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ORIGINAL ARTICLE
Devices

Accelerated Early Discharge and Clinical Outcomes in Heart Failure Patients With Cardiac Implantable Electronic Devices

— Subanalysis From a Multicenter Cohort Study —

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Background: Previous studies have demonstrated that a shorter hospital stay reduces adverse outcomes in heart failure (HF), primarily in observational study settings. This trend was further emphasized during the COVID-19 pandemic, resulting in case-control study-like results.

Methods and Results: A subanalysis was conducted on 239 patients from a Japanese multicenter cohort study (HINODE), encompassing 32 months before and 6 months after pandemic onset. The duration of hospitalization and clinical outcomes were compared between these 2 periods in HF patients who received guideline-directed medical and cardiac implantable electronic device (CIED) therapy. The duration of HF hospitalization was significantly shortened by 41.1% (95% confidence interval [CI] 6.7–62.8%) during the pandemic period (median 13 days; interquartile range [IQR] 6–19 days) compared with the prepandemic period (median 21 days; IQR 12–38 days). Nonetheless, the incidence rate (IR) of outcomes in the pandemic group was similar (ventricular arrhythmia, HF events, HF and cardiac hospitalization) or lower (all-cause hospitalization [IR ratio 0.6; 95% CI 0.4–1.0]) compared with the prepandemic group. The odds ratio of adverse events was also similar between the 2 groups.

Conclusions: A significant reduction in hospitalization duration during the COVID-19 pandemic was associated with similar or improved clinical outcomes for guideline-adherent HF patients. Current hospitalization durations for advanced HF patients are likely unnecessarily long, and efforts to reduce them are warranted.

Key Words: Cardiac implantable electronic device; Clinical outcomes; COVID-19 pandemic; Early discharge; Heart failure

The length of hospital stay is a critical concern in heart failure (HF) patients.[1–7] Although this issue is also pertinent for other diseases requiring hospitalization due to nosocomial infection risks and escalating medical costs,[2,6,8,9] its significance in HF is further amplified by the substantially large patient population.[4,5] More importantly, several reports indicate that the length of hospital stay can affect subsequent clinical outcomes, particularly rehospitalization rates, in HF patients after discharge.[1–6] However, it is not clear whether the reduction in the length of hospital stay is causally related to prognosis or merely associated with it. Although the results of many studies advocate for shorter hospitalization periods,[1–3,5] other studies have reported contrasting results.[4,6]

Conflicts among sources of evidence may originate from study settings. Most studies regarding the length of hospital stay use observational study designs,[1–6] where physicians share the same intention of 'avoiding unnecessary hospitalization' for all patient groups. In addition, HF severity is positively associated with prolonged hospitalization.[10,11] Therefore, the length of hospital stay analyzed in those studies may be more reflective of the severity of a patient's condition rather than the physician's intention. In this context, patients with shorter hospitalization periods show better clinical outcomes, possibly because they were hospitalized for a shorter duration as their condition was less severe. However, these results do not adequately address the question of whether there is a need for a fur-

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ther reduction in the length of hospital stay.

In the early period of the COVID-19 pandemic, both patients and physicians felt the pressure to shorten hospitalization periods, aiming to avoid in-hospital contagion.[12] Consequently, the length of hospital stay for patients with cardiovascular disease was significantly reduced during the pandemic compared with prepandemic periods.[13–15] Although the pandemic was a worldwide tragedy, it inadvertently provided unprecedented data of a therapy crossover design and facilitated investigation of the effects of accelerated early discharge on clinical outcomes.

In this study, we analyzed data from the Heart faIlure iNdicatiOn and sudDEn cardiac death prevention trial Japan (HINODE),[16,17] which tracked HF patients indicated for cardiac implantable electronic device (CIED) implantation over a period encompassing 32 months before (prepandemic) and 6 months after (pandemic) the onset of the COVID-19 pandemic. We compared the length of hospital stay between these 2 periods and analyzed its effect on clinical outcomes.

