

## Original article

# Impacts of integrated multidisciplinary care in heart failure clinic among tertiary care level hospitals: A retrospective cohort study

Artit Torpongpun\*, Suphamas Wongmanee, Chomplern Khambua

*Department of Internal Medicine, Chonburi Hospital, Ministry of Public Health, Chonburi, Thailand*

## Abstract

**Background:** Heart failure (HF) causes a high morbidity and mortality rate and is also one of the most common causes of unscheduled hospital admissions.

**Objective:** To determine clinical outcomes of high-risk heart failure patients treated by multidisciplinary care at Chonburi HF clinic.

**Methods:** A retrospective cohort study was conducted in the HF clinic at Chonburi Hospital. Data included rehospitalization, quality of life score, knowledge score, 6 minute walk test, left ventricular ejection fraction (LVEF), percent of achieving a standard dose of HF medications, and cost of HF hospitalization at baseline and 6<sup>th</sup> to 12<sup>th</sup> month follow-up.

**Results:** Eighty-two patients were treated and followed up at the HF clinic from 1<sup>st</sup> February 2017 to 19<sup>th</sup> February 2020. Mean age was  $56.7 \pm 14.5$  years, and 43 patients (51.2%) were male. Sixty-seven patients (81.7%) were previously admitted from acute decompensated HF. The baseline means LVEF (%) was  $33.2 \pm 12.8$ . After entering the HF clinic, the total HF hospitalization was reduced from 1.4 times/person-year to 0.2 times/person-year (7 time reduction). The mean LVEF (%) was increased to  $45.0 \pm 15.4$  and  $49.9 \pm 13.1$  at the 6<sup>th</sup> and 12<sup>th</sup> months, respectively. The 6 minute walk test (meter) had improved from  $369.0 \pm 132.2$  (in the 6<sup>th</sup> month) to  $399.0 \pm 153.3$  (in the 12<sup>th</sup> month). The cumulative hospitalization cost before the HF clinic of 1,831,660.00 Baht was reduced to 105,128.75 Baht (17-time reduction).

**Conclusions:** A multidisciplinary approach to managing high-risk HF patients can substantially reduce rehospitalization rates and costs. These programs have improved LVEF, symptoms, quality of life, and HF knowledge and helped achieve the treatment to target dose of HF standard medications.

**Keywords:** Heart failure clinic, heart failure hospitalization cost, heart failure hospitalization rate, multidisciplinary care.

**\*Corresponding to:** Artit Torpongpun, Department of Internal Medicine, Ministry of Public Health, Chonburi 20000, Thailand.

E-mail: t.artit@hotmail.com

**Received:** August 21, 2022

**Revised:** November 1, 2023

**Accepted:** December 4, 2023

Heart failure (HF) is a significant healthcare problem worldwide associated with high morbidity and mortality rates. It is the leading cause of hospitalization and re-admission in individuals > 65 years. <sup>(1)</sup> Multiple co-morbidity conditions are often present in patients with chronic HF (CHF), which could lead to poorer treatment outcomes. Especially the elders with chronic heart failure who developed frailty were at significantly increased risk of mortality. <sup>(2)</sup> The treatment costs of HF were an enormous burden to the global healthcare system. <sup>(1)</sup> In Thailand, despite the low prevalence of HF, around 0.4%, the percentage of HF hospitalization was as high as 19.0% of the total hospitalization. <sup>(3)</sup> The mean length of hospital stay was 7.5 days, and the inpatient mortality rate was reported as 6.0%. <sup>(3)</sup>

A previous study showed that up to 25.0% of patients admitted with HF were hospitalized again within 30 days of discharge, with only 35.0% of these readmissions caused by HF, and the remainder were from renal impairment, pneumonia, arrhythmias, etc. This high rehospitalization rate was due to failure to understand and follow the complex care plan. <sup>(4)</sup>

