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Original Article

Factors Effecting Readmission of Acute Heart Failure Patients to Emergency Department

Ömer Faruk Gülsoy, Gorkem Alper Solakoglu, Ferhat Arslan, Çağatay Nuhoğlu, Şennaz Şahin

Emergency Medicine, Medeniyet University Faculty of Medicine, İstanbul, Türkiye

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Correspondence: Ömer Faruk Gülsoy, Emergency Medicine, Medeniyet University Faculty of Medicine, İstanbul, Türkiye

E-mail: omer.faruk.gulsoy93@gmail.com

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ABSTRACT

Objective: The clear reasons for the re-presentation of acute heart failure patients to the emergency department have not been definitively established in the literature, yet it is anticipated that this patient group will utilize emergency services more frequently in the future. In our study, we aimed to determine the impact of demographic, biochemical, imaging, and outcome variables on the re-presentation to the emergency department within 90 days in patients revisiting due to acute heart failure.

Methods: Patients revisiting the emergency department within 90 days due to acute decompensated heart failure between January 1, 2019, and January 1, 2021, were included in our study. A retrospective analysis of patients' demographic and clinical characteristics was conducted, and factors influencing re-presentation were evaluated.

Results: Our study included 250 patients who revisited the emergency department on average after 34±12.5 days. A significant relationship was observed between patients requiring intensive care unit or hospital admission and their re-presentation within 90 days ($p<0.005$). Furthermore, patients who received non-invasive mechanical ventilation in the emergency department re-presented earlier compared to those who did not ($p<0.005$). Patients' ejection fraction values were also found to be associated with early re-presentation ($p<0.005$). Pearson's R correlation analysis revealed a significant relationship between the use of furosemide within 90 days and re-admission ($r=0.2015$, $p=0.0014$).

Conclusion: Our research demonstrated that re-presentation is influenced by the use of NIMV, furosemide, low ejection fraction, and hospitalization. Consequently, exercising caution while discharging patients receiving NIMV and high-dose furosemide in the emergency department, as well as formulating a follow-up strategy for patients with low ejection fraction in acute heart failure, holds paramount importance.

INTRODUCTION

Heart failure is a disease characterized by multiple acute decompensations, progressive deterioration of heart function, and, eventually, death of the patient. Heart failure has been reported as one of the most important causes of unplanned hospitalizations, along with polypharmacy, urinary incontinence, and dementia.[1,2] It is known that heart failure patients use every aspect of the healthcare system, and the applications of this patient group to primary healthcare services have decreased in recent years,[3] which might eventually lead to more acute decompensations and eventually more utilization of emergency department resources.

Acute heart failure is a global public health problem, and the overall clinical prognosis of patients with acute heart failure is grim.[4] According to U.S. data, acute heart failure results in over one million annual hospitalizations and is one of the leading causes of rehospitalization within 30 days.[5] Patients with acute heart failure are primarily treated in emergency departments, regardless of the severity of their symptoms. Although various studies have been conducted with the aim of reducing hospitalizations for heart failure, the literature lacks detailed information from emergency departments. While some risk factors predicting readmission of heart failure patients have been identified in the literature, there are contradictory views about which parameters are most valuable.[6]

Because heart failure is one of the most common reasons for hospital admission of adults older than 65 years, it is vital to find ways to predict readmission in order to re-

duce costs, morbidity, and mortality.[7] The decision to discharge a patient from the emergency department is generally based on an evaluation of the patient's clinical status, response to treatment, and the presence of acute coronary syndrome.[8] Previous studies have shown that rehospitalization of up to 50% of patients can be prevented with a short follow-up and treatment, suggesting that emergency department discharge criteria need to be revised.[9] Identifying the clinical parameters of heart failure patients that can be easily measured in the emergency department may help clinicians predict hospital readmission and aid in discharge planning.[10] Determining the risk factors for a patient's return to the emergency department may contribute to planning the patient's ongoing treatment.[11]

Our study aimed to determine the effects of demographic, biochemical, imaging, and outcome parameters on readmission rate within 90 days in patients admitted to the emergency department with acute heart failure.

