Master's Thesis of Medicine

Effect of Discharge Checklist in Guideline-Directed Medical Therapy (GDMT) for Heart Failure Patients

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Abstract

Effect of Discharge Checklist in Guideline-Directed Medical Therapy (GDMT) for Heart Failure Patients

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Background: Initiating guideline-directed medical therapy (GDMT) during hospitalization is recommended in heart failure (HF) patients. However, GDMT is underutilized in real-world practice.

Aims: This study evaluated the effect of the discharge checklist on the prescription and adequacy score of GDMT. Also, two months' survival and readmission for HF were assessed as a primary outcome.

Method: The study was a single-center observational study. We retrospectively included patients hospitalized for HF from March 2021 to February 2022. The exclusion criteria were patients who died before discharge or were transferred to another department during hospitalization.

Result: Among overall hospitalized HF patients, the checklist was fulfilled in 244 patients (the checklist group) and not in 171 patients (the non-checklist group). Apart

from the age differences and higher cardiomyopathy caused, the baseline characteristics (including sex, body mass index, HF aggravating factors, etiology, comorbid, phenotype, and baseline GDMT medications) were similar in both groups. A higher proportion of patients in the checklist group were prescribed with GDMT, especially beta-blockers, than in the non-checklist group (67.6% vs. 50.9%, p = 0.001). A lower rehospitalization rate at two months (6.1% vs. 14.6%, p = 0.004) and marginally lower mortality outcome (1.6% vs. 4.7%, p = 0.069) showed in the checklist group. The primary outcome of composite readmission or all-cause mortality occurred in 7.4% of patients in the checklist group and 18.1% in the non-checklist group (p = 0.001). As compared with the non-checklist group, the discharge checklist reduced the risk of the composite outcome by 59% (hazard ratio, 0.41 95% CI 0.23-0.73, p = 0.003). All subgroup analyses according to age, sex, body mass index, diabetes mellitus, HF phenotype, and HF specialist care showed consistent results.

Conclusion: The discharge checklist is simple but effective in GDMT initiation during hospitalization. Importantly, the discharge checklist was associated with better mid-term outcomes in HF patients.

Keywords: Checklist, Guideline-directed medical therapy, heart failure, heart failure therapy, quality of care.

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Chapter 1. Introduction

Heart failure (HF) is a heterogeneous clinical syndrome that results from structural or functional impairment of ventricular filling or ejection(1). It is associated with a high burden of morbidity and mortality(1, 2). There are estimated to be 64 million people suffering from HF, which remains rising worldwide(2). The prevalence of HF morbidity in Asia is around 1 to 6 percent, higher than in Western countries(3, 4). According to the Korean Acute HF (KorAHF) registry, the in-hospital mortality rate for acute HF is about 5%, and the probability of death after 30 days and 1-year of discharge is 3% and 18%, respectively(5).

Guideline-directed medical therapy (GDMT) is a proven HF treatment to reduce mortality and morbidity for patients with HF with reduced ejection fraction(6). GDMT includes the following drug therapies: renin-angiotensin system inhibitors consisting of angiotensin receptor blockers, angiotensin-converting enzyme inhibitors, or angiotensin receptor-neprilysin inhibitors in combination with beta-blockers, and mineralocorticoid-receptor-antagonists(7). The recent European guideline also includes sodium-glucose co-transporter two inhibitors as the fourth pillar of GDMT for HF patients(1). The European HF pilot survey showed that more than 70% of acutely decompensated HF patients were treated with the GDMT (renin-angiotensin system inhibitors, beta-blockers, and mineralocorticoid-receptor-antagonists) upon discharge(8). However, the GDMT prescription rate in Asia-Pacific regions, including Korea, was only about 50%(9). Therefore, the promotion strategy to enhance GDMT installation during hospitalization is warranted.

Basoor and colleagues demonstrated in a small randomized controlled trial that utilizing a simple HF discharge checklist was associated with better physician-prescribed HF treatment and reduced 30-day readmission rates for HF patients(10). In another study by Allain et al. regarding the usefulness of a discharge checklist, they found that a simple checklist improved comorbidities management and referral programs for patient follow-up(11). The Korean Society of HF provided a discharge checklist for the public. This checklist aims to ensure that all standard treatment drugs are prescribed. However, the effect of using such a discharge checklist on GDMT prescription in Korea has not been studied. The discharge checklist also may be a solution for enhancing the initiation of GDMT for patients by the clinician during hospitalization.

We aimed to evaluate the effect of the discharge checklist on the management of HF patients. The hypothesis of this study was that there would be a significantly better quality of care in patients who completed the discharge checklist. Specifically, our hypothesis was that HF patients who completed the discharge checklist would have a higher GDMT prescription and outpatient follow-up rate and lower two-month readmission rate and mortality than those who did not. We evaluated the completion rate of the discharge checklist and its impact on the total GDMT prescription and adequacy score. The primary outcomes in this study were readmission and mortality rate within two months of follow-up.

Chapter 2. Literature review

2.1 Disease definition used in this study

A. HF phenotypes classification

According to recent American and European guidelines, HF phenotypes may be distinguished on the basis of the left ventricular (LV) ejection fraction as measured by echocardiography(1, 12). HF has been divided into three distinct phenotypes(1). First, HF with reduced ejection fraction (HFrEF) is characterized by reduced left ventricular ejection fraction (LVEF) less than or equal to 40%. Second, Patients with LVEF between 41% and 49% are designated as HF with mildly reduced ejection fraction (HFmrEF)(1, 12). Third, those with signs and symptoms of HF, with evidence of increased LV filling pressures, thus raised cardiac markers such as natriuretic peptides and with an LVEF equal to or more than 50% are classified as HF with preserved ejection fraction (HFpEF)(1, 12).

B. Acute HF

Acute HF is a condition with gradual or rapid onset symptoms and signs of HF leading to unplanned hospital admission(1). Acute HF by onset consists of 2 types, de novo (first onset of HF) and acute decompensated on chronic HF. New-onset acute HF patients have higher in-hospital mortality yet lower mortality after discharge and rehospitalization rate than HF aggravation in chronic patients(13).

C. HF comorbidities

The coexistence of HF and comorbidities are common(14). The most important cardiovascular comorbidities are hypertension and atrial fibrillation(1). Hypertension defines as office systolic blood pressure (SBP) ≥ 140 mmHg or diastolic blood pressure (DBP) ≥ 90mmHg or prescribed with antihypertensive medication(15). Atrial fibrillation is symptomatic or asymptomatic condition documented by an electrocardiogram or electrocardiography (ECG). The minimal duration of an ECG tracing of atrial fibrillation required to establish the diagnosis is at least 30 seconds or a whole 12-lead ECG(16).

Non-cardiovascular comorbidities of HF are diabetes mellitus, kidney dysfunction, anemia, lung disease (chronic obstructive pulmonary disease and asthma), and dyslipidemia. Diabetes mellitus is defined as the patient who has a (prior) diagnosis of diabetes mellitus or laboratory documented with the following criteria: eight-hour fasting plasma glucose of ≥126 mg/dL, plasma glucose concentration of ≥200 mg/dL at 2 hours after oral glucose tolerance test or glycated hemoglobin (HbA1c) level ≥6.5%(17). Chronic kidney disease is defined as persistently detected urinary albumin excretion of ≥30 mg/day, or the estimated glomerular filtration rate stayed less than 60 mL/min/1.73 m^2 for longer than three months(18). Anemia is when red blood cells are insufficient to meet the body's physiologic needs. The World Health Organization (WHO)defines anemia among women as hemoglobin (Hb) levels below 12.0 g/dL and among men as levels below 13.0 g/dL (19). Chronic obstructive lung disease is defined as documented post-bronchodilator airflow limitation in a

spirometry test(20). According to the National Cholesterol Education Program-Adult Treatment Panel III, dyslipidemia defines as total cholesterol ≥240 mg/dL, high-density lipoprotein cholesterol (HDL-C) <40 mg/dL, low-density lipoprotein cholesterol (LDL-C) ≥160 mg/dL, and triglyceride ≥200 mg/dL(21).

D. Guideline-directed medical therapy (GDMT)

American and European guidelines recommend GDMT in HF stage C with HFrEF, including angiotensin-converting enzyme inhibitors (ACEI) or angiotensin receptor blockers (ARB), beta-blockers, and mineralocorticoid receptor antagonists (MRA) (1, 22). Moreover, European guidelines recommend angiotensin receptor-neprilysin inhibitor (ARNI) to replace ACEI and propose sodium-glucose co-transporter 2 (SGLT2) inhibitors prescription in patients with HFrEF(1). ARNI and RASI and the first pillars of GDMT(23). The evidence has emerged to show that ARNIs' role in improving HFrEF patients' health status, symptoms, physical functioning, and quality of life demonstrates the reverse-remodeling effect (24-26) and diminishes HF rehospitalization death(27). Beta-blocker is the second pillar and is beneficial in preventing mortality and morbidity in hemodynamically stable HFrEF patients(28-30). ACEI showed improved symptoms and reduced mortality and morbidity in clinical trials and meta-analyses(7, 31, 32). An observational study demonstrated that ACEI and ARB are safe and effective interventions for acute HF during hospitalization, with decreased rehospitalization and mortality(33).

