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Original Research Article

Predictors of Rehospitalization in Patients with Acute Decompensated Heart Failure (ADHF)

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Abstract

Background: Acute decompensated heart failure (ADHF) is a major cause of hospitalisation and is associated with frequent rehospitalisation, leading to increased morbidity, mortality, and healthcare costs. Early identification of patients at high risk of readmission is essential for improving outcomes.

Methods: This prospective observational study included 150 patients admitted with ADHF at a tertiary care hospital. Demographic characteristics, comorbidities, laboratory investigations, echocardiographic parameters, lung ultrasound findings, Venous Excess Ultrasound Score (VExUS), and discharge medications were recorded. Patients were followed for 180 days for rehospitalisation. Univariable and multivariable logistic regression analyses were performed to identify independent predictors.

Results: During follow-up, 45 patients (30.0%) experienced rehospitalisation. Rehospitalised patients were significantly older and had a higher prevalence of hypertension, diabetes mellitus, chronic kidney disease, and previous heart failure admission. They also had significantly higher serum creatinine, NT-proBNP, pulmonary artery systolic pressure, lung B-line score, and residual congestion, along with lower eGFR, serum sodium, LVEF, and TAPSE (all $p<0.05$). Multivariable analysis identified residual congestion at discharge (aOR 4.21), previous heart failure admission (aOR 3.06), hyponatraemia (aOR 2.72), NT-proBNP >7500 pg/mL (aOR 2.44), eGFR <60 mL/min/1.73 m² (aOR 2.18), and VExUS ≥2 (aOR 1.97) as independent predictors of rehospitalisation.

Conclusion: Residual congestion, previous heart failure admission, renal dysfunction, hyponatraemia, elevated NT-proBNP, and increased VExUS score independently predicted 180-day rehospitalisation in patients with ADHF. Early risk stratification and optimisation of discharge management may reduce recurrent hospitalisations.

Keywords: Acute decompensated heart failure (ADHF); Rehospitalization; Residual congestion; NT-proBNP; VExUS; Guideline-directed medical therapy; Renal dysfunction; Prognostic factors.

Introduction

Heart failure (HF) is a progressive syndrome in which structural or functional myocardial abnormalities prevent the heart from delivering adequate blood flow to meet metabolic needs at rest or during activity [1]. Patients typically present with exertional dyspnoea, peripheral oedema and declining exercise tolerance. HF spans the full spectrum of left-ventricular ejection fraction (LVEF) and is now classified as reduced, mildly reduced or preserved ejection fraction [1]. Beyond haemodynamic impairment, disease progression is driven by sympathetic activation, the renin–

angiotensin–aldosterone system and inflammatory pathways, leading to adverse cardiac remodelling [2].Despite therapeutic advances, HF remains a major public-health challenge: prevalence is about 1–2 % in the general population and exceeds 10 % among adults over 70 years [2]. Ageing populations and improved survival after acute cardiovascular events continue to enlarge the pool of patients living with HF, while the proportion with preserved ejection fraction is steadily rising [3].Acute decompensated heart failure (ADHF) represents either the first clinical presentation of HF or, more commonly, an acute deterioration of chronic disease that necessitates urgent hospitalisation [1]. Among adults ≥ 65 years, ADHF is the leading cause of unplanned admission [4]. Although most patients stabilise during the index stay, the early post-discharge period is hazardous: roughly one in five individuals are readmitted within 30 days and up to half within six months [5]. Recurrent hospitalisations accelerate ventricular remodelling, exacerbate frailty, diminish quality of life and markedly increase long-term mortality [6]. They also impose a substantial economic burden on health-care systems [2].Readmission is driven by a complex interplay of haemodynamic, renal, neuro-hormonal, behavioural and system-level factors. Easily identified clinical markers—advanced age, prior HF admission, higher New York Heart Association class, tachycardia and low systolic blood pressure—flag patients at heightened risk [1], whereas laboratory abnormalities such as persistent elevation of natriuretic peptides, hyponatraemia, anaemia, hypoalbuminaemia and worsening renal function provide additional prognostic insight [7]. Echocardiographic indices of ventricular dysfunction and imaging evidence of residual congestion refine risk stratification, and persistent congestion at discharge is a powerful driver of early relapse [8]. Point-of-care venous ultrasound scores, notably the Venous Excess Ultrasonography Score (VExUS), further improve prediction of short-term readmission [9]. Non-cardiac comorbidities—including chronic kidney disease, diabetes mellitus, chronic obstructive pulmonary disease, atrial fibrillation and depression—also modulate outcomes [10].

