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EURASIAN JOURNAL OF EMERGENCY MEDICINE
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Enhancing Prognostic Accuracy in Acute COPD Exacerbations: The Role of DECAF-L and Other Predictive Scores

Sunil Chhajwani

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Keywords: COPD, exacerbation, mortality, prognosis, scoring systems, DECAF-L, emergency department

Chronic obstructive pulmonary disease (COPD) remains a formidable global health challenge, projected to rise as a leading cause of mortality and disability worldwide. Its acute exacerbations (AECOPD) frequently lead to emergency department (ED) visits and hospitalizations, placing a significant burden on healthcare systems (1,2). Accurately predicting patient outcomes, including the need for intensive care, length of hospital stay, and short-term mortality, is paramount for timely intervention and optimal resource allocation in the ED setting.

In response to this critical need, several prognostic scoring systems have been developed to aid clinicians in risk stratification. The BAP-65 score, incorporating parameters such as blood urea nitrogen, altered mental status, pulse rate, and age, serves as an early indicator for predicting the need for mechanical ventilation and mortality risk in acute exacerbations (3). Similarly, the DECAF score, which evaluates dyspnea, eosinopenia, consolidation, acidemia, and atrial fibrillation, has proven its utility in predicting in-hospital mortality among AECOPD patients, demonstrating strong performance over other clinical scores (4,5). These scores offer valuable, readily available insights for emergency physicians and consultation teams in managing COPD patients (6,7).

While these established scores provide foundational insights, the complex pathophysiology of AECOPD, often characterized by hypoxemia and inflammation, suggests the potential for additional, dynamically changing biomarkers. Lactic acid, a byproduct of anaerobic metabolism under hypoxemic conditions, has emerged as a significant prognostic indicator in various acute respiratory conditions, reflecting the severity of tissue hypoperfusion and cellular distress (8,9). Recent research highlights the enhanced predictive power of the DECAF-L score, which integrates blood lactate levels into the DECAF framework. A prospective observational study of patients admitted to the ED with acute COPD exacerbations demonstrated that while BAP-65 and DECAF scores were significantly associated with initial clinical outcomes (discharge, general ward admission, or intensive care unit transfer), the DECAF-L score stood out as the sole independent predictor of 30-day mortality. Patients with higher DECAF-L scores exhibited a significantly increased risk of mortality (odds ratio: 1.296 for each unit increase), with lactate values also being independently higher in deceased patients (study findings).

This finding underscores the clinical utility of incorporating lactate into existing prognostic models. The rapid availability of lactate measurements in the ED, coupled with the straightforward calculation of DECAF-L, makes it an accessible and practical tool. For emergency physicians, a reliable score like DECAF-L can facilitate crucial decisions regarding patient disposition, guiding whether a patient can be safely discharged, requires general ward admission, or necessitates immediate intensive care unit transfer, thereby optimizing patient flow and potentially preventing adverse outcomes, such as repeated admissions or delayed critical care.

Conclusion

The integration of lactate into established prognostic scores like DECAF-L represents a significant advancement in the acute management of AECOPD. While further multi-center validation

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studies are warranted to generalize these findings, the compelling evidence from recent research strongly advocates for the routine assessment and application of DECAF-L in ED patients presenting with acute exacerbations of COPD. Such tools empower clinicians to make more informed and timely decisions, ultimately improving short-term morbidity and mortality for this vulnerable patient population.

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Association between Platelet-to-Lymphocyte Ratio, C-reactive Protein to Albumin Ratio, Red Cell Distribution Width, and APACHE II Score in Predicting Prognosis and Mortality in Sepsis

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Abstract

Aim: Intensive care unit (ICU) provide critical care and treatment to enhance patient outcomes. There is limited data on new scoring systems that predict prognosis during sepsis. The study aimed to assess the prognostic value of platelet-to-lymphocyte ratio (PLR), C-reactive protein to albumin ratio (CAR), red cell distribution width (RDW), acute physiology and chronic health evaluation II (APACHE II) score, and procalcitonin (PCT) in sepsis.

Materials and Methods: This retrospective observational study covered patients diagnosed with sepsis who were admitted to the ICU between January 2018 and April 2023. Clinical data were recorded within 24 hours after ICU admission, including age, sex, comorbidities, APACHE II score and blood test results.

Results: A total of 446 patients were included. The mortality rate at 28 days was 69.7%. Two hundred and forty-six patients were male (55.2%), 200 were female (44.8%) with a mean age of 72 years. Patients were divided into two groups based on their survival status on the twenty-eighth day of ICU stay: survivors (Group 1) and non-survivors (Group 2). There were 131 (31.3%) and 311 (69.7%) patients in Group 1 and Group 2, respectively. We did not observe any statistically significant differences in terms of Glasgow Coma scale, APACHE II score, C-reactive protein, CAR, PLR and RDW values between groups. PCT was significantly higher in Group 2 compared to Group 1 ($p<0.05$), and was found to be a significant predictor of 28-day mortality.

Conclusion: Further studies are needed to determine whether RDW, PLR, and CAR scores can effectively predict prognosis in sepsis.

Keywords: Platelet-to-lymphocyte ratio, C-reactive protein to albumin ratio, red cell distribution width, sepsis

Introduction

Sepsis is a sudden and potentially life-threatening organ dysfunction that poses significant mortality risks, particularly when it is combined with shock and multiorgan failure (1). While the exact mechanisms underlying sepsis remain complex and not completely understood, the disrupted response of the body to infection forms its basis (2). Innovative treatment approaches, as well as timely identification and the utilization of evidence-based treatment protocols, are possibilities for enhancing the outcomes of patients affected by sepsis (3). New dependable, real-time accessible, and practical risk indicators could enhance the management of septic patients by promptly identifying high-risk patients and subgroups. This might facilitate prompt and aggressive treatment, as well as appropriate allocation of intensive care resources (4).

In recent years, various hemogram-derived indices have been suggested for screening and predicting the outcomes of sepsis and bacteremia (5). To enhance screening, assessing these indices in conjunction with established markers of systemic inflammation, including C-reactive protein (CRP), leucocytosis and procalcitonin (PCT), is suggested (6). For better prognostication, these indices could be used alongside established intensive care unit (ICU) scoring systems, such as Simplified Acute Physiology score II (SAPS

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II), Acute Physiology and Chronic Health Evaluation II (APACHE II), and Sequential organ failure assessment (SOFA) (2). Platelet-lymphocyte ratio (PLR), CRP-to-albumin ratio (CAR), and red cell distribution width (RDW) were selected as biomarkers due to their emerging role in assessing the prognosis of sepsis. Unlike traditional markers such as the SOFA score and lactate, which have been extensively utilized for years, these newer biomarkers may provide additional insights into systemic inflammation and immune response dynamics. Their potential to enhance prognostic accuracy and accessibility in clinical practice makes them valuable alternatives in sepsis research.

RDW is traditionally used for the differential diagnosis of anemias. An elevated RDW indicates disrupted erythrocyte homeostasis and impaired erythropoiesis. Abnormal metabolic conditions, including inflammation, oxidative stress, nutritional disorders, and dyslipidemia, have been reported to be associated with RDW values exceeding the upper limit of 14.5% (7). RDW is a noteworthy predictor of mortality for sepsis (4,8) in studies examining the relationship between RDW and sepsis morbidity and mortality. Recently, a meta-analysis on the prognostic role of RDW in sepsis, indicated that patients with increased RDW are more likely to have higher mortality (9).

High levels of CRP, triggered by cytokine stimulation under inflammatory conditions, are linked to poor prognosis and increased mortality. Similarly, low serum albumin levels are known to be associated with increased mortality rates. Likewise, studies examining the CAR in the context of systemic inflammation have shown that this parameter is a significant predictor of prognosis in cases of infection and malignancy (10,11). Furthermore, numerous studies have highlighted the prognostic significance of the PLR in assessing systemic inflammatory responses, showing its ability to represent the intricate interplay between the immune response, coagulation, and inflammation (12).

Nevertheless, the limitations of these researches were geographical and possible publication bias. Hence, more scientific and multicenter trials on the prognostic role of RDW, CAR, PLR in sepsis are still needed. Therefore, this study aimed to evaluate the prognostic value of the RDW, CAR and PLR for predicting the prognosis and mortality sepsis and the feasibility of using any of these parameters with the APACHE II scoring system.

Materials and Methods

Study Design and Setting

This retrospective observational study was performed in the 48-bed Anesthesiology and Reanimation Intensive Care Unit of the Selçuk University Faculty of Medicine. The protocol of this study was approved by the Clinical Research Ethics Committee of Konya Selçuk University (decision number: 2023/261, date: 02.06.2023).

Selection of Patients

The study included patients who were diagnosed with sepsis and admitted to the ICU between January 2018 and April 2023. Sepsis and septic shock patients were grouped within the same cohort. Patients aged <18 years, pregnant or breastfeeding patients, patients admitted with hematological disorders or active bleeding, or who had received blood and blood products during hospitalization before admission to the ICU or within the first three days of admission to the ICU, and had a length of stay of less than 24 hours were excluded from the study. The RDW, PLR, CAR values, and APACHE II scores at ICU admission were recorded. Patients were divided into two groups on the basis of their survival status on the twenty-eighth day of ICU stay: survivors (Group 1) and non-survivors (Group 2). These two groups were comparatively analyzed for factors contributing to differences.

Measurements

Clinical data including age, sex, comorbidities (diabetes mellitus, hypertension, history of cardiac disease, malignancy, chronic obstructive pulmonary disease, chronic renal failure), and clinical outcomes, including in-hospital mortality status and ICU length of stay, were recorded. Laboratory parameters: platelets, neutrophils, lymphocytes, urea, creatinine, CRP, albumin, pH, lactate, PCT, RDW levels, Glasgow Coma scores, APACHE II scores, CAR, PLR were recorded within 24 hours after ICU admission.

Outcome

To determine the relationship between RDW, PLR, CAR, PCT values, APACHE II scores, and sepsis prognosis, the outcome was considered.

Statistical Analysis

All the statistical analyses were performed using the R statistical language, version 4.2.1 (www.r-project.org). To check the normality of the data, Shapiro-Wilk tests and Q-Q plots were used. The Levene test was used to assess the homogeneity of the variances. Numerical variables are presented as the mean ± standard deviation, medians with ranges (minimum-maximum), or medians with interquartile ranges (IQRs, 1st quartile-3rd quartile), as appropriate. Categorical variables are also described as counts (n) and percentages (%). The demographic and clinical characteristics of the survivors and non-survivors are compared via the Mann-Whitney U test, Student's t-test or Welch's t-test for numerical variables, and the Pearson chi-square test or chi-square test with Yates continuity correction for categorical

variables. Two-tailed p-values <0.05 were considered statistically significant.

Results

Of the 649 patients in the study, 21 patients with hematological malignancies, 104 patients who did not survive in the first 24 hours, and 78 patients who received blood or blood products in the first 3 days were excluded from the study. Therefore, the study group consisted of 446 subjects aged between 18-99 years who were followed up in the ICU due to sepsis. With a mean age of 72 years, A total of 246 patients were male (55.2%), and 200 were female (44.8%). There were 131 (31.3%) and 311 (69.7%) patients in Group 1 and Group 2, respectively. There were no significant differences in baseline characteristics such as age, sex, or underlying disease between Group 1 and Group 2 (Table 1).

The mean overall APACHE II score and Glasgow Coma score were 25.51±8.28 and 7.75±4.42, respectively, and there were no significant differences between the groups. The 28-day mortality rate was 69.7% (n=311). Among the laboratory findings, the serum urea [64 (IQR: 43-106 vs. 82 IQR: 48.5-116, p=0.011)] and creatinine [1.12 (IQR: 0.69-1.98)] vs. 1.33 [(IQR: 0.86-2.44), p=0.033] levels were lower in non-survivors than in survivors, whereas the platelet counts [(239 IQR: 165-326.5 vs. 209 IQR: 141-294.5, p=0.044)] were significantly higher in non-survivors than in survivors. CAR and PLR levels were similar between survivors and non-survivors. We also did not observe any statistically significant differences in CRP, albumin, lymphocyte, pH, lactate, or RDW values between the survivors and the non-survivors. The median length of ICU stay was 12 days (range: 2-140 days) for survivors and was 15 days (range: 2-450 days) for non-survivors; however, this difference was not statistically significant.

Discussion

The 28-day mortality rate in our study was 69.7%. This value is slightly higher than that reported in the literature. This difference occurred because our study included patients from a tertiary ICU.

In this retrospective study conducted at a single center, we aimed to assess the clinical utility of the PLR, CAR, and RDW in critically ill sepsis patients. Our findings indicated that these parameters were ineffective in predicting early mortality in this context. Although the PLR, CAR, and RDW proved impractical for prognostication, we found that PCT could serve as a valuable supplement to CRP or the APACHE II score in predicting mortality in sepsis patients.

Sepsis is defined by an abnormal host response to infection, leading to changes in the hemostatic system that affect the quantity and function of white and red blood cells, as well as platelets (2). Numerous studies have identified PLR as a novel inflammatory indicator in various disorders, including cancers, atherosclerosis, and acute kidney injury (13-16). In contrast, a study conducted in Türkiye in 2016 reported no significant difference in the PLR between patients with sepsis and those with septic shock (17). Similarly, in our study, the PLR was not significantly correlated with sepsis prognosis. This finding may be explained by several factors. First, the PLR might not be significant because it was monitored only in the first 24 hours and was not checked later. Second, we categorized patients with sepsis without distinguishing between sepsis and septic shock. If we had reassessed them later and evaluated the PLR after diagnosing septic shock or sepsis, we might have found a significant difference between the groups, which were defined as survivors (Group 1) and non-survivors (Group 2).

Several studies have demonstrated a relationship between CAR, prognosis, and mortality in ICU patients (18-22). Park et al. (18) reported that CAR levels within the first 24 hours of ICU admission were significantly linked to 28-day mortality. An association between higher CAR levels and increased 30-day mortality was reported by Oh et al. (19). Similarly, Kim et al. (20) identified the CAR for 180-day mortality in patients with sepsis and septic shock as an independent risk factor. In a Turkish study, the CAR and neutrophil-to-lymphocyte ratio values were found to be associated with 90-day mortality in ICU patients with acute ischemia (21). Bender et al. (22) also reported a relationship between CAR values and mortality in patients with acute intracranial hemorrhage. In contrast, our study revealed no correlation between CAR values and 28-day ICU mortality. Although elevated CAR levels indicate increased inflammation and protein loss, the literature suggests that the CAR can be a prognostic factor for mortality even in non-infected patients. However, our results do not support this finding. The lack of correlation in our study could be due to the small sample size of ICU patients. Additionally, the sensitivity and specificity for predicting 28-day mortality were inadequate. Ranzani et al. (23) reported that the CAR at discharge was associated with 90-day mortality. Had we conducted our study on the basis of 90-day mortality, we might have obtained significant results.

The potential pathophysiological mechanisms of the close association between RDW and mortality in septic patients are not the focus of this study. Thus, we can only speculate about them on the basis of literature (24). RDW is an indicator of anisocytosis and therefore shows variability in erythrocyte volume (24). A study by Cheng et al. (25) revealed that RDW was associated with increasing age. Dankl et al. (4) reported that, septic patients with elevated RDW appeared to be older. However, the relationship between RDW and mortality persisted regardless of

Table 1. Demographic and clinical characteristics of the study groups				
	Overall (n=446)	**Survivors (n=135)**	**Non-survivors (n=311)**	**p value**
Demographical characteristics				
Age (years)	72 [18-99]	73 [18-97]	71 [18-99]	0.5381
Sex (M/F)	246 (55.2) 200 (44.8)	77 (57) 58 (43)	169 (54.3) 142 (45.7)	0.5992
Comorbidities				
Hypertension	142 (31.8)	43 (31.9)	99 (31.8)	0.9972
Diabetes mellitus	102 (22.9)	27 (20)	75 (24.1)	0.3422
Chronic obstructive pulmonary disease	79 (17.7)	25 (18.5)	54 (17.4)	0.8743
Coronary artery disease	120 (26.9)	35 (25.9)	85 (27.3)	0.7592
Chronic renal failure	42 (9.4)	10 (7.4)	32 (10.3)	0.4353
Malignancy	117 (26.2)	41 (30.4)	76 (24.4)	0.1912
Disease severity scores				
APACHE II	25.51±8.28	26.11±7.90	25.25±8.44	0.3164
GCS	7.75±4.42	7.30±4.33	7.94±4.45	0.1564
Laboratory parameters				
Urea	68 (44-110)	82 (48.5-116)	64 (43-106)	0.0111
Creatinine	1.19 (0.75-2.08)	1.33 (0.86-2.44)	1.12 (0.69-1.98)	0.0331
CRP	104 (39.35-190.75)	114 (40.95-214.5)	98.3 (37.95-185.5)	0.1441
Albumin	2.68±0.69	2.65±0.69	2.70±0.69	0.4334
Platelets	228 (156-319)	209 (141-294.5)	239 (165-326.5)	0.0441
Lymphocyte	1.00 (0.60-1.60)	0.90 (0.50-1.58)	1.00 (0.60-1.60)	0.1051
pH	7.38 (7.31-7.44)	7.38 (7.30-7.44)	7.38 (7.31-7.44)	0.7961
Lactate	2.40 (1.70-3.80)	2.60 (1.85-3.95)	2.40 (1.60-3.80)	0.1031
Procalcitonin	278 (62.3)	95 (70.4)	183 (58.8)	0.0212
RDW	16.60 (15-18.67)	16.70 (15.10-19.05)	16.50 (15-18.60)	0.5511
CAR	42.79 (13.13-75.56)	50.45 (13.82-84.62)	39.05 (12.12-73.38)	0.1251
PLR	221.04 (125.85-379.50)	236 (124.74-352.85)	212.5 (130.33-388.77)	0.9521
The length of ICU stays (days)	13 [2-450]	12 [2-140]	15 [2-450]	0.1451

1 Mann-Whitney U test, 2 Pearson chi-square test, 3 chi-square test with Yates continuity correction, 4 student's t-test, 5 Welch's t-test. Data were expressed as mean ± standard deviation, median with ranges [minimum-maximum] or median with quartiles (1st quartile-3rd quartile), as appropriate.
APACHE II: Acute Physiology And Chronic Health Evaluation II, GCS: Glasgow Coma Score, CRP: C-reactive protein, RDW: Red cell distribution width, CAR: C-reactive protein to albumin ratio, PLR: Platelet-to-lymphocyte ratio, ICU: Intensive care unit

age. Notably, Fontana et al. (26) studied 122 septic patients and reported no correlation between RDW and sepsis prognosis or microcirculatory alterations. In our study, increased RDW were not a predictor of poor outcomes among septic patients. Ju et al. (27) reported that despite a single measurement at admission, serial RDW measurements on the first, fourth, and seventh days, and a continuing increase in RDW values are more effective in the prediction of mortality in aged patients with septic shock. We conducted this study on the basis of single RDW levels at ICU admission, and we might have found a significant difference between the groups if we measured RDW values more than once. Another explanation could be related to patient selection; previous studies usually included consecutive patients admitted for different reasons to the ICU, whereas we considered only septic patients.

PCT is the inactive propeptide of calcitonin, released by C cells of the thyroid gland, hepatocytes, and peripheral monocytes. While PCT demonstrates greater specificity for bacterial infections compared to CRP and other conventional markers, its levels may also be elevated in non-infectious conditions (28). Lee et al. (28) studied presepsin, PCT, and CRP prognostic value in sepsis and found that the prognostic value of presepsin was superior to that of PCT and CRP in patients with sepsis and septic shock. According to Kim et al. (29), PCT appears to have a limited capacity to predict sepsis-related mortality. For diagnosing bloodstream

infections and bacteremia, studies have shown that PCT has a high diagnostic performance (30-32). PCT has been proven more effective than white blood cell and CRP for distinguishing blood contamination from true bloodstream infection in patients with coagulase-negative staphylococci growth in their blood cultures (30). Additionally, two other studies examined the use of PCT to predict bacteremia in patients with community-acquired pneumonia and urinary tract infections (31, 32).

The diagnostic value of CRP and PCT has been evaluated in multiple registries which have yielded results varying. Silvestre et al. (33) investigated the diagnostic and prognostic roles of CRP in a prospective registry involving 158 patients with sepsis and septic shock. Their investigation revealed no association between CRP concentrations on day 1 and sepsis severity. Additionally, higher CRP levels are not associated with ICU mortality (33). In a prospective study of 349 patients, PCT proved to be more effective than CRP in diagnosing septic shock (34). However, neither PCT nor CRP appeared to have a high predictive value for 30-day all-cause mortality in sepsis and septic shock patients (34). The current study confirms that CRP levels have no prognostic significance in patients with sepsis or septic shock, which is in line with the studies mentioned above. In contrast to CRP, we found that the situation was different for PCT, which is a highly sensitive ($p<0.05$) parameter for predicting 28-day mortality from sepsis, in the ICU. Schupp et al. (34) investigated PCT from diagnostic and prognostic points of view in sepsis and reported that PCT has poor predictive value for both aspects. The reasons for these different results can be categorized under two different headings. One is that their study was planned prospectively, and ours was retrospectively. Another observation is that they measured PCT values on different days from ICU admission until the tenth day in the ICU, and they observed that the PCT values decreased even if the sepsis persisted. We measured PCT once at the time of ICU admission. A new study can be planned to include repeated recordings instead of single time-point measurements.

Study Limitations

The potential limitations of our study should be taken into account. First, it had a retrospective design. Second, we did not consider the origin of sepsis. Additionally, we had no data on bacterial cultures, including the rate of positive cultures for each patient and the most common bacteria along with their resistance status. This requires further clarification in future research. Third, there could be bias regarding the influence of multimodal personalized treatment, which comprises antibiotics, adjuvant therapy and source control techniques. The lack of association between the outcome measures and the results may be because the results were dependent on the type of treatment. The final limitation is the number of measurements. This measurement plan may influence our results, as we relied on single-time point measurements rather than multiple time points.

Conclusion

On the basis of the findings of this negative study, we may infer that an elevated PCT could be useful for predicting 28-day mortality in sepsis patients. However, the CAR, PLR, and RDW are not associated with mortality in this specific clinical setting, even when evaluated alongside the APACHE II score.

Ethics

Ethics Committee Approval: This retrospective observational study was performed in the 48-bed Anesthesiology and Reanimation Intensive Care Unit of the Selçuk University Faculty of Medicine. The protocol of this study was approved by the Clinical Research Ethics Committee of Konya Selçuk University (decision number: 2023/261, date: 02.06.2023).

Informed Consent: Retrospective study.

Footnotes

Authorship Contributions

Surgical and Medical Practices: Concept: Y.C., Y.Ş.B., Design: Y.Ş.B., Data Collection or Processing: Y.Ş.B., Analysis or Interpretation: Y.C., Y.Ş.B., Literature Search: Y.Ş.B., Writing: Y.C., Y.Ş.B.

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

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The Relationship between Intra-Abdominal Pressure and Abdominal Perfusion Pressure Measurements with Prognosis in Patients Monitored in Critical Emergency Care

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Abstract

Aim: Intra abdominal hypertension (IAH) and abdominal compartment syndrome have emerged as significant causes of morbidity and mortality in critically ill surgical and medical patients. The prognostic value of elevated intra-abdominal pressure (IAP) has led to its recognition as a near-routine vital parameter in high-risk patients. This study aimed to monitor IAP elevations, low abdominal perfusion pressure (APP), and their clinical implications in patients admitted to emergency critical care units.