MATERIALS AND METHODS

This study included patients with acute decompensated heart failure who applied to a tertiary research hospital emergency department between January 1, 2019 and January 1, 2021, and who reapplied within 90 days. Based on the results of the HAPPY study, the country-wide population prediction was calculated as 6.9%. Based on this study, the required number of patients was determined as 100 in the sample size calculation made with a 95% confidence interval and 5% margin of error; our study's final sample size included 250 patients. If a patient had more than one application within 90 days, only the data obtained from the first application were included. In this retrospective study, the following information was collected from the hospital information management system (HIMS): sociodemographic information (age, gender); biochemical results, including hemogram, urea, creatinine, CRP, sodium, potassium, calcium, AST, ALT, BNP, pH, lactate; imaging data (echocardiography [ECHO]); noninvasive mechanical ventilation [NIMV] treatment , and patient outcome data (discharge, regular ward admission, or intensive care admission) and hospital length of stay. The normal values of the investigated parameters were as follows: urea 16.6–48.5 mg/dL, creatinine 0.7–1.2 mg/dL, CRP 0–5 mg/dL, sodium 136–145 mEq/L, potassium 3.5–5.5 mEq/L, calcium 8.4–102 mg/dL, pH 7.35–7.45, lactate 0–0.9 mmol/L , and BNP 0–100 pg/mL. Hemogram values were analyzed according to the recommendations of the World Health Organization.[12] In line with the 2021 European Society of Cardiology acute heart failure guidelines, the patients were categorized as having heart failure with a mild/low ejection fraction, heart failure with a preserved ejection fraction, or heart failure with a low ejection fraction.[13] Posteroanterior chest X-rays were analyzed to detect pleural effusion. We also used a scoring system developed by Kobayashi et al.[14] in 2019, which aims to determine the prognosis of heart failure (HF) patients. The reapplication rate of the patients within 90 days was determined using the HIMS and recorded.

Statistical Analyses

The data were analyzed using the SPSS V.19.0 statistical analysis program, and the findings were analyzed at a 95% confidence interval and a 5% significance level.[15] Number and percentage were used to describe categorical data; mean and standard deviation were used for numerical data. Kolmogorov–Smirnov or Shapiro–Wilk test was used to determine whether the groups were normally distributed. Student's t-test and Mann–Whitney U test were selected to evaluate numerical data, and Chi-square test was used to evaluate categorical data. Correlation analysis was performed between the continuous data with a nominal distribution. Linear regression analysis was performed to evaluate the relationship between the data. A value of $p \leq 0.05$ was considered statistically significant.

RESULTS

Our study included 250 patients who were readmitted to the emergency department after an average of 34±12.5 days. The relationships between age, gender, biochemical parameters, diagnostic parameters, the use of NIMV, and the readmission of patients are presented on Table 1. Table 2 shows the relationship between the patients' comorbidities and their readmission. There was a significant difference between the readmission times of discharged patients (n=124) and patients who were hospitalized in the intensive care unit (n=76) ($p<0.005$). There was also a significant difference between the readmission times of patients discharged from the hospital and those admitted to the cardiology ward ($p<0.005$). Table 3 shows the analysis of the parameters affecting readmission using multiple regression analysis; it was determined that hospitalized patients showed a high readmission rate ($p<0.005$). The comorbidities in our patient population included hypertension (n=190), diabetes mellitus (n=96), coronary artery disease (n=121), chronic renal failure (n=71), chronic obstructive pulmonary disease (n=71), atrial fibrillation (n=41), malignancy (n=24), and neurological disease (n=8). The average readmission times of patients with these diseases were 34.94±23.12, 34.83±22.55, 36.35±23.19 35.19±21.79, 30.87±21.57, 38.07±23.91, and 36.8±18 days, respectively.