Several rehospitalisation risk scores have been proposed, but performance varies because most were derived from single-centre cohorts, excluded contemporary disease-modifying therapies or omitted emerging congestion metrics [10]. Therefore, this study was designed to study the Predictors of Rehospitalization in Patients with Acute Decompensated Heart Failure (ADHF).

Methodology:

This is Prospective, single-centre cohort study carried out in the medicine department of a tertiary-care teaching hospital.One hundred fifty (n = 150) consecutive adults hospitalised with acute decompensated heart failure (ADHF). Size was calculated for an expected 30 % 6-month readmission rate (precision 7 %, 95 % confidence, 10 % attrition).

Eligibility

- Inclusion: age ≥ 18 y; primary diagnosis ADHF; informed consent.
- Exclusion: cardiogenic shock needing MCS, STEMI requiring immediate PCI/CABG, terminal non-cardiac illness (< 6 mo), or inability to complete follow-up.

Data collected

- Baseline: demographics, comorbidities, precipitating factors, NYHA class, vital signs.
- Laboratory: creatinine, electrolytes, haemoglobin, albumin, BNP/NT-proBNP (admission & discharge).
- Imaging: transthoracic echocardiography (LVEF, LA volume, TAPSE, PASP), lung ultrasound B-line score, Venous Excess Ultrasound Score (VExUS) within 24 h pre-discharge.
- Therapy: in-hospital IV diuretics/inotropes; guideline-directed medical therapy (GDMT) at discharge; discharge planning details.

Follow-up

Participants were followed for 180 days via clinic visits (30, 90, 180 d) and telephone calls; unplanned admissions ≥ 24 h to any hospital were verified with records.

Outcomes

- Primary: all-cause rehospitalisation within 180 days.
- Secondary: cardiovascular rehospitalisation, time-to-first rehospitalisation, all-cause mortality.

Statistical analysis

Continuous data: mean ± SD or median (IQR); categorical: n (%). Group comparisons with t/Mann–Whitney U or χ^2/Fisher tests. Variables with $p < 0.10$ entered into multivariable logistic regression; results expressed as adjusted odds ratio (aOR) with 95 % CI. Model performance assessed by AUC and Hosmer–Lemeshow goodness-of-fit. Significance set at $p < 0.05$. Analyses performed using SPSS v29.

Results:

A total of 150 patients with acute decompensated heart failure (ADHF) were included, of whom 45

(30.0%) were rehospitalised within 180 days. Rehospitalised patients were significantly older than those without rehospitalisation (66.3 ± 11.8 vs. 60.8 ± 13.0 years; p=0.028). Hypertension (84.4% vs. 66.7%; p=0.030), diabetes mellitus (66.7% vs. 48.6%; p=0.040), previous heart failure admission (73.3% vs. 36.2%; p<0.001), and chronic kidney disease (62.2% vs. 34.3%; p=0.002) were significantly more frequent in the rehospitalised group, whereas sex and BMI were comparable between the groups (Table 1).Rehospitalised patients had significantly lower haemoglobin (11.7 ± 1.8 vs. 12.4 ± 1.9 g/dL; p=0.041), higher serum creatinine (1.62 ± 0.49 vs. 1.27 ± 0.39 mg/dL; p<0.001), lower eGFR (49.6 ± 15.4 vs. 62.1 ± 18.3 mL/min/1.73 m²; p<0.001), lower serum sodium (133.7 ± 4.9 vs. 136.7 ± 4.0 mmol/L; p=0.002), higher serum potassium (4.5 ± 0.7 vs. 4.2 ± 0.5 mmol/L; p=0.030), and higher NT-proBNP levels (8140 vs. 5420 pg/mL; p=0.014) (Table 2).Compared with patients without rehospitalisation, rehospitalised patients had lower LVEF (30% vs. 36%; p=0.003), lower TAPSE (17.4 ± 3.5 vs. 19.1 ± 3.7 mm; p=0.008), higher PASP (49.8 ± 11.1 vs. 44.8 ± 10.3 mmHg; p=0.020), higher lung B-line scores (16 vs. 10; p<0.001), more frequent VExUS ≥2 (40.0% vs. 20.0%; p=0.022), and greater residual congestion at discharge (64.4% vs. 18.1%; p<0.001) (Table 3).

