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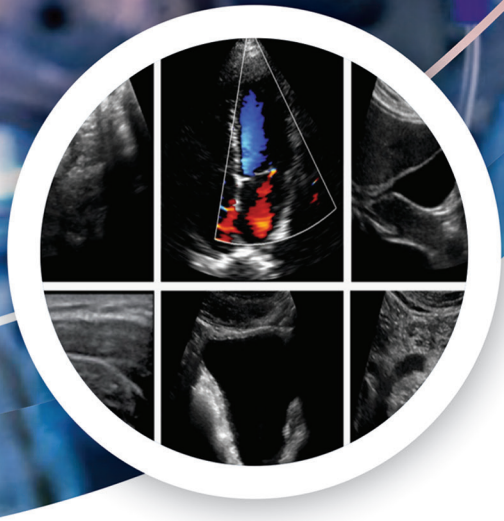

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The Influence of Alcohol on Geriatric Trauma: Adding Insult to Injury

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Keywords: Alcohol, geriatrics, injury, trauma

Advancement in healthcare systems and resultant increase in life expectancy has lead to a significant rise in geriatric population (1). Geriatric trauma patients, because of preexisting comorbidities, frailty and age-related physiological and anatomical changes present unique challenges in emergency care (2,3).

Age related physiological changes, like impaired hearing, diminished vision, slower reflexes, poorer balance, impaired motor and cognitive function, in addition to decreased muscle mass, bone density and joint flexibility make them prone for increased severity of traumatic injury (4,5).

The most common mechanism of injury in patients aged ≥65 is the ground-level fall followed by road traffic accident. A significant percent of ground-level falls patients will sustain a fracture, and one fourth of these patients will have polytrauma (6,7).

In geriatric patients, alcohol metabolism and its effects differ significantly from younger populations. Reduced liver function, changes in body composition, and polypharmacy amplify alcohol's physiological impact. Even moderate blood alcohol levels may lead to heightened impairment in balance, reaction time, and cognitive function, increasing the risk of trauma such as falls or vehicular accidents (8,9). Older adults may be more susceptible to the effects of alcohol on certain measures of driving performance. Alcohol's effects on decision-making and motor coordination heighten the likelihood of high-energy trauma in scenarios like motor vehicle collisions, which carry severe implications for older adults (10). Alcohol consumption in geriatric age group is associated with increased mortality and length of hospital stay (11).

For emergency departments, the interplay between alcohol positivity and geriatric trauma necessitates targeted protocols. Screening for alcohol use should be standard in all trauma evaluations, with particular attention to older patients. Thorough understanding of geriatric physiology is essential for their appropriate management. Blood alcohol concentration testing, alongside cognitive and neurological assessments, can guide the identification of injuries that may be underreported or clinically silent.

Keeping a lower threshold for an aggressive approach of management in view of limited physiological reserve in these patients holds the key. Focussing on Frailty rather than absolute age may be more fruitful. Inclusion of Clinical Frailty scale in trauma pathways to aid patient management may result in improved outcome (12,13). Management strategies should also incorporate the potential for alcohol-related complications, such as withdrawal symptoms or interactions with medications commonly used in trauma care. Multidisciplinary collaboration-integrating emergency physicians, geriatricians, and social workers-can ensure comprehensive care that addresses both immediate injuries and underlying substance use patterns.

The current body of literature underscores the need for more robust research into the intersection of alcohol positivity and geriatric trauma. Prospective studies can clarify alcohol's impact on injury patterns, severity, and recovery trajectories. In conclusion, the evaluation of alcohol positivity in geriatric trauma represents a pivotal area of study with significant clinical implications. By deepening our understanding of this dynamic, we can enhance

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emergency care delivery, mitigate risks, and improve outcomes for one of the most vulnerable segments of the population.

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A Telemedicine Model to Improve and Facilitate Access to Healthcare: Online Polyclinic

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Abstract

Significant congestion occurs in healthcare facilities worldwide, especially in hospitals. Turkey's healthcare system has a notably higher patient density than other countries. This overcrowding is evident across all healthcare units, particularly emergency departments. A key reason is the mismatch between patients and healthcare systems, which leads to an imbalance between supply and demand. Each country seeks solutions to address this increasingly challenging problem within its resources. Finding and creating urgently needed solutions also falls under the responsibility of healthcare professionals.

In this study, we propose a model that can alleviate congestion to reasonable and acceptable levels through an online clinic. This model offers a comfortable experience for healthcare providers and recipients without obstructing the patient's need to see a physician. This unique method, the Online Polyclinic Model, leverages modern technological advancements to deliver a highly secure, accessible, and convenient healthcare service that reaches everyone, reducing healthcare costs without compromising quality while saving time and space. Patient density is often defined in the emergency department congestion literature. The examples in our study also primarily focused on emergency department congestion. However, the aim is to find a solution for congestion that affects the entire healthcare system.

Keywords: Patient congestion, solution, quality, cost, online clinic

Introduction

Emergency Department Overcrowding (EDO) refers to the inability of an emergency department (ED) to meet the demand for services within a specific time (1-4). Given its many triggering factors and consequences, EDO has become a global health issue. Given the increasing workload, healthcare systems need to provide sufficient and quality care. This problem has become a worldwide crisis affecting developed and developing countries. Since a reasonable solution that satisfies healthcare providers and recipients has yet to be found, this crisis continues to grow annually. This crisis becomes more apparent during global events like the COVID-19 pandemic, as access barriers and the risk of coronavirus transmission exacerbate EDO (5). Patients waiting in EDs are at increased risk of mortality and morbidity because of limited access to alternative healthcare units (6,7). Due to the lack of a widespread and applicable solution, the current situation has become a global public health issue (8).

The reasons for EDO have been extensively studied, and various solutions have been proposed. However, a global solution that can effectively ease this burden must be developed. Some studies have developed an input, process, and output framework to classify and measure EDO (9). The input component includes factors that increase the number of patients presenting to EDs, such as limited access to primary care, reluctance to use it, a surge in emergency visits, and inefficient triage procedures (10). Triage processes, time to diagnostic testing, and treatments administered in the

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ED are defined as the "process flow" (11). After completing these procedures, the patient's discharge or transfer to inpatient units constitutes the "output component," which reflects challenges within healthcare systems (12). Improvements in this area could reduce the waiting time for admitted patients, leading to greater satisfaction for ED and patients (12).

Research has demonstrated that EDO causes delays in treatment access, postponed discharges (13), extended procedures, and repeated emergency visits (14). Some studies have focused on optimizing the causes and effects of EDO by measuring parameters such as hospital bed occupancy, patient length of stay in the ED, and ED volume (15). These measurements will contribute to clinical practice guidelines and support research. Over the past few years, more than 200 studies have been published in different categories focusing on EDO (1).

Studies evaluating patient flow and hospital occupancy rates are central to understanding EDO (16). Time is a primary factor in flow measurements, whereas non-flow measurements emphasize human count and resource usage (16). Subgroups were also evaluated according to input, process flow, and output parameters (17). Studies have measured factors like the number of patients in the ED waiting room, levels of overcrowding (18), and discharge times (19) to assess the quality of care. Global assessment tools, such as the National EDO and Emergency Department Work Index scores, are essential for evaluating the severity of EDO (16).

Causes of Overcrowding and Recommendations

Studies investigating ED overcrowding are essential to understand its impact on healthcare personnel and the healthcare system (20). Factors contributing to extended time in the ED include increased emergency admissions, rising critical illness cases related to aging, male sex, delays in discharge times, non-urgent visits, delayed imaging and lab results, insufficient bed capacity, prolonged consultation times for inpatient care, staff fatigue, and the employment of unqualified healthcare personnel (21).

Various methods have been tested to address overcrowding. Essential methods include rapid assessment, implementation of an effective triage system, and development of early diagnostic approaches. Fast-tracking of patients with minor symptoms has been shown to reduce waiting times in the ED and decrease the number of patients who leave without being seen (22). It has also been reported that implementing a triage model tailored to the facility can reduce ED mortality (23). Procedures known as "point-of-care" in the ED eliminate the need to transport samples to a central laboratory, thereby ensuring quicker results. This method was highlighted as facilitating diagnosis and preventing overcrowding (24). Each of these models has its own benefits and challenges, depending on the context, but more is needed to solve the issue of extreme overcrowding. Numerous similar solutions are mentioned in the literature; however, while some may be beneficial locally, their global impact may need to be improved.

Online Polyclinic Model

Model Name: The literature describes these services as telemedicine" or "telehealth". Due to its unique characteristics and innovations, we define our model as the "OPM".

The Online Polyclinic Model

We propose a novel approach targeting ED overcrowding and aiming to reduce the burden on primary, secondary, and tertiary healthcare facilities. The OPM prioritizes chronic disease management, preventive and routine care, and non-urgent medical consultations. This study demonstrated that the proposed service structure differs significantly from the existing configuration.

The primary features of this model, which utilize modern technological resources, are as follows:

- Convenience for healthcare recipients and providers
- Cost-effectiveness,
- Enhance the quality of patient care
- Safety,
- Ability to continually update the technology
- Offering equal healthcare services to all
- Access is independent of time and place

Primary Objective: To contribute to the future of healthcare services.

Core Features of Online Polyclinic Model

- AI-assisted Diagnosis and Treatment: AI algorithms will analyze patients to support accurate diagnoses and enhance treatment planning.

- Remote Patient Monitoring: Wearable devices can aid in managing chronic conditions.

Personalized Medicine: Customized treatment plans are implemented depending on individual health profiles.

Efficient Triage and Workflow: AI-based classification optimizes triage and reduces workload.

Virtual Assistance Support: AI-assisted virtual assistants will provide 24/7 support for patient inquiries and symptom monitoring and connect patients with relevant specialists as needed.

Target Audience: In 2024, the number of individuals visiting a doctor in Turkey is expected to exceed one billion. It is estimated that 40% (400 million) of these visits will be to the primary care setting, and 25% (250 million) will be to the ED. Including visits to outpatient clinics such as ophthalmology, ENT, internal medicine, pediatrics, and dermatology clinics, the potential patient population for this model is approximately 450 million. This 450 million constitute the primary target population of the proposed model. Primary care visits will also be addressed separately.

Common Complaints Among Target Patients: Common complaints include difficulty finding appointments, long hospital queues, lack of available beds, attending the wrong clinic, unresolved issues, and the need to return due to inadequate treatment. Our model seeks to address or reduce the underlying causes of these complaints.

How the Online Polyclinic Model Works

The model is based on providing healthcare services-primarily outpatient-through modern information and communication technologies (such as AI, virtual reality, and video) without a hospital setting. This enables the delivery of professional healthcare services by healthcare providers, including taking a patient's history, conducting physical examinations, checking vital signs, and prescribing medications, without requiring patients and providers to be in the exact location.

Services Available Via Online Polyclinic Model

1. Establishing a Medical Team: Physicians providing this service can be organized according to the need, which will be determined by the patient's clinical condition or local resources. Teams may include emergency medicine specialists, family medicine specialists, internal medicine specialists, and pediatrics specialists, or individual physicians can evaluate and manage patients independently. Physicians are not required to be in the exact location; thus, physicians can work from different cities, places, or even countries.

2. Data Recording: Depending on the authority, data entry personnel or nurses may be assigned to record patient data within groups, or physicians may record data themselves.

3. Taking the Patient's History: The system allows all patient inquiries regarding current complaints, past illnesses, family history, medications, surgeries, follow-up results, and data from e-Nabız (an electronic health system) to be collected and recorded in written, verbal, or visual format.

4. Checking Vital Signs: Technological digital tools will be available within OPM to assess vital signs, including blood pressure, temperature, pulse, respiratory rate, oxygen saturation, and blood glucose.

5. Examination: The OPM will facilitate various examinations, including skin, throat, and ear examinations; visual inspection of the thorax, abdomen, and extremities; auscultation (lungs, heart, abdomen); refractive error assessment; intraocular pressure measurement; and retinal screening. New examination options may be added as technology advances.

6. Treatment: After the examination, physicians may prescribe either collective or individual treatments. Patients will receive a prescription code that allows them to obtain their medications. In addition, the system provides various recommendations and other services, as listed below:

- Review of current medications

- Issuing new prescriptions
- Generating medication and equipment reports
- Rest, employment, sports health, mental capacity, and committee reports
- Request consultations from other specialties when necessary

1. Follow-up: Follow-up visits and monitoring of patients will also be part of the model's services. These services include the following:

- Routine check-ups,
- Monitoring treatment continuity
- Follow-up tests,
- Monitoring of vital signs
- Managing chronic illnesses
- Monitoring treatment adherence
- Weight monitoring

2. Consultation Services: The proposed model offers various medical consultation services, including:

- Supportive treatment recommendations
- Physical therapy recommendations
- Referrals to relevant clinics
- Elderly patient monitoring
- Pregnancy follow-up,

- Geriatric care,
- Well-child check-ups,
- Vaccination tracking,
- Home patient care monitoring
- Surgical follow-up,
- Arranging outpatient appointments,
- Advanced clinic services for patients with geographical barriers
- Assessing and managing other patients in the same household
- Performing self-care assessments with a focus on nutrition

The OPM can be used to achieve progress in two primary areas in Turkey and worldwide. This model is expected to benefit countries with high outpatient visit rates.

1. Primary Area: With well-established infrastructure, trained personnel and informed patients, any country with the means to implement a successful OPM service can benefit from it globally.

2. Secondary Area: Compared with global averages, Turkey has a significantly higher outpatient doctor visit rate. Therefore, the OPM is expected to provide significant benefits in Turkey. Although not limited to the following topics, critical areas of improvement include the following:

- Reduced physical visits to hospitals
- Meeting patient appointment demands more quickly
- Expand healthcare services independently of time and place to reach the entire population
- Reducing the need for physical buildings and clinics and optimizing existing ones
- Prevent unnecessary physical clinic visits
- Minimizing unnecessary clinic visits
- Reducing hospital expenses (e.g., water, electricity, fuel, space, and parking usage),
- Extending the lifespan of all hospital equipment
- Enabling patients to access healthcare professionals from all specialties as needed
- Support healthcare providers by alleviating malpractise concerns through artificial intelligence (AI)-assisted algorithms and promoting safer patient management
- Enhancing patient trust in the healthcare system through collaborative care
- Streamlining consultation services to relevant specialties
- Record the entire examination process to prevent irregular requests and actions:
  - Fraudulent report requests
  - Requests to prescribe drugs on behalf of others
  - Inappropriate medication requests
  - Irregularly requested mental capacity assessments and work entry reports
  - Unnecessary laboratory tests, imaging, and treatment
- Minimizing travel time and related productivity losses for patients and their families, thereby improving their satisfaction
- Providing equal service to all
- Allows patients to be seen by multiple physicians simultaneously
- Documenting patient history, examinations, and vital signs in an audio-visual format
- Eliminating complaints such as “the doctor did not examine me, asked few questions, or prescribed medication without examining me”.
- Preventing violence against healthcare professionals (since the interactions are recorded audio-visually);
- They protect hospitals, systems, patients, healthcare workers, and the public from contamination by infectious diseases such as the flu

Table 1 partially outlines examples of vital signs and examinations that can be detected using OPM.

Operating Mechanism of the System and Its Benefits

The OPM operation is anticipated by following the points highlighted below. By following these steps, it will be possible to provide care and improvement for patients much better than physical clinic conditions.

- The patient will make an appointment for an online examination by following a pathway like MHRS (Central Hospital Appointment System used in Turkey).
- A link indicating the specific time and minutes of the examination will be sent to the doctor and patient before the examination.
- A secure area is created using a peer-to-peer protocol, in which communication between two individuals is encrypted at an advanced level to ensure that no one else can intervene.

Table 1. Vital signs and examinations that can be detected using Online Polyclinic Model

Examples of technological tools for online clinic models		
Vital signs • Blood pressure • Temperature • Pulse • ECG • Oxygen saturation • Respiratory function tests • Using camera • Hearing tests	**Virtual reality glasses and artificial intelligence** • Refractive errors • Intraocular pressure measurement • Retina screening	**The future of technology** • By integrating new players in the augmented reality technology economy, it is possible to achieve much more with this system

ECG: Electrocardiogram

- The patient's history will be recorded during the online examination, and the necessary vital signs will be obtained using a vital sign monitor.
- When sufficient evidence for diagnosis and treatment is obtained, a prescription will be issued; if necessary, a report can be prepared.
- If follow-up is necessary, an appointment will be made for a follow-up examination. If a physical exam is required, an appointment will also be made.
- Pre-prepared videos regarding lifestyle changes and supportive therapies related to the patient's illness will be sent to the patient (e.g., drink plenty of fluids and rest for a cold).
- Information on how to use medications obtained from the pharmacy (as paid for by the patient) will be sent via video (e.g., take on an empty stomach, after a meal, etc.).
- The top professionals will provide health recommendations.
- The patient's complaints will be recorded using voice recognition systems during the examination. With the support of artificial intelligence, possible diagnostic suggestions related to the complaints will be given to the doctor.
- Algorithms to be followed for the patient's diagnosis will be presented to the doctor.
- If requested, records of the patient's past vital signs and test results will be presented to the doctor with graphical support (e.g., blood pressure records for a patient wishing to renew their blood pressure report; past blood sugar measurements for a patient whose sugar medications will be checked).
- Prescriptions for reported medications used for chronic diseases will be issued online if no additional tests are required.
- If there is a need for follow-up after examination and treatment, the patient will be notified, and a follow-up appointment will be arranged. If tests are required before follow-up, they will be entered online into the system.
- The patient will undergo blood testing directly at a blood collection center without visiting any clinic. After recording the results, the patient can undergo a follow-up examination.
- In addition, with a system adapted to technological tools, fatal arrhythmias like ventricular fibrillation and ventricular tachycardia, and deadly conditions like hypoglycemia can be detected and reported to the physician. This could reduce the risk of sudden death and sequelae.

Comfort: Numerous studies have examined factors affecting the satisfaction and, consequently, comfort of healthcare providers and recipients. Generally, trust, quality, quick results, intensity, staff quality, and direct patient interaction emerge as prominent factors (25). Studies have also been conducted to examine satisfaction in the field of telehealth (26). For this reason, we emphasize this point in the model we present. The most significant advantage of OPM is the ease of use. Below are some examples of how comfort can be achieved:

- OPM services can be provided 24/7, independent of time and place.
- Patients can benefit from this service whenever they want, without giving up their work or other commitments, traveling long distances, or dealing with stressful traffic.
- Physicians can provide this service at any time and place (at home, while traveling, or on vacation) and receive compensation.
- Each treated patient can be recorded in the current system using a point system for the physician.
- Patients' relatives will be relieved of the burden of taking patients to the hospital. This will also be recorded as a gain in time and space for the patient's relatives.
- This will provide economic savings for both the service providers and recipients.
- OPM's operational secure flow chart was clarified in Figure 1.

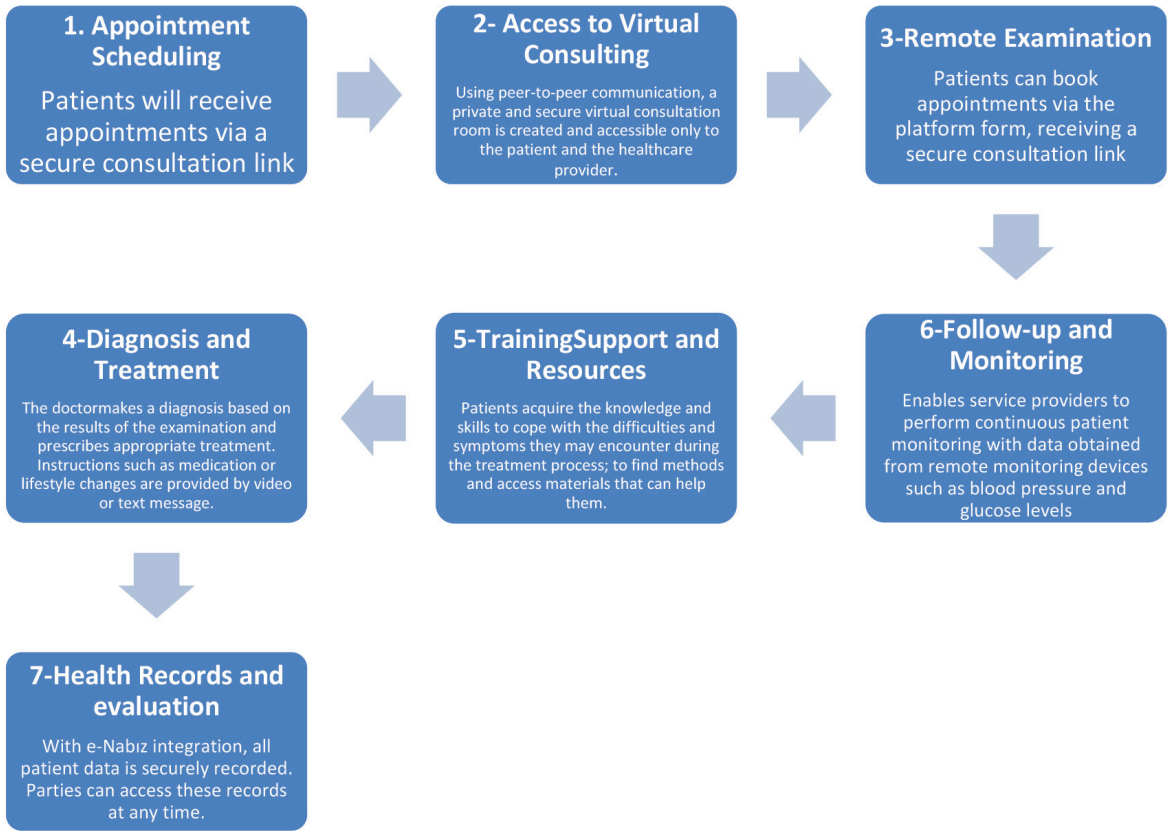

Figure 1. Online Polyclinic Model's operational secure flow-chart

Challenges in Online Polyclinic Model (Table 2): All new systems will face presentation and practical implementation challenges. The essential point is to anticipate these challenges and take measures to minimize damage. The potential challenges we might encounter in OPM will be explained under the following five headings.

1. Reliability and Identity Verification: Healthcare services should be maintained by models with high-reliability capacity that can overcome challenges, are accountable, and ensure continuous communication among strong core operators (27). In digital systems, providing personal data protection is critical for success. Reliability is essential for healthcare providers and recipients. Healthcare workers who believe their data could be more secure want to provide services only if the situation is comfortable. Even if society knows a hundred benefits, they may want to avoid such healthcare services. OPM will ensure a secure registration system by using applications that successfully use TC identity card verification, facial recognition, and voice recognition systems, separately or together.

2. Sustainability: Although sustainability has different meanings, it can be briefly described as the ability to be permanent. The balanced provision of change in an environment demonstrates the potential to meet human needs and desires, appropriate resource utilization, correctly directing investments and technological development, and ensuring that institutional change is in harmony (28). Given this definition, the need for a sustainable system is crucial. The necessity and severity of the need for healthcare services are indisputable. Current systems that meet this need must be developed to ensure that life can continue. The online polyclinic is designed as a model for the sustainability of healthcare services. After implementation, it can be improved with necessary adjustments to make it more qualified.

3. Accessibility: Accessibility refers to making services and environments as rational, meaningful, and usable as possible for as many people as possible. It is essential to distinguish between the problem and the goal correctly. Providing equitable access regardless of the abilities or circumstances of those in need, forms the essence and spirit of accessibility (29). One of the most critical steps in OPM is accessibility. For this purpose, modern technological facilities aim to reach everyone under equal or acceptable conditions, regardless of age: adults, hearing-sight-speech impaired individuals, bedridden patients, and irrespective

Table 2. Challenges encountered by Online Polyclinic Model and strategies to mitigate them

Challenges For OPM and strategies to mitigate them		
Challenge	**Definition**	**Mitigation Strategy**
Patient identity verification and security	Remote verification of patient identities is crucial for preventing unauthorized access and ensuring data security	Multifactor authentication (e.g., national ID, facial recognition, voice recognition) to secure access, ensure patient privacy, and build patient trust
Infrastructure and internet access	Limited internet connectivity in rural areas can hinder access to telemedicine applications	Collaborate with telecommunications providers to improve connectivity in underserved areas, including low-bandwidth options like text-based support for wider accessibility
System reliability	Reliable and consistent telemedicine access is vital because service interruptions can disrupt patient care	Establish a dedicated IT support team for care and rapid issue response. Perform routine performance checks to ensure system stability
Financial constraints	High initial infrastructure, licensing, and support costs can complicate nationwide scaling	Seeking government funding and private partnerships. Highlight the long-term benefits of telemedicine, such as reduced facility strain and resource optimization, to ensure sustainable funding
Cultural acceptance and patient engagement	Trust in telemedical treatment is particularly important because the Turkish culture values face-to-face interactions and family involvement	Implement a cultural integration strategy: facilitate familiarity with local providers, encourage family participation in consultations, and inform the public about the safety and convenience of telemedicine

OPM: Online Polyclinic Model

of short or long distances. 24/7 accessibility will be provided for those who wish to be examined without working hours. Parents can receive support from their pediatric patients and family members when they experience communication problems. The availability of the Internet is crucial for accessibility. As of 2023, the Turkish Statistical Institute reported that the internet access rate in Turkey was 95.5%, and the smartphone usage rate was 92% (30). It is assumed that a significant proportion of the remaining population lives with another individual who uses a smartphone at home. These results indicate that OPM can easily access the Internet.

4. Cost: According to 2022 data from the Turkish Statistical Institute, healthcare expenditures increased by 71.5% to 7,141 TL per capita; the total healthcare expenditure was 606 billion 835 million TL (31). It is critical for forward-looking financial planning in healthcare management to keep costs at the same level or reduce them without compromising the quality and quantity of treatment. The primary purposes of cost calculations in healthcare include determining total and unit costs, monitoring expenditures, increasing efficiency, improving planning quality, conducting benefit-cost comparisons, and performing income-expense-volume analyses (32). The use of new technological developments in disease diagnosis and treatment has increased healthcare costs worldwide (33). By leveraging the power of technology, the delivery of telehealth services can be redesigned. Increased accessibility and reduced travel can enhance productivity for healthcare providers and recipients, reduce service costs, and increase sensitivity to the needs of special populations (34). In OPM, we believe that analyses, infrastructure studies, target audience selection, and appropriate personnel employment will reduce healthcare service costs. The benefits related to time and space, reduced personnel expenses and employment, accessibility and special patient groups, and increased employee-patient satisfaction will positively impact costs. Considering that the rate of outpatient visits in our country is very high and involves at least 450 million trips in our target audience, we believe that the model has a high chance of success in terms of cost. If OPM's contributions regarding costs are exemplified, the subject will be clarified. The average prescription cost in Turkey is expected to reach 300 TL by 2024.

- Travel costs for those living in rural areas requiring physical examination facility.
- The loss of workforce for those living in cities.
- Relapses and flare-ups of diseases requiring advanced treatment because healthcare services are not accessible at the right time, leading to complications.
- Annual expenses for providing physical space.
- The financial burden is imposed on the state and individuals due to the stress, fatigue, and time loss experienced when dealing with all these issues.

Providing the healthcare services people need at a comfortable cost and without interruption is a significant gain. OPM precisely aims to realize this gain.

Long-Term Benefits: The long-term economic benefits of OPM are explained in six steps with brief descriptions.

a. Cost Savings for Patients and the System: Reducing travel and visit expenses benefit patients financially while minimizing system expenses by reducing face-to-face demand.

b. Optimized Resource Allocation: Reduced facility density extends the lifespan of infrastructure and allows for focused resource use in high-priority cases.

c. Enhanced Provider Productivity: Explains how AI technology is used in healthcare services and how it contributes to the triage process. AI organizes patient flow, allowing healthcare workers to effectively attend to more patients. This technology can also assist in making initial treatment decisions, enabling faster and more precise actions.

d. Minimized Complications: Long-term effective service delivery reduces the incidence of complications from untreated conditions, which can lead to significant healthcare expenses.

e. Increased Patient Retention: Patients who receive timely treatment are more likely to continue using healthcare services and remain loyal to their service providers. This loyalty translates into increased revenue in the long run.

f. Proactive Health Management: The preventive care approach adopted by OPM aims to detect health issues early, potentially lowering long-term treatment costs.

