regression model is crucial, as not all variables may exert a significant influence on survival or mortality outcomes. Albumin emerged as an independent predictor of in-hospital mortality in AIS patients, while other inflammatory markers lost significance in multivariable logistic regression analysis. This underscores the potential role of albumin in early risk stratification and prognosis.

Keywords: Acute ischemic stroke, emergency department, markers of inflammation, logistic regression analysis, accurate modeling, prognosis

Introduction

Acute ischemic stroke (AIS), accounting for approximately 87% of all stroke cases, is a critical medical emergency caused by the abrupt cessation of blood flow to a specific area of the brain, leading to neurological deficits (1). Mortality in AIS is influenced by various risk factors, including age, sex; comorbidities such as diabetes, hypertension, atrial fibrillation, and coronary artery disease; metabolic factors like high systolic blood pressure, elevated low-density lipoprotein and cholesterol levels, renal dysfunction, high body mass index; and the timing of interventions such as tissue plasminogen activator administration and endovascular thrombectomy (2-4). Despite these well-established prognostic factors, our study specifically aimed to assess the independent prognostic value of inflammatory markers, which are readily available at emergency department (ED) admission, and objectively measurable. This approach allows for a focused analysis of laboratory-based markers without the variability associated with clinical scoring systems.

The role of inflammation in AIS has gained growing attention due to its emerging significance in stroke outcomes. Inflammation exacerbates stroke severity by promoting secondary brain injury through mechanisms such as endothelial dysfunction, increased blood-brain barrier permeability, and the activation of pro-inflammatory cytokines (5,6). This process ultimately worsens patient outcomes by leading to cerebral edema, increased intracranial pressure, and further ischemic damage. For instance,

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elevated levels of markers such as C-reactive protein (CRP), neutrophil-to-lymphocyte ratio (NLR), and interleukin-6 have been linked to poor prognoses in AIS patients (7-10). Despite its recognized importance, studies specifically examining the prognostic value of inflammatory markers measured at the time of emergency admission remain limited. Therefore, identifying reliable inflammatory biomarkers is crucial for timely risk stratification in AIS patients.

Given this context, the present study focuses on evaluating the predictive value of inflammatory markers measured during ED admission in patients with AIS. Determining which biomarkers most effectively predict mortality could guide early risk stratification and improve patient management. To achieve this, we employed binary logistic regression, a statistical method commonly used for modeling binary outcomes such as survival or death (11). The accurate construction of logistic regression models is crucial for ensuring reliable predictions. Proper variable selection is essential because including irrelevant or highly correlated predictors may lead to misleading results. For instance, Yang et al. (12) highlighted the importance of appropriate variable selection in improving logistic regression model accuracy when predicting heart failure risk factors. Similarly, Bélanger et al. (13) demonstrated that selecting clinically significant variables enhanced prediction accuracy in models assessing Alzheimer's disease risk. These examples underscore the direct relationship between variable selection and the predictive power of a logistic regression model.

Additionally, addressing multicollinearity where predictors are highly correlated is vital for maintaining stable coefficient estimates and ensuring the statistical reliability of the model. As Algamal and Hammood (14) emphasized, failure to manage multicollinearity can compromise the validity of logistic regression results by inflating standard errors and producing unstable coefficients.

Thus, this study aims to identify key inflammatory markers associated with in-hospital mortality in AIS patients and construct a robust logistic regression model to evaluate their prognostic value. By focusing on both clinical relevance and statistical robustness, we aim to contribute to more effective risk stratification strategies and improve early clinical decision making in the ED setting.

Materials and Methods

Study Design and Patient Selection

This study was initiated with the approval of Niğde Ömer Halisdemir University Non-Interventional Clinical Research Ethics Committee (decision number: 2024/123, date: 12.12.2024). This retrospective study included 259 patients admitted to the ED of Niğde Training and Research Hospital between October 1, 2021, and October 1, 2023, with a confirmed diagnosis of AIS. Patient identification was performed through a systematic review of hospital electronic medical records using the International Classification of Diseases codes related to AIS. Medical records were reviewed to verify diagnoses through clinical findings supported by radiological findings such as brain computed tomography and diffusion magnetic resonance imaging. Patients aged 18 years and older with a definitive AIS diagnosis were eligible for inclusion. Inclusion criteria required accessible hospital records, hospitalization with an AIS diagnosis, and complete laboratory data. Severe chronic diseases, including terminal cancer, end-stage renal failure, and advanced liver failure, were excluded because they can trigger persistent systemic inflammation, potentially influencing inflammatory indices NLR, [CRP/albumin ratio (CAR), platelet/lymphocyte ratio (PLR), and neutrophil/platelet ratio (NPR)] and obscure the relationship between stroke-related inflammation and mortality outcomes. Additionally, patients with hemorrhagic stroke, acute trauma, or incomplete hospital records were excluded.

Operational Definitions

The following formulas were used to calculate the inflammatory indices:

NLR: Neutrophil count (10^3/μL)/Lymphocyte count (10^3/μL)

CAR: C-reactive protein (mg/dL)/Albumin (g/dL)

PLR: Platelet count (10^3/μL)/Lymphocyte count (10^3/μL)

NPR: Neutrophil count (10^3/μL)/Platelet count (10^3/μL)

Statistical Analysis

The Shapiro-Wilk test was applied to determine the normality of the data distribution, revealing that all quantitative data exhibited a non-parametric distribution. Descriptive statistics are expressed as medians (interquartile range: 25-75 percentiles) for continuous quantitative variables, while categorical variables are presented as frequencies and percentages. Pearson's chi-square test or Fisher's exact test was used to compare categorical variables. The Mann-Whitney U test was applied for comparisons of non-parametric continuous variables. Binary logistic regression analysis was conducted using the enter method to evaluate factors affecting mortality. Correlation analysis using Spearman's rho test was performed to detect multicollinearity among variables. Variables showing a high degree of correlation were reviewed, and one was excluded to avoid redundancy, ensuring that only the most representative variable was included in the logistic regression model. Both univariable and multivariable

logistic regression analyses were conducted to identify the most predictive inflammatory markers for mortality. All data were recorded using Microsoft Excel (2010, Redmond, WA, USA), and statistical analyses were performed using IBM SPSS Statistics Version 27 (SPSS Inc., Chicago, IL, USA). Statistical significance was set at $p<0.05$.

Testing the Multicollinearity Problem for Logistic Regression Analysis

To detect multicollinearity, attention should be paid to highly correlated pairs of variables in the correlation matrix. Typically, a correlation coefficient of 0.7 or above indicates a multicollinearity problem (15). Furthermore, a variation inflation factor (VIF) of >10 indicates a high probability of multicollinearity, and it is recommended to exclude variables with high VIF values from the model (16). In this context, if two variables showed a correlation coefficient of $|r| > 0.7$, or VIF value > 10, indicating a high degree of collinearity, the variable with less clinical relevance or weaker association with the outcome, based on previous literature, was excluded to improve model stability and interpretability.

Results

The relationships between demographic, clinical, and laboratory characteristics and mortality in patients with AIS are presented in Table 1. In total, 259 patients were included in this study (Table 1). The median age of the patients was 75 years (67-82); it was 75 years (66-80) in survivors and 83 years (71-90) in deceased patients, and this difference was statistically significant (p=0.001). Male patients constituted 58.7% of the entire group, 60.5% of the survivors, and 47.2% of the deceased patients (p=0.186). In laboratory data, white blood cell (WBC) count was significantly higher in the deceased group, with a median of 8.50 (6.81-10.49) in survivors and 9.86 (7.75-12.07) in deceased patients (p=0.025). Similarly, the neutrophil count was significantly higher in the deceased median: 7.67 (4.63-10.14). In survivors, it was 5.34 (4.30-6.98) (p=0.005). In terms of lymphocyte count, the median was 1.38 (1.01-1.69) in the deceased and 1.79 (1.25-2.55) in the survivors, and this difference was significant (p=0.004). The median albumin level was 42 g/L (a range of: 39-44) among the survivors and 38 g/L (a range of: 34-41) among the deceased group, showing a significant difference (p<0.001). CRP values were significantly higher in the deceased group (median: 11.90, 2.67-68.07) compared to the survivors (median: 3.40, 1.70-9.40) (p=0.002). Among the inflammatory indices, NLR was higher in the deceased group median: 5.52 (2.67-11.44) and in the survivors median: 2.92 (1.82-5.39) (p=0.001). Similarly, PLR and CAR were significantly higher in the deceased group (p=0.004 and p=0.001, respectively). The length of hospital stay was longer in patients who died 10 days (5-22.25) vs. 5 days (3-9), p<0.001. There was no significant difference between the groups in terms of NPR values (p=0.557).

Variable Selection and Multicollinearity Management

Accordingly, the correlation analysis revealed high correlations between WBC and neutrophils (r=0.846, p<0.001; VIF for WBC: 1.760, VIF for neutrophil: 8.245), CRP and CAR (r=0.997, p<0.001;

Table 1. Association of demographic, clinical and laboratory characteristics with mortality in patients with acute ischemic stroke

Parameters	Mortality		p value
	Yes n=36	No n=223	
Age	83 (71-90)	75 (66-80)	<0.001
Sex, n (%) Male Female	 17 (47.2) 19 (52.8)	 135 (60.5) 88 (39.5)	0.186
Length of hospitalization (days)	10 (5-22.25)	5 (3-9)	<0.001
WBC (x10^3/µL)	9.86 (7.75-12.07)	8.50 (6.81-10.49)	0.025
CRP (mg/dL)	11.90 (2.67-68.07)	3.40 (1.70-9.40)	0.002
Neutrophils (x10^3/µL)	7.67 (4.63-10.14)	5.34 (4.30-6.98)	0.005
Platelets (x10^3/mL)	340 (258-452)	289 (190-426)	0.066
Lymphocytes (x10^3/µL)	1.38 (1.01-1.69)	1.79 (1.25-2.55)	0.004
Albumin (mg/dL)	38 (34-41)	42 (39-44)	<0.001
NLR	5.52 (2.67-11.44)	2.92 (1.82-5.39)	0.001
CAR	0.33 (0.07-1.75)	0.08 (0.40-0.22)	0.001
PLR	240.54 (136.32-380.75)	159.42 (96.05-267.61)	0.004
NPR	0.209 (0.014-0.035)	0.0194 (0.012-0.032)	0.557

Continuous data are presented as median (interquartile range: 25-75). WBC: White blood cell, CRP: C-reactive protein, NLR: Neutrophil/lymphocyte ratio, CAR: C-reactive protein/albumin ratio, PLR: Platelet/lymphocyte ratio, NPR: Neutrophil/platelet ratio

VIF for CAR: 28.956, VIF for CRP: 27.618), neutrophil count and NLR (r=0.720, p<0.001; VIF for neutrophil: 8.245, VIF for NLR: 7.253), and neutrophils and NPR (r=0.773, p<0.001; VIF for neutrophil: 8.245, VIF for NPR: 6.071), raising the possibility of multicollinearity. Based on the correlation matrix and VIF values, it was deemed appropriate to include neutrophils as a more direct marker of inflammation, CAR as a more comprehensive inflammatory marker, and NLR as a comparative marker. In addition, albumin, which has a statistically significant effect on mortality and does not exhibit multicollinearity, was included in the model. Finally, PLR, which is a more clinically relevant marker than NPR, was included in the model. Consequently, neutrophils, CAR, NLR, PLR, and albumin were preferred in the proposed model (VIF values: 3.200, 1.414, 4.651, 2.031, and 1.288, respectively).

Univariable and Multivariable Modeling

The results of binary logistic regression analysis of the five parameters included in the model are presented in Table 2. In the univariable model, each unit increase in neutrophil count and CAR, NLR, and PLR levels increased the risk of mortality and decreased the probability of survival. In contrast, an increase in albumin levels has a decreasing effect on mortality risk and an increasing effect on survival probability.

In the multivariable model, albumin level was the only variable significantly associated with mortality risk, while other factors, including neutrophil count, CAR, NLR, and PLR, showed no statistically significant impact. Given its strong association with mortality, albumin emerged as the most critical factor contributing to survival. Model fit analysis revealed a -2 log likelihood value of 184.353 and a Nagelkerke R^2 value of 0.163, indicating that the variables in the final model explained 16.3% of the variance in mortality risk (Table 2).

Discussion

This study evaluated the association between inflammatory markers measured at emergency admission and in-hospital mortality among patients with AIS using a binary logistic regression model. The results highlight the prognostic value of albumin and CAR in predicting mortality risk. Univariable analysis indicated that elevated neutrophil count, CAR, NLR, and PLR were associated with an increased mortality risk, whereas higher albumin levels were protective. However, in the multivariable model, only albumin retained statistical significance, underscoring its critical role in patient survival.