Methods

Patient Population

The study design and primary results of HINODE have been published previously.[16,17] Briefly, HINODE was a prospective multicenter registry designed to collect clinical outcomes in HF patients who were indicated for CIED implantation. HF patients with risk factors for sudden cardiac death were enrolled and classified by the type of CIED, such as implantable cardioverter-defibrillators (ICD), cardiac resynchronization therapy defibrillator (CRT-D), cardiac resynchronization therapy pacemaker (CRT-P), or pacemakers. All patients provided written informed consent and were followed until the last enrolled patient completed the closeout visit after a minimum of 12 months. The study protocol was approved by the ethics committees of all 34 participating centers, with the Institutional Review Board (IRB) of the University of Tsukuba Hospital serving as the representative (IRB no. H29-45). All procedures were performed in accordance with the principles of the Declaration of Helsinki.

In the present study, HF patients adhering to Japanese Circulation Society guideline-directed medical and CIED therapy were selected by excluding the non-device group in HINODE, who met European Society of Cardiology guideline CIED implantation criteria but were not implanted. Patients were enrolled in the study from June 2017 to June 2019 and remained under follow-up until their closeout visit, typically June through September 2020 (**Supplementary Figure 1**). The follow-up periods were categorized into prepandemic and pandemic periods based on the outbreak of the COVID-19 pandemic (World Health Organization declaration March 11, 2020). In addition, the prepandemic period was further categorized into 2 therapy periods to provide a baseline for the effect of CIED therapy duration on outcomes, because patients who were followed in the pandemic period had already received CIED therapy during the prepandemic period. HINODE was originally designed to follow up patients for a minimum of 1 year after CIED implantation. In this study, 98% of patients who contributed to the pandemic period had already been followed up for more than 1 year during the prepandemic period (mean [±SD] follow-up 18.0±5.7 months). Therefore, the prepandemic period was divided into the first year of therapy (≤1Y period; 0–12 months after implant) and the second year of therapy (>1Y period; 12–24 months after implant). Comparison of prepandemic length of hospital stay and clinical outcomes stratified by first and second years of therapy provides a baseline for the effect of CIED therapy duration on outcomes in the absence of a pandemic and is included to assess the longitudinal effects that may be present when comparing the pandemic and prepandemic periods.

Length of Hospital Stay and Clinical Outcomes

To confirm the decrease in hospitalization period, the length of hospital stay in each period was compared with regard to HF hospitalization, cardiac hospitalization, and all-cause hospitalization. Hospitalization was defined as admission to a hospital with at least 1 calendar date change. HF hospitalization was defined as hospitalization for an event classified as HF by an independent adjudication committee. Cardiac hospitalization was defined as hospitalization for an event classified as cardiovascular condition related by the study sponsor, including HF hospitalization. All-cause hospitalization covers all hospitalizations, including HF and cardiac hospitalization. However, planned admissions with less direct relevance to the patient's clinical outcomes, such as initial implant procedures or scheduled replacements for CIED, were excluded.

The incidence rates (IR) of clinical outcomes for each period were compared with regard to ventricular arrhythmia (VA) events, HF events, HF hospitalization, cardiac hospitalization, and all-cause hospitalization. VA events were adjudicated by an independent event committee and defined as requiring treatment by shock or antitachycardia pacing or causing hemodynamic instability requiring treatment. HF events were adjudicated by an independent event committee and defined as having primary cause linked to cardiac dysfunction with signs and symptoms consistent with congestive HF and either of the following conditions met: (1) the patient was hospitalized and received a new or increased decongestive HF regimen, with oral or parenteral medications; or (2) the patient was not hospitalized but received intravenous decongestive HF therapy. In addition, the odds of an adverse event being related to HF or resulting in intravenous or intramuscular medication change or adjustment were compared for each period. The relationship of an adverse event with HF was assessed by the site physician, and medication changes were collected for all adverse events.