5. Legal Framework: A system requires a legal framework that is both beneficial and successful without leading to abuse. This is also true for healthcare services. Every person who possesses universal moral and legal rights should be protected and able to receive the treatment they deserve under equal conditions. The principles of minimizing harm in healthcare, ensuring justice, doing good, and respecting individuals' privacy can only be secured through legal regulations. Legal regulations worldwide have transformed patients from passive recipients of healthcare services to active partners in decision-making (35).

In addition, AI has become a popular area of interest globally and in almost every field. It has also begun to be widely used in healthcare services. Therefore, it is natural for both producers and consumers in this field to expect governments and relevant companies to develop protective mechanisms. Healthcare systems, physician groups, health insurance companies, and other stakeholders have explored AI's potential to improve various aspects of healthcare services. Therefore, they are interested in this topic. However, new legal risks and challenges emerge daily (36). AI has the potential to positively affect healthcare outcomes, reduce costs, and improve patient lives; thus, it will inevitably be widely used in this field. In this regard, users must implement legal regulations in advance.

In our study, we will benefit from technologies such as AI and virtual reality within the framework of the principles of not harming healthcare, ensuring justice in services, contributing to better healthcare, and respecting patients' privacy. The Ministry of Health has some legislative provisions regarding the remote provision of certain healthcare services remotely (37). We believe that with a few additions to these provisions, the legal foundation of OPM can also be strengthened. The points referred to as challenges are not limited to these five items; these are the essentials.

Some of the challenges that OPM may encounter in practice, along with their solution strategies, are presented in Table 2.

Implementation Stages

This subsection explains how OPM operates by ensuring smooth and secure interactions between service providers and recipients. It comprises four phases:

6. Pilot Phase: Initial implementation begins in large cities such as Istanbul and Ankara. Comprehensive training is provided to healthcare workers to effectively manage OPM services and establish a secure digital infrastructure.

7. Implementation Phase: Basic telemedical services are expanded to other urban centers, the infrastructure is strengthened; protocols are improved based on initial pilot feedback; seamless connectivity is ensured, and the user experience for both service providers and recipients is enhanced.

8. The Scaling Phase: Telemedical access is expanded to rural and underserved areas; partnerships with telecommunications companies are formed to close connectivity gaps. The focus is on expanding network capacity and providing technical support for broader access.

9. Evaluation Phase: Continuous evaluations are conducted to measure patient satisfaction, the impact of implementation, and treatment outcomes. Feedback is provided; continuous updates and improvements are made to adequately meet health service needs.

Like a deep river flowing slowly on flat land, suddenly gaining speed downhill, everything in life has started to flow rapidly in recent years. The knowledge that took fifty years can now be accessed in fifty minutes. Human needs have increased

from five to 100. The number of diseases has increased from approximately twenty to one hundred and twenty. Medicine and all its parameters are the fields most affected by these changes and are followed by the most significant interest. It would have been inconceivable. From this perspective, three methods can be used to meet people's health needs. The first step is to bring people to healthcare institutions. Until now, only this method has been valid because certain circumstances required it. The second is to partially bring healthcare services to people. Our capabilities now allow this. This trend became particularly prominent during the COVID-19 pandemic. The third approach is to use both methods in a complementary manner. The OPM views the service provided by the first method as significant; it strengthens the second and proposes the third.

Developments in nanotechnology, information technology, genetic technology, synthetic biology, regenerative medicine, robotic applications, neurotechnology, artificial intelligence, and virtual reality have accelerated at a tremendous pace in recent years (38). These technologies developed in the medical field are accelerating the diagnosis and treatment of diseases, aiming for a more robust and healthier life. Utilizing these technologies in a timely manner and benefiting from their potential is crucial to achieving the intended outcome. To avoid being a hundred days behind developments, one must start a day earlier. An OPM was prepared and presented for this purpose.

Obtaining a detailed patient history and conducting a complete physical examination are essential in the medical profession. Patients have always trusted physicians who listen to their stories and possess stronger communication skills than others (39). However, keeping pace with technological developments in medicine has become a necessity for all healthcare providers. Those who need help along this path will struggle to pursue and protect their profession. Unexpected severe healthcare issues can also lead to innovations. The COVID-19 pandemic has confined people to their homes to protect them from the risk of contagion. This phenomenon was one of the reasons for the rapid increase in virtual or telehealth visits (40). Development also brings about doubts and discussions. While discussions often minimize the shortcomings of developments, they can sometimes lead to unnecessary and difficult-to-repair resistance. This situation is valid for both telehealth and OPM. Physicians' sense of security regarding telehealth depends on their ability to behave objectively and improve their skills (41). In virtual visits, a complete history can be obtained, and physical examination can be performed alongside medication inquiries. Requesting tests suitable for physical examination and history can also help in starting treatment. Experiences gained during the pandemic demonstrate that patients responded positively to these applications. In regular outpatient clinics, physicians gather information about the patient's clinical status by observing the patient's movements, such as walking, sitting, and other movements. The likelihood of obtaining such information during telehealth visits may decrease. If doctors review in advance what information they want from remote examinations, they can minimize this issue. Knowing their limits and capabilities during video examinations, experienced and trained physicians can make the process easier by asking the right questions for proper guidance. The success rate increases when these evaluations are supplemented with measurements of vital parameters like blood pressure, oxygen saturation, pulse, respiratory rate, and temperature (42).

Various recommendations for the use of telemedicine can be found in different studies. During the COVID-19 pandemic, recommendations were made for telemedicine usage to monitor weight, blood pressure, jugular venous distention, pulse oximetry, and temperature (43-45), and to identify arrhythmias (46). Benziger et al. (42) proposed a ten-step algorithm for physical examination via telemedicine. When technological advancements, human needs, the necessity to meet those needs, experienced and trained healthcare professionals, scientific study results, and courageous proposals come together, providing healthcare services with OPM becomes a necessity rather than a dream.

Studies on hospital congestion generally continue through emergency services. Although our study covers the congestion of all steps in the healthcare system, examples have been provided primarily through emergency services. The shortcomings could not be indicated because it was written before the pilot application was submitted. The literature does not include many comprehensive and practically ongoing applications like the online outpatient clinic model. For this reason, the comparisons in the discussion section are weak.

Conclusion

Healthcare services will inevitably evolve into a new form by collaborating with advancing technologies. OPM will yield beneficial results in providing services under more comfortable conditions, saving time and space, ensuring 24/7 continuity, ensuring high-level security, being accessible, reducing healthcare costs, providing measurable outcomes, being continuously updatable, offering healthcare services to everyone by the principle of equality, increasing the satisfaction of both healthcare providers and recipients, and being a solution to increasing hospital congestion and facilitating the monitoring of chronic diseases. In cases like a pandemic, earthquake, or flood, OPM emerges as the safest haven to provide comfortable healthcare

services for patients who need home care, are bedridden, or can only reach doctors by covering long distances and enduring hardships. During applications, there may be challenges, such as ensuring information security due to insufficient experience and training, identity verification processes, accessibility, legal infrastructure, and costs.

Ethics

Acknowledgments

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Footnotes

Authorship Contributions

Surgical and Medical Practices: B.A., E.Y., S.A., Concept: B.A., E.Y., S.A., Design: B.A., E.Y., S.A., Data Collection or Processing: B.A., E.Y., S.A., E.T., Analysis or Interpretation: B.A., E.Y., Literature Search: B.A., E.Y., E.T., Writing: B.A., E.Y., S.A.

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Role of Cardiac Biomarkers and Tomographic Right Ventricular Dysfunction Findings in the Treatment of Pulmonary Thromboembolism

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Abstract

Aim: Deaths from acute pulmonary thromboembolism are caused by right ventricular dysfunction (RVD) and often occur within the first hour. Diagnostic computed tomography-pulmonary angiography (CTPA) is a useful tool for the early and rapid evaluation of RVD. We aimed to evaluate the effect of RVD findings on risk classification and treatment.

Materials and Methods: This retrospective study included patients who applied to the emergency department on specified dates and were diagnosed with pulmonary thromboembolism. The right ventricle (RV) and left ventricle (LV) diameters (mm), ratio of these diameters RV/LV, pulmonary artery and aortic diameter (mm), troponin, and BNP were evaluated.

Results: A total of 119 patients were studied. The average age of the participants was 63.3 years. The mortality rate was 12.6%. Reperfusion therapy was applied to 25 (21%) patients. RV/LV was superior for predicting thrombolytic therapy. N-terminal proBNP (NT-proBNP) was more significant than troponin. When both parameters were evaluated together, the result was superior in predicting reperfusion therapy in patients with RVD.

Conclusion: CTPA can be used safely to determine the risk group and for treatment with its high sensitivity. NT-proBNP is an important biomarker for determining thrombolytic treatment, and its diagnostic specificity increases when evaluated together with RV/LV.

Keywords: BNP, pulmonary embolism, reperfusion therapy, RV/LV, pulmonary artery diameter, troponin

Introduction

Pulmonary thromboembolism (PTE), which develops as a result of varying degrees of occlusion of the pulmonary arteries caused by any material originating from another body part, is a cardiovascular emergency that can be fatal. Despite treatment optimization, all-cause mortality in the first 30 days is between 3-12%. Early mortality in high-risk PTE can reach 50% (1). Right ventricular dysfunction (RVD) is the most important cause of adverse clinical outcomes in PTE (2). Therefore, early detection of RVD in patients who may require more aggressive treatment, such as systemic reperfusion, is the primary prognostic step. Echocardiography is frequently used to evaluate RVD in acute pulmonary thromboembolism (APTE) (3). However, the role of parameters obtained from computerized tomography-pulmonary angiography (CTPA) in predicting adverse outcomes and early mortality in patients with APTE has recently been evaluated (4). One of the most frequently evaluated parameters, the ratio of right ventricle to left ventricle (RV/LV), has been reported to correlate with the severity of the disease (5). An RV/LV >1 has been shown to be associated with increased in-hospital mortality and intensive care admission rates (6). In a recent study, it was

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reported that the ratio of the pulmonary artery diameter to aortic diameter (PAD/AOD) is a useful tool for identifying high-risk patients and can be used for risk classification (7).

Most PTE mortality prediction models require RVD measurement and/or myocardial biomarkers. Troponin and natriuretic peptides are used for this purpose. Increased cardiac biomarkers are adverse prognostic factors (8,9).

In acute PTE, deaths often occur within the first hour, and RVD caused by thrombi is the main cause of mortality. Therefore, patients with dysfunction should be identified early. This study was designed to evaluate the role of cardiac biomarkers in treatment management with RVD findings measured using CTPA, which is considered the gold standard for diagnosis, as well as all these advantages, such as obtaining easily accessible, rapid results in risk classification, and not relying on the experience of the practicing physician.

Materials and Methods

This retrospective, single-center study included patients who applied to Dışkapı Yıldırım Beyazıt Training and Research Hospital emergency department and were diagnosed with PTE.

Ankara Etlik City Hospital Clinical Research Ethics Committee (decision number: AESH-EK1-2023-441, date: 31.08.2023), and it was conducted following the ethical principles determined by the Declaration of Helsinki.

Patients were classified into low, intermediate-low, intermediate-high, and high risk groups in terms of early death according to the European Society of Cardiology (ESC) guidelines. The demographic characteristics, comorbidities, vital signs, chest radiography, computed tomography (CT) angiography, laboratory values and medical treatments of the patients were studied.

Patients with APTE were included in the study. Patients under the age of 18 years, pregnant women, those with decompensated congestive heart failure, those with contraindications to thrombolytic therapy, those with previous pulmonary hypertension, those with advanced chronic obstructive pulmonary disease, those with advanced interstitial lung disease, those with chronic thrombi, and those with missing data were excluded from the study.

Radiological Measurements

All images in this study were obtained using a 128-segment multi-detector CT device with the standard CTPA protocol created for the diagnosis of pulmonary embolism (detector width 40 mm, slice thickness 0.625 mm, rotation time 0.4 seconds, 120 kVp and 380 mAs). During BTPA recording, 100 mL of contrast material was administered at a rate of 5 mL/s. In CTPA, parameters such as RV and LV diameters (mm), the ratio of these diameters to each other (RV/LV), main PAD (mm), and ascending AOD were measured. RV and LV diameter measurements were made in axial sections from the distances between the septum endocardium and ventricle lateral wall endocardium, just below the atrioventricular valve, and were rated to each other (Figure 1). As a result of the ROC analysis, the cutoff value for RV/LV was 1.01, and a value >1.01 was defined as dysfunction. Pulmonary artery measurements were obtained from the axial section in the mediastinal window immediately before pulmonary bifurcation, and the diameters of the ascending aorta at the same level were measured obliquely in millimeters and rated to each other (Figure 2). As a result of the ROC analysis, the cutoff value for the PAD was determined to be 28.05 mm, and a value above this value was defined as an increase in pulmonary vascular resistance (PVR).

Statistical Analysis

The statistical analysis of the data obtained was performed using the IBM SPSS 27.0 statistical package program. The suitability of the variables for normal distribution was examined using visual analytical methods (Shapiro-Wilk test). Descriptive statistics were expressed as mean and standard deviation in normally distributed numerical data, median and minimum-maximum range in non-normally distributed data, and number and percentage in nominal data. We analyzed normally distributed numerical variables using the "t-test in independent groups" for two groups and 'ANOVA' for three groups. Numerical variables that did not show normal distribution were analyzed using the "Mann-Whitney U test" between two groups and the "Kruskal-Wallis test"

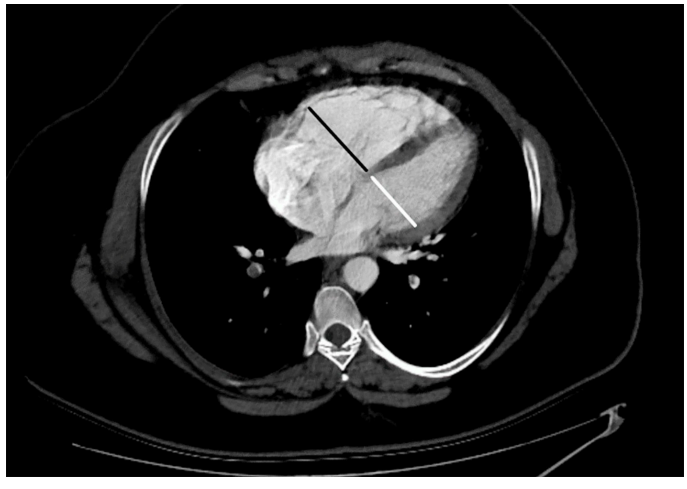

Figure 1. In computed tomography-pulmonary angiography, right ventricular diameter (black line) and left ventricular diameter (white line) are measured in the axial section in the mediastinal window, and it is noteworthy that the right ventricular diameter has increased significantly and the interventricular septum has flattened

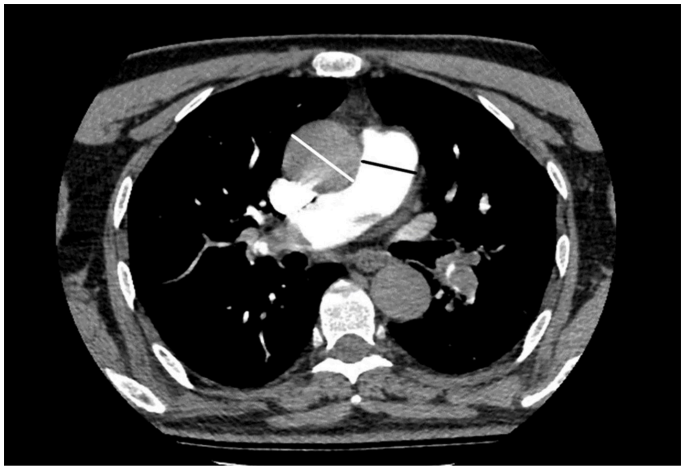

Figure 2. Computed tomography-pulmonary angiography axial section shows ascending aorta diameter (white line) and pulmonary artery diameter (black line) measurements in the mediastinal window. Embolism is observed in the right pulmonary artery and left lobar arteries

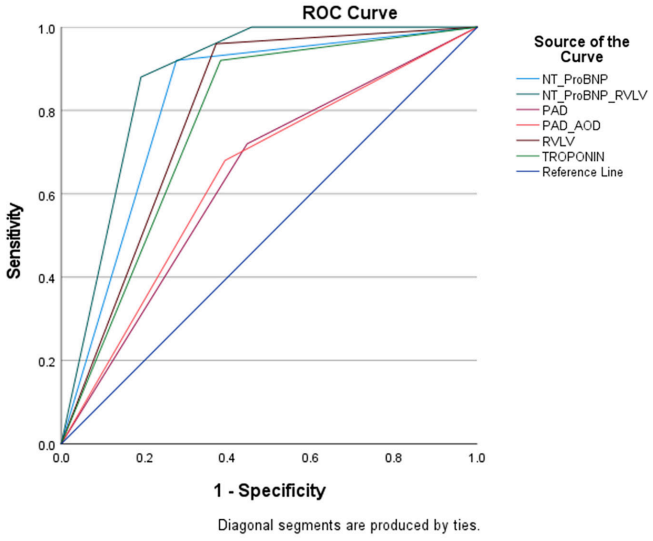

Figure 3. ROC curve in reperfusion therapy prediction

ROC: Receiver operating characteristic, NT-proBNP: N-terminal proBNP, RVLV: Right ventricle/left ventricle, PAD: Pulmonary artery diameter, AOD: Aortic diameter

between three groups. Intra-group analyses were evaluated using the "paired t-test" for those with normal distribution. Nominal data were evaluated between the two groups using the "Pearson chi-square test" or "Fisher's exact test". To determine the factors affecting the prediction of reperfusion treatment, the area under the curve (AUC) was evaluated in the ROC curve analysis, and the data were expressed with a 95% confidence interval (CI). The correlation of normally distributed numerical variables was analyzed with the "Pearson's correlation test", and non-normally distributed numerical variables were analyzed with the "Spearman's correlation test". Comparisons with a p value 0.05 were considered statistically significant.

Results

One hundred and nineteen patients were included in the study. The average age of the patients was 63. Sixty-five (54.4%), and the patients included in the study were women. When the thrombus burden of the patients included in the study was evaluated radiologically, 64.7% of the patients had non-massive PTE and 35.3% had massive PTE.

When the demographic characteristics and clinical findings of the patients included in the study were evaluated according to the ventricular diameter ratio, RVD was observed more frequently in elderly patients (p=0.011). Acquired risk factors and comorbid diseases were observed to be more common in patients with RVD findings (p=0.037; p=0.01). It was observed that patients with RVD presented with syncope more often (p=0.006).

When the vital signs of the patients included in the study were evaluated according to the ratio of their ventricular diameters, systolic and diastolic blood pressures were found to be significantly lower in patients with an RV/LV of 1.01 and above. The respiratory rate was significantly higher in patients with a higher RV/LV (p=0.006). Saturation was significantly lower in this patient group (p<0.001) (Table 1).

Twenty-eight (23.5%) patients were in the high-risk group, 17 (14.3%) were in the intermediate-high-risk group, 36 (30.3%) were in the intermediate-low-risk group, and 38 (31.9%) were in the low-risk group.

The PAD and AOD of the patients included in the study were rated, and the average was 0.86. Patients were divided into two groups: above and below the median. Among the risk groups, no significant difference was observed between the groups (p=0.312) (Table 2).

Twenty-five (21%) patients included in the study required thrombolytic treatment. When these patients were grouped according to their ventricular diameter, RV/LV was >1.01 (p<0.001) in 96% of the patients who received thrombolytic therapy (Table 3). When the pulmonary artery diameters were compared, a significant difference was found between the groups (p=0.004) (Table 3). Additionally, when evaluated according to the ratio of pulmonary artery to AOD, a significant difference was observed between the groups (p=0.01) (Table 3).

Table 1. Evaluation of patient admission vitals				
Vital signs	**All patients (n=119) Mean±SD**	**RV/LV<1.01 (n=58) Mean ± SD**	**RV/LV>1.01 (n=61) Mean ± SD**	**p value**
Systolic blood pressure (mm/Hg)	114±21	122±19	106±21	**<0.001**
Diastolic blood pressure (mm/Hg)	69±12	72±10	65±15	**0.010**
Pulse (beats/min)	98±19	94±15	102±21	0.058
Respiratory rate	21±7	20±9	22±4	**0.006**
Saturation	87±7	90±7	84±7	**<0.001**
SD: Standard deviation, RV: Right ventricle, LV: Left ventricle				

Table 2. Distribution of patients in risk groups according to RV/LV and PAD/AOD ratios					
Early mortality risk classification	**Low risk (n=38)**	**Intermediate-low risk (n=36)**	**Intermediate-high risk (n=17)**	**High risk (n=28)**	**p value***
RV/LV>1.01 (n=61)	5 (13.2%)	15 (41.7%)	14 (82.4%)	27 (96.4%)	**<0.001**
PAD/AOD>0.86 (n=54)	17 (44.7%)	12 (33.3%)	10 (58.8%)	15 (53.6%)	0.312
*The test was evaluated using the Kruskal-Wallis test, RV: Right ventricle, LV: Left ventricle, AOD: Aortic diameter, PAD: Pulmonary artery diameter					

Table 3. Evaluation of CTPA findings and cardiac biomarkers according to reperfusion status			
	Patients who require reperfusion therapy	**Patients who do not need reperfusion therapy**	**p value**
RV/LV>1.01	24 (96%)	1 (4%)	**<0.001**
PAD/AOD>0.86	17 (68%)	8 (32%)	**0.01**
Pulmonary arter diameter (mm)	31.42±4.24	28.39±4.38	**0.004**
Troponin elevation	23 (92%)	2 (8%)	**<0.001**
Nt-proBNP	3429± 2730	997±780	**<0.001**
CTPA: Computed tomography-pulmonary angiography, RV: Right ventricle, LV: Left ventricle, PAD: Pulmonary artery diameter, AOD: Aortic diameter, Nt-proBNP: N-terminal proBNP			

Among the CTPA findings, RV/LV, PAD, and PAD/AOD were identified as determinants of the need for thrombolytic treatment (Table 4).

When the reperfusion therapy status of the patients included in the study was evaluated according to cardiac biomarkers, troponin and N-terminal proBNP (NT-proBNP) were found to be determinative (Table 4).

When NT-proBNP and RV/LV were evaluated together, they were found to be predictive of the need for thrombolytic treatment with 88% sensitivity and 80.9% specificity (AUC: 0.877, 95% CI 0.815-0.939, p<0.001) (Figure 3). In determining thrombolytic treatment, combining these parameters was superior to separately evaluating them.

Discussion

PTE encompasses a wide spectrum, ranging from asymptomatic to life-threatening shock (10). In acute PTE, deaths frequently occur within the first hour, with RVD caused by the thrombus being the primary cause of mortality. Therefore, early identification of patients with dysfunction is crucial. CTPA has become an effective tool not only for diagnosing acute PTE but also for developing therapeutic strategies and risk classification (11). In our study, CTPA, which provides rapid diagnostic results, was a significant tool in determining the risk of PTE.

In the evaluation of RVD in acute PTE, echocardiography or CTPA can be performed. Particularly in patients with obesity or chronic lung disease, visualizing the RV free wall via echocardiography may be challenging. Additionally, rapid access to echocardiography may not always be feasible. For this reason, the ratio of RV/LV measured on CTPA has become a parameter used to assess RVD (12). The RV/LV ratio can also be used in therapeutic strategies and risk classification (13). A study by Ammari et al. (14) demonstrated a strong correlation between RVD measured on CTPA and echocardiographic parameters, with similar specificity in predicting 30-day mortality risk. In our study, the RV/LV ratio was an important tool in determining mortality risk.

APTE can present as a clinical spectrum ranging from asymptomatic to hemodynamic instability and sudden death (15). Therefore, the greatest challenge in managing APTE is the rapid and accurate classification of prognosis. Since 2014, the risk classification of APTE has been based on the patient's hemodynamic status (1). Hemodynamically unstable patients are

Table 4. Evaluation of parameters for predicting patients' needs for reperfusion therapy

	AUC	95% Confidence interval	Sensitivity	Specificity	PPV	NPV	LR+	LR-	p value
Troponin positivity	0.769	0.676-0.861	92	61.7	39	96.7	2.40	0.24	<0.001
NT-proBNP>665 pg/mL	0.822	0.737-0.907	93	72.3	46.9	97.1	3.35	0.25	<0.001
RV/LV and NT-proBNP	0.877	0.815-0.939	88	80.9	55	97.4	4.60	0.14	<0.001
PAD>28.05 mm	0.637	0.517-0.756	72	55.3	30	88	1.61	0.50	0.016
PAD/AOD>0.86	0.643	0.522-0.764	68	63.8	31.5	87.7	1.87	0.50	<0.001

AUC: Area under the curve, PPV: Positive predictive value, NPV: Negative predictive value, LR+: Likelihood ratio +, LR-: Likelihood ratio -, NT-proBNP: N-terminal-proBNP, RV: Right ventricle, LV: Left ventricle, PAD: Pulmonary artery diameter, AOD: Aortic diameter

immediately classified into the high-risk group, and reperfusion therapy is recommended regardless of other risk markers. Our study showed that patients with a higher RV/LV ratio had a lower mean arterial pressure. Among patients who received systemic reperfusion therapy, 96% had an RV/LV ratio >1.01. This suggests that the RV/LV ratio is also an important parameter for determining the appropriate treatment approach.

In patients with PTE who do not present with hypotension or shock, further risk assessment should be performed after diagnosis. This risk assessment combines the pulmonary embolism severity index (PESI) or simplified pulmonary embolism severity index (sPESI) scores with RVD cardiac biomarkers (1). In our study, patients were grouped based on their early mortality risk according to the ESC guidelines, and when comparing their RV/LV ratios, 96% of high-risk patients had an RV/LV ratio >1.01. A significant difference was observed between the risk groups. The RV/LV ratio, which can be easily calculated using a single parameter, can also be used as an indicator for determining patient risk.

In acute PTE, direct mechanical obstruction caused by clot burden leads to increased. Additionally, an increase in vasoactive mediators (such as thromboxane A2) elevates PVR (16). On CTPA, PVR is a well-defined and straightforward measurement used to detect pulmonary hypertension (17). A study by O'Corragain et al. (18) demonstrated that the PAD correlates with echocardiographic parameters and can be used to assess RVD. In our study, an increase in PVR was defined as a PAD of 28.05 mm or greater. In the intermediate-high and high-risk groups, PAD was higher than that in the other groups. Additionally, PAD was higher in patients who received reperfusion therapy. PAD is a key parameter that can be used in the assessment of RVD and in guiding treatment management.

In a study conducted by Schneider et al. (19), the ratio of PAD/AOD was identified as a marker that can be used in the diagnosis of pulmonary hypertension, emphasizing that it should be assessed in all patients suspected of having pulmonary hypertension. In a study by Gašparović et al. (20), PAD/AOD was evaluated in patients with advanced COPD, and it was noted that this ratio had high specificity and was an independent predictor of pulmonary hypertension. Cheng et al. (21) found that an increase in the PAD was associated with treatment failure in patients hospitalized for COPD exacerbations. A recent study indicated that an elevated PAD/AOD ratio is associated with PTE and may be linked to the development of chronic thromboembolic pulmonary hypertension (22). In a study assessing risk factors associated with mortality in acute PTE, increased PVR was found to be correlated with adverse outcomes (23). Another recent study suggested that the PAD/AOD ratio is a useful tool for identifying high-risk patients and could be employed for risk classification (7). In our study, when patients were evaluated according to their risk groups, no significant difference was observed in the PAD/AOD ratio. However, both the PAD and the PAD/AOD ratio were shown to be predictive parameters for systemic reperfusion therapy.