Materials and Methods: This study included 89 patients admitted to intensive care units (ICUs), whose IAP was measured using the bladder pressure method. A volume of 25 mL saline was instilled into the bladder, and measurements were taken with the symphysis pubis level as the zero-reference point. Patients were grouped based on IAP values (<12 mmHg and ≥12 mmHg) and APP values (<60 mmHg and ≥60 mmHg). Morbidity outcomes included inotropic support, ventilator dependency, sepsis incidence, SOFA scores, and mortality rates. Statistical analyses were performed.

Results: Among 89 patients, 36 had IAH, and 34 exhibited low APP. Patients with IAH and low APP demonstrated a higher need for inotropic support, increased sepsis incidence, and higher rates of organ failure. A strong association was observed between mortality and low APP, particularly in cases of IAH.

Conclusion: Bladder pressure measurement is a simple and effective method to evaluate IAP in critically ill ICU patients. Elevated IAP and low APP were associated with poorer morbidity and mortality outcomes. IAP measurement should be considered essential for the survival prediction of critically ill patients in future ICU protocols.

Keywords: Intra-abdominal pressure, intra-abdominal hypertension, intensive care unit, critically ill patients, abdominal perfusion pressure

Introduction

The presence of intra-abdominal hypertension (IAH), which results from increased intra-abdominal pressure (IAP) and can progress to abdominal compartment syndrome (ACS), has recently been recognized as a significant cause of morbidity and mortality in critically ill surgical and medical patients (1,2). Elevated IAP leads to pressure-induced organ dysfunction, causing significant impairments in cardiac, pulmonary, renal, gastrointestinal, hepatic, and central nervous system functions. Studies have shown that IAH disrupts venous return to the right side of the heart from the periphery, thereby reducing cardiac output. This reduction results in lower blood pressure, which impairs organ perfusion pressure. The pathophysiological process initiated by regional blood flow disturbances worsens with the development of ACS, ultimately leading to end-organ failure (3,4).

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Therefore, in critically ill patients, such as those in intensive care units (ICUs), IAH and elevated IAP have been identified as independent predictors of multi-organ failure and mortality (5-10). The prognostic significance of IAP necessitates routine measurement of this physiological parameter in at-risk patients. Early measurement of IAP facilitates identification of IAH, enabling comprehensive medical management strategies to reduce elevated IAP, restore end-organ perfusion, and implement timely decompression and physiologically appropriate fascial closures for cases of refractory organ dysfunction. These strategies have been shown to significantly improve patient survival, reduce complications, and optimize resource utilization (11).

Abdominal perfusion pressure (APP), defined as the difference between mean arterial pressure (MAP) and IAP, not only reflects the severity of IAP but also provides insight into its impact on abdominal blood flow. APP has been demonstrated in several studies to be superior to IAP alone in guiding resuscitation targets (12-14).

This study aims to evaluate the clinical implications of routine IAP and APP measurements in patients admitted to the ICU for more than 24 hours, alongside their monitoring practices.

Materials and Methods

This prospective observational study was conducted in the Emergency Medicine Department of Selçuk University Meram Faculty of Medicine Hospital between October 2008 and June 2009, following approval from the local ethics committee (decision number: 2008/209, date: 25.07.2008). Written informed consent was obtained from the patients.

Study Protocol

The study included medical and surgical patients who required intensive care and were monitored in the emergency department with an indwelling urinary catheter for more than 24 hours. Demographic and clinical data such as age, sex, vital signs, mechanical ventilation status, presence of sepsis, use of positive inotropic support, daily SOFA scores, IAP, APP, length of ICU stay, and survival outcomes were recorded on a structured data form. Patients under 18 years of age, pregnant patients, and those with nephrotomies or prior bladder surgeries were excluded from the study.

IAP was measured using the bladder pressure method, which is both practical and widely accepted. A central venous pressure manometer was connected to the tip of the urinary catheter, and 25 mL of sterile saline was instilled into the empty bladder. Measurements were taken in the supine position at the end of expiration, with the symphysis pubis set as the "0" reference point. The pressure readings were recorded in cmH^2O and subsequently converted to mmHg.

IAP measurements commenced within the first hour of admission to the ICU and were repeated every 12 hours until discharge, transfer to another department, or death. For patients with prolonged ICU stays, IAP monitoring was limited to a maximum of seven days. The highest IAP value recorded each day was used for analysis. Patients were categorized into groups based on their IAP (<12 mmHg and ≥12 mmHg) and APP (<60 mmHg and ≥60 mmHg). Simultaneously, MAP was recorded, and APP was calculated using the formula:

APP = MAP - IAP

Statistical Analysis

Data were analyzed using SPSS version 13.0 software. Categorical variables were expressed as n (%), while numerical variables were presented as mean ± standard deviation. Comparisons between groups (IAP <12 mmHg vs. IAP ≥12 mmHg; APP <60 mmHg vs. APP ≥60 mmHg) were performed using the chi-square test for categorical variables, the Mann-Whitney U test for non-normally distributed numerical variables; and the Independent samples t-test for normally distributed numerical variables. A p value of <0.05 was considered statistically significant.

Results

During the study period, 174 patients were admitted to our emergency ICU. Of these, 85 patients were excluded for the following reasons: 48 (56.5%) were discharged or transferred to other departments within 24 hours, 14 (16.5%) were under 18 years of age, 7 (8.2%) were pregnant, 13 (15.3%) did not require a urinary catheter, and 3 (3.5%) had nephrostomy tubes. A total of 89 patients were included in the study, and IAP measurements were completed (Figure 1). The demographic and clinical characteristics of these patients at the time of ICU admission are summarized in Table 1.

The mean age of the patients was 65.7±15.7 years, and 47 patients were male. Upon ICU admission, the SOFA score was 6.83±3.19, the MAP was 79.6±19.7 mmHg, the mean IAP was 9.9±5.7 mmHg, and the APP was 69.5±21.8 mmHg.

Table 1. Demographic and clinical characteristics of patients in intensive care follow-up			
Socio- demographic and general characteristics			**Mean ± SD**
	Age		65.7±15.7
	GKS		11.4±4.6
	SOFA		6.8±3.2
	Gender	Male	47 (52.8)
		Female	42 (47.2)
			n (%)
	Ventilator support		49 (55.1)
	Sepsis status		24 (27.3)
	Patient fate	Ex	34 (41.0)
		Under observation	18 (21.7)
		Transfer to another clinic	31 (37.3)
Clinical evaluations	MAP		79.6±19.7
	IAP-1		9.9±6.1
	IAP-2		9.9±5.7
	APP		69.45±21.8
	Pulse rate		99.12±20.1
	Respiratory rate		23.04±6.3
Pharmaceutical applications			**n (%)**
	Mannitol		18 (20.5)
	Diuretic		23 (26.4)
	Inotrope support		31 (34.8)
Laboratory tests			**Mean ± SD**
	Ph		7.36±0.21
	pO_2 (mmHg)		83.40±36.55
	pCO_2 (mmHg)		36.81±11.68
	SpO_2		89.34±10.48
	HCO_3 (mmol/L)		21.59±7.41
	Urea (mg/dL)		81.47±51.37
	Creatinine (mg/dL)		1.79±1.17
	Hgb (g/dL)		11.06±2.62
	PLT (10^3/µL)		227.91±123.91
			Median (min-max)
	Bilirubin (mg/dL)		1 (0.1-13.5)
	CRP (mg/L)		68 (0-128)

GKS: Glasgow coma scala, SOFA: Sequential organ failure assessment, MAP: Mean arterial pressure, IAP: Intra abdominal pressure, APP: Abdominal perfusion pressure, CRP: C-reactive protein, Hgb: Hemoglobin, PLT: Platelet

At the time of ICU admission, elevated IAP was observed in 22 (25%) of the 89 patients. During follow-up, an additional 14 patients (16%) developed elevated IAP. Of the total 89 patients, 30 (34%) required positive inotropic support, and 49 (53%) required mechanical ventilation. ACS developed in 5 patients (5.6%), 3 of whom died.

Patients were categorized into two groups based on their IAP values: those with IAP ≥12 mmHg and those with IAP <12 mmHg. Comparisons of variables between these groups are presented in Table 2. Additionally, patients were grouped according to APP values (<60 mmHg and ≥60 mmHg), and the results are shown in Table 3.

Among the 36 patients with elevated IAP, 18 (50%) died, whereas 16 (29%) of the 53 patients with normal IAP died (p=0.059, Table 2). When all 89 patients were evaluated based on APP, 34 patients

(38.2%) had APP values below 60 mmHg. Of these 34 patients, 18 (52.9%) died, compared to 16 (29%) deaths among the 55 patients with APP ≥60 mmHg (p=0.02, Table 3).

When IAP and APP were evaluated together, 11 (31%) of the 36 patients with elevated IAP had APP values ≥60 mmHg. Of these 11 patients, 10 (91%) were discharged or transferred to other departments, and only 1 (9%) died. In contrast, among the 25 patients (69%) with elevated IAP and APP <60 mmHg, 15 (60%) died, and 10 (40%) were discharged or transferred (Table 4).

Among the 53 patients with normal IAP and the 44 patients with normal APP (above 60 mmHg), 15 (34%) patients died. In contrast, among the 9 patients with normal IAP but APP below 60 mmHg, 3 (33%) died, while 6 were either discharged or transferred to other clinics (Table 4). Additionally, all 5 patients with low APP (below 60 mmHg for three consecutive days) among the 34 patients with low APP died.

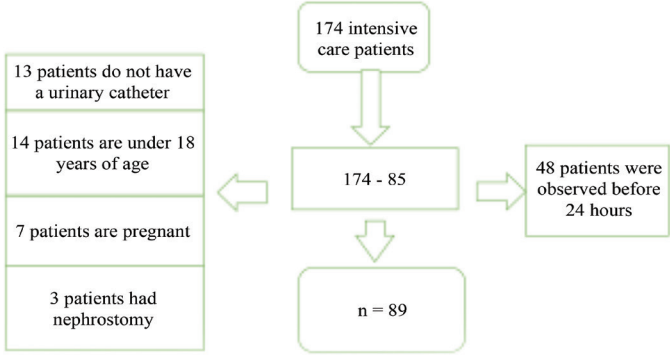

Figure 1. Patient selection scheme for the study

Table 2. Comparison of parameters in patient groups according to IAP ≥12 mmHg (n=36) and IAP <12mmHg (n=53)

	IAP ≥12 mmHg	IAP <12mmHg	p value
	Mean ± SD	Mean ± SD	
Age	69.9±14.6	62.7±15.8	0.032
SOFA, First day	8.06±3.34	6.00±2.84	0.002
MAP, First day	71.9±20.4	84.8±17.6	0.002
	n (%)	n (%)	
APP <60 mmHg	25 (69.4)	9 (17.0)	<0.001
Sepsis	12 (33.3)	11 (21.6)	0.220
Positive inotrope	19 (52.8)	10 (19.6)	0.001
Mechanical ventilation	21 (58.3)	28 (52.8)	0.608
Mortality	18 (50)	16 (30.1)	0.059

SOFA: Sequential organ failure assessment, MAP: Mean arterial pressure, APP: Abdominal perfusion pressure, IAP: Intra abdominal pressure

Discussion

This study demonstrates that elevated IAP and decreased APP are critical parameters for patients admitted to the ICU. The mortality and morbidity of these patients are directly related to these parameters. In patients with IAH and low APP, morbidity was found to be higher, as indicated by the increased need for positive inotropic support, sepsis, and organ failure. Therefore, these patients required more supportive treatment. The measurement of vital parameters, like other important health indicators, is crucial for ICU patients and should be a part of routine monitoring.

In our study group, the incidence of IAH was found to be 40.4% (36/89). While IAH was present in 22 patients at the time of initial ICU admission, 14 developed IAH during follow-up. The data at admission were similar to those of Malbrain et al. (14) prospective multicenter epidemiological study. In that study, the one-day incidence of IAH was found to be 59%. The difference in this rate could be attributed to differences in IAH values. Both in the Malbrain et al. (14), a value greater than 12 mmHg was

Table 3. Comparison of parameters in patient groups according to APP <60mmHg (n=34) and APP ≥60mmHg (n=55)

	APP <60mmHg	APP ≥60mmHg	p value
	Mean ± SD	Mean ± SD	
Age	67.5±15.1	64.5±16.1	0.385
SOFA, first day	8.21±3.29	5.98±2.85	0.001
MAP, first day	62.8±12.9	90.0±15.6	<0.001
	n (%)	n (%)	
IAP ≥12 mmHg	25 (73.5)	11 (20.0)	<0.001
Sepsis	12 (35.3)	11 (20.0)	0.101
Positive inotrope	21 (61.8)	8 (14.5)	<0.001
Mechanical ventilation	23 (67.6)	26 (47.3)	0.048
Mortality	18 (52.9)	16 (29)	0.02

SOFA: Sequential organ failure assessment, MAP: Mean arterial pressure, IAP: Intra abdominal pressure, APP: Abdominal perfusion pressure

Table 4. Mortality or survival status of patients in the IAP and APP groups

		IAP high n (%)	IAP normal n (%)
APP Low	Ex	15 (60)	3 (33.3)
	Survival	10 (40)	6 (66.7)
	Total	25 (100)	9 (100)
APP Normal	Ex	1 (9.1)	15 (34.1)
	Survival	10 (81.9)	29 (65.9)
	Total	11 (100)	44 (100)

IAP: Intra abdominal pressure, APP: Abdominal perfusion pressure

considered IAH for a single measurement. Some studies use average IAP values, whereas most studies use the highest IAP values (15). Some studies use average IAP values, whereas most studies use the highest IAP values. The debate over which value, the average or highest IAP measurement, best reflects the clinical condition, remains. In our study, we used the highest value, which is more widely accepted.

Another critical variable is the APP, which is physiologically advantageous as it indicates the severity of IAH and inadequate organ perfusion. A threshold of 60 mmHg is typically used for APP (16). In our study, 25 out of 36 patients (69%) with elevated IAP had an APP below the critical threshold of 60 mmHg. Among these 25 patients, 15 (60%) died. Additionally, all five patients with APP below 60 mmHg for three consecutive days died. Our results suggest a significant relationship between increased IAP, low APP, and mortality.

Other research indicates that many physicians perform IAP measurements when clinically indicated, with only 27% of them conducting measurements every 4 to 8 hours (17). In our study, measurements were taken every 12 hours for ICU patients. Among the 89 patients, 36 exhibited IAH. Mortality in patients with IAH was 45%, while it was 34% in patients without IAH. These results support the impact of IAH on mortality. Early intervention upon detecting IAH by ICU physicians is vital for improving patient outcomes.

In observational studies, a tight relationship between negative fluid balance and survival has been reported (18, 19). Some studies suggest that early and goal-directed therapy with aggressive fluid resuscitation yields better outcomes in severe sepsis and septic shock (20). In our study, 30 patients received positive inotropic support due to shock. Contrary to the literature, our findings indicated that despite the administration of supportive therapy in cases of elevated IAP, particularly with low APP, there was poor clinical progression and high mortality rates.

The SOFA scores were calculated for the patients under follow-up. In patients monitored after the third day, no significant relationship was found between SOFA scores and outcomes. However, in patients monitored during the first two days, a significant relationship was found between SOFA scores and morbidity, as well as mortality. This may be due to the higher number of patients and the increased mortality rates in the first two days.

There is strong evidence supporting the inclusion of IAP measurement in the classification of vital signs for monitoring. A multicenter study further clarifies the effects of IAP and APP, including comorbid factors (15). In our study, the difference in outcomes between patients who survived and those who died based on IAP and APP measurements was evident. In patients with IAH, mortality was 50%; for those with low APP (below 60 mmHg), it was 53%. These values were higher than the overall ICU mortality rate of 38%.

The literature suggests that APP is numerically superior to other parameters in predicting survival in patients with IAH and ACS. Failure to maintain at least 60 mmHg of APP during the day has been shown to help predict survival in IAH and ACS (21-23).

Study Limitations

There are several limitations in this study. Some measurements may have been influenced by the inability to position the patient, which could have contributed to increased IAP due to head elevation. Continuous IAP monitoring was not feasible, and thus the duration of IAH could not be precisely determined. Furthermore, the relatively small sample size and the single-center design limit the generalizability of the results to all ICU settings.

Conclusion

Our study has shown that nearly half of the patients in the ICU experience increased IAP, and this pressure elevation appears to be a significant predictor of adverse outcomes such as mortality, sepsis, and the need for positive inotropic support. We believe that the identification of increased IAP and decreased APP can be crucial for early intervention. Therefore, it may be beneficial to monitor IAP and APP at regular intervals in intensive care patients to allow for timely preventive measures.

Ethics

Ethics Committee Approval: This prospective observational study was conducted in the Emergency Medicine Department of Selçuk University Meram Faculty of Medicine Hospital between October 2008 and June 2009, following approval from the local ethics committee (decision number: 2008/209, date: 25.07.2008).

Informed Consent: Written informed consent was obtained from the patients.

Footnotes

Author Contributions

Surgical and Medical Practices: O.L.D., E.D., Z.D.D., Concept: O.L.D., A.S.G., B.C., Design: O.L.D., A.S.G., B.C., Data Collection or Processing: O.L.D., E.D., Z.D.D., Analysis or Interpretation: O.L.D., Literature Search: O.L.D., Writing: O.L.D., A.S.G.

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

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Assessing Mortality in Patients with Acute Ischemic Stroke: A Turkish Cohort

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Abstract

Aim: Acute ischemic stroke (AIS) has a high morbidity and mortality. We aimed to investigate the etiologic types, involved vascular territory, and mortality rates of patients with AIS in a Turkish cohort.

Materials and Methods: The archive records of a total of 403 patients with AIS were included retrospectively. Medical histories, neurological examinations, and death dates were collected through the hospital automation system. Based on the clinical data and imaging features, all patients were etiologically categorized according to the the Trial of Org 10172 in Acute Stroke Treatment classification.

Results: The mean age was 72.3±12.4 years, with a slight female predominance at 50.4%. According to the Acute Stroke Treatment classification, the etiologic types of AIS patients were as follows: large-artery atherosclerosis at 50.6%, cardioembolism at 28.3%, small-vessel occlusion at 12.4%, undetermined etiology at 7.2%, and other determined etiology at 1.5%. Compared to the other vascular territories, the middle cerebral artery (MCA) was the most frequently involved territory (45.7%) and also had the highest mortality rate in older patients with AIS ($p<0.001$). When compared to inferior divisions, superior divisional infarctions had higher mortality for both right and left MCA strokes ($p<0.001$). Compared to male patients, female patients had significantly higher mortality rates at 0-30 days for internal cerebral artery stroke ($p=0.048$) and at all time periods for right MCA stroke ($p=0.046$).

Conclusion: We found that advanced age, being female, having right-sided and having superior divisional MCA infarctions were highly related to mortality in patients with AIS.

Keywords: Acute ischemic stroke, female, middle cerebral artery, mortality, TOAST

Introduction

Stroke is the second leading cause of death worldwide and a major cause of disability (1,2). Notably, 63% of stroke cases occur in people under the age of 70, challenging the perception that stroke is primarily a disease of the elderly (3). While stroke rates vary by region, ischemic strokes account for the majority of cases (4).

In more than 20% of patients with acute ischemic stroke (AIS), the underlying etiology remains unknown (1). Because of its high mortality and associated costs, identifying and preventing AIS is critical (5). Prevention is possible because most risk factors can be controlled, even in older adults. Several classification systems have been developed, with the most widely used being the Trial of Org 10172 in Acute Stroke Treatment (TOAST) (6). In this study, we aimed to retrospectively investigate the etiologic types, involved vascular territory, and mortality of patients with AIS in Kırşehir region, known as Central Anatolia.

Materials and Methods

Study Population

In the present study, the archival records of a total of 403 patients, aged between 20 and 85 years, who were admitted to the emergency department and diagnosed with AIS at Kırşehir Training and Research Hospital, Kırşehir, Türkiye between January

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2019 and December 2021 (during the COVID-19 pandemic) were retrospectively reviewed. The study was approved by Kırşehir Training and Research Hospital, Kırşehir Ahi Evran University Faculty of Medicine Local Research Ethics Committee (decision number: 2022-02/19, date: 25.01.2022). Patients with hemorrhagic stroke, patients with transient ischemic attack, and those with missing data were excluded from the study.

Data Collection

Due to the retrospective nature of the study, we did not obtain informed consent from the included patients; most of whom were conservatively managed with antiaggregant and/or anticoagulant therapy. Demographic data included age and sex. Medical history, neurological examination, and date of death were collected through the hospital's automated system.

Cardiac evaluation, including standard 12-lead electrocardiogram (ECG), and transthoracic echocardiography and, if indicated, 24-hour ECG monitoring, was performed to rule out a possible cardiac source of cerebral embolism. Duplex scanning of the carotid and vertebral arteries performed during hospitalization was used to document any stenosis or plaque suggestive of atherothrombotic etiology. Patients with vertebrobasilar stroke were evaluated with computed tomography (CT) angiography of the brain and neck. Admission brain CT and diffusion-weighted magnetic resonance imaging were used to determine the involved vascular territory.

Based on clinical data and imaging features, all patients were etiologically categorized according to the TOAST classification, which included large-artery atherosclerosis, small-vessel occlusion, cardioembolism, other determined etiology, and undetermined etiology (6).

Statistical Analysis

Histograms and q-q plots were examined, and the Kolmogorov-Smirnov test was performed to assess the normality of the data. Values are expressed as frequencies (n) and percentages (%), means and standard deviations, or medians (minimum-maximum). chi-squared analysis was used to determine associations between categorical variables. ANOVA was performed after assessing the normality of the quantitative data. Analyses were performed using SPSS 23.0 (SPSS; Chicago, IL; USA), with $p<0.05$ considered statistically significant.

Results

The demographic and clinical characteristics of the patients with AIS are summarized in Table 1. The mean age of the patients was 72.3±7.4 years and 50.4% were female. The median length of hospital stay was 6 days (2-106). 80.9% of patients had hypertension (HT); 43.7% had diabetes mellitus (DM); 32.3% had previous ischemic stroke; 32.3% had atrial fibrillation (AF); 31.5% had hyperlipidemia (HL); 31.3% were smokers; 30.0% had coronary artery disease; and 13.4% had congestive heart failure (Table 1). In terms of vascular territories, AIS was most common in the middle cerebral artery (MCA) territory with a rate of 45.7%. This was followed by the posterior cerebral artery with 11.4%, the basilar artery with 8.7%, the internal carotid artery (ICA) with 5.9%, the vertebral artery with 5.2%, and the anterior cerebral artery with 2.2%. In addition, 12.9% of patients had multisite infarcts and 8% had watershed infarcts. Mortality rates were 20.6% for 0-30 days, 6.4% for 31-90 days, and 10.4% for 91 days to 1 year (Table 1). According to the TOAST classification, the etiology types of AIS patients were as follows: large-artery atherosclerosis in 50.6%, cardioembolism in 28.3%, small-vessel occlusion in 12.4%, undetermined etiology in 7.2%, and other determined etiology in 1.5%.