Statistical Analysis

Data are summarized in as counts and percentages for categorical variables and as the median with interquartile range (IQR) for continuous variables. The length of hospital stay in each period was compared by estimating the difference for the average patient by fitting a normal regression model with log-transformed length of stay (days) as the outcome, period as the predictor, and adjusted for repeat hospitalizations per patient using a generalized estimating equation (GEE). In addition, log-transformed length of stay was plotted against days from CIED implant for each period with a fitted line produced by locally weighted scatterplot smoothing. IRs were calculated as the number of events per patient year in each period and compared using an IR ratio, estimated using a negative binomial regression model with GEE to adjust for patient contribution to both periods. Relationships between all-cause hospitalization incidence per period and subgroups of age (≤70 vs. >70

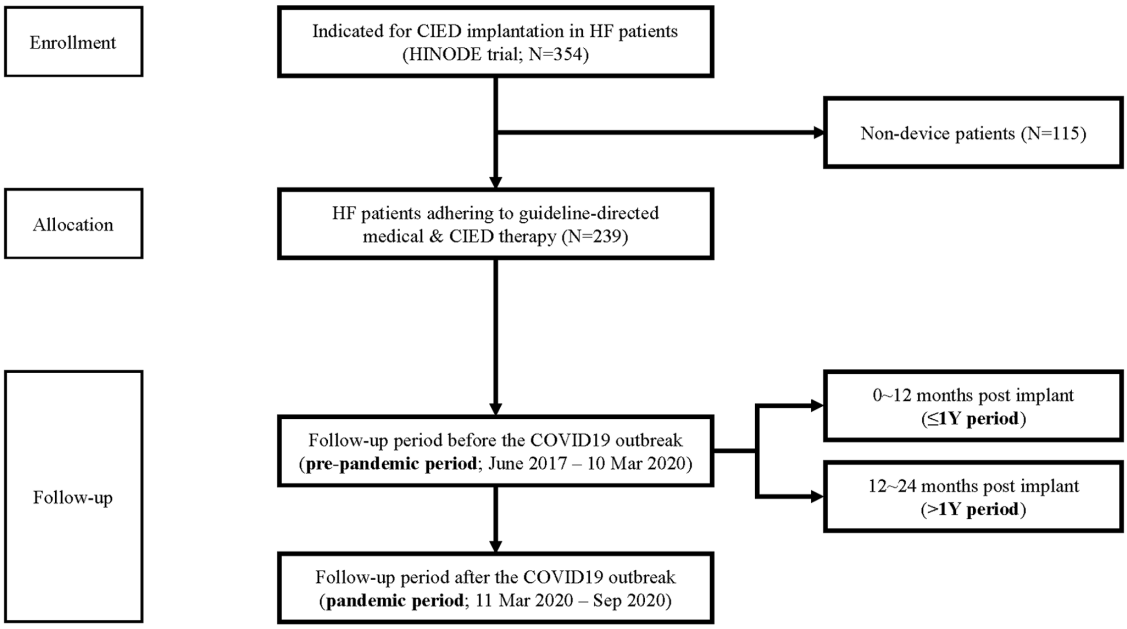


Figure 1. Study design. Advanced heart failure (HF) patients receiving guideline-directed medical and cardiac implantable electronic device (CIED) therapy were selected and divided into prepandemic and pandemic periods. The prepandemic period was further divided into ≤1Y and >1Y based on time from CIED implantation.

years), left ventricular ejection fraction (LVEF; ≤40% vs. >40%), CIED type, and connection to remote monitoring were evaluated by adding the covariate and interaction term to the model. Additional outcomes beyond all-cause hospitalization were not assessed due to the limited number of events per subgroup. Among adverse events, the probability of an event being related to HF or resulting in medication change within each period was compared using odds ratios calculated from logistic regression with GEE to adjust for repeat events per patient and additionally adjusted for hospitalization when evaluating the outcome of medication change. A significance level of 5% and 2-sided 95% confidence intervals (CI) were used throughout. All statistical analyses were performed using SAS version 9.4 (SAS Institute Inc., Cary, NC, USA).