The protective effect of albumin aligns with its established anti-inflammatory and neuroprotective properties (17,18). Its inverse association with mortality risk supports its role as a negative acute phase reactant. Hypoalbuminemia may reflect a heightened inflammatory response and compromised nutritional status, which are both associated with adverse AIS outcomes (19). The prominence of albumin as a strong independent predictor in multiple analyses emphasizes that it is a potential biomarker for in-hospital mortality risk. This may make an important contribution to clinical practice and suggests that routine monitoring of albumin levels may play a role in the management of serious diseases, particularly stroke. This finding corroborates previous research demonstrating that lower albumin levels predict worse survival across various acute medical conditions. Although CAR emerged as a strong mortality indicator in the univariable model, its statistical significance was diminished in the multivariable analysis. This outcome likely reflects its inherent correlation with albumin, which is a key component of the CAR calculation. Similarly, while NLR and PLR were significant predictors in univariable analysis, their effects weakened after adjustment, suggesting multicollinearity as a contributing factor.

Systemic inflammation plays a significant role in stroke severity, influencing both acute and long-term outcomes. Elevated levels of inflammatory markers have been linked to worse functional recovery and increased mortality following both ischemic and hemorrhagic strokes (20,21). Numerous studies in the literature highlight the prognostic value of these inflammatory indices in AIS, although their applicability may vary depending on the

Table 2. Logistic regression model

Variable	Univariable model		Multivariable model*	
	OR (95% CI)	p value	OR (95% CI)	p value
Neutrophil	0.900 (0.833-0.973)	**0.008**	0.974 (0.837-1.133)	0.729
CAR	0.729 (0.589-0.902)	**0.004**	0.965 (0.751-1.240)	0.780
NLR	0.920 (0.873-0.970)	**0.002**	0.920 (0.858-1.100)	0.646
PLR	0.998 (0.996-0.999)	**0.007**	0.999 (0.996-1.001)	0.291
Albumin	1.164 (1.081-1.253)	**<0.001**	1137 (1.043-1.240)	**0.003**

Model summary: Nagelkerke R square: 0.163, Hosmer and Lemeshow test, the chi-square: 3.614, sig. (p): 0.890 CAR: C-reactive protein/albumin ratio, NLR: Neutrophil/lymphocyte ratio, PLR: Platelet/lymphocyte ratio, CI: Confidence interval, OR: Odds ratio CI: Confidence interval

patient population and study context (22-24). For instance, several investigations have found that elevated NLR levels are associated with poorer functional outcomes and higher mortality rates in AIS patients (9,10). However, unlike these studies, the present research found, albumin to be the only significant independent predictor of mortality in multivariable analysis, despite the initial significance of markers like CAR and NLR. Again, this finding underlines the importance of considering albumin not merely as part of CAR but as an independent indicator of prognosis. Vo et al. (25) reported that elevated WBC levels in patients with acute ischaemic stroke increased the risk of death and new vascular events after adjustment for infection. The present study also found that WBC and neutrophil counts were significantly higher in deceased patients, which is consistent with the role of systemic inflammation in stroke severity. While these markers were excluded owing to multicollinearity, their significance underscores the need for future studies exploring more comprehensive inflammatory profiles.

Furthermore, a statistically significant effect of advanced age on mortality was observed, which was hypothesized to be primarily attributable to frailty and diminished physiological reserves associated with senescence. Although the sex differences were not statistically significant, subsequent investigations in larger cohorts may elucidate potential gender-related disparities. Additionally, in a study by Labán-Seminario et al. (26), prolonged hospitalization in patients with ischemic stroke was associated with increased mortality. In our study, the duration of hospitalization was longer in patients who died. This is probably due to the severity of the disease at baseline and complications that arise during treatment.

Finally, future research should include larger multicenter cohorts and dynamic monitoring of inflammatory markers to capture their temporal evolution. Studying the interactions between albumin and other biomarkers may provide a more comprehensive understanding of the risk of inflammation-induced mortality in AIS.

Study Limitations

This study has several limitations. The most significant limitation is that, although various clinical and demographic factors influence AIS mortality, this study specifically focused on laboratory-based inflammatory markers to assess their independent prognostic value. While data on age, sex, and length of hospital stay were available, they were not included in the final multivariable regression model. This decision was made to maintain the focus on inflammatory indices and avoid potential collinearity or distort the impact of inflammatory parameters, which could have affected the generalizability of the findings.

Another important limitation was the lack of stroke severity scores, such as the National Institutes of Health Stroke Scale and modified Rankin Scale, which are widely used prognostic indicators. As these scores were not systematically recorded for all patients, their inclusion in the model could have introduced selection bias and affected the validity of the results. Additionally, inflammatory markers were measured only at hospital admission, making it impossible to assess the changes over time.

The single-center nature of this study may also limit the generalizability of the findings to broader populations. Finally, as this was an observational study, it does not allow for definitive conclusions regarding causality. Future research should integrate both inflammatory biomarkers and clinical severity scores to develop a more comprehensive prognostic model for AIS mortality.

Conclusion

This study highlights albumin level as an independent predictor of in-hospital mortality in patients with AIS. While inflammatory indices such as CAR, NLR, and PLR offer valuable initial insights, the consistent significance of albumin underscores its clinical utility for risk stratification. Routine albumin assessment in emergency settings can facilitate early risk evaluation and guide treatment strategies in patients with AIS.

Ethics

Ethics Committee Approval: This study was initiated with the approval of Niğde Ömer Halisdemir University Non-Interventional Clinical Research Ethics Committee (decision number: 2024/123, date: 12.12.2024).

Informed Consent: This retrospective study included 259 patients admitted.

Footnotes

Authorship Contributions

Concept: A.V., Design: A.V., Data Collection or Processing: A.V. M.O.C., Analysis or Interpretation: A.V. M.O.C., Literature Search: A.V. M.O.C., Writing: A.V. M.O.C.

Conflict of Interest: The authors declare that they have no conflict of interest.

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The Evaluation of ChatGPT-4's Capacity to Provide Information on Febrile Seizures

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Abstract

Aim: This study aims to evaluate the capacity of ChatGPT-4 to provide accurate and reliable information about febrile seizures, focusing on its ability to deliver educational content and support caregivers and healthcare professionals.

Materials and Methods: A total of 30 questions related to febrile seizures were derived from the National Institute of Neurological Disorders and Stroke (NINDS) website. These questions were categorized into five main themes: "overview of febrile seizures," "symptoms and causes," "diagnosis," "treatment and management strategies," and "advice for families." Responses generated by ChatGPT-4 were assessed by experienced pediatricians and neurologists for accuracy and educational value, with results compared against ChatGPT-3.5 and the NINDS guidelines.

Results: Of the 30 responses evaluated, 22 were classified as "educationally valuable," 7 as "accurate but insufficient," and 1 as a "mix of correct and outdated information." None of the responses were deemed completely incorrect. In comparison with ChatGPT-3.5, ChatGPT-4 provided "better" responses for 8 questions, "similar" responses for 20, and "worse" responses for 2. Compared to the NINDS guidelines, ChatGPT-4 delivered comparable or superior responses in most cases, except for four questions where the official guidelines performed better due to richer context and graphical support.

Conclusion: ChatGPT-4 demonstrates substantial potential as an educational tool for febrile seizures, offering accurate and comprehensible information to caregivers and healthcare professionals. However, limitations such as the lack of detailed explanations and visual aids highlight the need for further development. Future research should explore broader datasets and user feedback to optimize these tools for personalized medical education.

Keywords: ChatGPT-4, febrile seizures, artificial intelligence in healthcare

Introduction

Febrile convulsions are defined as seizures with fever of 38°C or higher in children between the ages of 6 months and 5 years without central nervous system infection (1). The fact that it is seen in 2-5% of children makes this condition a common problem in pediatric neurology (2). Although it is generally considered benign, the recurrence rate during the same fever attack is 14.8% (3). Febrile convulsions are divided into two main groups: simple and complex. Simple febrile convulsions last less than 15 minutes, have a generalized seizure structure at the beginning, and occur only once in 24 hours. In contrast, complex febrile convulsions may last longer than 15 minutes, have focal features, or recur more than once in 24 hours (4). Although febrile convulsions are generally considered self-limiting and "benign," they often prompt pediatric consultations. Management strategies may vary depending on the clinical context (5). High recurrence rates and unusual accompanying symptoms such as loss of consciousness or cyanosis increase the risk of traumatic accidents and the frequency of healthcare visits by increasing parents' anxiety levels. Therefore, providing accurate information and support mechanisms may contribute to more effective management of families during this process. Informing parents about the possible consequences of febrile convulsions and the development of self-

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management skills in daily life are critical. However, the gap between the information families need and the information they can access often leads them to alternative information sources such as web search engines (6,7). This lack of information can have potentially negative consequences such as misdirection and unnecessary anxiety.

Introduced in November 2022, ChatGPT is an artificial intelligence-based large-language model that can produce human-like responses to users' text-based inputs. Developed by OpenAI (OpenAI, L.L.C., San Francisco, CA, USA), this model is based on a generative pre-trained transformer (GPT) architecture, and is particularly notable for its capacity to provide text-based information flow (8). Its most recent version, GPT-4, was released in March 2023 and demonstrates superior accuracy in solving more complex problems due to its improved reasoning ability and broader knowledge base (9). ChatGPT has the potential to provide education and information in the field of healthcare. For example, it has been reported to be effective patient for patient education regarding conditions such as laryngopharyngeal reflux (10). However, the accuracy and reliability of knowledge-based responses remain a matter of debate, especially in clinical contexts. In common complaints, such as fever in children, ChatGPT responses have been stated to be high-quality, reliable, and understandable (11). However, studies on answering questions from patients with epilepsy have emphasized that the model provides both accurate and supportive answers but occasionally carries the risk of misleading users by providing incorrect information (12).

This study aimed to evaluate the accuracy and reliability of ChatGPT responses to questions frequently asked by parents and caregivers regarding febrile seizures. In addition, the performance of this model in providing educational information was analyzed, and its information capacity and problem-solving skills were also examined.

Materials and Methods

Data Source-Question Selection

For this study, questions were collected from the "febrile seizures" section of the National Institute of Neurological Disorders and Stroke (NINDS) website (13). This section provides a wide range of information covering symptoms, causes, risk factors, diagnosis, treatment, and management strategies related to febrile convulsions. A total of 30 questions were selected within the scope of the study and divided into the following categories: "overview of febrile convulsions," "symptoms and causes," "diagnosis," "treatment and management strategies,", and "recommendations for families." Access to the NINDS website was provided, where this content is publicly available (13). The selected content consisted of English texts and was translated into Turkish by a professional translator. During the translation process, texts were transferred verbatim preserving their accuracy and originality. These questions were based on the aim to support a better understanding of febrile convulsions to raise awareness among patients and families.

GPT Usage

The questions were integrated into the 4th version of ChatGPT on September 1, 2024. ChatGPT-4 is a language model developed by OpenAI that offers more advanced features than the previous versions. This version, which stands out for its improved reasoning ability, wider knowledge base, and superior performance in natural language processing tasks, can be accessed via OpenAI's official website or APIs. ChatGPT-4 offers a monthly subscription model and is used as a powerful tool for educational and research purposes.

The questions were prepared in English and grouped by category to analyze the relationships between them. Each question was entered into the system twice using the "New Chat" feature, and the answers were compared. In cases where no significant differences were observed between the answers, the initial answers were preferred for the analysis. In addition, the same questions were asked in ChatGPT version 3.5, and the responses were evaluated by comparing them with ChatGPT-4. This method was applied to analyze the performance differences between versions and examine the information-providing capacity of ChatGPT-4 more comprehensively.

Evaluation of Responses

The responses generated by a ChatGPT were reviewed by a pediatrician and a pediatric neurologist experienced in treating children with febrile seizures. Responses were evaluated for accuracy and educational value in four categories: "adequate and educationally valuable", "accurate but inadequate", "mix of correct/incorrect/outdated information", and "incorrect". In cases of disagreement between raters, a third reviewer with expertise in febrile seizure management was involved in making the final decision. In addition, ChatGPT-3.5 responses were compared with content from the NINDS "febrile seizures" section and with ChatGPT-4 responses. ChatGPT-4 performance was rated as "much better," "better," "similar," "worse," or "much worse" compared to other sources. Final evaluations were performed using a systematic approach, and expert opinions were used in cases of equivalence. This method was designed to analyze the information-providing capacity of ChatGPT-4 in detail and compare it with previous versions. This study was exempted from ethical review by the Institutional Review Board because it used

only publicly available programs and did not involve human participants. Patient consent was not obtained.

Statistical Analysis

All statistical analyses were conducted using SPSS version 22 (IBM SPSS Statistics for Windows, Armonk, NY: IBM Corp). Agreement between the two reviewers assessing ChatGPT's responses was calculated using the Weighted Cohen's Kappa coefficient. The Shapiro-Wilk test was used to assess the normality of the variables. Normally distributed data were reported as mean ± standard deviation, while non-normally distributed data were presented as median (range). Categorical variables were expressed as frequencies and percentages. Pearson's correlation test was used for parametric data and Spearman rank correlation test for non-parametric data to evaluate relationships between variables.