Table 1. The demographic and clinical features of the patients with acute ischemic stroke (n=403)

Age	72.3±12.4
Female gender	203 (50.4%)
Length of hospitalization	6 (2-106)
Medical history	
Hypertension	326 (80.9%)
Diabetes mellitus	176 (43.7%)
Hyperlipidemia	127 (31.5%)
Coronary artery disease	121 (30.0%)
Congestive heart failure	54 (13.4%)
Atrial fibrillation	129 (32.0%)
Smoking	126 (31.3%)
Previous ischemic stroke	130 (32.3%)
Involved vascular territory	
Internal carotid artery	24 (5.9%)
Middle cerebral artery	184 (45.7 %)
Anterior cerebral artery	9 (2.2%)
Vertebral artery	21 (5.2%)
Basilar artery	35 (8.7%)
Posterior cerebral artery	46 (11.4%)
Multiple	52 (12.9%)
Watershed	32 (8%)
Mortality rates	
0-30 days	83 (20.6%)
31-90 days	26 (6.4%)
91 days -1 year	42 (10.4%)

Values are expressed as frequencies (n) and percentages (%), means and standard deviations (SD), or medians (minimum and maximum).
SD: Standard deviation

Mortality rates by vascular territory are shown in Table 2. Compared to the other vascular territories, MCA strokes were significantly higher in all mortality groups (p<0.001). Mortality rates in pure MCA strokes are shown in Table 3. Compared to inferior territory infarcts, superior territory infarcts had higher mortality for both right and left MCA strokes (p<0.001). However, mortality rates were similar between right and left MCA total infarctions (p>0.05). Regarding the mortality rates by sex in the different vascular territories, female patients had significantly higher mortality rates within 0 to 30 days for ICA stroke (p=0.048) and in all mortality groups for right MCA stroke (p=0.046) compared to male patients. However, there were no significant differences in other vascular territories (p>0.05).

Discussion

Accumulating data showed that HT, DM, HL, AF, ischemic heart disease, smoking, and previous cerebrovascular events are primary risk factors for AIS (7). Among these, advanced age is the best-defined risk factor (8). In agreement with the literature, we found a mean age of 72.3±7.4 years, which is indicative of vascular aging leading to stenosis (8). In addition, 50.4% of the patients were female, which is consistent with the literature and may indicate the predisposing hormonal factors for thrombosis formation (5). Among the modifiable factors, HT was the most obvious, being present in 80.9% of the patients in our study. This prevalence was significantly higher in all types of stroke, except for the "other determined etiology" group according to the TOAST classification. These findings are similar to those of the Indonesian (83%) and Lebanese (77%) cohorts (9,10). The INTERSTROKE study, which included 32 countries, also highlighted HT as the most prevalent risk factor (11). Effective treatment of HT has been shown to reduce the risk of stroke by 22% (12). DM is another significant risk factor, as demonstrated in our study, with 43.7% of the cohort exhibiting this risk factor. This is consistent with the 48.5% prevalence of DM reported by Harris et al. (9), in their retrospective cross-sectional study. In addition, DM was shown to be an important risk factor for atherothrombotic stroke in the same study. Our study showed a significantly higher frequency of DM in both atherothrombotic and lacunar stroke, which is in agreement with the study by Malek et al. (10). This suggests that poor glycemic control may contribute significantly to the pathogenesis of both large and small vessel disease (13). Another risk factor, HL, was found in 31.5% of the patients, which is consistent with the literature (14). Consistent with the literature, AF is also high (32.3%) in our AIS patients (15). In contrast to the previous report, we found a high prevalence of smoking (50%) in the "other determined etiology" group (10). This finding may be due to the small number of patients in this subgroup.

Based on the TOAST classification, atherothrombotic stroke (50.6%) and cardioembolic stroke (28.3%) were more common than the other types of stroke (in line with the literature) (16). The oldest patients were found among those with cardioembolic stroke, a difference that was statistically significant. This may

Table 2. Mortality rates according to involved vascular territories in patients with acute ischemic stroke (n=403)

Mortality rates	Vascular territory								p value
	Internal carotid artery	Middle cerebral artery	Anterior cerebral artery	Vertebral artery	Basilar artery	Posterior cerebral artery	Multiple	Watershed	
Alive	15 (6.0%)	114 (45.8%)	8 (3.2%)	14 (5.6%)	21(8.4%)	30 (12.0%)	21 (8.4%)	26 (10.4%)	**<0.001**
0-30 days	6 (7.3%)	38 (46.3%)	0 (0.0%)	5 (6.1%)	10 (12.2%)	8 (9.8%)	12 (14.6%)	3 (3.7%)	**<0.001**
31-90 days	3 (11.5%)	12 (46.2%)	1 (3.8%)	1 (3.8%)	1 (3.8%)	2 (7.7%)	6 (23.1%)	0 (0.0%)	**<0.001**
91 days-1 year	0 (0.0%)	20 (54.1%)	0 (0.0%)	1 (2.7%)	3 (8.1%)	6 (16.2%)	4 (10.8%)	3 (8.1%)	**<0.001**

Values are expressed as frequencies (n) and percentages (%)

Table 3. Mortality rates in patients with acute ischemic stroke involving pure middle cerebral artery (n=127)

Middle cerebral artery territory	Mortality rates					p value
		Alive	0-30 days	31-90 days	91 days-1 year	
Left MCA	Superior division	17 (36.2%)	4 (40.0%)	2 (66.7%)	0 (0.0%)	**<0.001**
	Inferior division	30 (63.8%)	6 (60.0%)	1 (33.3%)	4 (100.0%)	**<0.001**
Right MCA	Superior division	21 (34.4%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	**<0.001**
	Inferior division	40 (65.6%)	0 (0.0%)	0 (0.0%)	2 (100.0%)	**<0.001**

Values are expressed as frequencies (n) and percentages (%). MCA: Middle cerebral artery

be related to the increasing prevalence of AF with age, as shown in a Norwegian (15). In addition, the young patients were predominantly of "other determined etiology," which is consistent with the literature (17). Moreover, the female gender was most common in the cardioembolic stroke group, but this difference was not statistically significant. Regarding survival times, patients with lacunar stroke had the highest survival rate, which is consistent with the study by Hauer et al. (13).

It is well known that more than half of AIS occurs in the MCA territory (18). Similarly, we observed a higher frequency of MCA strokes, especially on the left side, compared to the other territories. Previous data showed that the mortality rate of untreated patients with malignant MCA infarction can reach 80% (19). Consistent with this, we had a higher mortality rate for stroke than in other territories. Further analysis revealed that superior division infarcts were more lethal than inferior division infarcts in both right and left MCA strokes. Similarly, Seker et al. (20) found that upper division strokes had a worse outcome than lower division strokes despite similar recanalization and complication rates. However, the mortality rates were similar for total occlusion of either the right or left side, supporting a previous study by Mateo et al. (21) showing that the side of MCA infarction does not affect mortality during the initial hospitalization period for AIS. On the contrary, a long-term study (up to 10 years) by Aszalós et al. (22) showed a higher but not significant mortality rate in right MCA strokes compared to the control group. Naess et al. (23) and Hedna et al. (24) also showed that left cerebral hemisphere infarcts and left MCA strokes were more frequent and associated with higher mortality. female patients had a higher mortality rate than males for ICA and right MCA strokes. This may be because our female patients had a higher prevalence of comorbidities, which may have led to a higher risk of adverse outcomes (data not shown). Similarly, a very recent multicenter study by Wang et al. (25) showed that women with AIS in China tended to have a poor prognosis at 3 months compared with men. However, studies on sex-specific mortality in patients with AIS are controversial. For example, a German study showed that female patients had better functional outcomes at discharge, which may be related to differences in risk factors between populations (25,26). Overall, our mortality rates for all stroke subtypes were higher than those reported in the literature, which may be attributed to the underuse of definitive treatment options such as thrombolysis or thrombectomy, in acute cases complicated by the COVID-19 pandemic (25-27). Multiple studies have dominantly documented the overexpression of cytokines, hypercoagulable state, and thromboembolism as potential factors leading to stroke. However, the exact relationship between COVID-19 and ischemic stroke is unclear (28).

Study Limitations

This study has several limitations. First, it was retrospective, which may result in missing data that could potentially alter the results. Second, multiple pathologies were included in the "undetermined etiology" subgroup, which may affect the significance of other stroke subtypes. Third, this study was conducted during the COVID-19 pandemic, so the decrease and/or delay in hospital admissions, quarantine period, and high infection rates may have combined to affect our results.

Conclusion

The present study demonstrated that the majority of AIS occur in the MCA territory. The mortality rate for MCA strokes is higher than other vascular territories. Patients with occlusion of the upper branch of the MCA have a higher mortality rate compared to those with occlusion in the lower branch. Female patients with AIS in the ICA and right MCA territories were more likely to have a poor prognosis. This small cohort study needs to be further validated in a multicenter study population.

Ethics

Ethics Committee Approval: The study was approved by Kırşehir Training and Research Hospital Kırşehir Ahi Evran University Faculty of Medicine Local Research Ethics Committee (decision number: 2022-02/19, date: 25.01.2022).

Informed Consent: Due to the retrospective nature of the study, we did not obtain informed consent from the included patients; most of whom were conservatively managed with antiaggregant and/or anticoagulant therapy.

Footnotes

Authorship Contributions

Surgical and Medical Practices: O.J., Concept: O.J., Design: H.M.C., A.C., Data Collection or Processing: O.J., H.M.C., Analysis or Interpretation: O.J., H.M.C., A.C., Literature Search: O.J., A.C., Writing: O.J., A.C.

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

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The Role of Scoring in Predicting Mortality and Morbidity in Patients with Chronic Obstructive Pulmonary Disease

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Abstract

Aim: In this study, we aimed to determine the role of BAP-65, DECAF and DECAF-L scores in predicting morbidity and mortality in chronic obstructive pulmonary disease patients. These scores offer a potential standardized approach for evaluating chronic obstructive pulmonary disease (COPD) exacerbations in the emergency department.

Materials and Methods: This is a prospective observational study including COPD patients admitted to the emergency department. BAP-65, DECAF and DECAF-L scores were calculated. Initial outcomes including discharge, hospitalization or transfer to the intensive care unit, 30-day readmission and 30-day mortality were recorded.

Results: A total of 200 patients were included. BAP-65, DECAF and DECAF-L scores were significantly associated with the type of initial outcomes (discharge, hospital admission, or intensive care unit admission) and ($p<0.001$ for each). Lactate values were higher in deceased patients than in survived patients ($p=0.004$). When the lactate value increased by 1 unit, the risk of 30-day mortality increased by 35.8%. A significant difference was found between 30-day mortality and the DECAF-L score obtained by adding lactate to the DECAF score (area under the curve=0.653; $p=0.039$). This risk increased by 29.6% when the DECAF-L value increased by 1 unit.

Conclusion: Increasing the use of BAP-65, DECAF, and DECAF-L scores in the decision for discharge or hospitalization in COPD patients admitted to emergency departments will provide great convenience. In addition, we believe that it would be beneficial to increase the use of the DECAF-L score, which was found to be effective in predicting mortality in emergency departments.

Keywords: BAP-65, COPD, DECAF, DECAF-L, morbidity, mortality

Introduction

Chronic obstructive pulmonary disease (COPD) is a common and significant public health problem world-wide, with high mortality and morbidity. It is a preventable disease that occurs with air confinement due to airway obstruction, alveolar damage, airway collapse caused by damage to the small airways, and increased respiratory effort (1).

According to the World Health Organization, COPD is the third most common cause of death. Approximately 3 million people have died from COPD world-wide each year (2). In Türkiye, COPD is the fourth most common cause of death. The increase in the incidence of COPD leads to increases in hospital admissions, medical drug use, and costs (3).

COPD is a disease that progresses with exacerbations, clinically characterized by shortness of breath, cough, and increased sputum purulence (4). In adults with risk factors and long-term respiratory system symptoms, COPD is diagnosed by spirometric examination with FEV1/FVC <70% after bronchodilator treatment. Risk factors for COPD include genetic factors, age, sex, use of tobacco and tobacco products, air pollution, atopy, asthma, chronic bronchitis, infections, and low socioeconomic status (5). The main treatment approaches for COPD are bronchodilators, inhaled corticosteroids, antibiotics, and respiratory support treatments.

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In the management of COPD patients, biomarkers are needed to predict mortality, and to decide early whether discharge and palliative care are necessary. However, such markers that can determine hospital stay duration and patient mortality are limited.

The BAP-65 score consists of four parameters: blood urea nitrogen (BUN>25 mg/L), mental status change, pulse rate (>109 beats/minute), and patient age (≥65 years). The BAP-65 scoring system determines the need for mechanical ventilation and predicts the risk of in-hospital mortality and length of stay (6).

The DECAF score was developed to predict the risk of in-hospital mortality in COPD exacerbation. DECAF consists of five parameters: dyspnea, eosinopenia, consolidation, acidemia, and atrial fibrillation. The DECAF score is a simple risk score that can be applied at the bedside using the indices available in the emergency department and during hospitalization (7).

Lactic acid is a product of intracellular anaerobic respiration mechanisms, occurring due to hypoxemia associated with airway pathologies. DECAF-L scoring is obtained by adding the blood lactate value to the DECAF score. When the existing literature was examined, a limited number of studies were found using the DECAF-L score.

In our study, we aimed to determine BAP-65, DECAF, and DECAF-L scores for predicting patient outcomes and the 30-day mortality in patients diagnosed with COPD who were admitted to the emergency department with shortness of breath.

Materials and Methods

The prospective observational study included patients with COPD who presented for shortness of breath, at the Emergency Department of the Manisa Celal Bayar University Faculty of Medicine Hospital between May 1, 2022 and May 1, 2023. Written consent was obtained from Manisa Celal Bayar University Faculty of Medicine Ethics Committee (decision number: E-20478486-050.04.04-358705, date: 20.07.2022). Informed consent was obtained from the participants in the study.

All adult patients (≥18 years old) with COPD confirmed by spirometry were included in this study. Patients with coronavirus disease-2019 and pregnant women were excluded.

Age, gender, fever, pulse, systolic and diastolic pressures, respiratory rates, glasgow coma scale values, and peripheral capillary oxygen saturation measurements were recorded in the patients' follow-up charts. Hemogram, biochemical, and blood gas tests taken from the patients at the first admission were recorded. In addition, electrocardiograms were evaluated, and atrial fibrillation (AF) was recorded. The presence of consolidation areas was assessed in the radiological imaging of the patients.

After the follow-up of the patients in the emergency department, the following were recorded: the diagnosis, type of initial outcomes (e.g., discharge, hospitalization, and intensive care unit transfer), the 30-day mortality, the length of hospital stay in the emergency department, intubation status, and the 30-day readmission were recorded.

Statistical Analysis

Statistical analyses were performed using the SPSS program (IBM SPSS Statistics 27). For the variables with normal distribution, the Independent sample t-test (t-table value) was used to compare the two independent groups. For the variables that are not normally distributed, the Mann-Whitney U test (z-table value) was used to compare two independent groups, and the Kruskal-Wallis H test (x^2-table value) was used to compare three or more independent groups. Pearson's chi-squared cross-tabulations were used to examine the relationships of two qualitative variables. Binary logistic regression: the Backward LR model was used to examine the factors affecting the 30-day mortality. ROC curves were used to evaluate the significant variables in predicting the 30-day mortality.

Results

A total of 200 patients with COPD were included in the study. Of those, the mean age was 70.69±9.42 years, and 73% were male. AF was present in 27 patients (13.5%). Community-acquired pneumonia was diagnosed in 94 patients (47.0%). When the types of initial outcomes in the emergency department were examined: of the 200 patients, 37.5% (n=75) were admitted to the general wards, 33% (n=66) were admitted to the intensive care unit, and 29.5% (n=59) were discharged from the emergency department. The mean length of hospital stay in the emergency department was 4.29±1.34 hours.

BAP-65, DECAF, and DECAF-L scores were significantly associated with the type of initial outcomes (discharge, hospital admission, or intensive care unit admission) (χ^2=26.685, p<0.001; χ^2=82.793, p<0.001; χ^2=91.701, p<0.001). Significant differences were found between patients transferred to the intensive care unit and those patients hospitalized in general wards and discharged. BAP-65, DECAF, and DECAF-L values of hospitalized patients in the intensive care unit were significantly higher than those in general wards and those of discharged patients. Likewise, a significant difference was found between discharged patients and patients hospitalized in general wards. BAP-65, DECAF, and DECAF-L values were significantly higher in hospitalized patients than in discharged patients (Table 1).

BAP-65, DECAF, dyspnea scale, and severity of exacerbation were not associated with 30-day mortality (all p value >0.05). DECAF-L score was associated with 30-day mortality (z=-2.067; p=0.039). DECAF-L score was higher in deceased patients than in survivors (Table 2).

According to the results of Backward logistic regression analysis, including significant parameters in the univariate analysis, the DECAF-L value was the only independent parameter affecting risk of 30-day mortality (p<0.05). When the DECAF-L value increased by 1 unit, the risk of mortality increased by 29.6% (odds ratio=1.296) (Table 3).

Discussion

COPD is one of the leading causes of mortality and morbidity world-wide. Many studies are conducted world-wide to detect COPD early, implement preventive measures, reduce exacerbation

Table 1. Comparison of quantitative characteristics according to the outcome pattern

Outcome variable	Hospital admission (n=75)		Intensive care unit transfer (n=66)		Discharge (n=59)		Statistical analysis* Probability
	Mean±SD	Median [IQR]	Mean±SD	Median [IQR]	Mean±SD	Median [IQR]	
BAP-65	1.52±0.76	2.0 [1.0]	2.12±1.10	2.0 [2.0]	1.18±0.84	1.0 [1.0]	χ^2=26,685 p<0.001 [2-1.3] [1-3]
DECAF	2.37±1.07	2.0 [1.0]	3.26±1.19	3.0 [1.0]	1.00±1.00	1.0 [2.0]	χ^2=82,793 p<0.001 [2-1.3] [1-3]
DECAF-L	2.77±1.32	3.0 [1.0]	4.03±1.59	4.0 [2.0]	1.08±1.10	1.0 [2.0]	χ^2=91,701 p<0.001 [2-1.3] [1-3]

*BAP-65: Blood urea nitrogen (BUN>25 mg/L), mental status change, pulse rate (>109 beats/minute) and patient age (≥65 years). DECAF: Dyspnea, eosinopenia (<0.05×10⁹/L), consolidation, acidemia (pH <7.30) and atrial fibrillation. DECAF-L: Dyspnea, eosinopenia (<0.05×10⁹/L), consolidation, acidemia (pH <7.30), atrial fibrillation and blood lactate value. *Kruskal-Wallis H test (χ^2-table value) statistics were used to compare the measurement values of three or more independent groups in data that did not have a normal distribution. IQR: Interquantile range, SD: Standard deviation

Table 2. Comparison of quantitative characteristics according to the 30-day mortality

Variable	Deceased (n=16)		Survived (n=184)		Statistical analysis* Probability
	Mean±SD	Median [IQR]	Mean±SD	Median [IQR]	
BAP-65	1.81±0.83	2.0 [1.0]	1.60±0.99	2.0 [1.0]	z=-1.025 p=0.305
DECAF	2.69±1.35	3.0 [2.0]	2.22±1.41	2.0 [2.0]	z=-1.572 p=0.116
DECAF -L	3.50±1.71	3.5 [2.8]	2.62±1.78	3.0 [3.0]	z=-2.067 p=0.039

*BAP-65: Blood urea nitrogen (BUN>25 mg/L), mental status change, pulse rate (>109 beats/minute) and patient age (≥65 years). DECAF: Dyspnea, eosinopenia (<0.05×10⁹/L), consolidation, acidemia (pH <7.30) and atrial fibrillation. DECAF-L: Dyspnea, eosinopenia (<0.05×10⁹/L), consolidation, acidemia (pH <7.30), atrial fibrillation and blood lactate value. *In the normally distributed data, Independent sample t-test (t-table value) statistics were used to compare the measurement values of the two independent groups. Mann-Whitney U test (z-table value) statistics were used to compare the measurement values of two independent groups in the data without normal distribution. IQR: Inter quantile range, SD: Standard deviation

Table 3. Logistic regression model based on exitus in the last 1 month

Variable	β	SE	Wald-χ^2	df	p value	OR	95% Confidence interval (OR)	
							Under	Top
DECAF-L	0.260	0.139	3.470	1	0.042	1.296	1.110	1.704
Lactate	0.306	0.117	6.819	1	0.009	1.358	1.079	1.709
Constant	-3.233	0.543	35,516	1	<0.001	0.039		
CCR=92.0% $\chi 2_{(8)}$=8.593; p=0.474 Hosmer-lemeshow test								

CCR: Correct classification rate, DECAF-L: Dyspnea, eosinopenia (<0,05×10⁹/L), consolidation, acidemia (pH <7.30), atrial fibrillation and blood lactate value, Df: Degrees of freedom, OR: Odds ratio, SE: Standard error, β: Beta coefficient

frequency, preserve lung capacity to enhance quality of life, decrease hospital admissions, and prevent deaths. There are few studies evaluating the prognosis in patients hospitalized with the diagnosis of the exacerbation of COPD (8). In our study, we investigated the performance of BAP-65, DECAF, and DECAF-L scores to predict short-term morbidity and mortality of patients with COPD who were admitted to the emergency department with shortness of breath.

Advanced age is a well-known risk factor for COPD. With age, COPD-like changes are seen in the lung parenchyma and airways (GOLD2024). In our study, the mean age was 70.69±9.42 years, and 73% were male. Our results are similar to those in the literature (9,10).

BAP-65 and DECAF scores have been used to show the prognosis in patients presenting with acute exacerbation of COPD (11, 12). Steer et al. (7) conducted a study in 2012 involving 920 patients to determine the prognosis of patients hospitalized with COPD exacerbation complicated by pneumonia. Therefore, the researchers developed the DECAF score. They demonstrated that the DECAF score showed an outstanding performance in predicting mortality (area under the receiver operating characteristic curve=0.86, 95% confidence interval=0.82 to 0.89), and this score outperformed other clinical scores. The meta-analysis of Shen et al. (12), published in 2021, was the first large-scale study using the DECAF score in the evaluation of mortality in patients with COPD exacerbation. Sangwan et al. (13) showed that the DECAF and BAP-65 scores were important predictors for mortality in patients hospitalized with COPD exacerbation. The sensitivity of both scores was 100%. Specificity was 34.1% in the DECAF score and 63.4% in the BAP-65 score.

In our study, we found significant relationships between the type of initial outcome and BAP-65 ($p<0.001$) and DECAF scores ($p<0.001$) in patients admitted to the emergency department with COPD exacerbation, in accordance with the literature. We found that patients with high BAP-65 or DECAF scores were more likely to be hospitalized in general wards or transferred to the intensive care unit compared to those with lower BAP-65 or DECAF scores. We believe that these scores can be beneficial for emergency room physicians and consultation physicians in managing patients with COPD.

There are a limited number of studies on the DECAF-L score in the literature. In our study, we evaluated scores and some blood parameters that may be effective in predicting morbidity and mortality in COPD patients. In these patients, we assessed the levels of lactic acid, which is produced resulting from the intracellular anaerobic respiratory mechanism due to hypoxemia caused by airway pathologies. Seker et al. (14) examined the blood lactate value to predict mortality in COPD patients admitted to the emergency department. The blood lactate level was significantly higher in patients who did not survive. Villanueva Rábano et al. (15) emphasized that NEWS2-L, a novel score created by adding lactate to NEWS2, had better performance than NEWS2 and lactate separately in predicting mortality in the emergency department. Chen and Li (16) examined 1641 pneumonia patients admitted to the emergency department and reported that blood lactate level was superior to CURB-65 in predicting mortality, admission to the general ward, and transfer to the intensive care unit. They also reported that the LAC-CURB-65 score with the addition of lactate significantly improved the performance of CURB-65 in predicting mortality.

In our study, a significant difference was found between blood lactate values of patients who died within 30 days, those who survived ($p=0.004$). In addition, a significant relationship was found between the 30-day mortality and the DECAF-L score, obtained by adding the lactate value to the DECAF, ($p=0.039$). In addition, we found the DECAF-L score was associated with the decision for discharge or hospitalization ($p<0.001$).

Study Limitations

A limitation of our study is that it was conducted in a single-center setting. Therefore, our results are open to regional differences.

In addition, some patients could not be hospitalized due to limited bed capacity in the Chest Diseases unit. These patients were treated in the emergency room and discharged. However, this may cause repeated admissions of patients in a short time, an increase in the number of intensive care unit admissions, and deaths.

