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Cardiac Rehabilitation

Impact of Radar Chart-Based Information Sharing in a Multidisciplinary Team on In-Hospital Outcomes and Prognosis in Older Patients With Heart Failure

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Background: A multidisciplinary team (MDT) approach is crucial for managing older patients with heart failure (HF). We investigated the impact on clinical outcomes of implementation of a conference sheet (CS) with an 8-component radar chart for visualizing and sharing patient information.

Methods and Results: We enrolled 395 older inpatients with HF (median age 79 years [interquartile range 72–85 years]; 47% women) and divided them into 2 groups according to CS implementation: a non-CS group (before CS implementation; n=145) and a CS group (after CS implementation; n=250). The clinical characteristics of patients in the CS group were assessed using 8 scales (physical function, functional status, comorbidities, nutritional status, medication adherence, cognitive function, HF knowledge level, and home care level). In-hospital outcomes (Short Physical Performance Battery, Barthel Index score, length of hospital stay, and hospital transfer rate) were significantly better in the CS than non-CS group. During the follow-up period, 112 patients experienced composite events (all-cause death or admission for HF). Inverse probabilities of treatment-weighted Cox proportional hazard analyses demonstrated a 39% reduction in risk of composite events in the CS group (adjusted hazard ratio 0.65; 95% confidence interval 0.43–0.97).

Conclusions: Radar chart-based information sharing among MDT members is associated with superior in-hospital clinical outcomes and a favorable prognosis.

Key Words: Conference sheet; Heart failure; Information sharing; Multidisciplinary team approach

Heart failure (HF) represents a worldwide healthcare predicament, affecting over 26 million people worldwide, predominantly in the aging population.[1] With the incidence of HF reaching 10 per 1,000 in individuals aged >65 years,[1] hospitalizations are escalating, imposing significant strains on healthcare systems and resources.[2–4] Older HF patients have multifaceted challenges including multimorbid illness, polypharmacy, malnutrition, cognitive impairment, frailty, and social and economic burdens.[5–11] Consequently, there is a pressing need for effective management strategies tailored for this patient cohort.

The multidisciplinary team (MDT) approach has garnered significant attention due to its potential to enhance patient care and outcomes.[12] Studies have revealed its positive impact on HF patients, including reductions in hospi-

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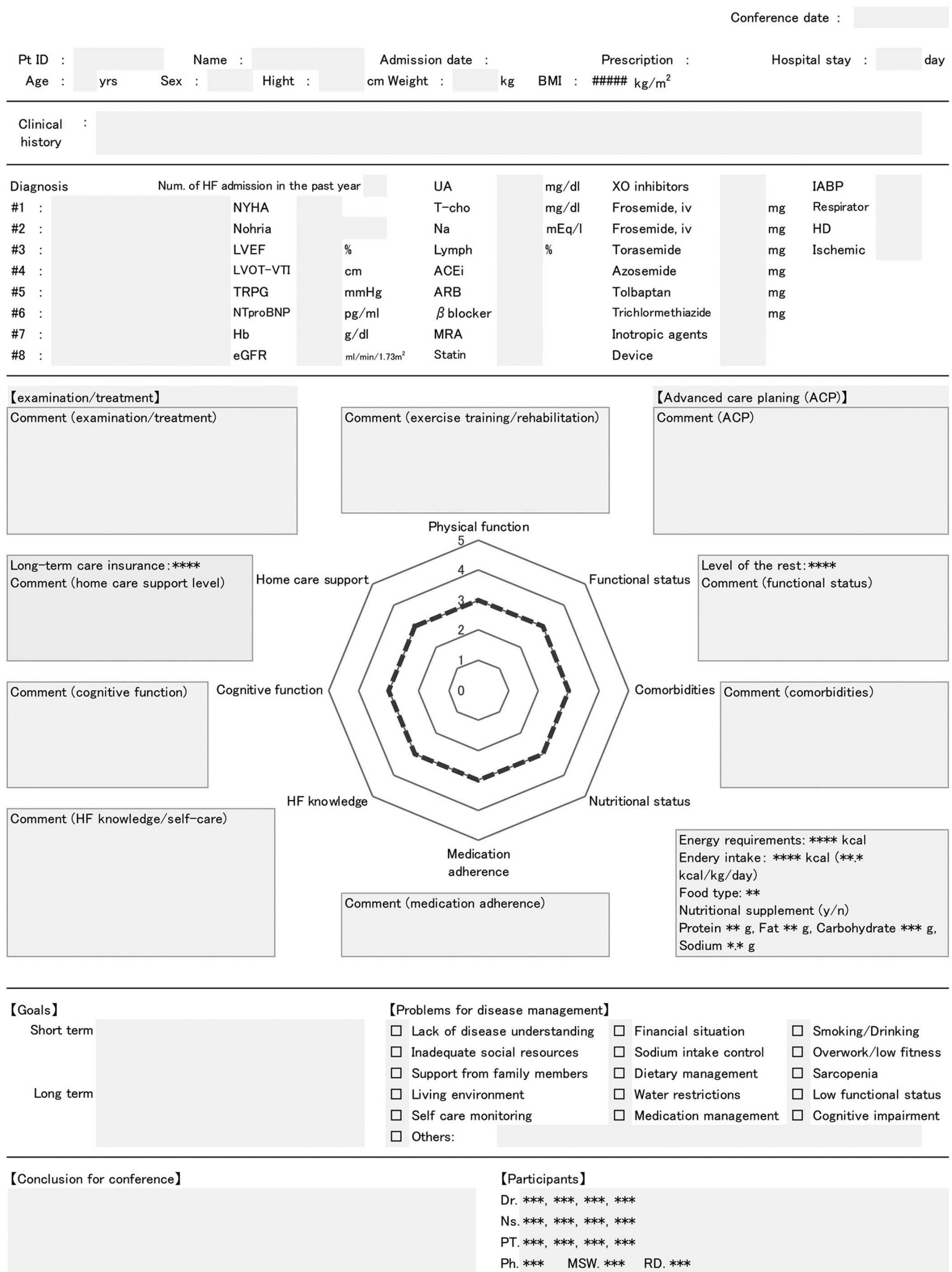