In PTE, a rapid increase in RV afterload leads to an increase in wall tension. The reduction in lung perfusion results in decreased oxygen delivery, but the oxygen demand in the ventricular muscle rises, leading to ischemia and ultimately causing troponin release (24). High cardiac troponin levels are observed in 30-60% of patients with acute PTE. An increase in troponin levels is an adverse prognostic factor of acute PTE (25). In patients without hypotension, elevated troponin levels are associated with an early mortality (26). It has been shown that combining troponin levels with clinical scores (PESI or sPESI) improves the prognostic classification of patients with PTE (27). In our study, 96% of patients who underwent reperfusion therapy had elevated troponin levels. The increase in troponin levels was found to be a predictive factor for thrombolytic therapy requirement.

An increase in RV afterload in APTE induces RV dilation, leading to the release of brain natriuretic peptide and its precursor, NT-proBNP. In 2003, the first study was published showing that elevated NT-proBNP levels are associated with an increased risk of PTE-specific mortality or adverse outcomes (28). In a study by Chen et al. (29), NT-proBNP was found to be a highly sensitive

marker for detecting RV dysfunction and predicting mortality, with significantly lower mortality observed when NT-proBNP levels were low. In our study, NT-proBNP levels were higher in patients who received reperfusion therapy and were determined to be a key predictor of thrombolytic therapy. Compared with the other parameters, NT-proBNP level and the RV/LV ratio showed high sensitivity and negative predictive value in determining the need for reperfusion therapy.

Most mortality prediction models for PTE require assessment of RVD and/or measurement of myocardial biomarkers. The combination of RVD and biomarkers is recommended for predicting early mortality (1). In a study by Santos et al. (30) evaluating treatment management in PTE, the cumulative presence of cardiac biomarkers and imaging findings of should be considered. Particularly in normotensive patients, the combined assessment of NT-proBNP, troponin, and CT parameters can improve diagnostic accuracy and prevent delayed treatment (31). In our study, the combined use of NT-proBNP and the RV/LV ratio was superior to that of other markers or their individual use. It is recommended that both parameters be used together to identify patients with acute PTE who may require more aggressive treatment.

Study Limitations

There are some limitations in our study. Due to changes in the hospital information management system, not all radiological images could be accessed. Therefore, the number of patients in the study was limited. Another limitation is that this study was conducted in a single center; supporting it with multicenter studies will increase the value of our study.

Conclusion

In APTE, a significant cause of cardiovascular mortality, CTPA is a readily accessible imaging method that is unaffected by patient compliance or the clinician's experience. With these advantages, CTPA can be reliably used for risk classification and treatment management. NT-proBNP is an important biomarker for determining the need for thrombolytic therapy, and when evaluated together with the RV/LV ratio, its specificity increases. Therefore, it should be used together in the identification and treatment management of patients who may be mortal due to RVD.

Ethics

Ethics Committee Approval: Ankara Etlik City Hospital Clinical Research Ethics Committee (decision number: AESH-EK1-2023-441, date: 31.08.2023), and it was conducted following the ethical principles determined by the Declaration of Helsinki.

Informed Consent: Retrospective study.

Footnotes

Authorship Contributions

Surgical and Medical Practices: M.A., Z.K.C., Concept: M.A., E.A., Design: M.A., E.A., Data Collection or Processing: Z.K.C., E.U., E.A., U.K., M.A., Analysis or Interpretation: E.A., U.K., Literature Search: E.U., E.A.,Writing: M.A., Z.K.C., E.U.

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

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Evaluation of the Effects of Concomitant Alcohol Positivity on the Characteristics and Severity of Injury in Geriatric Trauma Patients in the Emergency Department

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Abstract

Aim: This study aimed to evaluate whether concomitant alcohol positivity is an effective factor in trauma characteristics and severity in geriatric trauma patients and evaluate the relationship with poor composite outcomes in alcoholic patients.

Materials and Methods: Patients aged 60 and over who presented to the emergency department due to trauma and whose blood ethanol level was studied were included in the study. Patients were assigned to the poor composite outcome group according to the intensive care unit stay, need for emergency blood transfusion/operation, or in-hospital mortality, and the groups with and without poor composite outcomes were compared.

Results: Three hundred thirty-six patients with complete data were included in the study. There were 101 patients with an ethanol level of >0.5 mg/dL. Ethanol-positive patients had more head trauma, and their Injury Severity Scores and liver function tests were higher ($p<0.05$ for all values). 11.3% (n=11.3) of all patients and 15.8% (n=16) of ethanol-positive patients developed poor composite outcomes. When ethanol-positive patients were compared according to the poor composite outcome, it was observed that patients had more diabetes, more trauma to the head, abdomen, and extremities, higher creatine levels, and lower albumin and blood ethanol levels ($p<0.05$ for all values).

Conclusion: In this study, we showed that the majority of alcoholic geriatric trauma patients were male and single, that they had more frequent head trauma compared to the non-alcoholic group, that the presence of alcohol was associated with increased severity of injuries regardless of the ethanol level, but was not effective in terms of poor composite outcomes.

Keywords: Ethanol, alcohol, geriatric, trauma, poor outcome

Introduction

As life expectancy increases, the elderly population naturally expands, and the frequency of exposure to serious injury in the geriatric group also increases. Geriatric patients have high trauma-related morbidity and mortality rates due to comorbid diseases, age, and injury severity (1). Geriatric patients are more injured than young patients in similar accidents. Increased comorbidities and decreased physiological reserve due to changes in the physiological response to trauma in old age are the main causes of increased geriatric mortality (2). Geriatric trauma patients constitute an important and difficult case group for health professionals because of increased hospital admissions and high mortality (2,3). However, studies on the diagnosis and treatment process in trauma patients have generally focused on the young population, and there is not enough research on injury mechanisms, scoring systems, resuscitative variables, advanced treatment management, and many other issues in geriatric trauma patients.

Physiological changes that occur with advanced age (such as decreased liver function and decreased total body water) increase the susceptibility of elderly adults to side effects caused by substances such as drugs and alcohol (4,5). The relationship between ethanol consumption and trauma has been previously reported (5-8). Alcohol consumption may contribute to the risk of trauma because it can lead to gait and balance disorders and

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cognitive changes (5,6). In the literature, alcohol use has been shown to increase in the geriatric population. In a meta-analysis, it was reported that the average annual percentage increase in the prevalence of alcohol use and binge drinking (4 or more drinks for women and 5 or more drinks for men) was approximately 1% and 3.4%, respectively (2). With the improvement in health services and advances in the management of chronic diseases, elderly people who had to completely withdraw from social life at an earlier age participate more in active life today (7). This makes the geriatric population vulnerable to injury. Although there are relevant studies in the literature, our data on alcohol-related injuries in patients with geriatric trauma are insufficient.

This study aimed to evaluate whether concomitant alcohol positivity is an effective factor in trauma characteristics and trauma severity in geriatric trauma patients in the emergency department and to evaluate the relationship with poor composite outcomes in alcoholic patients.

Materials and Methods

The study design was retrospective. The current study was conducted in a tertiary care emergency department that receives approximately 250,000 patient admissions annually. Local ethics committee approval was obtained prior to the study. It received ethical approval from the University of Health Sciences Turkey, Ankara Atatürk Sanatorium Training and Research Hospital Clinical Research Ethics Committee (decision no: 2012-KAEK-15/789, date: 12.09.2023). Patients aged 60 years and older who presented to the emergency department due to trauma between 01.01.2018 and 31.12.2022 and whose blood ethanol level was studied were included in the study. Patients with missing data were excluded. In our emergency department, a blood ethanol test is requested for patients admitted due to traffic accidents and assault and violence-related conditions, those with physical examination findings incompatible with injury mechanisms, and those admitted with forensic conditions and whose change in consciousness cannot be explained by physical examination and laboratory findings. In this study, ethanol levels >0.5 mg/dL were considered ethanol-positive. Ethanol-positive and ethanol-negative patients were divided into two groups and compared.

Information on patients' demographic characteristics (age, sex, marital status, etc.), comorbid diseases (hypertension, cardiac disease, diabetes mellitus, chronic obstructive pulmonary disease and others), mechanisms of injury (fall from height and mechanical falls, motor vehicle collisions, pedestrian accidents, assault and penetrating trauma), injury sites (head/face, extremities/vertebra, thorax, abdomen/internal injury, hip/pelvis and superficial wound injury), ethanol level, laboratory [hemoglobin, platelet, aspartate aminotransferase (AST), alanine aminotransferase (ALT), international normalized ratio, albumin, creatine], blood transfusion and/or operation, and outcomes (discharge/hospitalization status and length of hospital stay, in-hospital mortality) was obtained from patient files by retrospective review. The occurrence was dated as weekdays from Monday to Friday and weekends on Saturday or Sunday.

Glasgow Coma Scale and Injury Severity Score (ISS) were calculated for all patients. In ISS scoring to determine prognosis in patients with multiple trauma, injuries are first calculated at the anatomical region according to the Abbreviated Injury Scale table and then submitted to the ISS system. The lowest score is 0, which indicates the best prognosis, and the highest score is 75, which indicates the most harm and the poorest prognosis (9). ISS scores were calculated retrospectively using tomography images and emergency department records, and radiologic imaging of the patients. Patients with an ISS score of 1-8 were considered mild trauma, and those with an ISS score of 9 and above were considered to have moderate to severe trauma. Patients were assigned to the poor composite outcome group according to intensive care unit stay, emergency blood transfusion/operation, or in-hospital mortality, and groups with and without poor composite outcomes were compared.

Statistical Analysis

The analysis of the study data was performed using the IBM SPSS 20.0 (Chicago, IL, USA) statistical software. The Kolmogorov-Smirnov test was used to investigate whether the distribution of discrete and continuous numerical data was in accordance with a normal distribution. Continuous numerical variables are presented as median (IQR 25-75), and categorical variables are presented as number of cases and (%). Categorical variables were evaluated using the chi-square and Fisher's exact tests, and continuous variables were evaluated using the Mann-Whitney U test. Results for $p<0.05$ were considered statistically significant.

Results

Within the study period, 351 geriatric trauma patients with ethanol levels were identified. A total of 336 patients with complete data were included in the study. A total of 101 patients had an ethanol level of >0.5 mg/dL. Of the patients, 9.8% were female, and the most common reason for admission was assault. The demographic data of all patients are presented in Table 1.

According to the comparison of ethanol-positive and ethanol-negative patients, most alcoholic patients were male and single. Ethanol-positive patients had more head trauma, and their ISS, AST, and ALT scores were higher ($p=0.021$, $p<0.001$, $p<0.001$, $p=0.001$, respectively) (Table 2). However, there was no statistically significant correlation between the ISS score and

ethanol level in the ethanol-positive group (p=0.560). When the data of 5 patients with liver injury were not included in the statistical analysis, AST and ALT levels were higher in the ethanol-positive group (p<0.001, p=0.003, respectively).

11.3% (n=38) of all patients and 15.8% (n=16) of ethanol-positive patients developed poor composite outcomes. Patients with poor composite outcomes had more cardiac disease, more frequent non-thoracic system injuries, and higher AST, ALT, and creatine values (p=0.021, p<0.001, p=0.007, p=0.039, p=0.005, respectively) (Table 3).

Table 1. Demographic data of all patients (n=336)

Sex, n (%)	
Female	33 (9.8%)
Age, median (IQR 25-75)	64 (62-68)
Marital status, n (%)	
Married	256 (76.2%)
Single	80 (23.8%)
Day, n (%)	
Mid-week	234 (69.6%)
Weekend	102 (30.4%)
Comorbidity, n (%)	
Hypertension	189 (56.3%)
Cardiac diseases	48 (14.3%)
Diabetes mellitus	39 (11.6%)
COPD	35 (10.4%)
Other	24 (7.1%)
Mechanism of injury (n (%)	
Assault	127 (37.8%)
Motor vehicle collisions	96 (28.6%)
Fall	91 (27.1%)
Pedestrian	22 (6.5%)
Penetrating	0 (0%)
GCS, median (IQR 25-75)	15 (14-15)
Ethanol level, median (IQR 25-75)	237 (156-293) 227±93.4
ISS, median (IQR 25-75)	2 (1-4)
ISS group, n (%)	
Mild	301 (89.6%)
Moderate-severe	38 (11.3%)
Injury area, n (%)	
Superficial wound injury	221 (65.8%)
Extremity/vertebra	50 (14.9%)
Thorax	27 (8%)
Head/face	26 (7.7%)
Abdomen	9 (2.7%)
Pelvis/hip	8 (2.4%)
Patient outcome, n (%)	
Discharge	293 (87.2%)
Hospitalization	20 (6%)
Intensive care unit	23 (6.9%)
Hospital length of stay, median (IQR 25-75)	4 (3-6)
In-hospital mortality, n (%)	6 (1.8%)

COPD: Chronic obstructive pulmonary disease, GCS: Glasgow Coma Scale, ISS: Injury Severity Score, IQR: Interquartile range

When ethanol-positive patients were compared according to the poor composite outcome, it was observed that patients had more diabetes, more trauma to the head, abdomen, and extremities, higher creatine levels, and lower albumin and blood ethanol levels (p=0.011, p<0.001, p=0.024, p<0.001, p=0.007, p=0.030, p=0.007, respectively) (Table 4).

Discussion

In this study, in which we evaluated whether concomitant alcohol positivity was effective on trauma characteristics and severity in geriatric trauma patients in the emergency department, we showed that the majority of alcoholic geriatric trauma patients were male and single, that they had more frequent head trauma compared with the non-alcoholic group, that the presence of alcohol was associated with increased severity of injuries regardless of the ethanol level, but was not effective in terms of poor composite outcomes.

The overall rate of ethanol intake was lower in the geriatric population. Data on the effects of alcohol on elderly patients are limited, these effects are potentially important (10,11). While the retardation in mental processes and the decline in limb coordination contribute to the formation of trauma, the decrease in self-care due to physical and psychological limitations and the inability to self-protection may pave the way for elder abuse and violence (12). The frequency of assault was high in our study. Ethanol levels are routinely requested in patients admitted to the emergency department due to assault. Consequently, this patient group is likely to have been alcohol-positive from the beginning. The frequency of falls and traffic accidents was similar in our patient group. In the literature, emergency admissions due to falls were higher among alcohol-positive elderly men than among elderly women (2,4). In our study, we observed that elderly men were more likely to drink alcohol than elderly women and that ethanol positivity was higher in single patients. Alcohol consumption may differ according to demographic and social factors, such as sex and marital status. Although alcohol-related trauma positivity increased in the younger age group during weekdays and weekends, no such difference was observed in the elderly (13).

It has been reported that the frequency of alcohol use among geriatric patients has increased, especially in the last 20-30 years. In the literature, some studies have examined the effect of alcohol on trauma and its severity in geriatric patient population has been examined (2,4,11,14). In a study conducted by Teichman to evaluate the effect of alcohol on geriatric trauma patients, young and elderly populations were compared, and it was shown that the morbidity and mortality rates of alcoholic geriatric patients were higher and their length of intensive care and hospital stay

Table 2. Comparison of ethanol-positive and ethanol-negative patients			
	Ethanol-positive (n=101)	**Ethanol-negative (n=235)**	**p-value**
Age median (IQR 25-75%)	64 (61.5-67)	64 (62-69)	0.072
Sex, n (%)			
Female	4 (4%)	29 (12.3%)	0.018
Male	97 (96%)	206 (87.7%)	
Marital status, n (%)			
Single	37 (36.6%)	43 18.3 (%)	<0.001
Married	64 (63.4%)	192 (81.7%)	
Day, n (%)			
Mid-week	70 (69.3%)	164 (69.8%)	0.930
Weekend	31 (30.7%)	71 (30.2%)	
Comorbidity, n (%)			
Hypertension	49 (49.5%)	96 (40.7%)	0.137
Diabetes	7 (7.1%)	33 (14%)	0.075
COPD	7 (7.1%)	29 (12.3%)	0.159
Cardiac diseases	14 (14.1%)	31 (13.1%)	0.805
Injury area, n (%)			
Head/face	13 (12.9%)	13 (5.5%)	0.021
Thorax	4 (4%)	23 (9.8%)	0.072
Abdominal	2 (2%)	7 (3%)	0.729
Pelvis/hip	0 (0%)	8 (3.4%)	0.111
Extremity/vertebra	11 (10.9%)	39 (16.6%)	0.178
Superficial wound injury	67 (66.3%)	154 (65.5%)	0.887
ISS, median (IQR 25-75)	3 (2-4)	1 (1-3)	<0.001
ISS groups, n (%)			
Mild	85 (84.2%)	213 (90.6%)	0.086
Moderate-severe	16 (15.8%)	22 (9.4%)	
Laboratory, median (IQR 25-75)			
Hemoglobin	15 (14-16)	14 (13-15)	0.077
Platelet	216 (180-262)	230 (190-270)	0.233
INR	1.1 (1-1.1)	1.1 (1-1.1)	0.360
Albumin	4.0 (3.6-4.2)	4.1 (3.9-4.2)	0.032
AST	30 (25-44)	22 (18-28)	<0.001
ALT	22 (17-31.5)	18 (14-25)	0.001
Creatinine	0.9 (0.9-1.09)	0.91 (0.90-1.1)	0.591
In-hospital mortality, n (%)	4 (4%)	2 (0.9%)	0.069
Poor composite outcome (n (%)	16 (15.8%)	22 (9.4%)	0.086
Length of hospital stay, median (IQR 25-75)	4.5 (3-5)	3 (2-5)	0.091

COPD: Chronic obstructive pulmonary disease, ISS: Injury severity score, INR: International normalized ratio, AST: Aspartate aminotransferase, ALT: Alanine aminotransferase, IQR: Interquartile range

Table 3. Comparison of patients according to poor composite outcome among all patients			
	Poor composite outcome (n=38)	**No-poor composite outcome (n=298)**	**p-value**
Age median (IQR 25-75%)	65.5 (62-69.2)	64 (62-68)	0.228
Sex, n (%)			
Female	3 (7.9%)	30 (10.1%)	1.00
Male	35 (92.1%)	288 (89.9%)	
Comorbidity, n (%)			
Hypertension	21 (55.3%)	126 (42.3%)	0.129
Diabetes	5 (13.2%)	34 (11.4%)	0.787
COPD	3 (7.9%)	32 (7.9%)	0.781
Cardiac diseases	10 (26.3%)	38 (79.2%)	0.024

Table 3. Continued			
	Poor composite outcome (n=38)	**No-poor composite outcome (n=298)**	**p value**
Injury area, n (%)			
Head/face	19 (50%)	7 (2.3%)	<0.001
Thorax	6 (15.8%)	21 (7%)	0.103
Abdominal	7 (18.4%)	2 (0.7%)	<0.001
Pelvis/hip	4 (10.5%)	4 (1.3%)	0.007
Extremity/vertebra	18 (47.4%)	32 (10.7%)	<0.001
Superficial wound injury	31 (81.6%)	190 (63.8%)	0.029
ISS, median (IQR 25-75)	17 (9.7-19.2)	2 (1-3)	<0.001
Ethanol level, median (IQR 25-75)	0 (0-106.7) 68.7±101.8	0 (0-134) 68.2±118	0.296
Laboratory, median (IQR 25-75)			
Hemoglobin	14 (13-15)	15 (13-15)	0.719
Platelet	216 (184-262.7)	222 (186-268)	0.508
INR	1.08 (1-1.1)	(1-1.1)	0.838
Albumin	4 (3.6-4.2)	4.1 (3.9-4.2)	0.146
AST	30 (20-80)	24 (19-32)	0.007
ALT	25 (14-48)	19 (15-26)	0.039
Creatinine	1.02 (0.9-1.22)	0.9 (0.87-1.08)	0.005
Length of hospital stay, median (IQR 25-75)	5 (3-6)	3 (1.5-4.5)	0.056

COPD: Chronic obstructive pulmonary disease, ISS: Injury severity score, INR: International normalized ratio, AST: Aspartate aminotransferase, ALT: Alanine aminotransferase, IQR: Interquartile range

Table 4. Comparison of patients according to poor composite outcome in the ethanol-positive group			
	Poor composite outcome (n=16)	**Non-poor composite outcome (n=85)**	**p-value**
Age median (IQR 25-75%)	64.5 (62-67)	64 (61-66.5)	0.432
Sex, n (%)			
Female	0 (4%)	4 (4.7%)	0.496
Male	16 (100%)	81 (95.3%)	
Comorbidity, n (%)			
Hypertension	10 (62.5%)	41 (48.2%)	0.295
Diabetes	4 (25%)	3 (3.5%)	0.011
COPD	1 (6.2%)	6 (7.1%)	1,000
Cardiac diseases	5 (31.2%)	12 (14.1%)	0.138
Injury area, n (%)			
Head/neck	10 (62.5%)	3 (3.5%)	<0.001
Thorax	2 (12.5%)	2 (2.4%)	0.117
Abdominal	2 (12.5%)	0 (0%)	0.024
Extremity/vertebra	7 (43.8%)	4 (4.7%)	<0.001
Superficial wound injury	11 (68.8%)	56 (65.9%)	0.824
ISS, median (IQR 25-75)	18 (11-65)	3 (2-3)	<0.001
Laboratory, median (IQR 25-75)			
Hemoglobin	15 (14-16)	15 (14-16)	0.858
Platelet	210 (166-249)	216 (182-262)	0.612
INR	1.09 (0.92-1.26)	1.1 (1-1.1)	0.957
Albumin	3.7 (3.6-4.07)	4.1 (3.8-4.2)	0.030
AST	35.5 (24-42.5)	29 (25-39)	0.108
ALT	30 (15-84)	20 (17-30)	0.075
Creatinine	1.06 (0.91-1.19)	0.91 (0.88-1.0)	0.007
Ethanol level, median (IQR 25-75)	127.5 (73.7-263.2)	242 (177-299.5)	0.007
Length of hospital stay, median (IQR 25-75)	4 (3-5)	3 (2-5)	0.099

COPD: Chronic obstructive pulmonary disease, ISS: Injury severity score, INR: International normalized ratio, AST: Aspartate aminotransferase, ALT: Alanine aminotransferase, IQR: Interquartile range

was longer compared with the young population (11). It has been suggested that higher mortality and morbidity rates are expected in patients with geriatric trauma, but alcohol does not play an important role in these results and that such results are related to age and comorbidities. In our study, we evaluated the effect of alcohol consumption in a patient population with similar age, comorbidities, and mechanism of trauma and showed that being alcoholic was associated with increased injury severity in the elderly regardless of alcohol consumption. According to our study results, alcohol consumption increases the severity of trauma, regardless of alcohol level. At the same time, comorbidities, such as diabetes mellitus, elevated creatine and low albumin levels, in the patient group with poor composite outcomes may have contributed to the poor outcome.

The effects of alcohol on traumatic brain injury (TBI) are controversial (14). It has been proposed that the overall mortality and complication rates in the presence of ethanol intoxication are potentially unaffected or increase (15-17). We observed that the incidence of head trauma was higher in the alcoholic group. Alcohol consumption impairs physical balance, movements, and responses and negatively affects self-defense responses, which restrict arm movements during falls. These conditions increase the risk of TBI, particularly in the geriatric population (18).

Although it has been suggested in the literature that most patients present with alcoholic liver disease (ALD) in their 50s and 60s, a study conducted in the United States showed that the highest incidence of alcoholic cirrhosis is in the seventh decade. Likewise, a study conducted in Britain showed that 28% of patients with ALD were aged over 60 (19,20). In humans, liver anatomy and physiology change with age. There is a reduction in liver size, reflecting a decrease in the number of hepatocytes and a decrease in hepatic blood flow, all of which have an impact on ethanol elimination. Age also affects the activity of alcohol-metabolizing enzymes (21). Increased age is associated with increased blood alcohol levels (20). Chronic alcohol consumption causes alcoholic fatty liver in 90-100% of cases, leading to elevated liver function tests (LFTs) and decreased albumin (22). In our study, the alcohol-positive group had higher LFTs. When patients with liver trauma were excluded from the analysis, LFT incidence was still higher among current alcohol users. Although we could not document the frequency of alcohol use in patients, high LFT levels and low albumin levels may be associated with alcoholic fatty liver disease.

Study Limitations

Our study has a retrospective design, and the consequent loss of data is one of our limitations. Our study population consisted of patients for whom ethanol level was requested. There may be missing data due to incorrect diagnosis code records. Another important limitation of our study is that the frequency and amount of alcohol use in patients was not documented. Additional complicating factors, such as delirium or alcohol withdrawal, whose medical data may have contributed to unfavorable outcomes in this patient population, could not be obtained.

Conclusion

This study aimed to better elucidate the effect of alcohol in patients with geriatric trauma. We showed that alcohol use in geriatric patients with ethanol-positive trauma was associated with increased injury severity regardless of alcohol level. Although alcohol use and related injuries are less common in geriatric trauma patients, who are a more privileged group, we believe that alcohol should be questioned in the evaluation of these patients and should be considered an important component of trauma management.

Ethics

Ethics Committee Approval: It received ethical approval from the University of Health Sciences Turkey, Ankara Atatürk Sanatorium Training and Research Hospital Clinical Research Ethics Committee (decision no: 2012-KAEK-15/789, date: 12.39.2023).

Informed Consent: Retrospective study.

Footnotes

Authorship Contributions

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

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Demographic Characteristics of Patients with Dermatological Complaints in Emergency Departments: A 3-Year Retrospective Study

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Abstract

Aim: Data on the characteristics and outcomes of patients presenting to the emergency department with dermatological complaints are limited. This study aimed to provide an overview of the general characteristics and outcomes of emergency department patients with dermatological conditions.

Materials and Methods: A retrospective analysis was conducted on all emergency department visits related to dermatological conditions extracted from the hospital database of a tertiary adult care center. The preliminary and final diagnoses were reviewed, and demographic and clinical data, including sex, age, diagnosis, and patient outcomes, were collected. Our article was previously presented as an oral presentation at the 11th Intercontinental Emergency Medicine Congress on 16-20 May 2024.

Results: Over a 3-year period, 14.956 patients (0.89% of all admissions) presented with dermatological complaints. The mean age of patients was 42 years (range: 19-82 years), and 54.9% (n=8.221) were female. The most common dermatological diagnoses were anaphylaxis, urticaria, cellulitis, and eczema/dermatitis. The overall hospitalization rate was 3.7%. Dermatology-related emergency department presentations were more frequent during evening hours or weekends, accounting for 72.1% (n=10.783) of cases. Notably, only 5.7% (n=852) of the patients required dermatology consultation.

Conclusion: The proportion of patients with dermatological issues presenting to the emergency department was relatively low. Despite the predominantly non-urgent nature of these conditions, emergency physicians are typically able to manage them effectively without the need for specialized dermatological consultation.

Keywords: Emergency department, dermatology-related symptoms, urgent dermatology

Introduction

Although dermatological emergencies are relatively rare, existing reports indicate that approximately 4-8% of all emergency department (ED) visits are related to skin diseases (1,2). Despite the limited occurrence of urgent or life-threatening conditions associated with dermatological symptoms, the high frequency of ED visits for skin complaints may be attributed to a combination of factors, including geographical disparities, socioeconomic influences, healthcare system dynamics, and cultural considerations (3). Emergency medicine (EM) physicians should promptly identify patients who require immediate care. Rapid assessment of the urgency of dermatological complaints, initiating appropriate treatment, and referring non-urgent cases to outpatient services are essential both for the care of patients presenting to the ED and for the overall efficiency and workflow of the department. This approach enhances work efficiency and improves patient satisfaction. Although most dermatological conditions are not urgent or life-threatening, prompt management of dermatological emergencies is critical to prevent high mortality and morbidity (4). Understanding common dermatological presentations in the ED can aid clinicians in educating patients on when to appropriately seek ED care for skin conditions and plays a key role in guiding the training of ED clinicians.

The literature contains limited data regarding the general characteristics and outcomes of ED patients with dermatological complaints. This study aimed to report the general characteristics and outcomes of patients with ED who presented with dermatological conditions at a tertiary care center in Turkey.