Results

Patient Population

Among the 354 HF patients enrolled in HINODE from June 2017 to June 2019, 115 patients who met the criteria for CIED implantation but did not receive the device were excluded from the present study (**Figure 1**). Consequently, this study analyzed 239 HF patients who adhered to guideline-directed medical and CIED therapy.

The mean (±SD) patient follow-up duration after CIED implant was 20.4±6.8 months, with 17.3±6.2 months prepandemic and 3.4±1.0 months during the pandemic. The total follow-up was 406.4 patient-years (345.1 patient-years prepandemic and 61.3 patient-years during the pandemic). Within the prepandemic period, the mean follow-up after CIED implantation was 11.4±1.7 months for the ≤1Y period, and 7.0±3.9 months for the >1Y period. The total follow-up after CIED implantation was 226.5 patient-years for the ≤1Y period and 108.6 patient-years for the >1Y period.

The baseline characteristics of the patients are summarized in **Table 1**. The median age of the patients was 71 years (IQR 64–78 years), and 74.5% were male. The patients had a median of 4 (IQR 3–4) risk factors for sudden cardiac death, with the most common factor being LVEF ≤35%, which accounted for 87.0%. All patients in the analysis were implanted with a CIED, including ICD (42.7%), CRT-D (28.9%) or CRT-P/pacemakers (28.5%).

As indicated in **Table 1**, the median systolic blood pressure was 108 mmHg (IQR 98–118 mmHg), and 61.9% of patients had a history of previous hospitalization for HF. The median QRS width on the electrocardiogram was 140 ms (IQR 110–160 ms), and the median LVEF on the echocardiogram was 29% (IQR 23–33%). In terms of medications, 78.7% of patients were taking β-blockers and 42.7% and 27.2% of patients were taking angiotensin-converting enzyme inhibitors and angiotensin receptor blockers, respectively.

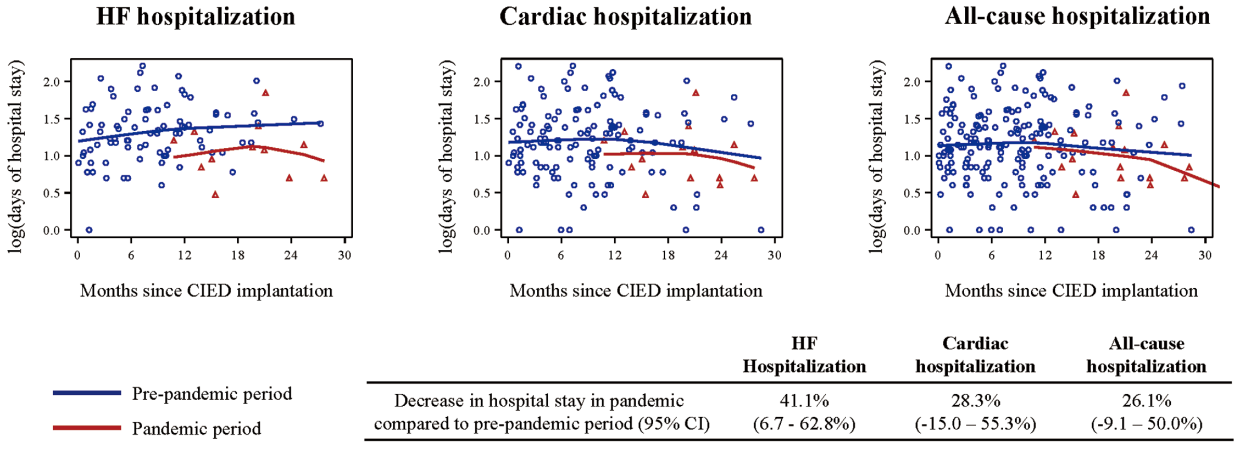
Length of Hospital Stay

The length of HF hospitalization during the pandemic period (median 13 days; IQR 6–19 days) decreased significantly to 41.1% (95% CI 6.7–62.8) of that during the prepandemic period (median 21 days; IQR 12–38 days; **Figure 2**). The median lengths of cardiac and all-cause hospitalization during the prepandemic period were 16 (IQR 8–32) and 15 (IQR 7–31) days, respectively, compared with 11 (5–16) and 8 (5–16) days during the pandemic period. The decreases in length of hospital stay of cardiac and all-cause hospitalization were 28.3% (95% CI −15.0%, 55.3%) and 26.1% (95% CI −9.1%, 50.0%) respectively, showing a trend towards a shorter hospitalization stay during the pandemic than prepandemic period