The potassium values of the patients were categorized as below 3.5 mEq/L, between 3.5 and 5.5 mEq/L, or above 5.5 mEq/L, and were included in the additional analysis. Ten patients had potassium levels below 3.5 mEg/L; 226 patients had potassium levels between 3.5 and 5.5 mEq/L; and 14 patients had potassium levels above 5.5 mEq/L. While hospital readmission and low/average potassium values were correlated ($p=0.0033$), there was no relationship between hospital readmission and average/high potassium values ($p=0.553$).

The mean BNP level was 3463 pg/mL. The effect of BNP value on readmission was not statistically significant ($p=0.648$) A significant relationship was found between furosemide use and readmission time ($r=0.2015$, $p=0.0014$). There was no significant difference between

Table 1. Characteristics of patients and relationship with readmission times

		n	Mean readmission duration in days (Mean+SD)	p	r	CI
Gender						
Male		119	32.25±22.19	0.23	0.48	-2.27 to 9.23
Female		131	35.73±23.84	0.25	0.59	-3.87 to 7.65
Na		250	34.5±5.25	0.39	0.002	-0.07 to 0.17
≤135 meq/L		109	32.46±6.58			
>135 meq/L		143	35.29±4.63			
K		250	44.49±0.63	0.05	0.01	-0.003 to 0.24
≤3.5 meq/L		14	11.22±4.96			
3.5-5.5 meq/L		219	35.41±5.49			
>5.5 meq/L		17	28.93±3.54			
Lactate		250	33.5±1.07	0.89	6.54	-0.13 to 0.11
≤0.9 mmol/L		60	32.7±1.56			
>0.9 mmol/L		190	34.51±4.65			
Hemogram		250	41.18±2.06	0.63	0.008	-0.15 to 0.09
Male	Female					
≤8 g/dl	≤8 g/dl	15	46.56±6.53			
11-8 g/dl	11-8 g/dl	102	49.75±4.98			
13-11 g/dl	12-11 g/dl	65	44.66±3.67			
>13 g/dl	>12 g/dl	68	45.85±2.5			
Blood urea nitrogen		250	40.89±7.98	0.63	0.0009	-0.25 to 0.18
≤48 mg/dl		90	34.39±24.6			
>48 mg/dl		160	34.6±22.42			
Creatinine		250	38.96±3.65	0.92	0.0009	-2.65 to 4.96
≤1.2 mg/dl		118	45.5±9.86			
>1.2 mg/dl		132	45.5±8.75			
C-reactive protein		250	46.97±3.46	0.43	0.08	-3.47 to 1.69
≤100 mg/dl		238	47.45±9.56			
>100 mg/dl		12	45.98±6.63			
Aspartate aminotransferase		250	43.56±9.46	0.11	0.04	-1.98 to 0.62
≤40 mg/dl		221	44.96 ±8.63			
>40 mg/dl		29	42.36±4.36			
Alanin aminotransferase		250	39.78±5.22	0.108	0.025	-2.62 to 0.96
≤40 mg/dl		226	39.75±4.69			
>40 mg/dl		24	39.98±7.32			
ph		250	39.32±4.66	0.156	0.0235	-0.78 to 3.45
≤7.35		68	37.35±5.78			
7.35-7.45		139	40.21±7.65			
>7.45		43	39.86±4.69			
Ejection fraction		250	46.68±12.91			
<41%		98	34.29±23.03	0.02	0.04	-1.10 to 1.12
41%-49%		17	45±0	<0.001	0.009	-0.10 to 0.15
>49%		135	56.78±6.12	0.007	0.01	-2.26 to 0.38
Congestion scores						
1		82	42.6±5.69	0.68	0.12	-2.50 to 7.61
2		146	38.86±7.56	0.15	0.27	-0.004 to 2.15
3		22	37±9.56	0.31	0.96	-1.35 to 3.64
Noninvasive mechanical ventilation						
Yes		28	32.92±22.65	0.02	0.006	-0.57 to 0.98
No		222	43.25±24.91	0.09	0.07	-3.54 to 7.85
Outcome						
Hospitalisation		124	28.22±21.19	0.03	0.06	-0.13 to 0.11
Discharge		50	37.58±22.87	0.000	0.004	-0.25 to 0.89
Intensive care		76	41.33±24.05	0.62	0.15	-1.98 to 1.78
Furosemide dosage						
<140mg		110	28.75±23.10	0.01	0.02	-1.10 to 1.12
>140mg		140	38.59±23.19			