Results

Evaluation of Responses from ChatGPT-4

The performance of the ChatGPT-4 was evaluated using 30 questions. Responses to 22 of these questions were classified as having "sufficient educational value," while 7 responses were found to be "correct but insufficient." Of the 22 responses that had 'sufficient educational value,' 21 were accepted by both raters and only one response had to be evaluated by a third expert. One response was evaluated as "a mixture of correct/incorrect/outdated information," but no response fell into the "incorrect" category (Table 1). When examined by category, all four responses under the heading "diagnosis" were evaluated as having "sufficient educational value". Three of the five responses in the "treatment and management strategies" category had "sufficient educational value," while two were considered "correct but insufficient." Four of the six responses under the heading "symptoms and causes" had "sufficient educational value," whereas two were included in the "correct but insufficient" category. Three of the five questions in the "febrile convulsions overview" category were rated as having "sufficient educational value," while the other two were found to be "correct but inadequate." All four responses under the "advice for families" heading were rated as having "sufficient educational value."

These findings suggest that ChatGPT-4 is effective in producing educational materials related to febrile convulsions. However, some categories were found to have gaps in the information and required more detail. Addressing these gaps could increase the model's educational capacity and strengthen its reliability in providing health information.

Comparison of ChatGPT-4 Responses with ChatGPT-3.5 Responses and Febrile Convulsions Guide

When the responses of ChatGPT-4 and ChatGPT-3.5 were compared in the evaluation of a total of 30 questions, no response from ChatGPT-4 was classified as "much better." However, eight responses were rated as "better," twenty responses were rated as "similar," and two responses were rated as "worse." These findings indicate that ChatGPT-4 generally performed similarly to or better than ChatGPT-3.5. In particular, ChatGPT-4 performed worse than ChatGPT-3.5 on the questions "impact of fever during febrile convulsion" and "Is long-term drug therapy appropriate for the management of febrile convulsions?" (Table 2). Compared to the official guideline, ChatGPT-4 provided a "much better" response to the question, "What should I do if my child has a febrile seizure?" In addition, it provided "better'" responses to 16 questions and 'similar' responses to 10 questions. However, four responses were rated as 'worse' compared to the guideline, and no response fell into the "much worse" category. Questions on which official guidelines elaborated on included: "What is a febrile seizure?", "What is the risk of developing epilepsy in children with febrile seizures?", "How is long-term febrile seizure treatment planned?", "Should a child with febrile seizures go back to school?". Overall, ChatGPT-4 responses were found to be equivalent to or better than the official guidelines.

Discussion

To our knowledge, this is the first study to analyze the Chat GPT-4 responses related to febrile seizures. ChatGPT can interpret natural language inputs and produce responses that are appropriate for user needs. In this study, AI was evaluated using a dataset containing information and frequently asked questions about febrile convulsions. The results revealed that ChatGPT can provide accurate and comprehensive answers on topics such as the causes, symptoms, and management strategies of febrile convulsions. It also provides practical and understandable information about emergency measures to be taken during febrile convulsions and long-term treatment approaches.

In recent years, reliance on the Internet as a source of health information has increased. Individuals frequently use online resources to search for information about febrile convulsions, such as diagnoses, treatment options, and drug side effects (14).

In a study evaluating GPT-4, the model demonstrated higher accuracy rates compared to GPT-3.5 in the Japan Medical Licensing Examination, especially in general and clinical sentence questions. This suggests that GPT-4 can be an effective tool for medical education and clinical support in non-English-speaking countries such as Japan (15). In our study, the responses in the

Table 1. Performance evaluation of ChatGPT-4 responses

Category	Questions	Sufficient educational value	Correct but inadequate	Mixed with correct/ incorrect/outdated data	Completely incorrect
Febrile convulsions overview	What is febrile convulsion?	✓			
	What are the symptoms of febrile convulsion?	✓			
	Who is more likely to have febrile convulsions?	✓			
	Are febrile convulsions harmful?	✓			
	What is the risk of developing epilepsy in children who have febrile convulsions?		✓		
Symptoms and causes	What are the main causes of febrile convulsions?	✓			
	What changes occur in the body during febrile convulsions?	✓			
	Does fever trigger febrile convulsions?		✓		
	Is there a connection between febrile convulsions and family history?	✓			
	What are the typical symptoms of febrile convulsions?	✓			
Diagnosis	How is febrile convulsion diagnosed?	✓			
	What tests are used to diagnose febrile convulsions?	✓			
	Do brain imaging methods detect febrile convulsions?	✓			
	Are laboratory tests necessary to diagnose febrile convulsions?	✓			
Treatment and management strategies	What should be done during febrile convulsions?	✓			
	Should febrile convulsions be treated with medication?		✓		
	How is long-term febrile convulsion treatment planned?		✓		
	Does the use of anticonvulsant medications prevent febrile convulsions??	✓			
	What should be the treatment plan for children after febrile convulsions?	✓			
Advice for families	What should I do if my child has a febrile convulsion?	✓			
	What precautions can I take to prevent my child from having a febrile seizure?	✓			
	Should I see a doctor after a febrile convulsion?	✓			
	How are the daily lives of children with febrile convulsions affected?	✓			
	What do parents need to know to manage febrile convulsions?	✓			
	How should genetic predisposition within the family be assessed?	✓			
	How should children with febrile convulsions return to school?	✓			
	Does misinformation about febrile convulsions pose a risk to families?	✓			
	Do children need a special diet after a febrile convulsion?	✓			
	How are the psychological effects of febrile convulsions on the family managed?	✓			

Table 2. Comparison of ChatGPT-4 responses with ChatGPT-3.5 and 'febrile seizures guidelines'

Categories	Questions	ChatGPT-3.5 much better	ChatGPT-3.5 better	ChatGPT-3.5 similar	ChatGPT-3.5 worse	ChatGPT-3.5 much worse	Guidelines much better	Guidelines better	Guidelines similar	Guidelines worse
Overview of febrile seizures	What are febrile seizures?		✓	✓				✓	✓	
	What are the symptoms of febrile seizures?		✓	✓				✓	✓	
	Who is more likely to have febrile seizures?		✓	✓				✓	✓	
	Are febrile seizures harmful?		✓	✓				✓	✓	
	What is the risk of epilepsy in children with febrile seizures?			✓	✓			✓	✓	
Symptoms and causes	What are the main causes of febrile seizures?		✓	✓				✓	✓	
	What changes occur in the body during febrile seizures?		✓	✓				✓	✓	
	Does fever level trigger febrile seizures?			✓	✓			✓	✓	
	Is there a genetic link to febrile seizures?		✓	✓				✓	✓	
	What are the typical symptoms of febrile seizures?		✓	✓				✓	✓	
Diagnosis	How are febrile seizures diagnosed?		✓	✓				✓	✓	
	What tests are used to diagnose febrile seizures?		✓	✓				✓	✓	
	Do brain imaging techniques detect febrile seizures?		✓	✓				✓	✓	
	Are lab tests necessary for diagnosing febrile seizures?			✓	✓			✓	✓	
Treatment and management	What should be done during a febrile seizure?		✓	✓				✓	✓	
	Should febrile seizures be treated with medication?			✓	✓			✓	✓	
	How should long-term treatment for febrile seizures be planned?			✓	✓			✓	✓	
	Does anticonvulsant medication prevent febrile seizures?		✓	✓				✓	✓	
	What is the treatment plan for children after febrile seizures?		✓	✓				✓	✓	

Table 2. Continued

Categories	Questions	ChatGPT-3.5 much better	ChatGPT-3.5 better	ChatGPT-3.5 similar	ChatGPT-3.5 worse	ChatGPT-3.5 much worse	Guidelines much better	Guidelines better	Guidelines similar	Guidelines worse
Advice for families	What should I do if my child has a febrile seizure?	✓	✓					✓	✓	
	What precautions can I take to prevent febrile seizures in my child?		✓	✓				✓	✓	
	Should I see a doctor after a febrile seizure?		✓	✓				✓	✓	
	How do febrile seizures affect daily life for children?		✓	✓				✓	✓	
	What should parents know about managing febrile seizures?		✓	✓				✓	✓	
	How should genetic predisposition in families be assessed?		✓	✓				✓	✓	
	When can children return to school after a febrile seizure?		✓	✓				✓	✓	
	Do misconceptions about febrile seizures pose risks for families?		✓	✓				✓	✓	
	Is a special diet needed for children after febrile seizures?		✓	✓				✓	✓	
	How should psychological impacts on families be managed?		✓	✓				✓	✓	

"general overview" category received a lower evaluation than the other categories. This was attributed to the fact that the information was generally presented in a listing format and in-depth explanations were lacking. For example, basic information was provided for the question "What is a febrile convulsion?" However, the details are insufficient. Despite this, clear listing of symptoms in questions such as "What are the symptoms of a febrile convulsion?" attracted attention, providing correct information. The genetic predisposition information was evaluated as "accurate but insufficient" since it was not sufficiently detailed in questions such as "Is there a connection between febrile convulsion and family history?" In general, ChatGPT-4 provided useful information in this category, but performed poorly against the visually supported explanations of the official guide.

In a study evaluating the electrocardiogram interpretation capabilities of emergency medicine specialists, cardiologists, and ChatGPT, GPT-4 was shown to be more successful than emergency medicine specialists in evaluating both daily and challenging ECG questions. It performed better than cardiologists in daily questions, but as the difficulty of the questions increased, its performance closely matched that of the cardiologists (16). In our study, the "diagnosis" category received a positive evaluation and all answers provided correct information. Although there is a risk of information obsolescence or inaccuracy when using artificial intelligence sources, it is noteworthy that it can provide accurate and useful information. A study evaluating GPT-4 to select antidepressant treatment for major depression reported that such models may create the risk of providing incorrect treatment options if used as a guide in sensitive areas such as psychopharmacological treatment without any human supervision or expert control (17). In our study, ChatGPT-4 provided generally useful and accurate information in the "treatment and management strategies"

category. Comprehensive answers to the questions "What should be done during a febrile convulsion?" and "What should be the treatment plan for children after febrile convulsions?" with sufficient educational value are needed. However, the answers to the questions "Should febrile convulsions be treated with medication?" and "How is long-term febrile convulsion treatment planned?" were evaluated as "correct, but insufficient" due to a lack of detail. The answers to the question "Does the use of anticonvulsant drugs prevent febrile convulsions?" were found to be detailed and comparable to the guidelines.

In a study evaluating the answers given by ChatGPT-4 to questions about epilepsy, it was emphasized that this model can be a valuable tool in conveying general medical information about epilepsy to the public. Although concerns about accuracy, copyright, and the ability of artificial intelligence to provide individual-specific information continue, it has been reported that such models can be used as auxiliary tools to reduce the educational burden of healthcare professionals in terms of patient education (6). In our study, in the "advice for families" category, ChatGPT-4 provided useful and accurate information on questions frequently asked by parents about febrile convulsions. Practical and understandable suggestions were provided for critical questions such as "What should I do if my child has a febrile convulsion?" and "What precautions can I take to prevent my child from having a febrile convulsion?" In addition, the answers given to the question "Should I see a doctor after a febrile convulsion?" were considered effective. The answers given to the question "How are the daily lives of children with febrile convulsions affected?" contain valuable information, both in terms of children's adaptation to their daily lives and parents' awareness. However, the official guide made the information easier to understand because of its graphic and visual support. The overall performance of ChatGPT-4 in this category was found to be satisfactory, but the lack of visual support led to a lower evaluation in some questions. Overall, this study demonstrates that generative AIs, such as ChatGPT, can be an effective tool for providing information and support for families and caregivers of children with febrile seizures. The increasing popularity of ChatGPT worldwide is expected to increase the demand for access to medical information through similar chatbot-based tools (18). As the performance of AI-powered chatbots improves and the amount of data used in their training processes increases, it will become increasingly critical to evaluate their ability to provide personalized responses appropriate to each patient's situation.

Study Limitations

Although this study focused on evaluating the capacity of ChatGPT-4 to provide information about febrile convulsions, it had some limitations. First, the ChatGPT-4 responses were evaluated based only on a selected dataset. Evaluations using larger datasets may provide more comprehensive information regarding the overall performance of the model. Second, the study was conducted only in English texts but was based on Turkish translations. The loss of meaning or changes in wording during the translation process may have affected the evaluation. The third limitation is that the responses were classified only by expert evaluation, and no evaluation was conducted from the user perspective. In addition, the accuracy of ChatGPT responses was examined only according to existing guidelines and expert knowledge. This does not completely eliminate the risks related to up-to-date information. Finally, factors such as lack of visual support may have limited the educational adequacy of the model.

Conclusion

This study, as one of the first to analyze the capacity of ChatGPT-4 to provide information on febrile convulsions, demonstrates that the model can provide accurate and comprehensive answers. ChatGPT-4, which has shown remarkable performance, especially in the categories of "treatment and management strategies" and "advice for families," stands out as an effective tool in patient and family education. However, limitations such as a lack of detail and insufficient visual support in some questions indicate the need for improvement in information transfer.

AI-based chatbots have increasing potential to become important tools that facilitate access to information in healthcare services. For this potential to be fully realized, the capacity of models to provide personalized and error-free information appropriate for individuals needs improvement. Although ChatGPT-4, in its current form, is a supportive tool that can alleviate the educational burden of healthcare professionals, the effectiveness and usefulness of such models should be examined in greater depth with larger datasets and analyses based on user experience in future studies.

Ethics

Ethics Committee Approval: This study was exempted from ethical review by the Institutional Review Board because it used only publicly available programs and did not involve human participants. Patient consent was not obtained.