Figure 1. A newly developed conference sheet. The sheet contains treatment details, clinical issues, and goals and provides multidisciplinary team (MDT) members with insights into patients' clinical characteristics across 8 distinct scales: physical function, functional status, comorbidities, nutritional status, medication adherence, level of knowledge about heart failure (HF), cognitive function, and home care support level.

tal readmissions and mortality, as well as improved quality of life.[12–17] Several guidelines strongly advocate MDT management in HF patient care.[18–21] Effective communication among team members is vital, necessitating regular conferences and the use of electronic medical records and other technologies.[12]

Information sharing, which is crucial to an MDT approach, facilitates informed decision making based on current comprehensive patient data, consequently improving care quality and patient outcomes.[22] However, there

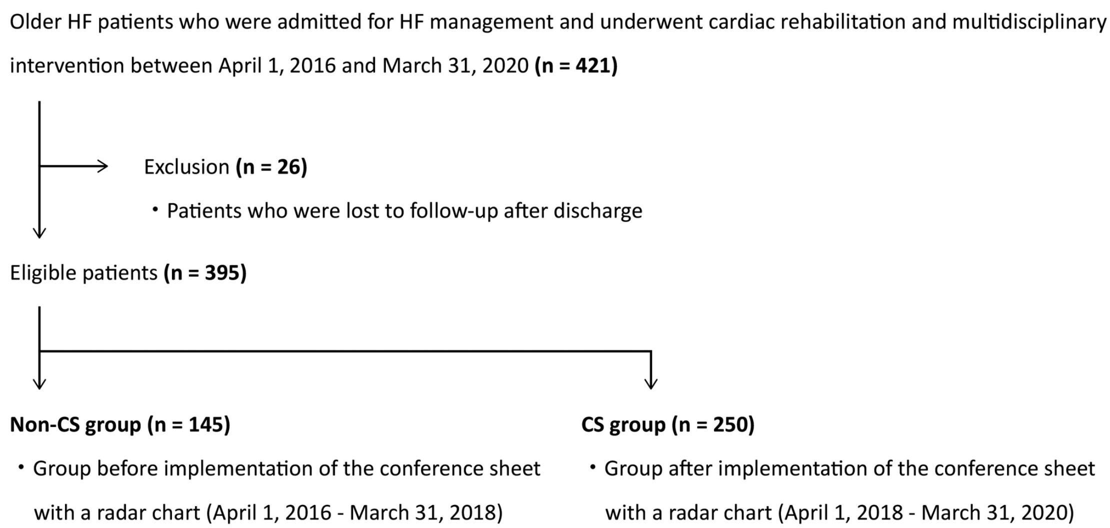

Figure 2. Flowchart of the inclusion of study subjects. CS, conference sheet; HF, heart failure.

are some obstacles to information sharing within an MDT, such as complexity arising from diverse backgrounds and expertise, resulting in misunderstandings and misinterpretations. In addition, unequal information distribution among members can impede effective communication.[22]

To address these issues, we devised a conference sheet (CS) using a radar chart with 8 components representing the characteristics of older HF patients (**Figure 1**). This method, integrated into electronic medical records, enables efficient visualization of individual patient attributes and fosters intuitive understanding of issues and their significance. A prior case report demonstrated the potential advantages of radar charts in information sharing, aiding healthcare professionals in identifying patients' precise conditions and improving prognostic markers and estimated outcomes based on the Seattle Heart Failure model.[23] This evidence underscores the possible advantages of incorporating radar chart-based information sharing within MDT approaches for older HF patients.

In this study we examined the impact of information sharing through a newly developed CS with an 8-component radar chart as part of the MDT approach on clinical outcomes for older hospitalized HF patients.

Methods

Study Design and Study Subjects

Consecutive patients diagnosed with HF and admitted to our institute for treatment between April 1, 2016 and Match 31, 2020 were enrolled in this ambispective, historical cohort study. The retrospective study was conducted for the period from April 1, 2016 to April 10, 2019, and the prospective study continued until Match 31, 2020. HF was diagnosed according to the Japanese Circulation Society/Japanese Heart Failure Society guidelines for HF. To be eligible for inclusion, patients had to be aged ≥65 years and participating in a multidisciplinary cardiac rehabilitation program, which included exercise training, education on self-monitoring and medications, and nutritional guidance provided by an HF team consisting of cardiologists, nurses, physical therapists, pharmacists, dietitians, and social workers. We have developed and applied a multidisciplinary HF management program focusing on comprehensive medical and non-medical interventions for patients hospitalized with HF since August in 2010, as described previously.[8] Patients who were lost to follow-up after discharge were excluded from the analyses. Patients were divided into 2 groups (**Figure 2**): a non-CS group (April 1, 2016–March 31, 2018) and a CS group (April 1, 2018–March 31, 2020).

This study adhered to the Declaration of Helsinki and was approved by the Clinical Investigation Ethics Committee of Sapporo Medical University Hospital (No. 302-243). Before April 10, 2019, participants' consent was assumed through an opt-out strategy. After April 11, 2019, participants were required to provide explicit written informed consent.

Multidisciplinary Conference and a Novel CS

Consistently, each week following the prescription of cardiac rehabilitation (generally on the sixth day after admission; interquartile range [IQR] Day 4–Day 9; **Table 1**), we facilitated a multidisciplinary conference. This brought together a diverse array of professionals including physicians, nurses, physical therapists, dietitians, pharmacists, and medical social workers. The conference's agenda included patient introductions, discussing HF-related issues, progress updates, information sharing, strategic planning, addressing social and psychological aspects, and discharge planning.