Table 1. Patient Characteristics at Baseline (n=239)	
Patient demographics	
Age (years)	71 [64–78]
Male sex	178 (74.5)
Risk factors for sudden cardiac death	
LVEF ≤35%	208 (87.0)
NYHA Class III or IV	78 (32.6)
LBBB with QRS >130 ms or QRS >150 ms	121 (50.6)
BUN >26 mg/dL or ≥9.28 mmol/L	53 (22.2)
Diabetes (Type 1 and 2)	88 (36.8)
Chronic AF	37 (15.5)
Prior MI	70 (29.3)
Age ≥70 years	128 (53.6)
Smoking history (past 5 years)	56 (23.4)
Total no. risk factors	4 (3–4)
CIED classification	
ICD	102 (42.7)
CRT-D	69 (28.9)
CRT-P and pacemaker	68 (28.5)
Physical examinations	
BMI (kg/m^2)	23 [20–25]
SBP (mmHg)	108 [98–118]
DBP (mmHg)	62 [56–70]
Resting heart rate (beats/min)	69 [59–76]
Medical history	
Ischemic cardiomyopathy	92 (38.5)
Hypertension	112 (46.9)
AF	64 (26.8)
Previous hospitalization for HF	148 (61.9)
History of non-sustained spontaneous VA >30 s	27 (11.3)
History of inducible VA during past 12 months	20 (8.4)
ECG findings	
QRS width (ms)	140 [110–160]
PR interval (ms)	190 [170–208]
QT interval (ms)	450 [419–484]
LBBB	85 (36.2)
RBBB	29 (12.3)
Echocardiographic findings	
LVEF (%)	29 [23–33]
LVEF ≤25%	88 (36.8)
LVEDD (mm)	61 [56–67]
Medications	
Antiarrhythmic	73 (30.5)
Anticoagulant	107 (44.8)
Antiplatelet	109 (45.6)
ACEi	102 (42.7)
ARB	65 (27.2)
β-blocker	188 (78.7)
Calcium channel blocker	38 (15.9)
Diuretics	172 (72.0)
Digitalis	13 (5.4)
Statins	115 (48.1)

Values are presented as the median [interquartile range] or n (%). ACEi, angiotensin-converting enzyme inhibitor; AF, atrial fibrillation; ARB, angiotensin receptor blocker; BMI, body mass index; BUN, blood urea nitrogen; CIED, cardiac implantable electronic device; CRT-D, cardiac resynchronization therapy with a defibrillator; CRT-P, cardiac resynchronization therapy pacemaker; DBP, diastolic blood pressure; ECG, electrocardiogram; HF, heart failure; ICD, implantable cardioverter defibrillator; LBBB, left bundle branch block; LVEDD, left ventricular end-diastolic dimension; LVEF, left ventricular ejection fraction; MI, myocardial infarction; NYHA, New York Heart Association; RBBB, right bundle branch block; SBP, systolic blood pressure; VA, ventricular arrhythmia.

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



	HF Hospitalization	Cardiac hospitalization	All-cause hospitalization
Decrease in hospital stay in pandemic compared to pre-pandemic period (95% CI)	41.1% (6.7 - 62.8%)	28.3% (-15.0 – 55.3%)	26.1% (-9.1 – 50.0%)

Figure 2. Decreases in hospital stay during the pandemic. The days of hospital stay are presented in log scale for heart failure (HF), cardiac, and all-cause hospitalizations. Blue circles and red triangles represent events from the prepandemic and pandemic periods, respectively. CI, confidence interval; CIED, cardiac implantable electronic device.