Informed Consent: Patient consent was not obtained.

Footnotes

Authorship Contributions

Surgical and Medical Practices: E.Ö.K., Concept: E.Ö.K., Design: E.Ö.K., G.Ş., Data Collection or Processing: E.Ö.K., Analysis or Interpretation: E.Ö.K., Literature Search: E.Ö.K., Writing: E.Ö.K.

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Inflammatory Markers in Supraventricular Tachycardia: Insights for Emergency Management

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Abstract

Aim: Supraventricular tachycardia (SVT) is a common reason for emergency department visits and can significantly impact patients' quality of life. Certain hematological parameters may support the diagnosis and aid in the clinical management of conditions that often occur in the absence of structural heart disease. This study aimed to evaluate hematological markers, particularly inflammatory parameters, and their potential role in SVT.

Materials and Methods: This retrospective study included 243 newly diagnosed SVT patients and 220 healthy controls. Demographic data and laboratory parameters such as white blood cell count, neutrophil count (NE), red cell distribution width (RDW), platelet count, and mean platelet volume (MPV) were analyzed. Additionally, the neutrophil-to-lymphocyte ratio (NLR) and the platelet-to-lymphocyte ratio were calculated to assess inflammatory status.

Results: The findings revealed that NLR, RDW, and NE levels were significantly higher in the SVT group, while eosinophil, hemoglobin, and hematocrit levels were significantly lower. ROC analysis identified NLR as a significant predictor of SVT, with an optimal cut-off value of 2.62 and a specificity of 72.3%. Although MPV did not reach statistical significance, a proportional increase was observed in SVT, patients.

Conclusion: This study highlights the potential role of NLR and RDW as supportive biomarkers in SVT diagnosis. Our findings indicate that NLR and RDW levels were significantly higher in SVT patients compared to controls, suggesting a link between inflammation and SVT pathogenesis. These findings suggest that inflammation may play a role in SVT and that hematological parameters could aid its evaluation.

Keywords: Supraventricular tachycardia, biomarkers, inflammation, lymphocyte counts, neutrophil-to-lymphocyte ratio, red cell distribution width

Introduction

Palpitations, defined as an irregular, rapid, or forceful sensation of the heartbeat, are among the most common complaints in patients presenting to the emergency department (ED). It is estimated that approximately 10% of ED visits are due to palpitations (1,2). Given the broad differential diagnosis ranging from benign conditions to potentially life-threatening arrhythmias accurate and efficient evaluation is essential for patient management and risk stratification. Although palpitations can originate from both cardiac and non-cardiac causes, identifying underlying arrhythmias is particularly important to guide appropriate treatment strategies.

Among cardiac arrhythmias, supraventricular tachycardia (SVT) accounts for approximately 2.25 per 1000 ED admissions for palpitations (3). SVT is an umbrella term encompassing various rhythm disturbances originating anatomically above the atrioventricular node. Although SVT has multiple subtypes, most episodes present as paroxysmal (3). Paroxysmal supraventricular tachycardia (PSVT) is characterized by the sudden onset and abrupt termination of tachycardia (4). Most patients with PSVT do not have

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structural heart disease, and the primary mechanisms include increased automaticity, triggered activity, and reentry (5). Due to these mechanisms, PSVT is more commonly observed in younger patients and is often first diagnosed in the emergency setting (6). Although electrocardiogram (ECG) remains the gold standard for diagnosing SVT, transient episodes that resolve before evaluation can complicate diagnosis. Identifying laboratory biomarkers associated with SVT could provide additional diagnostic support, particularly in patients presenting with nonspecific symptoms or an unclear arrhythmic history.

Previous studies have demonstrated that blood parameters possess predictive and prognostic value in various cardiac pathologies (7-10). In particular, hemogram parameters have been widely investigated for their diagnostic and prognostic utility (11-14). However, the relationship between PSVT and hemogram parameters remains controversial, with only a limited number of conflicting reports available in the literature (8,15). Additionally, several studies suggest that inflammation may serve as a triggering factor for SVT (1,9,16-18), acting both as an initiator and a facilitator (1). Emerging evidence suggests that inflammation may contribute to arrhythmogenesis by promoting autonomic imbalance, myocardial excitability, and atrial remodeling, which may increase susceptibility to SVT (1,9,16-18). Consequently, some evidence indicates that inflammatory markers could have a predictive role in tachyarrhythmias. Although hematological parameters have been investigated in various cardiovascular conditions, their specific role in SVT remains unclear, with conflicting findings in the literature (8,15).

In this study, we aimed to assess laboratory parameters that may support SVT diagnosis and contribute to patient evaluation in the emergency setting. By analyzing these parameters, our goal is to provide additional insights that could assist clinicians in managing SVT more effectively.

Materials and Methods

Our study was designed as a retrospective analysis and conducted on patients newly diagnosed with SVT in the emergency department of Etlik City Hospital between December 1, 2022, and December 8, 2024, based on clinical presentation and ECG findings (6,19). Since this was a retrospective study, only patient data were analyzed. Ethical approval was obtained from the Etlik City Hospital Scientific Research Evaluation and Ethics Board Commite before data collection, and the study was conducted in accordance with institutional regulations and ethical guidelines (desicion number: AESH-BADEK-2025-0021, date: 08.01.2025).

To minimize confounding factors, we evaluated patients with nearly isolated SVT by excluding various conditions that could influence the results. The control group consisted of patients who presented to the ED without chronic diseases and met none of the exclusion criteria. This approach aimed to eliminate the potential effects of comorbidities and medication use on laboratory results.

For all patients, demographic data, medical history, medication history, and laboratory blood parameters were collected and analyzed. The SVT group and the control group were compared, with a particular focus on hemogram parameters.

Inclusion criteria:

- Patients aged 18 years and older
- Patients diagnosed with SVT for the first time in the emergency department

Exclusion criteria:

- Pregnant patients
- Presence of known heart disease
- History of previously diagnosed arrhythmia
- History of major trauma or surgery within the past 3 months
- Presence of chronic inflammatory disease
- Presence of acute rheumatologic or infectious disease
- Diagnosis of malignancy
- Diagnosis of rheumatologic disease
- Presence of immunosuppressive disease

Statistical Analysis

Data were analyzed using IBM SPSS Statistics version 25.0 software (IBM Corp., Armonk, NY, USA). Descriptive statistics were presented as frequency (n), percentage (%), mean ± standard deviation, or median (Q1-Q3) values. The Pearson chi-square test was used to evaluate categorical variables. The normality of numerical variables was assessed using normality tests and Q-Q plots. For comparisons between two groups, the independent samples t-test was used for normally distributed variables, while the Mann-Whitney U test was applied for non-normally distributed variables. Additionally, ROC analysis was conducted to evaluate the predictive value of certain parameters in SVT. A p value <0.05 was considered statistically significant.

Result

The study included 243 patients diagnosed with SVT and 220 control patients. The mean age of the SVT group was 51.1±16.5 years, while the mean age of the control group was 40.4±9.6 years. Gender distribution, lymphocyte count, mean platelet volume (MPV), platelet distribution width (PDW), and platelet (PLT) values were comparable between the two groups (Table 1).

However, white blood cell (WBC) count, neutrophil count (NE), red cell distribution width (RDW), urea, creatinine, alanine aminotransferase, and aspartate aminotransferase levels were significantly higher in the SVT group. In contrast, eosinophil count (EO), hemoglobin (HGB), and hematocrit (HCT) values were significantly lower in patients with SVT (Table 1).

The neutrophil-to-lymphocyte ratio (NLR) was significantly higher in the SVT group compared to the control group [median: 2.16 (0.39-43.0) vs. 1.92 (0.60-18.60), p=0.0219] (Figure 1). In contrast, the platelet-to-lymphocyte ratio (PLR) did not differ significantly between the two groups (p=0.335).

ROC analysis demonstrated that NLR had a significant predictive value for SVT [area under the curve (AUC): 0.562, p=0.022]. The optimal cut-off value for NLR in predicting SVT was determined as 2.62, with a sensitivity of 40.0% and a specificity of 72.3% (Figure 2).

Additionally, RDW (AUC: 0.591, p=0.001), NE (AUC: 0.617, p<0.001), and EO (AUC: 0.557, p=0.036) have significant predictive values for SVT as indicated by. However, MPV (AUC: 0.552, p=0.053), PDW (AUC: 0.549, p=0.069), and PLR (AUC: 0.526, p=0.335) did not demonstrate significant predictive value (Table 2).

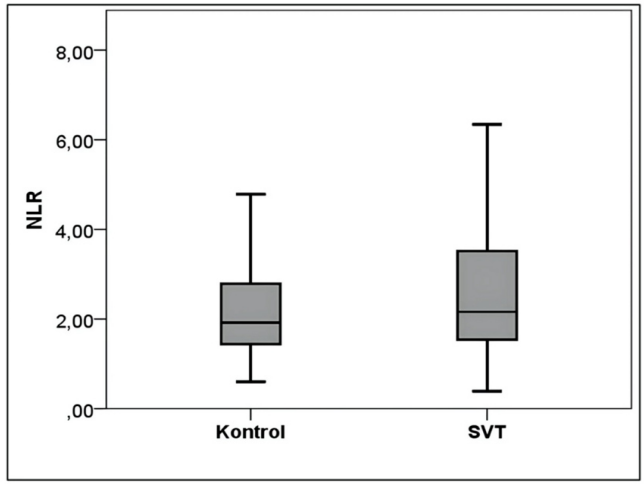

Figure 1. Comparison of NLR between groups
SVT: Supraventricular tachycardia, NLR: Neutrophil-lymphocyte ratio

Table 1. Demographic features and hematological findings in SVT and control patients

	SVT (n=243)	Control (n=220)	p value
Gender			
Male	98 (40.3%)	100 (45.5%)	0.266
Woman	145 (59.7%)	120 (54.5%)	
WBC	10.34±3.98	8.95±2.78	<0.001
EO	0.13±0.11	0.15±0.13	0.035
NE	6.56±3.02	5.51±2.43	<0.001
LY	2.74±1.25	2.59±0.96	0.287
MPV	10.60±0.88	10.45±0.91	0.053
RDW	43.44±4.62	42.10±3.69	0.001
PDW	12.49±2.01	12.19±2.06	0.069
HGB	13.70±2.00	14.14±1.94	0.017
HCT	42.20±5.27	43.24±5.06	0.040
PLT	278.35±86.23	281,43±75.45	0.622
Ure	34.42±15.49	27.11±8.68	<0.001
Creatine	0.95±0.50	0.79±0.19	<0.001
AST	32.66±35.05	21.55±21.38	<0.001
ALT	30.63±49.24	22.08±29.27	<0.001

Chi-square test, t test for independent variables, Mann-Whitey U test.
SVT: Supraventricular tachycardia, WBC: Wight blood cell, NE: Neutrophil count, EO: Eosinophil count, LY: Lymphocyte count, MPV: Mean platelet volume, RDW: Red cell distribution width, PDW: Platelet distribution width, HGB: Hemoglobin, HCT: Hematocrit, PLT: Platelet, NE: Neutrophil count, AST: Aspartate aminotransferase, ALT: Alanine aminotransferase

Discussion

SVT is a common cause of ED visits and can significantly impact patients' quality of life. It is characterized by sudden onset and termination and typically occurs without underlying structural heart disease. Given these characteristics, supportive laboratory parameters may serve as valuable diagnostic and prognostic aids. In our study, we analyzed hematological parameters and assessed their potential role in SVT diagnosis and pathogenesis. We found that inflammatory markers were consistently elevated in the SVT group, with NLR and RDW emerging as significant predictors of SVT.

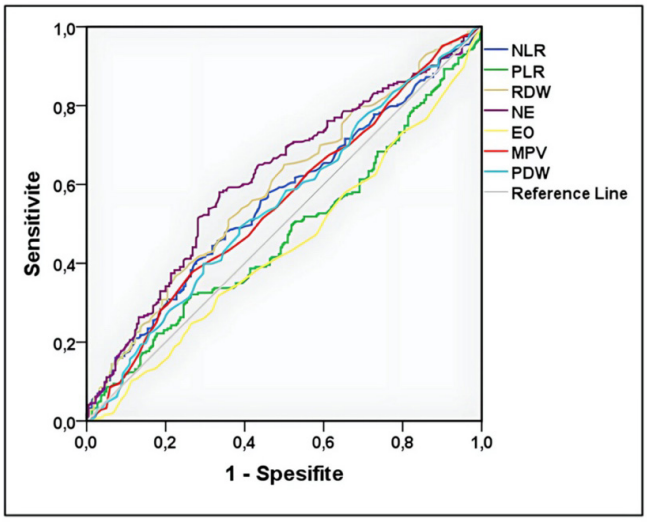

Figure 2. ROC analysis of haemogram parameters

NLR: Neutrophil-lymphocyte ratio, PLR: Platelet-lymphocyte ratio, RDW: Red cell distribution width, NE: Neutrophil count, EO: Eosinophil count, MPV: Mean platelet volume, PDW: Platelet distribution width

Inflammation has been recognized as a contributing factor in arrhythmogenesis, particularly in the development of premature cardiac beats, which can serve as triggers for SVT onset (18). Additionally, the association between inflammatory markers and premature cardiac beats has been well documented in various cardiovascular diseases (18,20). This supports the hypothesis that inflammation may increase susceptibility to SVT by promoting ectopic activity and reentry mechanisms. Several studies have further suggested that inflammation is involved in SVT etiology (1,8,15). Our findings align with the cardiovascular inflammatory hypothesis, which suggests that inflammation is a key factor in the pathogenesis of cardiologic and vascular diseases, as previously proposed by Sen et al. (21).