Prior to the adoption of the radar chart, we had already been using a CS to consolidate essential patient data for comprehensive management. However, to optimize information sharing, we devised a CS that has been implemented since April 1, 2018. This innovative tool was designed with the objective of optimizing the communication and understanding of patient-specific details within the MDT. The sheet contains treatment details, clinical issues, and goals and provides MDT members with insights

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Table 1. Baseline Characteristics

	No. missing (%)	Overall (n=395)	Non-CS group (n=145)	CS group (n=250)	P value
Age (years)		79 [72–85]	79 [73–85]	79 [72–85]	0.40
Female sex		188 (48)	77 (53)	111 (44)	0.10
Height (cm)		156.8±9.5	155.0±8.9	157.8±9.7	<0.01
Body weight (kg)		53.2 [45.0–61.2]	50.4 [43.3–57.8]	55.4 [46.5–62.5]	<0.01
BMI (kg/m²)		21.6 [19.2–24.1]	20.9 [18.4–23.7]	21.9 [19.4–24.2]	0.03
SBP (mmHg)		118 [104–131]	118 [101–131]	118 [105–131]	0.36
Prior or current smoker		190 (48)	64 (44)	126 (50)	0.23
NYHA functional class					0.10
I		12 (3)	1 (0.7)	11 (4)	
II		240 (61)	93 (64)	147 (59)	
III		143 (36)	51 (35)	92 (37)	
LVEF (%)		51.2 [36.7–63.6]	51.8 [36.8–63.6]	50.9 [36.7–63.6]	0.98
LVEF <40%		115 (29)	45 (31)	70 (28)	0.52
History of hospital admission due to HF		173 (44)	75 (52)	98 (39)	0.02
Etiology					0.94
Cardiomyopathy		98 (25)	38 (26)	60 (24)	
Valvular heart disease		168 (43)	59 (41)	109 (44)	
Ischemic		73 (18)	27 (19)	46 (18)	
Comorbidity					
Hypertension		288 (73)	110 (76)	178 (71)	0.31
Dyslipidemia		231 (58)	74 (51)	157 (63)	0.02
Diabetes		166 (42)	66 (46)	100 (40)	0.28
Chronic kidney disease	33 (8)	258 (71)	99 (78)	159 (68)	0.04
Atrial fibrillation		168 (43)	74 (51)	94 (38)	<0.01
History of cancer		107 (27)	42 (29)	65 (26)	0.52
Charlson comorbidity index (points)		3 (2–5)	4 (3–5)	3 (2–4)	<0.01
Physical function					
10-m gait speed (m/s)	30 (8)	0.800 [0.613–0.966]	0.759 [0.609–0.946]	0.814 [0.613–0.972]	0.43
Nutritional status					
MNA-SF score (points)	3 (1)	8 [6–10]	7 [5–8]	9 [7–11]	<0.01
Energy intake (kcal/day)		1,528 [1,274–1,600]	1,400 [1,131–1,600]	1,572 [1,344–1,600]	<0.01
Energy intake (kcal/kg/day)		27.0±7.0	26.2 [21.5–32.3]	26.9 [23.3–31.3]	0.57
Protein intake (g/day)		65 [50–73]	59 [44–71]	67 [56–73]	<0.01
Protein intake (g/kg/day)		1.16±0.32	1.12±0.35	1.18±0.30	0.08
Laboratory data					
NT-proBNP (pg/mL)		1,231 [584–2,998]	1,490 [763–3,734]	1,091 [497–2,772]	<0.01
Albumin (g/dL)		3.5 [3.2–3.7]	3.5 [3.2–3.7]	3.5 [3.3–3.7]	0.04
Hemoglobin (g/dL)		11.3 [10.3–12.7]	11.0 [10.0–12.3]	11.4 [10.4–13.0]	<0.01
Cystatin C	33 (8)	1.29 [1.05–1.76]	1.41 [1.10–2.02]	1.23 [1.04–1.66]	<0.01
eGFRcys (mL/min/1.73 m²)	33 (8)	48.0 [32.6–63.1]	43.8 [27.1–57.8]	51.5 [34.9–64.9]	<0.01
Medication					
β-blocker		264 (67)	108 (74)	156 (62)	0.01
ACEi or ARB		197 (50)	66 (46)	131 (52)	0.19
MRA		177 (45)	68 (47)	109 (44)	0.53
Loop diuretics		246 (62)	91 (63)	155 (62)	0.88
Tolvaptan		76 (19)	43 (30)	33 (13)	<0.01
Statin		215 (54)	71 (49)	144 (58)	0.10
SGLT2i		27 (7)	1 (0.7)	26 (10)	<0.01
CR					
Time between admission and start of CR (days)		6 [4–9]	7 [5–10]	6 [3–9]	0.01
Duration of CR (days)		12 [7–21]	18 [11–27]	10 [6–16]	<0.01
No. CR sessions		7 [4–13]	11 [6–15]	6 [3–11]	<0.01
Total time of CR (min)		340 [180–580]	400 [240–680]	280 [140–520]	<0.01

(**Table 1** continued the next page.)

	No. missing (%)	Overall (n=395)	Non-CS group (n=145)	CS group (n=250)	P value
Socioeconomic status					
Living alone		93 (24)	44 (30)	49 (20)	0.02
Certification in national long-term care insurance		174 (44)	73 (50)	101 (40)	0.06
Cognitive function					
Mini-Cog score (points)		5 [4–5]		5 [4–5]	NA
Home care score		15 [13–17]		15 [13–17]	NA
Medication adherence score		57 [52–63]		57 [52–63]	NA
HF knowledge level		11 [8–13]		11 [8–13]	NA

Unless indicated otherwise, data are given as the mean±SD, median [interquartile range], or n (%). ACEi, angiotensin-converting enzyme inhibitor; ARB, angiotensin receptor blocker; BMI, body mass index; CR, cardiac rehabilitation; CS, conference sheet; eGFRcys, cystatin C-based estimated glomerular filtration rate; HF, heart failure; LVEF, left ventricular ejection fraction; MNA-SF, mini nutritional assessment short form; MRA, mineralocorticoid receptor antagonist; n, number of patients for whom the parameter was available; NT-proBNP, N-terminal pro B-type natriuretic peptide; NYHA, New York Heart Association; SBP, systolic blood pressure; SGLT2i, sodium-glucose cotransporter 2 inhibitor.