Prescription rates of ACEI/ARB/ARNI, mineralocorticoid receptor antagonists, SGLT2 inhibitors, and triple GDMT were significantly lower among rehospitalised patients (all p<0.05), whereas β-blocker use was comparable between groups (Table 4, Figure 1).Univariable analysis showed that residual congestion (OR 8.37), previous heart failure admission (OR 4.31), hyponatraemia (OR 3.10), eGFR <60 (OR 2.99), VExUS ≥2 (OR 2.65), NT-proBNP >7500 pg/mL (OR 2.56), and LVEF <35% (OR 2.37) were significant predictors of 180-day rehospitalisation (Table 5, Figure 2).After adjustment, residual congestion at discharge remained the strongest independent predictor of rehospitalisation (adjusted OR 4.21; p<0.001), followed by previous heart failure admission (adjusted OR 3.06; p=0.007), hyponatraemia (adjusted OR 2.72; p=0.014), NT-proBNP >7500 pg/mL (adjusted OR 2.44; p=0.038), eGFR <60 (adjusted OR 2.18; p=0.048), and VExUS ≥2 (adjusted OR 1.97; p=0.046) (Table 6, Figure 3).

Table 1. Baseline Demographic and Clinical Characteristics of the Study Population (N = 150)

Variable	Total (N= 150)	Rehospitalised (n=45)	Not Rehospitalised (n=105)	p-value	Statistical Test
Age (years), mean ± SD	62.4 ± 12.9	66.3 ± 11.8	60.8 ± 13.0	0.028	Independent t-test
Male, n (%)	94 (62.7)	31 (68.9)	63 (60.0)	0.300	Chi-square test
Female, n (%)	56 (37.3)	14 (31.1)	42 (40.0)		
BMI (kg/m²), mean ± SD	28.3 ± 4.8	29.1 ± 4.7	28.0 ± 4.8	0.170	Independent t-test
Hypertension, n (%)	108 (72.0)	38 (84.4)	70 (66.7)	0.030	Chi-square test
Diabetes mellitus, n (%)	81 (54.0)	30 (66.7)	51 (48.6)	0.040	Chi-square test
Previous HF admission, n (%)	71 (47.3)	33 (73.3)	38 (36.2)	<0.001	Chi-square test
CKD, n (%)	64 (42.7)	28 (62.2)	36 (34.3)	0.002	Chi-square test

Table 2. Admission Laboratory Parameters

Variable	Total	Rehospitalised	Not Rehospitalised	p-value	Statistical Test
Haemoglobin (g/dL)	12.2 ±1.9	11.7 ±1.8	12.4 ±1.9	0.041	Independent t-test
Serum Creatinine (mg/dL)	1.38 ±0.44	1.62 ±0.49	1.27 ±0.39	<0.001	Independent t-test

eGFR (mL/min/1.73m²)	58.4 ±18.2	49.6 ±15.4	62.1 ±18.3	<0.001	Independent t-test
Serum Sodium (mmol/L)	135.8 ±4.4	133.7 ±4.9	136.7 ±4.0	0.002	Independent t-test
Serum Potassium (mmol/L)	4.3 ±0.6	4.5 ±0.7	4.2 ±0.5	0.030	Independent t-test
NT-proBNP (pg/mL)	6240 ±5180	8140 ±5960	5420 ±4620	0.014	Mann–Whitney U test

Table 3. Echocardiographic and Congestion Parameters

Variable	Total	Rehospitalised	Not Rehospitalised	p-value	Statistical Test
LVEF (%)	34 (28–42)	30 (24–38)	36 (30–44)	0.003	Mann–Whitney U test
TAPSE (mm)	18.6 ±3.7	17.4 ±3.5	19.1 ±3.7	0.008	Independent t-test
PASP (mmHg)	46.2 ±10.8	49.8 ±11.1	44.8 ±10.3	0.020	Independent t-test
Lung B-line score	12 (8–18)	16 (11–22)	10 (6–15)	<0.001	Mann–Whitney U test
VExUS ≥2, n (%)	39 (26.0)	18 (40.0)	21 (20.0)	0.022	Chi-square test
Residual congestion, n (%)	48 (32.0)	29 (64.4)	19 (18.1)	<0.001	Chi-square test