Table 2. Incidence Rate Ratios for Clinical Outcomes

Clinical outcomes	No. events	Incidence rate (events/year)	Incidence rate ratio (95% CI)	P value
Ventricular arrhythmia events				
Prepandemic	61	0.18	0.3 (0.1–1.2)	0.088
Pandemic	4	0.07		
HF events				
Prepandemic	107	0.31	0.9 (0.6–1.4)	0.589
Pandemic	16	0.26		
HF hospitalization				
Prepandemic	86	0.26	0.9 (0.5–1.5)	0.641
Pandemic	13	0.21		
Cardiac hospitalization				
Pre-pandemic	137	0.40	0.7 (0.4–1.1)	0.088
Pandemic	16	0.26		
All-cause hospitalization				
Prepandemic	201	0.58	0.6 (0.4–1.0)	0.031
Pandemic	22	0.36		

CI, confidence interval; HF, heart failure.

(**Supplementary Table 1**).

Because those 2 periods are temporally sequential with most patients in the later period having received >1 year of CIED treatment, the impact of CIED implantation duration on length of hospital stay was evaluated to exclude natural treatment course bias. Within the prepandemic period, the median length of HF hospitalization was 24 days (IQR 14–37 days) in the >1Y period and 20 days (IQR 11–41 days) in ≤1Y period, with no significant decrease in the later period −12.9%; 95% CI −58.4, 19.5; **Supplementary Figure 2**). Furthermore, the median length of hospital stay in cardiac and all-cause hospitalization in ≤1Y period were 17 (IQR 8–32) and 15 (IQR 7–29) days, respectively, with corresponding values during the >1Y period of 15 (IQR 6–28) and 13 (IQR 5–27) days. The decreases in length of hospital stay of cardiac and all-cause hospitalization were 18.9% (95% CI −28.3, 48.7) and 24.5% (95% CI −15.5, 50.6) respectively.

Clinical Outcomes

The IRs of VA events, HF events, HF hospitalization, and cardiac hospitalization in the pandemic period were 0.07, 0.26, 0.21, and 0.26 events per year, respectively (**Table 2**). No significant difference was found compared with the prepandemic period, although the rates of VA events and cardiac hospitalizations trended lower during the pandemic (IR ratios 0.3 [95% CI 0.1–1.2] and 0.7 [95% CI 0.4–1.1], respectively). The rate of all-cause hospitalization was also lower during the pandemic than during the prepandemic period, reached a significant difference with an IR ratio of 0.6 (95% CI 0.4–1.0). Cardiac hospitalizations accounted for 68.2% and 72.7% in the prepandemic and pandemic periods, respectively, and no COVID-19 infections were reported in either period.

The impact of CIED implantation duration on IRs was evaluated within the prepandemic period. Within the prepandemic period, the respective IRs of VA and HF events were 0.11 and 0.36 events per year in the ≤1Y period, and 0.32 and 0.21 events per year in the >1Y period, which showed no significant worsened outcomes. Yet, HF, cardiac, and all-cause hospitalizations were significantly lower in the >1Y than ≤1Y period, with IR ratios of 0.6 (95% CI 0.3–1.0; P=0.041), 0.5 (95% CI 0.4–0.8; P=0.006), and 0.6 (95% CI 0.4–0.8; P=0.003), respectively (**Supplementary Table 2**).

In addition, the decrease in the all-cause hospitalization IR during the pandemic period was similar across age,

Table 3. Incidence Rate Ratios for All-Cause Hospitalization in Subgroups

Subgroup	Incidence rate ratio[A] (95% CI)	P for interaction
Age		
Age ≤70 years	0.6 (0.2–1.3)	0.722
Age >70 years	1.1 (0.6–2.0)	
LVEF		
LVEF >40%	0.6 (0.1–3.5)	0.936
LVEF ≤40%	0.6 (0.4–1.0)	
Defibrillator		
No defibrillator	0.8 (0.3–2.2)	0.663
ICD or CRT-D	1.0 (0.6–1.9)	
CRT		
No CRT	0.5 (0.3–1.0)	0.328
CRT-D or CRT-P	0.5 (0.3–0.9)	
Remote monitoring		
No remote monitoring	0.5 (0.2–1.6)	0.646
Remote monitoring	0.6 (0.3–1.1)	

[A]Pandemic/prepandemic. CI, confidence interval; CRT, cardiac resynchronization therapy. Other abbreviations as in Table 1.