2.2 Literature review:

A. Previous results of discharge checklist

Basoor et al. investigated the effectiveness of using simple discharge questionnaire with 27 questions in 2013(10). The study showed that after implementing a heart failure discharge checklist, the 30-day readmission rate for cardiac events declined ten folds after excluding death during follow-up. Additionally, the important findings from this study were that GDMT prescriptions and dose titration rate have increased during hospitalization for beta-blockers with or without an ACEI or ARB combination (10).

Allain et al. published a paper about the effect of a personalized HF discharge checklist, with the primary outcome being a composite of mortality or readmission for HF at six months(11). The secondary endpoints were mortality, readmission for HF, and quality of care (evidence-based medications, management of HF comorbidities, and planned care plan). After six months of follow-up, the checklist group reached 43% of the primary outcome and more than half of the patients in the non-checklist groups(11). The essential finding of using the discharge checklist was associated with a significantly higher referral to a follow-up program and better screening and treatment of malnutrition in acute HF patients(11).

B. GDMT adequacy score

In North America, some researchers proposed a scoring system for GDMT medications. Fiuzat et al., based on the previous HF guidelines, defined an optimized score based on the maximum target dose of each drug. Score 0

means there is no GDMT medication; score 1 implies the treatment is below the median dose of ACEI, ARB, and beta-blockers, or MRA. Score 2 is above the median dose of ACEI, ARB, and beta-blockers, or ARNI prescription with any dose(34).

C. Quality of care in HF patients

A quality assessment is an essential aspect of tracking and improving medical care(35). The evidence of the benefits of these care processes is robust that failing to adhere to them reduces the chances of optimal patient outcomes(35). Accordingly, the American College of Cardiology and the American Heart Association (ACC/AHA) published a current report on quality measures and clinical performance for HF patients that developed sets of performance measures that are evidence-based, quantifiable quality indicators (36). The comprehensive set of standards by ACC/AHA included initiation or continuation of ACEI, ARB, or ARNI, in conjunction with beta-blockers and MRA prescription in patients with left ventricular systolic dysfunction, complete discharge instructions, and medication list and post-discharge appointment for patients(36). This report is reinforced by the American and European recommendations for prescribing HFrEF patients with ACEI or ARB, or ARNI, beta-blockers, and MRA(1, 12).

Chapter 3. Methods

3.1 Study design

This study is a single-center observational study. We sought to retrospectively include all patients hospitalized for HF from March 2021 to February 2022 in the cardiology wards at Seoul National University Hospital.

3.2 Study subject

The patients recruited in this study were those who fulfilled the following inclusion criteria: First, all patients were hospitalized for HF between March 2021 and February 2022. Second, all patients were observed with a complete pre-discharge checklist or not by the attending physician, ward doctor, or residents. Lastly, HF was diagnosed by cardiologists, internists, or residents based on standard definition. Exclusion criteria were patients who died or were transferred to other departments during hospitalization.

3.3 Research tools

The clinical data of the enrolled patients were retrieved from the electronic medical records, and discharge checklist. The checklist is showed in Figure 1 and retrieved from the Korean Society of HF (KSHF) website: (https://khfs.or.kr/news/news_01.php?boardid=ksnotice&mode=view&idx=27&sk). Data from electronic medical records included baseline demographic and clinical characteristics of HF patients and type of medication. The baseline characteristics included sex, age, height, weight, body mass index, and history

of previous HF. We obtained clinical information from electronic medical records such as etiology, aggravating factors, comorbidities, vital signs at admission and discharge, GDMT prescriptions at baseline and discharge, discharge date, readmission date, and follow-up data. We received information from the discharge checklist: HF etiology, phenotype, aggravating factors, and type of GDMT at discharge. We reviewed the outpatient history to observe and calculate the follow-up rates and mortality outcomes.

In the case of an untracked patient (follow-up loss), it is estimated whether or not the patient died due to the cancellation of health insurance. We confirmed mortality data from the National Statistical Office through the medical information protection office in the hospital.

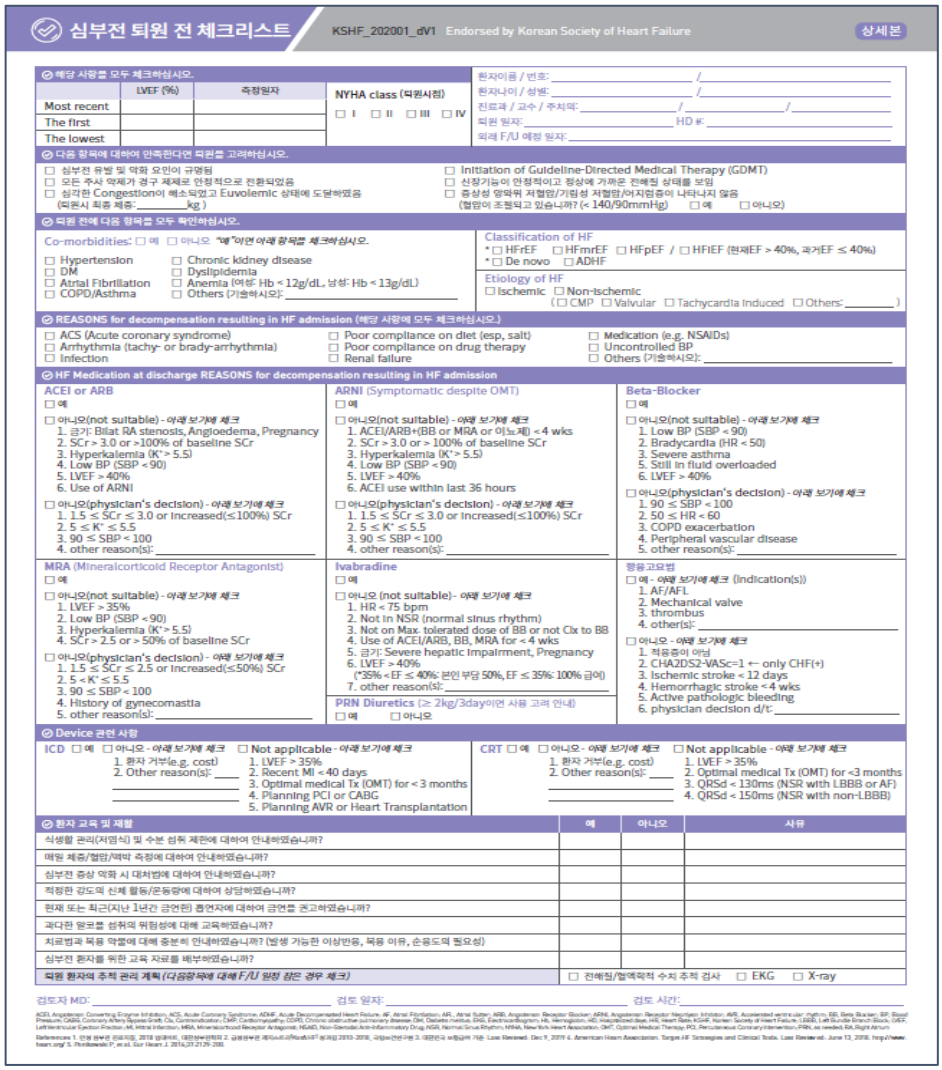


Figure 1. Discharge checklist distributed by the Korean Society of HF

3.4 Data collection method

Firstly, the HF research assistant handled the patient's list from the hospital record according to the research period. Secondly, we collected data for baseline demographic and clinical characteristics of patient HF from the electronic medical records and discharge checklists. Since March 2021, in

accordance with the HF Society in Korea recommendations, ward doctors and residents have been oriented by the cardiologists or attending physicians on how to fill up the discharge checklist. They have used the checklist prior to discharge time for patients admitted due to acute HF.

The ward doctors/residents have no interest in research and have applied the checklist for patients admitted due to acute HF prior to discharge time according to the recommendation by the HF Society in Korea. Lastly, for the non-checklist group, we collected data that met eligibility equal to the checklist group from electronic medical records.

3.5 Ethical considerations

This study has been reviewed and approved by the Institutional Research Ethical Board (IRB) Committee of Seoul National University Hospital, IRB No. 2202-095-1301, and declared to be exempt from acquiring written consent due to its retrospective design and anonymous sampling.

3.6 Data analysis method

We analyzed the completion rate of the discharge checklist every month. We evaluated trends in the completion rate of the discharge checklist to understand the change of utilization discharge checklist by the resident or physician before discharging HF patients.

Among eligible patients in the analyses, we calculated and evaluated the adequacy of GDMT prescriptions between patients discharged with a new HF discharge checklist and those without a discharge checklist. The adequacy of

GDMT prescriptions was evaluated in three ways: the total number of GDMT and two types of adequacy scores. We analyzed adequacy score type 1 based on dose scoring of ACEI, ARB, or ARNI combined with beta-blockers and MRA. We also analyzed adequacy score type 2 based on the heart rate response of beta-blocker medication apart from other GDMT dose scoring bases. After two months, we assessed survival, rehospitalization, or lost to follow-up data. The procedure of collecting data and analyzing data is depicted in Figure 2.