Table 2. Relationship between readmission times and chronic diseases

											|t|	P	Estimate	STD	95% confidence interval
Readmission time in days	1										8.03	<0.0	33.4	4.16	25.2 to 41.6
Hypertension	-0.58	1									0.12	0.89	0.438	3.45	-6.37 to 7.24
Diabetes mellitus	-0.22	-0.15	1								0.47	0.63	-1.4	3.13	-7.65 to 4.70
Coronary artery disease	-0.52	0.05	0.00	1							1.13	0.25	3.57	3.15	-2.64 to 9.78
Valve disease	-0.16	0.03	0.04	0.06	1						1.65	0.09	-11.4	6.94	-25.1 to 2.19
Chronic pulmonary disease	-0.31	0.03	0.02	0.07	0.03	1					1.20	0.22	-4.01	3.32	-10.5 to 2.53
Chronic renal disease	-0.21	-0.05	-0.11	-0.003	0.08	0.12	1				0.30	0.75	-1.05	3.43	-7.81 to 5.70
Neurological disease	-0.26	-0.05	0.15	0.17	0.04	0.00	0.11	1			0.29	0.77	-1.39	4.75	-10.7 to 7.98
Atrial fibrillation	-0.32	-0.03	0.09	0.30	-0.06	0.00	0.07	0.07	1		1.59	0.11	6.78	4.24	-1.57 to 15.1
Malignancy	-0.21	-0.01	0.03	0.09	0.01	0.06	0.04	0.06	0.13	1	0.01	0.989	0.067	4.95	-9.69 to 9.82

Table 3. Multiple regression analysis showing the relationship between parameters affecting readmission time

Variable	Estimate	SE	95% CI	|t|	P
Outcome	5.78	1.54	2.74 to 8.81	3.75	0.0002
Potassium	4.39	2.25	-0.03 to 8.83	1.95	0.05
Congestion score	2.55	2.56	-2.50 to 7.61	0.99	0.32
Ejection fraction	0.12	0.11	-0.09 to 0.34	1.08	0.27
Non-invasive mechanical ventilation	0.14	0.13	0.01- 0.26	1.24	0.02

lactate values (n=190) (p=0.597).

Correlations were found between EF, congestion score, and BNP, and the status of NIMV use. The mean EF value of the patients treated with NIMV was significantly lower (p=0.0144), while the mean congestion score of the patients treated with NIMV was significantly higher (p<0.0001). No significant correlation was found between the BNP values and NIMV need (p=0.9121). An analysis revealed a significant relationship between furosemide use and the 90-day readmission rate (r=0.2015, p=0.0014).

In the study, 124 of the patients were admitted during their first visit. The average duration of hospitalization was determined as 7.48 days with a median of 3.8. While an association was found between the length of hospital stay and hemoglobin levels (p=0.038), no relationship was observed between the length of stay and EF (ejection fraction), the utilization of NIMV in the emergency department, or the dosage of Lasix administered in the emergency department (with respective p-values of 0.952, 0.097, and 0.852).

DISCUSSION

The reasons for hospital readmission within 90 days of a visit to an emergency department with acute heart failure are unclear. In previous studies, the time before hospital readmission of patients presenting with acute heart failure is unclear, the clinical characteristics of patients are ignored, and the treatments provided to patients are varied and not standard. For this reason, standardization is necessary in evaluating the parameters that lead to readmission.