Multiple studies support the hypothesis that inflammation plays a role in arrhythmogenesis by evaluating conditions such as stroke, pulmonary thromboembolism (PTE), and peripheral artery disease. Yang et al. (22) investigated systemic inflammatory markers in arrhythmia, while Pektezel et al. (23) and Sadeghi et al. (24) examined NLR, PLT, and MPV values in stroke. Similarly, Gosav et al. (25) evaluated NLR in common cardiovascular diseases, and Zhang et al. (26) explored its relationship with myocardial infarction and heart failure.

In atrial fibrillation (AF), Berkovitch et al. (27) investigated NLR, while da Silva et al. (28) examined NLR and RDW in AF and rheumatic valve diseases. Further, Guan et al. (29) assessed NLR, RDW, and PLR in critically ill patients with AF (29). The diagnostic utility of hematological parameters in PTE was highlighted by Karakurt et al. (30), while Işık et al. (14) examined eosinophil counts in patients undergoing cardiopulmonary resuscitation. Teperman et al. (31) also studied NLR in lower extremity peripheral artery disease. Collectively, these studies emphasize the role of inflammatory processes in disease pathogenesis

Table 2. Effectiveness of blood parameters in predicting SVT

	AUC	SE	95% CI		p value
			Lowest	Highest	
NLR	0.562	0.027	0.510	0.614	0.022
PLR	0.526	0.027	0.473	0.579	0.335
RDW	0.591	0.026	0.539	0.642	0.001
NE	0.617	0.026	0.566	0.668	0.000
EO	0.557	0.027	0.504	0.609	0.036
MPV	0.552	0.027	0.500	0.604	0.053
PDW	0.549	0.027	0.496	0.601	0.069

SVT: Supraventricular tachycardia, NLR: Neutrophil-lymphocyte ratio, PLR: Platelet-lymphocyte ratio, RDW: Red cell distribution width, NE: Neutrophil count, EO: Eosinophil count, MPV: Mean platelet volume, PDW: Platelet distribution width, AUC: Area under the curve, SE: Standard error, CI: Confidence interval

and their potential use as biomarkers for risk stratification and clinical decision-making.

The Coumel arrhythmia development theory, as discussed by Farré and Wellens (32) and Rebecchi et al. (33), highlights three key contributors: an anatomical factor (extra/accessory pathway), a triggering factor, and a modulating factor (e.g., autonomic nervous system). Our findings suggest that inflammation serves as a key triggering factor in SVT pathogenesis, leading to premature beats and increasing SVT susceptibility. This aligns with evidence from Güngör et al. (34), who reported an association between inflammatory markers and AF recurrence. Conversely, Marcus et al. (35) found that reducing inflammation contributes to arrhythmia regression, further supporting the role of inflammation as a modifiable risk factor. Additionally, Frustaci et al. (36) provided histopathological evidence of inflammatory infiltrates in atrial biopsies of AF patients, reinforcing the mechanistic role of inflammation in arrhythmogenesis.

Among the hematological markers evaluated, NLR and RDW were found to be significant predictors of SVT in our study. We determined an optimal NLR cut-off value of 2.62, with a specificity of 72.3%, highlighting its potential diagnostic relevance. A similar study by Akpek et al. (37) in acute coronary syndrome (ACS) reported an NLR cut-off of 3.3 with a specificity of 83%, though the difference may be attributed to ACS, being a more hemodynamically disruptive pathology.

Similarly, RDW, a marker reflecting red blood cell size variation, has been linked to systemic inflammation and adverse cardiovascular events, independent of HGB and HCT levels (38-41). Our study demonstrated significantly higher RDW levels in SVT patients, consistent with findings from Güngör et al. (34) and Li et al. (42), the latter of whom identified RDW as an independent predictor of paroxysmal atrial fibrillation. However, Bassareo et al. (18) found no significant correlation between RDW and arrhythmias, possibly due to differences in patient selection criteria and study methodology.

While MPV values did not reach statistical significance in our study, a proportional increase was observed in SVT patients, aligning with previous literature. Differences in study design and sample size may explain why Ocak et al. (1) found a significant association, whereas Cosgun et al. (15) did not.

Additionally, our findings of higher WBC counts and lower EO, HGB, and HCT levels in SVT patients further support the inflammatory hypothesis. These hematological alterations have been linked to poor clinical outcomes in prior studies (14,43). Elevated liver and kidney function markers observed in our study also suggest potential hemodynamic consequences of SVT, further reinforcing the interplay between inflammation and cardiovascular pathology.

Conclusion

Our study demonstrates that NLR, RDW, and NE may serve as valuable diagnostic markers and contribute to the clinical management of SVT patients. These hematological parameters could assist in risk stratification and guide treatment decisions. However, further prospective, multicenter studies are needed to validate these findings and support their clinical implementation.

Study Limitations

This study has several limitations. Its single-center, retrospective design may limit generalizability. Consequently, we were unable to assess the effects of recurrent SVT attacks. Excluding patients with chronic thromboembolic events could have strengthened the study's findings. Moreover, we did not evaluate inflammatory markers (e.g., C-reactive protein, tumor necrosis factor, interleukin), which could have provided a more comprehensive assessment of SVT-related inflammation. Additionally, variability in findings may have been introduced due to the non-homogeneous patient population. Despite these limitations, our study provides valuable insights by analyzing a large cohort of newly diagnosed SVT patients. Future multicenter, prospective studies are needed to validate these findings and establish their clinical relevance.

Ethics

Ethics Committee Approval: Ethical approval was obtained from the Etlik City Hospital Scientific Research Evaluation and Ethics Board Commite before data collection, and the study was conducted in accordance with institutional regulations and ethical guidelines (desicion number: AESH-BADEK-2025-0021, date: 08.01.2025).

Informed Consent: Our study was designed as a retrospective analysis and conducted on patients newly diagnosed.

Footnotes

Authorship Contributions

Surgical and Medical Practices: Ö.F.T., N.İ.I., Concept: Ö.F.T., Design: Ö.F.T., Data Collection or Processing: Ö.F.T., N.İ.I., Analysis or Interpretation: Ö.F.T., Literature Search: N.İ.I., Writing: Ö.F.T.

Conflict of Interest: The authors declare that they have no conflict of interest.

Financial Disclosure: There are no financial conflicts of interest to disclose.

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Contrast-Induced Renal Injury After Computed Tomography in Ischemic Stroke Patients Receiving Intravenous Thrombolytic Therapy

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Abstract

Aim: This study aimed to evaluate the incidence of contrast-induced nephropathy (CIN) and the factors influencing its development in patients with acute ischemic stroke who were admitted to the emergency department and received intravenous thrombolytic therapy along with intravenous contrast.

Materials and Methods: This retrospective observational study included acute ischemic stroke patients aged over 18 years who received intravenous thrombolytic therapy at the emergency department of a tertiary care training and research hospital, a major stroke center in its region. The study was carried out between 1 January 2024 and 1 January 2025. All patients underwent contrast-enhanced brain and supraaortic computed tomography angiography, after receiving a standard dose of intravenous contrast. CIN was defined as either an increase of more than 25% increase in baseline serum creatinine levels or an absolute increase of ≥0.50 mg/dL within 48-72 hours post-contrast administration.

Results: A total of 194 patients met the inclusion criteria, with a median age of 74 years, half of whom were female. CIN was observed in 14.9% of patients, although none required dialysis. Patients who developed CIN had significantly lower creatinine levels at admission compared to those who did not (p=0.020). No other parameters, rates, or scores at admission showed statistically significant differences between the groups.

Conclusion: The incidence of CIN in patients receiving intravenous thrombolysis for acute ischemic stroke was 14.9%. Patients who developed CIN exhibited significantly lower creatinine levels at admission.

Keywords: Acute kidney injury, contrast media, emergency medicine, glomerular filtration rate, nephropathy

Introduction

Ischemic stroke is a leading cause of morbidity and mortality worldwide, making the early detection and treatment of cerebrovascular occlusion critical for minimizing post-stroke disability (1). Current national and international guidelines for acute ischemic stroke recommend several non-invasive intracranial vascular imaging modalities for the initial evaluation of patients in the emergency department (ED) to guide decisions regarding medical or mechanical endovascular treatments (2,3). Among these imaging techniques, computed tomography angiography (CTA) of the brain and great vessels is one of the most frequently utilized modalities in the acute setting (1). While CTA is generally considered safe and well-tolerated, contrast-induced nephropathy (CIN) remains a potentially serious complication associated with the intravenous (IV) contrast media used in such imaging studies. The incidence of CIN has been reported to be as high as 7% in some studies (4). Additionally, the reported incidence of CIN in acute ischemic stroke varies widely, ranging from 2% to 23% across different clinical contexts (5).

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There are also studies suggesting that CIN alternatively referred to as contrast-associated nephropathy or post- computed tomography (CT) acute kidney injury may have no significant difference in incidence between imaging with contrast and without contrast, and that its relevance is now primarily historical due to advancements in tomography and contrast agent technology, such as the development of lower-osmolality contrast materials (6,7). CIN is typically characterized by a sudden decline in renal function occurring within 48-72 hours of IV contrast administration (5,8). Although there is no universally agreed definition of CIN, the most widely accepted criterion, as proposed by the Kidney Disease Improving Global Outcomes guidelines, defines CIN as either a greater than 25% increase from baseline serum creatinine levels or an absolute increase of ≥0.50 mg/dL (9). Various factors, including renal vascular stenosis, direct renal tubular toxicity, decreased renal blood flow, oxidative stress, endothelial dysfunction, and pre-existing chronic kidney disease, have been implicated in the pathogenesis of CIN. However, the precise mechanisms underlying why some patients develop CIN after contrast administration while others do not remain unclear (6,10). Additionally, IV tissue plasminogen activator (t-PA) therapy, commonly used in the treatment of acute ischemic stroke, may contribute to the development of CIN (11).

Our ED and hospital serve as one of the primary centers for IV thrombolysis, neuroendovascular treatment, and neurointensive care for ischemic stroke in our province. It also functions as an on-call stroke center, for emergency medical and interventional endovascular treatment of ischemic stroke, about 7-8 days per month. In this study, our objectives were to evaluate (1) the incidence of CIN development, (2) the factors influencing this incidence, and (3) the impact of baseline creatinine levels, on the development of CIN in patients admitted to our ED with acute ischemic stroke, and treated with IV t-PA therapy.

Materials and Method

Patients and Study Design

This study was designed as a single-center, retrospective, and observational study. Patients who presented to the ED of University of Health Sciences Türkiye Ankara Training and Research Hospital from 1 January 2024 to 1 January 2025 with a preliminary diagnosis of acute ischemic stroke, who received thrombolytic therapy and underwent contrast-enhanced brain and supraaortic CTA, were evaluated.

Patients aged 18 years or older with documented creatinine and estimated glomerular filtration rate (GFR) values at admission and within 48-72 hours post-admission were included in the study. Exclusion criteria were as follows: patients with missing laboratory data at admission, those on dialysis for chronic renal failure, those with a GFR <30 mL/min/1.73 m² at admission, patients whose contrast-enhanced tomography was performed at another center, those without measured creatinine levels within 72 hours of admission, and patients transferred to another center within 48 hours. As all eligible patients meeting the inclusion criteria during the specified time period were enrolled, no sample size calculation was performed.

Study Protocol

Demographic data (sex, age), comorbidities (hypertension, diabetes mellitus, coronary artery disease, previous stroke, atrial fibrillation), laboratory parameters (hemoglobin, platelets, glucose, creatinine, urea, aspartate aminotransferase, alanine aminotransferase, international normalized ratio, and lactate levels), creatinine levels at 48 and 72 hours, and Mehran scores were recorded. The Mehran score, originally developed to predict the risk of CIN following percutaneous coronary intervention, is calculated based on variables such as blood pressure, age, intra-aortic balloon pump status, congestive heart failure, anemia, diabetes mellitus, contrast volume, and GFR values (12). It classifies patients into four risk categories: low risk (≤5), intermediate risk (6-10), high risk (11-15), and very high risk (16). Laboratory parameters, scores, and other variables (vital signs, comorbidities, etc.) studied for the patients were selected for their similarity to prior studies in the literature, and as much as retrospective data of the study allowed.

The diagnosis of contrast-associated nephropathy was defined as either an increase in serum creatinine level of ≥0.5 mg/dL within 72 hours after contrast administration or a ≥25% increase in serum creatinine compared with baseline. Patients were classified in terms of CIN based on the difference between their creatinine levels at admission and at 48-72 hours post-contrast administration.