into patients' clinical characteristics using 8 scales: physical function, functional status, comorbidities, nutritional status, medication adherence, level of knowledge about HF, cognitive function, and home care support levels (**Figure 1**). Each scale is scored using a 5-point scoring system (excellent=5, good=4, fair=3, poor=2, failure=1), plotted on a radar chart (**Supplementary Table**) with reference to previous research.[23] Higher scores and larger charts indicate better conditions, whereas lower scores and smaller charts denote poorer conditions (**Supplementary Figure**). The CS is designed to enhance the visualization of individual patients' clinical characteristics, fostering an intuitive understanding of clinical issues and their significance among MDT team members with diverse expertise.

Physical function was assessed using the Short Physical Performance Battery (SPPB), consisting of a 4-meter gait speed test, a time-based test for 5 repeated chair stands, and a balance test (side-by-side, semitandem, and tandem stands).[24] The SPPB was scored on a scale of 0 (worst) to 12 (best) points, with scores of 0–4 points awarded for each component.

Functional status for basic activities of daily living was assessed using the Barthel Index by trained physical therapists before discharge.[6,8] The Barthel Index consists of 10 questions about feeding, transfers, grooming, toilet use, bathing, ambulation, stair climbing, dressing, and bowel and bladder care, with scores ranging from 0 (complete dependence) to 100 (complete independence).

Comorbidities were assessed using the Charlson Comorbidity Index (CCI) on the basis of medical information including the patient's history and prescribed drugs.[10,25] The CCI considers 19 conditions: myocardial infarction, congestive HF, peripheral artery disease, cerebrovascular disease, dementia, chronic pulmonary disease, connective tissue diseases, rheumatic disease, peptic ulcer disease, mild liver disease, diabetes with or without chronic complications, hemiplegia/paraplegia, renal disease, any malignancy without metastasis, leukemia, lymphoma, moderate or severe liver disease, metastatic solid tumor, and HIV infection.

Nutritional status was assessed using the Mini Nutritional Assessment Short Form (MNA-SF) within 3 days before discharge, as described previously.[8,10,26] The MNA-SF consists of 6 questions about reducing food intake over the past 3 months, weight loss during the past 3 months, mobility, psychological stress or acute disease in the past 3 months, neuropsychological problems, and body mass index (BMI) and is scored from 0 to 14. The daily energy intake was estimated as reported previously.[8,10]

Cognitive function was assessed before hospital discharge using Mini-Cog©, which combines a 3-item recall test and clock drawing test. The test method was based on the Mini-Cog© website (https://mini-cog.com). Patients were scored using a 5-point scale (0=worst; 5=best), with scores <3 points being considered abnormal.[27,28]

Medication adherence was assessed using the 12-item Medication Adherence Scale,[29] comprising 4 subscales: medication compliance, collaboration with healthcare providers, willingness to access and use information about medication, and acceptance to take medication and how taking medication fits the patient's lifestyle. Each item was rated on a 5-point Likert-type scale, with answers ranging from 1 (never) to 5 (always). Scores were summed for each subscale and total scores ranged from 14 to 70 points, with higher scores indicating better adherence.[29] A trained pharmacist evaluated medication adherence before discharge.

HF knowledge level was assessed using the Japanese Heart Failure Knowledge Scale, which is a valid and reliable tool.[30] The scale has 15 items on general HF (2 items), HF symptoms/signs (4 items), and treatment/self-care (9 items). Patients answered "yes", "no", or "I don't know". Correct answers received 1 point and incorrect or "I do not know" answers received 0 points. Total scores ranged from 0 to 15 points, with higher scores indicating better HF knowledge.[30] Trained nurses evaluated the HF knowledge level before discharge.

The home care support level was evaluated using the Home Care Score (HCS),[31] comprising 7 components related to the ability for care support (care provider's health; availability of a care provider; availability of a substitute care provider; care provider's motivation; bedroom availability; home environment [rental house or owned home]; and family income and expected public pension) and 8 components related to the patient's general condition (ability to feed oneself, bathe, transfer, dress, and use the toilet; verbal communication skills; mental status; medical condition; and motivation). Each component was scored from 0 to 4 points, with total scores ranging from 0 to 21 points. Trained nurses assessed the HCS during hospitalization.

Collection of Data for Other Clinical Parameters

Demographic data, medications, and laboratory and echocardiographic data were obtained from patients' medical records.

Laboratory data for N-terminal pro B-type natriuretic peptide (NT-proBNP), serum albumin, hemoglobin, cystatin C, and cystatin C-based glomerular filtration rate (eGFRcys) were obtained within 7 days before discharge. The eGFRcys was calculated using an equation developed for Japanese individuals.[32] Chronic kidney disease (CKD) was defined as eGFRcys <60 mL/min/1.73 m^2. Transthoracic echocardiography was performed by the standard protocol, and left ventricular ejection fraction (LVEF) was measured by the modified Simpson method; HF with reduced ejection fraction (HFrEF) and HF with preserved ejection fraction (HFpEF) were defined as LVEF <40% and ≥50%, respectively.

Clinical Outcomes

In-hospital outcomes included SPPB at discharge, Barthel Index score at discharge, length of hospital stay, and hospital transfer rate. Long-term outcomes were the first adverse event, a composite of all-cause death and unscheduled readmission due to worsening HF. An episode of worsening HF was defined as either an unplanned scheduled hospitalization for HF or an urgent visit due to worsening HF symptoms. Clinical endpoints were obtained for up to 2 years after enrollment.