A study of 116 heart failure patients who were hospitalized for any reason found that many comorbidities, in particular depression and chronic lung disease, predicted readmission within 30 days.[16] Another study reported that parameters such as low health literacy, a history of cerebrovascular disease, and not using beta blockers affected readmission within 30 days, mostly in patients with heart failure.[17] Contrary to the literature, our study found that no other disease predicted readmission to the emergency department. Since our study was retrospective, we could not measure the severity of the diseases that might cause early return to the emergency department.

Previous studies have examined the effects of biochemical parameters and the clinical characteristics of patients at the time of admission on out-of-hospital outcomes. For example, in a study evaluating readmission to the emergency department for heart failure, patients' hemoglobin levels were classified according to the criteria of the World Health Organization, and it was observed that anemia increased both hospitalization and emergency department visits.[18] A study of 1.033 patients showed that approximately 10% of patients with BNP, troponin elevation, clinical tachypnea, and dialysis experienced adverse events.[19] In a study examining the readmission of patients discharged from the emergency department, previous percutaneous intervention or bypass, the use of antiarrhythmics, heart rate above 80/min, systolic blood pressure below 140 mmHg, oxygen saturation above 96%, high troponin level, and pleural effusion were shown to be effective.

[20] In a study of patients discharged from the emergency department, 30-day adverse effects were examined, and heart valve disease, COPD, malignancy, New York Class 3, and low serum sodium were found to be predictive for readmission. In that study, the precipitating factors were anemia, acute kidney injury, and a lack of detailed and precise recommendations for discharge.[21] Another analysis stated that a significant portion of the patients reapplied to the emergency department after 16–30 days, and the most influential parameters during the 30-day readmission period were disability, more than one emergency service admission, hospitalization for more than five days at the first admission, and a high BUN value.[22] Another study examining the relationship between discharge from the emergency department and readmission found no relationship between readmission and patients' age, gender, blood pressure, EF, or coronary artery disease, while a relationship was found between readmission and high creatinine levels and previous hospitalization due to HF.[23]

In our study, EF and potassium levels lower than accepted clinical values were predictive of readmission, while no effects on readmission were demonstrated for other parameters, including BNP and anemia. Anemia is a clinical condition that has been shown to affect mortality and morbidity in heart failure patients, and clinicians provide effective treatment for heart failure patients with anemia. [23] Therefore, anemia evaluated in the emergency department may not have affected readmission, as the condition is likely to be treated after hospitalization at outpatient clinics. As ejection fraction is one of the main determinants of the severity of heart failure and a worse prognosis,[24] a relationship between low ejection fraction and early return to the emergency department is expected.

Indices such as HOSPITAL, which are based on data that can be easily obtained retrospectively, such as hospitalization, hemoglobin level, and emergency service admissions, have been put forward in evaluating readmissions to hospitals due to various diseases. However, the relationship between these scores and the readmission of acute heart failure patients to emergency services has not been demonstrated.[25] In a study performed on 704 patients with previously mentioned scores,[25] the hospitalization of heart failure patients was found to be a predictor of unplanned visits to the emergency department within 30 days, which is in line with the results of our study.

As can be seen, most of the studies in the literature are retrospective studies conducted with a small sample in a single center. Even though emergency departments are the first place to treat patients with acute heart failure, large population and intervention studies may overlook emergency department data[26] and only a small number of studies have investigated treatments given in emergency departments, ejection fraction parameters, and standard pleural effusion scores. In our study, hospital readmission increased with low EF, hospitalization, and NIMV and furosemide treatment. Among these, hospitalization mainly determines readmission. NIMV is used more frequently in patients with high congestion scores and low EF, and patients who receive NIMV and have a low EF are more frequently hospitalized from the emergency department. Our study revealed the importance of predicting future readmissions of patients based on the performance of ECHO by emergency physicians. In a study of over 10.000 patients discharged home after hospitalization for heart failure, follow-up with a cardiologist or general medical provider within seven days of discharge was found to reduce 30-day hospital readmission.[27] According to our results, patients who received NIMV or high-dose furosemide treatment in the emergency department or who had a low EF were re-admitted to the emergency department. Careful post-discharge plans for this patient group, follow-up with a cardiology consultation, and necessary medication adjustments may reduce readmission.[28]

The most important limitation of our study is that it was a single-center study with a relatively small number of patients and, in particular, a small number of young heart failure patients. Also, only the applications to our hospital were evaluated, although applications to private or other hospitals may have occurred during the study period. In addition, echocardiograms were not performed by a single physician, but by a physician who was scheduled to perform the examination that day. For this reason, there may not have been standardization in evaluating the echocardiograms. The fact that some of the chest radiographs used in the evaluation of the congestion score of the patients were conducted at the bedside may have resulted in a suboptimal imaging evaluation.