Conclusion

Considering the density of patients in emergency departments, it is extremely important for emergency room physicians to evaluate and make appropriate decisions quickly and effectively. The most important result of our study is the utility of BAP-65, DECAF, and DECAF-L scores to predict morbidity and mortality in patients admitted to the emergency department with exacerbation of COPD. However, among these scores, the DECAF-L score, created by adding the lactate value, was found to be superior in predicting morbidity and mortality. For this reason, we recommend the use of the DECAF-L score in COPD patients admitted to the emergency department.

Ethics

Ethics Committee Approval: Written consent was obtained from Manisa Celal Bayar University Faculty of Medicine Ethics Committee (decision number: E-20478486-050.04.04-358705, date: 20.07.2022).

Informed Consent: Informed consent was obtained from the participants in the study.

Footnotes

Authorship Contributions

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

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

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Evaluation of First Aid Knowledge Levels of Elementary Teacher Education Students at a Public University in İstanbul

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Abstract

Aim: Children are prone to unexpected accidents and injuries, making emergency preparedness essential in schools. Elementary teachers must be skilled in first aid. This study aims to evaluate first aid knowledge and raise awareness among students in an elementary teacher education program at a public university in İstanbul.

Materials and Methods: This cross-sectional study targeted 200 students of second-, third-, and fourth-year in the elementary teacher education program at a public university during the 2023-2024 academic year. Surveys included questions on sociodemographic factors and the First Aid Knowledge Level scale (FAKLS), scored from 0 to 46, with scores ≥40 indicating adequate knowledge. Data analysis employed Jamovi software, with a significance level of 0.05.

Results: Of the 174 students participating in the study, 76.4% (n=133) were female with a median age of 22 years. 11.6% (n=20) had a family member in the healthcare field, and 31.0% (n=54) had prior first aid training. Based on the FAKLS, 98.3% (n=171) had insufficient first aid knowledge. Second-year students scored significantly higher on the FAKLS than those in other years (p=0.018), and students with a family member in healthcare also performed better (p=0.006). Students who hesitated about performing first aid had significantly higher FAKLS scores than those who did not hesitate (p=0.030).

Conclusion: This study highlights the insufficient first aid knowledge among elementary teacher education students. To address this, it is recommended that first aid training be systematically planned, ongoing, and practice-oriented, and that it be incorporated into university curricula.

Keywords: First aid knowledge level, elementary teacher education students, teacher candidates, first aid knowledge

Introduction

First aid is defined as practices performed to saving life or preventing the situation from worsening in case of an accident or life-threatening situation until the help of medical personnel is provided (1). It is important that all members of the society can perform these interventions correctly, regardless of whether they have received health education or not (2). Every individual encounter situation that suddenly require first aid throughout their life, and they should be knowledgeable and prepared for these situations. First aid knowledge enables quick and effective intervention in unexpected situations. First aid knowledge provides the ability to protect not only one's own safety but also the health of those around them. Providing first aid in a timely and effective manner can prevent further harm and death. Therefore, learning and frequently updating first aid skills contributes to each individual's ability to create a safer environment in society. In learning first aid information, one should learn what not to do, as well as what to do (3). The person administering first aid can also save lives by preventing things that should not be done during an accident.

Elementary teachers play a critical role in the education and development processes of students. Teachers are responsible not

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only for the academic success of students, but also for their safety. Children may encounter unexpected accidents and injuries more often than adults. Considering that students spend a significant amount of their time in school, there is always the possibility of unexpected situations arising in the school environment (4). Therefore, teachers who care for children should be prepared and experienced for all kinds of emergency situations such as accidents, injuries, and poisoning (5). Children may encounter unexpected accidents and injuries more often than adults. According to 2021 data from the Turkish Statistical Institute, deaths due to external injuries and poisonings between the ages of 5-14 constitute 20.2% of all deaths (6). In this context, it is vital that teachers, especially elementary teachers, who spend a significant amount of time with students, apply first aid interventions correctly. In addition, teachers' lack of current first aid knowledge may lead to incorrect first aid practices being administered to students, resulting in possible adverse outcomes. Therefore, it is extremely important for teachers to know proper first aid interventions (7).

The aim of this study is to evaluate the first aid knowledge levels of students studying at Marmara University Atatürk Faculty of Education, Department of Elementary Teacher Education, to raise awareness among students, and to encourage them to intervene in case of emergency.

Materials and Methods

Type of Research

This is a cross-sectional study. The approval from Marmara University Faculty of Medicine Ethics Committee was obtained with the (decision number: 2023/09/08.12/1632, date: 08.12.2023) and permission was granted by the Department of Elementary Teacher Education with the decision number: 2024/01/05/703816. The study was conducted in accordance with the principles of the Helsinki Declaration.

Sample

The population of the research consists of 450 students studying in all classes at a public university; department of elementary teacher education, in İstanbul, Türkiye, during the 2023-2024 academic year. First-grade students, who were considered to lack a developed awareness of elementary teacher education, were excluded from the study. All second, third, and fourth-grade students (n=250) were invited to participate, and 69.6% of the sample (n=174) was reached. While the sample size was 208, 174 data was collected because the administration of the survey coincided with the exam week, and the students were busy working.

Data Collection

After obtaining written consent from the participants, data were collected through a survey conducted under observation voluntarily between 10-16 January 2024. The first part of the survey consists of questions about sociodemographic characteristics (age, gender) and related factors that may affect the level of first aid knowledge. These factors include receiving first aid training, the perceived usefulness of the training received, the possession of a first aid certificate approved by the Ministry of Health, and past situations where first aid was needed. The second part of the survey includes the First Aid Knowledge Level scale (FAKLS) (8). The scale consists of 23 propositions with two sub-dimensions. Two propositions (7 and 22) present conflicting arguments. The maximum score that can be obtained from the scale is 46, and the minimum is 0. Those who score 40 or more on the scale are considered to have sufficient first aid knowledge. The Cronbach's alpha value of the survey is 0.87.

Statistical Analysis

Categorical data are presented in tables with percentages and frequencies. The chi-square test was applied to evaluate categorical variables. For continuous variables, the mean, standard deviation, median, minimum, and maximum values were calculated, and normality tests, including the Kolmogorov-Smirnov test and histograms, were applied. In comparing the means of two groups, the Student's t-test was used for data presenting normal distributions, and the Mann-Whitney U test was used for non-normal distributions. When it was desired to compare the average of more than two groups and the subgroups were not normally distributed, the Kruskal-Wallis test was applied. The statistical significance level was accepted as 0.05.

Results

A total of 174 students participated in the research (Table 1). The mean age of the students is 21.9 years (±1.8 years; median: 22.0 years; min-max: 19-30 years). The other characteristics of the participants are presented in Table 1.

Those who have previously performed first aid response to the question "If you have performed an first aid, what was the intervention aimed at?": 44.4% (n=8) "First aid for a case of foreign body escape", 22.2% (n=4) "First aid for a case of unconsciousness", 5.6% (n=1) "First aid for injuries", 5.6% (n=1) "First aid for bleeding and shock", 5.6% (n=1) "First aid for burns, heatstroke and frostbite", and 16.6% (n=3) "Other".

To the question "Do you have any hesitations about giving any first aid intervention?", 87.4% of participants (n=152) answered "Yes" (Table 1). When we asked the participants what their

Table 1. Sociodemographic characteristics		
Characteristic	**n**	**%**
Gender		
Female	133	76.4
Male	41	23.6
Age groups (Years)		
19-20 years	36	20.7
21 years	42	24.1
22 years	40	23.0
23 years and above	56	32.2
Grade		
Second grade	51	29.3
Third grade	74	42.5
Fourth grade	49	28.2
Healtcare worker in the family		
Yes	20	11.6
No	152	88.4
Previous first aid training		
Yes	54	31.0
No	120	69.0
Location of previous first aid training		
High school	15	27.8
University	4	7.4
Driving license course	25	46.3
Non govermental organisation	2	3.7
Public Education Center	6	11.0
Internet	1	1.9
Scout camp	1	1.9
If he/she received training, whether he/she found the training useful		
Yes	26	48.1
No	11	20.4
Undecided	17	31.5
Having a first aid certificate approved by the Ministry of Health		
Yes	5	9.4
No	169	90.6
First aid intervention has ever been performed before		
Yes	18	10.3
No	154	88.5
Do not want to answer	2	1.2
If there was a situation around you that required first aid intervention, would you have the courage to intervene?		
Yes	51	29.3
No	59	33.9
Undecided	64	36.8
Being hesitant about giving any first aid intervention		
Yes	152	87.4
No	22	12.6

hesitations were, the answers were: "I am afraid of making the wrong intervention and having a bad outcome," "I don't feel competent because I don't have any training," "I received training, but I don't think the training I received is sufficient,"

First Aid Knowledge Scale

The responses given by participants to the questions on the FAKLS are provided in Table 2. In the 23-question scale used in the study, the question with the highest rate of incorrect answers among students was related to how to provide first aid to a drowning person, with an error rate of 45.4%. Conversely, the question most frequently answered correctly by students, at a rate of 92.5%, was about the symptoms of individuals with head trauma and the necessity of seeking emergency medical services (Table 2).

The participants' average total score for the FAKLS is 32.3 (±4.2; median: 33.0; minimum: 20.0 - maximum: 41.0). While 98.3% of participants (n=171) had insufficient first aid knowledge, only 1.7% of them (n=3) were found to have sufficient knowledge.

In the study, a significant difference was found based on the students' grade (p=0.018), with FAKLS scores decreasing as the grade level increased. 2nd-grade students had significantly higher FAKLS scores compared to 4th-grade students (Table 3). Among 54 students who previously received first aid training, the average time since their last training was 39.0 months. No significant difference in FAKLS scores was found between those who had received first aid training and those who had not (p=0.694), nor was there a correlation between the time since training and FAKLS scores.

Discussion

Our research aimed to measure and evaluate the FAKLS of university students in the elementary teacher education department, who take an active role at all levels of society.

The study revealed that the majority of students (69.0%) had not received any prior first aid training. Similar findings have been reported in studies conducted at various faculties of different universities in Türkiye, showing comparable rates of students receiving first aid training (9-11). The most common place where participants received first aid training was driver's license courses, followed by high schools and public education centers in the study. Although health education classes are offered in primary and secondary schools in Türkiye, the majority of the population receives first aid training during driving courses. However, it is crucial to introduce such an important topic at an earlier age. Moreover, only 9.4% of participants possess a first aid certificate approved by the Ministry of Health. while only 29.3%

Table 2. First aid knowledge level scale questions

Questions	True n (%)	False n (%)	I don't know n (%)
1. The three most important steps in first aid are: evaluation of the respiratory tract, evaluation of breathing, and evaluation of circulation.	117 (67.3)	10 (5.7)	47 (27.0)
2. The primary purposes of first aid are to ensure the maintenance of vital functions, to prevent the patient's condition from worsening, and to facilitate recovery.	158 (90.8)	8 (4.6)	8 (4.6)
3. Eliminating life-threatening situations is one of the primary goals of first aid.	133 (76.4)	25 (14.4)	16 (9.2)
4. In emergency situations where an accident occurs, the first thing to do at the scene is to create a safe environment by identifying possible dangers.	151 (86.8)	10 (5.7)	13 (7.5)
5. Initial care, such as opening the airway and applying pressure to the area of severe bleeding, should be provided before leaving the patient's side to call 112 for help.	106 (60.9)	20 (11.5)	48 (27.6)
6. When an emergency ambulance call is made, the place where the incident took place, the caller, the description of the incident, the number of patients or injured people, their condition, and what kind of help they received should be explained.	156 (89.7)	6 (3.4)	12 (6.9)
7. If a patient with an injured spine is conscious, he/she should be allowed to move.	152 (87.3)	5 (2.9)	17 (9.8)
8. If the shock is not caused by trauma or injury, first aid should be given to the patient by opening the respiratory tract, laying his/her on her back, and elevating the legs 30-60 degrees	69 (39.7)	9 (5.2)	96 (55.1)
9. For diagnosed asthma patients who complain of shortness of breath, previously prescribed inhaler bronchodilators (drugs that are inhaled, expand the bronchi and help breathing) should be used.	86 (49.5)	22 (12.6)	66 (37.9)
10. The patient suspected of having a stroke should be evaluated quickly to see whether there is sagging or retraction on his face, whether his arm falls within 10 seconds when he raises his arm and closes his eyes, whether there is any speech disorder, and when he last appeared normal.	84 (48.3)	8 (4.6)	82 (47.1)
11. A patient with chest pain who is suspected of having a heart attack should be given chewable aspirin and 112 should be called.	23 (13.2)	56 (32.2)	95 (54.6)
12. In case of anaphylaxis, emergency call should be called immediately, and it should be administered immediately to individuals who are known to have a diagnosed anaphylactic reaction and have a prescription adrenaline injector.	37 (21.3)	10 (5.7)	127 (73.0)
13. Patients with complaints of hunger, tremors, sweating and restlessness should be considered as having low blood sugar, they should be encouraged to consume sugary drinks and foods, and their complaints should be expected to subside within 10-15 minutes. If it does not subside or if there is a deterioration in consciousness, 112 should be called immediately.	84 (48.3)	35 (20.1)	55 (31.6)
14. In case of dehydration caused by excessive exercise and sweating, the patient should be given an electrolyte-rich drink (water containing lemon, salt, sugar).	56 (32.2)	19 (10.9)	99 (56.9)
15. Eyes exposed to toxic chemicals should be washed with plenty of water for 15 minutes and emergency healthcare services should be sought.	112 (64.3)	13 (7.5)	49 (28.2)
16. In a patient with an open wound and bleeding, direct pressure should be applied to the bleeding area until it stops.	96 (55.2)	26 (14.9)	52 (29.9)
17. It is recommended that the tourniquet be applied by specially trained people due to the harm it may cause in patients with heavy and external bleeding.	133 (76.4)	4 (2.3)	37 (21.3)
18. If people with head trauma have complaints such as feeling dizzy, headache, nausea, visual impairment, or confusion, they should definitely seek emergency medical services.	161 (92.5)	2 (1.1)	11 (6.4)
19. In cases where spinal cord injury is suspected, it is recommended that the patient wear a neck collar by the first aid practitioner.	116 (66.7)	15 (8.6)	43 (24.7)
20. In case of electric shock, the victim's contact with the electric current is cut off with a piece of wood or plastic.	134 (77.0)	11 (6.3)	29 (16.7)
21. In case of heat stroke, liquid drinks should be given to the patient if there is no nausea or vomiting.	61 (35.1)	24 (13.8)	89 (51.1)
22. The swallowed water of a drowned person should be removed by applying pressure to his/her abdomen and chest.	27 (15.5)	79 (45.4)	68 (39.1)
23. In cases of chemical poisoning, all clothing should be removed and the body should be washed with plenty of water.	17 (9.8)	43 (24.7)	114 (65.5)

Table 3. Comparison of independent variables with the first aid knowledge level scale					
Characteristic	**n**	**%**	**Median**	**IQR**	**p value**
Gender					
Female	133	76.4	33.00	5.0	0.094
Male	41	23.6	32.00	5.0	
Age groups (Years)					
19-20 years	36	20.7	32.5	6.5	0.421
21 years	42	24.1	34.0	6.0	
22 years	40	23.0	32.0	4.0	
23 years and above	56	32.2	32.0	4.0	
Grade					
Second grade	51	29.3	34.00	7.0	0.018
Third grade	74	42.5	32.50	5.0	
Fourth grade	49	28.2	32.00	5.0	
Healtcare worker in the family					
Yes	20	11.6	34.00	5.75	0.006
No	152	88.4	32.00	5.0	
Previous first aid training					
Yes	54	31.0	32.00	6.0	0.694
No	120	69.0	33.00	5.0	
If he/she received training. whether he/she found the training useful					
Yes	26	48.1	32.50	6.5	0.377
No	11	20.4	31.00	8.0	
Undecided	17	31.5	32.00	5.5	
Having a first aid certificate approved by the Ministry of Health					
Yes	5	9.4	37.00	9.5	0.151
No	169	90.6	32.00	5.0	
First aid intervention has ever been performed before					
Yes	18	10.3	32.00	5.75	0.903
No	154	88.5	33.00	5.0	
Do not want to answer?	2	1.2	32.50	5.0	
If there was a situation around you that required first aid intervention, would you have the courage to intervene?					
Yes	51	29.3	33.00	6.0	0.929
No	59	33.9	32.00	6.0	
Undecided	64	36.8	33.00	5.0	
Being hesitant about giving any first aid intervention					
Yes	152	87.4	33.00	5.0	0.030
No	22	12.6	30.00	7.5	
IQR: Interquartile range					

of participants expressed confidence in applying first aid, 87.4% stated they would hesitate to perform it. This situation once again highlights the gravity of the issue.

A significant difference was found between the students' FAKLS scores depending on the grade they were in, and as the grade increased, a decrease was found in their FAKLS scores. The FAKLS score of the 2nd grade is significantly higher than that of the 4th grade. This situation may indicate that participants mostly receive first aid training since high school and that university first aid education is provided in a more superficial manner. This problem can be eliminated by providing planned and continuous first aid training to students every year.

It was found that 98.3% of the participants had insufficient first aid knowledge. In a study conducted in 2020 at the faculties of education of a university, the knowledge levels of teacher candidates were found to be approximately 50% (9). Similarly, a study conducted with vocational school students also found their knowledge level to be around 50% (12). Other studies found that the majority of students' FAKLS was insufficient in case of a possible emergency (13,14). In our study, the reason a large proportion of students was found to be insufficient may be because of the high cut-off value of the scale used and the binary classification as sufficient or insufficient. If a three-tier scoring system had been applied, it would have been observed that our participants also achieved a moderate level score. Since students are future elementary teachers and unexpected situations can arise in schools, awareness should be increased through legal regulations mandating compulsory first aid courses throughout their education. Studies have shown that first aid training has a positive impact on first aid skills (15,16).

In our research, 87.4% of the participants stated that they would hesitate to provide first aid. In a study in Türkiye, it was found that when candidate teachers were asked if they would provide first aid when faced with someone who needs it, only 8.0% said yes (17). A qualitative study on the public's willingness to perform cardiopulmonary resuscitation (CPR) found that individuals who are knowledgeable about CPR are more likely to voluntarily perform it (18). It is evident that enhancing students' first aid knowledge is crucial, as individuals who are knowledgeable about first aid practices are likely to provide first aid without hesitation.

In the current study, a significant difference was seen between the FAKLS scores of those who were hesitant about giving any first aid intervention compared to those who were not. The FAKLS scores of those who were hesitant were higher. The reason for this may be that people with hesitations already understand the importance of first aid and have more knowledge and experience regarding interventions. The fact that they have more knowledge and experience but may lack certain practical skills may have led students to abstain.

The lack of significant effect on the FAKLS scores from having a first aid certificate approved by the Ministry of Health did not significantly affect the FAKLS scores may be due to the fact that, only 9.4% of those who received first aid training had the certificate they received their first aid training an average of 39 months ago. It may have caused the learned information to be forgotten over time. The FAKLS scores of students who had a healthcare worker in their family were found to be significantly higher than those of students who did not. This actually shows that parents being knowledgeable causes their children to be knowledgeable. Therefore, awareness about first aid should be created not only among students but also in all segments of society. Public health courses and formal first aid training should be organized.

When the general knowledge level was examined using the 23-question scale, in our research, it was seen that most students gave incorrect answers to the questions about how first aid should be given to a drowned person and a patient with chest pain who is suspected of having a heart attack. In this case, it has been observed that students do not have sufficient knowledge about situations such as drowning and swallowing water, are unaware that no medical drugs should be used in first aid, and that sufficient training is not given in schools on this subject. It has been determined that students are generally aware of issues such as the symptoms of people with head trauma and the need to seek emergency health services. In another study, when the students' general knowledge levels regarding first aid were examined, it was determined that the majority of them knew that the primary purpose of first aid was to eliminate life-threatening situations, 112 should be called after administering first aid, and that the injured person should not be moved (11). The high rate of students who have the misconception that first aid is only performed by people trained in a health-related department, shows that there is a lack of awareness on this issue (3).

Study Limitations

The study has some limitations. Efforts were made to reach all participants; however, because the data collection period coincided with the exam season, not all participants could be reached. Secondly, the high cut-off score of the scale used in the study led to most participants being categorized as having insufficient first aid knowledge. Therefore, it is recommended that the cut-off value of the relevant scale be reconsidered.

Conclusion

The study shows that elementary teacher candidates have low first aid knowledge. Considering that accidents are likely to occur frequently in schools, the necessity for teacher candidates to receive first aid training during their university education has become evident. Therefore, planned and continuous training should be supported by practice-based first aid training, especially in educational institutions. In future studies aimed at measuring the first aid knowledge of society, research will help to better identify deficiencies.

Ethics

Ethics Committee Approval: The approval from Marmara University Faculty of Medicine Ethics Committee was obtained with the (decision number: 2023/09/08.12/1632, date: 08.12.2023) and permission was granted by the Department of Elementary Teacher Education with the decision number: 2024/01/05/703816. The study was conducted in accordance with the principles of the Helsinki Declaration.

Informed Consent: This is a cross-sectional study.

Footnotes

Author Contributions

Concept: F.B.D., S.T.N., M.K., S.H., Design: F.B.D., S.T.N., M.K., S.H., Data Collection or Processing: F.B.D., B.K., B.Ö., M.C., S.F., Analysis or Interpretation: F.B.D., S.T.N., M.K., S.H., B.K., B.Ö., M.C., S.F., Literature Search: F.B.D., M.K., S.H., B.K., B.Ö., M.C., S.F., Writing: F.B.D., B.K., B.Ö., M.C., S.F.

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

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Malpractice Risk Assessment in Emergency Medical Services: A Field Study

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Abstract

Aim: This study examined the malpractice risks in emergency medical services as assessed by emergency medical workers.

Materials and Methods: This methodological, descriptive and cross-sectional study was conducted with 447 emergency medical workers across Türkiye. Data were collected using the malpractice risk assessment scale in emergency health services, developed by the researchers within the scope of this research. In the scale development study, according to the explanatory factor analysis, the scale was formed with a single dimension and 23 items. Confirmatory factor analysis fit indices for this structure were X^2/standard deviation=3.05, goodness of fit index=0.88, comparative fit index=0.90, Tucker Lewis index=0.90, root mean square error of approximation=0.07 and root mean square residual=0.07. Cronbach's alpha value was 0.931.

Results: The mean score of the emergency medical workers on the malpractice risk assessment scale in emergency medical services was 3.390±0.737. The participants reported that adverse physical conditions in emergency departments, patient density, medical procedures performed at night, negative attitudes or behavior of patient relatives during emergency medical intervention processes, and the presence of pediatric patients are high-risk factors for malpractice. The emergency medical workers with less than one year of experience, being single, working in the private sector, working 41 hours or more per week, working in shifts, and following mixed work patterns had higher scores.

Conclusion: Malpractice risk assessment scale in emergency medical services is a valid and reliable measurement tool. Emergency medical workers face a moderate level of malpractice risk exposure. Malpractice risk assessment is influenced by the characteristics of emergency medical providers. Strategies should be developed, on topics identified as high risk for malpractice.

Keywords: Emergency medical services, emergency medical workers, malpractice, medical error, risk assessment.

Introduction

In 2021, as per the World Health Organization's Global Patient Safety Action Plan (2021-2030), a decision was made to aim for "a world in which no one is harmed in health care, and every patient receives safe and respectful care, every time, everywhere" (1). It is estimated that 1 in 10 patients in high-income countries are harmed while receiving hospital care, with approximately 50% of these harms thought to be preventable (2). Zuccotti et al. (3) examined 477 malpractice claims involving seven different topics in the USA and found that approximately half of these errors were preventable.