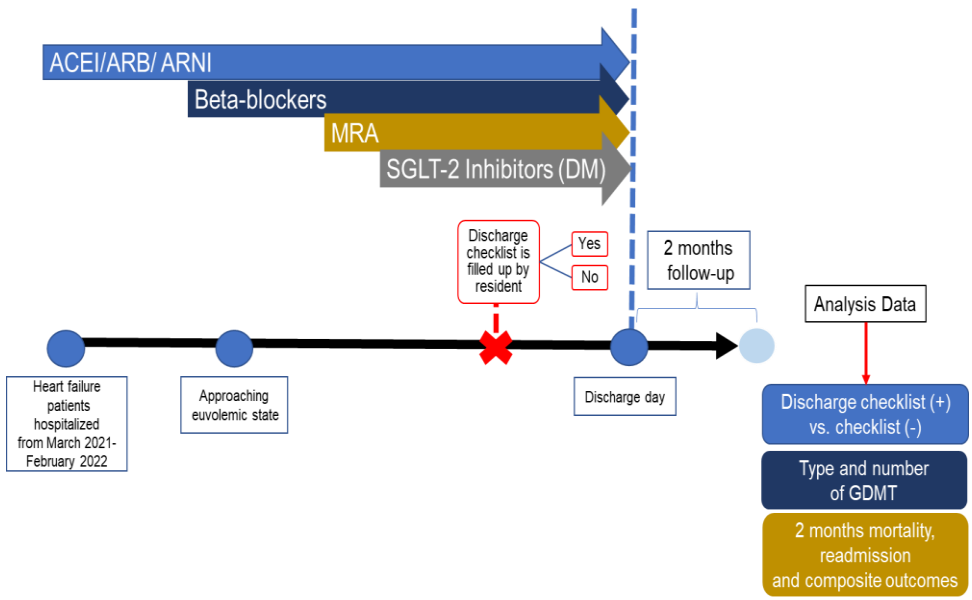


Figure 2. The procedure of the data collection process

In this research, we designed adequacy scoring calculation based on the clinical trials evidence (7, 27, 28, 32, 37)and guidelines based on the target dose and heart rate response to produce the scoring system(1). This scoring system aims to help the physician evaluate the optimal medical therapy presented in Table 1.

Table 1. GDMT adequacy scores

Adequacy Score Type 1	Scores
ACEI or ARB	1-3
Beta-blockers (Heart rate-based)	1-3
MRA	2
ARNI	3-5
Maximum score 1	10

Adequacy Score Type 2	Scores
ACEI or ARB	1-3
Beta-blockers (Dose based)	1-2
MRA	2
ARNI	3-5
Maximum score 2	9

Angiotensin-receptor blockers (ARB)	
Losartan dose (once daily)	Scores
<50 mg	1
50-99 mg	2

≥100 mg	3
Candesartan dose (once daily)	
<8 mg	1
8-15.9 mg	2
≥16 mg	3
Valsartan dose (twice daily)	
<80 mg	1
80-159 mg	2
≥160 mg	3
Fimasartan prescription (once daily)	1
Telmisartan prescription (once daily)	1
Olmesartan prescription (once daily)	1
Angiotensin-converting enzyme inhibitors (ACEI)	
Ramipril dose (twice daily)	Scores
<5 mg	1
5-9.9 mg	2
≥10 mg	3
Enalapril dose (twice daily)	
<10 mg	1
10-19.9 mg	2
≥20 mg	3
Perindopril dose (once daily)	
<2 mg	1
2-4.9 mg	2

≥5 mg	3

Angiotensin receptor-neprilysin inhibitors (ARNI)	
ARNI dose (twice daily)	Scores
<50 mg	3
50-99.9 mg	4
≥100 mg	5

Beta-blockers (Heart rate-based for Type 1 Adequacy Score)	
Heart rate/minute (Sinus rhythm)	Scores
≥80	1
60-79	2
<60	3
Heart rate/minute (Atrial fibrillation)	Scores
≥100	1
80-99	2
<80	3

Beta-blockers (Dose-based for Type 2 Adequacy Score)		
Drug Class	**Dose**	**Score**
Beta-blockers (BB)	None	0
	<50% target dose	1
	≥50% target dose	2
Bisoprolol	None	0
	< 5mg once daily	1
	≥ 5mg once daily	2
Carvedilol	None	0

	< 12.5 mg twice daily	1
	≥ 12.5 mg twice daily	2
	None	0
Nebivolol	< 5 mg once daily	1
	≥ 5 mg once daily	2

It is modified from initial, median, and target dose based on 2021 ESC Guidelines for diagnosing and treating acute and chronic heart failure.

Abbreviations: ACEI = angiotensin-converting enzyme inhibitors; ARB = angiotensin receptor blockers; MRA = mineralocorticoid receptor antagonists; ARNI = angiotensin receptor-neprilysin inhibitors.

The optimal adequacy score is reflected and modified from recent guidelines and recent studies(1, 34). Score 0 means there is no medication on each GDMT drug; score 1 implies the treatment is below the median dose or initial dose of ACEI, ARB, and beta-blockers, or MRA. Score 2 is the median dose of ACEI, ARB, and beta-blockers, or ARNI prescription with any dose. Score 3 is greater than the median dose or the target dose.

3.7 Statistical analysis

Demographic and baseline characteristics are presented using descriptive statistics for continuous variables are presented as mean ± standard deviation (SD) and for categorical variables frequencies (n) and percentages (%)(38). Univariate analysis was used for comparison between groups and to determine the factors associated with outcomes. The unpaired Student's t-test or Mann–Whitney U test

was used to compare continuous variables; in contrast, the Chi-square test or Fisher's exact test was used to compare the proportions.

(39, 40). We performed survival analysis using Kaplan–Meier estimation, and Kaplan-Meier curves were used to plot the time-to-event distribution of the composite outcome. The variables were examined using univariable and multivariable Cox proportional hazards regression analyses to predict the association between the discharge checklist, baseline characteristics, and the composite outcome. Variables with univariable p-value below 0.05 were entered into multivariable Cox proportional hazards regression analysis to identify the independent factors of composite outcome(41, 42). All data analyses were conducted using the SPSS statistical software (version 25, IBM Corp, Armonk, NY, USA). A statistical *p*-value below 0.05 was considered statistically significant.

Chapter 4. Results

4.1 Completion rate for HF discharge checklists for 12 months

A total of 464 patients were enrolled from March 2021 to February 2022. Twenty-five patients were excluded because of in-hospital death, and twenty-four were excluded because of they were transferred to other departments. A total number included in the analysis was 415 patients. The discharge checklist was completed in 244 patients (58.8%, the checklist group) and not completed in 171 patients (41.2%, the non-checklist group). The study flow chart is depicted in Figure 3.