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Materials and Methods

Study Group

This retrospective study was conducted in the adult ED from October 2020 to October 2023. The analysis involved a thorough examination and screening of all ED visits to identify dermatological-related conditions, using the comprehensive hospital database of our adult tertiary care center. Subsequently, both pre- and post-diagnoses documented in the patient records were meticulously reviewed. The final dataset included demographic variables, such as sex and age, as well as detailed information on diagnoses and patient outcomes. The hospital is the largest tertiary referral hospital in the city and serves a population of more than 3 million people. Emergency care is provided by EM specialists and residents, general practitioners, and dermatology services on-call for 24 hours. Ethics approval for the study was obtained from the Konya City Hospital Ethics Committee (decision no: 34028104-799, date: 07.03.2024).

Statistical Analysis

The retrospective data of the study were subjected to descriptive statistical analysis, and the descriptive statistics were calculated as a percentage by taking averages. Descriptive statistics were provided for all variables. All statistical analysis was performed using SPSS statistics 21 (IBM Solutions).

Results

In this study period of 3 years, approximately 1 million six hundred and eighty thousand (1,680,000) patients were admitted to the adult ED. Among those, 14956 patients (0.89%) were admitted with dermatology-related symptoms (Table 1). The mean age of patients in the dermatology group was 42 years (range: 19-82 years), and approximately 54.9% were female (n=8.221).

The most common diseases that presented to the ED with dermatological issues were anaphylaxis, urticaria, cellulitis, and eczema/dermatitis. Among the admissions, necrotizing fasciitis and Fournier's gangrene patients were hospitalized. A total of 428 patients (31.9%) with cellulitis were hospitalized, and the highest rate of hospitalization was related to cellulitis. The number of hospitalized patients was 52 (0.76%) with anaphylaxis, 29 (0.44%) with urticaria, 47 (57.3%) in angioedema patients, and 2 (0.73%) in patients diagnosed with varicella zoster infection. The overall hospitalization rate was 3.7%. Dermatology patients most frequently presented during evening hours or weekends (72.1%, n=10.783). Dermatology consultations were required in 5.7% (n=852) of all dermatology-related admissions.

Table 1. Distribution of diseases admitted to the ED with dermatology-related symptoms

Disease	No patients		
	Female	Male	Total
Anaphylaxis	3441	3360	6801
Urticeria	3543	2461	6004
Cellulitis	674	665	1339
Eczema/dermatitis	329	122	451
Varicella zoster infections	173	99	272
Angioedema	56	26	82
Necrotizan faciit	4	1	5
Fournier gangren	1	1	2

ED: Emergency department

Discussion

Epidemiological data on the number of patients presenting to the ED with dermatological symptoms may be influenced by sociocultural factors and can vary across countries. However, in our country, data on dermatological presentations to the ED are limited. In this study, we found that dermatology-related admissions accounted for less than 1% of the total hospital admissions, with a slight predominance of female patients and a mean age of 42 years. The most common presentations were allergic skin reactions and cellulitis. Generally, the admissions were in evening hours or weekends, and approximately 3.7% of patients were hospitalized with these symptoms. In comparison with previous studies, the proportion of dermatology-related admissions to the ED in this study was lower. A study conducted at a tertiary care hospital in Australia reported that 3.9% of patients presented to the ED with primary dermatological complaints (5). Similarly, research from Northern Cyprus found that 1.8% of ED visits over an 18-month period were attributed to dermatological conditions, with the most common causes being urticaria/angioedema, drug reactions, insect bites, and cellulitis (6). Notably, during the study period, the COVID-19 pandemic was ongoing, and patients were likely hesitant to visit hospitals unless for very urgent medical emergencies. This finding could explain the lower rates of dermatology-related ED admissions observed in this study. In our center, there was a slight predominance of women (55%) among ED admissions related to dermatological conditions. This finding is consistent with previous studies in the literature (7,8). A recent study conducted in our country analyzed patients presenting with dermatological complaints to the ED of a university hospital over a two-year period and found that 57.1% of those presenting were female. This consistent trend suggests that women are more likely to seek emergency care for dermatological issues

than men. However, in contrast to our results, dermatitis was the most common cause of ED admissions in this study (9). Dermatological presentations accounted for 4.7% of presentations in another study from Australia. Of those presenting with dermatological conditions, 41.5% were female, and the mean age was 47. Cellulitis, abscesses, unspecified rash, and ulcers are also the most common dermatological presentations (10). We did not analyze the gender distribution of general admissions to the ED; this female dominance may be related to general admissions to the hospital. The most common dermatological conditions presenting to EDs in this study were anaphylaxis (food, drug, or insect bite), urticaria, cellulitis, and eczema/dermatitis. In a previous study in our country, the most common skin diseases were also similar to our findings, acute urticaria-angioedema, contact dermatitis, and insect bites in emergency patients (11). Similarly, in another study conducted in our country, the most common disease groups were urticaria-angioedema, followed by infectious diseases in patients presenting to the ED with dermatological problems (12). In another study conducted in Australia, one of the most commonly observed conditions was cellulite, skin involvement with allergies, boils/furuncles/pilonidal sinuses, eczema/dermatitis, and varicella-zoster infection (5). In another study conducted in the United States, the three most common skin presentations to the ED were cellulitis plus abscess, rash plus other non-specific skin eruptions, and dermatophytosis of the nail (13).

Our results align with those of the existing literature, indicating that dermatological complaints categorized as non-urgent were more prevalent in the ED than emergent cases. Among these admissions, the hospitalization rate was approximately 3.7%. This is also similar to previous studies (7,8). In our study, most dermatology patients (72.1%) presented during evening hours or on weekends. This finding is in contrast with another study from our country, in which the majority of patients were admitted to the ED between 8:00 am and 4:59 pm (14). Dermatology patients are often categorized as "greenfield" cases, meaning their conditions are typically non-urgent. It is possible that patients tend to postpone or overlook symptoms that arise during the day, only seeking emergency care when their condition worsens or becomes more bothersome in the evening or on weekends. This may be because our dermatology outpatient clinics are open during working hours, and it is not difficult to find an appointment in these outpatient clinics. In our study, consultation with a dermatologist was required in only 5.7% of the dermatology-related admissions. This is consistent with another study conducted in our country, which reported that 59.5% of patients admitted to the ED with dermatological complaints were female, with the most frequent diagnosis being urticaria, including drug-induced urticaria. In this study, dermatology consultation was required in 6.4% of the patients, and the hospitalization rate was 2.2% (13). A recent study from Korea, which analyzed >20,000 patients admitted to the ED with dermatological complaints, found that 19.5% were referred to dermatologists. Overall, these findings suggest that the majority of patients presenting to the ED with dermatological issues can be effectively managed by emergency physicians, with specialist consultation being necessary in only a small proportion of cases.

Study Limitations

First, this was a retrospective study and may not represent all dermatological problems observed in the ED. Second, the study date covers the pandemic period. It would be useful to compare these data with the pre-pandemic period.

Conclusion

The proportion of patients presenting to the ED with dermatological problems was relatively low. Although these conditions are typically non-urgent, they are generally well managed by emergency physicians. Therefore, it is essential to incorporate the identification and management of common skin conditions and diagnoses into emergency physician training programs. This will enhance their ability to provide appropriate care and improve patient outcomes in emergency settings.

Ethics

Ethics Committee Approval: Konya City Hospital Ethics Committee (decision no: 34028104-799, date: 07.03.2024).

Informed Consent: Retrospective study.

Footnotes

Authorship Contributions

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

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Investigation of the Efficacy of Risk Scoring Systems on Prognosis in Patients with STEMI Presenting to the Emergency Department

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Abstract

Aim: ST-elevation myocardial infarction (STEMI), is a common cause of morbidity and mortality. Emergency departments (ED) have a very important role in the management of these patients. Prediction of mortality in STEMI is decisive in establishing therapeutic management to improve outcomes. This study aims to investigate whether triage in emergency departments early warning score (TREWS), modified early warning scoring, national early warning score2 (NEWS-2), and rapid emergency medicine score (REMS) scoring systems are as effective as thrombolysis in myocardial infarction (TIMI), Portuguese registry of acute coronary syndromes (ProACS), and Canadian acute coronary syndrome (C-ACS) in predicting the prognosis in patients diagnosed with STEMI.

Materials and Methods: Patients presenting to a tertiary emergency service in a single center between 01.07.2021 and 30.06.2022 and diagnosed with STEMI were prospectively analyzed. The mortality prediction performances of the patients' measured scores in the first 24 hours and 30 days were evaluated.

Results: A total of 213 patients who met the criteria were included in the study. When the area under the curve values for the first 28-day mortality diagnosis were examined, the NEWS-2 [0.713 (0.574-0.852), $p<0.05$], REMS [0.768 (0.642-0.894), $p<0.05$], TREWS [0.823 (0.736-0.911), $p<0.001$], TIMI [0.761 (0.646-0.876), $p<0.05$], ProACS [0.769 (0.670-0.868), $p<0.05$], and C-ACS [0.743 (0.601-0.885), $p<0.05$] were found to be significant.

Conclusion: The TREWS, NEWS-2 and REMS scores measured at admission were seen to be as effective as the TIMI, ProACS, and C-ACS scores commonly used by cardiologists in predicting the prognosis of STEMI patients presenting to the ED. Among all these scorings, we found that the TREWS showed the best performance. We think that the TREWS score can be used to predict the prognosis of STEMI patients.

Keywords: Emergency medicine, ST-elevation myocardial infarction, mortality, TIMI risk score

Introduction

ST-elevation myocardial infarction (STEMI) is defined as a complete thrombotic occlusion of the coronary vessels caused by rupture of an atherosclerotic plaque (1). STEMI remains one of the leading causes of death worldwide. There are many factors affecting the mortality rate of STEMI patients. Factors such as old age, diabetes mellitus, killip classification, treatment delay, renal failure, emergency medical-oriented STEMI networks existence, myocardial infarction history, left ventricular ejection fraction, problematic coronary arteries existence, and improper treatment strategy. In-hospital mortality of STEMI patients ranges from 4-12%. The 1-year mortality rate of this condition is approximately 10% (2-4). The response and tendency toward unfavorable situations differ among patients with acute coronary syndrome acute coronary syndrome (ACS) receiving treatment methods administered at presentation. For this reason, individualized treatment methods should be developed by predicting the risk of

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mortality in ACS patients (5). Within this scope, several risk-scoring tools have been developed (6). Some of these commonly used risk scores are the thrombolysis in myocardial infarction (TIMI) risk score, the Portuguese registry of acute coronary syndromes (ProACS) risk score, and the Canadian acute coronary syndrome risk score (C-ACS) (6-8). The management of patients with severe conditions requires great care, and emergency departments (ED) play a crucial role in managing such patients. Evaluation methods may be helpful in some conditions, such as sepsis, acute stroke, and STEMI. Additionally, some physiological scoring systems have been proven effective in predicting mortality in patients with ED (9-12). Among these scoring systems, the modified early warning score (MEWS) (13), national early warning score-2 (NEWS-2) (14), rapid emergency medicine score (REMS) (15), and triage in emergency departments early warning score (TREWS) (16) are most commonly used for ED patients. Some risk scores, such as MEWS, NEWS-2, REMS, and TREWS, have been designed to predict critically ill outcomes, prognosis, and mortality in EDs using a variety of signs and symptoms (14-17). These scores are widely used to predict the prognosis of many critical clinical conditions, such as sepsis, COVID-19, pneumonia, and trauma. These scores are widely used to predict the prognosis of many critical clinical conditions, such as sepsis, COVID-19, pneumonia, and trauma (18-20).

In our literature search, we did not find any studies evaluating the effectiveness of the TREWS, NEWS, NEWS-2, and REMS scoring systems in predicting 24-h and 28-day mortality in patients with STEMI. The aim of this study was to investigate the effectiveness of the TREWS, MEWS, NEWS-2, and REMS scoring systems, which are commonly used by emergency physicians, and the TIMI, proACS, and C-ACS scores, which are commonly used by cardiologists, in predicting short-term mortality in patients with STEMI.

Materials and Methods

This study was conducted at the Bursa Yüksek İhtisas Training and Research Hospital Ethics Committee Department of Emergency Medicine, with approval obtained from the clinical research ethics committee of the same hospital (decision no: 2011-KAEK-25 2021/06-02, date: 23.11.2011). In the statistical analysis performed using G power 3.1 software, a sample size of 210 cases was required to conduct the study with a medium effect level (d=0.5), 5% type 1 error level, and 95% power. Patients over the age of 18 who presented to the emergency service between 01.07.2021 and 30.06.2022, diagnosed with STEMI, whose data were fully accessible, and who gave consent to participate in the study were included in this prospective study. On the other hand, patients under the age of 18, those whose data could not be reached, pregnant women, those who did not give consent for the study, and those without STEMI findings on electrocardiogram were not included in the study.

By creating a standard data entry form, patients' demographic information (age, gender), date of admission to the ED, vital signs (fever, respiratory rate per minute, oxygen saturation in room air and oxygen-assisted fingertips, saturation of peripheral oxygen, glasgow coma scale, systolic blood pressure (SBP), diastolic blood pressure, presence/absence of newly developed confusion, STEMI type, admission complaints and onset time of complaints, chronic diseases, medication use, and patient's outcome in the ED (service admission, intensive care unit admission, death, referral) were recorded. TREWS, MEWS, NEWS-2, REMS, TIMI, ProACS, and C-ACS of the patients were calculated.

Statistical Analysis

In addition, the patients were followed up for the development of mortality within 24 hours and 28 days. After the study was completed, the data in the study forms were recorded in an electronic format for statistical analysis. IBM SPSS statistics for Windows, version 21.0 (IBM Corp., Armonk, NY: USA. The released 2012) package program and MedCalc ver 20.014 (MedCalc Software Ltd., Ostend, Belgium) were used for statistical analysis. In descriptive statistics, numerical variables were expressed as mean ± standard deviation (minimum-maximum), median to range, and/or interquartile range, whereas categorical variables were expressed as number of cases and (%). The Kolmogorov-Smirnov test was used to determine the normality of data distribution. Whether the assumption of homogeneity of variances was met was investigated using Levene's test. The significance of the difference between the groups in terms of continuous numerical variables in which parametric test statistics assumptions were met was evaluated using Student's t-test, while the significance of the difference in terms of continuous numerical variables in which parametric test statistics assumptions were not met was evaluated using the Mann-Whitney U test. One-Way ANOVA or Kruskal-Wallis test was used for comparisons of groups of three or more. Receiver operating characteristic analysis was performed for predicting mortality within the first 24 hours and 28 days. In addition, a C-statistics model was administered for the first 24 hours and first 28 days of mortality prediction using the scoring systems. Logistic regression analysis was performed to determine the factors affecting mortality. Chi-square and Fisher's exact tests were used to analyze whether there was a relationship between categorical variables. $P<0.05$ was considered statistically significant. Results are presented as 95% confidence intervals (CI).

Results

A total of 213 patients were included in the study. The median age of the patients was 57 (51-67) years, and 177 (83.1%) were males. Additionally, 111 (52.1%) patients had a history of additional diseases. The most common additional disease was hypertension (n=90, 42.3%). The most common STEMI was anterior STEMI (n=114, 53.5%). Mortality was observed in 4 (1.9%) patients in the ED; it occurred within the first 24 hours in 8 (3.8%) and 28 days in 15 (7.3%) patients (Table 1).

The median SBP was 131 (110-152) mm/Hg, and the median pulse rate was 80 (67-92.5) minutes. The median REMS score of the patients was 5 (3-7), the median TREWS score was 3 (3-4), the median TIMI score was 3 (2-5) and the median ProACS score was 2 (1-3) (Table 2).

In the analysis performed to investigate whether there was a difference between the MEWS, NEWS-2, REMS, TREWS, TIMI, ProACS, and C-ACS with the first 24-hour and first 28-day mortality, the NEWS-2, REMS, TREWS, TIMI, ProACS, and C-ACS of patients who developed mortality within the first 24 hours were found to be significantly different [($p<0.05$), ($p<0.05$), ($p<0.05$), ($p<0.05$), ($p<0.05$), ($p<0.05$)]. In addition, the NEWS-2, REMS, TREWS, TIMI, ProACS, and C-ACS of patients who developed mortality within 28 days were found to be significantly different [($p<0.05$), ($p<0.001$), ($p<0.001$), ($p<0.05$), ($p<0.001$), ($p<0.05$)] (Table 3).

ROC analysis was performed for MEWS, NEWS-2, REMS, TREWS, TIMI, ProACS, and C-ACS, and the diagnostic value of the first 24 hours and first 28 days of mortality. In the analysis, the area under the curve (AUC) of TREWS 0.847 [(95% CI: 0.751-0.943),

Table 1. Clinical and demographic data

Variables		p value
Age[&]		57 (51-67)
Gender[#]	Male	177 (83.1)
	Female	36 (16.9)
Additional disease[#]		111 (52.1)
Additional diseases[#]	Hypertension	90 (42.3)
	Diabetes mellitus	58 (27.2)
	Chronic renal failure	14 (6.6)
	Hyperlipidemia	11 (5.2)
	Congestive heart failure	21 (9.9)
	Previous myocardial infarction	43 (20.2)
	Past cardiac event	57 (27.7)
Family history of cardiac event[#]		44 (20.7)
Smoking[#]		120 (53.3)
Alcohol use[#]		64 (30.3)
STEMI electrocardiography findings[#]	Anterior STEMI	60 (28.2)
	Inferior STEMI	114 (53.5)
	Inferoposterior STEMI	11 (5.2)
	Anteroseptal STEMI	6 (2.8)
	Anterolateral STEMI	11 (5.2)
	Lateral STEMI	6 (2.8)
	Posterior STEMI	4 (1.9)
	Posteriolateral STEMI	1 (0.5)
Emergency department outcome[#]	Mortality in the emergency department	4 (1.9)
	Coronary intensive care hospitalization	209 (98.1)
Mortality[#]	First 24 hours	8 (3.8)
	28 days	15 (7.3)
Total		213

[#]n (%), [&]Median (IQR 25-75), STEMI: ST-elevation myocardial infarction, IQR: Interquartile range

(p<0.05)], AUC of ProACS: 0.769 [(95% CI: 0.634-0.903), (p<0.05)], and AUC of C-ACS: 0.734 [(95% CI: 0.549-0.919), (p<0.05)]. On the other hand, the AUCs of TREWS of 0.823 [(95% CI: 0.736-0.911), (p<0.001)], AUC of ProACS: 0.769 [(95% CI: 0.670-0.868), (p<0.05)] and AUC of C-ACS: 0.743 [(95% CI: 0.601-0.885), (p<0.05)] (Figure 1).

When the TREWS had a cut off value of ≥6 in the first 24-hour mortality, the sensitivity and specificity were 62.5% and specificity was 87.3%. When the ProACS had a cutoff value of ≥3 in the first 24-hour mortality, the sensitivity and specificity were 75.0% and 70.2%, respectively. When the C-ACS had a cutoff value of ≥3 in the first 24-hour mortality, its sensitivity and specificity were 62.5% and specificity was 73%. On the other hand, when the ProACS had a cutoff value of ≥3 in the first 24-hour mortality, the sensitivity and specificity were 73.3% and specificity was 1.7%, and finally, when the cutoff value of the C-ACS in the first 24-hour mortality was ≥3, its sensitivity and specificity were 60.0% and specificity was 74.2% (Table 4).

Logistic regression analysis was performed using variables that may affect mortality within the first 24 hours. As a result of this analysis, the effective factors for the diagnosis of 24-h mortality were male sex [odds ratio (OR): 5.406 (95% CI: 1.285-22.734), p=0.021], age ≥65 years [OR: 8.181 (95% CI: 1.603-41.754), p=0.011]. On the other hand, in the logistic regression analysis performed with variables that may affect mortality in the first 28 days, the effective factors for the diagnosis of 28-day mortality were age ≥65 years [OR: 12.163 (95% CI: 3.296-44.885), p<0.001], (Table 5).

Discussion

STEMI is one of the most common emergency and critical conditions in cardiovascular patients presenting to the ED. It is important to classify the factors that affect the early risk and short-term prognosis of STEMI. Therefore, in addition to the current diagnosis, treatment modalities, and procedures, it is critical to identify clinical indicators that can assist in the early identification of high-risk patients with potential risks or poor prognosis by analyzing the risk factors of STEMI that affect prognosis to improve the quality of care and reduce the risks (21). The TIMI risk score for early mortality prediction is widely used in all cardiology guidelines, and prognostic factors are used to predict early risk in patients with STEMI (7). In the study of Wei et al. (22), when the TIMI risk score was >7.5, the sensitivity and specificity were 64.3% and the specificity was 85.3% (AUC: 0.803, p<0.001). In another study, the AUC value for in-hospital mortality among patients with STEMI was 0.832 (95% CI: 0.786-0.878) (23). In our study, it was statistically significant in predicting mortality within the first 24 hours and 28 days after STEMI. These results are consistent with the literature.

Table 2. Clinical and laboratory data

Variables	p value
GCS median IQR (25-75)	15 (15-15)
SBP mm/Hg median IQR (25-75)	131 (110-152)
DBP mm/Hg median IQR (25-75)	80 (70-94)
MBP mm/Hg median IQR (25-75)	98 (84-113)
Fever °C mean ± SD	37.35±0.36
SpO_2 % median IQR (25-75)	98 (96-99)
Heart rate/min median IQR (25-75)	80 (67-92.5)
Respiratory rate/min median IQR (25-75)	17 (15-20)
MEWS median IQR (25-75)	1 (1-2)
NEWS-2 median IQR (25-75)	1 (0-4)
REMS median IQR (25-75)	5 (3-7)
TREWS median IQR (25-75)	3 (3-4)
Killip score median IQR (25-75)	2 (1-3)
TIMI median IQR (25-75)	3 (2-5)
ProACS median IQR (25-75)	2 (1-3)
C-ACS median IQR (25-75)	1 (0-2)

GCS: Glasgow coma scale, SBP: Systolic blood pressure, DBP: Diastolic blood pressure, MEWS: Modified early warning score, NEWS-2: National early warning score-2, REMS: Rapid emergency medicine score, TREWS: Triage in emergency departments early warning score, TIMI: Thrombolysis in myocardial infarction score, ProACS: Portuguese registry on acute coronary syndromes, C-ACS: Canada acute coronary syndrome score, IQR: Interquartile range, MBP: Mean blood pressure, SpO_2: Saturation of peripheral oxygen

Table 3. First 24-hour and 28-day mortality analysis of variables

	24-hour mortality	n	Median (IQR: 25-75)	p value*	First 28-day mortality	n	Median (IQR: 25-75)	p value*
MEWS	No	205	1 (1-2)	>0.05	No	198	1 (1-2)	>0.05
	Yes	8	3.5 (0.25-9.75)		Yes	15	2 (1-4)	
	Total	213	1 (1-2)		Total	213	1 (1-2)	
NEWS-2	No	205	1 (0-3)	<0.05	No	198	1 (0-3)	<0.05
	Yes	8	7.5 (1-16)		Yes	15	4 (1-9)	
	Total	213	1 (0-4)		Total	213	1 (0-4)	
REMS	No	205	5 (3-7)	<0.05	No	198	5 (3-7)	<0.001
	Yes	8	8 (6-16.75)		Yes	15	8 (6-13)	
	Total	213	5 (3-7)		Total	213	5 (3-7)	
TREWS	No	205	3 (3-4)	<0.05	No	198	3 (3-4)	<0.001
	Yes	8	6 (4-11.5)		Yes	15	6 (4-8)	
	Total	213	3 (3-4)		Total	213	3 (3-4)	
TIMI	No	205	3 (2-5)	<0.05	No	198	3 (1.75-5)	<0.05
	Yes	8	5 (4-6.75)		Yes	15	5 (4-7)	
	Total	213	3 (2-5)		Total	213	3 (2-5)	
ProACS	No	205	2 (1-3)	<0.05	No	198	2 (1-3)	<0.001
	Yes	8	3.5 (2.25-6.25)		Yes	15	4 (2-5)	
	Total	213	2 (1-3)		Total	213	2 (1-3)	
C-ACS	No	205	1 (0-2)	<0.05	No	198	1 (0-2)	<0.05
	Yes	8	2 (1-2.75)		Yes	15	2 (1-3)	
	Total	213	1 (0-2)		Total	213	1 (0-2)	

*Mann-Whitney U test, MEWS: Modified early warning score, NEWS-2; National early warning score-2, REMS: Rapid emergency medicine score, TREWS: Triage in emergency departments early warning score, TIMI: Thrombolysis in myocardial infarction score, ProACS: Portuguese registry on acute coronary syndromes, C-ACS: Canada acute coronary syndrome score, IQR: Interquartile range

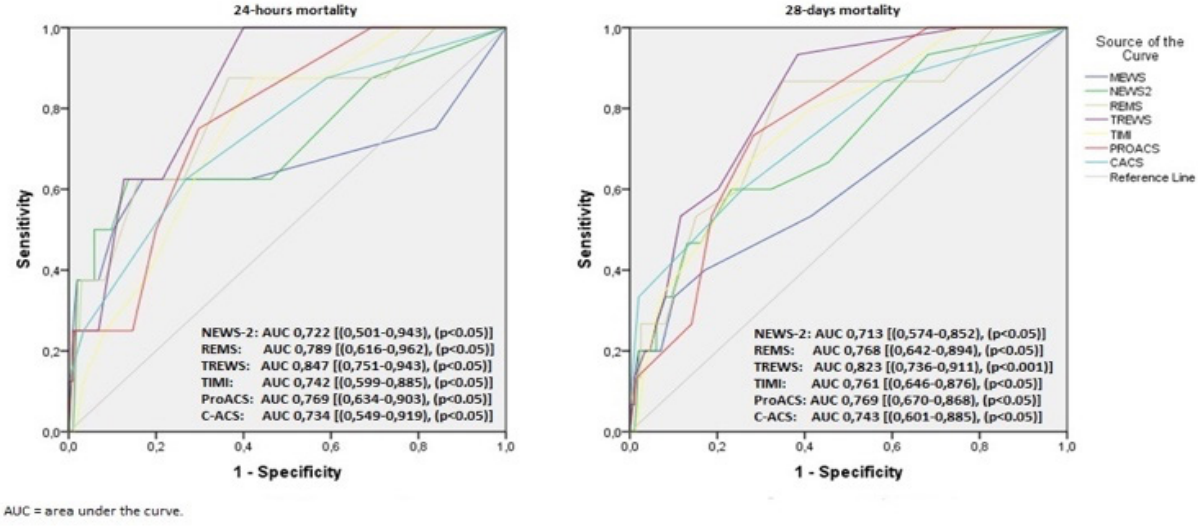

Figure 1. ROC analysis curve showing the diagnostic value of variables on mortality in the first 24 and first 28 days

AUC: Area under the curve, NEWS-2: National early warning score-2, REMS: Rapid emergency medicine score, TREWS: Triage in emergency departments early warning score, TIMI: Thrombolysis in myocardial infarction, ProACS: Portuguese registry of acute coronary syndromes, C-ACS: Canadian acute coronary syndrome

Table 4. Cut-off values of scoring systems for prediction of first 24-hour and 28-day mortality

	Variables	AUC (95% CI)	Sensitivity (%)	Specificity (%)	PPD (%)	NPD (%)
First 24-hour mortality	NEWS-2 > 6	0.722 (0.501-0.943)	62.50	86.30	15.10	98.30
	ProACS > 3	0.769 (0.634-0.903)	75.00	70.20	8.90	98.60
	REMS > 8	0.789 (0.616-0.962)	62.50	83.90	13.10	98.20
	TIMI > 5	0.742 (0.599-0.885)	62.50	71.20	7.81	97.90
	TREWS >6	0.847 (0751-0.943)	62.50	87.30	16.10	98.30
	C-ACS >2	0.734 (0.549-0.919)	62.50	73.20	8.30	98.00
First 28-day mortality	NEWS-2 > 4	0.713 (0.574-0.852)	60.00	76.80	16.30	96.20
	ProACS > 3	0.769 (0.670-0.868)	73.30	71.70	16.40	97.20
	REMS > 7	0.768 (0.642-0.894)	60.00	74.70	15.20	96.10
	TIMI > 5	0.761 (0.646-0.876)	66.70	72.70	15.60	96.60
	TREWS > 5	0.823 (0.736-0.911)	60.00	79.80	18.30	96.30
	C-ACS >2	0.743 (0.601-0.885)	60.00	74.20	15.00	96.00

MEWS: Modified early warning score, NEWS-2: National early warning score-2, REMS: Rapid emergency medicine score, TREWS: Emergency department triage early warning score, TIMI: Thrombolysis in myocardial infarction score, ProACS; Portuguese registry on acute coronary syndromes, C-ACS: Canada acute coronary syndrome score, PPD: Positive predictive value, NPD: Negative predictive value, AUC: Area under the curve, CI: Confidence interval

Huynh et al. (8) analyzed the data of several studies in 2013 and developed an effective, fast, simple, and easily applicable C-ACS score for determining short- and long term. In the study by Huang et al. (24) comparing the C-ACS score with other scoring systems in patients with ACS, the AUC value of C-ACS for in-hospital mortality in the STEMI group was 0.767 (95% CI: 0.740-0.793); p<0.001. In this study, C-ACS was found to have a lower prognostic value than age, creatinine, and ejection fraction, Global Registry of Acute Coronary Events, and age, estimated glomerular filtration rate and ejection fraction scoring systems. In addition, the C-ACS showed the lowest predictive performance in the NSTEMI group. In a study of 589 STEMI cases by He et al. (25), the AUC value of C-ACS for predicting in-hospital mortality was 0.683 (95% CI: 0.551-0.816). In this study, both NT-pro-BNP and C-ACS were found to be risk markers for poor in-hospital outcomes in patients with STEMI, and a combination of these could yield a more accurate prediction of clinical outcomes in these patients. Pogorevici et al. (26) found that C-ACS was effective in demonstrating in-hospital mortality in both the STEMI and NSTEMI groups. In that study, using C-statistics, the AUC value of C-ACS for predicting in-hospital mortality among patients with STEMI was 0.920 (95% CI: 0.89-0.94). Accordingly, the authors concluded that C-ACS was the strongest predictor of in-hospital mortality in all patients with C-ACS and well-predicted mortality in the STEMI subgroup of patients aged >75 years. Our results are consistent with the literature.