Wong et al. (4) examined 135.490 malpractice claims, referred to as medical professional liability, in emergency departments (ED) and emergency care settings between 2001 and 2015 in the USA, and reported that emergency medicine ranked first among 6.779 claims. Malpractice claims are an important problem for emergency medical physicians (MDs) and the medical system that needs to be addressed rationally and effectively. In solving this problem, claims analysis seems to be the best way to identify risk factors and areas, which elaborates risk management recommendations. Emergency medical units are known to be one of the high-risk areas (5). Therefore, it seems important to examine the risks of malpractice in the ED in this study.

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This study aimed to investigate the malpractice risks in emergency medical care units based on the assessments of emergency MDs. In the literature, the risk attitudes of emergency MDs (6), recommendations to reduce malpractice risks in emergency nurses (RNs) (7), or brief approaches for emergency MDs to minimise the risk of malpractice (8). However, no study has been found that demonstrates malpractice risks by using a valid and reliable measurement tool that covers the evaluation of all emergency medical workers in units providing emergency medical services (EMS). As such, we aimed to develop a "malpractice risk assessment scale in "EMS" to realise the study's aim, thus making a secondary contribution to the literature.

Materials and Methods

Study Design and Time Period

This study was conducted using a methodological, descriptive and cross-sectional design between November 2022 and May 2023. The required ethics committee permission was obtained from the Ordu University Rectorate Social and Human Sciences Research Ethics Committee to conduct the research (decision number: 2022-186, date: 06.10.2022).

Data Collection

Data collection tools prepared with Google Forms were delivered to the participants using WhatsApp and personal e-mail addresses. Participants were asked to check the voluntary consent box before answering the questions. Since it was mandatory to respond to all statements in the questionnaire, there were no blank or invalid items.

Population and Sample Size

The study population comprised all emergency medical workers (MDs, RNs, paramedics, emergency medical technicians, laboratory technicians, and other medical personnel) working in public and private sector emergency medical organisations in Türkiye.

The researchers were unable to find a publicly available figure on the number of people working in EMS in Türkiye. However, according to the statistics on the number of health personnel working in the ministry of health, university and private sector published by the Turkish statistical institute (TurkStat) in 2022, it was reported that there were a total of 604,654 medical workers in 2020 (9). Based on their observations, the researchers assumed that is, approximately 100,000 emergency medical workers were involved.

In scale studies, an average of 5-10 people can be taken per item to determine the sample (10) or, for a sufficient sample size in factor analysis, it is suggested that "50 is very poor, 100 is poor, 200 is moderate, 300 is good, 500 is very good, and 1000 is excellent" (11). This study was conducted with 447 emergency medical workers, indicating an adequate sample size.

Data Collection Tools

Emergency Medical Worker Information Form

This form, created by the researchers, contains 14 items, including demographic information about emergency medical personnel (age, gender, marital status, educational status, occupation, years of occupation, work unit and workplace, weekly working time, working status, encounters with malpractice and satisfaction with the profession).

Malpractice Risk Assessment Scale in EMRS

The scale developed by the researchers consists of 23 items and one dimension. EMRS aims to measure malpractice risk levels by patient type, occupational group, working times, communication, physical conditions, and types of malpractice in EMS. The five-point Likert-type scale is scored as 1-strongly disagree, 2-disagree, 3-undecided, 4-agree, and 5-strongly agree. There are two reverse items in the scale (m23, m24). The arithmetic mean is used to calculate the scale score, the sum of the answers given to the item is scored between 1 and 5. The score calculation uses the formula distribution range = (maximum value-minimum value)/ number of degrees. The item's score range is categorized as "low" between 1.00 and 2.33, "medium" between 2.34 and 3.66, and "high" between 3.67 and 5.00.

Validity and Reliability Analysis of EMRS

Creating an Item Pool and Obtaining Expert Opinions

Researchers reviewed relevant literature (8,12-14) to structure the scale items and consulted field workers. Expert opinions were obtained from five academicians for the draft scale, which consisted of 36 items. Required revisions were made in line with the academics' opinions.

Construct Validity

Exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) factor analyses were conducted to ensure the scale's construct validity. In EFA, the Kaiser-Meyer-Olkin value was calculated to understand the adequacy of the sample, which was found to be 0.931. The value, ranging from 0.7 to 1.0, showed that the sample size was sufficient for EFA (15). Bartlett's test of sphericity result was p=0.000, indicating that the data were fit for factor analysis (16). Then, 13 items having factor loadings from EFA below 0.30 were removed from the 36-item scale. According to the literature, a factor loading value between 0.30 and 0.40 is acceptable (17). The total variance explained in the scale was 41.014%. The factor number of the scale was decided based on

the scree plot and the eigenvalue >1 criterion (18). The analysis revealed that structurally, the scale consisted of 23 items and one sub-dimension (one factor) (Table 1).

CFA was conducted to confirm the scale structure formed by EFA. Modification indices were analysed to improve the model fit in the context of CFA. After the analysis, modification indices were improved for items 1-2, 2-5, 9-10, and 10-11. New covariances were created by determining the variables that reduced the fit among those with high covariance of residual values (Figure 1).

As a result, the fit indices of EMRS improved; X^2/standard deviation=3.05, goodness of fit index=0.88, adjusted goodness of fit index=0.85, comparative fit index=0.90, Tucker Lewis index=0.90, root mean square error of approximation=0.07 and root mean square residua=0.07 (Table 2).

These fit index values were acceptable (11,19,20). The analysis showed that the fit statistics calculated by CFA were acceptably consistent with the previously determined factor structure of the scale. When the standardised coefficients were examined, factor loadings were high, standard error values were low, and t values

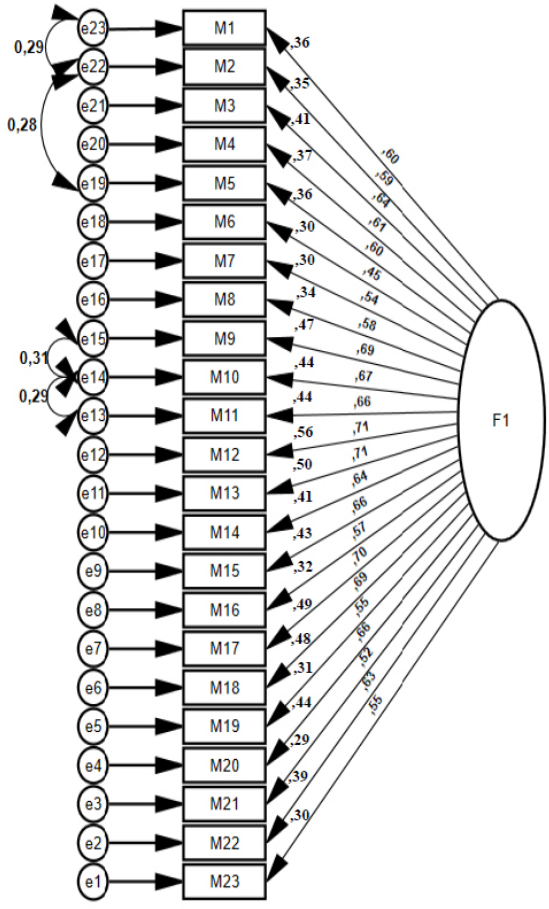

Figure 1. Confirmatory factor analysis validity model

Table 1. Item factor loadings in exploratory factor analysis of the malpractice risk assessment scale in emergency medical services

Scale item	Factor loading
1. There is a high risk of medical errors in infant and paediatric patients.	0.537
2. There is a high risk of making medical errors in young and adult patients.	0.608
3. There is a high risk of making medical errors in elderly patients.	0.631
4. There is a high risk of making medical errors in male patients.	0.700
5. There is a high risk of making medical errors in female patients.	0.714
6. There is a high risk for medical physicians to make medical errors.	0.693
7. There is a high risk for nurses to make medical errors.	0.753
8. There is a high risk for paramedics/emergency medical technicians to make medical errors.	0.751
9. There is a high risk for medical secretaries to make medical errors.	0.598
10. There is a high risk for laboratory technicians to make medical errors.	0.722
15. There is a high risk of medical error in daytime medical practices.	0.650
16. There is a high risk of making medical errors in night medical practices.	0.573
21. Negative attitudes or behaviours of patient relatives in emergency medical services processes increase the risk of making medical errors.	0.368
23. Unfavourable physical conditions of emergency medical services (insufficient light, loud noises, poorly ventilated environment, insufficient stretchers, etc.) increase the risk of making medical errors.	0.440
24. Patient density increases the risk of making medical errors.	0.318
28. There is a high risk of making medical errors (administration site, dose, method of administration, wrong drug, etc.) in drug applications.	0.512
30. There is a high risk of making medical errors in infected patients.	0.652
31. There is a high risk of making medical errors in gynaecological patients.	0.688
32. There is a high risk of making medical errors in intoxication cases.	0.732
33. There is a high risk of making medical errors in accident response (traffic, home, work, etc.).	0.724
34. There is a high risk of medical errors during patient/injured person transport (falls, etc.).	0.735
35. There is a high risk of making medical errors in blood transfusion practices.	0.680
36. There is a high risk of making medical errors in emergency medical services.	0.696

Table 2. Model fit index of the malpractice risk assessment scale in emergency medical services regarding confirmatory factor analysis

Index	Normal value	Acceptable value	EMRS values
x^2/SD	<2	<5	3.05
GFI	>0.95	>0.85	0.88
AGFI	>0.95	>0.85	0.85
CFI	>0.95	>0.90	0.90
TLI	>0.95	>0.90	0.90
RMSEA	<0.05	<0.08	0.07
RMR	<0.05	<0.08	0.07

SD: Standard deviation, EMRS: Malpractice risk assessment scale in emergency medical services, GFI: Goodness of Fit Index, AGFI: Adjusted Goodness of Fit Index, CFI: Comparative Fit Index, TLI: Tucker Lewis index, RMSEA: Root Mean Square Error of Approximation, RMR: Root mean square residual

were significant. These results confirm the construct validity of the previously determined factor structure.

Reliability Analysis

Cronbach's alpha coefficient was used to evaluate the scale's reliability, and the alpha value of the final 23-item scale was found to be 0.931. This value is highly reliable (11).

Data Analysis

As part of the scale development study, EFA with the IBM SPSS 22 program and CFA with the AMOS 24.0 program were conducted for construct validity. The t-test, one-way ANOVA test, and correlation analysis were also applied to determine the links between the scale and the demographic information and professional characteristics of EMS workers. The data obtained were statistically evaluated and interpreted at a significance level of p=0.05.

Results

J9 54% worked 41 hours or more and 40% worked in shifts. Regarding satisfaction with their profession, 30.6% stated that they were satisfied (Table 3). The mean EMRS score of emergency medical workers was 3.390±0.737 (min: 1.26, max: 5.00).

The malpractice risk assessments of participant emergency medical workers, according to the scale items, were analysed in three parts: high risk (importance range= 3.67-5.00), medium-high risk (importance range= 3.01-3.66) and medium-low risk (importance range= 2.34-2.99). Participants reported that the unfavourable physical conditions of EMS, patient density, medical procedures performed at night, negative attitudes or behaviours of patient relatives during emergency medical intervention processes, and the presence of paediatric patients were high-risk items for malpractice. Participants reported that no scale item had a low risk (Table 3).

When the demographic characteristics and malpractice risk assessments of the emergency medical workers participating in this study were compared, it was found that statistically significantly higher malpractice risk assessments were associated with those who were single (t: -3.935, p=0.000), laboratory technicians (F: 9.619, p=0.000), had 1-3 years of professional experience (F: 10.266, p=0.000), worked in private hospitals (t: -4.077, p=0.000), worked 41 hours or more per week (t: 6.428, p=0.000), and worked in a shift system (F: 7.930, p=0.000) (Table 4).

Among emergency medical workers, 28.6% stated that they had witnessed medical errors in the last year, 33.8% stated that they had heard about medical errors from their colleagues in the last year, and 22.1% stated that they had committed medical errors in their professional lives. The emergency medical workers who had committed medical errors in their professional lives had higher malpractice risk assessments than those who had not (t=-5.484, p=0.000). Finally, a statistically weak and negative relationship was found between the satisfaction levels of emergency medical workers and malpractice risk assessments (r: -0.152, p=0.001).

Discussion

National and international literature shows that EMS involves a high level of malpractice risk (4,21,22). This study demonstrated that emergency medical workers assessed the malpractice risk in EMS as moderate, with this assessment being based on EMRS. Ferguson et al. (8) also found that the environment of the ED has a moderate risk of malpractice.

The emergency medical workers in this study noted that, particularly, the negative attitudes or behaviours of patient relatives, unfavourable physical conditions in the ED, patient density, paediatric patients, and night-time medical procedures involve a high level of malpractice risk. In ED, infants and children are at high risk of malpractice (8), and high patient density increases the likelihood of malpractice (13). Malpractice in ED has also been associated with a high risk (23). A study conducted in South Korea noted that night shifts in EDs had a high risk for musculoskeletal disorders (24). It is essential to develop strategies for malpractice risk assessment and to take measures against risks in EMS.

Furthermore, this study demonstrated that malpractice risk assessments of emergency medical workers were affected by several factors. Those who were single, had less than one year of professional experience, and worked in the private sector made higher malpractice risk assessments. Likewise, İntepeler et al. (25) found that single RNs had more malpractice tendencies. A study has shown that MDs working in the private sector engaged in more malpractice cases (26). These results suggest that the habit brought by marriage of taking on more responsibility may also affect the profession of married medical professionals.

Table 3. Differentiation of malpractice risk assessment scale in emergency medical services scores according to demographic characteristics

Variable	Category (n)	Mean ± SD
Gender	Female (201)	3.433±0.734
	Male (246)	3.353±0.739
Test, p value		t=1.146, >0.05
Age	18-25 (98)	3.510±0.657
	26-30 (127)	3.399±0.757
	31-35 (83)	3.451±0.775
	36-40 (69)	3.213±0.814
	41 and above (70)	3.389±0.650
Test, p value		F=2.062, >0.05
Marital status	Married (222)	3.254±0.749
	Single (225)	3.524±0.700
Test, p value		t=-3.935, =0.000*
Educational status	High school/associate degree (123)	3.427±0.732
	Bachelor's degree (266)	3.403±0.771
	Postgraduate (58)	3.248±0.564
Test, p value		F=1.274, >0.05
Occupation	MDsa (100)	3.401±0.692
	RNsb (150)	3.540±0.705
	Paramedicc (81)	2.940±0.681
	EMTsd (33)	3.453±0.838
	Laboratory technicians e (30)	3.751±0.656
	Other medical personnelf (53)	3.386±0.694
Test, p value		F=9.619, =0.000*
Post-hoc		e>a, a>c, b>c, d>c, e>c, f>c, e>f
Years of occupation	Less than 1 yearg (64)	3.391±0.731
	1-3h (74)	3.591±0.668
	4-7i (107)	3.655±0.673
	8-12j (63)	3.264±0.799
	13 year and abovek (139)	3.134±0.702
Test, p value		F=10.266, =0.000*
Post-hoc		i>g, h>j, i>j, g>k, h>k, i>k
Unit	112 emergency (87)	3.253±0.798
	Emergency departments (360)	3.423±0.719
Test, p value		t=-1.926, >0.05
Workplace	Public (385)	3.334±0.751
	Private (62)	3.738±0.719
Test, p value		t=-4.077, =0.000*
Weekly working time	1-40 hours (204)	3.334±0.798
	41 hours or more (243)	3.738±0.719
Test, p value		t=6.428, =0.000*
Working status	8-16 shiftsl (86)	3.226±0.826
	Shift m (59)	3.647±0.555
	Night shiftn (179)	3.268±0.749
	Mixedo (123)	3.558±0.668
Test, p value		F=7.930, =0.000*
Post-hoc		m>l, o>l, m>n, o>n

t: t Test, F: One-way ANOVA test, Post-hoc: Tukey and LSD: Least significant difference, SD: Standard deviation

Tablo 4. Participants' participation percentages in scale statements and severity ranges

EMRS	Strongly disagree		Disagree		Undecide		Agree		Strongly agree		Importance range	SD
In emergency health services	n	%	n	%	n	%	n	%	n	%	1-5	
1. There is a high risk of medical errors in infant and paediatric patients.	23	5.1	41	9.2	86	19.2	140	31.3	157	35.1	3.82	±1.15
2. There is a high risk of making medical errors in patients.	49	11.0	132	29.5	158	35.3	70	15.7	38	8.5	2.81	±1.09
3. There is a high risk of making medical errors in elderly patients.	28	6.3	82	18.3	128	28.6	142	31.8	67	15.0	3.30	±1.21
4. There is a high risk of making medical errors in male patients.	79	17.7	133	29.8	135	30.2	64	14.3	36	8.1	2.65	±1.16
5. There is a high risk of making medical errors for female patients.	64	14.3	113	25.3	133	29.8	91	20.4	46	10.3	2.87	±1.19
6. There is a high risk for medical physicians to make medical errors.	44	9.8	105	23.5	116	26	112	25.1	70	15.7	3.13	±1.22
7. There is a high risk of nurses making medical errors.	38	8.5	97	21.7	117	26.2	128	28.6	67	15.0	3.19	±1.18
8. There is a high risk for paramedics/emergency medical technicians to make medical errors.	35	7.8	81	18.1	129	28.9	130	29.1	72	16.1	3.27	±1.16
9. There is a high risk of medical secretaries making medical errors.	59	13.2	99	22.1	121	27.1	107	23.9	61	13.6	3.02	±1.23
10. There is a high risk that laboratory technicians will make medical errors.	49	11.0	103	23.0	119	26.6	96	21.5	80	17.9	3.12	±1.26
11. There is a high risk of medical error in daytime medical practices.	94	21.0	138	30.9	124	27.7	48	10.7	43	9.6	2.57	±1.20
12. There is a high risk of medical errors occurring in nighttime medical practice.	24	5.4	51	11.4	86	19.2	140	31.3	146	32.7	3.74	±1.18
13. Negative attitudes or behaviours of patient relatives in emergency medical intervention processes heighten the risk of medical errors.	7	1.6	27	6.0	57	12.8	128	28.6	228	51.0	4.21	±0.98
14. Unfavourable physical conditions of emergency medical services (insufficient light, loud noises, poorly ventilated environment, insufficient stretchers, etc.) increase the risk of making medical errors.	8	1.8	18	4.0	70	15.7	139	31.1	212	47.4	4.18	±0.95
15. Patient density increases the risk of making medical errors.	46	10.3	27	6.0	30	6.7	60	13.4	284	63.5	4.13	±1.36
16. There is a high risk of making medical errors (administration site, dose, method of administration, wrong drug, etc.) in drug applications.	17	3.8	71	15.9	108	24.2	124	27.7	127	28.4	3.61	±1.16
17. There is a high risk of committing medical errors in infected patients.	30	6.7	89	19.9	167	37.4	105	23.5	56	12.5	3.15	±1.08
18. There is a high risk of making medical errors in gynaecological patients.	33	7.4	71	15.9	155	34.7	121	27.1	67	15.0	3.26	±1.12
19. There is a high risk of making medical errors in intoxication cases.	29	6.5	71	15.9	130	29.1	124	27.7	93	20.8	3.40	±1.16
20. There is a high risk of making medical errors in accident response (traffic, home, work, etc.).	24	5.4	67	15.0	93	20.8	148	33.1	115	25.7	3.58	±1.17
21. There is a high risk of medical errors during patient or injured person transport, such as falls.	26	5.8	66	14.8	98	21.9	128	28.6	129	28.9	3.59	±1.21
22. There is a high risk of making medical errors in blood transfusion practices.	29	6.5	87	19.5	108	24.2	117	26.2	106	23.7	3.41	±1.22
23. There is a high risk of making medical errors in emergency medical services.	19	4.3	49	11.0	81	18.1	127	28.4	171	38.3	3.85	±1.16

SD: Standard deviation, EMRS: Malpractice risk assessment scale in emergency medical services

High risk (importance range =3.67-5.00)
Medium-high risk (importance range =3.01-3.66)
Medium-low risk (importance range =2.34-2.99)

Additionally, in private hospitals, the risks and the perception of malpractice seemed higher with a lack of professional experience and inadequate working conditions and resources. Therefore, it is recommended that medical professionals be employed in the right positions, orientation programs for inexperienced personnel be conducted, and studies be carried out to improve the provision of EMS in the private sector.

In this study, the medical workers who worked more than 41 hours per week, particularly in shifts and mixed work patterns, had higher malpractice risk assessments. Indeed, according to a previous study, longer working hours increase the risk of malpractice (27). A study has also found a higher likelihood of malpractice during night shifts for medical workers (28). As the medical sector is one where shifts and mixed work patterns are common, medical workers' biorhythms may be disrupted, which may increase malpractice incidents. Sleep disturbances, fatigue, difficulty maintaining attention, and other factors associated with shift and mixed work patterns, unlike daytime shifts, may contribute to increased malpractice risk assessments. In this context, it is crucial to make proper staffing plans for emergency medical workers in Türkiye, considering the Organisation for Economic Co-operation and Development data, and to establish appropriate work schedules per International Labour Organization standards.

Additionally, the risk assessment of laboratory technicians was higher than that of MDs, paramedics, and other medical personnel in this study. Çakmak et al. (29) also identified errors in the laboratory environment as the most reported type of malpractice. This may be due to the working conditions of laboratory technicians, which may cause errors in rapid examinations and examinations in emergency service conditions or from inadequate maintenance and calibration of the devices. In this study, MDs, RNs, EMTs, and other medical personnel had higher malpractice risk assessments than paramedics. Implementing profession-specific measures in delivering EMS which include various professional groups at different hierarchical levels, may help reduce malpractice risks. In this context, it may be useful to conduct multidisciplinary studies.

Study Limitations

This study found that emergency medical workers were moderately satisfied with their professions. Similar conclusions were drawn in Germany's ED, where emergency medical workers were found to be moderately satisfied with their professions (30). In this study, as the level of job satisfaction increased, there was a slight decrease in malpractice risk assessment.

Conclusion

EMRS is a valid and reliable tool that can be used to assess malpractice risks in emergency medical services. Emergency medical workers assessed EMS as moderately risky. In addition, malpractice risks are affected by the individual and professional characteristics of emergency medical workers. Consequently, we believe it is critical to carry out larger-scale studies to evaluate malpractice risks and to take necessary occupation-specific measures. It may be helpful to review health policies and develop remedial strategies regarding the measures to be taken against malpractice risks that threaten patient safety.

Ethics

Ethics Committee Approval: The required ethics committee permission was obtained from the Ordu University Rectorate Social and Human Sciences Research Ethics Committee to conduct the research (decision number: 2022-186, date: 06.10.2022).

Informed Consent: Data collection tools prepared with Google Forms were delivered to the participants using WhatsApp and personal e-mail addresses. Participants were asked to check the voluntary consent box before answering the questions.

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Footnotes

Authorship Contributions

Surgical and Medical Practices: V.K., S.B., Concept: V.K., S.B., Design: V.K., S.B., Data Collection or Processing: V.K., Analysis or Interpretation: V.K., S.B., Literature Search: V.K., S.B., Writing: V.K., S.B.

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Comparison of the Hemolysis Rate According to Biochemistry Test Results of Patients Admitted to The Emergency Department with the Results of the Hemcheck Device

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Abstract

Aim: A large proportion (approximately 80%) of medical decisions made by clinicians are based on laboratory test results. The most common cause of sample rejection is hemolysis. The sample must be centrifuged to detect hemolysis. The laboratory of our hospital provides precise hemolytic index measurements. However, since the biochemistry test takes a long time to result, in cases of hemolysis, the sample should be reworked, and the result should be waited. Early detection of hemolysis will provide great convenience to prevent the factors that cause hemolysis.