Patients included in this study had a pre-existing diagnosis of acute ischemic stroke and presented to the ED within the first 4.5 hours of symptom onset. At presentation, all patients underwent a non-contrast brain CT, and contrast-enhanced brain and supraaortic CTA, to assess eligibility for thrombolysis or mechanical thrombectomy. Contrast-enhanced studies were performed using a routine and standard injection of 60.4 g iohexol (Biemexol, 350 mgI/mL, Biem® İlaç, Ankara) during CTA. The volume of contrast media was administered in standard doses, independent of the weight of the patients.

The present study was conducted in accordance with the principles of the Declaration of Helsinki. The Ethics Committee of Health Science University Türkiye, Ankara Training and Research Hospital approved the study (decision number: E25-396, date: 22.01.2025).

Statistical Analysis

Statistical analysis was conducted using SPSS version 26 (SPSS Inc., Chicago, Illinois, USA) and Jamovi version 2.6.2.0. The normality of data distribution was evaluated using histograms, Q-Q plots, and the Shapiro-Wilk test. Descriptive statistics were presented as mean ± standard deviation or median with interquartile range (IQR) for continuous variables, and as frequencies and percentages for categorical variables. Comparisons between paired groups were performed using the Mann-Whitney U test for continuous variables and the chi-Squared test for categorical variables. A p value of less than 0.05 was considered statistically significant.

Results

A total of 253 patients with acute ischemic stroke were admitted to the ED, underwent contrast-enhanced CT, and received thrombolytic therapy. Of these, 194 patients met the inclusion criteria and were included in the study (Figure 1). Among the included patients, 97 (50%) were male, and the median age was 74 years. The median creatinine level at admission was 0.88 mg/dL (IQR: 0.73-1.06), and the median creatinine level at 48-72 hours post-admission was 0.90 mg/dL (IQR: 0.74-1.17). CIN developed in 29 (14.9%) of the patients. Demographic and laboratory data for all patients are presented in Table 1.

Patients were divided into two groups based on the development of CIN. Demographic characteristics, laboratory results, and comorbidities were compared between the two groups (Table 2). In pairwise comparisons, the median creatinine level at presentation was 0.80 mg/dL (IQR: 0.70-0.94) in patients who developed CIN, compared to 0.89 mg/dL (IQR: 0.74-1.10) in patients who did not develop CIN (p=0.020). The median creatinine level at 48-72 hours was 1.85 mg/dL (IQR: 1.59-2.42) in patients with CIN, compared to 0.86 mg/dL (IQR: 0.72-0.99) in patients without CIN (p<0.001).

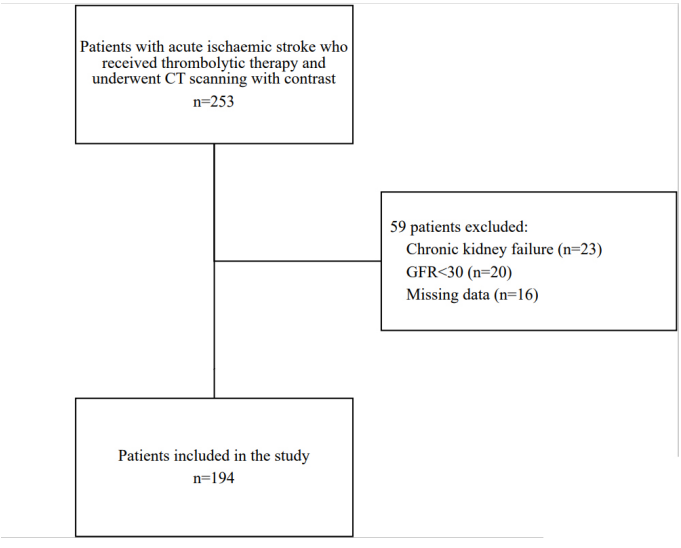

Figure 1. Patient flow chart
CT: Contrast-induced nephropathy, GFR: Glomerular filtration rate

No significant difference was observed in the median Mehran score, or between the subgroups based on Mehran scores in the groups with and without CIN (p=0.050). Additionally, there were no statistically significant differences between the two groups for any other parameters examined.

Table 1. The demographic characteristics of patient population

Characteristics	Total n=194
Age, median (IQR)	74 (64-81)
Gender, male, n (%)	97 (50)
Systolic blood pressure, (mmHg), (IQR)	160 (140-186)
Diastolic blood pressure, (mmHg), (IQR)	85 (75-94)
Heart rate (/min) (IQR)	79 (69-87)
Laboratory parameters, median (IQR)	
Hemoglobin (g/dL)	13.1 (11.8-14.6)
Platelets (x10^3/L)	219 (171-273)
INR	1.05 (1.01-1.13)
Glucose (mg/dL)	127 (108-170)
Admission creatinine (mg/dL)	0.88 (0.73-1.06)
Creatinine at 48-72 hours (mg/dL)	0.90 (0.74-1.17)
Admission GFR (mL/min)	75.50 (59.25-90.75)
Urea (mg/dL)	36 (28-47)
AST (U/L)	19 (15-23)
ALT (U/L)	13 (10-19)
Lactate (mmol/L)	2.1 (1.6-2.7)
MEHRAN score, median (IQR)	7 (3-12)
≤5, n (%)	82 (42.3)
6-10, n (%)	53 (27.3)
11-15, n (%)	50 (25.8)
≥16, n (%)	9 (4.6)
Comorbidities, n (%)	
Diabetes mellitus, n (%)	97 (50)
Hypertension, n (%)	148 (76.3)
Coronary artery disease, n (%)	74 (38.1)
Atrial fibrillation, n (%)	44 (22.7)
Previous stroke, n (%)	52 (26.8)
Contrast induced nephropathy, n (%)	29 (14.9)

IQR: Inter quantile range, INR: International normalized ratio, AST: Aspartate aminotransferase, ALT: Alanine transaminase, GFR: Glomerular filtration rate

Discussion

Contrast-enhanced CT plays a crucial role in the accurate and effective diagnosis of vascular emergencies, including aortic dissection, pulmonary embolism, and ischemic stroke, particularly in ED settings. The use of contrast media in CT has increased over the years (13,14). However, as the administration of contrast agents is associated with potential adverse events such as CIN, some centers may adopt policies that recommend waiting for baseline creatinine levels in acute ischemic stroke patients, or, if this is not feasible, opting for alternative imaging modalities such as ultrasound (15). Nonetheless, in the context of ischemic stroke, waiting for these blood tests can have significant negative consequences on patient outcomes, particularly in terms of delaying treatment and impairing neurological recovery (16). Given that time is a critical factor in stroke management, emergency physicians often proceed with contrast-enhanced CT without waiting for certain routine laboratory results, provided the potential benefits outweigh the risks. This approach, while essential for timely diagnosis and intervention, also makes the ED one of the highest-risk areas in the hospital for the development of CIN (5).

Table 2. Comparison of demographic characteristics, laboratory parameters, comorbidities, and Mehran scores of patients with and without CIN

Characteristics	CIN present n=29	CIN absent n=165	p value
Age, median (IQR)	78 (69-83)	73 (64-81)	0.100
Gender, male, n (%)	13 (44.8)	84 (50.9)	0.546
Systolic blood pressure, (mmHg), (IQR)	145 (138-180)	160 (140-187)	0.292
Diastolic blood pressure, (mmHg), (IQR)	79 (75-90)	85 (77-94)	0.079
Heart rate(/min) (IQR)	75 (68-80)	79 (69-88)	0.127
Laboratory parameters, median (IQR)			
Hemoglobin (g/dL)	12.6 (10.3-13.8)	13.2 (12-14.7)	0.099
Platelets (x10^3/L)	211 (168-278)	221 (174-271)	0.979
INR	1.08 (0.98-1.14)	1.05 (1.01-1.11)	0.639
Glucose (mg/dL)	139 (118-189)	126 (106-163)	0.186
Admission creatinine (mg/dL)	0.80 (0.7-0.94)	0.89 (0.74-1.1)	**0.020**
Creatinine at 48-72 hours (mg/dL)	1.85 (1.59-2.42)	0.86 (0.72-0.99)	**<0.001**
Admission GFR (mL/min)	77 (68-91)	75 (57-90)	0.201
Urea (mg/dL)	34 (26-44)	37 (28-47)	0.230
AST(U/L)	17 (15-21)	19 (15-24)	0.267
ALT(U/L)	12 (10-16)	13 (9-19)	0.442
Lactate (mmol/L)	1.7 (1.5-2.5)	2.1 (1.6-2.7)	0.148
MEHRAN score, median (IQR)	7 (4-12)	7 (3-11)	0.268
≤5, n (%)	11 (37.9)	71 (43)	0.050
6-10, n (%)	5 (17.2)	48 (29.1)	
11-15, n (%)	13 (44.8)	37 (22.4)	
≥16, n (%)	0 (0)	9 (5.5)	
Comorbidities, n (%)			
Diabetes mellitus, n (%)	12 (41.4)	85 (51.5)	0.314
Hypertension, n (%)	20 (69)	128 (77.6)	0.315
Coronary artery disease, n (%)	15 (51.7)	59 (35.8)	0.103
Atrial fibrillation, n (%)	6 (20.7)	38 (23)	0.781
Previous stroke, n (%)	10 (34.5)	42 (25.5)	0.311

IQR: Inter quantile range, INR: International normalized ratio, AST: Aspartate aminotransferase, ALT: Alanine transaminase, CIN: Contrast-induced nephropathy

Studies examining this high-risk situation in EDs report varying rates of CIN for different clinical conditions. For instance, a study by Turedi et al. (17) involving 257 patients with suspected pulmonary embolism, all of whom received prophylactic measures before and after contrast-enhanced CT, found CIN in nearly a quarter of the patient population. Similarly, a South African study on multi-trauma patients reported a high incidence of CIN (14.7%) following contrast-enhanced CT (18). In contrast, a study of trauma patients over the age of 55 found the incidence of CIN to be only 1.9% in the contrast group (19), while a study from our country reported a higher rate of 4.9% in patients with undifferentiated diagnoses who underwent contrast-enhanced CT for various reasons in emergency department (20). In addition to these varying rates, the literature presents differing perspectives on the clinical significance of CIN. Some studies (6,7) regard CIN as a "historical reality" that is now considered less clinically relevant due to advancements in contrast media and CT technology, and thus, recommend routine contrast-enhanced CT scans. Conversely, other studies (5,11,21) continue to view CIN as a high-incidence complication and urge caution in its management, particularly in EDs. In our study, we aimed to contribute to this ongoing debate by evaluating a cohort of patients in our ED who shared similar pathology, received uniform treatment, and underwent comparable physiological changes. Our findings reveal a CIN incidence of 15% among patients with acute ischemic stroke who received IV thrombolytic therapy, suggesting a significant concern for this patient population. In our study, the incidence of CIN was found to be as high as 15% in patients with acute ischemic stroke who received IV thrombolysis. However, it is noteworthy that none of our patients required temporary or permanent dialysis. This finding aligns with other studies (1,22) that prioritize neurovascular function and patient benefit over concerns about CIN in ischemic stroke patients receiving t-PA. When comparing the incidence of CIN in our study with other stroke-related literature, we find that it is significantly higher than some studies (6,7,8,23), slightly higher than others (11,22), but similar to very few (1). This disparity may be attributed to the heterogeneity of patient populations in other studies, which included patients with ischemic stroke, hemorrhagic stroke, and intracerebral hemorrhage, as well as variations in treatment approaches (mechanical thrombectomy, intravenous t-PA, and other anticoagulant therapies). In contrast, our study focused exclusively on ischemic stroke patients treated with intravenous t-PA and patients with bleeding were excluded. This made our study cohort more homogeneous, with similar pathology, identical treatment regimens, and comparable amounts of IV contrast administered, all triggered by similar physiological stimuli, while excluding other complicating factors such as vascular injury or embolism. We believe this homogeneity is a significant strength of our study. In our review of the literature, we found no other studies investigating the development of CIN specifically in ischemic stroke patients receiving intravenous t-PA alone. Moreover, the relatively older age (median = 74 years) and higher comorbidity (at least 50% of the cohort had one or more comorbidities) compared to other studies, as well as the fact that all patients received intravenous t-PA, may have contributed to the higher incidence of CIN observed. In fact, one study has suggested that receiving intravenous t-PA in acute stroke is associated with a seven-fold increased risk of CIN (8).

Several studies have identified various factors that increase the risk of developing CIN, including an estimated GFR <30 mL/min (6,8,22), diabetes mellitus (1), hypertension (8), chronic kidney disease (6,22), and higher volumes of contrast (23). Other risk factors include elderly patients, those using non-steroidal anti-inflammatory drugs after contrast administration, and patients on angiotensin-converting enzyme inhibitors, angiotensin II receptor blockers, beta-blockers, statins, or insulin (22). Smoking (1) and intravenous t-PA therapy (8) have also been associated with an increased risk of CIN. In our study, patients with an initial GFR <30 mL/min were excluded, as they were deemed at high risk of developing severe chronic kidney disease (stage V). Although some studies suggest that CIN is clinically significant only in this high-risk population and report that CIN is less important in patients with a GFR >60 mL/min (6), the literature remains divided on this matter. In our cohort, no statistically significant differences were observed in the risk of CIN in relation to comorbidities or vital signs at presentation. The retrospective nature of our study, the loss of data, and the urgency of acute ischemic stroke management in patients receiving IV thrombolytics within the treatment window limited our ability to access detailed home medication lists during the stable period. Consequently, we were unable to evaluate the impact of specific medications on CIN development, which we consider a limitation of our study. Additionally, all patients in our study received intravenous t-PA, and were administered a standard dose of 60.4 g of non-ionic low-osmolality contrast material during CTA. Surprisingly, CIN did not develop in our patients with high Mehran scores. This may be due to two reasons: our patients with high Mehran scores are very few in number (9 patients), and this number may not be reflected in a statistical significance. Additionally, the score itself is more related to cardiological interventional contrast studies and higher contrast volumes (12,24). In our study, patients received 80 cc (60.4 g) of IV contrast material as a standard dose.