ProACS was designed by Portuguese scientists to predict short- and long-term mortality in patients with ACS (6). This newly developed score showed similar performance when the STEMI and NSTEMI groups were compared [STEMI, AUC: 0.799, (95% CI: 0.768-0.830), NSTEMI, AUC: 0.809 (95% CI: 0.774-0.845)] (6). The number of studies on ProACS is low. Some risk scores, such as MEWS, NEWS-2, REMS, and TREWS, have been designed to predict critically ill outcomes, prognosis, and mortality in EDs using a variety of signs and symptoms (14-17). These scores are widely used to predict the prognosis of many critical clinical conditions, such as sepsis, COVID-19, pneumonia, and trauma. These scores are widely used to predict the prognosis of many critical clinical conditions, such as sepsis, COVID-19, pneumonia, and trauma (18-20). There are only few studies in the literature regarding the use of MEWS, NEWS-2, REMS, and TREWS in predicting prognosis in patients with ACS (27,28). Mehmood et al. (28) suggested that the REMS is a simple and highly valid tool that can be used in emergency medicine for the diagnosis of ACS with limited resources. In a machine learning study on the early prediction of in-hospital cardiac arrest in patients with ACS, Wu et al. (29) found that the performance of the MEWS was inadequate compared with other machine learning models [AUC: 0.673 (95% CI: 0.605-0.736)]. Liu et al. (30), on the other hand, found that the AUC of MEWS was 0.672 for the prediction of acute cardiac complications. Ma et al. (27) compared the MEWS with a scale developed to predict the prognosis of patients with type 1 MI. In this study, the predictive AUC value of the MEWS in these patients was 0.800 (95% CI: 0.777-0.823).

Table 5. Logistic regression analysis of variables with 24-hour and 28-day mortality				
	Variables	**OR**	**95% CI**	**p value**
24-hour mortality	Diabetes mellitus	1.636	0.378-7.076	0.509
	Hypertension	1.383	0.336-5.687	0.652
	Heart failure	3.263	0.615-17.308	0.164
	Previous myocardial infarction	2.475	0.567-10.791	0.227
	Male gender	5.406	1.285-22.734	0.021
	Chronic renal failure	2.109	0.241-18.466	0.499
	Age ≥ 65	8.181	1.603-41.754	0.011
	Mean arterial pressure	0.995	0.972-1.019	0.711
	Heart rate	1.022	0.988-1.057	0.198
	Smoking	0.451	0.105-1.939	0.284
	Killip ≥3	4.027	0.932-17.389	0.061
	C-ACS ≥ 2	4.545	1.051-19.657	0.042
	ProACS ≥ 3	7.082	1.390-36.077	0.018
	TIMI ≥ 5	4.124	0.955-17.811	0.057
	TREWS ≥ 6	11.474	2.587-50.878	0.001
	MEWS ≥ 3	8.095	1.848-35.451	0.005
	NEWS-2 ≥6	11.059	2.537-48.199	0.001
	REMS ≥ 8	8.687	1.979-38.124	0.004
28-day mortality	Diabetes mellitus	1.871	0.635-5.514	0.255
	Hypertension	1.212	0.423-3.474	0.72
	Heart failure	2.5	0.645-9.689	0.185
	Previous myocardial infarction	0.987	0.265-3.666	0.985
	Male gender	2.693	0.861-8.421	0.088
	Chronic renal failure	1.016	0.123-8.345	0.987
	Age ≥ 65	12.163	3.296-44885	<0.001
	Mean arterial pressure	0.991	0.969-1.013	0.457
	Heart rate	1.011	0.986-1.036	0.368
	Smoking	2.771	0.913-8.408	0.071
	Killip ≥ 3	3.803	1.293-11.181	0.015
	C-ACS ≥ 2	4.32	1.466-12.744	0.007
	ProACS ≥ 3	6.973	2.131-22.817	0.001
	TIMI ≥ 5	5.333	1.743-16.316	0.003
	TREWS ≥ 5	5.925	1.993-17.617	0.001
	MEWS ≥3	1.616	0.564-4.634	0.371
	NEWS-2 ≥ 4	4.539	1.537-13.402	0.006
	REMS ≥ 7	4.225	0.928-19.236	0.062

MEWS: Modified early warning score, NEWS-2: National early warning score-2, REMS: Rapid emergency medicine score, TIMI: Thrombolysis in myocardial infarction score, TREWS: Emergency department triage early warning score, ProACS: Portuguese registry on acute coronary syndromes, C-ACS: Canada acute coronary syndrome score, OR: Odds ratio, CI: Confidence interval

As mentioned above, we could not find any study that investigated whether some scoring systems (TREWS, MEWS, NEWS-2, and REMS) are effective in predicting the prognosis of these patients and whether there is a relationship between TIMI, ProACS, and C-ACS in STEMI patients presenting to the ED. To our knowledge, this study is the first in the literature in terms of its scope. In this study, we found that TREWS, NEWS-2, REMS, TIMI, ProACS, and C-ACS were significantly different between patients who developed mortality in the first 24 hours and 28 days.

In this study, in the ROC analysis of TREWS, MEWS, NEWS-2, REMS, TIMI, ProACS, and C-ACS in the first 24 hours and 28 days of mortality in patients with STEMI, the TREWS score had the best performance among all mortality predictions in the first 24 hours and 28 days. The AUC values of the TREWS in all three periods were above 0.800. As a result, TREWS can also be used as an effective risk factor for mortality in the first 24 hours and first 28 days with age.

Study Limitations

This study has some limitations. The small number of patients and the single-center nature of the study are among the main limitations. A multicenter study would have been better in terms of patient representation. In addition, only short-term mortality was considered as another limitation in this study. It would have been better to consider mortality and other major cardiac events that may occur in the medium and long term.

Conclusion

In conclusion, we believe that TREWS measured at admission are as effective as TIMI, ProACS, and C-ACS, which are commonly used by cardiologists, in predicting the prognosis of patients with STEMI admitted to the ED. Among these scorings, we found that the TREWS had the best performance. We believe that the TREWS score can be used to predict theprognosis of patients with STEMI.

Ethics

Ethics Committee Approval: Committee approval was obtained from Bursa Yüksek İhtisas Training and Research Hospital Ethical Committee (decision no: 2011-KAEK-25 2021/06-02, date: 23.11.2011).

Informed Consent: Those who agreed to participate in the study were included in this prospective study.

Footnotes

Authorship Contributions

Surgical and Medical Practices: C.K., M.Y., M.O.A., N.A., A.İ., H.K., Concept: C.K., M.Y., B.Ş., M.O.A., Y.İ., H.K., Design: C.K., M.Y., B.Ş., N.A., A.İ., Y.İ., H.K., Data Collection or Processing: C.K., M.Y., B.Ş., M.O.A., N.A., A.İ., H.K., Analysis or Interpretation: C.K., M.Y., B.Ş., M.O.A., A.İ., Y.İ., H.K., Literature Search: C.K., M.Y., N.A., Y.İ., H.K., Writing: C.K., M.Y., B.Ş., M.O.A., N.A., A.İ., Y.İ., H.K.

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The Etiological and Prognostic Value of Factor VIII in Patients Diagnosed with Myocardial Infarction: A Prospective Controlled Randomized Study

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Abstract

Aim: The purpose of this study was to evaluate the association between factor VIII (FVIII) and myocardial infarction. A comparative study was performed on patients diagnosed with acute myocardial infarction with/ non-ST-elevation myocardial infarction (STEMI/NSTEMI) and patients presenting with non-cardiac chest pain and no evidence of myocardial injury on electrocardiogram and troponin testing.

Materials and Methods: We evaluated 55 patients with acute STEMI or NSTEMI. The control group consisted of individuals between the ages of 18 and 80 who presented to the emergency department with chest pain and had no electrocardiogram and troponin changes after 0, 1, and 3 hours of follow-up. Samples for FVIII levels were collected from patients and control group at minute 0 on admission.

Results: The mean FVIII levels in the patient and control groups exhibited a notable disparity, yet this difference was not statistically significant. In the patient group, FVIII levels were compared between the STEMI and NSTEMI subgroups, and no significant discrepancy was identified (p=0.226). Furthermore, FVIII levels did not demonstrate a statistically significant divergence in patients with a prior diagnosis of coronary artery disease (p=0.79). In our acute coronary syndrome cohort, women exhibited significantly elevated FVIII levels compared to men.

Conclusion: This study revealed no correlation between FVIII levels and acute myocardial infarction. The findings indicated that there is no significant difference between STEMI and NSTEMI for FVIII levels in subgroup analysis and no significant risk for recurrent coronary events.

Keywords: Acute coronary syndromes, Factor VIII, non-ST elevated myocardial infarction

Introduction

Myocardial infarction (MI) is defined as ischemia-induced myocardial cell death and is one of the leading causes of mortality and morbidity worldwide (1,2). Although the risk of MI increases with age (3), a significant increase has been observed in young patients in recent years (4). The increase in the number of patients presenting with coronary disease and the concurrent reduction in the mean age of this patient group have highlighted the urgency to investigate a broader set of potential causes than previously considered, including factors such as hypertension, obesity, family history, diabetes, hyperlipidemia, and tobacco use (5). Atherosclerotic plaque rupture, coronary dissection, hypercoagulability, drug effects, vasospasm, coronary embolism, and autoimmunity have been identified as potential contributors to the pathogenesis of acute MI (6). However, there is a paucity of research examining factor VIII (FVIII) levels, which are a risk factor for venous thrombosis due to hypercoagulability, in the etiology of coronary thrombosis. FVIII, a crucial protein in the blood coagulation cascade, has been implicated in the development of venous thrombosis. It has been established that elevated FVIII levels are a known risk factor for venous thrombosis (7). However, the role of this factor in arterial thrombosis, such

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as acute MI, remains unclear. The findings of this study may inform the development of novel therapeutic and preventive pharmacological strategies and may be valuable for identifying treatments that can be employed to reduce the burden of arterial thrombosis.

Materials and Methods

Our study was accepted according to the ethical rules with the decision of Atatürk University Faculty of Medicine Non-Interventional Clinical Research Ethics Committee (decision no: 13, date: 28.03.2016).

Trial Design

This prospective study was conducted at the Research Hospital, Faculty of Medicine, Atatürk University, Erzurum, Turkey, within the Department of Emergency Medicine. The diagnosis and treatment guidelines for acute coronary syndromes (ACS) published by the American Heart Association were used for all patients with suspected ACS. Furthermore, the dynamic changes between the prehospital electrocardiogram (ECG) obtained by the emergency service team and the ECG obtained in the emergency department (ED) upon arrival were carefully considered. Patients admitted to the ED will be evaluated by interns, emergency physicians in training (assistants), and ED specialists. From patients who met the definition of ST-elevation myocardial infarction (STEMI), an appropriate sample for biochemical parameters and FVIII was obtained, and the patient was transferred directly to the angiography unit as soon as possible. Appropriate samples for FVIII were obtained from patients presenting with cardiac chest pain on admission and were included in the study when a diagnosis of NSTEMI was made.

Participants

Patients who applied to the Atatürk University Emergency Medicine Department over a 3-month period with a chief complaint of chest pain. The study included 64 patients aged 18 years and older (32 patients with STEMI) and 32 patients with non-ST-elevation myocardial infarction (NSTEMI) who were diagnosed with STEMI or NSTEMI in light of clinical evaluation and biochemical assays according to the fourth universal MI definition. Samples were collected to measure FVIII levels in patients after obtaining consent. Patients who had received fibrinolytic for MI at different centers, patients with ECG and/or troponin positivity, sepsis, hypovolemia, heart failure, acute pulmonary embolism, aortic dissection, myocarditis, myocardial contusion, drug toxicity (including kounis syndrome, cardiotoxic agent used), carbon monoxide poisoning, renal failure and cerebrovascular event (ischemia or hemorrhage) were excluded. The control group consisted of 64 healthy individuals aged 18 years and older without cardiovascular disease, diagnosis of thrombophilia, and/or diagnosis of hemophilia A who presented to our ED with chest pain without ECG and troponin changes after 6-8 hours. The patient and control groups were included in the study via simple randomization.

Interventions

To measure FVIII levels, venous blood samples were placed in tubes containing 3.2% sodium citrate with light blue caps. These samples were centrifuged at 4500 rpm for 5 minutes at +4°C to obtain plasma. Plasmas were stored at -80˚C. The frozen plasmas were thawed at the time of analysis and run on the ACL TOP 700 Coagulometer, and the results were evaluated.

Sample Size

A sample size of 128 individuals was planned for the study, with 64 patients in each of the two groups, to achieve an effect size of 0.5, 80% power, and a 5% margin of error (8). However, one sample from the control group and nine samples from the patient group were excluded due to an error in the laboratory measurement process that resulted in excessive hemolysis.

Statistical Analysis

The SPSS 22.0 package, which is compatible with Windows, was used for the statistical analysis of the data. Frequency analysis and percentages were calculated for the demographic characteristics of the groups. The mean and standard deviation were calculated for the numerical data. The chi-square test was used to compare the categorical data. The Student's t-test was used to compare continuous variable data. The Kendall regression test was used to determine the relationship between the laboratory parameters. The significance level was set at $p<0.05$.

Results

A summary of demographic, clinical, and laboratory data is presented in Table 1. A total of 55 patients with ACS were included in the study, of whom 26 had STEMI and 29 had NSTEMI. The study cohort comprised 11 female patients (20%) and 44 male patients (80%). The mean age was 63±14 years (range: 23-91 years). A total of 63 patients were included in the volunteer group. The control group was composed of 28 female patients (45.5%) and 35 male patients (55.5%). The mean age was 42±16 years.

The mean FVIII levels in the patient and control groups were significantly different but not statistically significant. The STEMI and NSTEMI groups were subgrouped within the patient group and FVIII levels were compared, and there was no significant difference ($p=0.226$). FVIII levels were not significantly different in patients with known coronary artery disease ($p=0.79$). In our

ACS group, FVIII levels were significantly higher in women than in men (Table 2). A total of 10% (n=5) of patients exhibited low FVIII levels (i.e., <70% activity), while high FVIII levels (>150% activity) were observed in 14.5% (n=8) of patients. The remaining 42 patients (75.5%) exhibited normal FVIII levels (70-100% activity).

Twenty-three patients (41.8%) were admitted with anterior MI and 25 (45.4%) with inferior MI. The results are presented in Table 3.

Correlations were found between biochemical parameters and survival, with statistically significant results observed for hematocrit (p=0.029), aspartate aminotransaminase (AST) (p=0.006), and albumin (p=0.02) values. A comparison of the remaining parameters is presented in Table 4.

AST (p=0.003) and alanine transaminase (p=0.014) levels were significantly elevated in patients with a known history of coronary artery disease compared with those without such a diagnosis. A correlation was observed between the degree of coronary artery narrowing and the AST, as illustrated in Figure 1.

Table 1. Demographic characteristics and biochemical parameters

Characteristics	STMI Mean (min-max)	NSTEMI Mean (min-max)	Control Mean (min-max)	p value	Reference ranges
Gender (Female%-n)	54.5-6	45.5-5	71.8-28	0.017	-
Age	64.58 (45-91)	61.97 (23-89)	41.81 (19-85)	0.5	18-90
Factor VIII	112 (31-346)	92 (37-238)	91 (28-233)	0.22	70-150
WBC (*10^3 µL)	12.3 (6.5-23)	9.3 (4-19.5)	7.9 (7-19.5)	0.021	4.3-10.3
Lymphocyte (*10^3 µL)	3 (0.8-7)	2 (0.7-6)	2 (4.7-5.1)	0.04	1.3-3.6
Neutrophil (*10^3 µL)	7.8 (0.8-21.6)	5.7 (2.4-16)	4.7 (1.8-16)	0.12	2.1-8.1
HGB (g/dL)	14.5 (12.4-17.4)	14.5 (9-18)	15.5 (10.3-20)	0.1	13.6-17.2
HCT (%)	47 (37-60)	44 (28-53)	45 (33-56)	0.08	39.5-50.3
MCV (fL)	92.5 (81-101)	89 (59-112)	85 (69-91)	0.13	80.7-95.5
RDW	13.5 (12-16)	14 (11-19)	13 (12-19)	0.54	
AST (U/L)	70 (15-311)	103 (13-446)	22 (13-58)	0.25	1-50
ALT (U/L)	43 (13-289)	52 (8-344)	22 (7-62)	0.62	1-60
Albumin (g/dL)	4.02 (3.5-4.6)	3.97 (2.94-4.7)	4.1 (3.3-4.9)	0.67	3.5-0.2
Troponin (ng/mL)	6 (0-58.6)	10.4 (0-67.4)	0 (0-0.2)	0.32	0.01-0.04

STEMI: ST-Elevation Myocardial Infarction, NSTEMI: Non-ST-Elevation Myocardial Infarction, WBC: White blood cell, HGB: Hemoglobin, HCT: Hematocrit, MCV: Mean corpuscular Volume, RDW: Red cell distribution width, AST: Aspartate aminotransferase, ALT: Alanine transaminase

Table 2. Factor VIII levels for gender

	Female	Male	p value
Factor VIII (Median ± SD) (min-max)	108±76.5 (28-346)	89±54.2 (29-311)	0.009

SD: Standard deviation

Table 3. Distribution of affected vessels

	LAD	RCA	CX	Normal	Total
Patient (n)	23	18	7	7	55
Patient (%)	41.8	32.7	12.7	12.7	100
Factor VIII (Median ± SD) (min-max)	104±82 (31-315)	123±90 (37-346)	67±45 (46-181)	93±46.5 (28-233)	124±78 (28-346)

LAD: Left anterior descending artery, RCA: Right coronary artery, CX: Circumflex artery

Tablo 4. Effect of biochemical parameters on survival

Characteristics	Discharged (n=50)	Exitus (n=5)	Control (n=63)	p value	Total (n=118)
Age	63±15	68±10	42±16	0.45	52±18
Factor VIII	118.8 ± 74.537	177.2±98.7	101.8±47.3	0.11	112.2±64
HTC	42.3±6.3	48.3±1.97	44.98±4.6	0.029	45.2±5.3
RDW	13.8±1.5	13.3±0.6	13.2±1.4	0.43	13.5±1.4
AST	76±98	208±115	22±7	0.006	53±80
ALT	38±51	147±111	22±13	0.09	35±48
ALbumin	4.04±0.4	3.6±0.4	4.1±0.4	0.02	4.1±0.4
Troponin	8.76±17	4.43±8.1	0,00532± 0.026	0.58	3.9±11.9
Obstruction (%)	85.6±31.6	98±4.5	-	0.39	86.8±30.3

WBC: White blood cell, HGB: Hemoglobin, HCT: Hematocrit, MCV: Mean corpuscular volume, RDW: Red cell distribution width, AST: Aspartate aminotransferase, ALT: Alanine transaminase

	LYMP	WBC	FVIII	NEU	HGB	HTC	RDW	PDW	PLT	Ca	AST	ALT	ALB	hsTN	PTT	OBS%
Lymphocyte	1	0.18	-0.14	-0.76	0.17	0.22	-0.19	-0.09	0.22	0.21	-0.11	0.02	-0.1	-0.15	0.05	0.19
WBC	0.18	1	-0	0.74	0.17	0.09	0.065	0.06	0.32	0.25	0.2	0.2	0.21	0.15	0.003	0.22
Factor VIII	-0.01	-0.003	1	-0.01	-0.27	-0.26	-0.09	-0.13	-0.04	-0.1	0.02	0.03	-0.2	-0.13	-0.15	0.18
Neutrophile	-0.08	0.73	-0.01	1	0.13	0.05	0.12	0.1	0.21	0.22	0.25	0.19	0.24	0.23	0.01	0.16
HGB	0.17	0.17	-0.27	0.13	1	0.43	-0.11	0.29	-0.02	0.09	0.22	0.15	0.15	0.05	0.11	-0.05
HTC	0.22	0.09	-0.26	0.05	0.43	1	-0.18	0.1	-0.03	0.3	0.07	0.11	0.17	-0.05	0.19	-0.06
RDW	-0.2	0.07	-0.09	0.12	-0.11	-0.18	1	0.21	-0.08	-0.1	0.14	0.04	-0.1	0.2	-0.03	0.09
PDW	-0.09	0.06	-0.13	0.1	0.28	0.1	0.21	1	-0.32	90.2	0.16	0.01	-0	0.18	0.07	0.03
PLT	0.22	0.32	-0.04	0.21	-0.02	-0.03	-0.08	-0.32	1	0.3	-0.1	-0	0.29	-0.03	-0.01	0.13
Ca	0.21	0.25	-0.08	0.22	0.09	0.3	-0.07	-0.19	0.29	1	0.06	0.07	0.39	0.03	0.17	0.1
AST	-011	0.2	0.02	0.25	0.22	0.07	0.14	0.16	-0.1	0.06	1	0.53	0.17	0.46	-0.02	0.16
ALT	0.02	0.2	0.03	0.19	0.15	0.11	0.04	0.007	-0.03	0.07	0.54	1	0.11	0.25	-0.05	0.02
Albumin	-0.05	0.21	-0.17	0.24	0.15	0.17	-0.05	-0.05	0.29	0.39	0.17	0.11	1	0.14	0.09	0.04
Troponin	-0.15	0.15	-0.13	0.23	0.05	-0.05	0.2	0.18	-0.03	0.03	0.46	0.25	0.14	1	0.12	-0.007
PTT	0.05	0	-0.15	0.009	0.11	0.19	-0.03	0.07	-0.01	0.17	-0.02	-0.1	0.09	0.12	1	0
OBS%	0.19	0.22	0.18	0.15	-0.05	-0.06	0.09	0.03	0.13	0.1	0.16	0.02	0.04	-0.01	0	1

LYMP: Lymphocyte, WBC: White blood cell, FVIII: Factor VIII, NEU: Neutrophil, HGB: Hemoglobin, HCT: Hematocrit, RDW: Red cell distribution width, PLT: Platelet, Ca: Calcium AST: Aspartate aminotransferase, ALT: Alanine transaminase, ALB: Albumin, HsTN: High-sensitivity Troponin, PTT: Partial thromboplastin time, OBS: Obstruction

Figure 1. The Kendall's correlation between variables

Discussion

The results revealed no significant difference in FVIII levels between the ACS and control groups. Furthermore, no correlation was observed between FVIII levels and patient prognosis. The subgroup analysis demonstrated no significant difference between STEMI and NSTEMI for FVIII levels, and no significant difference was observed in recurrent coronary events.

Prior research has demonstrated that FVIII levels are elevated in women relative to men in the context of venous thromboembolism, with the underlying mechanism attributed to oral contraceptive (OCS) usage (9). Similarly, in the ACS group, FVIII levels were significantly higher in women than in men, although there was no history of OCS use in the study group. Given the age range of the patients in the control group, it was hypothesized that they might have the potential to use OCS. In a study by von Kanel et al. (10) investigating the increase in FVIII levels associated with physiological stress, FVIII levels were found to be lower in patients treated with acetylsalicylic acid (ASA) + propranolol compared with those receiving ASA alone, propranolol alone or placebo. The majority of patients in the study group were transported to the ED by ambulance following the administration of the recommended dose of ASA (325 mg) in the prehospital setting, irrespective of whether the patients were chronic ASA users or not. In light of the aforementioned evidence, the FVIII levels of our patients may have been influenced.

In a study published in 1990, Rosendaal et al. (11) observed that low FVIII levels were associated with a reduced risk of developing ischemic heart disease. Patients with FVIII levels >200 IU/dL had a threefold increased risk of recurrent thrombosis, according to Timp et al (12). However, the results of the study conducted by Šrámek et al. (13) indicated that high FVIII levels were associated with venous rather than arterial thrombosis. Zakai et al. (14) showed that high FVIII levels were associated with both increased stroke and coronary artery disease. In this study, participants were contacted via telephone, basic demographic and risk factor data were collected, and COX modeling was performed. A recent literature review indicated that abnormalities in the coagulation cascade that predispose to thrombosis increase the risk of stroke in young patients more than MI (15). The pathology in our study group was coronary artery occlusion, and there was no significant difference in FVIII levels between the study and control groups.

Study Limitations

It should be noted that the present study is subject to certain limitations. The most significant limitations of this study are the relatively small number of patients and the lack of multi-centered recruitment. A larger patient population and a more diverse geographical range would yield more effective results. Many medications affect FVIII levels. The absence of data on the medications used by the patients represents a significant limitation of our study. FVIII levels were measured only from the initial blood samples collected upon patient arrival. Further measurements are required to demonstrate potential changes in levels. The inability to perform consecutive measurements represents another limitation of our study.

Conclusion

This study revealed no correlation between FVIII levels and acute MI. The findings indicated no significant difference between STEMI and NSTEMI for FVIII levels in the subgroup analysis and no significant risk of recurrent coronary events. A larger sample size would allow for the design of studies that could demonstrate a statistically significant difference in the effect of FVIII on arterial thrombosis.

Ethics

Ethics Committee Approval: Our study was accepted according to the ethical rules with the decision of Atatürk University Faculty of Medicine Non-Interventional Clinical Research Ethics Committee (decision no: 13, date: 28.03.2016).

Informed Consent: Samples were collected to measure FVIII levels in patients after obtaining consent.

Footnotes

Authorship Contribution

Surgical and Medical Practices: M.G., Concept: M.G., Design: M.G., Data Collection or Processing: M.G., S.D., T.S.M., Analysis or Interpretation: M.G., A.T., Literature Search: M.G., Writing: M.G., A.T.

Conflict of Interest: No conflict of interest was declared by the authors.

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Effect of CRISP Method Training on ECG Diagnosis Skills of Prehospital Medical Services Personnel

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Abstract

Aim: In critical care settings where every minute is vital, early diagnosis and timely intervention are essential for preventing complications and improving patient outcomes. Prehospital and emergency department staff must be highly trained and capable of promptly applying medical knowledge, with electrocardiography (ECG) interpretation being a core competency.