Table 4. ORs of Adverse Events

Adverse events	OR[A] (95% CI)	P value
Events related to HF	1.25 (0.67–2.35)	0.487
Events resulting in medication changes	0.63 (0.29–1.40)	0.260

[A]Pandemic/prepandemic. CI, confidence interval; HF, heart failure; OR, odds ratio.

LVEF, CIED type, or remote monitoring subgroups (**Table 3**). Although the decrease in the all-cause hospitalizations was less evident for patients aged >70 years vs. those aged ≤70 (IR ratios 1.1 vs. 0.6, respectively) and for those implanted with a defibrillator (ICD or CRT-D) vs. those with a pacing device (IR ratios 1.0 vs 0.8, respectively), no significant differences were detected.

Finally, the odds of adverse events being related to HF or requiring medication change were not significantly different during the pandemic and prepandemic periods, or in the >1Y vs. ≤1Y period (**Table 4**; **Supplementary Table 3**).

Discussion

This subanalysis of HINODE, encompassing the early pandemic period, examines the appropriate length of hospital stay for HF patients. Despite the shortened length of stay available for HF hospitalization in the pandemic period, the IRs of clinical outcomes during the pandemic were similar or lower than those in the prepandemic period. Current hospitalization lengths for guideline-adherent HF patients may be unnecessarily long, suggesting that efforts to determine more appropriate durations are warranted. In the present study, reducing nearly half the HF hospitalization periods did not aggravate the subsequent outcomes after discharge.

Furthermore, subanalysis within the prepandemic period was conducted to exclude the possible bias due to natural treatment course. Longer treatment periods (>1 year) did not reduce the length of hospital stay compared with shorter treatment periods (≤1 year), unlike comparisons of the pandemic and prepandemic periods. Yet, whether the length of hospital stay was reduced or not, both the >1Y and pandemic periods showed similar or improved clinical outcomes compared with the ≤1Y and prepandemic periods, respectively. Together, the data indicate that natural treatment course was less likely to affect clinical outcomes in the pandemic period.

In addition, it is of note that some clinical outcomes showed significant improvement or trends towards improvement with a shortened hospitalization period. For example, the IR ratio of all-cause hospitalization improved significantly, with trends towards improvement in the IR ratios of VA events and cardiac hospitalization during the pandemic compared with prepandemic period. The natural treatment course bias mentioned above seems to have influenced these outcomes, because both cardiac and all-cause hospitalizations improved in the >1Y vs. ≤1Y period. Furthermore, there are reports of a significant decrease in VA events during the pandemic period, possibly due to social isolation and reduced real-life stressors.[18,19]

The issue of the appropriate length of hospital stay is not merely a numerical matter, because "necessary admission" cannot be easily defined and varies according to factors such as time,[1] country,[4] and the context of a pandemic, as seen in the present study. Regarding temporal differences, one study analyzed the annual length of hospital stay and readmission rates for HF and other diseases over 14 years.[2] In that study, although the length of hospital stays decreased over the study period, this did not exacerbate the readmission rates.[2] These findings may suggest that a further reduction in HF hospitalization duration could be beneficial. However, the yearly decrease in hospitalization duration is likely not solely attributable to changes in treatment intention. Therefore, using these results as evidence to actively shorten HF hospitalization periods may not be appropriate. In terms of differences among countries, an analysis of data from 27 countries revealed that the average length of hospital stay for HF patients ranged from 4.9 to 14.6 days.[4,20] Although countries with longer hospital stays tended to have lower readmission rates for HF patients, most countries did not show a significant correlation between these 2 factors.