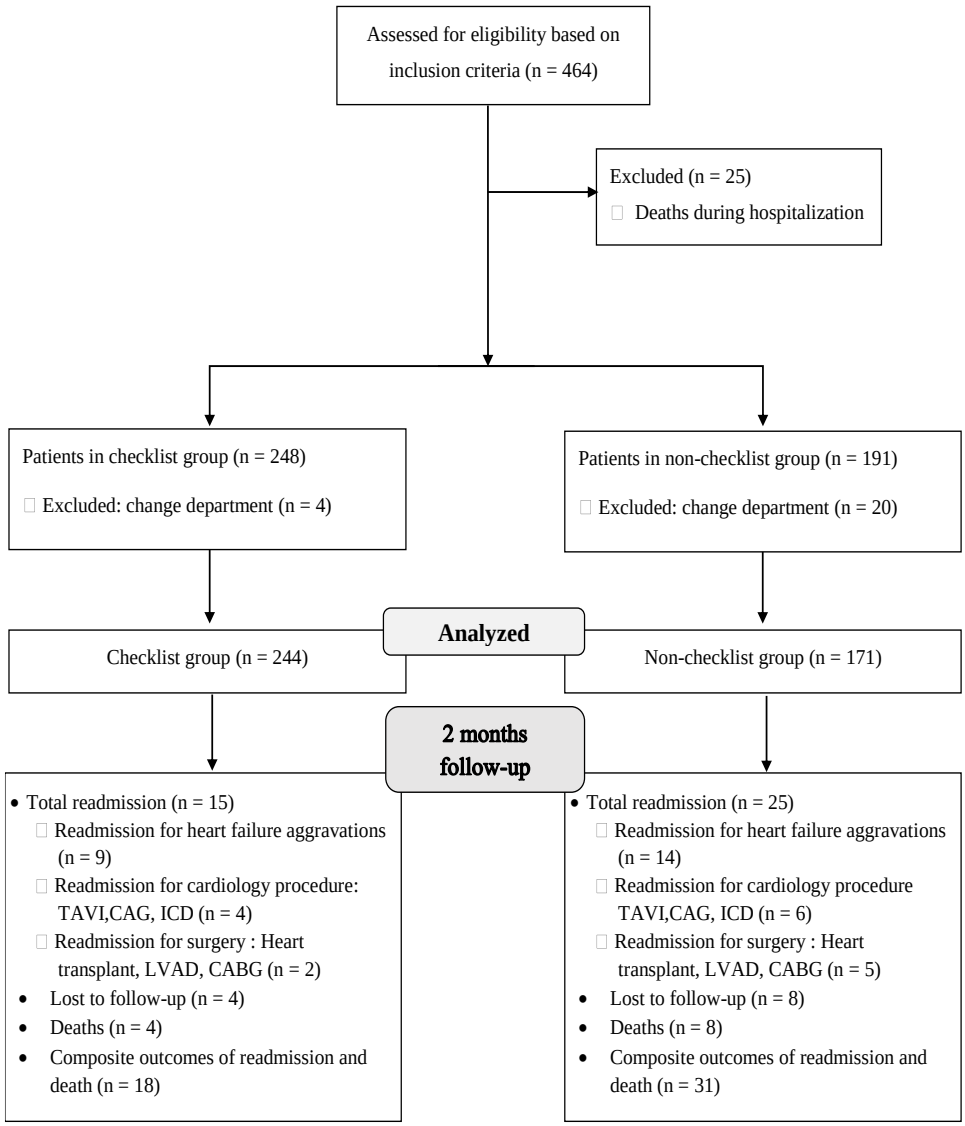


Figure 3. Discharge checklist study flow chart

Abbreviations: CAG, coronary angiography; CABG, coronary artery bypass graft surgery; ICD, implantable cardioverter-defibrillator; LVAD, left ventricular assist device; TAVI, transcatheter aortic valve implantation.

The number of hospitalized HF patients in the hospital fluctuates over the 12 months. The highest number of HF hospitalization occurred in April 2021, and the lowest in March 2021(Figure 4). Although the attending physician continued to encourage the residents to complete the discharge checklist before discharge, the actual completion rate remained 60.3% (Figure 5).

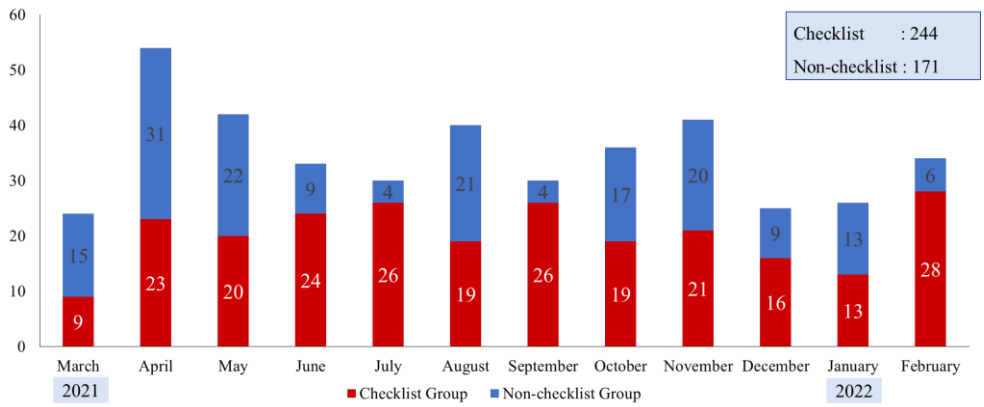


Figure 4. Number of HF patients in the checklist and non-checklist groups in 12 months

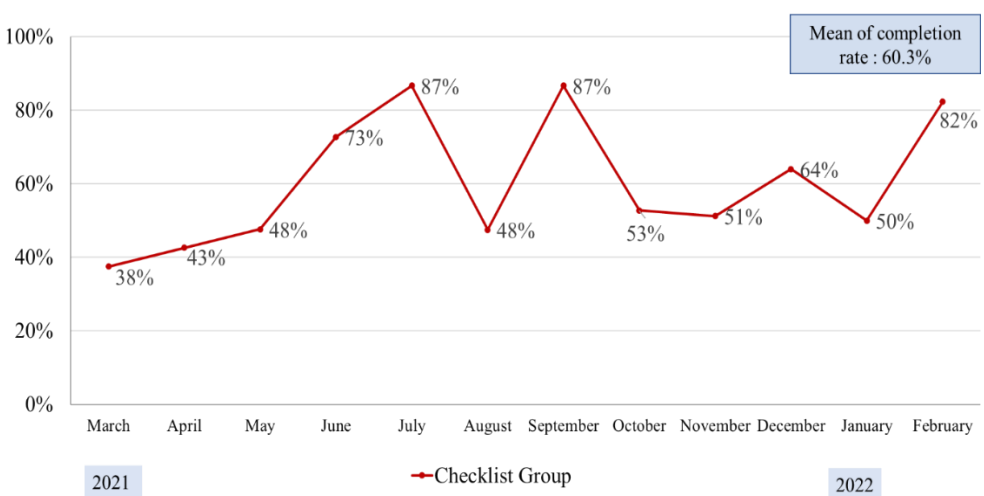


Figure 5. Trends in the completion rate of a discharge checklist

We analyzed the completion rates from the first to the last week of the month, because residents rotate in the cardiology ward every month. Hence, at the beginning of each month, there was an orientation from the previous resident and encouragement from the attending physician to examine the discharged HF patient with a discharge checklist. When we evaluated the completion rate on a weekly basis, the completion rate was the highest in the first week and steadily decreased from the second to the last week of the month (Figure 6).

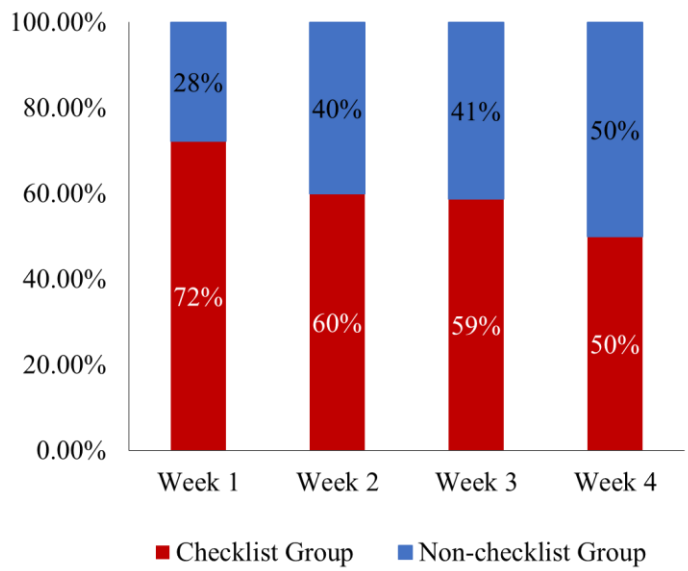


Figure 6. The proportion of discharge checklist completion rate on weekly discharge

4.2 Comparison of patient characteristics in checklist and non-checklist group

The baseline characteristics of the discharge checklist are shown in Table 2. HF patients were male predominant in both groups (p = 0.646). Patients in the checklist group were significantly older (73.08 ± 13.32 years vs. 70.26 ± 14.62 years, p = 0.042) than those in the non-checklist group. HF phenotypes (HFrEF, HmrEF, HFpEF) were comparable between the two groups (p = 0.159). The proportion of patients who had a previous HF diagnosis was a marginally higher in the checklist group (54.5% vs. 45.0%, p = 0.057). The primary etiology of HF in both groups was ischemia (33.2% vs. 32.7%, p = 0.924), then followed by cardiomyopathy in the checklist group and valvular caused in the non-checklist group. The etiology of HF was nearly comparable between the two groups. However, cardiomyopathy caused was higher in the checklist group (20.9% vs. 12.9%, p = 0.034).

The aggravating factors and the comorbidities were comparable between the two groups. The most common aggravating factor was arrhythmia (26.2% vs. 26.3%; p = 0.984) followed by acute coronary syndrome (22.5% vs. 20.5%; p = 0.614). The predominant comorbidity in both groups was hypertension (50.0% vs. 59.1%; p = 0.068). The baseline clinical characteristics of patients at admission, systolic, diastolic, and heart rate, were comparable between checklist and non-checklist groups. The baseline medication, number of GDMT, and adequacy score were similar in both groups (Table 2).