Materials and Methods: This randomized controlled trial included 176 participants divided into experimental and control groups. Baseline ECG analysis skills were assessed using a pretest. The control group received training using the classical method, while the experimental group was trained using the Cardiac Rhythm Identification for Simple People (CRISP) method. Post-training knowledge levels were evaluated through a post-test.

Results: Statistically significant improvements were observed in the experimental group in the interpretation of normal sinus rhythm, supraventricular tachycardia, atrial fibrillation, and second-degree atrioventricular blocks (Mobitz type 1 and type 2). The CRISP method demonstrated superior effectiveness compared to the classical method in diagnosing these conditions.

Conclusion: Both the classical and CRISP methods positively influenced participants' ECG analysis skills. However, the CRISP method resulted in significantly better post-test performance and proved especially effective in identifying fatal arrhythmias. Importantly, the CRISP method was not less successful than the classical method in any aspect of ECG interpretation.

Keywords: CRISP method, ECG training, ECG analysis, prehospital education

Introduction

Emergency departments and prehospital medical services are critical settings where life-threatening situations frequently arise. In these environments, rapid and accurate decision-making directly impacts patient survival rates. In scenarios where every minute counts, early diagnosis and timely intervention are essential to prevent complications and improve patient outcomes (1). Consequently, it is imperative for emergency department staff and prehospital medical personnel to be highly trained and possess the ability to swiftly apply medical knowledge.

Electrocardiography (ECG) is a pivotal tool for the rapid and accurate diagnosis of cardiac emergencies (2). ECG records the electrical activity of the heart, facilitating the swift detection of arrhythmias, myocardial infarctions, ischemic changes, and other cardiac abnormalities (2). This diagnostic tool is particularly vital for patients presenting to the emergency department with symptoms such as chest pain, enabling the assessment of the emergency's severity and the immediate initiation of appropriate treatment. The American Heart Association (AHA) recommends the prehospital acquisition and interpretation of electrocardiograms (ECGs) for suspected acute coronary syndrome symptoms. When accurately interpreted, ECGs enable the early detection of ST-

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elevation myocardial infarction and allow for the prehospital activation of the cardiac catheterization laboratory, thereby reducing total cardiac ischemic time. The rapid and accurate information provided by ECGs facilitates timely, life-saving interventions. However, the AHA has highlighted a lack of standardized protocols for prehospital ECG interpretation due to variations in training and procedures across different countries (3).

It is essential for healthcare personnel, particularly nurses and paramedics, to enhance their skills in reading and interpreting ECGs (4). Studies have demonstrated that nurses' ability to correctly interpret cardiac arrhythmias leads to reduced mortality rates (5). Unfortunately, healthcare personnel exhibit varying levels of proficiency in ECG interpretation (6). Given that healthcare professionals frequently encounter cardiac emergencies, they must swiftly identify ECG abnormalities and promptly notify a physician. Accurate ECG interpretation can significantly improve emergency care and patient outcomes. Therefore, regular training in ECG reading is crucial for enabling nurses and paramedics to perform their roles in cardiac emergencies more effectively.

The Cardiac Rhythm Identification for Simple People (CRISP) method, standing for CRISP, is a contemporary approach specifically designed for reading and interpreting ECGs (4). The primary objective of this method is to provide a step-by-step guide for rapid and effective ECG assessment.

C - Calibration: The ECG device is checked for proper calibration. This step ensures that the paper speed and voltage settings are accurate.

R - Rate: The heart rate is calculated by measuring the distance between R waves on the ECG, determining the number of heartbeats per minute.

I - Intervals: Various ECG intervals (PR, QRS, QT, etc.) are measured and assessed to determine if they fall within normal ranges.

S - Shape: Wave shapes are examined by evaluating the morphologies of the P, QRS, and T waves to identify any abnormalities.

P - Pattern: Overall patterns on the ECG are assessed to identify any ischemic changes, arrhythmias, or other pathological conditions.

The aim of this study was to evaluate the effect of CRISP training on healthcare personnel's ability to read and interpret ECGs. Specifically, we sought to determine whether the use of the CRISP method enhances the staff's ability to analyze ECG results more quickly and accurately. This evaluation aimed to demonstrate the contribution of CRISP training to the diagnostic and intervention processes in cardiac emergencies.

Materials and Methods

This study was designed as a randomized controlled trial. Ethical approval was obtained from the Non-Interventional Clinical Research Ethics Committee of İzmir Bakırçay University (decision number: 1547, date: 17.04.2024). Participants were recruited from the staff of the Aydın Provincial Health Directorate and the Provincial Ambulance Service Chief Directorate. Based on reference studies, a power analysis (G*Power) was conducted with a 90% confidence interval and an α=0.05 margin of error, estimating a required sample size of 172 participants (control group: 86, experimental group: 86). Inclusion criteria comprised individuals aged 18-65, while those working in administrative units were excluded. Participant characteristics such as age, gender, title, educational background, professional experience, region of work, and prior participation in similar training programs were assessed. Simple randomization was employed to allocate participants into control and experimental groups.

Baseline levels of ECG analysis skills were evaluated for both groups using a pre-test. Subsequently, all participants underwent ECG interpretation training. The control group received training using the classical method, which involved detailed explanations of the mechanisms underlying ECG wave formation. Arrhythmia diagnoses were introduced sequentially, with relevant information provided for each, followed by illustrative ECG examples that were reviewed with the participants. The experimental group, in contrast, received training on basic ECG concepts and was introduced to the CRISP algorithm. This was followed by the interpretation of ECG examples guided by the CRISP framework. Both training sessions were standardized in duration, lasting approximately 50 minutes.

ECG examples provided to participants included only the D2 derivation, with evaluations conducted based on this derivation. Each participant was presented with 14 ECG examples, which were used for both pre-test and post-test assessments. Scoring was based on the accurate interpretation of ECG examples, with each correct response assigned a value of one point. Total scores for the pre-test and post-test were calculated for each participant.

Statistical Analysis

Statistical analysis were conducted using IBM SPSS Statistics version 20.0 (IBM Corp., Armonk, NY). Group distributions were evaluated using the Kolmogorov-Smirnov and Shapiro-Wilk tests, as well as visual inspection of the data. Descriptive

statistics were presented as medians with interquartile ranges (25^{th}-75^{th} percentiles). Comparisons between the two groups were performed using the Mann-Whitney U test, while within-group changes following the training were assessed using the Wilcoxon signed-rank test. Pearson's chi-square test was employed to evaluate associations between pre-test and post-test outcomes. When the assumptions for the Pearson chi-square test were not satisfied, Fisher's exact test was applied. Statistical significance was defined as a p-value <0.05.

Results

A total of 176 participants were included in the study. There were 89 participants in the control group and 87 in the experimental group. In terms of age, the median age is 36 (range: 29-39) for the control group and 30 (range: 26-37) for the experimental group. There was a statistically significant difference between the groups in terms of age (p<0.001). When comparing the groups based on years of professional experience, the median number of years of service was 12 (range: 9-16) for the control group and 10 (range: 9-16) for the experimental group. There was a statistically significant difference between the groups in terms of professional experience (p=0.005).

When comparing the control and experimental groups by gender, no significant difference was found between the groups (p=0.176) (Table 1). However, when comparing the groups based on prior training, a significant difference was observed between the groups (p=0.016) (Table 2).

Table 1. Gender distribution of study participants

	Gender				
	Female		Male		Total
	n	%	n	%	n
Control group	57	64.0%	32	36.0%	89
Experimental group	47	54.0%	40	46.0%	87
Total	104	59.1%	72	40.9%	176
Pearson chi-square p=0.176					

Table 2. Distribution of participants with prior ECG training

	ECG training				
	No		Yes		Total
	n	%	n	%	n
Control group	57	64.0%	32	36.0%	89
Experimental group	40	46.0%	47	54.0%	87
Total	97	55.1%	79	44.9%	176
Pearson chi-square p=0.016, ECG: Electrocardiography					

When comparing the pre-training knowledge levels between the experimental and control groups, no significant difference was found (p=0.366). However, a statistically significant difference was observed between the groups in the post-training comparison (p<0.001) (Graphic 1).

In the control group, the median score was 7 (range: 4-8) before training and increased to 8 (range: 7-10) after training. This difference was found to be statistically significant (p<0.001, Wilcoxon) (Graphic 1).

In the experimental group, the median score was 6 (range: 5-9) before training and increased to a median of 9 (range: 8-11) after training. The difference in scores before and after training was statistically significant (p<0.001) (Graphic 1).

In the pre-test phase, there was no significant difference between the experimental and control groups in the recognition of normal sinus rhythm. However, a difference was detected between the groups after training, with the experimental group showing better results. A similar situation was observed in ECG examples of supraventricular tachycardia, atrial fibrillation, second-degree Mobitz type 1, and Mobitz type 2 atrioventricular block. The CRISP training method was found to be more successful in diagnosing these conditions than the classical method.

For ECG examples of sinus bradycardia and second-degree Mobitz type 2 atrioventricular block, no statistically significant difference was observed between the experimental and control groups in the post-test. However, in the pre-test phase, the control group was less successful, indicating that CRISP training had a greater impact on these diagnoses.

No differences were found between the two training methods for the diagnosis of atrial flutter, first-degree atrioventricular block, third-degree atrioventricular block, ventricular tachycardia, ventricular fibrillation, and asystole (Table 3).

Graphic 1. Comparing scores

Table 3. Pre- and post-training evaluations									
	Control group				Experimental group				p value
	Wrong		Correct		Wrong		Correct		
	n	%	n	%	n	%	n	%	
Pre-test NSR	33	37%	56	63%	37	43%	50	57%	p=0.460
Post-test NSR	18	20%	71	80%	7	8%	80	92%	p=0.021
Pretest sinus tachycardia	71	80%	18	20%	62	71%	25	29%	p=0.189
Posttest sinus tachycardia	52	58%	37	42%	42	48%	45	52%	p=0.177
Pretest sinus bradycardia	74	83%	15	17%	59	68%	28	32%	p=0.018
Pretest sinus bradycardia	50	56%	39	44%	41	47%	46	53%	p=0.229
Pre-test SVT	30	34%	59	66%	20	23%	67	77%	p=0.115
Post-test SVT	17	19%	72	81%	5	6%	82	94%	p=0.007
Pretest AF diagnosis	35	39%	54	61%	35	40%	52	60%	p=0.902
Posttest AF diagnosis	19	21%	70	79%	7	8%	80	92%	p=0.013
Pre-test Atrial Flutter	25	28%	64	72%	29	33%	58	67%	p=0.451
Post-test Atrial Flutter	8	9%	81	91%	12	14%	75	86%	p=0.315
Pre-test First-Degree AV Block	75	84%	14	16%	63	72%	24	28%	p=0.056
Posttest First-Degree AV Block	52	58%	37	42%	38	44%	49	56%	p=0.050
Pre-test Second-Degree Mobitz 1 AV Block	72	81%	17	19%	76	87%	11	13%	p=0.242
Post-test Second-Degree Mobitz 1 AV Block	76	85%	13	15%	59	68%	28	32%	p=0.006
Pre-test Second-Degree Mobitz 2 AV Block	74	83%	15	17%	61	70%	26	30%	p=0.041
Post-test Second-Degree Mobitz 2 AV Block	57	64%	32	36%	46	53%	41	47%	p=0.133
Pre-test Second-Degree Mobitz 2 AV Block	85	96%	4	4%	82	94%	5	6%	*p=0.486
Post-test Second-Degree Mobitz 2 AV Block	85	96%	4	4%	71	82%	16	18%	p=0.004
Pretest Third-Degree AV Block	77	87%	12	13%	81	93%	6	7%	p=0.149
Posttest Third-Degree AV Block	71	80%	18	20%	77	89%	10	11%	p=0.113
Pretest VT Diagnosis	15	17%	74	83%	15	17%	72	83%	p=0.966
Posttest VT Diagnosis	8	9%	81	91%	3	3%	84	97%	p=0.129
Pre-test VF	19	21%	70	79%	17	20%	70	80%	p=0.766
Post-test VF	9	10%	80	90%	3	3%	84	97%	p=0.079
Pre-test Asystole	5	6%	84	94%	2	2%	85	98%	*p=0.231
Post-test Asystole	1	1%	88	99%	2	2%	85	98%	*p=0.491

Pearson chi-square, *Fisher's exact test, NSR: Normal sinus rhythm, SVT: Supraventricular tachycardia, AF: Atrial fibrillation, AV: Atrioventricular, VT: Ventricular tachycardia, VF: Ventricular fibrillation

Discussion

ECG training plays a crucial role in the early diagnosis and treatment of critically ill patients. In this study, healthcare personnel were divided into two groups and provided ECG training. The effectiveness of the traditional training method was compared to the CRISP method. Both approaches positively impacted participants' ECG analysis skills; however, post-test results indicated that the experimental group trained with the CRISP method achieved significantly better results. Notably, there was no instance where the CRISP method was less effective than the traditional method in any aspect of ECG analysis.

Our findings revealed that the experimental group demonstrated superior recognition of normal sinus rhythm compared to the control group. This ability is critically important in avoiding misdiagnosis and preventing unnecessary or inappropriate interventions. Similarly, Gausche et al. (6) emphasized the importance of rapid, accurate, and effective diagnosis and treatment in their study evaluating the prehospital use of adenosine.

The experimental group also showed statistically significant success in identifying supraventricular tachycardia, atrial fibrillation, and second-degree Mobitz type 1 and type 2 atrioventricular block in ECG samples. These arrhythmias are among the most frequently encountered rhythm disorders in emergency and prehospital settings (7). The capacity to accurately diagnose these potentially fatal arrhythmias through the CRISP method highlights the critical importance of our study. Davis et al. (8) further supported this finding, noting that the early diagnosis of such arrhythmias through prehospital ECG evaluation has significant implications for patient management and outcomes.

Traditional lecture-based training remains the most commonly used approach to teaching ECG interpretation. However, ECG interpretation demands extensive experience and expertise (9). Traditional methods often fail to develop critical thinking and problem-solving skills in students, leaving them in a passive learning role (10).

Similar findings to our study have been reported in the literature. Çıkrıkçı et al. (11) observed that the CRISP method was more effective than traditional methods in their study on nurses, particularly in enhancing the detection of fatal arrhythmias. Additionally, alternative approaches to the CRISP method have been tested to improve ECG interpretation, with results demonstrating greater efficacy than traditional training (12). Understanding healthcare personnel's experiences and insights regarding arrhythmias is vital for assessing their skills and for tailoring effective training methods to meet their needs (13).

Study Limitations

Our study has several limitations. Although no significant difference was observed between the control and experimental groups regarding gender distribution, the groups were not homogeneous in terms of age and professional experience. These factors may have influenced the test results. Furthermore, when comparing the experimental and control groups' prior ECG training, a higher proportion of participants in the experimental group were found to have received such training. This imbalance suggests that the experimental group trained using the CRISP method may have included more participants with prior training experience, potentially extending their training duration and contributing to the higher success rates observed in this group.

Participants were assigned to groups using a randomization method, whereby individuals were randomly allocated to the training groups. However, this method did not effectively ensure group homogeneity. To address these limitations in future studies, it is essential to collect detailed demographic data when forming participant and control groups. Factors such as age, gender, professional experience, educational background, and prior training should be matched, with group assignments conducted systematically by researchers to minimize potential biases.

Conclusion

A single teaching method or format is unlikely to be universally effective in improving ECG interpretation skills. ECG interpretation is inherently challenging, requiring sustained effort to acquire and maintain proficiency (2). Nevertheless, the development of innovative and algorithmic learning techniques has yielded positive outcomes in ECG education. Our study demonstrated that the CRISP method was more effective than traditional approaches for improving ECG analysis skills.

Ethics

Ethics Committee Approval: The necessary permissions for the study were obtained from the Non-Interventional Clinical Research Ethics Committee of İzmir Bakırçay University (decision number:1547, date: 17.04.2024).

Informed Consent: Informed consent was obtained from all participants following the provision of detailed information about the study.

Footnotes

Authorship Contributions

Surgical and Medical Practices: F.M.A., S.Y., Z.K., Concept: M.E., İ.B., Design: M.E., Ö.F.T., Data Collection or Processing: M.E., Ö.F.T., İ.B., F.M.A., S.Y., Z.K., Analysis or Interpretation: Ö.F.T., F.M.A., S.Y., Z.K., Literature Search: M.E., F.M.A., Writing: M.E., Ö.F.T.,

Conflict of Interest: No conflict of interest was declared by the authors.

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Challenges and Opportunities for Telemedicine Integration in Disaster Medicine: A Saudi Arabian Perspective

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Abstract

Aim: Telemedicine has become a crucial tool in disaster medicine, enabling remote consultations, diagnostics, and patient monitoring when traditional healthcare systems are disrupted. This study examines the perceptions of telemedicine among 100 disaster medicine and emergency management professionals in Saudi Arabia, highlighting its benefits, challenges, and areas for improvement.

Materials and Methods: A descriptive survey design was employed to assess telemedicine perceptions among staff at the National Health Emergency Operations Center. A structured questionnaire, utilizing validated tools such as the Telemedicine Satisfaction and Usefulness Questionnaire and the Technology Acceptance Model, was used to collect quantitative data on telemedicine's effectiveness, ease of use, and potential to replace in-person consultations during disasters. Regression analysis was conducted to identify the demographic and contextual factors that influenced the perceptions. The survey was administered electronically via WhatsApp over two weeks. Participation was voluntary, with informed consent obtained. The study was approved by the Institutional Review Board.

Results: A 75% response rate was achieved, with 75 participants completing the survey. Respondents reported that telemedicine significantly improved communication [mean=3.70, standard deviation (SD)=1.10] and enhanced patient care (mean=3.76, SD=1.08) during disasters. Confidence was moderate regarding telemedicine's ease of use (mean=3.41, SD=1.11), reliability (mean=3.44, SD=1.13), and ability to replace in-person consultations (mean=2.94, SD=1.24). Regression analysis revealed gender as a significant predictor of perceptions of telemedicine-improving communication (p=0.035), with male participants reporting lower agreement. Other factors, such as age, experience, and perceived barriers, were not significant predictors.

Conclusion: Telemedicine has substantial potential to enhance disaster response in Saudi Arabia, particularly in improving communication and care delivery during emergencies. Addressing technological and training challenges is critical for successful integration. These findings offer actionable insights for policymakers and practitioners seeking to optimize disaster preparedness and response strategies.

Keywords: Telemedicine, disaster medicine, emergency management, disaster response

Introduction

Telemedicine has become a vital tool in disaster medicine, particularly when traditional healthcare infrastructures are compromised during natural disasters or large-scale emergencies. By enabling remote consultations, diagnostics, and patient monitoring, telemedicine enhances the efficiency and effectiveness of disaster response efforts (1). Globally, the ability to maintain access to medical expertise under challenging conditions has made it an essential component of modern disaster preparedness and response (2). In Saudi Arabia, the integration of telemedicine holds particular promise given the region's vulnerability to natural and man-made disasters, yet its adoption remains underexplored (3).

Previous studies have demonstrated that telemedicine improves patient outcomes, reduces the burden on healthcare facilities, and enhances coordination among emergency response teams (4). However, barriers such as lack of training, privacy concerns, and high technology costs continue to hinder adoption, particularly

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in Saudi Arabia (5,6). Research in Riyadh and the Eastern Province has highlighted low awareness and limited perceived benefits among healthcare professionals, underscoring the need for tailored strategies to overcome these challenges (7,8). The findings from a recent study on the Use of Technology in Disaster Medicine further emphasize the importance of aligning telemedicine solutions with local needs to maximize their potential impact (4).

This study uniquely explores the perceptions of telemedicine among disaster medicine professionals in Saudi Arabia, addressing an underexplored yet vital area. The survey included 100 professionals and identified key benefits, challenges, and opportunities for improving telemedicine integration in disaster response. The findings provide actionable recommendations to enhance telemedicine adoption, bridge gaps in the existing literature, and strengthen disaster preparedness and response efforts in the region.

Materials and Methods

This study employed a descriptive survey design to evaluate the perceptions and experiences of telemedicine in disaster medicine among the employees of the National Health Emergency Operations Center (NHEOC). The survey aimed to capture insights into key aspects of telemedicine, including its effectiveness, ease of use, and potential to substitute in-person consultations during disaster scenarios. A comprehensive approach was adopted by targeting all 100 employees at the NHEOC to ensure that the entire population of professionals with relevant expertise in emergency management and disaster response was included. Participants were purposefully selected based on their roles and experience to maximize the relevance and depth of the findings.

Survey Development and Validation

The survey instrument was specifically designed for this study, incorporating elements from established tools, such as the Telemedicine Satisfaction and Usefulness Questionnaire (9), the Technology Acceptance Model (10), and the Disaster Preparedness and Response Questionnaire (11). These instruments provide a robust foundation for evaluating telemedicine adoption, satisfaction, and perceived effectiveness in disaster medicine.

The questionnaire was divided into several sections to gather a wide range of data, including demographic information, experiences with telemedicine, perceived benefits and challenges, and overall effectiveness in disaster contexts. Responses were measured using a Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree), allowing for detailed quantitative analysis. To ensure cultural and contextual relevance, the questionnaire was initially developed in English, translated into Arabic and then back-translated into English. The survey was distributed electronically via WhatsApp, enabling convenient and efficient participation. Responses were collected over two weeks using Google Forms.

The survey instrument included a range of questions to capture the participants' perceptions and experiences with telemedicine in disaster medicine. Examples of the questions included "What is your role in emergency management?" (e.g., general director, specialist, administrative support) and "Have you used telemedicine in disaster response?" Participants were also asked to rate their agreement with statements such as "Telemedicine improves communication during disasters" on a Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Additionally, an open-ended question invited participants to provide recommendations for improving the implementation of telemedicine in disaster medicine. These questions ensured a comprehensive assessment of both quantitative and qualitative aspects relevant to the study objectives.

Statistical Analysis

Descriptive statistics were used to summarize the participants' demographic characteristics and responses to the survey items. The mean scores and standard deviations (SDs) were calculated for each item to assess the central tendency and variability of the responses. Correlation analysis was performed to identify significant relationships between different aspects of telemedicine in disaster medicine. To explore the factors influencing perceptions of telemedicine, a regression analysis was conducted. The dependent variable was the participants' agreement with the following statement: "Telemedicine improves communication during disasters" (rated on a Likert scale from 1 to 5). Independent variables included age, gender, years of experience, and key barriers such as technical issues, lack of training, resistance to change, privacy concerns, and costs. The analysis was performed using ordinary least squares regression, and the results were evaluated for statistical significance ($p<0.05$).

Results

Participant Demographics

The survey included responses from 75 participants (75% response rate). The age distribution was primarily within three groups: 24-34 years (42 respondents), 35-44 years, and 45-54 years. The majority of respondents were male (52 respondents), with females making up the remainder. Participants' roles in emergency management varied, with 65 unique job titles reported, the most common being "administrative" roles (3 respondents). Experience in emergency management varied widely, with the most common experience bracket being 6-10 years (30 respondents).

Descriptive Analysis

Telemedicine Improves Communication During Disasters (Figure 1a)

Participants reported that telemedicine significantly improved communication during disasters, with a mean score of 3.70 and a SD of 1.10. The high mean score indicates a consensus among respondents about the effectiveness of telemedicine in enhancing communication. The low standard deviation suggests that most respondents had similar views about this aspect.

Telemedicine Enhances Patient Care During Disasters (Figure 1b)

The perception that telemedicine enhances patient care during disasters was assessed using a mean score of 3.76 with a standard deviation of 1.08. This finding highlights the confidence among participants that telemedicine can play a crucial role in improving patient care during disasters. The relatively low standard deviation indicates consistent responses across participant groups.

Telemedicine is Easy to Use in Emergencies (Figure 1c)

The ease of use of telemedicine in emergencies was rated with a mean score of 3.41 and a standard deviation of 1.11. This score indicates moderate confidence in the usability of telemedicine technologies during emergencies. While most respondents found it easy to use, the slightly higher standard deviation indicates some variability in the responses.

Telemedicine Can Replace In-Person Consultations (Figure 1d)

The potential for telemedicine to replace in-person consultations during disasters was rated with a mean score of 2.94 and a standard deviation of 1.24. This lower mean score reflects respondents' skepticism or caution about the complete replacement of face-to-face consultations. The higher standard

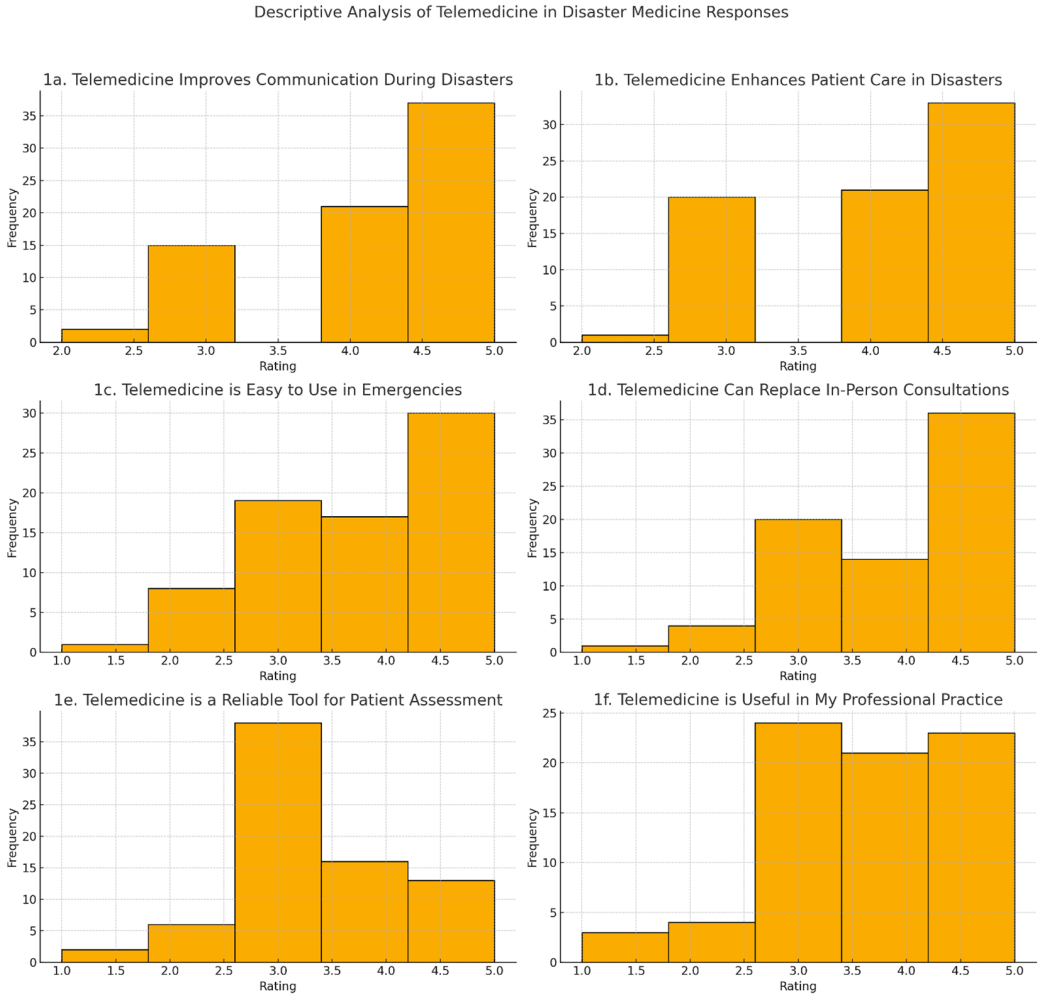

Figure 1. Descriptive analysis of telemedicine in disaster response

deviation suggests that there are diverse opinions on this matter.