Statistical Analyses

Data are presented as the mean±SD, median with interquartile range (IQR; 25th–75th percentile), or numbers with percentages. Baseline characteristics were compared using Welch's t-test, the Mann-Whitney U test, or the Chi-squared test as appropriate.

In-hospital outcomes were compared between the non-CS and CS groups using analysis of covariates or logistic regression analyses. Adjusted least square means or odds ratios (ORs) with 95% confidence intervals (CIs) were calculated by incorporating age, sex, BMI, New York Heart Association (NYHA) functional class, history of hospital admission due to HF, CCI, dyslipidemia, atrial fibrillation, log-transformed NT-proBNP concentration, eGFRcys, albumin, hemoglobin, duration between admission and the start of cardiac rehabilitation, the use of a β-blocker, an angiotensin-converting enzyme inhibitor (ACEi) or an angiotensin receptor blocker (ARB), a mineralocorticoid receptor antagonist (MRA), a sodium-glucose cotransporter 2 inhibitor (SGLT2i), and tolvaptan for the adjustments.

To explore the impact of the implementation of the CS on long-term outcomes, survival curves were calculated by the Kaplan-Meier method, and the statistical significance of differences between the curves was assessed using log-rank statistics.

A multivariate logistic regression model was fit to calculate the propensity scores (PS) for the CS group based on the following baseline variables: age, sex, BMI, NYHA functional class, history of hospital admission due to HF, LVEF <40%, CCI >2, dyslipidemia, atrial fibrillation, NT-proBNP, eGFRcys, albumin, hemoglobin, use of a β-blocker, ACEi, or ARB, MRA, and SGLT2i, living alone, certification in national long-term care insurance, and length of hospital stay. The area under the receiver operating characteristic (ROC) curve for the PS model was 0.79 (95% CI 0.74–0.83). Inverse probability of treatment weighting (IPTW) was calculated using the PS to minimize differences in potential confounding factors between the 2 groups. The CS group was weighted by 1/PS and the non-CS group was weighted by 1/(1−PS). The standardized mean difference (SMD) was used to confirm covariate balance before and after IPTW, with >0.1 considered a meaningful difference. Unadjusted and inverse probability of treatment-weighted Cox proportional hazards analyses were performed to evaluate the impact of CS implementation on long-term outcomes. For sensitivity analysis, multivariate Cox proportional hazard analyses were performed with adjustment for variables in the PS calculation.

Missing data were imputed using multiple imputation analysis, in which the imputation model included the outcome and all exposures and adjustment variables. Assuming missing at random, we performed 100 imputations using chained equations and pooled the estimates to obtain least square means, ORs, or hazard ratios (HRs) following Rubin's rule.[33]

Two-tailed P<0.05 was considered statistically significant. Statistical analyses were performed using JMP Pro version 17.0.0 (SAS Institute Inc., Cary, NC, USA) and R version 4.2.1 (R Foundation for Statistical Computing, Vienna, Austria; https://www.R-project.org/).

Results

Of 421 HF patients who were screened, 395 patients (non-CS group: 145 patients; CS group: 250 patients) were analyzed (**Figure 2**).

Baseline Characteristics

Baseline characteristics were determined from discharge data. The median age of the patients was 79 years (IQR 72–85 years) and 48% of the patients were women. The median BMI of the patients was 21.6 kg/m^2 (IQR 19.2–24.1 kg/m^2). At the time of enrollment, 3%, 61%, and 36% of patients were classified as having NYHA Class I, II, and III, respectively. The median LVEF of the patients was 51.2% (IQR 36.7–63.6%), and 29% of patients were classified as having HFrEF. The most frequent etiology of HF was valvular heart disease (43%), followed by cardiomyopathy (25%) and ischemic cardiomyopathy (18%). Hypertension, diabetes, CKD, and atrial fibrillation were present in 73%, 42%, 71%, and 43% of patients, respectively.

A comparison of baseline characteristics between the non-CS and CS groups showed that there were significant differences (**Table 1**). Patients in the CS group had significantly higher body weight, significantly lower BMI, a significantly lower prevalence of a history of hospital admission due to HF, a significantly higher prevalence of dyslipidemia, a significantly lower prevalence of atrial fibrillation, a significantly lower CCI, a significantly lower MNA-SF score, significantly lower energy and protein intake, significantly lower NT-proBNP and cystatin C concentrations, significantly higher serum albumin, hemoglobin, and eGFRcys levels, significantly less frequent usage of β-blockers and tolvaptan, and a significantly more frequent usage of SGLT2i. The CS group also included fewer patients living alone. In addition, patients in the CS group started multidisciplinary cardiac rehabilitation sooner, although with shorter durations, fewer sessions, and reduced total time dedicated to cardiac rehabilitation.

Table 2. Comparisons of In-Hospital Outcomes Between Patients in the Non-CS and CS Groups				
	No. missing (%)	Non-CS group (n=145)	CS group (n=250)	P value
SPPB (points)	68 (17)	7.3 (6.1–8.4)	8.3 (7.3–9.3)	<0.01
Barthel Index score (points)		75.3 (70.0–80.5)	78.9 (74.3–83.5)	0.03
Barthel Index score ≥85 points		1.00 (Ref.)	1.69 (0.95–3.00)	0.08
Length of hospital stay (days)		35.1 (28.6–41.7)	28.1 (22.3–33.9)	<0.01
Home discharge		1.00 (Ref.)	2.72 (1.41–5.26)	<0.01

Unless indicated otherwise, data are presented as least square means or odds ratio (95% confidence intervals). Missing values were imputed by the multiple imputation technique. Statistical analyses were performed based on analysis of covariates or logistic regression analyses with adjustment for age, sex, BMI, NYHA functional class, history of hospital admission due to heart failure, Charlson comorbidity index, dyslipidemia, atrial fibrillation, log NT-proBNP, eGFRcys, albumin, hemoglobin, duration between admission and start of CR, the use of β-blockers, the use of an ACEi or ARB, the use of mineralocorticoid receptor antagonists, the use of SGLT2i, and the use of tolvaptan. CS, conference sheet; SPPB, Short Physical Performance Battery. Other abbreviations as in Table 1.