Table 2. Baseline characteristics of discharge checklist study

Variables	Checklist Group (n = 244)	Non-checklist Group (n = 171)	P-value
Age, mean years ± SD	73.08 ± 13.32	70.26 ± 14.62	0.042
Men, n (%)	134 (54.9)	90 (52.6)	0.646
BMI, mean kg/m^2 ± SD	23.98 ± 4.29	23.58 ± 4.17	0.352
Previous heart failure, n (%)	133 (54.5)	77 (45.0)	0.057
Heart failure phenotype, n (%)			0.159
HFrEF	131 (53.7)	75 (43.9)	
HFmrEF	29 (11.9)	26 (15.2)	
HFpEF	84 (34.4)	70 (40.9)	
Vital signs at admission			
SBP (mm Hg), mean ± SD	133.3 ± 26.7	136.1 ± 28.2	0.298
DBP (mm Hg), mean ± SD	76.5 ± 16.5	77.3 ± 16.6	0.652
Heart rate, mean ± SD	83.2 ± 22.0	81.3 ± 22.3	0.386
Aggravating factors, n (%)			
Acute coronary syndrome	55 (22.5)	35 (20.5)	0.614
Arrhythmia	64 (26.2)	45 (26.3)	0.984
Infection	30 (12.3)	13 (7.6)	0.123

Poor compliance on diet & drug	36 (14.8)	15 (8.8)	0.068
Renal failure	32 (13.1)	16 (9.4)	0.239
Medication	5 (2.0)	2 (1.2)	0.493
Uncontrolled blood pressure	6 (2.5)	3 (1.8)	0.628
Unidentified	59 (24.2)	52 (30.4)	0.158
Heart failure etiology, n (%)			
Ischemia	81 (33.2)	56 (32.7)	0.924
Non-ischemic cardiomyopathy	51 (20.9)	22 (12.9)	0.034
Valvular	40 (16.4)	35 (20.5)	0.288
Tachycardia induced	34 (13.9)	30 (17.5)	0.316
Unidentified	38(15.6)	28 (16.4)	0.996
Comorbidities, n (%)			
Hypertension	122 (50.0)	101 (59.1)	0.068
Diabetes mellitus	104 (42.6)	66 (38.6)	0.412
Atrial fibrillation	104 (42.6)	60 (35.1)	0.122
COPD/asthma	21 (8.6)	10 (5.8)	0.293
Chronic kidney disease	90 (36.9)	60 (35.1)	0.708
Dyslipidemia	71 (29.1)	59 (34.5)	0.243
Anemia	119 (48.8)	92 (53.8)	0.313
Heart failure medications, n (%)			

RASI (ACEI, ARB, ARNI)	92 (37.7)	55 (32.2)	0.245
ACEI/ARBs	67 (27.5)	44 (25.7)	0.695
ARNI	25 (10.2)	11 (6.4)	0.174
Beta-blockers	98 (40.2)	64 (37.4)	0.574
MRA	57 (23.4)	31 (18.1)	0.199
Ivabradine	8 (3.3)	5 (2.9)	0.832
SGLT2 Inhibitor	12 (4.9)	8 (4.7)	0.903
Number of GDMT and adequacy score			
Number of GDMT (maximum 3)	1.02 ± 0.99	0.91 ± 0.91	0.251
Adequacy score 1 (maximum 10)	1.98 ± 2.19	1.74 ± 1.91	0.254
Adequacy score 2 (maximum 9)	1.81 ± 2.03	1.54 ± 1.73	0.153

Abbreviations: ACEI = angiotensin-converting enzyme inhibitors; ARB = angiotensin receptor blockers; ARNI = angiotensin receptor-neprilysin inhibitors; BMI = body mass index; COPD = chronic obstructive pulmonary disease; DBP = diastolic blood pressure**;** HFmrEF = HF with reduced ejection fraction; HFpEF = HF with preserved ejection fraction; HFrEF = HF with reduced ejection fraction; mm Hg = millimeters of mercury; MRA = mineralocorticoid receptor antagonists; RASI

= Renin-angiotensin system inhibitors; SBP = Systolic blood pressure; SD = standard deviation SGLT2 = sodium-glucose co-transporter 2.

4.3 The GDMT prescription rate according to the discharge checklist completion status

The GDMT prescription rate and impact of the discharge checklist on number of GDMT and adequacy score according to the discharge checklist completion status are shown in Figure 7 and Table 3. The number of GDMT prescriptions at discharge was higher in the checklist group than in the non-checklist group (mean 1.64 vs. 1.29, $p < 0.001$). The adequacy scores type 1 with a maximum of ten scores were higher in the checklist group compared to the non-checklist group (mean 3.43 vs. 2.65, $p < 0.001$). The adequacy scores type 2, with a maximum of nine scores, were also higher in the checklist group than in the non-checklist group (mean 2.78 vs. 2.25, $p = 0.006$). Furthermore, we analyzed the change number of GDMT and adequacy scores at admission and discharge. Surprisingly, the discharge checklist significantly affects the change in the total number of GDMT and adequacy score 1 (Table 3, Figure 7).

Table 3. Impact of discharge checklist on GDMT

Variable	Time		Checklist Group (N = 244)	Non-checklist Group (N = 171)	*p*-value
Number GDMT	Baseline (Admission)	Mean ± SD	1.02 ± 0.99	0.91 ± 0.91	0.251
	Discharge	Mean ± SD	1.64 ± 0.93	1.29 ± 0.97	<0.001‖
	Change*	Mean ± SD	0.62 ± 1.05†	0.39 ± 1.04‡	0.025§
Adequacy score 1	Baseline (Admission)	Mean ± SD	1.98 ± 2.19	1.74 ± 1.91	0.254
	Discharge	Mean ± SD	3.43 ± 2.24	2.65 ± 2.14	<0.001‖
	Change*	Mean ± SD	1.45 ± 2.19†	0.91 ± 2.06‡	0.012§
Adequacy score 2	Baseline (Admission)	Mean ± SD	1.81 ± 2.03	1.54 ± 1.73	0.153
	Discharge	Mean ± SD	2.78 ± 1.95	2.25 ± 1.95	0.006§
	Change*	Mean ± SD	0.97 ± 1.80†	0.71 ± 1.78‡	0.141

Abbreviations; GDMT = guideline-directed medical therapy, std. deviation = standard deviation.

*Change = (value at discharge) - (value at 1st day admission)

† The change of value in the checklist group (unpaired student *t*-test)

‡ The change of value in the non-checklist group (unpaired student *t*-test)

§ *p*-value < 0.05

‖ *p*-value< 0.001

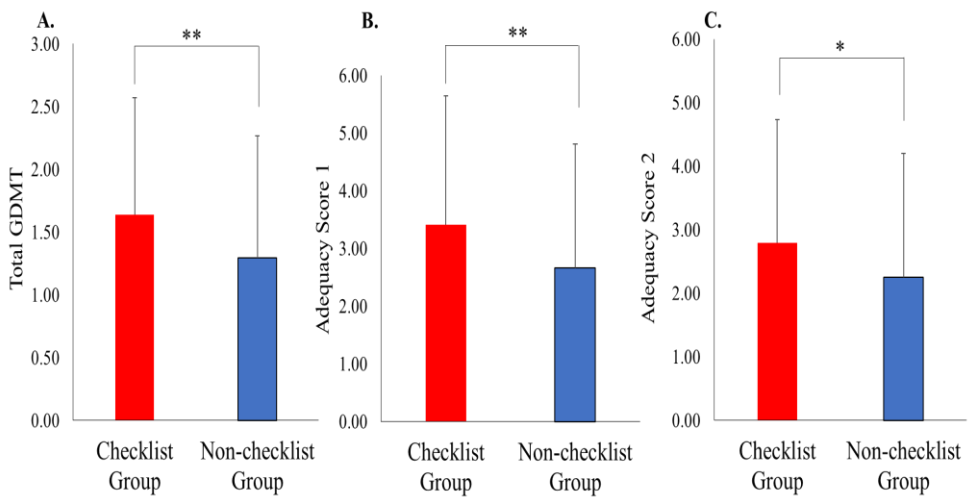


Figure 7. The effect of using a discharge checklist on GDMT prescription and adequacy scores

(A-C) The GDMT prescription (A)The mean difference of total GDMT prescription between checklist and non-checklist. (B) The mean of difference of adequacy score 1. (C) The mean of difference of adequacy score 2. Data are presented as mean ± standard deviation (*p <0.05 or p <0.001).

The detailed prescription pattern according to the discharge checklist completion status is depicted in Table 4. A higher proportion of patients were prescribed GDMT in the checklist group, especially beta-blockers (67.6% vs. 50.9%, $p = 0.001$). There was a marginally significant difference between the two groups of renin-angiotensin system inhibitors (RASI), including ACEI, ARB, and ARNI (54.9% vs. 45.6%, $p = 0.062$). A higher beta-blockers prescription was consistent after sub-analysis with HFrEF subtype (79.4% vs. 62,7; $p = 0.009$).