Telemedicine as a Reliable Tool for Patient Assessment (Figure 1e)

The reliability of telemedicine as a tool for patient assessment had a mean score of 3.44 and a standard deviation of 1.13. Participants generally viewed telemedicine as a reliable assessment tool, although some variability was noted in their responses. This indicates room for improvement in ensuring consistent reliability of patient assessments via telemedicine.

Telemedicine is Useful in My Professional Practice (Figure 1f)

The usefulness of telemedicine in professional practice received a mean score of 3.76 with a standard deviation of 1.08. This high mean score reflects a positive perception of telemedicine's role in professional settings. The low standard deviation indicates that the perception was widely shared among respondents.

Statistical Analysis

The correlation matrix (Figure 2) reveals several significant relationships between the survey variables. This matrix illustrates how different aspects of telemedicine in disaster management are interrelated.

Regression Analysis

The regression analysis revealed that gender was a significant predictor of perceptions regarding telemedicine's ability to improve communication during disasters (p=0.035). Specifically, male participants were less likely to strongly agree with this statement than their female counterparts. Other factors, such as age, experience, and barriers, such as technical issues and costs, did not show statistically significant relationships with this perception. The model explained 30.2% of the variance in perceptions, although the adjusted R^2 was 2.3%, suggesting limited explanatory power (Table 1).

Recommendations for Improving Disaster Medicine Implementation of Telemedicine

Based on the findings from the survey, several recommendations have been proposed to enhance the implementation of telemedicine in disaster medicine. These recommendations address key areas such as technological infrastructure, training, software development, collaboration, and community awareness. Each recommendation targets specific aspects crucial for the successful integration of telemedicine, ensuring a comprehensive approach to improving disaster medicine practices (Table 2).

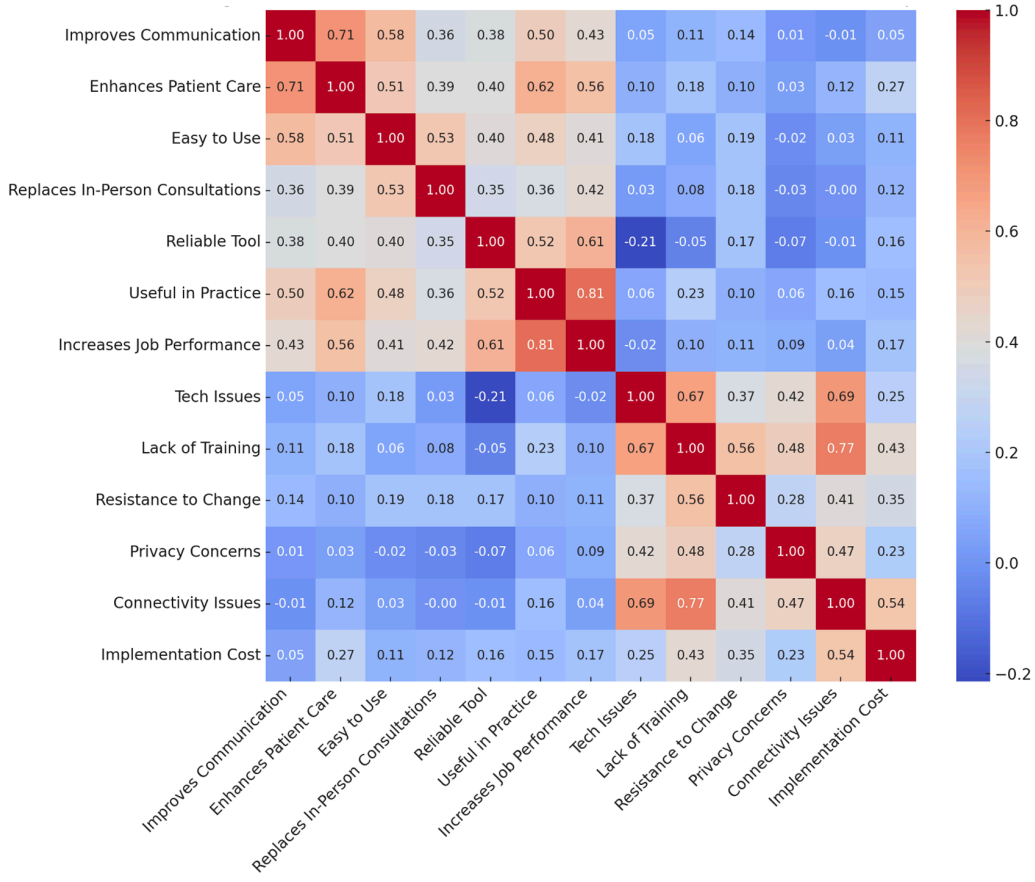

Figure 2. Descriptive analysis of telemedicine in disaster response

Discussion

The findings of this study indicate a generally positive attitude toward the use of telemedicine in disaster situations among healthcare professionals in Saudi Arabia. The high mean scores for perceived improvement in communication and patient care highlight telemedicine's potential to enhance disaster response efforts. These results are consistent with those of previous studies demonstrating the effectiveness of telemedicine in improving communication and coordination during emergencies (3). The ability to deliver remote consultations and diagnostics plays a crucial role in bridging the gap between healthcare providers and patients during disasters (11).

A case study by Jamal et al. (12) illustrated how telemedicine effectively bridged healthcare gaps in emergency scenarios.

Table 1. Regression analysis of factors influencing perceptions of telemedicine-based communication improvement during disasters

Predictor	Coefficient (β)	Standard error	t value	p value	95% Confidence interval
Constant	1.922	1.528	1.258	0.223	[-1.265, 5.109]
Age	0.031	0.037	0.823	0.420	[-0.047, 0.109]
Gender (Male)	-0.778	0.344	-2.261	0.035*	[-1.496, -0.060]
Experience	0.014	0.043	0.317	0.754	[-0.076, 0.104]
Technical issues	0.249	0.247	1.010	0.324	[-0.266, 0.764]
Lack of training	0.047	0.215	0.217	0.831	[-0.402, 0.495]
Resistance to change	0.030	0.147	0.202	0.842	[-0.278, 0.337]
Privacy concerns	-0.018	0.148	-0.121	0.905	[-0.326, 0.290]
Cost	0.079	0.157	0.505	0.619	[-0.248, 0.406]

*Note: Adjusted R^2=0.023; F-statistic = 1.083, p=0.413, *Statistically significant at p<0.05

Table 2. Recommendations for improving the implementation of telemedicine in disaster medicine

Recommendation	Points
1. Improving technological infrastructures	1. Ensure strong and stable internet connectivity in remote areas. 2. Provide durable and portable devices for harsh environments.
2. Training and awareness	1. Training medical teams on using telemedicine technologies effectively. 2. Educate the community about the use of telemedicine during emergencies.
3. Development of software and applications	1. Develop specialized applications for disaster medicine with features like interactive maps and real-time reports. 2. Enhance cybersecurity to protect patient information.
4. Collaboration and coordination	1. Strengthen partnerships among governments, NGOs and international bodies to achieve unified disaster response. 2. Ensure integrated and comprehensive collaboration to improve efficiency and resource utilization.
5. Preparedness and field exercises	1. Organize field exercises simulating disasters to improve response. 2. Create and regularly update emergency plans, including telemedicine scenarios.
6. Funding and government support	1. Provide financial support for developing and improving telemedicine services. 2. Establish policies supporting telemedicine use during emergencies.
7. Research and development	1. Support research to study and improve telemedicine technologies in disaster medicine. 2. Continuously updating technologies based on research findings.
8. Enhancing partnerships	1. Promote strong cooperation among stakeholders to ensure effective telemedicine use during disasters. 2. Create strategic alliances to leverage shared expertise and resources.
9. Continuous training	1. Regular training programs to ensure medical teams are proficient in telemedicine technologies. 2. Provide ongoing education to ensure readiness and adaptability to disaster scenarios.
10. Community awareness	1. Increase public awareness of telemedicine's role in emergencies and how to access these services. 2. Educate communities about the benefits and use of telemedicine during disasters.
11. Improving communication and knowledge sharing	1. Enhance communication channels between field and telemedicine teams to improve task distribution. 2. Promote knowledge sharing and best practices to improve overall response capabilities.

Similarly, this study confirms telemedicine's ability to enhance communication and patient care during disasters. Innovative technologies such as Google Glass have also been explored in disaster telemedicine triage (13), demonstrating how wearable devices enhance situational awareness and real-time decision-making. Wearable health monitoring technologies, like wireless electrocardiography systems, further expand telemedicine applications by providing reliable, continuous patient monitoring in disaster settings (14).

The regression analysis further explored factors influencing perceptions of telemedicine. Gender was identified as a significant predictor, with male participants reporting lower agreement with the statement that telemedicine improves communication during disasters compared to their female counterparts ($p=0.035$). This finding underscores the potential role of demographic factors in shaping attitudes toward telemedicine. Other variables, such as age, experience, and barriers like technical issues and costs, did not show significant relationships in this study. The limited explanatory power of the model (adjusted $R^2=2.3\%$) suggests that additional factors, such as cultural attitudes and prior exposure to telemedicine, may be crucial in shaping perceptions.

Despite the positive perceptions, significant barriers to telemedicine adoption were identified. The relatively low mean score for telemedicine's potential to replace in-person consultations suggests cautious acceptance. This could stem from concerns about the reliability of remote consultations, a challenge noted in previous research as a critical factor influencing telemedicine adoption (4). Other barriers, such as lack of training, privacy concerns and high technology costs, mirror findings from studies conducted in Riyadh and other Middle Eastern regions, where infrastructural limitations, cultural considerations and policy gaps hinder progress (6,15).

The role of telemedicine has expanded significantly during the COVID-19 pandemic, as highlighted by Bains et al. (16), where it has become integral to managing emergency department patient care. This aligns with the current findings, demonstrating telemedicine's utility in delivering remote healthcare in disaster scenarios.

Moderate scores for the ease of using telemedicine technologies suggest that healthcare professionals recognize the benefits of telemedicine, but further training and familiarization are needed. Research in the Eastern Province has emphasized that awareness and training are essential for enhancing adoption (6). Ensuring healthcare professionals are proficient in telemedicine technologies is critical for successful integration into disaster response.

Correlation analysis revealed significant relationships between the key aspects of telemedicine. Enhancing technological infrastructure could improve reliability and ease of use, thereby increasing healthcare professionals' acceptance. Previous studies have emphasized that successful telemedicine initiatives in disaster settings require robust technological systems and clear protocols (8). The strong positive correlation between perceived ease of use and reliability suggests that hands-on experience with telemedicine technologies builds confidence in their reliability. Similarly, the perceived usefulness of telemedicine in professional practice was strongly correlated with its effectiveness in improving patient care. These insights underscore the need for targeted training and practical experience to strengthen telemedicine adoption (16).

Overall, the study highlights telemedicine's potential to enhance disaster response efforts in Saudi Arabia. However, addressing barriers such as technological infrastructure, training, privacy concerns, and costs is critical. Successful implementations in similar settings, like the California Valley Fire response, emphasize the importance of these strategies (17).

Study Limitations

This study has several limitations. First, the sample was drawn primarily from NHEOC professionals in Saudi Arabia, which may limit the generalizability of the findings to other healthcare settings or disaster management roles. Second, the reliance on self-reported data introduces the potential for social desirability and recall bias. Third, although regression analysis provided insights into factors influencing perceptions, the model's limited explanatory power suggests that additional variables, such as cultural attitudes and prior telemedicine experience, may also play significant roles. Finally, the cross-sectional design limits the ability to infer causal relationships, and longitudinal studies are valuable for capturing changes in perceptions over time. Participation in the survey was voluntary, and informed consent was obtained from all participants prior to their participation. The survey was designed to ensure the anonymity and confidentiality of the responses. Approval was obtained from Kingdom of Saudi Arabia Ministry Health of IRB GDRS the Institutional Review Board prior to the commencement of the study, ensuring the ethical conduct of the research (decision no: 24-55-M, date: 29.05.2024).

Conclusion

This study highlights a generally positive perception of telemedicine among healthcare professionals in Saudi Arabia. Telemedicine is recognized for its potential to enhance communication and patient care during disasters; however,

significant barriers remain, including technological challenges, lack of training, and privacy concerns. The regression analysis revealed that gender significantly influenced perceptions, with male participants reporting lower agreement on telemedicine's ability to improve communication. These findings underscore the need for targeted strategies to facilitate telemedicine adoption, such as improving infrastructure, providing training, and addressing privacy and cost concerns. Future research should explore additional factors, including cultural attitudes and prior telemedicine experience, to further enhance disaster preparedness and response efforts.

Ethics

Ethics Committee Approval: The survey was designed to ensure the anonymity and confidentiality of the responses. Approval was obtained from Kingdom of Saudi Arabia Ministry Health of IRB GDRS the Institutional Review Board prior to the commencement of the study, ensuring the ethical conduct of the research (decision no: 24-55-M, date: 29.05.2024).

Informed Consent: The survey was administered electronically via WhatsApp over two weeks. Participation was voluntary, with informed consent obtained. The study was approved by the Institutional Review Board.

Footnotes

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

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Factors Influencing Mortality in Patients with Pacemaker/ICD Dysfunction Presenting to Emergency Departments

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Abstract

Aim: Management of patients with heart failure and implanted cardioverter defibrillators (ICDs) is as important as ICD placement. Inappropriate shocks and factors affecting mortality are the factors determining management. Appropriate intervention and detection improve the quality of life of patients. We aimed to investigate the complaints, medication use, electrocardiography findings, symptoms, laboratory findings and body mass index affecting mortality in patients with pacemaker/ICD dysfunction who presented to the emergency department.

Materials and Methods: Our study is a single-center, prospective, observational cohort. It included patients aged 18 years and older with pacemakers of both genders who gave their consent between 09/01/2022 and 09/01/2023.

Results: Ninety-one patients were included. The mean age was 65.02±13.71 years and 61 (67.0%) were male. The most common diseases were hypertension (86.8%) and congestive heart failure (76.9%). The most commonly used drugs were beta blockers (70.3%) and antiplatelet agents (59.3%). ICD shock rates were higher in men and those with dyspnea did not experience inappropriate ICD shocks. There was a significant correlation between in-hospital mortality and systolic blood pressure (BP), diastolic BP, partial oxygen saturation (sPO_2) and potassium (K) levels.

Conclusion: We found that ICD shock rates were higher in men and in patients without diabetes mellitus. The incidence of infection due to pacemaker/ICD use was low. We found that ICD patients with low partial sPO_2 and hypotensive patients had a worse prognosis. We found that K levels above 4.65 mEq/L were associated with increased mortality.

Keywords: Body mass index, emergency department, implantable cardioverter defibrillators, pacemaker, pacemaker dysfunction.

Introduction

The use of pacemaker/implanted cardioverter defibrillator (ICD) implantation is on the rise due to increasing life expectancy and the prevalence of cardiovascular disease.

Recent technological advancements and studies have led to significant changes in medical practice. Pacemaker/ICD therapy has expanded to include the concept of "rhythm control for quality of life". The indications for pacemaker/ICD implantation have expanded, and the programable features have diversified. The accumulation of data from well-designed randomized clinical trials has ushered in an era in which patients can be offered the most appropriate treatment options (1,2).

Clinical trials have demonstrated that implantable cardioverter defibrillators are effective for preventing sudden death caused by ventricular arrhythmias in patients with left ventricular dysfunction (3-5).

However, the increasing use of implantable cardiac devices has led to a rise in complications, such as battery pocket infection, lead malfunction, improper positioning, or dislodgement (6).

As the number of patients receiving pacemakers/ICDs increases, the likelihood of emergency physicians encountering these patients also increases. The purpose of our study was to examine the presenting complaints, medication usage, electrocardiography findings, symptoms, laboratory results, body mass index (BMI), and conditions affecting mortality in pacemaker dysfunction among patients with pacemaker-implanted emergency department.

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Materials and Methods

This was a single-center prospective study approved by the Ethics Committee of Health Sciences University, Bursa Faculty of Medicine, Bursa High Specialty Training and Research Hospital (decision no.: 2011-KAEK-25, date: 24.08.2022).

The study included emergency department patients aged 18 years and older, of both sexes, who had pacemaker implants, consented to participate, and had fully accessible data. The patients were admitted to the Emergency Department of Bursa High Specialty Training and Research Hospital between 09.01.2022 and 09.01.2023. Patients aged below 18 years, pregnant women, those who did not provide informed consent, and those with incomplete study data were excluded from the study. The hospital automation system, patient examination cards, and routine blood parameters were used.

The study assessed the relationship between BMI and several factors, including age, sex, admission complaints, comorbidities, medication use, fever, blood pressure (BP), pulse, respiratory rate, saturation, electrocardiogram, physical examination findings, complete blood count, and biochemical tests. A data collection form was prepared for the patients included in the study to record their age, sex, height, and weight.

Statistical Analysis

The statistical analysis was performed using IBM SPSS Statistics for Windows (version 21.0. Descriptive statistics were presented as mean ± standard deviation (minimum-maximum), median and range, and/or interquartile range (IQR) for numerical variables. For categorical variables, the number and percentage (%) of cases were reported. The Kolmogorov-Smirnov test was used to determine the normal distribution of the data. Levene's test was used to assess the homogeneity of variances. The significance of differences between groups for continuous numerical variables was tested using the Student's t-test, where the assumptions of parametric test statistics were met.

Where the statistical assumptions of parametric tests were not met, differences between continuous numerical variables were assessed using the Mann-Whitney U test. For comparisons between three or more groups, we used either one-way ANOVA or the Kruskal-Wallis test. Pearson correlation analysis was used to assess the relationships between parametrically distributed data, whereas Spearman's rank correlation analysis was preferred for non-parametrically distributed data. To analyze the relationship between categorical variables, we used either the chi-square test or Fisher's exact test. We considered a significance level of $p<0.05$ to be statistically significant. Results were presented with a 95% confidence interval.

Results

A total of 91 patients were included. The mean age of the patients was 65.02±13.71 years and 61 (67.0%) patients were male. The most common presenting complaints were dyspnea (n=22, 24.2%) and ICD shock (n=16, 17.6%).

All patients had a history of comorbidities. The most common comorbidities were hypertension (HT) (n=79, 86.8%) and congestive heart failure (n=70, 76.9%). The most common medications were beta-blockers (n=64, 70.3%) and antiplatelets (n=54, 59.3%). The most commonly used pacemaker was DDD, which was implanted in 28 (30.8%) of the patients, while 73 (80.2%) had been implanted 5 years or more previously. Of the patients who presented to the emergency department, 51 (56.0%) were discharged and 20 (22.0%) were admitted to the coronary intensive care unit. In-hospital mortality occurred in 6 (15.8%) patients (Table 1).

Table 1. Clinical and demographic findings

Age (years)*		**65.02±13.71**
Gender#	Male	61 (67.0)
	Woman	30 (33.0)
Application complaints#	Dyspnea	22 (24.2)
	ICD shock	16 (17.6)
	Chest pain	12 (13.2)
	Palpitation	9 (9.9)
	Stinging in the chest	5 (5.5)
	Headache/dizziness	4 (4.4)
	Syncope	3 (3.3)
	Cough	3 (3.3)
	Speech disorder	2 (2.2)
	Leakage at the battery place	1 (1.1)
	Other	8 (8.8)
Additional diseases#	Hypertension	79 (86.6)
	Congestive heart failure	70 (76.9)
	Coronary artery disease	67 (73.6)
	Diabetes mellitus	40 (44.0)
	Chronic kidney failure/disease	17 (18.7)
	Chronic obstructive pulmonary disease	8 (8.8)
	Malignancy	3 (3.3)
	Asthma	1 (1.1)
	Other	17 (18.7)

Table 1. Continued		
Medical drugs used#	Beta blocker	64 (70.3)
	Antiplatelet	54 (59.3)
	Anticoagulant	47 (51.6)
	Calcium channel blocker	37 (40.7)
	Angiotensin-converting enzyme ınhibitors	35 (38.5)
	Angiotensin 2 receptor blocker	25 (27.5)
Pace-maker type#	DDD	28 (30.8)
	ICD	25 (27.5)
	CRT	21 (23.1)
	VVI	17 (18.7)
	Biventricular pace	1 (1.1)
	VDD	0 (0)
	5 Years and before	73 (80.2)
	6 Years and above	18 (19.8)
History of pace dysfunction	Yes	15 (16.5)
	No	76 (83.5)
	Discharge	51 (560)
Emergency department outcome	Intensive care hospitalization	20 (22.0)
	Service hospitalization	18 (19.8)
	Extinction Other	0 (0) 2 (2.2)
Hospital outcome#	Discharge Extinction	32 (84.2) 6 (15.8)
Diagnosis of cardiac pacemaker dysfunction		4 (4.4)
Total#		91 (100)

ICD: Implanted cardioverter defibrillator, DDD: Dual dual dual, CRT: Cardiac resynchronization therapy, VVI: Ventriculer ventriculer inhibition, VDD: Ventriculer dual dual

The mean BMI was 36.52±0.57, the mean pulse rate was 80 (IQR: 25-75: 72-100) beats/min, the mean SBP was 137 (IQR: 25-75: 122-160) mm/Hg, the mean implant duration was 2 (IQR: 25-75: 1-5) years, the mean hemoglobin level was 12.4±2.3 g/dL, and the mean troponin level was 174.07±1034.38 ng/L.

Chi-square/Fisher's exact analysis to determine the relationship between sex, presenting complaints, comorbidities, and medications with pacemaker dysfunction showed no statistical significance. Chi-square/Fisher's exact analysis to determine the relationship between emergency department and hospital outcomes with pacemaker dysfunction showed no statistical significance.

The ICD shock rate was significantly higher in men. However, the ICD did not shock any patient with shortness of breath ($p<0.05$) (Table 2).

In the analysis performed to determine the relationship between comorbidities and ICD shock, a significant relationship was found between diabetes mellitus (DM) and ICD shock ($p<0.05$). ICD shock rates were significantly higher in non-diabetic patients (Table 3).

The chi-square/Fisher's exact analysis performed to determine the relationship between patients' medications, emergency department, and hospital outcomes in patients with ICD shock showed no statistical significance.

Mann-Whitney U and Student t-tests, which were performed to determine the relationship between age, BMI, vital signs, duration of pacemaker implantation, and laboratory findings with pacemaker dysfunction, showed no statistical significance.

The Mann-Whitney U test and Student's t-test were performed to determine whether there was a difference between age, BMI, vital signs, pacemaker implantation time, and laboratory findings with ICD shock status of the patients. The age of the patients whose ICD was shocked was significantly different ($p<0.05$). The mean age of patients whose ICD was shocked was 57.38±15.01 years, whereas the mean age of patients who did not experience shock was 66.65±12.94 years, which was significantly different.

The Mann-Whitney U and Student's t-tests were performed to investigate whether there was a relationship between age, BMI, vital signs, duration of pacemaker implantation, laboratory findings, and in-hospital mortality in patients with pacemakers. Accordingly, systolic BP (SBP), dibutyl phthalate (DBP), oxygen saturation (sPO_2), and potassium levels were significantly different in patients with pacemakers who developed in-hospital mortality [($p<0.05$), ($p<0.05$), ($p<0.05$), ($p<0.05$), ($p<0.05$), ($p<0.05$)] (Table 4).

When the cut-off values for potassium in the diagnosis of in-hospital mortality in patients with pacemakers were 4.50, 4.65, and 4.85, the sensitivity and specificity values were as follows, respectively (83.3%, 59.4%; 66.7%, 78.1%; 66.7%, 81.3%) (Table 5).

Discussion

Despite increased life expectancy and technological advances, cardiovascular disease remains the leading cause of mortality and morbidity. Accordingly, the need for pacemaker/ICD use is increasing. The main findings of our study are as follows: (a) the incidence of infection associated with pacemaker/ICD use is low; (b) the rate of ICD shock is higher in men and in patients without a diagnosis of DM; (c) low partial sPO_2 and hypotension in patients with ICDs should be considered with regard to mortality; and (d) a potassium level above 4.65 mEq/L increases mortality.

In the study by Jacob et al. (7), the mean age of patients with inappropriate shock was 56.05±12.68 years, whereas the mean age of patients without inappropriate shock was 55.57±12.64 years. In our study, the mean age of patients who received shock was 57.38±15.01 years, whereas the mean age of patients who did not receive shock was 66.65±12.94 years, which was significantly different.

In the study by Tompkins et al. (8), male and female patients were analyzed to determine the incidence of inappropriate shocks and their effects on outcomes. The results showed that 13.5% of men and 9.2% of women received inappropriate shocks. This finding showed that the incidence of inappropriate shocks was lower in women. A study including data from 14 centers across 11 European countries found that ICD shock rates were higher in men (9). In our study, the ICD shock rates were 23% in men and 6.7 % in women.

In a study by Rautiio et al. (10), the need for ICD was higher in patients with DM. In a study by Junttila et al. (11), 28% of patients with ICD implantation had DM, and mortality was higher in patients with DM. In our study, ICD shock rates were higher in patients with HT than in those with DM. We believe that this result was obtained because only patients with ICD shock were included in the study.

The infection rates after permanent transvenous pacemaker implantation range from 0.03% to 7.9% in small studies (12). These rates range from 0.3% to 2.2% in multicentre registries (13-15). Infection can affect any part of the pacemaker system, but the most common cause is infection in the pacemaker pocket (16). In our study, we found one case of infection in the pacemaker pocket (1.1 %).