Several studies have identified potential independent predictors for the development of CIN, including total white blood cell count (23), the C-reactive protein/albumin ratio (10,21), gamma-glutamyl transferase (25), and erythrocyte distribution width

(26). However, in our patient cohort, none of the biochemical parameters, ratios, or scores evaluated at the time of presentation for ED were found to differ significantly between patients with and without CIN. Interestingly, only the creatinine level at presentation was significantly lower in patients who developed CIN (p=0.020). This finding is somewhat surprising, as the general literature suggests that creatinine levels at presentation are typically higher in patients who develop CIN (1,5,6). This discrepancy may be attributed to the more homogeneous nature of our patient cohort, with similar pathology, treatment protocols, and physiological responses. Furthermore, as all of our patients were monitored in intensive care following acute ischemic stroke treatment, we did not investigate the potential relationship between the development of CIN and intensive care unit admission, which could be another limitation of the study.

Study Limitations

The primary limitations of this study include its single-center, retrospective design and the relatively small sample size, which may limit the generalizability of the findings. Additionally, the inability to include patient medication data in the analysis represents another limitation, considering that routine medications play a crucial role in renal function. This is particularly relevant given the elderly nature of the study population, where comorbidities and polypharmacy are common. These factors could influence the development of CIN and warrant further investigation in future studies.

Conclusions

Our study found that the incidence of CIN in patients with acute ischemic stroke receiving intravenous t-PA treatment was 14.9% (29/194). Notably, none of the CIN patients required temporary or permanent hemodialysis. The median age of our patient cohort was relatively high, and many had multiple comorbidities. A statistically significant difference was observed between the groups with and without CIN in creatinine levels, measured at presentation with the CIN group showing lower creatinine levels. However, no significant differences were found between the groups with regard to any other parameter, rate, or score at presentation.

Ethics

Ethics Committee Approval: The present study was conducted in accordance with the principles of the Declaration of Helsinki. The Ethics Committee of Health Science University Türkiye, Ankara Training and Research Hospital approved the study (decision number: E25-396, date: 22.01.2025

Informed Consent: This study was designed as a single-center, retrospective, and observational study.

Footnotes

Authorship Contributions

Surgical and Medical Practices: D.Ü.K., C.U.T., Concept: D.Ü.K., S.G., S.C.Y., Design: D.Ü.K., C.U.T., Data Collection or Processing: S.G., S.C.Y., C.U.T, Analysis or Interpretation: S.G., S.C.Y., C.U.T, Literature Search: D.Ü.K., S.G., S.C.Y., Writing: D.Ü.K., S.G.

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The Role of Health Literacy in the Effective Utilization of Emergency Medical Services: A Focus on 112 Emergency Health Services

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Abstract

Aim: The aim of this study is to evaluate the patients transported by ambulance to the emergency department (ED) of a large metropolitan hospital and to draw attention to the effect of health literacy on whether 112 emergency health services (112 EHS) is used effectively or not.

Materials and Methods: This study is a cross-sectional retrospective study conducted by scanning the data of patients admitted to the ED from January 1 to December 31, 2023. Patient records were analyzed for demographic characteristics, ED diagnoses, type of cases (forensic, emergency, etc.) nationality, services provided in the ED, and hospitalization status. Descriptive statistics were presented as frequency distributions for categorical variables. The chi-square (χ^2) test was used to compare categorical data, while the Mann-Whitney U test was applied for ordinal variables.

Results: During the study period, 36,235 patients were transported to the ED via ambulance. Among them, 52% were male and 48% were female. The mean age was 46±24 years. Regarding the type of cases, 11.7% were forensic cases, 10.3% were traffic accidents, 1.7% were work-related injuries, 0.4% were natural disasters, and 0.8% were emergency conditions. Within one year, 3.182 patients (10.2%) had repeated ambulance admissions. Among forensic cases transported by ambulance, 1b303 patients (30%) required hospitalization. Furthermore, 61.2% of these patients were admitted to the toxicology intensive care unit.

Conclusion: Enhancing public health literacy is a crucial factor in ensuring the more effective use of 112 EHS. The increase in public education initiatives, training programs, and social media content on emergency medical services is essential to achieve this goal.

Keywords: 112 emergency health services, emergency departments, health literacy

Introduction

Prehospital emergency medical services (EMS) are units responsible for the rapid transportation of patients in need to healthcare facilities while also providing appropriate medical interventions during transit. In Türkiye, 112 emergency health services (112 EHS), which operate within the EMS framework, have made significant advancements in recent years (1).

The progress within 112 EHS is directly linked to the rapid increase in the number of ambulances and stations, improved accessibility for patients, timely transportation to hospitals, and the growing number of hospitals capable of meeting patient needs. Despite substantial improvements in resources, technical equipment, and personnel support in recent years, the inappropriate or excessive use of 112 EHS has not been adequately addressed (2,3).

This issue can be attributed to insufficient health literacy among the population. Health literacy refers to an individual's ability to evaluate health information and use it to make informed health decisions. According to the World Health Organization, health literacy is defined as an individual's capacity to access, understand, and utilize health information and services effectively to enhance both personal and public health. Patients with low health literacy not only misuse hospitals and emergency departments (ED), but also utilize 112 ambulance services unnecessarily and inappropriately (4).

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In metropolitan areas, where there are numerous districts and neighborhoods, the demand for 112 EHS tends to be significantly higher. This study aims to evaluate patients transported by ambulance to the ED of a large metropolitan hospital and to assess whether 112 EHS is being utilized effectively.

Materials and Methods

This study is a cross-sectional, retrospective analysis. Administrative approval was obtained from the Konya Provincial Health Directorate, Konya City Hospital Committee (decision number: 34028104-799, date: 01.02.2024). Patients admitted to the ED of our hospital between January 1, 2023, and December 31, 2023, were identified using the hospital information management system. Patients admitted to the obstetrics and gynecology or pediatric EDs were excluded. The study included adult patients (age ≥18 years) admitted for medical or traumatic reasons and trauma patients under 18 years old who were admitted to the Adult ED.

Patient data were collected from medical records, including demographic characteristics (e.g., age, gender), ED diagnoses and ICD codes, case type (e.g., forensic or emergency cases) nationality, city of origin, services provided in the ED, and hospitalization status.

Statistical Analysis

The collected data were analyzed using statistical software. Descriptive statistics were used to present frequency data as numbers and percentages, while continuous numerical data were expressed as mean ± standard deviation. The chi-square (χ^2) test was used for categorical variable comparisons, and the Mann-Whitney U test was applied for comparisons of ordinal data between two groups. Statistical significance was set at $p<0.05$ for all tests.

Results

During the study period, 36,235 patients were transported to the ED by ambulance. Of these, 52% were male and 48% were female. The mean age of the patients was 46±24 years, with a minimum age of 0 and a maximum of 112 years.

It was determined that 10% of patients were foreign nationals, with 8.1% being Syrian. Additionally, 11.8% of patients transported by ambulance came from outside the city, with most originating from the nearby province of Karaman, and 0.6% originated from Hatay.

Among patients transported by ambulance:

- 11.7% were forensic cases,
- 10.3% were traffic accident victims,
- 1.7% were work-related injury cases,
- 0.4% were classified as natural disaster-related cases,
- 0.8% were classified as emergency cases.

The top 10 ED diagnoses (n=39) are presented in Table 1.

Within one year, 3.182 patients (10.2%) had recurrent ED visits via ambulance. The highest number of visits by a single individual was 27, observed in a patient diagnosed with chronic obstructive pulmonary disease (COPD) who presented with dyspnea. Among patients with recurrent visits, 48% (1.526) were male, and 52% (1.656) were female. A statistically significant association was observed between visit frequency (single vs. recurrent) and patient gender ($p<0.001$, $\chi^2 = 26.67$).

The mean age of patients with recurrent ambulance visits was 56±23 years, compared to 43±24 years among those with a single ambulance visit. This difference was statistically significant ($p<0.001$, $U=31,775,345.5$). Among recurrent ambulance visits, the most frequently reported complaint was dyspnea, followed by chest pain and abdominal pain.

Additionally, among patients transported by ambulance:

- 43.37% (15,717) received consultation services in the ED,
- 78.71% (28,521) were monitored for outpatient emergency care,

Table 1. Distribution of diagnoses according to the frequency of patients admitted by ambulance

Diagnosis	n	%
Traffic accident: examination and observation	3.653	10.08
Unspecified fall	2.752	7.59
Unspecified chest pain	2.616	7.22
Pregnancy-related conditions	1.933	5.33
Abdominal pain: other and unspecified	1.843	5.09
Dyspnea	1.833	5.06
Unspecified soft tissue disorders	1.539	4.25
Acute myocardial infarction	9.04	2.49
Exposure to drugs, pills, and biological agents: accidental poisoning	8.76	2.42
Nausea and vomiting	8.71	2.40
Dizziness (vertigo)	8.45	2.33
Syncope and fainting	8.10	2.24
Physical assault: examination and observation	7.73	2.13
Malaise and fatigue	7.06	1.95
Pain	5.98	1.65
Work accident: examination and observation	5.40	1.49
Myalgia	4.68	1.29
Headache	4.07	1.12

• 68.51% (24,828) received parenteral treatment,

• 11.27% (4.086) underwent observation,

• 22.56% (8.178) underwent electrocardiogram evaluation.

Further details regarding the services and examinations provided to ambulance-transported patients are summarized in Table 2.

Among forensic cases transported by ambulance, 1.303 patients (30%) required hospitalization. Of these, 55% were male, with a mean age of 31±20 years. The most common diagnoses in this group are presented in Table 3. It was observed that:

• 61.2% were admitted to the toxicology intensive care unit,

• 11.9% to the burn center,

• 7% to the pediatric surgery department.

Table 2. Data on other services and examinations performed on patients presenting by ambulance

Services and imaging tests	n	%
Foreign body removal and abscess drainage	4.4	0.12
Burn debridement and dressing	1.46	0.40
Suturing	2.258	6.23
Splint application	8.972	24.76
Joint reduction	3.6	0.10
Bladder catheterization	3.751	10.35
Nasogastric tube placement	7.42	2.05
Gastric lavage	5.13	1.42
Non-invasive mechanical ventilation	3.67	1.01
Endotracheal intubation	4.03	1.11
CT imaging requested	15.953	44.03
MRI imaging requested	4.679	12.91
Direct radiography requested	15.020	41.45

CT: Computed tomography, MRI: Magnetic resonance imaging

Among emergency cases transported by ambulance, 12.42% required hospitalization. These patients had a mean age of 63±20 years, with 47.2% being male and 52.8% female. The distribution of hospital admissions for this group was as follows:

• 19.9% were admitted to internal medicine intensive care units,

• 17.5% to general surgery departments,

• 13.8% to pulmonology departments,

• 7.7% to respiratory intensive care units,

• 6.8% to coronary intensive care units.

The most frequently observed ED diagnoses for these patients are also summarized in Table 3.

Discussion

Studies conducted in Türkiye indicate that men utilize 112 EHS at a higher rate than women. Menendi and Girişgin (5), reported that 60.9% of 112 EHS users were male, while Türkdoğan et al. (6) found this rate to be 55% in 2013. Consistent with these previous findings, our study showed that the male utilization rate was 52%.

In Türkiye, individuals aged 65 years and older have been observed to use ambulance services more frequently than other age groups. Ertan et al. (7) reported that the mean age of ambulance users was 47.97 years, while Menendi and Girişgin (5) found a similar mean age of 47.02 years. Likewise, in our study, the mean age of ambulance users was 46 years, aligning with the literature.