Table 4. Medication at discharge in checklist and non-checklist group

Medication in all subtypes of heart failure	Checklist Group (N = 244)	Non-checklist Group (N = 171)	*P*-value
RASI (ACEI, ARB, ARNI, n (%)	134 (54.9)	78 (45.6)	0.062
ACEI/ARB use, n (%)	97 (39.8)	60 (35.1)	0.335
ARNI use, n (%)	37 (15.2)	18 (10.5)	0.170
Beta-blockers use, n (%)	165 (67.6)	87 (50.9)	0.001
MRA use, n (%)	100 (41.0)	59 (34.5)	0.181
Ivabradine use, n (%)	15 (6.2)	6 (3.5)	0.224
SGLT2 Inhibitors, n (%)	40 (16.4)	25 (14.7)	0.642
Among DM, n (%)	26 (25.0)	20 (30.8)	0.412
Medication in HFrEF patients	Checklist Group (N = 131)	Non-checklist Group (N = 75)	*P*-value

RASI (ACEI, ARB, ARNI), n (%)	87 (66.4)	44 (58.7)	0.266
ACEI/ARB use, n (%)	53 (40.5)	26 (34.7)	0.411
ARNI use, n (%)	34 (26.0)	18 (24.0)	0.756
Beta-blockers use, n (%)	104 (79.4)	47 (62.7)	0.009
MRA use, n (%)	64 (48.9)	33 (44.0)	0.502
Ivabradine use, n (%)	14 (10.7)	6 (8.0)	0.531
SGLT2 Inhibitors, n (%)	30 (22.9)	13 (17.3)	0.344
Among DM, n (%)	20 (30.8)	9 (26.5)	0.425
Anticoagulant or antiplatelet medication	Checklist Group (N = 100)	Non-checklist Group (N = 58)	*P*-value
Anticoagulant, n (%)	66 (66.7)	39 (69.6)	0.703
NOAC, n (%)	52 (52.5)	32 (57.1)	0.579
Warfarin, n (%)	14 (14.1)	7 (12.5)	0.774
Antiplatelet, n (%)	10 (10.1)	4 (7.1)	0.537
Antiplatelet and anticoagulant, n (%)	14 (14.1)	9 (16.1)	0.745
None, n (%)	9 (9.1)	4 (7.1)	0.674
Number of GDMT and adequacy score			
Number of GDMT, mean ± SD (maximum 3)	1.64 ± 0.93	1.29 ± 0.97	<0.001

Adequacy score 1, mean ± SD (maximum 10)	3.43 ± 2.24	2.65 ± 2.14	<0.001
Adequacy score 2, mean ± SD (maximum 9)	2.78 ± 1.95	2.25 ± 1.95	0.006

Abbreviations: ACEI, angiotensin-converting enzyme inhibitors; ARB, angiotensin receptor blockers; MRA, mineralocorticoid receptor antagonists; ARNI, angiotensin receptor-neprilysin inhibitors; DM, diabetes mellitus; GDMT, guideline-directed medical therapy; HFmrEF, heart failure with mildly reduced ejection fraction; HFpEF, Heart failure with preserved ejection fraction; HFrEF, Heart failure with reduced ejection fraction; NOAC, Non-vitamin K oral anticoagulants; RASI, Renin-angiotensin system inhibitors; SGLT2, sodium-glucose co-transporter 2; SD, standard deviation.

4.4 Clinical parameters and study outcomes

The systolic and diastolic blood pressure were lower at discharge in the checklist group compared with those in the non-checklist group (116.4 ± 17.3 vs. 121.1 ± 21.7, $p = 0.015$, and 69.2 ± 9.9 vs. 71.4 ± 11.2, $p = 0.040$) (Table 5). The heart rates of patients were comparable between the two groups.

A total of 18 (7.4%) composite outcomes of 2 months readmission or all-cause mortality occurred in patients in the checklist group and 31(18.1%) in the non-checklist ($p = 0.001$, Table 5). Further analysis showed the rate of readmission at two months, death, and two composite outcomes were not significantly different according to HF specialists (Table 6).

Table 5. Clinical, primary, and secondary outcomes of discharge checklist study

Clinical outcome	Checklist Group (N=244)	No Checklist Group (N=171)	*p*-value
SBP (mm Hg), mean ± SD	116.4 ± 17.3	121.1 ± 21.7	0.015
DBP (mm Hg), mean ± SD	69.2 ± 9.9	71.4 ± 11.2	0.040
Heart rate, mean ± SD	72.7 ± 11.8	73.5 ± 13.7	0.487
Primary outcome			
2 months composite of readmission or all-cause death, n (%)	18 (7.4)	31 (18.1)	0.001

Secondary outcome			
1-month readmission, n (%)	12 (4.9)	22 (12.9)	0.004
2 months readmission, n (%)	15 (6.1)	25 (14.6)	0.004
2 months all-cause death, n (%)	4 (1.6)	8 (4.7)	0.069
2 months lost to follow up and survive, n (%)	4 (1.6)	8 (4.7)	0.069
2 months composite of readmission, all-cause death and lost to follow-up, n (%)	22 (9.0)	39 (22.8)	<0.001
Reasons for two months readmission			
HF aggravations, n (%)	9 (3.7)	14 (8.2)	0.049
Procedure (TAVI, CAG, ICD), n (%)	4 (1.6)	6 (3.5)	0.222
*Surgery	2 (0.8)	5 (2.9)	0.101

* Surgery: heart transplantation, LVAD, CABG, and valvular surgery

Abbreviations: CAG, coronary angiography; CABG, coronary artery bypass graft surgery; ICD, implantable cardioverter-defibrillator; LVAD, left ventricular assist device; TAVI, transcatheter aortic valve implantation, TPL, heart transplantation, DBP, diastolic blood pressure**;** SBP, Systolic blood pressure; SD, standard deviation.

Table 6. The primary and secondary outcomes of patients treated by HF Specialist and non-HF specialist

Outcome	HF specialist (n = 103)	Non-HF specialist (n = 312)	*p*-value
Primary outcome			
2 months composite of readmission or all-cause death, n (%)	11 (10.7)	38 (12.2)	0.683
Secondary outcome			
1-month readmission, n (%)	8 (7.8)	26 (8.3)	0.856
2 months readmission, n (%)	10 (9.7)	30 (9.6)	0.978
2 months all-cause death, n (%)	1 (1.0)	11 (3.5)	0.18
2 months lost to follow up and survive, n (%)	6 (5.8)	6 (1.9)	0.081
2 months composite of readmission, all-cause death and lost to follow-up, n (%)	17 (16.5)	44 (14.1)	0.551

We evaluated the impact of the discharge checklist by univariable and multivariable analysis (Table 7). Surprisingly, in the multivariable Cox-proportional hazard regression analysis and after adjustment with some significant covariates, the discharge checklist was associated as independent factor of composite outcomes with the hazard ratio (HR.41 (95% CI 0.23 to 0.73, $p = 0.003$) (Table 7).

Table 7. Univariable and multivariable analyses using cox proportional hazard regression analysis for the composite outcome of 2 months readmission or all-cause mortality

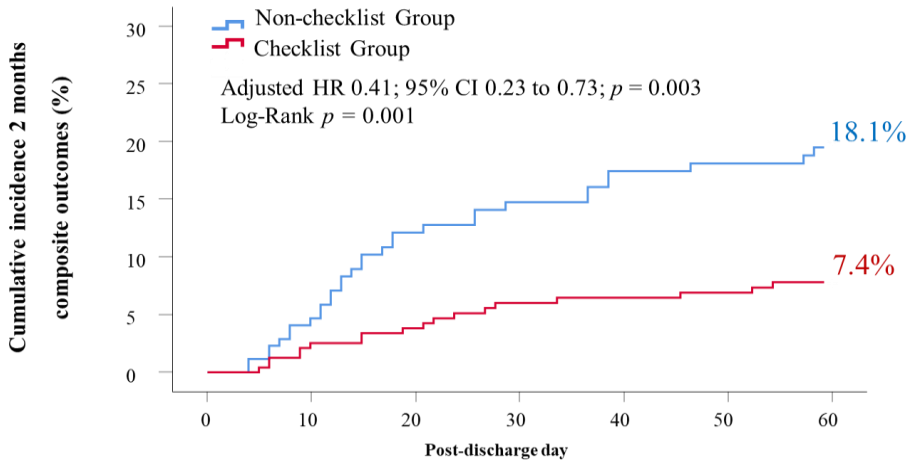
Variables	Univariable Analysis			Multivariable Analysis		
(Reference vs. Test)	Hazard Ratio	95% CI	*p*-value	Hazard Ratio	95% CI	*p*-value
Age (<65 vs.≥65)	0.84	0.45-1.56	0.577			
Sex (F vs. M)	0.67	0.38-1.18	0.168			
BMI (<25 vs.≥25)	0.81	0.44-1.49	0.507			
DM (No vs. Yes)	1.18	0.67-2.08	0.56			
CKD (No vs. Yes)	0.94	0.52-1.70	0.841			
Hypertension (No vs. Yes)	0.89	0.51-1.56	0.681			
Dyslipidemia (No vs Yes)	1.16	0.64-2.08	0.626			
Atrial fibrillation (No vs. Yes)	0.67	0.36-1.22	0.19			
Anemia (No vs. Yes)	1.43	0.81-2.52	0.222			

Number of comorbidities (≤2 vs.>2)	0.97	0.55-1.69	0.902			
LVEF (≥40% vs <40%)	1.69	0.96-2.99	0.071			
Discharge checklist (No vs. Yes)	0.38	0.21-0.68	0.001	0.41	0.23-0.73	0.003
NYHA functional class at admission	1.22	0.62-2.39	0.558			
HF specialist (No vs. Yes)	0.87	0.45-1.70	0.687			
Beta-blocker (No vs. Yes)	0.55	0.32-0.97	0.039	0.73	0.41-1.30	0.279
ACEI or ARB (No vs Yes)	0.46	0.23-0.90	0.023	0.51	0.26-1.01	0.055
MRA (No vs. Yes)	1.33	0.76-2.33	0.323			
ARNI (No vs. Yes)	1.09	0.49-2.42	0.84			
SGLT2 inhibitors (No vs. Yes)	1.07	0.50-2.29	0.857			
Diuretics (No vs. Yes)	1.23	0.67-2.28	0.504			
No. of GDMT (≤2 vs.>2)	0.58	0.23-1.46	0.247			

Adequacy score 1 (≤3 vs.>3)	0.74	0.41-1.34	0.323
Etiology of HF (Non-ischemic vs. ischemic)	0.56	0.29-1.10	0.092

Abbreviations: ACEI = angiotensin-converting enzyme inhibitors; ARB = angiotensin receptor blockers; ARNI = angiotensin receptor-neprilysin inhibitors; BMI = body mass index; CKD = chronic kidney disease; DM = diabetes mellitus; GDMT = guideline-directed medical therapy; HF = HF; MRA = mineralocorticoid receptor antagonists; NYHA **=** New York Heart Association**;** SGLT2 = sodium-glucose co-transporter 2.