Materials and Methods: This single-center, prospective study included 983 patients admitted to the emergency department, aged 18 years and over, admitted to the green or yellow area, and required routine biochemistry analysis. To determine whether the Hemcheck device detects hemolysis in advance, the results of the device were compared with those of the laboratory at our hospital.

Results: A total of 1049 samples from patients admitted to the emergency department were evaluated, and 983 of them were included in the study. Six hundred and twenty eight (63.9%) were female patients, and 325 (33.1%) were male patients. The mean age of the patients was 49.95±19.5 years, 734 (74.7%) were younger than 65 years, and 249 (25.3%) were elderly. In the evaluation according to the application site, 935 (95.1%) patients were antecubital, 18 (1.8%) were forearm, and 30 (3.1%) were overhand. According to the results of our study, the agreement between the device and the laboratory results was good and was found to be statistically significant (kappa statistical value=0.511±0.03 and $p<0.001$).

Conclusion: According to the results of our study, the Hemcheck device successfully detected hemolysis. It has been observed that the negative effects of hemolysis in emergency departments can be reduced by using this device.

Keywords: Hemolysis, hemolytic index, biochemistry analysis, emergency department

Introduction

A large proportion (approximately 80%) of medical decisions made by clinicians are based on the results of laboratory tests (1,2). Therefore, any error in the phlebotomy process can have serious negative consequences for patients, healthcare professionals, and the healthcare system (1). Many studies analyzing major diagnostic errors have shown that approximately 40% of diagnostic errors are associated with the results of services such as imaging or laboratory (3). Laboratory activities can be divided into three main phases: pre-analytical, analytical, and post-analytical (4). The pre-analytical phase includes all procedures before the start of laboratory analysis. Because these procedures involve many non-laboratory healthcare professionals (technicians, nurses, or general practitioners collecting specimens outside the laboratory environment where there is no direct supervision by laboratory personnel), they are responsible for most laboratory errors (1,4,5). At this stage, conditions such as patient preparation, tourniquet application time, blood collection sequence, mixing of blood tubes, and labeling of

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primary blood tubes can lead to changes in laboratory results (6). Problems resulting from improper collection and handling of specimens from patients include inadequate sampling, improper coagulation, contamination of infusion pathways, and, most importantly, specimen hemolysis (6).

Hemolysis is defined as the release of intracellular components into plasma or serum as a result of the breakdown of erythrocytes and other blood cells (6,7). Most hemolysis occurs *in vitro*. *In vitro* hemolysis is caused by inadequate collection or processing of specimens, leading to significant problems in hospitals, including specimen rejection (6,7). It has been shown that the incidence of specimen hemolysis is higher in emergency departments (EDs) than in other clinics (6-9). To reduce the rate of hemolysis, it is important to ensure that the patient adheres to a 12-hour fast, does not exercise for 72 hours prior to blood collection, and rests for at least 15-20 minutes prior to blood collection (6); in addition, knowledge regarding therapeutic drug use should be questioned (4). The assessment of fasting time is an important step prior to diagnostic blood sampling (10). Other factors that may increase the level of hemolysis include the use of venous catheters for blood collection, prolonged centrifugation, sample transport, tourniquet application time, cleanliness of the blood collection site, and distance of the tourniquet from the site of the procedure (6,10).

However, these optimal conditions are often not available in EDs. In addition, delays in the diagnosis and treatment of patients with hemolysis in EDs can lead to serious disruptions. For example, in the case of elevated potassium levels, which are affected by hemolysis and are an important parameter especially for emergency services, clinicians often have to repeat the test to confirm the potassium level, which can lead to prolonged hospital stay, multiple blood samples from the patient, increased use of healthcare resources, and unnecessary additional risk to the patient (11).

To detect hemolysis, the sample must be centrifuged (6). This may prolong the time to detect hemolysis and delay the diagnosis and treatment of patients. The aim of our study was to determine whether we could detect hemolysis in a shorter time compared with the laboratory results using the Hemcheck device, especially to minimize the possibility of incorrect or late diagnosis in patients admitted to the ED. We aim to reduce the length of stay of patients in the ED, avoid the need to draw blood from patients at long intervals to confirm hemolysis, minimize the anxiety of patients due to long waiting times, reduce the workload of nurses and laboratory staff, and reduce hospital costs.

Materials and Methods

The study was prospectively conducted in the ED between 08.01.2021 and 21.12.2021. This study was conducted in accordance with the tenets of the Declaration of Helsinki and was approved by the Clinical Research Ethics Committee of İstanbul Medeniyet University Göztepe Training and Research Hospital (decision number: 2021/0429, date: 25.08.2021). The Helsinki criteria were fulfilled. The procedure was performed using biochemistry test tubes, which are routinely requested from patients admitted to the ED within the indication. The Hemcheck Point-of-care test device was used to determine the presence of hemolysis in the blood samples collected, and the hemolytic index of the biochemistry analyzers in our hospital were calculated and compared (Figure 1). Informed consent was obtained from all participants who voluntarily participated in the study. Patients aged below 18 years, those with vascular problems, patients on hemodialysis, patients on oral anticoagulant use, and patients with suspected drug intoxication were excluded from the study. Prior to the study, 20 samples were tested to determine whether they were affected by the Hemcheck device. A pair of biochemistry tubes was collected from each patient, and one tube was sent directly to the biochemistry laboratory, the other to the Hemcheck device, and then to the biochemistry laboratory. A study was initiated when no significant difference in the results.

In this study, blood was collected in yellow-capped tubes (approximately 10 mL) from patients admitted to the yellow and green areas of the ED for routine biochemical testing. Blood samples were collected from the antecubital region of the upper extremities using standard syringes or 20G and 22G IV cannula intrakets. Samples were placed into the device without

Figure 1. Hemcheck Device

waiting. In this study, a blood sample was collected in a 10 mL yellow-capped tube and placed in the Hemcheck device without opening the cap and without clotting. Approximately 100 µL of blood was withdrawn from the sample placed in the Hemcheck device by piercing the cap of the tube with the Hemcheck device needle. The Hemcheck device was determined to be hemolysis present/absent (there are two warning lights on the device; green indicates the absence of hemolysis and red indicates the presence of hemolysis). The same sample was then sent to the laboratory. The hemoglobin concentration is converted to the hemolytic index between 0 and 555 with 1 HI unit equal to 1 mg/dL. The user can define which values are considered positive. In this study, a 100 mg/dL cutoff for hemolysis was considered positive.

The Test Procedure Using The Hemcheck Device:

1. Samples are collected in vacuum tubes and immediately tested for hemolysis.

2. Prepare a V-test I by placing it on a stable flat surface.

3. Open the protective cover of the V-test and insert the dispensing needle into the septum of the vacuum tube without opening the cover.

4. To activate the V-test, the vacuum tube is pressed down toward the dispensing needle by two firm compression in a row. Each compression should be held in the down position for at least 1 second.

5. Once activated, place the V-test in the test chamber of the Reader and press the Start button to begin the hemolysis measurement.

6. When the hemolysis measurement is complete, the results are displayed on the Reader. The result is "hemolysis" (indicator light is solid red) or "no hemolysis" (indicator light is solid green).

Statistical Analysis

Descriptive statistics of the obtained data were defined as mean±standard deviation, number, and frequency, depending on the data type. The agreement between the device and laboratory results was evaluated by kappa statistics, and the diagnostic success of the device was explained by the sensitivity, specificity, and false-positive and false-negative rates. The change in hemolysis rates according to sex, age group, and site was evaluated using the Pearson's chi-squared test. $p \leq 0.05$ was accepted as the level of statistical significance, and SPSS (version 23) was used for the calculations.

Results

A total of 1049 samples from patients admitted to the ED were evaluated. However, when we examined the results of some samples, we found that the biochemical parameters were not included in the content, and some of them were missing the recorded barcode numbers; thus, we excluded a total of 66 (6.3%) samples from the study. The remaining 983 samples were successfully analyzed by our hospital's routine laboratory tests and using the Hemcheck device. When the 983 samples analyzed were separated by sex, 628 (63.9%) belonged to female patients and 325 (33.1%) were male. The mean age of the patients was 49.95±19.5 years, 734 (74.7%) were younger than 65 years, and 249 (25.3%) were elderly. In the evaluation according to the application site, 935 (95.1%) patients were antecubital, 18 (1.8%) were forearm, and 30 (3.1%) were overhand.

To compare the Hemcheck results with the hospital laboratory results and determine the success of the device in detecting hemolysis based on this comparison, the compatibility of these two results was first examined in all patients (Table 1). When the table was examined, 684 (80.7%) of the patients (n=848) who did not have hemolysis according to the hospital laboratory results did not have hemolysis according to the Hemcheck device. This result demonstrates the specificity of the device. In addition, 129 (95.6%) of the patients (n=135) who had hemolysis according to the laboratory results also had hemolysis according to the Hemcheck device. This result demonstrates the device sensitivity. The number of patients who did not have hemolysis according to the laboratory results but had hemolysis according to the Hemcheck device was 164 (19.3%), indicating the false-positive rate of the device. In addition, the number of patients who had hemolysis according to the laboratory test but not according to the Hemcheck device was 6 (4.4%), indicating the false-negative rate of the device. The agreement between the device and laboratory results was good and statistically significant (Kappa=0.511±0.03 and $p<0.001$).

We also evaluated whether the agreement between the Hemcheck device results and the hospital laboratory results varied by sex and age, and the results are shown in Tables 2, 3.

Table 1. Compatibility between the laboratory result and the Hemcheck device

		Hemolytic index			
	n (%)	No	There is	Total	p value
Hemcheck	No	684 (80.7)	6 (4.4)	690	<0.001
	There is	164 (19.3)	129 (95.6)	293	
Total		848	135	983	

Table 2 shows that the agreement between the Hemcheck device and hospital laboratory results was similar in men and women, and significant agreement was found in both. According to the laboratory results, the success (sensitivity) of the Hemcheck device in diagnosing hemolysis was 95% in women and 96.4% in men. In addition, according to the laboratory results, the success (specificity) of the Hemcheck device in diagnosing no hemolysis was 82.1% in women and 78% in men. In addition, the probability of diagnosing hemolysis with the Hemcheck device in patients with positive laboratory results was 5% in women and 3.6% in men, and the probability of diagnosing hemolysis with the Hemcheck device in patients with negative laboratory results was 17.9% in women and 22% in men.

The rate of patients with hemolysis according to laboratory results was 12.7% in women and 15.5% in men, and there was no significant change according to sex (p=0.228, Table 2). In addition, according to the results of the Hemcheck device, the rate of patients with hemolysis was 27.7% in women and 33.5% in men, and significantly more positive results were obtained in men (p=0.050, Table 2).

Table 3 shows that all 734 patients under the age of 65 had no hemolysis according to the laboratory results. However, the Hemcheck device diagnosed 86.6% of these patients as having no hemolysis and 13.2% had hemolysis.

In geriatric patients, the correlation between Hemcheck device and hospital laboratory results was similar and statistically significant. According to the laboratory results in geriatric patients, the success (sensitivity) of the Hemcheck device in diagnosing hemolysis in patients with hemolysis was 95.5%. In addition, the success (specificity) of the Hemcheck device in diagnosing hemolysis in patients without hemolysis was found to be 41.2%. In addition, the probability of the Hemcheck device diagnosing hemolysis was 4.4% in patients with a positive laboratory result, whereas the probability of the Hemcheck device diagnosing hemolysis was 58.8% in patients with a negative laboratory result. These results showed that the false-positive rate was high among geriatric patients. In this case, the device is likely to be positive in elderly patients.

According to the laboratory results, the rate of hemolysis was 0% in people under 65 years of age, whereas it was 54.2% in geriatric patients, and the difference between them was found to be statistically significant (p<0.001, Table 3). In addition, according to the results of the Hemcheck device, the rate of patients with hemolysis was 13.2% in the group under 65 years of age, but it was 78.7% in geriatric patients, and this rate was 78.7% in geriatric patients and was significantly higher (p<0.001, Table 2). According to these results, the rate of hemolysis was higher in geriatric patients compared with that of both the laboratory and Hemcheck devices.

Table 4 shows that the rate of patients with hemolysis according to laboratory results and the rate of patients with hemolysis according to Hemcheck device results did not show a significant change according to location (p values 0.334 and 0.630 respectively, Table 4).

Table 2. Evaluation of the compatibility between the results of the Hemcheck device and the hospital laboratory results separately in both genders

		Woman			Male			p value
		Hemolytic Index			Hemolytic Index			
		N/A (%)	Was (%)	Total (%)	N/A (%)	Was (%)	Total (%)	
Hemcheck	No	450 (82.1)	4 (5.0)	454	234 (78)	2 (3.6)	236	0.050
		98 (17.9)	76 (95)	174 (27.7)	66 (22)	53 (96.4)	119 (33.5)	
Total	Were	548	80 (12.7)	628	300	55 (15.5)	355	
p				0.228				

Table 3. Evaluation of the compatibility between the results of the Hemcheck device and the hospital laboratory results according to the age group

		Under 65 years old			Geriatric			p value
		Hemolytic index			Hemolytic index			
		No (%)	Yes (%)	Total (%)	No (%)	Yes (%)	Total (%)	
Hemcheck	No	637 (86.8)	0	637	47 (41.2)	6 (4.4)	53	<0.001
		97 (13.2)	0	97	67 (58.8)	129 (95.6)	196 (78.7)	
Total	Yes	734		734	114	135 (54.2)	249	
p					<0.001			

Discussion

Hemolysis accounts for approximately 40-70% of all unsuitable specimens and is the leading cause of specimen rejection (6). This may lead to an increase in patient waiting time and delay in diagnosis. Yilmaz Başer et al. (12) emphasized the importance of early diagnosis and treatment for mortality. The purpose of this study was to evaluate the ability of the Hemcheck device to predict hemolysis-related errors in patients presenting to the ED for biochemistry testing.

In the study by Lippi et al. (9) when hemolyzed specimens were classified by clinic, the highest prevalence was 8.8% for specimens collected in the ED. In a study by Mielke et al. (13) focusing on pediatric patients, the rate of hemolysis in EDs was 14%, and the highest prevalence was reported in infants (0-1 years) (20.1%).

The American Society of Clinical Pathology recommends a hemolysis rate of 2% or less, but this standard may be difficult to achieve in the intensive care unit and ED (14). To reduce the rate of hemolysis in the ED, new studies should be conducted to improve blood collection techniques and apply new methods. As a result of our study, based on the laboratory system of our hospital, the specificity of the Hemcheck device was 80.7% and the sensitivity was 95.6%. In a study conducted by Duhalde et al. (15) using the same device and blood gas analysis, the specificity of the same device was found to be 99%, and the sensitivity was 80% when compared with their own laboratories.

These differences provide important information about how the device performs under different laboratory and testing conditions. The high specificity in the study by Duhalde et al. (15) suggests that the device is very effective at reducing false-positive rates, but the sensitivity of 80% suggests that some hemolyzed samples may be missed. On the other hand, the high sensitivity in our study indicates that the device was more successful in detecting hemolyzed specimens, but the specificity of 80.7% indicates that there may be some false positives.

One of the most critical measurements in the ED is the change in a patient's potassium level. Evaluation and treatment of hyperkalemia are priorities in the ED. However, many blood samples falsely report high potassium levels during collection because of hemolysis. In the case of high potassium levels due to hemolysis, a repeat sample must be drawn to confirm the test, which can lead to prolonged hospital stay, multiple blood draws, increased use of healthcare resources, and unnecessary risk to patients (16). In a study by Lam et al. (16), potassium levels were shown to be affected even by the use of hand sanitizers (17). Asirvatham et al. (17) found that all types of mechanical factors that cause hemolysis affect potassium levels. Changes in potassium levels are usually expected in critically ill ED patients. However, hemolysis in samples collected and the resulting changes in potassium levels can lead to misdiagnosis (15). Early detection of hemolysis in critically ill patients may help prevent these errors. In conclusion, early detection of hemolysis in the ED plays a critical role in patient safety and healthcare efficiency. The widespread use of hemolysis detection devices and methods can significantly contribute to preventing such errors and improving the quality of healthcare.

In our study, there was no significant difference in the hemolysis rates of blood samples obtained anatomically from the antecubital fossa, forearm, or upper hand. Of course, the fact that most of the samples were obtained from the antecubital fossa may have influenced the results. However, in a study conducted by Barnard et al. (7), blood samples obtained from the distal part of the antecubital fossa were found to be significantly more likely to be hemolyzed than those obtained from the antecubital fossa.

According to the laboratory results of our hospital, the rate of hemolysis was 0% in people under 65 years of age, whereas it was 54.2% in geriatric patients, and the difference between them was found to be statistically significant ($p<0.001$, Table 3). However, according to the results of the Hemcheck device, the rate of hemolysis was 13.2% in the group under 65 years of age, but it was 78.7% in geriatric patients, and this rate was 78.7% in geriatric patients and was significantly higher ($p<0.001$, Table 2). According to these results, the hemolysis rate was higher in geriatric patients compared with that of both the laboratory and Hemcheck devices. In the study by Jacob et al. (18), similar to our study, the age of the participant was found to be the only demographic characteristic significantly associated with hemolysis (median age 62 years vs. 70 years, $p=0.006$).

Table 4. Frequency of hemolysis obtained from the laboratory and obtained from the Hemcheck device by location

		Hemolytic index	Hemcheck conclusion	Total (n)
		+	+	
Location	Antecubital	125 (13.4)	276 (29.5)	935
	Forearm	4 (22.2)	7 (38.9)	18
	Over hand	6 (20)	10 (33.3)	30

Study Limitations

Our study was prospective and included approximately 1000 patients. The entire procedure was recorded by two observing physicians. The limitation of this study was that the Hemcheck device could not detect the rate of hemolysis because it only responded to the presence or absence of hemolysis. In addition, the fact that the nurses who draw blood on each shift differed may have affected the hemolysis situation.

Conclusion

According to our study, the success of the Hemcheck device in detecting hemolysis from the front was sufficient. It has been observed that this device can reduce negative effects, such as disruption of patient diagnosis and treatment due to hemolysis in EDs, prolonged patient waiting time, and increased workload of emergency personnel.

Ethics

Ethics Committee Approval: This study was conducted in accordance with the tenets of the Declaration of Helsinki and was approved by the Clinical Research Ethics Committee of İstanbul Medeniyet University Göztepe Training and Research Hospital (decision number: 2021/0429, date: 25.08.2021).

Informed Consent: Informed consent was obtained from all participants who voluntarily participated in the study.

Footnotes

Authorship Contributions

Surgical and Medical Practices: S.A., A.C., M.S.A., F.K.İ., Concept: S.A., M.K., M.S.A., F.K.İ., Design: S.A., A.C., M.S.A., F.K.İ., Data Collection or Processing: S.A., M.K., M.S.A., Analysis or Interpretation: S.A., M.S.A., K.A., F.K.İ., Literature Search: S.A., M.K., K.A., Writing: S.A., A.C., M.S.A., F.K.İ.

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

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

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Improving Disaster Preparedness Among Healthcare Professionals: A Comprehensive Approach

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Abstract

Aim: Effective disaster preparedness among healthcare professionals is crucial for efficient emergency response. This study evaluates the disaster preparedness levels of healthcare professionals and identifies factors influencing their readiness.

Materials and Methods: A cross-sectional survey was conducted among 137 healthcare professionals. The survey assessed demographics, professional experience, and disaster preparedness training. Data were analyzed using descriptive statistics, chi-square test, and Mann-Whitney U test.

Results: 65.6% of participants lacked prior disaster preparedness training. Participants with training reported higher confidence in disaster response capabilities. Key skills such as teamwork, stress management, and decision-making were significantly better among those trained ($p<0.05$).

Conclusion: The findings highlight critical gaps in disaster preparedness and emphasize the need for structured, simulation-based, and interdisciplinary training programs.

Keywords: Disaster preparedness, healthcare professionals, emergency response, interdisciplinary training, simulation drills

Introduction

Disaster preparedness is essential for healthcare systems to respond effectively to emergencies. Recent disasters, including pandemics and natural calamities, have stressed the importance of systematic training. Healthcare professionals play a critical role during crises, ensuring the continuity of care and minimizing casualties. However, gaps in training and preparedness can lead to significant inefficiencies in disaster response (1,2).

Globally, the increasing frequency and severity of disasters, from climate-induced events to pandemics like COVID-19, underscore the urgency of equipping healthcare workers with robust disaster response skills. By understanding current preparedness levels and the barriers faced by healthcare professionals, this study aims to provide actionable insights for enhancing disaster readiness.

Materials and Methods

Study Design and Participants

The study employed a cross-sectional design, surveying 137 healthcare professionals from hospitals and emergency services. Participants included physicians, nurses, and allied health staff. The sample size was calculated to achieve statistical power, with an effect size of 0.2, 80% power, and a 5% significance level, to ensure representativeness of the healthcare workforce (3).

Data Collection and Instruments

A structured questionnaire was utilized to evaluate participants' demographic characteristics, professional experience, and levels of preparedness for disaster response. The assessment focused on several key domains, including confidence in disaster response,

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proficiency in handling emergency equipment, the ability to work effectively in a team under stressful conditions, and decision-making skills in crisis situations.

The survey incorporated validated tools, such as the emergency preparedness information questionnaire (EPIQ), to measure perceived readiness and skill levels. Open-ended questions allowed participants to provide qualitative insights into their training experiences and suggestions for improvement (4).

The EPIQ uses a Likert scale for scoring, where participants rate their confidence in specific preparedness domains on a scale from 1 not confident) to 5 (very confident). The final score is calculated as the sum or average of responses, with higher scores indicating greater perceived preparedness.

The questionnaire assessed multiple aspects of disaster preparedness, including participants' familiarity with disaster response protocols, confidence in handling emergency equipment, perceived ability to function effectively within an interdisciplinary disaster response team, and knowledge of hospital disaster plans. A comprehensive list of the questionnaire items is provided in the Appendix 1.

Statistical Analysis

Data analysis involved descriptive statistics, chi-square test, and Mann-Whitney U test to examine correlations between training and preparedness. Demographic variables were analyzed to identify potential disparities in training and confidence levels. Qualitative responses were thematically analyzed to extract recurring themes and suggestions (5).

Results

Demographic Characteristics

The demographic analysis of the study population revealed that 63.3% of the participants were female, while 36.7% were male. The majority of participants (36.7%) were within the age range of 36 to 45 years. Additionally, 35.6% of the respondents had more than 21 years of professional experience, indicating a workforce with substantial expertise in their respective fields.

Training and Preparedness

The analysis of training and preparedness levels revealed that 65.6% of participants had not received any prior disaster preparedness training, highlighting a significant gap in professional education (Figure 1). Furthermore, participants who had undergone training reported significantly higher confidence in their ability to respond effectively to disasters (χ^2=16.83, p=0.002). This relationship is further illustrated in Figure 2, which presents confidence levels stratified according to training status.

Skills Assessment

The analysis of skills among trained and untrained participants revealed significant differences across three key areas:

Trained participants demonstrated a notable improvement in equipment handling skills, with a strong positive correlation (r=0.423) between training status and proficiency. Similarly, interdisciplinary training contributed to enhanced teamwork capabilities, as indicated by a moderate positive correlation (r=0.312). Lastly, participants with training reported higher stress management ability, with a positive correlation of r=0.297.

These findings underscore the critical role of disaster preparedness training in developing essential skills for effective response.