Shorter hospitalization lengths do not always lead to better clinical outcomes, and there are limitations in clearly establishing a causal relationship between them without considering the aforementioned factors. However, similar or improved clinical outcomes, even with an almost 50% reduction in HF hospitalization length (from a median of 21 to 13 days) during the pandemic, highlight the potentially unnecessary length of hospitalization. It is also notable that the reduced length of stay during the pandemic in this study remained longer than the usual length of stay in other countries or as reported in the MADIT-CRT substudy (mean[±SD] length of stay 4.2±0.79 and 4.8±0.58 days in the CRT-D and ICD groups, respectively; $P<0.001$).[21]

Another study also drew interesting insights based on desperate management strategies during the pandemic.[22] Guidelines recommend the use of non-invasive positive pressure ventilation is recommended for acute decompensated HF patients, but its use was significantly decreased during the pandemic due to concerns about aerosol spreading; however, although this was a desperate decision at the time, it did not worsen clinical outcomes or increase medical expenses.[22] As with our study, reviewing desperate decisions made during the pandemic may provide us with unprecedented data and unique insights.

Overall, determining the appropriate length of hospital stay from observational studies conducted at different times and in various countries has its limitations. Our subanalysis during the pandemic cannot equate to case-control studies, nor are such studies likely to be conducted on this issue. Nevertheless, the results of this study indicate that there is potential to reduce the length of hospital stays in HF hospitalization by up to 40%, without necessarily leading to adverse outcomes. Furthermore, this issue is likely to be further investigated with growing importance due to the development of remote monitoring, the possibility of another pandemic emerging, and skyrocketing medical costs due to increasing numbers of HF patients. Additional data on intentional or accelerated decreases in the hospitalization period will add to evaluations of patient and health economic benefits.

Our study has several limitations. First, the use of hospitalization as a surrogate marker for clinical outcomes in HF patients may be influenced by physician reluctance to admit patients during the pandemic.[12–15] This may be associated with the reduction in all-cause hospitalizations during the pandemic compared with pre-pandemic period. Nonetheless, other clinical outcomes in addition to hospitalizations were evaluated in this study, and these results support the shortened hospitalization periods. Second, the shorter follow-up period during the pandemic resulted in a smaller sample size and lower number of events compared with the prepandemic period. As such, the statistical power of some analyses was reduced and may have limited the ability to detect significant differences. Although a larger sample would be ideal for evaluation, most clinical outcomes demonstrated a decreasing trend in IRs, with the degree of decrease being significant for some clinical out-

comes. Finally, the present study compared 2 sequential time periods. Such a study design may introduce time-varying confounding variables or imbalanced effects of attrition, reducing the accuracy of effects estimates. Analysis comparing the first to second year of device therapy was used to quantify such effects and support the conclusions of the study. Although we set the cut-off value for the 2 device therapy groups as 1 year based on the original study design and baseline minimum follow-up period in the later group, the aforementioned smaller sample size and lower number of events were also considered for setting the cut-off value. Therefore, the subanalysis within the prepandemic group provides a baseline for longitudinal comparisons, with certain limitations. Overall, our study focused on the unprecedented accelerated decrease in hospitalization periods in HF patients, despite these potential limitations.

In conclusion, the reduction in HF hospitalization periods by approximately 40% during the pandemic has yielded better clinical outcomes, such as a decrease in all-cause hospitalizations, among HF patients receiving guideline-directed medical and CIED therapy. Although caution is warranted due to the unique circumstances of the pandemic, a further decrease in hospitalization periods for HF patients may be necessary, and this study can provide insight into approaches.

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Disclosures

K.A. is a member of *Circulation Journal*'s Editorial Team. The remaining authors have no conflicts of interest to declare.

IRB Information

This study was approved by the ethics committees of all 34 participating centers, with the IRB of the University of Tsukuba Hospital serving as the representative (IRB no. H29-45).

Data Availability

The research data are not publicly available on ethical grounds.

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Supplementary Files

Please find supplementary file(s);
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