Kaplan Meier curve illustrated that the checklist group showed a lower incidence of composite outcome endpoint than the non-checklist group (Figure 8). This result showed a similar tendency irrespective of the presence or absence of HF specialists (Figure 9).



Checklist Group	244	239	235	230	229	228	226
Non-checklist Group	171	164	151	147	143	142	140

Covariates for adjusted HR were as follows: ACEI or ARB and Beta-blocker medication as significant covariates.

Figure 8. Kaplan-Meier curves for the composite outcome of 2 months of readmission or all-cause mortality

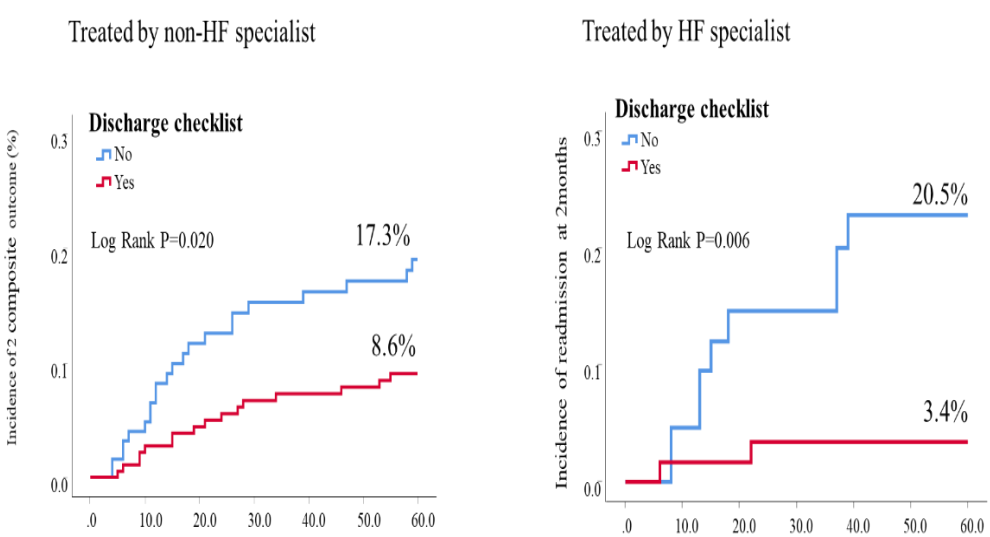


Figure 9. Kaplan-Meier curve for study outcome between treated by HF specialist and non-HF specialist

In addition, subgroup analyses were also performed to investigate the consistency of the effect of the discharge checklist among different subpopulations. The forest plot diagram of subgroup analyses showed the impact of the discharge checklist. It showed the checklist group was consistently better in advanced age patients, non-obese, diabetes, systolic dysfunction patients, non-ischemic cause, GDMT number below the median, and adequacy score below the median (Figure 10). This subgroup analysis was also consistent in both gender (male vs. female); regardless, patients were treated by HF or non-HF specialists. There is no interaction in the composite outcome with the subgroup analysis.

Subgroups	Checklist Group (n=244)	Non-checklist Group(n=171)	P-value	Forest Plot	Hazard Ratio [95% CI]	P for interaction
Age						
<65 years	4/51 (7.85%)	10/54 (18.52%)	0.071		0.35 [0.10, 1.10]	0.973
≥ 65 years	14/193(7.25%)	21/117 (17.95%)	0.006		0.38 [0.19, 0.75]	
Sex						
Female	10/110 (9.09%)	17/81 (20.99%)	0.030		0.41 [0.18, 0.92]	0.869
Male	8/134 (5.97%)	14/90 (15.56%)	0.011		0.31 [0.13, 0.76]	
BMI						
< 25	10/158 (6.33%)	24/114 (21.05%)	0.001		0.27 [0.13, 0.58]	0.109
≥ 25	8/85 (9.41%)	7/57 (12.28%)	0.498		0.68 [0.23, 2.06]	
Diabetes status						
No	11/140 (7.86%)	16/105 (15.24%)	0.086		0.50 [0.23, 1.10]	0.342
Yes	7/104 (6.73%)	15/66 (22.39%)	0.004		0.27 [0.11, 0.66]	
LV ejection fraction						
≤ 40% (HFrEF)	11/119 (9.24%)	18/74 (24.32%)	0.008		0.36 [0.17, 0.77]	0.842
> 40% (HFpEF and HFmrEF)	7/124 (5.65%)	13/98 (13.40%)	0.113		0.46 [0.18, 1.20]	
Etiology of HF						
Non-ischemic	14/163 (8.59%)	24/115 (20.87%)	0.006		0.39 [0.20, 0.76]	0.986
Ischemic	4/81 (4.94%)	7/56 (12.50%)	0.225		0.44 [0.12, 1.65]	
No. of GDMT						
≤ median (≤ 2)	15/200 (7.50%)	29/149 (19.46%)	0.001		0.35 [0.19, 0.66]	0.447
> median (> 2)	3/41 (6.82%)	2/22 (9.09%)	0.854		0.84 [0.14, 5.10]	
Adequacy score						
< median (≤ 3)	7/127 (5.51%)	25/117 (21.37%)	0.001		0.23 [0.10, 0.53]	0.052
≥ median (> 3)	11/117 (9.40%)	6/54 (11.11%)	0.765		0.86 [0.31, 2.38]	
HF specialist						
No	16/185(8.65%)	22/127 (17.32%)	0.025		0.47 [0.24, 0.91]	0.183
Yes	2/57 (3.39%)	9/44 (20.45%)	0.011		0.12 [0.03, 0.61]	

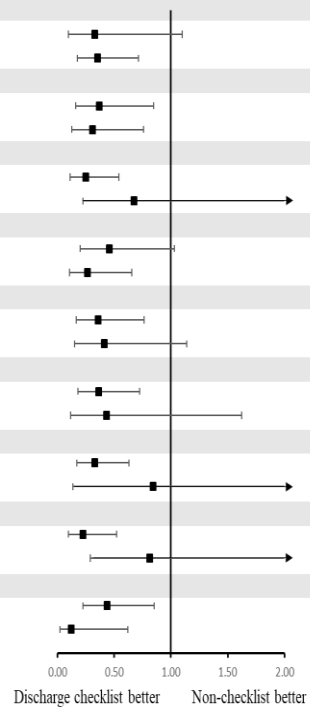


Figure 10. Subgroup analyses for the composite outcome

Chapter 5. Discussion

This study showed an inadequate checklist completion rate of around 60%. The GDMT prescription in the real world was unsatisfactory. Moreover, the adequacy score was worse. However, a simple discharge checklist improved the quality of care by increasing the number of GDMT prescriptions, especially beta-blockers. Furthermore, the checklist group showed a better outcome with significantly reduced composite outcome of 2 months readmission or all-cause mortality of 2 months of readmission or all-cause mortality.

The high filling in the first week is due to the encouragement and orientation provided by the attending physicians in the first week of the resident rotation on the cardiology ward. Hence, continuous encouragement to residents to fill up the discharge checklist is needed. Further research is required to determine the cause of the low completion rate.

5.1 Mechanism of the discharge checklist affects GDMT prescription rate in study

The discharge checklist mechanism affects the outcome improvement, both hospital readmission and composite of the two outcomes. It is possible due to the discharge checklist increases the number of GDMT prescriptions. This change can be seen from the differences in the type and number of GDMT prescriptions in the checklist and non-checklist groups at discharge. This change is supported by several studies on Guideline Adherence Indicators (GAI), which show an improvement in mortality outcomes in the high GAI group, which is defined as prescribing GDMT 2

or more medications (43). In the Survey of Guideline Adherence for Treatment of Systolic HF in Real World (SUGAR) trial, a multicenter observational study using treatment adherence indicators (GAI). In patients with high GAI, there is a significant reduction in 90-day mortality compared to poor GAI ($p = 0.001$)(43). Furthermore, a 2018 meta-analysis found that a high GAI score was associated with a significant 71% reduction in relative risk of mortality and 36% rehospitalization (*p*-value <0.005) (44).