The goals of HF therapy include many aspects of clinical outcomes, such as improving survival rates, decreasing symptoms, slowing disease progression and reducing hospitalization. The other outcomes include improving functional capacity and quality of life (QoL), promoting healthcare education, and minimizing health resource utilization to lessen the costs of treatment. <sup>(5)</sup> These goals could be achieved by an HF disease management program that includes various recommended components, for example, optimizing medical therapy with guidelines, vigilant follow-up, discharge planning, intense education and counseling, and increased access to the health care. <sup>(5)</sup> Most guidelines, therefore, emphasize the importance of a multidisciplinary care approach, which is widely accepted to provide comprehensive chronic disease management more efficiently. <sup>(2, 5)</sup>

Chonburi Hospital is a regional hospital with 850 beds located in Chonburi Province. The number of out-patients and in-patients with HF at the hospital was 1,037 and 1,033 in 2017, with an in-patient mortality rate of 36.3%. The lack of clinical outcomes benefits and the economic value of HF clinics in our country, particularly at the tertiary hospital level, led to this study's conduct. This retrospective cohort study aimed to describe the patient care approach and assess the outcomes of patients attending the HF clinic at Chonburi Hospital, which may benefit other healthcare settings wishing to establish an HF clinic in Thailand.

## Materials and methods

### *Study design and population*

This retrospective cohort study was conducted at the HF clinic of Chonburi Hospital between 1<sup>st</sup> February 2017 and 1<sup>st</sup> February 2020. The inclusion criteria were as follows: 1) age > 15 years; 2) having attended the Chonburi HF clinic for more than six months; 3) given consent for participating in the HF clinic and allowance for investigators to use patient information for this study. The exclusion criteria were as follows: 1) incomplete data; 2) expected survival rate < 1 year; and 3) patients with any severe co-morbidity such as chronic kidney disease requiring hemodialysis or advanced-stage cancer disease with palliative care. This study has been approved Chonburi Hospital research center (CBH-IRB no. 58/63/S/h3). Written informed consent was obtained from each subject. Data of all adult patients who were invited to receive multidisciplinary care at the HF clinic and provided written informed consent were collected from their medical records.

### *Establishment of a multidisciplinary care team at the HF clinic of Chonburi Hospital*

The HF clinic of Chonburi Hospital was entitled "Clinic Pra-kong Jai" (a Thai word that means support one's heart) and has been established since February 2017 with collaboration among multidisciplinary team members consisting of cardiologists, nurse practitioners, pharmacists, physiotherapists, and dietitians. The objectives of the HF clinic at Chonburi Hospital are to provide holistic care by the multidisciplinary team, to enhance patients' self-care knowledge, and to improve patient outcomes, including QoL, in alignment with the cardiac service plan and Advance Hospital Accreditation (HA).

Patients entering the HF clinic were high-risk patients verified by the discretion of the cardiologists/ cardiovascular and thoracic surgeons. During attendance at the clinic, patients received the following procedures from their respective healthcare providers. Patient screening, acquiring demographic data and medical history, initial physical examination and symptom evaluation, education on HF and self-care, explanation on self-adjust diuretic medication and patient appointment card generation by a nurse physical examination and treatment by a cardiologist cardiac function rehabilitation and a 6 minute walk test (6MWT) assessment by a physiotherapist education on suitable nutrition by a dietitian evaluation of patient compliance to treatment and side effects,

education on treatment drug, and drug reconciliation by a pharmacist mental health consultation, stress and depression assessment by a psychologist counseling on health promotion and behavior modification by a health educator echocardiogram for left ventricular ejection fraction (LVEF) evaluation by a cardiothoracic technologist call appointment reminder service by the clinic staff.

The patients also received an HF education material booklet and an HF diary book to record their daily weight and home blood pressure monitoring results. These materials served as a reminder tool for the HF knowledge and self-care instructions previously provided by the multidisciplinary care team and aided in patients' self-monitoring of their HF signs and symptoms.

In addition, the patients were asked to complete (either self-completion or by interview) the following HF knowledge test and a QoL questionnaire at clinic entry and 12<sup>th</sup> months after attending the clinic. HF knowledge test comprised five aspects of HF, i.e., general disease knowledge, nutrition, exercise, medication, and symptoms that need to see a physician. Each part consisted of 5 items, with one point for each correct answer. The total score, therefore, ranged from 0 to 25.