Table 4. Guideline-Directed Medical Therapy at Discharge

Medication	Total	Rehospitalised	Not Rehospitalised	p-value	Statistical Test
ACEI/ARB/ARNI	129 (86.0)	35 (77.8)	94 (89.5)	0.045	Chi-square test
β-blocker	135 (90.0)	38 (84.4)	97 (92.4)	0.140	Chi-square test
MRA	114 (76.0)	29 (64.4)	85 (81.0)	0.032	Chi-square test
SGLT2 inhibitor	69 (46.0)	15 (33.3)	54 (51.4)	0.022	Chi-square test
Triple GDMT	103 (68.7)	25 (55.6)	78 (74.3)	0.022	Chi-square test

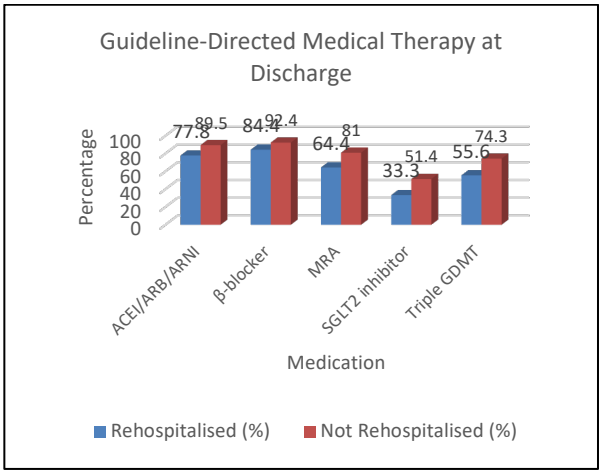

Figure 1. Guideline-Directed Medical Therapy at Discharge

Table 5. Univariable Logistic Regression Analysis for Predictors of 180-Day Rehospitalisation

Variable	Odds Ratio	95% CI	p-value
Previous HF admission	4.31	2.05–9.07	<0.001

LVEF <35%	2.37	1.17–4.80	0.017
Hyponatraemia	3.10	1.49–6.47	0.002
eGFR <60	2.99	1.47–6.08	0.003
NT-proBNP >7500 pg/mL	2.56	1.24–5.29	0.011
Residual congestion	8.37	3.70–18.90	<0.001
VExUS ≥2	2.65	1.28–5.47	0.009
Univariable Logistic Regression			

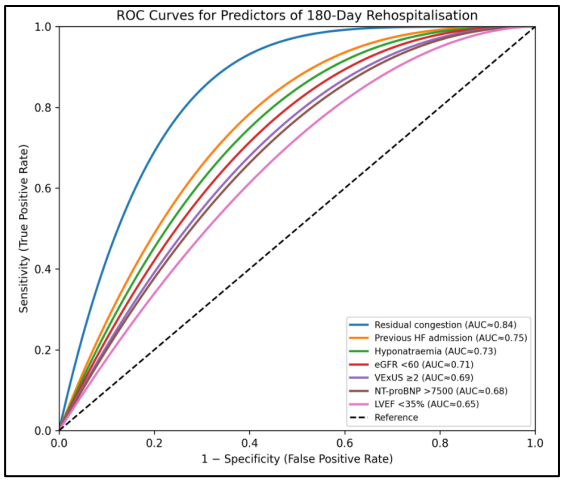

Figure 2. Univariable Logistic Regression Analysis for Predictors of 180-Day Rehospitalisation

Table 6. Multivariable Logistic Regression Analysis for Independent Predictors of 180-Day Rehospitalisation

Variable	Adjusted OR	95% CI	p-value
Residual congestion at discharge	4.21	1.95–9.10	<0.001
Previous HF admission	3.06	1.36–6.87	0.007
Hyponatraemia	2.72	1.22–6.05	0.014
NT-proBNP >7500 pg/mL	2.44	1.05–5.69	0.038
eGFR <60	2.18	1.01–4.71	0.048
VExUS ≥2	1.97	1.01–3.83	0.046
Multivariable Logistic Regression			