A previous study in Türkiye found that 94% of forensic cases reached hospitals by their own means, with only 6% utilizing 112 EHS (8). National data indicate that the primary reasons for ambulance calls are medical conditions (67.3%) and traffic

Table 3. Rates and diagnoses of patients hospitalized by ambulance

Diagnosis of forensic admission	n	%	Diagnosis of forensic admission	n	%
X44: Exposure to drugs, pills, and biological substances and accidental poisoning, other and unspecified	4.25	32.6	R10.4: Abdominal pain, other and unspecified	1.593	11.6
W19: Fall, unspecified	1.72	13.2	R06.0: Dyspnea	1.366	9.9
W26: Contact with knife, sword, or sharp object	6.4	4.9	R07.4: Chest pain, unspecified	6.01	4.4
T58: Toxic effects of carbon monoxide	5.2	4.0	W19: Fall, unspecified	5.54	4
Z04.5: Post-assault examination and observation	5.0	3.8	Z00.0: General medical examination	5.32	3.9
Y24: Other and unspecified firearm-related injury, unspecified occurrence,	4.9	3.8	R11: Nausea and vomiting	3.99	2.9
Z33: Pregnancy state	4.9	3.8	Z04: Other reasons for examination and observation	3.64	2.6
T62.0: Toxic effects of eating mushrooms	3.2	2.5	K21: Gastro-esophageal reflux disease	3.24	2.4
T32.1: Corrosions affecting 10-19% of the body surface area	3.1	2.4	R52: Pain, other unspecified	3.15	2.3

accidents (14.9%) (9). In our study, ambulance dispatches occurred due to traffic accidents (10.8%), falls (7.59%), and other medical conditions (81.61%), as shown in Table 1. Similarly, previous research has reported that ambulance calls were primarily due to medical emergencies (71%), traffic accidents (13%), and other injuries (9%) (10). In a study by Olia et al. (11) 17% of cases involved trauma, 46% were non-trauma medical cases, and 7.2% were inter-hospital transfers. These findings highlight that the majority of forensic patients transported by ambulance present with medical conditions rather than trauma.

Nationwide, trauma and cardiovascular diseases are frequently reported as leading causes of emergency calls. In our center, the high volume of trauma and chest pain cases transported by 112 EHS may be attributed to the hospital's status as both a trauma center and a coronary care center. Additionally, the presence of a toxicology intensive care unit (ICU) in our ED likely contributes to frequent referrals for suicide attempts and other toxicological emergencies.

Our study found that 10% of ED patients transported by ambulance were foreign nationals. This relatively high percentage corresponds to the increasing migrant population in Türkiye in recent years. Moreover, 11.8% of ambulance patients originated from outside the city, reflecting the hospital's status as a regional referral center with advanced equipment, specialized personnel, and comprehensive services.

Recurrent ambulance visits accounted for 10.2% (n=3.182), of all cases, with one individual making 27 visits due to COPD-related dyspnea. The literature supports the notion that comorbidities are a primary cause of recurrent ED visits (12).

Among ambulance-transported patients, 43.37% (n=15,717) received consultation services, highlighting the multidisciplinary nature of their medical needs. The literature indicates that 20-25% of all ED patients require consultations with other departments, a finding consistent with the 15% consultation rate observed in our ambulance cohort (13).

Among forensic cases transported by ambulance, 30% (n=1.303) required hospitalization, with the majority (61.2%) admitted to the toxicology ICU. The high rate of toxicology admissions can be attributed to several factors, including the prevalence of substance abuse among young individuals, overdose-related suicide attempts, and the continued use of coal and similar heating methods in the region's harsh climate (14-18).

Overall, 12.42% of patients transported for emergency reasons required hospitalization.

However, approximately 40% of ambulance calls were for non-emergency cases. This may be due to the free accessibility of 112 EHS, combined with public unawareness regarding appropriate service utilization (19).

The inappropriate and excessive use of 112 EHS for non-emergency cases can be linked to insufficient health literacy. Health literacy encompasses individual, social, and cognitive skills that influence one's ability to access, understand, and apply health-related information to protect or improve his or her well-being (20,21). Evidence suggests that patients with low health literacy levels tend to misuse EDs and 112 EHS (22).

Despite significant improvements in ambulance numbers, the number of EHS stations, and referral systems in recent years, the misuse and overuse of EHS continue. This suggests that public awareness regarding the appropriate use of 112 EHS has not yet reached the desired level.

Study Limitations

Since this is a single-center study, its findings cannot be generalized. Additionally, frequently used general and limited diagnostic codes in the hospital information system may not accurately reflect patients' actual diagnoses.

Conclusion

Enhancing public health literacy is essential for improving the efficiency of 112 EHS, ensuring equal access for all, reducing unnecessary patient burden on EDs and ambulance transfers, and minimizing healthcare expenditures.

Efforts should be made to increase public awareness through print, visual, and social media platforms. Furthermore, educational programs and courses aimed at raising awareness about the responsible and conscious use of 112 EHS should be organized in public education centers.

Ethics

Ethics Committee Approval: Administrative approval was obtained from the Konya Provincial Health Directorate, Konya City Hospital Committee (decision number: 34028104-799, date: 01.02.2024).

Informed Consent: This study is a cross-sectional, retrospective analysis.

Footnotes

Authorship Contributions

Surgical and Medical Practices: O.L.D., Concept: O.L.D., D.A., Design: O.L.D., D.A., Data Collection or Processing: O.L.D., Analysis or Interpretation: O.L.D., Literature Search: O.L.D., D.A., Writing: O.L.D., D.A.

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Letter to the Editor
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Beyond N-terminal Prohormone of Brain Natriuretic Peptide and Right Ventricular to Left Ventricular: Refining Risk Stratification in Acute Pulmonary Embolism

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Keywords: NT-proBNP, pulmonary embolism, right ventricle/left ventricle, pulmonary artery diameter

Dear Editor

We read the published article by Arı et al. (1) entitled "Role of Cardiac Biomarkers and Tomographic Right Ventricular Dysfunction Findings in the Treatment of Pulmonary Thromboembolism." This study represents a significant advance in evaluating and managing pulmonary thromboembolism (PTE). It highlights the combined utility of N-terminal prohormone of brain natriuretic peptide (NT-proBNP) levels and right ventricular to left ventricular (RV/LV) ratio in predicting the need for thrombolytic therapy. The authors present convincing evidence for the diagnostic and prognostic value of integrating biochemical and imaging findings. The high sensitivity and specificity reported for combined NT-proBNP and RV/LV parameters are noteworthy as they provide a feasible approach for early risk stratification. This integration may improve clinical workflows, especially in the acute setting where rapid and reliable risk assessments are critical (2). Although the study is robust and well-designed, several aspects deserve further consideration to increase its applicability and generalizability. For example, variability in NT-proBNP levels across demographic and clinical subgroups, such as elderly patients or those with preexisting cardiovascular conditions, may impact predictive accuracy (3). Future research could examine adjustments or alternative thresholds tailored to such subpopulations. Furthermore, the timing of biomarker measurement remains an important factor in establishing diagnostic reliability, particularly in dynamic conditions such as acute PTE (4,5). Including details on whether single or serial measurements were made would enhance clinical interpretation of the role of NT-proBNP in prognosis. The ratio of pulmonary artery diameter to aortic diameter, the pulmonary artery diameter to ascending aortic diameter ratio, is less predictive compared with NT-proBNP and RV/LV, but offers intriguing potential as an adjunctive marker (6). Exploring its use in scenarios where other markers provide borderline results may enhance its clinical utility, particularly in settings where biomarker testing is less accessible.

Further exploration of the broader economic implications of integrating these markers into routine practice is warranted, since their adoption may face cost-effectiveness issues in resource-limited settings. These considerations notwithstanding, the findings of this study contribute significantly to the field. The integration of imaging and biomarker data provides a template for future research and the development of clinical protocols and thus represents a forward-looking approach to PTE management. Extending these findings to multicenter and longitudinal studies will further validate their utility across diverse populations and healthcare systems.

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We commend the authors for their valuable work, which provides a foundation for improved diagnostic and therapeutic strategies in PTE. This study sets a benchmark for future innovation in the field, highlighting the critical role of interdisciplinary approaches in addressing complex cardiovascular emergencies.

Footnotes

Authorship Contribution

Concept: R.A., E.A., F.Ö., İ.A., Design: RA., E.A., F.Ö., İA., Data Collection or Processing: R.A., E.A., F.Ö., Analysis or Interpretation: R.A., E.A., İA., Literature Search: R.A., E.A., İ.A., Writing: R.A., E.A., F.Ö., İ.A.

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Erratum

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The mistake was made inadvertently during the process.

The institution information of **Ahmet Gökoğlu** (institution number 8), one of the authors on the first page of the article, has been corrected by the author as follows. The institutions in positions 8 and 9 have been swapped. Those listed as 8 are now listed as 9, and those listed as 9 are now listed as 8. Ahmet Gökoğlu's number will remain as 8.

Incorrect institution information of **Ahmet Gökoğlu** (institution number **8**).

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The mistake has been made inadvertently by the author.

On the first page of the article, the author name information of **Ahmet Gökoğlu** has been corrected by the author as follows.

The name information of **Ahmet Gökoğlu** is incorrect.

Serpil Yaylacı[1], Yıldız Dallar[2], Yavuz Sayar[2], Medine Ayşin Taşar[2], Ülkü Tıraş[2], Deniz Tekin[3], Ağahan Ünlü[4], Betül Ulukol[3], Fatma Yücel Beyaztaş[5], Celal Bütün[5], Ünal Özüm[6], Bora Büken[7], Ferhan Kandemir[7], Ahmet Gökoğlu[8], Meda Kondolot[8], Ahmet Menkü[9], Türkan Patıroğlu[8], Aydın Tunç[8], Fatih Yağmur[10], Ali Yıkılmaz[11], Taner Akar[12], Ufuk Beyazova[13], Bülent Değirmenci[12], Elvan İşeri[14], Figen Şahin[13], Aysun Baransel Isır[15], Ayşe Gül Bilen[15], Resmiye Oral[16], Nurperi Gazioğlu[17], Yasemin Balcı[18], Mesut Eryürük[18], Feyza Karagöz

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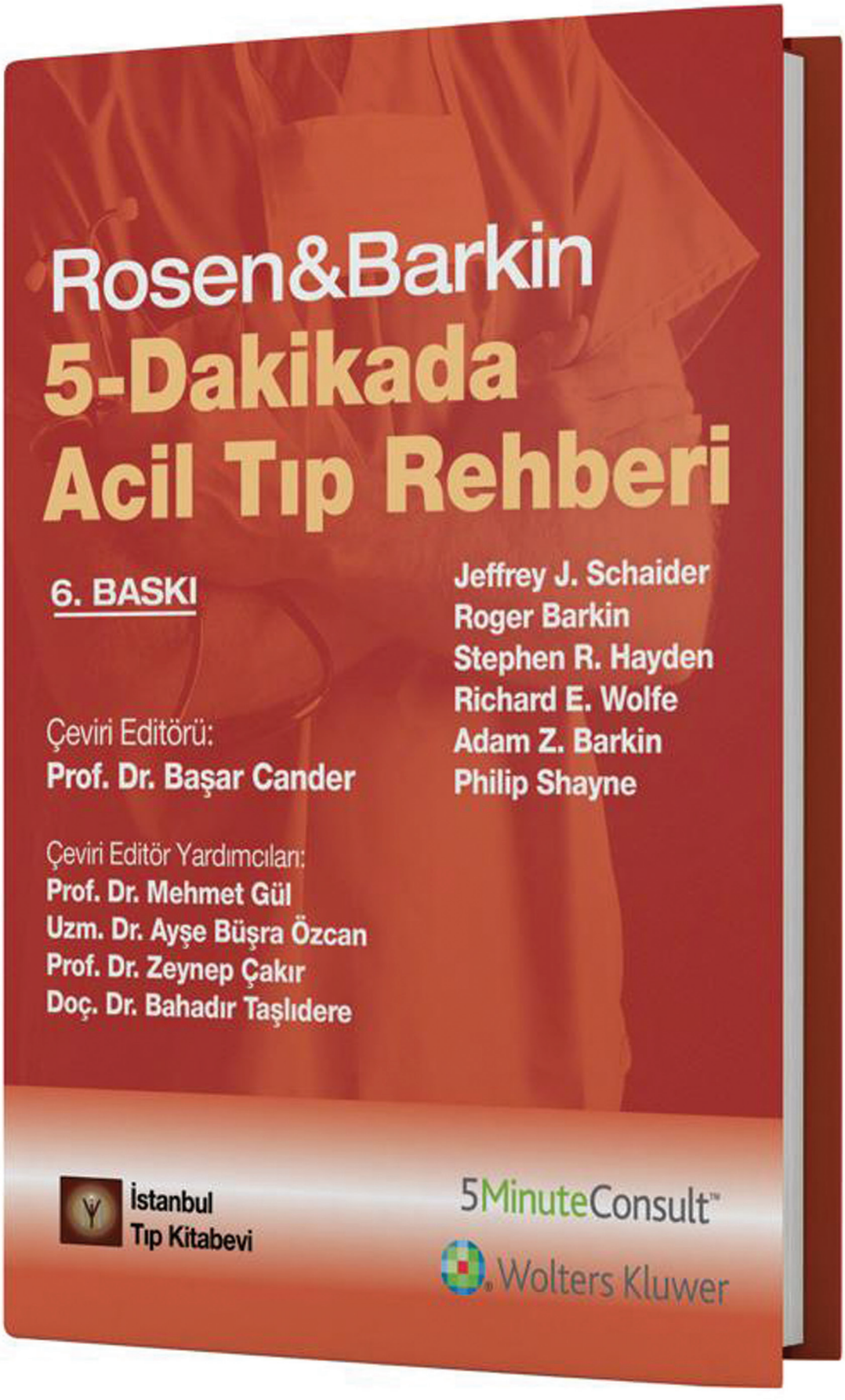
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