The Thai version of the Minnesota living with heart failure questionnaire (MLHFQ): The MLHFQ is the most widely used HF-specific health-related quality of life (HRQoL) Questionnaire. <sup>(6)</sup> It has 21 items on physical, socio-economic and emotional aspects. Each item response is on a six-point Likert scale ranging from 0 to 5 and the total score ranges from 0 to 105, with a lower score indicating less adverse effects of HF on the patients' lives (better HRQoL). We used the Thai version of this questionnaire, which was available with acceptable psychometric properties. <sup>(7)</sup>

### **Study outcomes assessment**

This study assessed the clinical data of patients in the HF clinic at baseline before and after entering the HF clinic with the following specified time points in each outcomes assessment. The primary outcome was HF rehospitalization rate at baseline within 12<sup>th</sup> months before and 12<sup>th</sup> months after entering the HF clinic. The secondary outcomes were: 1) all-cause mortality within 12<sup>th</sup> months; 2) LVEF (%) at baseline, 6<sup>th</sup> and 12<sup>th</sup> month; 3) a 6MWT distance at baseline, 6<sup>th</sup> and 12<sup>th</sup> month; 4) HRQoL at baseline and 12<sup>th</sup>

month; 5) HF knowledge test results at baseline and 12<sup>th</sup> month; 6) the expense incurred from hospitalization with heart failure, at baseline before and within 12<sup>th</sup> months after attending the HF clinic; and 7) guideline-directed medical therapy (GDMT) compliance by assessing the percent of cases who received  $\geq 50.0\%$  and  $100.0\%$  target dose of the recommended guideline at baseline and at 12<sup>th</sup> month after following-up with the clinic.

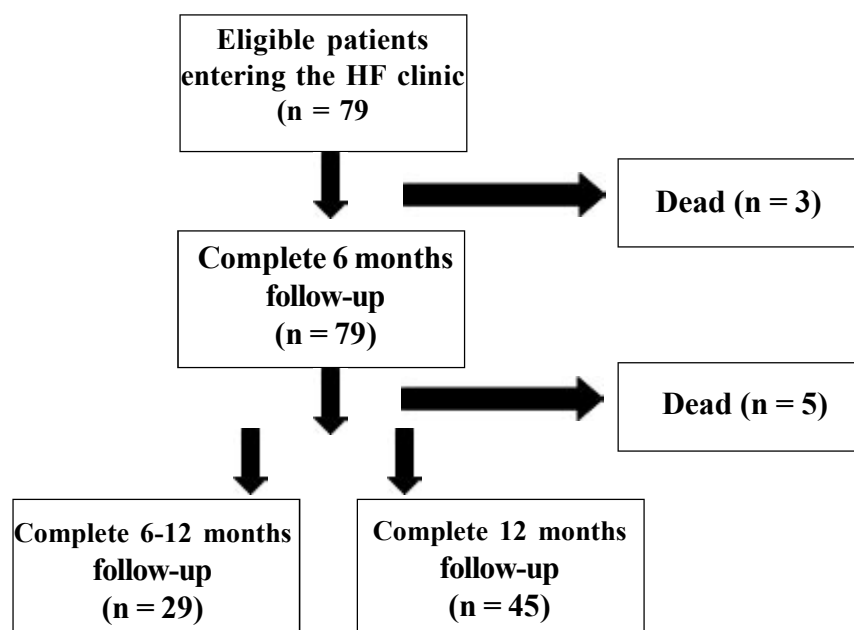
### **Statistical analyses**

Descriptive statistics were used to summarize patient demographic and clinical characteristics, as well as the outcomes at specified time points. Data were presented as either mean and standard deviation (SD) or median with interquartile range (IQR) for continuous data, and number and percentages for categorical data. Two-sample *t* - tests were statistical tests used to compare the mean of results before and after entry to the HF clinic. Kaplan Meier curve represents the cumulative incidence of all causes of death. The primary analyses were performed using SPSS software, version 25.0 (IBM). The statistical significance was a two-sided  $P < 0.05$ .