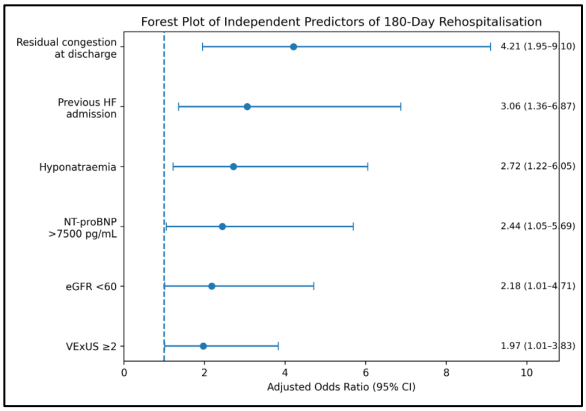

Figure 3. Multivariable Logistic Regression Analysis for Independent Predictors of 180-Day Rehospitalisation

Discussion

In the present study, 30.0% (45/150) of patients were rehospitalised within 180 days. Rehospitalised patients were significantly older (66.3 ± 11.8 vs. 60.8 ± 13.0 years; p=0.028) and had a higher prevalence of hypertension (84.4% vs. 66.7%), diabetes mellitus (66.7% vs. 48.6%), previous heart failure admission (73.3% vs. 36.2%), and chronic kidney disease (62.2% vs. 34.3%). Harmon et al. [11] reported a 21.2% 90-day readmission rate in HFpEF patients, identifying advanced age and greater comorbidity burden as important predictors of readmission. Similarly, Hidayaturrohman and Hanada [12] highlighted age, comorbidities, and previous hospitalisation as consistent predictors across heart failure risk models. These findings are comparable with our study.Rehospitalised patients had significantly higher serum creatinine (1.62 ± 0.49 vs. 1.27 ± 0.39 mg/dL; p<0.001), lower eGFR (49.6 ± 15.4 vs. 62.1 ± 18.3 mL/min/1.73 m²; p<0.001), lower serum sodium (133.7 ± 4.9 vs. 136.7 ± 4.0 mmol/L; p=0.002), and higher NT-proBNP levels (8140 vs. 5420 pg/mL; p=0.014). Multivariable analysis identified hyponatraemia

(aOR 2.72), elevated NT-proBNP (aOR 2.44), and impaired renal function (aOR 2.18) as independent predictors of rehospitalisation. Hidayaturrohman and Hanada [12] similarly reported renal dysfunction, natriuretic peptides, and electrolyte abnormalities as major predictors of heart failure readmission.Patients with rehospitalisation had significantly lower LVEF (30% vs. 36%; p=0.003), lower TAPSE (17.4 ± 3.5 vs. 19.1 ± 3.7 mm; p=0.008), higher PASP (49.8 ± 11.1 vs. 44.8 ± 10.3 mmHg; p=0.020), higher lung B-line scores (16 vs. 10; p<0.001), and more frequent residual congestion (64.4% vs. 18.1%; p<0.001). Residual congestion was the strongest independent predictor (aOR 4.21). Harmon et al. [11] also found pulmonary hypertension to be significantly associated with readmission, while Heidenreich et al. [13] emphasized achieving complete decongestion before discharge to reduce recurrent hospitalisation.Rehospitalised patients were less frequently prescribed ACEI/ARB/ARNI (77.8% vs. 89.5%), mineralocorticoid receptor antagonists (64.4% vs. 81.0%), SGLT2 inhibitors (33.3% vs. 51.4%), and triple GDMT (55.6% vs. 74.3%). Heidenreich et al. [13] similarly recommended optimisation of guideline-directed medical therapy before discharge to reduce rehospitalisation and mortality, supporting our findings.Independent predictors identified in our study included residual congestion (aOR 4.21), previous heart failure admission (aOR 3.06), hyponatraemia (aOR 2.72), elevated NT-proBNP (aOR 2.44), reduced eGFR (aOR 2.18), and VExUS ≥2 (aOR 1.97). Hidayaturrohman and Hanada [12] concluded that combining clinical, laboratory, and imaging variables provides superior prediction of heart failure readmission. Likewise, Drożdż et al. [14] designed the HEROES study to develop multidimensional risk prediction models using similar clinical and imaging parameters.Although length of hospital stay was not evaluated in our study, Stone et al. [15] identified hospital stay duration as an important variable in prediction models for adverse outcomes. Similarly, Sud et al. [16] demonstrated that both short and prolonged hospital stays were associated with increased 30-day readmission and mortality in heart failure patients. These findings highlight the importance of careful discharge planning and adequate clinical stabilisation before discharge.