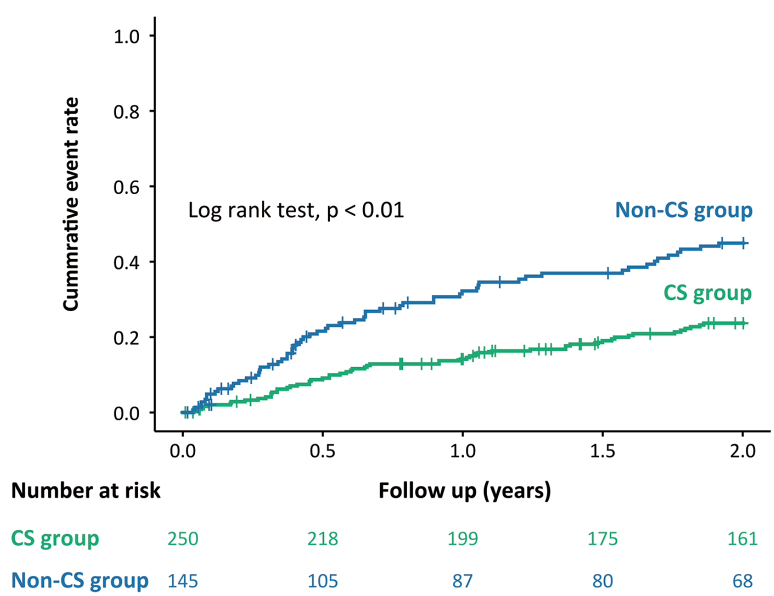

Figure 3. Kaplan-Meier survival curves for patients in the non-CS and CS groups. CS, conference sheet.

Impact of Radar Chart-Based Information Sharing Through the CS on In-Hospital Outcomes

Table 2 outlines the comparative in-hospital outcomes between the non-CS and CS groups. After adjusting potential confounders, including the use of guideline-directed cardioprotective medications, we observed that patients in the CS group had significantly higher SPPB scores, significantly higher Barthel Index scores, and significantly shorter lengths of hospital stay than patients in the non-CS group. Furthermore, the multivariate logistic regression model showed a tendency of higher OR in the CS group for achieving a Barthel Index >85 points (OR 1.69; 95% CI 0.95–3.00; P=0.08). More importantly, patients in the CS group had a significantly higher OR of being discharged home (OR 2.72; 95% CI 1.41–5.26; P<0.01) than those in the non-CS group.

Impact of Radar Chart-Based Information Sharing Through the CS on Long-Term Outcomes

During a mean follow-up period of 1.48±0.71 years, 115 patients (29%) experienced composite events. Kaplan-Meier survival curves demonstrated that patients in the CS group had a lower composite event rate than patients in the non-CS group (22% vs. 41%, respectively; log-rank test, P<0.01; **Figure 3**).

After IPTW, the SMDs of all covariates were <0.1, indicating that baseline differences in the incorporated covariates, including duration of hospital stay, hemoglobin level, CCI, and medication use, were substantially improved (**Figure 4**).

Univariate Cox proportional hazard analysis revealed a 55% reduction in the risk of composite events for patients in the CS group compared with the non-CS group (HR 0.45; 95% CI 0.31–0.64; P<0.01; **Table 3**). This was also the case for the inverse probability of treatment-weighted Cox proportional hazard analysis, which showed a 39% reduction in the risk of the composite event for patients in the CS group compared with the non-CS group (HR 0.61; 95% CI 0.37–0.98; P=0.04; **Table 3**). Similar results were obtained in the sensitivity analysis, with a 44% risk reduction in composite events for patients in the CS group compared with the non-CS group (HR 0.56; 95% CI 0.37–0.84;