## **Results**

### **Baseline clinical characteristics**

A total of 82 patients agreed to attend the HF clinic between 1<sup>st</sup> February 2017 and 19<sup>th</sup> February 2020. Seventy-nine patients had completed a 6<sup>th</sup> month follow-up period, 29 patients had completed within 6<sup>th</sup> - 12<sup>th</sup> months of follow-up and 45 patients had completed 12<sup>th</sup> months of follow-up duration (**Figure 1**). Most of the patients were male. The mean age was  $56.7 \pm 14.5$  years. A majority of 46 (56.1%) patients were endorsed by the Universal coverage scheme (UCS), 23 (28.0%) patients were covered by the social security scheme (SSS), and 13 (15.9%) used Civil servants medical benefit schemes (CSMBS). The causes of heart failure were 54.8% from DCM, 36.9% from ICM and 6.0% of patients had other causes. Sixty-seven patients (81.7%) were previously admitted from acute decompensated HF. Thirty-six patients (42.9%) received diagnostic coronary angiogram and 20 (23.8%) received percutaneous coronary intervention. Two patients (2.4%) received cardiac resynchronization therapy with defibrillator (CRT-D) implantation. Most patients 46 (76.2%) were classified with NYHA class II and 14 (16.7%) were NYHA class III-IV. The most



**Figure 1.** Flow chart of patient data collected at each follow-up time point.

common comorbidities were hypertension (56.6%) and diabetes mellitus (37.4%). The mean LVEF and NT-proBNP were  $33.2 \pm 12.8$  and  $1568.0 \pm 1735.9$ , respectively. All baseline clinical characteristics are presented in **Table 1**.

### *Patient outcomes after attending the HF clinic*

#### **HF rehospitalization and clinical outcomes (LVEF, 6MWT distance, HRQoL, HF Knowledge)**

Among 82 patients, the total number of HF hospitalizations within 12 months before entering the HF clinic was 112 times (1.4 times/person-year) (**Table 2**). Eighty admissions were at Chonburi Provincial Hospital and 32 were at other hospitals. Among 45 patients with at least 12<sup>th</sup> months of follow-up time at the HF clinic, the HF hospitalizations were reduced to only eight admissions (0.2 times/person-year). All eight hospitalizations occurred 6<sup>th</sup> - 12<sup>th</sup> months after entering the HF clinic; 5 admissions were at Chonburi provincial hospital, and the other three were at other regional hospitals. The mean LVEF at baseline before entering the HF clinic was  $33.2 \pm 12.8\%$ . The mean LVEF was increased to  $45.0 \pm 15.4\%$  and  $49.9 \pm 13.1$  in the 6<sup>th</sup> and 12<sup>th</sup> month

respectively. The 6 minute walk test had improved from  $369.0 \pm 132.2$  meters to  $399.0 \pm 153.3$  meters in the 6<sup>th</sup> and the 12<sup>th</sup> month respectively. The mean score of quality of life (HRQoL) at baseline was  $1.4 \pm 1.0$  and decreased (lower score means better quality of life) to  $1.1 \pm 0.9$  in the 12<sup>th</sup> month. The HF knowledge test's mean score was  $20.6 \pm 3.9$  and  $22.9 \pm 2.3$  at baseline and in the 12<sup>th</sup> month, respectively, as shown in **Table 2**.

#### **All-cause mortality outcomes**

Forty-five patients (54.9%) were followed up in the clinic over one year, 67 patients (81.7%) were followed up more than six months and 79 patients (96.3%) were followed up more than three months. There were eight mortality cases (9.6%), with two patients passing away within two months after entering the HF clinic. Four patients died from cardiac death (2 were sudden death, one was with acute myocardial infarction and one was from HF death) and the other four patients died from other causes. All causes of death and the time of death after entering the HF clinic are presented in **Table 3**. The Kaplan-Meier graph representing the cumulative incidence of all causes of death is shown in **Figure 2**.