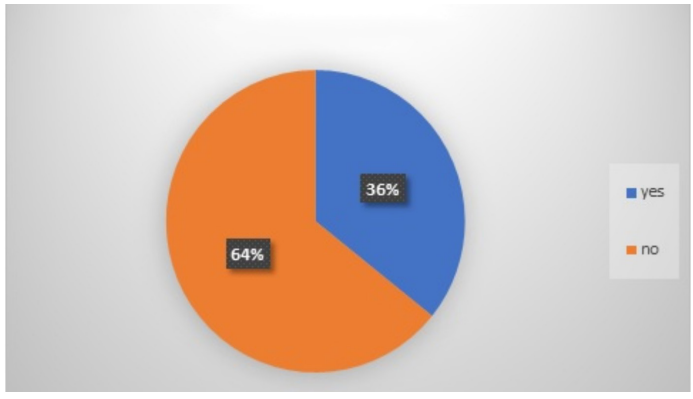

Figure 1. Proportion of participants with and without disaster preparedness raining. A pie chart illustrating the proportion of participants who have received disaster preparedness training versus those who have not. The chart highlights the distribution of trained versus untrained participants in the study, emphasizing the overall preparedness landscape

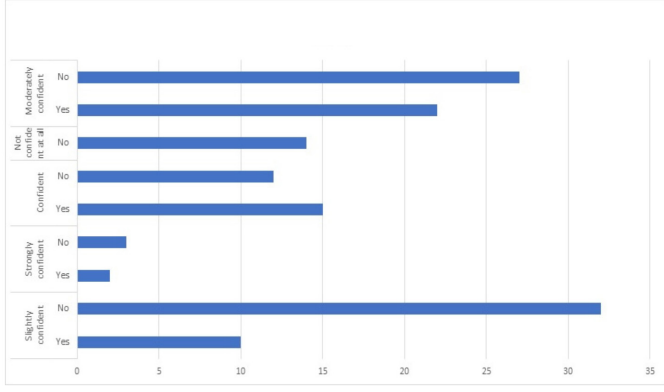

Figure 2. Comparison of confidence levels in disaster response based on training status. A bar chart comparing the confidence levels of participants in responding to disasters, segmented by their training status. Confidence levels are categorized (e.g., low, moderate, high), showing the impact of disaster preparedness training on participants' perceived readiness

Discussion

Addressing Training Deficiencies

The lack of disaster preparedness training among 65.6% of participants highlights a critical gap in healthcare education. This finding is consistent with international studies, which emphasize the need for standardized, comprehensive training programs to ensure readiness across healthcare systems (6,7).

Significance of Confidence Levels

The chi-square analysis demonstrated a statistically significant association between training and confidence levels in disaster response (χ^2=16.83, p=0.002). This reinforces the hypothesis that training enhances both perceived and actual preparedness. Confidence is a pivotal factor influencing decision-making and performance during crises, as highlighted in prior research (8).

Importance of Simulation-Based Training

Simulation-based training emerged as a highly effective method for improving disaster preparedness. Such training not only enhances practical skills but also builds confidence and reduces response times during actual emergencies. For instance, participants in our study who underwent simulation training reported significantly higher preparedness levels than those who only received theoretical instruction (9).

Multidisciplinary Collaboration

Interdisciplinary training fosters improved communication and coordination during emergencies. This is particularly important in disaster scenarios, where seamless collaboration between various healthcare roles is critical for effective response. Previous studies have shown that joint training sessions involving diverse professional groups enhance teamwork and reduce role ambiguity (10).

Role of Psychological Resilience

Stress management is a vital yet often overlooked component of disaster preparedness. Participants who received training in stress management techniques reported better performance under pressure. Incorporating psychological resilience training into disaster preparedness programs can mitigate burnout and improve overall workforce sustainability during prolonged crises (4).

Integration of Technology

The integration of technology, such as virtual reality (VR) and online learning platforms, offers innovative solutions for disaster preparedness training. These tools provide immersive, scalable, and cost-effective training options, making them ideal for large-scale implementation. Recent advancements in VR-based training have demonstrated significant improvements in participants' situational awareness and decision-making skills (8,10). Interprofessional simulation has been shown to enhance collaborative practice and disaster response skills (8).

Recommendations

Structured Training Programs: Develop standardized curricula tailored to the specific needs of different healthcare roles. These programs should include both theoretical knowledge and practical exercises to ensure comprehensive preparedness.

Regular Simulation Drills: Conduct realistic, hands-on training sessions to enhance practical skills and situational awareness. These drills should be tailored to mimic real-world disaster scenarios.

Interdisciplinary Collaboration: Promote teamwork through joint training initiatives that include physicians, nurses, administrative staff, and emergency responders. This approach fosters better communication and role clarity during crises.

Incorporate Psychological Resilience: Include stress management and mental health support in disaster preparedness training modules. This will help healthcare professionals maintain high performance levels during prolonged emergencies (10,11).

Leverage Technology: Utilize VR and e-learning platforms to expand access to disaster preparedness education. These tools can complement traditional training methods and provide flexible, on-demand learning opportunities.

Policy Advocacy: Engage policymakers to make disaster preparedness training a mandatory component of healthcare education and ongoing professional development programs.

Conclusion

This study underscores the critical need for enhanced disaster preparedness among healthcare professionals. By addressing training gaps, fostering collaboration, and leveraging technology, we can build a more resilient healthcare workforce capable of effectively responding to emergencies. Continuous improvement in training programs and policies will ensure better outcomes in future crises. Policymakers, educators, and healthcare institutions must collaborate to implement these recommendations and strengthen the global healthcare system's capacity for disaster response.

Ethics

Ethics Committee Approval: This study is based on a survey conducted among healthcare professionals to evaluate their disaster preparedness levels. As this was an observational survey

study with no intervention and did not involve patient data, it was not subject to ethical committee approval. Additionally, no identifiable personal data were collected during the survey, ensuring compliance with ethical standards for such research.

Informed Consent: The study did not involve any patients or patient-related procedures. Therefore, no patient consent forms are applicable or available for this work. The research exclusively focused on anonymous data collected from healthcare professionals.

Footnotes

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

Financial Disclosure: There is no financial conflict of interest to disclose.

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Appendix 1.

Disaster Preparedness Level Assessment Survey

Section 1: Participant Information

In this section, demographic information of the participants will be collected and basic information to be used in the analysis of the data will be provided.

1. Gender: *

○ Woman

○ Male

2. Age: *

○ 18-25

○ 26-35

○ 36-45

○ 46-55

○ 56 and above

3. Professional Experience (Years) *

○ 0-5

○ 6-10

○ 11-15

○ 16-20

○ 21 and over

4. Type of Institution You Work For *

○ Hospital (Except Emergency Departments)

○ Emergency room

○ Ambulance Services

○ Other:

Disaster Preparedness Level Assessment Survey

Chapter 2: Disaster Preparedness Training

In this section, participants will be questioned whether they have received disaster preparedness training and, if so, what type of training they have received.

5. Have you received disaster preparedness training? *

○ Yes

○ No

6. What type of education did you receive? (You can choose more than one) *

○ Basic Disaster Training

○ Advanced Disaster Training

○ Simulation Training

○ I didn't get it

○ Other:

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Disaster Preparedness Level Assessment Survey

Chapter 3: Disaster Preparedness Level Assessment

In this section, questions are asked to evaluate the participants' level of preparedness for disaster situations.

7. How confident are you in your ability to respond in disaster situations? *

○ I don't trust at all

○ I have little confidence

○ I am moderately confident

○ I trust

○ I trust you very much

8. What is your skill level in using the necessary equipment in disaster situations? *

○ Very low

○ Low

○ Middle

○ High

○ Very High

9. What is your ability to work as a team in disaster situations? *

○ Very low

○ Low

○ Middle

○ High

○ Very High

10. What is your ability to cope with stress in disaster situations? *

○ Very low

○ Low

○ Middle

○ High

○ Very High

11. What is your ability to make quick and accurate decisions in disaster situations? *

○ Very low

○ Low

○ Middle

○ High

○ Very High

12. What is your desire to contribute to disaster preparedness plans? *

○ I have no desire

○ I have little desire

○ I have a moderate desire

○ I have a request

○ I have many requests

13. What are your suggestions for improving disaster preparedness training?(Open-ended) (optional)

Your answer

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Comparison of Ibuprofen and Paracetamol for Fever Management in Sepsis and Septic Shock: A Randomized Controlled Trial

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Abstract

Aim: The aim of this study was to compare the efficacy of ibuprofen and paracetamol in fever management in patients with sepsis and septic shock and to evaluate their effects on body temperature and treatment outcomes.

Materials and Methods: This randomized, parallel-controlled, double-blind study was conducted at Ankara Bilkent City Hospital. Patients aged 18 years and older diagnosed with sepsis or septic shock and presenting with a fever of ≥38.3 °C were randomly assigned to receive either intravenous ibuprofen (400 mg) or paracetamol (1 g). Body temperature was measured before treatment and at 30, 60, and 120 minutes after treatment. The primary outcomes were changes in body temperature and the proportion of patients achieving a body temperature <38.3 °C. Secondary outcomes included rates of adverse effects, complications, and comparisons of severity scores (qSOFA, NEWS2, MEWS).

Results: After excluding patients with incomplete data, a total of 113 patients (64.6% female) were analyzed. Both groups demonstrated a reduction in fever at 30, 60, and 120 minutes. No significant differences were observed between the groups in demographic characteristics, clinical parameters, or severity scores ($p>0.05$). The most common source of infection was pulmonary, followed by urinary system infections. No significant difference in the distribution of infection sources was identified between the groups ($p>0.05$).

Conclusion: Although a significant effect favoring ibuprofen was observed at 30 minutes, both ibuprofen and paracetamol effectively reduced fever in patients with sepsis and septic shock, with no significant difference in efficacy between the two drugs over time.

Keywords: Sepsis, septic shock, ibuprofen, paracetamol, fever management

Introduction

Sepsis is a common and potentially life-threatening inflammatory syndrome caused by an excessive and dysfunctional response of the body to an infection (1). Septic shock occurs as an advanced stage of sepsis and is characterised by organ dysfunction and hypotension due to severe circulatory dysfunction (2). This condition can progress rapidly and significantly increase the patient's risk of death (3). For these reasons, sepsis should be recognised quickly, and treatment initiated early. The scoring used in the diagnosis and treatment of sepsis has been updated in the current guidelines. The latest guidelines recommend that the qSOFA score should not be used alone to diagnose sepsis (4). A study by Mellhammar et al. (5) reported that NEWS2 is superior to qSOFA in detecting sepsis and organ dysfunction. NEWS2 uses measurements such as respiratory rate, oxygen saturation, need for supplemental oxygen therapy, heart rate, blood pressure, level of consciousness, confusion, and body temperature in the context of "airway, breathing, circulation, disturbances and

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stress." In contrast to the qSOFA, this is a general assessment system for all clinical scenarios (6). The mEWS is a useful score for the emergency department and can be calculated more easily than the Early Warning score. It is calculated using 5 vital signs. It performs similarly to the NEWS2 score in predicting 30-day mortality (7).

Fever, which is also included in this scoring system, is a common symptom of sepsis that is generally thought to improve survival (8). The American College of Critical Care Medicine and the Infectious Diseases Society of America define fever as 38.3 °C and above, but there are different recommendations for fever between 38 and 38.5 °C (9,10). Experimental data suggest that elevated body temperature can slow the growth of microorganisms and enhance the host's immune response. However, the high energy expenditure caused by fever in patients with sepsis may exacerbate the life-threatening condition (8). Controlling fever is important for maintaining the balance of body systems and can help prevent potential complications and improve the patient's overall well-being (3). A recent controlled trial in patients with septic shock suggests that external cooling to reduce fever may reduce the need for vasopressors and improve early survival. However, the efficacy of antipyretic drugs in reducing body temperature remains unclear (8). Therefore, pharmacologic treatment of fever should be carefully planned, taking into account the patient's clinical condition (3). In this context, ibuprofen and paracetamol occupy an important place among the pharmacological agents commonly used to reduce fever (10).

In our literature search, we found no studies comparing these two drugs in patients with fever due to sepsis and septic shock. Comparing the efficacy of these two agents could help identify best practices in patient care and optimise treatment strategies. The main objective of this study was to compare the efficacy of ibuprofen and acetaminophen in the treatment of fever in patients with sepsis and septic shock. This study, which is designed as a randomised, controlled, double-blind trial, will comprehensively evaluate the efficacy of both drugs in reducing fever in the acute phase, as well as the response rates to treatment.

Materials and Methods

Study Design

This randomised, parallel-controlled, double-blinded study was conducted at Ankara Bilkent Hospital, a tertiary training hospital for emergency medicine. Patients over the age of 18 who presented to the hospital's emergency department with sepsis and septic shock between October 31, 2023 and October 31, 2024, were screened for possible inclusion in the study. Ethical approval was granted by the Ethics Committee of Ankara Bilkent Hospital No. 2 (desicion number: E2-23-4894, date: 06.09.2023). The study was also registered as a clinical trial with registration number NCT06061575. Patients were included in the study if they were classified as having sepsis and septic shock according to the "surviving sepsis campaign: International guidelines for management of sepsis and septic shock" (4), had a fever of 38.3 °C or more, were older than 18 years, and consented to participate in the study. All patients and their relatives were informed in detail about the study. All patients or their relatives signed a consent form agreeing to participate in the study.

Exclusion Criteria

Patients with a body temperature below 38.3 °C, patients for whom no written or verbal consent could be obtained from themselves or their relatives, patients with previous adverse reactions to the active substance ibuprofen or paracetamol, patients with chronic kidney and liver disease, pregnant women and patients with suspected pregnancy, patients with neuropsychiatric disorders and patients with neuropsychiatric drug use.

Intervention

Patients were divided into two groups: the Ibuprofen group and the Paracetamol group by computer-assisted 1:1 randomization method. In the double-blind study, similar vials were stored by removing the labels and numbering them according to the randomisation sequence. For the patient who met the eligibility criteria, the vial corresponding to the number in the randomisation sequence was delivered by the pharmacist, who removed the top cap, to the nurse who would administer the drug.

Ibuprofen Group: Patients received intravenous ibuprofen 400 mg (DORİFEN 400 mg/4 mL I.V. solution for infusion, VEM İLAÇ San. ve Tic. A.Ş, Tekirdağ/Türkiye).

Paracetamol Group: Intravenous paracetamol 1 g (PAROL 10 mg/mL Vial Containing Solution for Infusion, ATABAY KİMYA SAN. ve TİC. A.S., İstanbul/Türkiye) was administered to the patients.

The patients' body temperature was measured before treatment (minute 0) and 30, 60 and 120 minutes after treatment. The nurse who took the patient's temperature, the researcher who completed the case report form, and the patient were blinded.

The antipyretic effect of treatment was calculated using the differences between post-treatment and pre-treatment (minute 0) fever measurements in each patient: Diff-fever = baseline fever (minute 0) - fever at 30, 60, or 120 minute. Different fever

values were recorded and analysed separately for both groups. Patients for whom the fever measurements at 30, 60 and 120 minute could not be performed, for whom other data were missing, or whose data could not be accessed in any way, were not included in the analysis (per-protocol analysis).

Patients' qSOFA, NEWS2, and MEWS scores were assessed and recorded. Patients' comorbidities (e.g. diabetes, hypertension) were also recorded. Supportive care was provided in accordance with standard protocols for the treatment of sepsis and septic shock.

Primary and Secondary Outcomes

The differences between the baseline temperature values of the patients in the Ibuprofen and Paracetamol groups before treatment and the temperature values measured at 30, 60, and 120 minutes after treatment were compared and recorded as the primary outcome.

Treatment success, as the other primary outcome, was defined as a decrease in temperature below 38.3 °C and recorded as a dichotomous outcome.

The frequency and type of drug-related adverse reactions and possible complications after treatment were recorded as secondary outcomes. Comparative analyses of parameters such as severity score systems and focus of infection were also performed between the two groups.

Statistical Analysis

Study data were recorded on prepared case report forms and transferred to IBM Statistics for MacOS, version 28.0 (Armonk, NY: IBM Corp) for blinded analysis.

Normality of continuous data was assessed using the Shapiro-Wilk test, Q-Q plots, and histograms. Normally distributed parameters were presented as mean, standard deviation, and 95% confidence interval, while non-normally distributed parameters were expressed as median and interquartile range. The medians of non-normally distributed parameters were analysed by Mann-Whitney U test in pairwise comparisons, while the means of normally distributed parameters were compared by Independent sample t-test, in pairwise comparisons. Ratios of categorical data were analysed between groups by Pearson chi-square, or Fisher's exact test. The significance level was set at $p<0.05$.

Sample Size

In the power analysis based on the study by Alaje et al. (11), it was calculated that at least 42 patients should be included in each group with 80% power and 5% Type I error. However, to account for the possible loss of data and to increase the power of the study, the study was planned to include 120 patients, 60 patients in each group.

Results

Demographic and Clinical Characteristics

Demographic and clinical characteristics of the patients in Ibuprofen and Paracetamol groups are presented in Table 1. It was planned to include a total of 120 patients in the two groups, but 2 patients in the Ibuprofen group and 5 patients in the Paracetamol group were lost to follow-up in terms of controlling body temperature and other parameters. As a result, the data of a total of 113 patients, 64.6% of whom were female, were analysed using the per-protocol analysis principle (Figure 1).

When the demographic and clinical characteristics of Ibuprofen and Paracetamol groups were compared, no statistically significant difference was found between the groups in parameters such as age, height, weight, systolic and diastolic blood pressure, pulse rate, and oxygen saturation ($p>0.05$). However, respiratory rate was significantly higher in the Paracetamol group ($p=0.003$).

There was no significant difference between the groups in terms of gender distribution, comorbidities such as diabetes mellitus, malignancy, chronic obstructive pulmonary disease, congestive heart failure, coronary artery disease, oxygen support, and hypercapnic respiratory failure ($p>0.05$). However, the frequency of hypertension was significantly higher in the Ibuprofen group than in the Paracetamol group ($p=0.022$).

No significant difference was observed between the qSOFA, NEWS2, and MEWS scores of the groups ($p>0.05$). In addition, no significant difference was found between the groups in terms of the frequency of confusion and other clinical conditions ($p>0.05$).

Foci of Infection

Table 2 shows the distribution of foci of infection in the Ibuprofen and Paracetamol groups. When analysing the distribution of infection sites in the Ibuprofen and Paracetamol groups, it was found that the most common infection site in both groups was the pulmonary site, with 50.0% in the Ibuprofen group and 41.8% in the Paracetamol group ($p=0.288$). The rate of urinary tract infections was higher in the Paracetamol group (27.3%) compared to the Control group (17.2%); however, this difference was not statistically significant ($p>0.05$).

Gastrointestinal tract infections were only observed in the Ibuprofen group (5.29%), while the distribution of soft tissue infections and other sources of infection showed no significant difference between the groups ($p>0.05$).

Table 1. Comparison of demographic and clinical characteristics between the Ibuprofen and Paracetamol groups				
Variables		**Ibuprofen**	**Paracetamol**	**p value/(Diff % -95% CI)**
Age		64.39±16.93	61.16±18.52	0.335/(-3.37-9.84)*
Gender	Male	22 (37.9)	18 (32.7)	0.563†
	Female	36 (62.1)	37 (67.3)	
Height (cm)		169.44±7.78	170.09±9.43	0.693 (-3.86-2.57)*
Weight (kg)		73.67±12.96	73.87±14.40	0.938 (-5.30-4.90)*
SBP		124.91±28.30	122.69±27.77	0.675/(-8.23-12.68)*
DBP		69.70±12.98	70.90±12.42	0.616/(-5.94-3.54)*
Pulse rate (/min)		96.50±16.70	101.01±18.16	0.171/(-11.01-1.98)*
Oxygen saturation (%)		94.00 (90.75-95.00)	93.00 (88.00-96.00)	0.364‡
Respiratory rate (/min)		18.00 (17.00-20.25)	21.00 (18.00-22.00)	0.003‡
COPD		9 (15.5)	5 (9.1)	0.300†
CAD		11 (19.0)	8 (14.5)	0.530†
CHF		5 (8.6)	3 (5.5)	0.717§
HT		28 (48.3)	15 (27.3)	0.022†
DM		14 (24.1)	15 (27.3)	0.703†
Malignancy		13 (22.4)	9 (16.4)	0.417†
Others		24 (41.4)	22 (40.0)	0.881†
Oxygen support		33 (56.9)	25 (45.5)	0.224†
Hypercapnic respiratory failure		16 (27.6)	12 (21.8)	O.478†
Confusion		28 (48.3)	22 (40.0)	0.376†
qSOFA score		2.0 (2.0-2.0)	2.0 (2.0- 2.0)	0.606‡
NEWS2		9.0 (8.0-10.0)	9.0 (8.0-12.0)	0.444‡
MEWS		5.0 (4.0-6.0)	5.0 (4.0-6.0)	0.272‡

*Independent sample t test, Mean ± SD; †Pearson chi-square test, n (%); ‡Mann-Whitney U test, Median (25-75%); §Fisher's exact test, n (%).
SBP: Systolic blood pressure, DBP: Diastolic blood pressure, COPD: Chronic obstructive pulmonary disease, CAD: Coronary artery disease, CHF: Congestive heart failure, HT: Hypertension, DM: Diabetes mellitus, qSOFA: Quick sequential organ failure assessment, NEWS2: National early warning score 2, MEWS: Modified early warning score, CI: Confidence interval, Diff: Difference

Treatment Efficacy

Table 3 summarises the fever measurements of the patients in the Ibuprofen and Paracetamol groups at the beginning (0 minute), after 30, 60, and 120 minutes, as well as the changes in fever (diff-fever) over time. When comparing the fever measurements and the changes over time in the Ibuprofen and Paracetamol groups, no statistically significant difference was found between the measurements at the beginning (fever -0), at the 30th minute (fever -30), at the 60th minute (fever -60) and at the 120th minute (fever -120).

When the changes in fever were analyzed, it was found that the change in fever -30 was significantly greater in the Ibuprofen group than in the Paracetamol group (1.54±0.77 vs. 1.22±0.73, p=0.026). However, there was no significant difference (p>0.05) between the groups in the changes in fever -60 and fever -120. Fever values of 2 patients in the Ibuprofen group and 1 patient in the Paracetamol group, did not fall below 38.3 °C (p=0.496, Fisher's exact test).

These findings indicate that both treatments had a similar efficacy in terms of reducing fever; but the Ibuprofen group provided a more rapid decrease in fever at 30 minutes.

The left panel of Figure 2 shows the baseline (0 minute) temperature measurements and the mean temperature measurements at 30, 60, and 120 minute in the Ibuprofen and Paracetamol groups with 95% confidence intervals. In both groups, a steady decrease in temperature was observed over time. At 30 minutes, the Ibuprofen group showed a slightly faster decrease in temperature compared to the Paracetamol group, but this difference decreased at subsequent time points. The confidence intervals overlapped, showed similar efficacy.

The right panel shows the changes in fever (diff-fever) in both groups at 30, 60, and 120 minutes. The Ibuprofen group showed a significantly greater decrease in fever at 30 minutes compared to the Paracetamol group (p=0.026). However, when the changes at 60 and 120 minutes were compared between the groups, they were similar and the confidence intervals overlapped.