5.2 GDMT prescription rate in some registries

The GDMT initiation during hospitalization was insufficient in real-world practice. For instance, the Acute Decompensated HF Registry International-Asia Pacific (ADHERE-AP) is a large-scale HF registry involving ten thousand patients from eight Asia Pacific countries (45). This study reported insufficient GDMT prescription at discharge time; ACEI or ARB in 63%, beta-blockers in 41%, and aldosterone antagonists in 31% of patients(45). Furthermore, the KorAHF registry also showed inadequate prescription of GDMT. At discharge in the KorAHF registry, physicians prescribed ACEI or ARB, beta-blockers, and aldosterone antagonists in 69%, 52%, and 47% of the patients, respectively(9).

However, the GDMT prescription rate in Asia is lower than those of the United States registry, the Acute decompensated HF National Registry (ADHERE). According to ADHERE registry, ACEI/ARB, beta-blockers, and aldosterone antagonists were prescribed in 83%, 80%, and 33% of patients, respectively(46). Our study result in prescription rate is similar to KorAHF registry results but less than prescription in the ADHERE study.

ADHERE registry analyzed temporally from the first quarter to twelve quarter of prescription of GDMT for three years. It showed prescription of beta-blocker were increased significantly from 61.9% to 80.1% ($p < 0.001$) and MRA from 27.6% to 32.8% ($p < 0.001$)(46). They also assessed the discharge instruction and analyzed the temporal change of discharge instruction with a significant increase in discharge instruction by 133% over twelve quarters(46). This finding might be influenced by discharge instruction assessed using the 4 Joint Commission of Accreditation of Healthcare Organizations (JCAHO) core performance measures(47).

5.3 Evidence of physician effort to enhance GDMT prescription.

The Get With The Guidelines-HF (GWTG-HF) program is an American physician's effort to translate guidelines to improve patient care(48). Bergethon et al. used GWTG-HF data linked to Medicare claims between 2009 and 2012 with 21,264 patients from 70 hospitals(49). That study presented a relative reduction of 20% in rates of 30-day all-cause readmission among patients with HF and improvements in 30-day risk-adjusted readmissions between 2009 and 2012(49). Indeed, hospitals that used post-discharge HF management programs in the GWTG-HF program had lower relative readmission rates(49).

Seo et al. analyzed KorAHF registry data and evaluated the role of GDMT in reducing all-cause mortality. They found that GDMT prescription was associated with three years risk reduction of 53% mortality in HF patients compared with no GDMT (50). The GDMT was prescribed ACEI/ARB and beta-blockers in 892 HF patients (44%)(50). The GDMT prescription rate decreased due to advanced age patients, especially beta-blockers(50). Our study showed higher prescription of

GDMT compared to the previous research, especially beta-blockers in the checklist arm, counting 68%. If we investigated a smaller scope of the HFrEF subtype, beta-blocker prescriptions reached 79.5% in the discharge checklist arm.

5.4 A previous study of discharge checklist enhancing GDMT prescription

There is high-quality evidence backing the GDMT in reducing thirty days and six months readmission rates and outcomes for HF patients by Basoor et al. They evaluated a beneficiary of an HF discharge checklist in Oakland. This clinical trial showed that the implementation HF checklist increased the use of ACEI and ARB at discharge. This study yielded a significant reduction in 30-day and six-month readmission rates in the checklist group. This checklist may have a substantial impact on enhancing the quality of care, improving clinical outcomes, and in turn, decreasing the burden on the health care system(10). Legallois et al. also conducted a prospective cohort study to evaluate the discharge checklist effect on HF patients. This study showed better quality of care, including better care plan planning and therapeutic optimization of RASIs and beta-blocker dose. However, there was no significant reduction in readmission and mortality(51).

On the other hand, a prospective cohort study was conducted by Allain et al. in Europe using a personalized pre-discharge checklist. This study showed a significant improvement in the follow-up program, including screening and managing comorbidities and the referral program. However, this study's result was different in terms of readmission of HF patients, which is not significantly different between the two groups (11).

5.5 The role of the attending physician on the GDMT

A retrospective study by Masters et al. studied the role of HF specialists in improving 1-year mortality outcomes for HF patients. They mentioned that HF specialist was associated with increased prescription of GDMT. Therefore, this study included in the analysis the attending physicians and classified the attending physicians as HF specialists or non-HF specialists. HF specialists might be a confounding factor for this study due to HF specialists already acknowledging the effectiveness of GDMT for mortality and morbidity. Therefore, further analysis was done as follows. First, in baseline characteristics, there was no difference number of HF specialists between the two groups (24.2% vs. 25.7%, p = 0.719, Table 2). Second, the rate of readmission at two months, death, and two composite outcomes were not significantly different according to HF specialists (Chi-square statistical analysis, Table 6). Third, this study also confirmed using univariable and multivariable Cox-proportional hazards regression analyses for estimating the hazard ratio (HR) of the composite outcome, there was no association between the HF specialists and the composite outcome as the primary outcome (HR 0.87 95% CI 0.45-1.70, *p*-value = 0.687, Table 7) and patients who performed a discharge checklist had a lower risk of readmission and two composite outcomes than those who did not by Kaplan-Meier curve analysis. This result showed a similar tendency irrespective of the presence or absence of HF specialists (Figure 9). Furthermore, this result was confirmed in previously our subgroup analysis (Figure 10). A clinical trial study supported our result and found no significant difference in the role of the attending physician in the 30-day readmission outcome(10).

5.6 Strength and limitations of the study

Our study has several limitations. First, in an observational study, patients' loss of follow-up may influence readmission outcomes. Second, the design of this study was observational, and the non-randomized design of this study might exert a confounding effect. To overcome this limitation, we made adjustment with multivariable analyses. Third, treatment using SGLT2 inhibitors is only covered by insurance in patients with comorbid diabetes; therefore, it is not included in calculating the adequacy score for this study sample. Fourth, the outcomes assessed in this study were restricted to hospital rehospitalizations and mortality. Finally, we did not assess sodium intake, non-pharmacological management, fluid therapy during hospitalization, and sleep apnea should be considered because these factors are associated with the prognosis. Because of the aforementioned limitations, the associations between the discharge checklist and outcomes and its causality should be interpreted with caution.

Despite these limitations, our study has several strengths. Our study is the first to evaluate the HF discharge checklist specifically in Korean patients. Second, the application of a discharge checklist in clinical practice is simple, efficient, and essential to improve patient quality care. Third, an observational study might represent the real-world situation in the hospital.

Chapter 6. Conclusion

The role of a discharge checklist was associated with lower readmission rates for patients admitted with HF and better GDMT prescriptions, especially beta-blockers. The checklist is simple but effective in GDMT initiation during hospitalization. The checklist completion rate was insufficient and highest in the first week and decreased thereafter. Importantly, the discharge checklist was associated with better outcomes in HF patients. In conclusion, the discharge checklist is a beneficial and effective strategy to increase GDMT initiation during hospitalization.

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초록

서론: 진료지침 기반 치료(Guideline-directed medical therapy)는 심부전 환자의 증상 개선, 생존률 향상에 효과적임이 증명되어 있다. 그러나 실재 임상에서는 많은수의 환자가 진료지침 기반 치료를 받지 못하고 있다.

방법: 대한심부전학회에서 발간한 공개 자료인 퇴원전 심부전 진료 검토 목록 (Discharge checklist)을 작성하는 것이 진료지침 기반 치료에 미치는 효과를 확인하였다. 단일 기관 역향적 관찰 연구로 2021 년 3 월부터 2022 년 2 월까지 서울대학교병원에 심부전으로 입원한 환자를 분석하였다. 입원 환자 중 퇴원 전에 사망했거나 전과된 환자는 제외하였다.

결과: 대상 환자 중 244 명 환자에서 퇴원전 심부전 진료 검토 목록이 작성되었고, 171 명에서는 작성되지 않았다. 작성된 환자를 시험군, 미작성된 환자를 대조군으로 하여 비교하였다. 시험군이 대조군보다 나이가 많고(73.08 ± 13.32 years 대. 70.26 ± 14.62 years, p =0.042) 진료지침 기반 치료 비율이 더 높았고 특히 베타 차단제 처방률이 유의하게 높았다 (67.6% 대 50.9%, p =0.001). 퇴원 후 2 개월간의 재입원률이 시험군에서 대조군에 비해 유의하게 낮았으며 (6.1% 대 14.6% p = 0.004) 더 낮은 종합 결과(7.4% 대 18.1%. p =0.001)가 나타났다.. 다변량 분석에서 퇴원전 심부전 진료 검토 목록 작성이 심부전 재입원 또는

모든 원인 사망의 복합 결과의 위험을 59% 낮추는 것으로 나타났다(위험 비율 (HR), 0.41 95% CI 0.23-0.73, p =0.003).

결론: 퇴원전 심부전 진료 검토 목록은 진료지침 기반 치료률을 높힐 수 있는 것으로 나타났으며, 두 달 내 재입원과 모든 원인에 의한 사망의 합을 유의미하게 낮췄다.

주요어: 진료지침 기반 치료, 심부전, 퇴원전 심부전 진료 검토 목록, 재입원.

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