**Table 1.** Baseline clinical and laboratory characteristics (n = 82).

Baseline characteristic	n = 82
Male, n (%)	43 (51.2)
Age (year), mean ( $\pm$ SD)	56.7 ( $\pm$ 14.5)
Body weight (kg), mean ( $\pm$ SD)	66.7 ( $\pm$ 15.7)
<b>Health scheme, n (%)</b>	
Universal coverage scheme (UCS)	46 (56.1)
Social security scheme (SSS)	23 (28.0)
Civil servants medical benefit scheme (CSMBS), cause of heart failure, n (%)	13 (15.9)
Dilated cardiomyopathy (DCM)	46 (56.1)
Ischemic cardiomyopathy (ICM)	31 (37.8)
Others	5 (6.1)
<b>Type of heart failure, n (%)</b>	
HFrEF	69 (84.1)
HFmrEF	4 (4.9)
HFpEF	9 (11.0)
Previous admission with heart failure, n (%)	67 (81.7)
Duration after diagnosis to entry HF clinic (month), mean ( $\pm$ SD)	12.5 ( $\pm$ 21.4)
<b>Intervention, n (%)</b>	
Coronary artery angiography (CAG)	36 (42.9)
Percutaneous coronary intervention (PCI)	20 (23.8)
Coronary artery bypass grafting (CABG)	5 (6.0)
CRT-D	2 (2.4)
<b>NYHA functional class, n (%)</b>	
I	4 (4.8)
II	64 (76.2)
III	12 (14.3)
IV	2 (2.4)
<b>Comorbid disease, n (%)</b>	
Hypertension	47 (56.0)
Diabetes	30 (35.7)
Atrial fibrillation	16 (19.5)
<b>Smoking status, n (%)</b>	
Ex-smoking	24 (28.6)
Current smoking	3 (3.6)
Social drinking, n (%)	20 (23.8)
<b>Laboratory findings, mean (<math>\pm</math> SD)</b>	
Hematocrit (%)	38.3 ( $\pm$ 6.5)
Creatinine (mg/dl)	1.1 ( $\pm$ 0.4)
NT-Pro BNP (pg/ml)	1568.0 ( $\pm$ 1735.9)
LVEF (%)	33.2 ( $\pm$ 12.8)
<b>Medications, n (%)*</b>	
Beta-blocker	61 (88)
ACEIs/ARBs/ARNIs	64 (92)
MRAs	37 (54)