Conclusion

Residual congestion at discharge, previous heart failure admission, hyponatraemia, elevated NT-proBNP, impaired renal function, and VExUS score ≥2 were identified as independent predictors of 180-day rehospitalisation in patients with acute decompensated heart failure. Comprehensive clinical, laboratory, and ultrasound-based assessment before discharge improves risk stratification. Early optimization of decongestion and guideline-directed medical therapy may reduce recurrent hospitalisations and improve patient outcomes.

Limitations

This was a single-centre study with a relatively small sample size, which may limit the generalisability of the findings. In addition, the follow-up period was limited to 180 days, and external validation of the identified predictors was not performed.

Ethical approval

Ethical approval for this study was obtained from the Institutional Ethics Committee prior to the commencement of the study. The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki and applicable institutional guidelines.

Informed Consent

Written informed consent was obtained from all participants prior to their enrolment in the study.

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Conflict of Interest Declaration

The authors declare no conflict of interest.

Data Availability Statement

All data generated or analysed during this study are available from the corresponding author upon reasonable request.

References

1. McDonagh TA, Metra M, Adamo M, et al. 2021 ESC guidelines for the diagnosis and treatment of acute and chronic heart failure. Eur Heart J. 2021;42:3599-3726.
2. Savarese G, Becher PM, Lund LH, et al. Global burden of heart failure: a comprehensive and updated review of

epidemiology. Cardiovasc Res. 2023;118:3272-3287.
3. Tromp J, Teng TK, Tay WT, et al. Age-related characteristics and outcomes of patients with heart failure with preserved ejection fraction. J Am Coll Cardiol. 2019;74:601-612.
4. Crespo-Leiro MG, Anker SD, Maggioni AP, et al. European Society of Cardiology Heart Failure Long-Term Registry: 1-year follow-up outcomes and regional differences. Eur J Heart Fail. 2016;18:613-625.
5. Fudim M, O'Connor CM, Dunning A, et al. Aetiology, timing and clinical predictors of early versus late readmission following acute decompensated heart failure (ASCEND-HF). Eur J Heart Fail. 2018;20:304-314.
6. O'Connor CM, Miller AB, Blair JEA, et al. Causes of death and rehospitalisation in patients hospitalised with worsening heart failure and reduced ejection fraction: results from the EVEREST programme. Am Heart J. 2010;159:841-849.
7. Zhao W, Wang C, Zhang J, et al. Association between hyponatraemia and adverse clinical outcomes of heart failure: a systematic review and meta-analysis. Front Cardiovasc Med. 2023;10:117843.
8. Pagnesi M, Di Pasquale G, Baldini F, et al. Residual congestion and outcomes in patients hospitalised for acute decompensated heart failure. J Card Fail. 2025;31:xxx-xxx.
9. Rinaldi PM, Rihl MF, Boniatti MM. Venous excess ultrasound score at discharge as a predictor of readmission in acute decompensated heart failure. Arq Bras Cardiol. 2024;121:e20230745.
10. Hu J-B, Yang X-F, Chen J, et al. A predictive model of early readmission for patients with heart failure. J Vasc Dis. 2022;1:88-96.
11. Harmon D, Rathousky J, Choudhry F, Grover H, Patel I, Jacobson T, et al. Readmission risk factors and heart failure with preserved ejection fraction. J Am Osteopath Assoc. 2020;120(12):831-838.
12. Hidayaturrohman QA, Hanada E. Predictive analytics in heart failure risk, readmission, and mortality prediction: A review. Cureus. 2024;16(11):e73876.
13. Heidenreich PA, Bozkurt B, Aguilar D, Allen LA, Byun JJ, Colvin MM, et al. 2022 AHA/ACC/HFSA guideline for the management of heart failure: A report of the American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines. Circulation. 2022;145(18):e895-e1032.
14. Drożdż J, Jankowska EA, Gąsior M, Kałużna-Oleksy M, Lelonek M, Nessler J, et al. Rationale, objectives, and design of the HEart failuRe ObsErvational Study of the Polish Cardiac Society (HEROES). Kardiol Pol. 2025;83(3):321-324.
15. Stone K, Zwiggelaar R, Jones P, Mac PN. A systematic review of the prediction of hospital length of stay: Towards a unified framework. PLoS Digit Health. 2022;1(4):e0000017.
16. Sud M, Yu B, Wijeysundera HC, Austin PC, Ko DT, Lee DS, et al. Associations between short or long length of stay and 30-day readmission and mortality in hospitalized patients with heart failure. JACC Heart Fail. 2017;5(8):578-588.