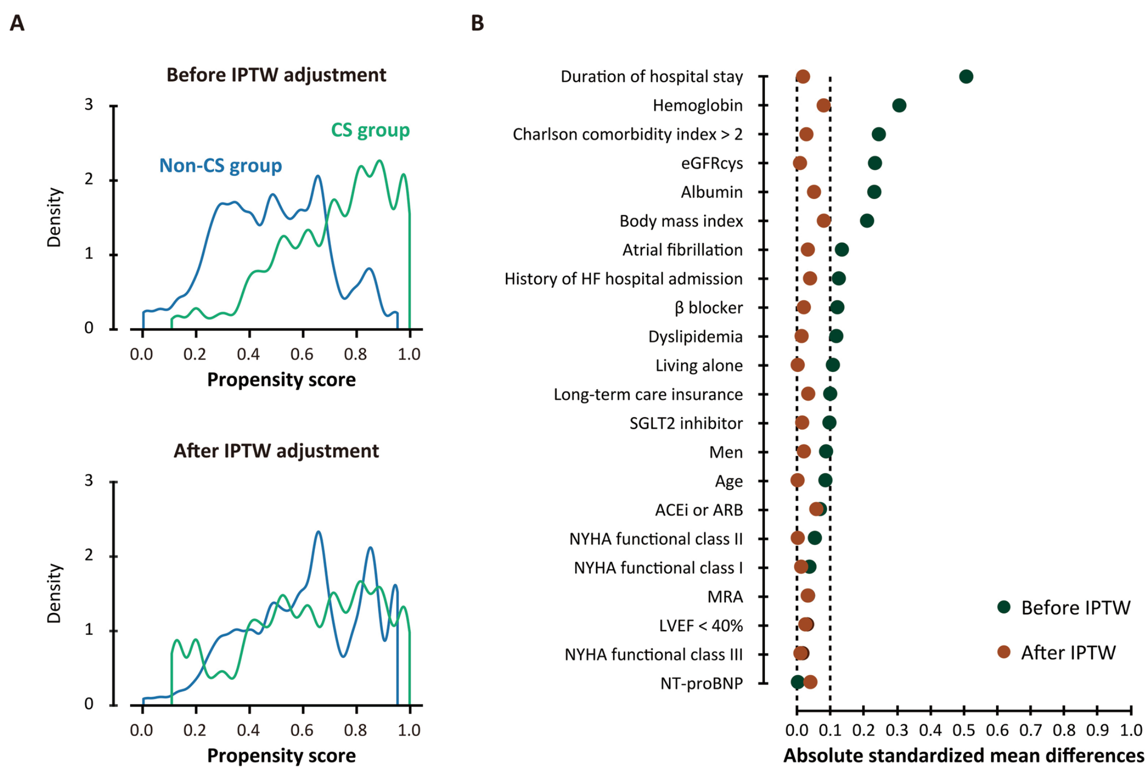

Figure 4. Distributions of (**A**) propensity scores and (**B**) standardized mean differences before and after inverse probability of treatment weighting (IPTW). ACEi, angiotensin-converting enzyme inhibitor; ARB, angiotensin receptor blocker; CS, conference sheet; eGFRcys, cystatin C-based estimated glomerular filtration rate; Log NT-proBNP, log-transformed N-terminal pro B-type natriuretic peptide; LVEF, left ventricular ejection fraction; MRA, mineralocorticoid receptor antagonist; NYHA, New York Heart Association; SGLT2, sodium-glucose cotransporter 2.

Table 3. Long-Term Outcome by Cox Proportional Hazard Analysis for Composite Event

	Non-CS group: HR	CS group: HR (95% CI)	P value
Univariate model	1.00	0.45 (0.31–0.64)	<0.01
IPTW model	1.00	0.61 (0.37–0.98)	0.04
Multivariate model	1.00	0.56 (0.37–0.84)	<0.01

The multivariate model was adjusted for age, sex, BMI, NYHA functional class, history of hospital admission due to heart failure, LVEF <40%, Charlson comorbidity index >2, dyslipidemia, atrial fibrillation, log-transformed NT-proBNP concentration, eGFRcys rate, albumin, hemoglobin, the use of β-blockers, the use of an ACEi or ARB, the use of mineralocorticoid receptor antagonists, the use of SGLT2i, living alone, certification in national long-term care insurance, and length of hospital stay. CI, confidence interval; HR, hazard ratio; IPTW, inverse probability of treatment weighting. Other abbreviations as in Tables 1,2.

P<0.01; **Table 3**).

The impact of implementing CS on long-term outcomes in the subgroups of interest was examined (**Figure 5**). There were no significant differences in HRs for composite events among the subgroups, including subgroups for age, sex, nutritional status, functional status, physical performance, and duration of hospital stay (**Figure 5**).

Discussion

In this study we developed a novel CS featuring an 8-component radar chart for visualizing and sharing clinical characteristics of older HF patients in an MDT context. We analyzed the impact of the radar chart-based information sharing system on in-hospital and long-term outcomes. Our results indicated noticeable in-hospital enhancements in the CS group, encompassing elevated SPPB and Barthel Index scores, diminished length of hospital stays, and increased discharge-to-home rates. Furthermore, a significant 39% risk reduction in the composite event rate was observed in the CS group compared with the non-CS group, reinforcing the potential advantages of radar chart-based information sharing in MDT approaches for older HF patients.

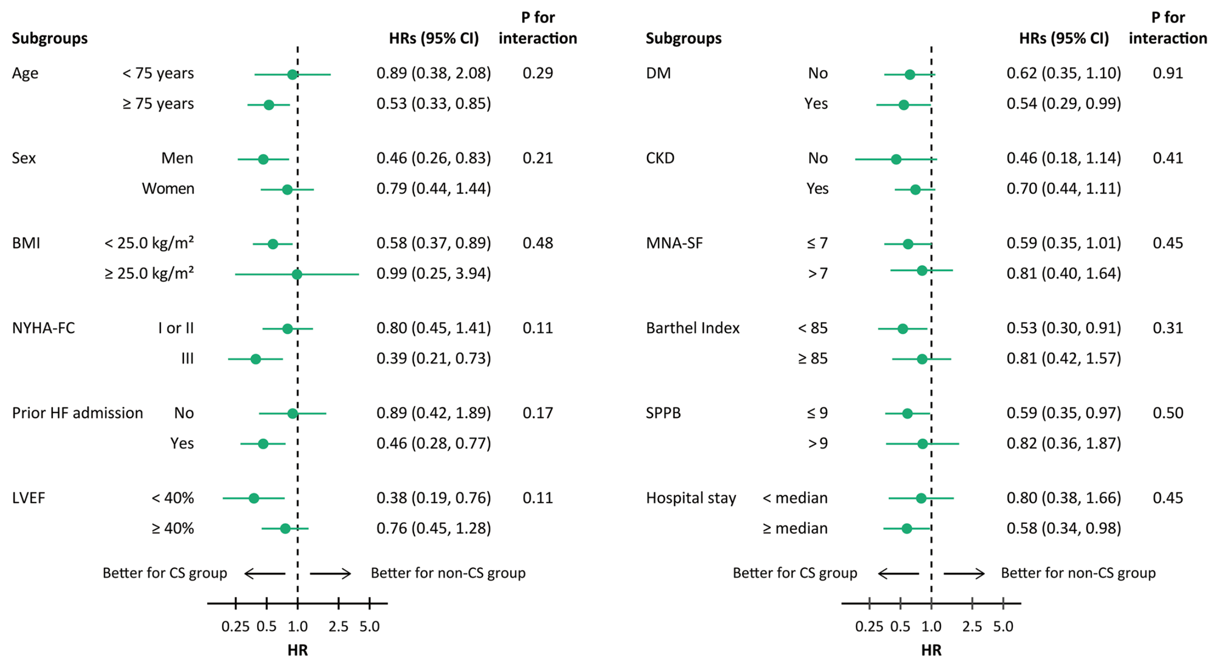

Figure 5. Subgroup analyses of the impact of a novel conference sheet (CS) on long-term outcomes. Models were weighted using propensity score overlap weighting. BMI, body mass index; CI, confidence interval; CKD, chronic kidney disease; DM, diabetes mellitus; HF, heart failure; HRs, hazard ratios; LVEF, left ventricular ejection fraction; MNA-SF, Mini Nutritional Assessment Short-Form; NYHA-FC, New York Heart Association functional class.