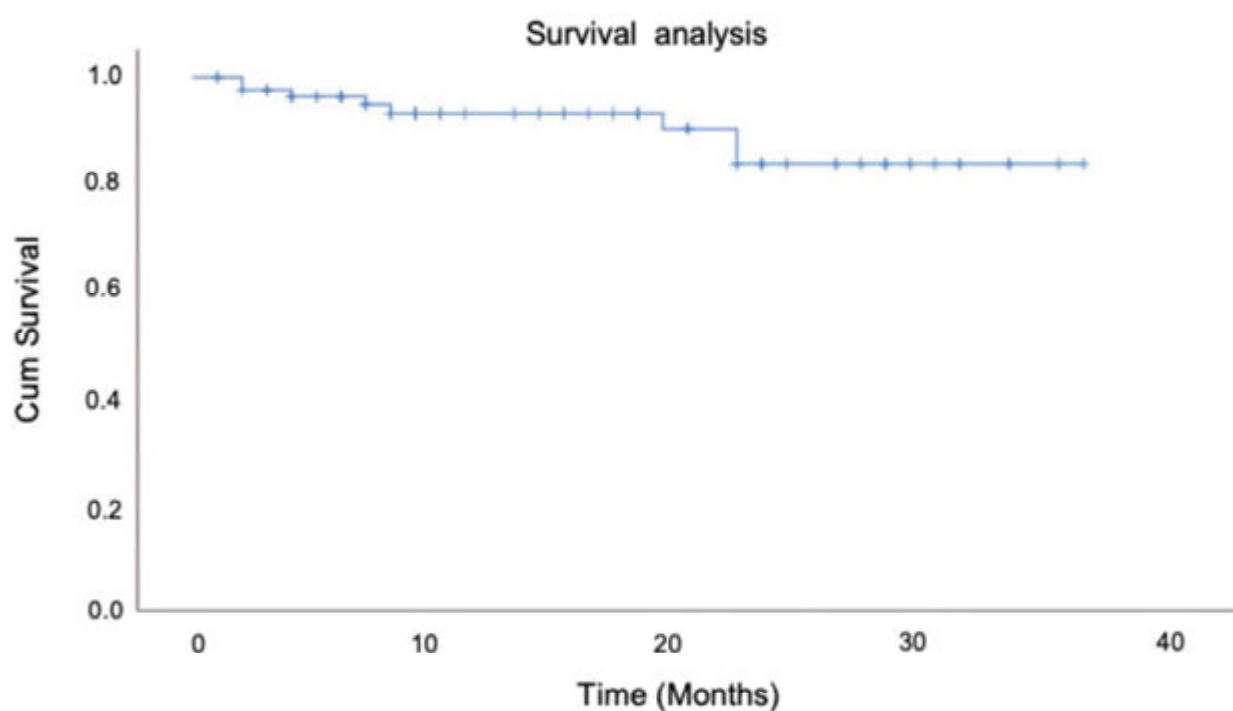
HFrEF, heart failure with reduced ejection fraction; HFmrEF, heart failure with mid-range ejection fraction; HFpEF, heart failure with preserved ejection fraction; CRT-D, cardiac resynchronization therapy with defibrillator; AF, atrial fibrillation; ACEIs, angiotensin-converting enzyme inhibitors; ARBs, angiotensin receptor blockers; ARNIs, angiotensin II receptor/neprilysin inhibitor; MRAs, mineralocorticoid receptor antagonist; \*n = 69 (only in patients with reduced ejection fraction)

**Table 2.** Patient outcomes at baseline, 6<sup>th</sup> months, and 12<sup>th</sup> months after attending the HF clinic.

Outcomes	Baseline (n = 82)	6 months (n = 79)	P - value	12 months (n = 45)	P - value
<b>Primary outcome</b>					
HF hospitalization (times)	112	0	<0.001	8	<0.001
HF hospitalization rate (time/person-year)	1.4			0.2	
<b>Secondary outcome</b>					
LVEF(%)	33.2±12.8 (n = 82)	45.2±15.4 (n = 64)	<0.001	49.9±13.1 (n = 35)	<0.001
6MWT distance (meter), mean ± SD	369.0±132.2 (n = 80)	398.0±134.7 (n = 48)	<0.002	399.0±153.3 (n = 30)	0.002
HRQoL, mean ± SD	1.4±1.0 (n = 73)	NA	NA	1.1±0.9 (n = 28)	0.138
HF knowledge, mean ± SD	20.6±3.9 (n = 80)	NA	NA	22.9±2.3 (n = 36)	0.009

**Table 3.** All causes of death and the time of death after entering the HF clinic (n = 8)

Patient no.	Time of death after entering the HF clinic	Causes of death
1	19 months	Lymphoma stage IV
4	22 months	Renal failure
5	22 months	Sepsis pneumonia
10	4 months	Sudden death
11	8 months	Sudden death
14	7 months	HF death
35	2 months	Trauma
56	2 months	Acute myocardial infarction

**Figure 2.** Kaplan Meier curve represents the cumulative incidence of all causes of death.

**Table 4.** The minimum, median, maximum and total costs of all HF hospitalizations before the HF clinic (n = 80 admissions) and after the HF clinic (n = 5 admissions).

Costs of HF hospitalization (Baht)	Before HF clinic (n = 80 admissions)	After HF clinic (n = 5 admissions)
Minimum	1,215	5,108
Median	8,565	14,634
Maximum	233,434	59,028
<b>Total</b>	<b>1,831,660</b>	<b>105,129</b>

### ***Costs of HF hospitalization***

The total costs of HF hospitalization among 67 patients before the HF clinic were 1,831,660 Baht from 80 admissions at Chonburi Hospital. After entering the HF clinic, the number of HF hospitalizations was reduced to 5 admissions and the total cost of admission was largely reduced to 105,129 Baht. The comparison of the total cost, the minimum, the maximum and the median costs of HF hospitalization before and after HF clinic are shown in **Table 4**.