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Ethics Committee Approval

This study approved by the Medeniyet University Faculty of Medicine Ethics Committee (Date: 30.03.2022, Decision No: 2013-KAEK-64).

Informed Consent

Retrospective study.

Peer-review

Externally peer-reviewed.

Authorship Contributions

Concept: Ö.F.G., G.A.S.; Design: Ö.F.G., G.A.S., Ş.Ş.; Supervision: G.A.S., F.A.; Fundings: Ö.F.G., F.A.; Materials: Ö.F.G., Ş.Ş.; Data: Ö.F.G., G.A.S.; Analysis: Ö.F.G., G.A.S; Literature search: Ö.F.G., G.A.S., F.A, Ç.N.; Writing: Ö.F.G., F.A, Ç.N.; Critical revision: G.A.S., C.N.

Conflict of Interest

None declared.

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Akut Kalp Yetmezliği Hastalarının Acil Servis Tekrar Başvurularını Etkileyen Faktörler

Amaç: Akut kalp yetmezliği hastalarının acil servise tekrar başvurusunu nedenleri literatürde net olarak ortaya konmamıştır ve gelecekte bu hasta grubunun acil servisi daha sık kullanacağı öngörülmektedir. Çalışmamızda, acil servise akut kalp yetmezliği nedeni 90 gün içinde tekrar başvuran hastaların demografik, biyokimyasal, görüntüleme ve sonlanım değişkenlerinin tekrar başvuruya etkisini belirlemeye çalıştık

Gereç ve Yöntem: Çalışmamıza 1 Ocak 2019-1 Ocak 2021 tarihleri arasında 90 gün içinde akut dekompanse kalp yetmezliği nedeni ile acile servise tekrar başvuran olan hastalar dahil edildi. Hastaların demografik ve klinik özelliklerinin retrospektif analizi ve yeniden başvuruyu etkileyen faktörlerin değerlendirilmesi yapıldı.

Bulgular: Çalışmamıza ortalama 34±12.5 gün sonra tekrar acil servise başvuran 250 hasta dahil edildi.Hastaların yoğun bakım veya servise yatırılmaları ile 90 gün içinde tekrar başvurmaları arasında anlamlı ilişki saptanmıştır. ($p<0,005$). Ek olarak acil serviste non-invazif mekanik ventilasyon alan hastaların acil servise tekrar almayanlara göre daha erken başvurmaktadır ($p<0,005$). Hastaların EF değerleri de erken tekrar başvuru ile ilişkili bulundu. ($p<0,005$). Pearson'ın R korelasyon analizi, 90 gün içinde furosemid kullanımı ile yeniden kabul arasında anlamlı bir ilişki olduğunu ortaya kondu ($r=0.2015$, $p=0.0014$).

Sonuç: Araştırmamız, yeniden başvurunun NIMV kullanımı, furosemid kullanımı, hastanın ejeksiyon fraksiyonunun düşük olması ve hastaneye yatıştan etkilendiğini göstermiştir. Sonuç olarak, acil serviste NIMV ve yüksek doz furosemid uygulanan hastaların ve düşük ejeksiyon fraksiyonu olan akut kalp yetmezliği hastalarını taburcu ederken titiz davranmak ve hastalar için takip stratejisi oluşturmak önem arz etmektedir.

Anahtar Sözcükler: Acil servis; hastane; hastanın yeniden başvurusu; kalp yetersizliği.