Given the complexity of managing older HF patients, attributed to challenges such as diminished physical function, functional disabilities, multiple comorbidities, polypharmacy, malnutrition, cognitive impairment, and social disconnection,[5–11,34] a comprehensive coordinated care approach becomes essential. The MDT concept has proven effective in various areas of cardiovascular medicine,[35] fostering interdisciplinary collaboration among diverse healthcare professionals.[36] This, in turn, enables individualized care plans and augments communication within the team, culminating in positive patient outcomes such as decreased HF hospitalization rates, all-cause mortality, healthcare costs, improved self-care adherence, and the utilization of guideline-directed medical treatment.[13–16]

Our novel CS integrates an 8-component radar chart to visually distill the complexities of older HF patients' clinical conditions, thereby augmenting interdisciplinary comprehension among the MDT members. Its visually intuitive format enables quick identification of areas requiring attention, thereby optimizing patient care priorities and reinforcing decision making and interdisciplinary collaboration.[37,38] Conversely, inadequate information sharing may result in fragmented care, increased risk of errors, and unfavorable outcomes. Through the visual advantages of radar charts, team members can collaborate more efficiently and make well-informed decisions, ultimately enhancing patient care and outcomes.[37,38]

Our findings can be interpreted within the broader literature on MDT approaches and information sharing in healthcare. The significant improvements in short-term outcomes, such as increased SPPB and Barthel Index scores, suggest that the CS may facilitate the comprehension of patients' physical functionality and overall wellbeing among areas of different expertise, leading to more effective interventions. Consequently, the reduced length of hospital stay could stem from more efficient care coordination and resource distribution, outcomes attributable to our radar chart-based information sharing via CS. Such advances in in-hospital outcomes may cascade, potentially leading to a decrease in composite event risk for patients under the care of the CS group.

Importantly, it is crucial to note that the CS is not only a tool for information sharing, but can also act as a catalyst to transform MDT interventions. An earlier case study affirmed the efficacy of an 8-component radar chart for evaluating older HF patients' conditions, aiding healthcare professionals to enhance patient conditions and prolong life expectancy based on the Seattle Heart Failure Model.[23] This underlines the potential of radar chart-based information sharing for improving clinical outcomes and overall patient care. Our findings suggest that the CS facilitates the identification of individualized patient care needs and areas requiring immediate attention, thereby informing the decision-making process. This promotes improvements in patient care, efficient resource distribution, and enhanced interdisciplinary collaboration.

When comparing the risk reduction in our study with preceding research, it is essential to consider each study's unique context and methods. Our study focused on radar chart-based information sharing in MDT approaches, whereas others have focused on various aspects of MDT approaches, including team composition, intervention nature, communication strategies, and care coordination techniques.[13,17,36,39] Nevertheless, the 39% risk reduction observed in our study aligns with benefits reported in the literature for effective MDT approaches,[13,16,40,41] thereby endorsing the significance of collaborative information sharing in managing older HF patients.

Study Strengths and Limitations

This study has several notable strengths. First, it is one of the pioneering studies exploring the impact of implementing an 8-component radar chart-based CS on both in-hospital and long-term outcomes in older HF patients. Second, the use of rigorous statistical methodologies including IPTW helps minimize potential biases and confounding variables, thereby increasing the reliability of our findings. Third, the study emphasizes the critical role of information sharing within an MDT, providing valuable insights for healthcare professionals across specialties. Finally, the study paves the way for future research into the broader implications of implementing a CS to aid in the sharing of patient clinical characteristics and the role of MDTs in managing HF and other chronic conditions.

Nevertheless, this study also has several limitations. First, its ambispective, single-center design with a small sample size may have introduced selection bias, despite using multiple imputation techniques. Second, the historical cohort design comparing 2 different periods may have left residual confounding factors intact, even after adjusting our statistical analysis via IPTW. In addition, disparate observation periods between the non-CS and CS groups could have influenced the outcomes. The observation period for the CS group coincided with the COVD-19 pandemic, potentially affecting readmission rates. In addition, the introduction of new HF treatments, such as angiotensin receptor-neprilysin inhibitors and ivabradine, in Japan during the CS group's observation period may have influenced the results. Importantly, our study design precludes us from establishing a definitive causal link between the implementation of a CS and the observed clinical outcomes. Third, the earlier initiation of cardiac rehabilitation in the CS group may indicate a better clinical condition of these patients than those in the non-CS group, potentially affecting the favorable outcomes. Finally, the absence of a healthcare cost analysis prevents us from evaluating the cost-effectiveness of implementing a CS-based MDT approach. Despite these limitations, our study contributes compelling evidence supporting the efficacy of radar chart-based information sharing in MDT approaches for the management of older patients with HF.

Conclusions

In conclusion, our study highlights the importance of radar chart-based information sharing within MDTs in managing hospitalized HF patients. By using an innovative CS incorporating an 8-component radar chart, in-hospital and long-term outcomes were notably enhanced. Our findings accentuate the imperative for cross-disciplinary collaboration to facilitate patient-centered care, ultimately leading to better patient outcomes and improved quality of life.

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Disclosures

The authors declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article. M.F. is a member of *Circulation Reports*' Editorial Team.

IRB Information

This study was conducted in strict adherence to the principles of the Declaration of Helsinki and was approved by the Clinical Investigation Ethics Committee of Sapporo Medical University Hospital (No. 302-243).

Data Availability

The deidentified participant data will not be shared.

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Supplementary Files

Please find supplementary file(s);
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