Low SBP is a well-known independent predictor of morbidity and mortality in patients with relatively reduced or preserved systolic HF. Studies have shown an association between low BP

Table 2. Analysis of variables with implanted cardioverter defibrillator shocking

Variables			ICD shock		Total	Fisher's exact test
			No	Yes		
Gender	Woman	n (%)	28 (93.3)	2 (6.7)	30 (100)	**p<0.05**
	Male	n (%)	47 (77.0)	14 (23.0)	61 (100)	
Chest pain	No	n (%)	63 (79.7)	16 (20.3)	79 (100)	p>0.05
	Yes	n (%)	12 (100)	0 (0)	12 (100)	
Palpitation	No	n (%)	66 (80.5)	16 (19.5)	82 (100)	p>0.05
	Yes	n (%)	9 (100)	0 (0)	9 (100)	
Dyspnea	No	n (%)	53 (76.8)	16 (23.2)	69 (100)	**p<0.05**
	Yes	n (%)	22 (100)	0 (0)	22 (100)	
Stinging in the chest	No	n (%)	70 (81.4)	16 (18.6)	86 (100)	p>0.05
	Yes	n (%)	5 (100)	0 (0)	5 (100)	
Syncope	No	n (%)	72 (81.8)	16 (18.2)	88 (100)	p>0.05
	Yes	n (%)	3 (100)	0 (0)	3 (100)	
Leakage at the battery place	No	n (%)	74 (82.2)	16 (17.8)	90 (100)	p>0.05
	Yes	n (%)	1 (100)	0 (0)	1 (100)	
Cough	No	n (%)	72 (81.8)	16 (18.2)	88 (100)	p>0.05
	Yes	n (%)	3 (100)	0 (0)	3 (100)	
Headache/dizziness	No	n (%)	71 (81.6)	16 (18.4)	87 (100)	p>0.05
	Yes	n (%)	4 (100)	0 (0)	4 (100)	
Dysarthria	No	n (%)	73 (82.0)	16 (18.0)	89 (100)	p>0.05
	Yes	n (%)	2 (100)	0 (0)	2 (100)	
Other	No	n (%)	67 (80.7)	16 (19.3)	83 (100)	p>0.05
	Yes	n (%)	8 (100)	0 (0)	8 (100)	
Total		n (%)	75 (82.4)	16 (17.6)	91 (100)	

ICD: Implanted cardioverter defibrillator

Table 3. Analysis of additional diseases with ICD shock

Variables			ICD Shock		Total	Fisher's exact test
			No	Yes		
Hypertension	No	n (%)	11 (91.7)	1 (8.3)	12 (100)	p>0.05
	Yes	n (%)	64 (81.0)	15 (19.0)	79 (100)	
Diabetes mellitus	No	n (%)	38 (74.5)	13 (25.5)	51 (100)	**p<0.05**
	Yes	n (%)	37 (92.5)	3 (7.5)	40 (100)	
Coronary artery disease	No	n (%)	18 (75.0)	6 (25.0)	24 (100)	p>0.05
	Yes	n (%)	57 (85.1)	10 (14.9)	67 (100)	
Congestive heart failure	No	n (%)	18 (85.7)	3 (14.3)	21 (100)	p>0.05
	Yes	n (%)	57 (81.4)	13 (18.6)	70 (100)	
Asthma	No	n (%)	74 (82.2)	16 (17.8)	90 (100)	p>0.05
	Yes	n (%)	1 (100)	0 (0)	1 (100)	
Chronic obstructive pulmonary disease	No	n (%)	68 (81.9)	15 (18.1)	83 (100)	p>0.05
	Yes	n (%)	7 (87.5)	1 (12.5)	8 (100)	
Chronic kidney failure/disease	No	n (%)	62 (83.8)	12 (16.2)	74 (100)	p>0.05
	Yes	n (%)	13 (76.5)	4 (23.5)	17 (100)	
Malignancy	No	n (%)	73 (83.0)	15 (17.0)	88 (100)	p>0.05
	Yes	n (%)	1 (66.7)	1 (33.3)	3 (100)	
Other	No	n (%)	60 (81.1)	14 (18.9)	74 (100)	p>0.05
	Yes	n (%)	15 (88.2)	2 (11.8)	17 (100)	
Total		n (%)	75 (82.4)	16 (17.6)	91 (100)	

ICD: Implanted cardioverter defibrillator

Table 4. Analysis of Variables with In-Hospital Mortality

Variables	In-Hospital Mortality	n	Value	p-value
Age	No	32	62.66±14.28	>0.05*
	Yes	6	71.50±8.80	
BMI	No	32	27.43±4.12	>0,05*
	Yes	6	27.99±5.09	
Implantationt time	No	32	1 (1-5)	>0.05#
	Yes	6	3.5 (0-6)	
Fever	No	32	36.3 (36.12-36.5)	>0.05#
	Yes	6	36.15 (36.07-36.3)	
Pulse rate	No	32	81.5 (72.5-102.25)	>0.05#
	Yes	6	83 (73.25-143)	
Systolic blood pressure	No	32	134 (120-154.75)	**<0.05#**
	Yes	6	102.5 (77.5-128.5)	
Diastolic blood pressure	No	32	84.5 (76.25-94.5)	**<0.05#**
	Yes	6	69.5 (55.75-79.25)	
Oxygen saturation	No	32	97 (96-98)	**<0.05#**
	Yes	6	93 (82-95.25)	

Table 4. Continued				
Variables	**In-Hospital Mortality**	**n**	**Value**	**p value**
Glucose	No	32	136.5 (112.75-180.25)	>0.05#
	Yes	6	157.5 (125.5-285.25)	
Hemoglobin	No	32	12.48±2.50	>0.05*
	Yes	6	11.85±2.17	
Sodium	No	32	137 (134-139)	>0.05#
	Yes	6	134 (131.75-142.25)	
Potassium	No	32	4.3 (3.7-4.6)	**<0.05#**
	Yes	6	5.05 (4.5-5.8)	
INR	No	32	1.09 (0.99-1.54)	>0.05#
	Yes	6	1.16 (1.04-1.33)	
Troponin	No	32	29.2 (14.6-129)	>0.05#
	Yes	6	59.25 (42-2865)	

*Student's t-test, #Mann-Whitney U test, INR: International normalized ratio, BMI: Body mass index

Table 5. In-hospital mortality diagnosis of potassium based on receiver operating characteristic analysis					
AUC (95% CI)	**p value**	**Risk factor**	**Cut-off value**	**Sensitivity %**	**Specificity %**
0.786 (0.607-0.966)	<0.05	Potassium	4.50	83.3	59.4
			4.65	66.7	78.1
			4.85	66.7	81.3

AUC: Area under the curve; CI: Confidence interval

and adverse clinical outcomes in patients with HF. BP <120 has been shown to be an independent predictor of morbidity and mortality (17).

In the National Registry of Acute Decompensated Heart Failure study, BP <115 mm Hg was the second-best independent predictor of mortality after renal failure in patients with preserved and reduced left ventricular ejection fraction (LVEF) (18). In another study, BP <110 mm Hg was a predictor of mortality and the need for heart transplantation in patients considering heart transplantation (19). In the Multicenter Automatic Defibrillation Study, BP <100 mm Hg was a predictor of mortality and the need for heart transplantation among patients considering heart transplantation.

The Multicentre Automatic Defibrillator Implantation Trial reported that SBP and DBP levels were inversely associated with sudden cardiac mortality in patients with ischemic left ventricular dysfunction (20). We found that low SBP and DBP were significant predictors of mortality.

In previous studies, weight loss in patients with left bundle branch block treated with cardiac resynchronization therapy with a defibrillator (CRT-D) was associated with a particularly high risk of HF or death. Although being underweight was associated with a higher risk of death and hospitalization, overweight and obese patients were found to have a lower risk of death after CRT-D (21). Another study comparing patients with low and high BMIs with ICDs found that mortality was higher in patients with low BMIs (22). Hsu et al. (23) also found that patients with low BMI and ICDs had higher rates of complications, hospital stay, and mortality compared with those with normal BMI patients. In our study, although our patients were overweight according to BMI, we did not find any significant value in terms of mortality.

Hyperkalemia is the most common electrolyte abnormality, leading to loss of capture. Hyperkalemia causes two important clinical abnormalities in pacemaker patients: First, when the K level exceeds 7 mEq/L, intraventricular conduction velocity is usually decreased, and the QRS complex widens. Second, it increases the atrial and ventricular pacing thresholds (24). Koul et al. (25) reported that hyperkalemia-induced T-wave oversensing leads to the loss of biventricular pacing and inappropriate ICD shocks. Kiamanesh et al. (26) reported that hyperkalemia-induced T-wave oversensing leads to the loss of biventricular pacing and inappropriate ICD shocks. A 33-year-old male patient with dilated cardiomyopathy (EF: 25%) and

end-stage renal disease on hemodialysis and an ICD with a low LVEF, missed a scheduled hemodialysis session and had a serum potassium level of 7.0 mmol/L. It was reported to cause inappropriate shock and ventricular fibrillation. Chua et al. (27) reported that hyperkalemia (9.7 mmol/L) in a patient with an ICD with non-ischemic cardiomyopathy and end-stage renal failure due to hemodialysis caused a large ventricular escape rhythm and T-wave complexes that caused the device to overdetect and fall into the tachycardia detection range, resulting in inappropriate shocks. The patient was placed on emergency dialysis due to a missed hemodialysis session and rapid correction of hyperkalemia. There were no inappropriate shocks after the correction of hyperkalemia. Botrus et al. (28) reported an inappropriate shock due to T-wave oversensing caused by hyperkalemia (7.4 mmol/L) in a patient with ICD. The patient was found to have hyperkalemia due to excessive banana consumption despite regular dialysis, and inappropriate shocks improved after dialysis.

In our study, inappropriate shock was observed in 17.58% of patients. In contrast to other studies, the K value in patients with inappropriate shocks was within the normal range of 4.45 (4.12-4.67). We could not find any reports on the relationship between inappropriate shocks and K value in patients with ICDs in the emergency department. To the best of our knowledge, this is the first study on this topic. The articles in the literature on inappropriate shock are mostly case reports, and K values were found to be higher than our measurements. In these cases, K elevation and rhythm disturbances were observed, and these patients often required urgent dialysis.

Interestingly, in our study, the sensitivity and specificity between serum potassium and mortality were 66.7% and 78.1%, respectively, when the potassium cutoff value was 4.65. Previous studies have reported that hyperkalemia may cause overdetection in ICD patients. In our study, we found that a potassium level >4.65 mEq/L, including normal limits, was significant for mortality. Further multicenter studies with larger numbers of patients are needed to investigate the relationship between K levels and both inappropriate shocks and mortality. Based on the results of our study, we believe that potassium levels should be rapidly detected by blood gas, and appropriate treatment should be initiated if the potassium level is above 4.65.

Study Limitations

The main limitation of this study was that it was conducted in a single center. This resulted in a relatively smaller number of patients compared with larger studies in the literature. The limited number of participating patients made it difficult to obtain statistically significant results. In addition, due to the prospective study design, some patients dropped out of follow-up or refused treatment before the end of the follow-up period and were referred to other healthcare facilities in emergencies, resulting in incomplete and inadequate data. In addition, the inability to contact some patients due to errors in contact information was also a limitation of our study.

Conclusion

We found that the rate of ICD shock in pacemaker/ICD patients presenting to the emergency department was significantly higher among males and patients without DM diagnosis. When a patient with a pacemaker/ICD presents to the emergency department with low sPO_2 and hypotension, more attention should be paid to mortality. We believe that mortality may be higher in patients with potassium levels >4.65. We believe that potassium levels in patients with pacemakers and ICDs could be revised to set a lower limit for hypopotassemia.

Ethics

Ethics Committee Approval: This was a single-center prospective study approved by the Ethics Committee of Health Sciences University, Bursa Faculty of Medicine, Bursa High Specialization Training and Research Hospital (decision no.: 2011-KAEK-25, date: 24.08.2022).

Informed Consent: An informed consent form was obtained from all patients before their inclusion in the study.

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Footnotes

Authorship Contributions

Surgical and Medical Practices: İ.F.Y., M.Y., U.O., Concept: Y.İ., M.Y., M.O.A., Design: İ.F.Y., Y.İ., U.O., Data Collection or Processing: Y.İ., H.K., U.O., Analysis or Interpretation: H.K., M.Y., M.O.A., Literature Search: İ.F.Y., H.K., M.O.A., U.O., Writing: İ.F.Y., Y.İ., U.O.

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Case Report
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Superior Mesenteric Artery Syndrome in Patients with Snake Bites

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Abstract

Superior mesenteric artery (SMA) syndrome is a rare cause of high section intestinal obstruction. SMA syndrome is characterized by compression of the 3rd duodenum segment due to a narrowing of the distance between the SMA and abdominal aorta. The main clinical signs of SMA syndrome are high intestinal obstruction, such as postprandial vomiting, epigastric pain, early abdominal fullness, and indigestion. Abdominal computed tomography plays an important role in diagnosis. There are two main methods of treating SMA syndrome: conservative and surgical treatment. We report a clinical case of a 18-year-old male patient admitted to the hospital because of a Bungarus bite in the second hour. On the 12th day of treatment, the patient developed diarrhea that lasted until the 24th day of treatment. On the 25th day of treatment, the patient lost 16 kg (from 56 down to 40). The patient had symptoms of vomiting after eating, indigestion, and epigastric pain. On abdominal computed tomography, the angle created by the SMA and the abdominal aorta was 17 degrees, and the distance between the two arteries was 3.8 m. Light dilation and stagnation of the D1 and D2 segments of the duodenum with gas and watery levels inside segments D3 and D4 of the duodenum were observed, and this segment was constricted. This patient was diagnosed with SMA syndrome due to Bungarus snake bites. Currently, the patients are treated with intravenous feeding through a jejunal tube to each other. Finally, the patient was discharged and returned to his home on the 45th day of treatment. We reported this clinical case to introduce the clinical and paraclinical signs, diagnoses, and treatment methods for Patients with SMA syndrome.

Keywords: Superior mesenteric artery syndrome, Bungarus snake bites, weight loss

Introduction

Superior mesenteric artery (SMA) syndrome is a rare condition that causes constriction of the third segment of the duodenum because it is clamped between the SMA and abdominal aorta. SMA syndrome was first described by carl freiherr von rokitansky in 1842 and was first published by wilkie; thus, it was also known as wilkie syndrome (1,2). Anatomically, the 3rd segment of the duodenum passes between the SMA and abdominal aorta. The SMA is surrounded by fatty and lymphatic tissue. Normally, the angle between the SMA and aorta is 38-65 degrees, and the distance between these two arteries is usually 10-28 mm. In SMA, the angle between the SMA and the aorta is narrow less than 20 degree, which can potentially cause duodenal compression. SMA syndrome is often found in groups of patients with significant weight loss, such as those with spinal injuries, paraplegia, prolonged bed immobilization, and burns, which will lead to the loss of fat layer of the mesentery, or in groups of patients with abnormal anatomy (congenital or acquired). Clinically, the patient will have symptoms of high intestinal obstruction, which may be acute or gradually progressive (3). Patients with mild obstruction may only experience epigastric pain after meals and early feeling of abdominal fullness, whereas patients with severe obstruction may experience vomiting of bile, epigastric pain, indigestion, and severe weight loss. Abdominal computed tomography is the most important paraclinical test that can be used to diagnose SMA syndrome. On abdominal computed tomography, duodenal obstruction can be observed in segment D3, and the angle between the aorta and SMA is less than 25 degree, And the distance between these two arteries is less than 8 mm (3). There are two main methods to treat SMA syndrome: conservative and surgical. Method of conservative treatment include decompression of the gastrointestinal tract, electrolyte balance, and nutritional support. Nutritional support will provide nutrition through a

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jejunal tube and intravenous nutrition. There are many surgical treatment options for SMA syndrome if conservative treatment is not effective. When the surgical treatment method is indicated for treatment. Surgical treatment consists of strong's surgery, gastrojejunostomy, and anastomosis surgery of the duodenum jejunum. In this clinical case, an 18-year-old male patient was diagnosed with SMA syndrome after bite of Bungarus snakes. This patient had clinical and paraclinical signs that conform with the characteristic of SMA syndrome.

Case Report

An 18-year-old male patient with a strong medical history was admitted to the poison Control Center of Bach Mai Hospital, Hanoi, Vietnam because of a Bungarus snake bite in the second hour with clinical manifestations of ptosis. The pupils of the two besides were dilated 5 mm and did not have a light reflex. Quadrupedal weakness with muscle strength 0 per 5. the patient was treated with an endotracheal tube and mechanical ventilation. From the first day to the eleventh day of treatment, upper limb muscle strength improved from 0 per 5 to 2 per 5 and lower limb muscle strength improved from 0 per 5 to 3 per 5. From the 12th day to 24th of treatment, upper limb muscle strength improved from 2 per 5 to 3 per 5 and lower limb muscle strength improved from 2 per 5 to 4 per 5. The patient presented with diarrhea (up to 10 times per day) at the 12th day of treatment, and his weight dropped from 56 kg (when he admitted to the hospital) to 40 kg at the 24th day of treatment. At the 25th day of treatment, the patient had epigastric pain after eating, vomiting bile, indigestion, and a lot of residual stomach fluid. Clinical signs of the patient who was bitten by Bungarus snake that were improved clearly. When we thought to SMA syndrome and the patient was taken computed tomography of the abdomen with contrast injection, the result of the patient was detected having images of SMA syndrome with angle between the SMA and the abdominal aorta was about 17 degrees, the distance between these two arteries was 3.8 millimeter (Figure 1), mild dilation, fluid retention in the stomach and the D1, D2 segment of duodenum, the D3, D4 segment of duodenum had water and gas inside each other constriction moreover the D3, D4 segment of duodenum didn't have wall thickening or fat infiltration (Figure 2). The patient was treated conservatively with jejunal tube feeding and intravenous nutrition. Currently, on the 38th day of treatment, upper and lower limb muscle strength of the patient was 5 per 5, finished ptosis, and the pupils of the two besides were dilated 4 mm. and did not have a light reflex. The patient was still fed through a jejunal tube with relieved vomiting and epigastric pain, and ate well every meal but weight of the patient still had not improved (from 40 kg down to 38.6 kg). The patient was treated continuously one weak. On the 45th day of treatment, the weight of the patient improved to 41 kg, and the patient was discharged and returned to his house.

Discussion

SMA syndrome is characterized by high-section intestinal obstruction caused by compression of the third segment of the duodenum between the SMA and aorta. The most common risk factor of SMA syndrome is weight loss, but SMA syndrome can also occur in patients with abnormal anatomy (congenital or acquired). The diagnosis of SMA syndrome is difficult because SMA syndrome is rare in clinics, its symptoms do not always correlate well with anatomical abnormalities on radiography, and their symptoms may not be completely resolved after treatment (3,4). Furthermore, the diagnosis of SMA syndrome may be confused with motility disorders of the intestine or

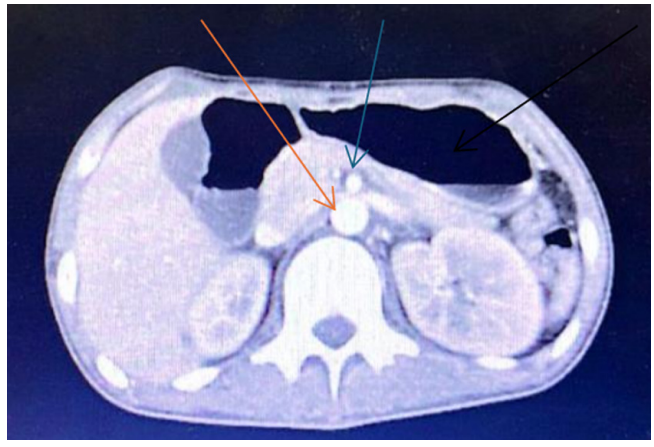

Figure 1. Computed tomography image of the abdomen of superior mesenteric artery syndrome in patient with snake bites

Red Arrow is Abdominal Aorta, Blue Arrow is Superior Mesenteric Artery, Black Arrow is Stomach Dilated

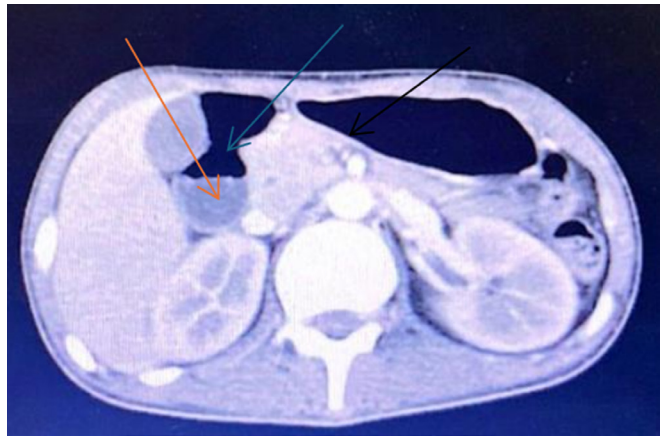

Figure 2. Computed tomography image of the abdomen of superior mesenteric artery syndrome in patient with snake bites

Red Arrow is Abdominal Aorta, Blue Arrow is Superior Mesenteric Artery, Black Arrow is Stomach Dilated

anatomical abnormalities of the duodenum (5). A diagnosis of SMA syndrome is thought and made paraclinical test to definitive diagnosis when the patient has clinical features suggesting high intestinal obstruction and on images of abdominal computed tomography showing narrowing of the angle between the SMA and the aorta and distance between those two arteries. Methods for treating SMA syndrome include conservative or surgical methods. Conservative treatment helps reduce gastrointestinal pressure, correct electrolyte disorders, and provide nutritional support. If conservative method is failure when surgical method is indicated to treatment. There are many different surgical methods for treating SMA syndrome, but currently, there are 3 main methods that consist of the strong method, gastrojejunostomy, and duodenojejunostomy. Our patient had risk factors which can be considered to the SMA syndrome, Such as prolonged bed immobilization, significant weight loss (losing 16 kg in 24 days of treatment), and clinical symptoms were highly suggested of SMA syndrome, such as vomiting bile, severe epigastric pain after eating, indigestion, images of abdominal computed tomography for SMA syndrome, such as angle between the SMA and the abdominal aorta was 17 degrees, the distance between these two arteries was 3.8 mm, and images of water and gas level in segment D1, D2 Of the duodenum, and segments D3 and D4 were constricted (6,7). Currently, the patient is being treated with the conservative method by feeding through a jejunal tube and intravenous nutrition. His clinical condition has improved at the 38th day of treatment, such as relief from vomiting, relief from abdominal pain, and ability to digest every meal. However, the weight of the patient did not improve at this time. It must come to the forty-fifth day of treatment, the weight of the patient was improved to 41 kg, and the patient was discharged and returned home.

Conclusion

SMA syndrome is a rare disease that is difficult to diagnose because its clinical symptoms are non-specific and sometimes do not match those of lesions on imaging (8). Abdominal computed tomography has value in determining diagnosis. Early diagnosis of SMA syndrome will help patients avoid complications, such as electrolyte disorders, gastric perforation, exhaustion, and death. Methods of treatment can include conservative and surgical methods in which the surgical method is considered in the treatment if the conservative method fails.

This is an interesting and the first clinical case of SMA syndrome recorded in a patient who was bitten by a Bungarus snake in vietnam.

Ethics

Informed Consent: Consent form was filled out by all participants.

Footnotes

Authorship Contributions

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

Conflict of Interest: No conflict of interest was declared by the authors.

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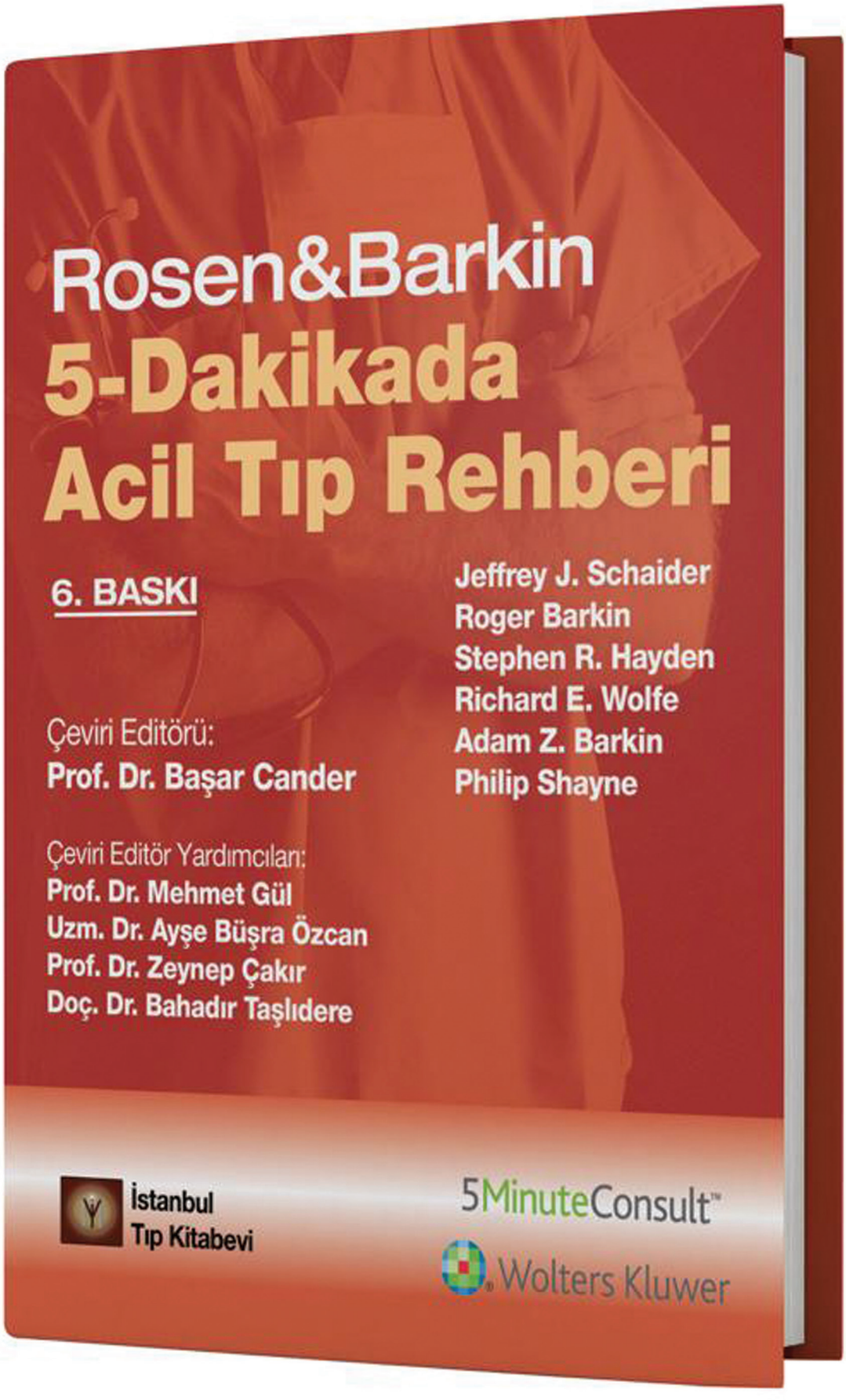
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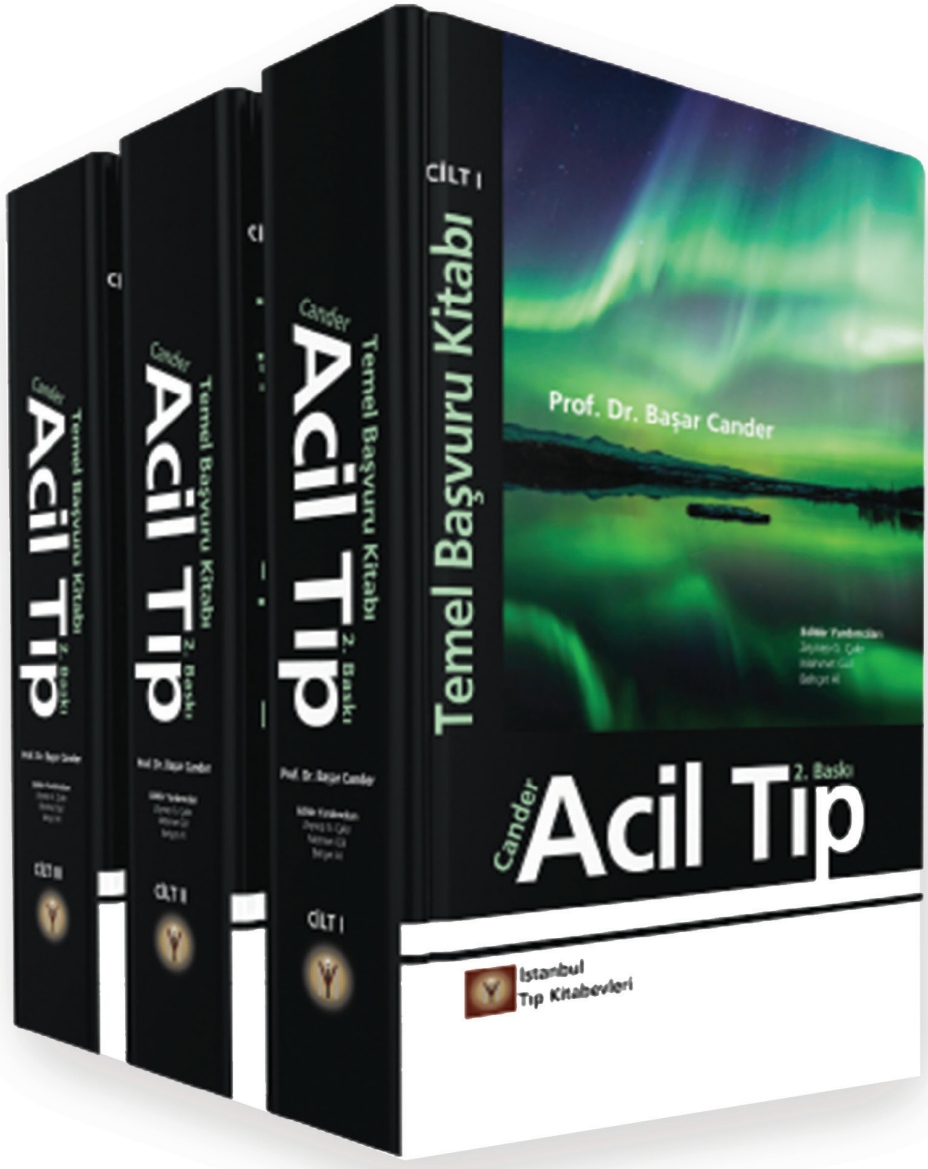

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