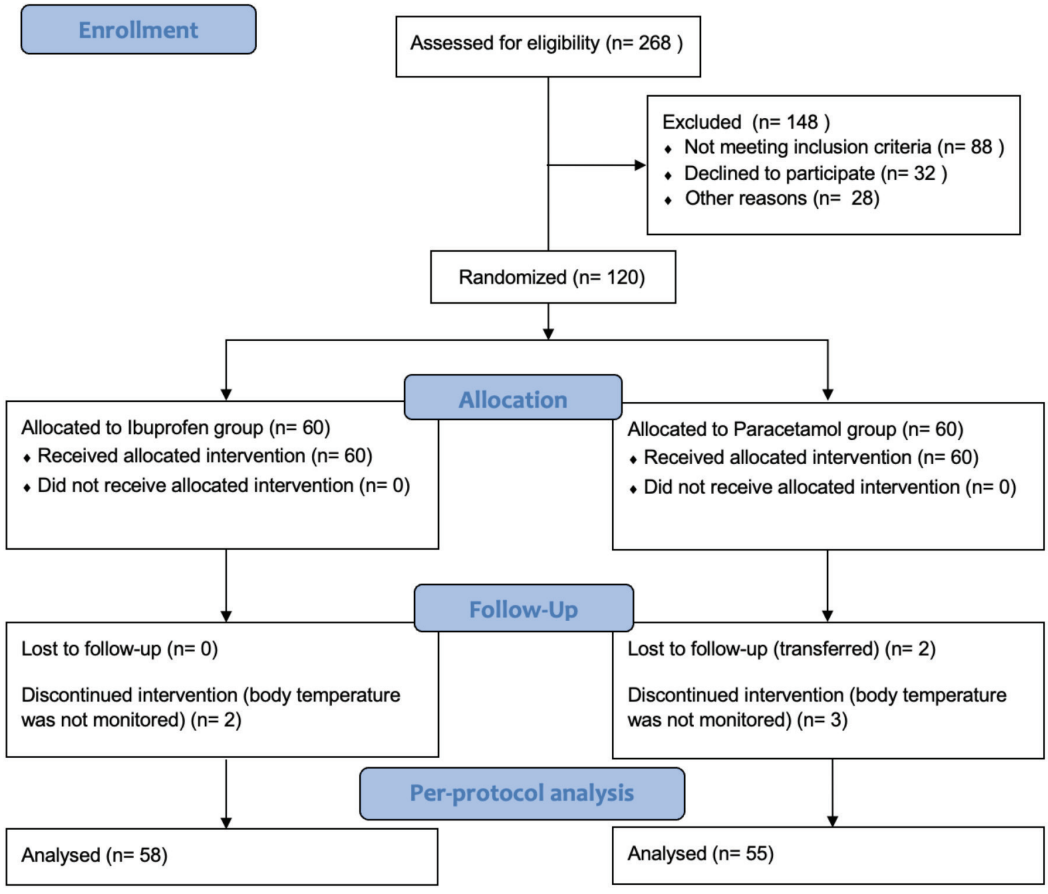

Figure 1. Flowchart of the study

Table 2. Distribution of infection foci between the Ibuprofen and Paracetamol groups

Variables	Ibuprofen	Paracetamol	Total	p value
Pulmonary	29 (50.0)	23 (41.8)	52 (46.0)	0.288
Urinary system	10 (17.2)	15 (27.3)	25 (22.1)	
Gastrointestinal system	3 (5.29	0 (0.0)	3 (2.7)	
Soft tissue	5 (8.6)	7 (12.7)	12 (10.6)	
Others	11 (19.0)	10 (18.2)	21 (18.6)	
Total	58 (100.0)	55 (100.0)	113 (100.0)	
Pearson chi-square test, n (%)				

Side Effects and Complications

No side effects or complications related to the drugs used in the study were observed, except for mild nausea in one patient in the Ibuprofen group.

Discussion

In this study, we aimed to compare the efficacy of ibuprofen and paracetamol in the management of fever in patients with sepsis and septic shock. Our results showed that both drugs were effective in reducing fever, but ibuprofen reduced fever more rapidly. This is the first randomised controlled double-blind study in the management of fever in patients with sepsis and septic shock.

Fever is a pathophysiological and clinically important symptom in patients with sepsis. Although fever is recognised as the body's attempt to fight infection, excessively elevated body temperature can lead to cellular damage, organ dysfunction and increased metabolic demands. Therefore, controlling fever may be a critical step in sepsis management (8). In our study, although both drugs were similarly effective in controlling fever, ibuprofen

Table 3. Comparison of fever measurements and changes over time between the Ibuprofen and Paracetamol groups			
Variables	**Ibuprofen**	**Paracetamol**	**p value/(Diff -95% CI)**
Fever -0	38.65±0.50	38.56±0.42	0.267/(-0.07-0.27)*
Fever -30	37.11±0.75	37.33±0.75	0.118/(-0.50-0.05)*
Fever -60	36.88±0.63	36.86±0.64	0.913/(-0.22-0.25)*
Fever -120	36.76±0.55	36.84±0.59	0.462/(-0.29-0.13)*
Diff-fever -30	1.54±0.77	1.22±0.73	0.026/(0.03-0.60)*
Diff-fever -60	1.78±0.73	1.69±0.75	0.524/(-0.18-0.36)*
Diff-fever -120	1.89±0.67	1.72±0.59	0.139/(-0.05-0.41)*
Persistent fever above 38.3 °C	2 (3.4)	1 (0.0)	0.496†
*Independent sample t test, Mean ± SD; †Fisher's exact test, n (%), CI: Confidence interval, Diff: Difference			

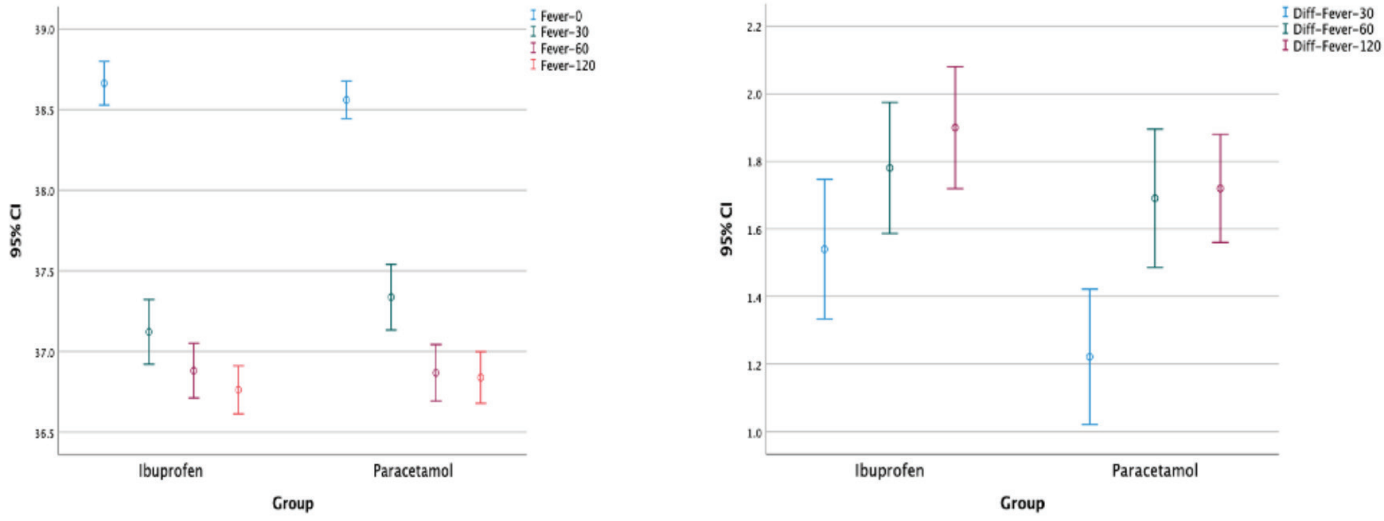

Figure 2. Comparison of fever measurements and changes over time between the Ibuprofen and Paracetamol groups

showed faster results. This difference may be due to the anti-inflammatory properties of ibuprofen, which suppress the body's inflammatory response and reduce fever faster.

In the literature, some randomised controlled trials on the management of fever, have reported similar efficacy of both drugs. For example, Can et al. (9) reported that both groups had similar efficacy when fever measurements at 15, 30, and 60 minutes were analyzed. In our study, although the difference in fever value at 30 minutes, in favour of ibuprofen, was significant, the efficacy of both groups was similar at 60 minutes. Although this is consistent with the literature, it is not possible to make a definite comment on this issue, since our data at 120 minutes needs to be compared.

In another study, Oncel et al. (12) compared ibuprofen and paracetamol in the treatment of fever secondary to tonsillopharyngitis, and reported that ibuprofen showed faster antipyretic activity at 15 minutes, but antipyretic activities were similar at 60 minutes. In our study, the antipyretic activity of the Ibuprofen group was more effective at 30 minutes, and there was no significant difference between the groups at 60 minutes. However, it was not possible to comment on the data at 120 minutes.

Kauffman et al. (13) compared the efficacy of oral ibuprofen and paracetamol in a small sample and stated that ibuprofen may be a safe antipyretic agent. In addition, Wong et al. (14) evaluated the efficacy of oral dipyrone, ibuprofen, and paracetamol doses and suggested that dipyrone and ibuprofen were more effective than paracetamol in reducing fever. In our study, compared to these two studies, although a difference was observed in favour of ibuprofen at 30 minutes, no statistical difference was found between the groups at 60 minutes. This result is not fully compatible with the literature. Jamerson and Haryadi (15) stated that the antipyretic effect of ibuprofen was stronger than that of paracetamol in COVID-19 patients. Especially in comparative studies conducted in children and adults, it was observed that ibuprofen reduced fever more effectively, and this effect lasted

longer. In another study conducted in healthy men aged 18-55 years, it was reported that the combination of ibuprofen 250 mg and paracetamol 500 mg had a more rapid onset of action within 6-8 hours compared to the treatment doses given alone, but all three groups showed similar antipyretic efficacy (16).

In a review of studies in the paediatric population aged 1 month to 12 years, it was reported that ibuprofen reduced fever slightly more effectively than paracetamol in six studies, but this difference was not statistically significant. However, it is generally concluded that both drugs are equally effective (17).

It was also shown that there was no significant difference between the two drugs at doses recommended by the doctor (paracetamol 15 mg/kg, ibuprofen 10 mg/kg) up to 6 hours, and in the 6-48 hour interval. However, in this review, it was reported that ibuprofen was more effective in some studies at over the counter doses (paracetamol 10-15 mg/kg, ibuprofen 2.5-10 mg/kg) (18). In another study conducted with a group of paediatric patients admitted to the emergency department due to fever, ibuprofen was reported to reduce fever more effectively than paracetamol (19). However, at this point, there are situations where the results of our study partially overlap with the literature.

In terms of side effect profile, the results of our study are largely compatible with previous studies in the literature. Derry et al. (20) reported that no serious side effects were observed in ibuprofen and paracetamol combinations. In a systematic review conducted by Alnasser et al. (21) for episodic tension type headaches, it was stated that ibuprofen is less likely to cause general and gastrointestinal side effects compared to placebo and paracetamol, but paracetamol may be preferred in high-risk individuals (e.g., those with renal failure or risk of gastrointestinal bleeding). Another study comparing ibuprofen and paracetamol in the treatment of fever due to tonsillopharyngitis reported that no side effects were observed in either group (12). The side effect profile of our study, generally, supports the literature.

When the literature is analysed, it is seen that ibuprofen is either more effective and faster or has efficacy similar to paracetamol, although there are different disease and age groups. However, ibuprofen shows a superior antipyretic effect in our study at 30 minute, but has similar efficacy at 60 and 120 minute. In light of these findings, we conclude that the pharmacological treatment approach in patients with sepsis should be carefully selected according to the patient's general condition, comorbidities, and response to treatment.

In our study, no significant difference was found in the response rates to treatment, suggesting that both drugs have similar effects in terms of controlling fever. This finding suggests that ibuprofen and paracetamol can be used as effective treatment options in patients with sepsis and septic shock.

Study Limitations

The study has several limitations. These include it was conducted as a single-centre study, the lack of fever monitoring after 120 hours, and the differences in parameters, such as respiratory rate and the presence of hypertension, which affect standardisation between the two groups.

The rapid effect of ibuprofen may be particularly important for symptomatic relief in patients who are unwell because of high fever. However, its effect on long-term patient outcomes should be evaluated in future studies. Although no serious adverse events were reported in the trial, the potential side effects of ibuprofen in long-term use, especially in patients with risk factors such as renal failure or a history of gastrointestinal ulcers, should be considered. Therefore, clinicians must carefully assess patient characteristics when prescribing ibuprofen.

In addition, given the pharmacokinetic properties of ibuprofen and paracetamol, the 120 minute follow-up period in our study may not be sufficient to evaluate long-term antipyretic efficacy. However, this duration is useful for assessing early response during the acute phase. Longer follow-up periods are recommended for future studies.

Conclusion

In conclusion, ibuprofen and paracetamol are effective in the management of acute fever in patients with sepsis and septic shock, and both drugs can be used safely in the treatment of patients. However, it is important to individualise treatment protocols by considering the advantages and disadvantages of both drugs. Factors such as general condition, age and comorbidities may affect the choice of medication and should be carefully evaluated during the treatment process.

Ethics

Ethics Committee Approval: Ethical approval was granted by the Ethics Committee of Ankara Bilkent Hospital No. 2 (desicion number: E2-23-4894, date: 06.09.2023).

Informed Consent: All patients or their relatives signed a consent form agreeing to participate in the study.

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Footnotes

Author Contributions

Surgical and Medical Practices: SD., AŞ., HO., Concept: SD., AŞ., HO, MY.,NİI., Design: SD., AŞ., HO, İA., Data Collection or Processing SD., AŞ., HO., Analysis or Interpretation: SD., AŞ., VS.,RİM., Literature Search: SD., AŞ.,İA., VS., RİM., MY., HO., Writing: SD., AŞ.,İA., NİI., VS., RİM., MY., HO.

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The Initial Step for Emergency Medicine Specialists to Transition into the Intensive Care Sub-Specialty: Subspecialty Examination 2024

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Keywords: Emergency medicine, subspecialty, intensive care, exam

Dear Editor,

The fruition of longstanding efforts to enable emergency medicine specialists in Türkiye to pursue intensive care subspecialty training marks a significant milestone, both in professional advancement and in the development of our country's healthcare system. As a result of over 20 years of dedicated work by emergency medicine associations in Türkiye, spearheaded by the Emergency Medicine Specialists Association, emergency medicine specialists have been granted the right to take the Subspecialty Examination (YDUS).

The Student Selection and Placement Center conducted the first YDUS in this context on December 15, 2024, in Ankara. The Emergency Medicine specialty exam required candidates to complete 60 multiple-choice questions within 80 minutes. No open-ended questions were included.

This important development will allow emergency medicine specialists to enhance their knowledge and skills further, and become integral part of a multidisciplinary team. However, analyzing the content, question distribution, and shortcomings of the first exam will serve as a guide for both candidates preparing for the examination shaping the future structure of these exams.

Content Analysis of YDUS 2024 in The Field of Emergency Medicine

The distribution of the 60 questions in YDUS 2024 has been analyzed. The findings are presented below:

- **Basic Principles of Intensive Care:** Three questions; topics such as ventilator management, hemodynamic support, and infection control were addressed.
- **Emergency Medicine-Related Cases:** Thirty-one questions; questions covered emergency situations such as shock, trauma management, cardiac arrest, airway management, and toxicology.
- **Pharmacology:** Thirteen questions; topics included drug interactions and the management of sedation and analgesia.
- **Basic Medical Knowledge:** Eight questions; questions assessed foundational knowledge acquired during medical school.
- **Guideline Knowledge:** Three questions; current guideline-based information was tested.
- **Scoring Systems and Criteria:** Seven questions; questions focused on clinical scoring systems and criteria.
- **Special Patient Groups and Cases:** Five questions; specific situations, such as pediatric patients, pregnant patients, and environmental emergencies, were addressed.

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- **Questions with Visuals:** Two questions; 1 question featured a plain radiograph, and another included a computed tomography image.
- **Ethical and Legal Issues in Intensive Care:** Zero questions; no questions were categorized under this topic.
- **Topics not Covered;** The exam did not include any questions with electrocardiogram visuals.

Additionally, a closer examination of the questions revealed that 24 were case-based, while four required knowledge of specific facts (1).

This analysis is expected to serve as a valuable resource for preparing for future exams.

Granting emergency medicine specialists, the right to enter the intensive care subspecialty is a significant achievement for our country's healthcare system. However, it is essential to focus on the content of the exams, alignment with the curriculum, and ensure a fair evaluation system during this process. The analysis of the first exam will contribute to the planning of more effective and inclusive exams in the future.

Footnotes

Authorship Contributions

Concept: Y.Y., M.K.Y., Design: Y.Y., M.K.Y., Literature Search: Y.Y., Writing: Y.Y., M.K.Y.

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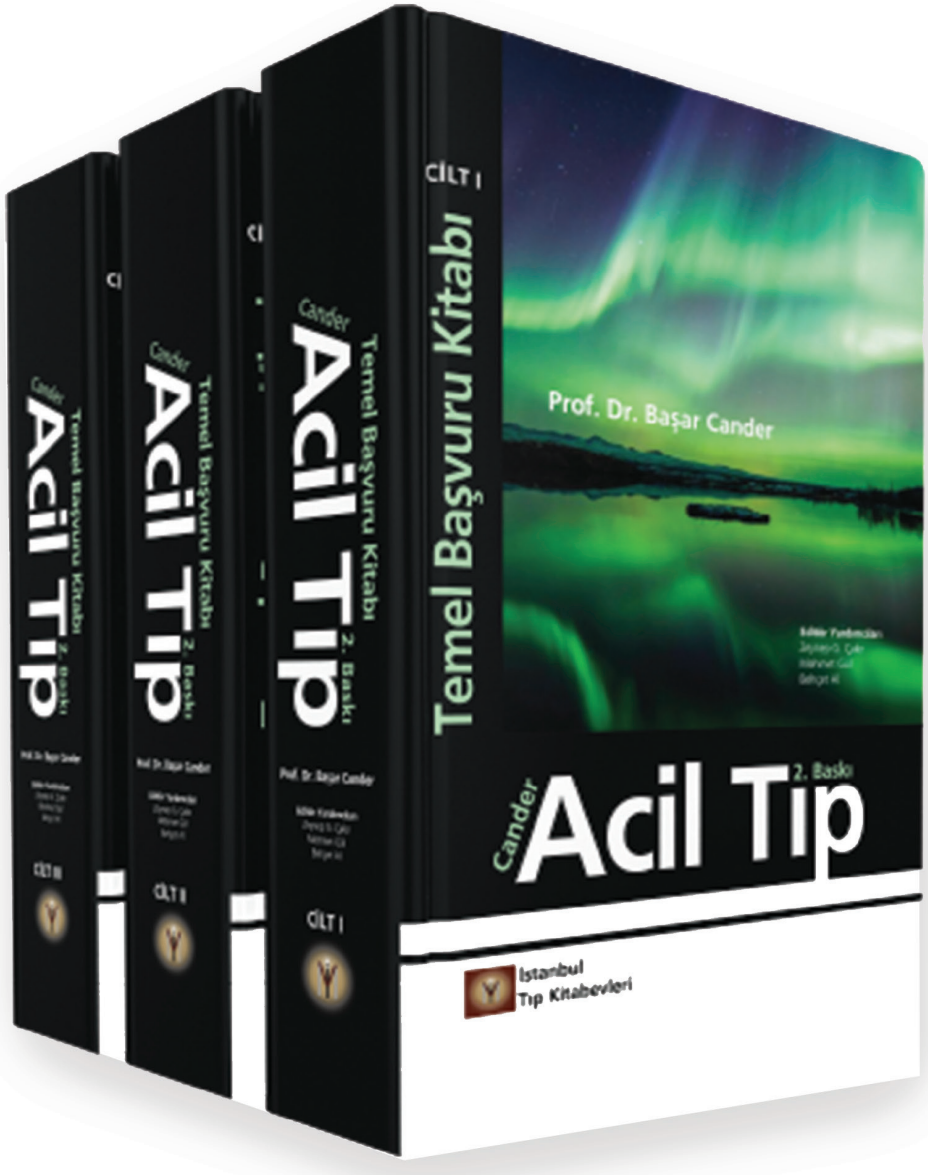

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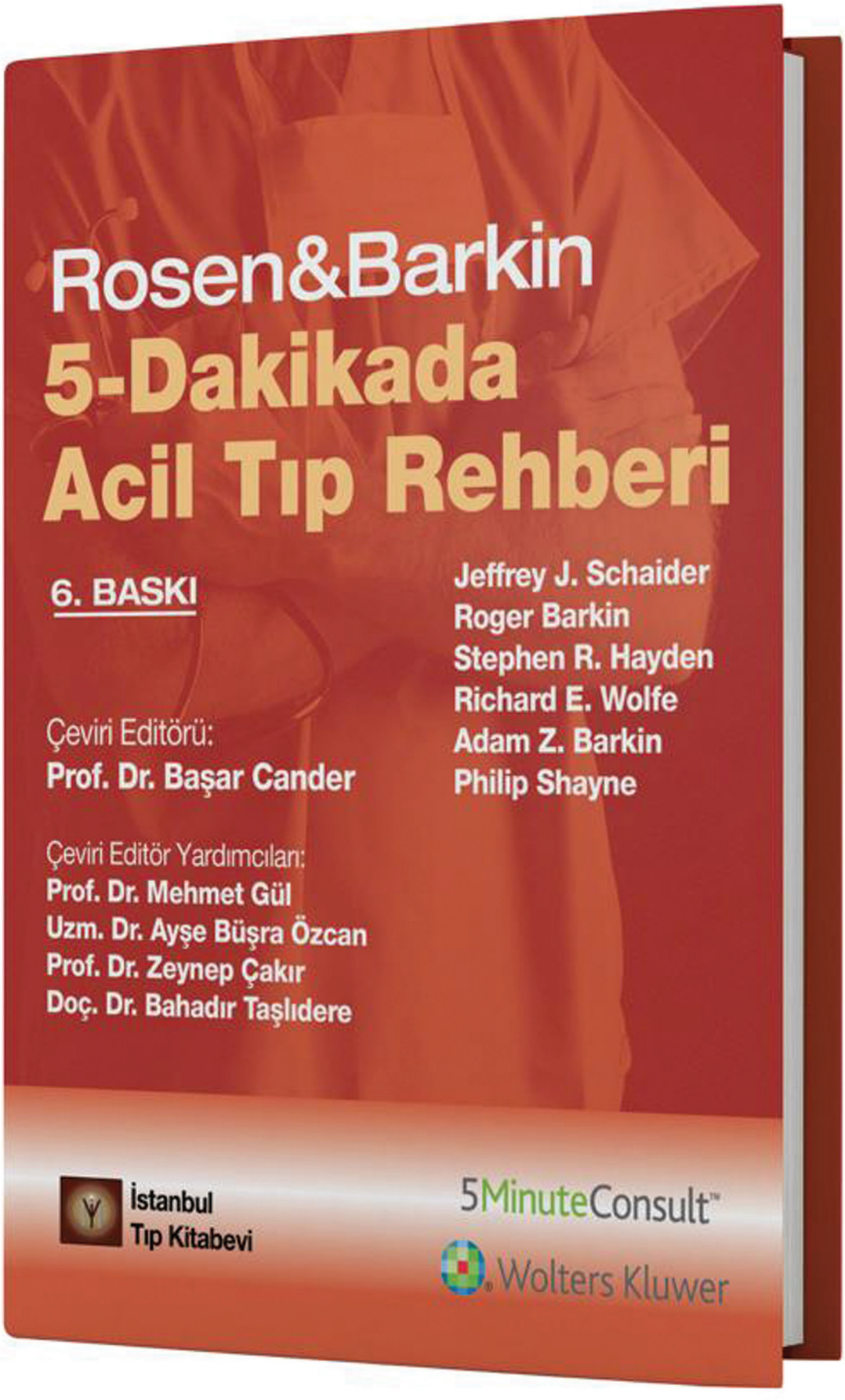
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