### ***Guideline-directed medical therapy (GDMT) compliance***

When comparing the standard medications of HF treatment, the usage of beta-blocker was 88.2%, 93.0% and 96.4% before the clinic, in the 6<sup>th</sup> month and the 12<sup>th</sup> month after attending the clinic, respectively. ACEI/ARB/ARNI was used 92.4%, 100.0% and 100.0% before the clinic, the 6<sup>th</sup> month and the 12<sup>th</sup> month after attending the clinic, respectively. MRA was used 54.4%, 53.2% and 46.4% before the clinic, 6<sup>th</sup> month and 12<sup>th</sup> month after following up, respectively (**Figure 3A**).

When comparing the 50.0% target dose of medications for standard HF treatment, Beta-blocker was used 18.3%, 86.1% and 92.6% before the clinic, 6<sup>th</sup> month and 12<sup>th</sup> month after attending the clinic, respectively. ACEI/ARB/ARNI was used 68.9%, 93.6% and 96.3% before the clinic, 6<sup>th</sup> month and 12<sup>th</sup> month after attending the clinic, respectively. MRA was used 100.0%, 100.0% and 100.0% before the clinic, 6<sup>th</sup> month and 12<sup>th</sup> month after attending the clinic, respectively (**Figure 3B**).

When comparing the 100.0% target dose of medications for standard HF treatment, beta-blockers were used at 3.3%, 41.9% and 48.2% before the clinic, 6<sup>th</sup> month and 12<sup>th</sup> month after attending the clinic, respectively. ACEI/ARB/ARNI was used 39.3%, 66.0% and 74.1% before the clinic, 6<sup>th</sup> month and 12<sup>th</sup> month after attending the clinic, respectively.

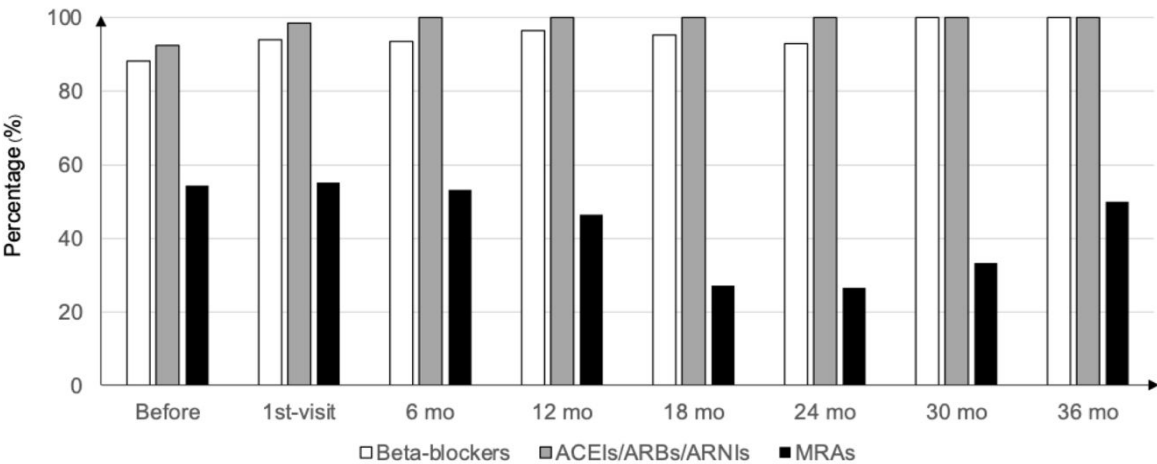
MRA was used 51.4%, 56.0% and 53.9% before the clinic, 6<sup>th</sup> month and 12<sup>th</sup> month after attending the clinic, respectively (**Figure 3C**). Other treatment was given in one case who was referred to King Chulalongkorn Memorial Hospital for a heart transplantation.

### ***Discussion***

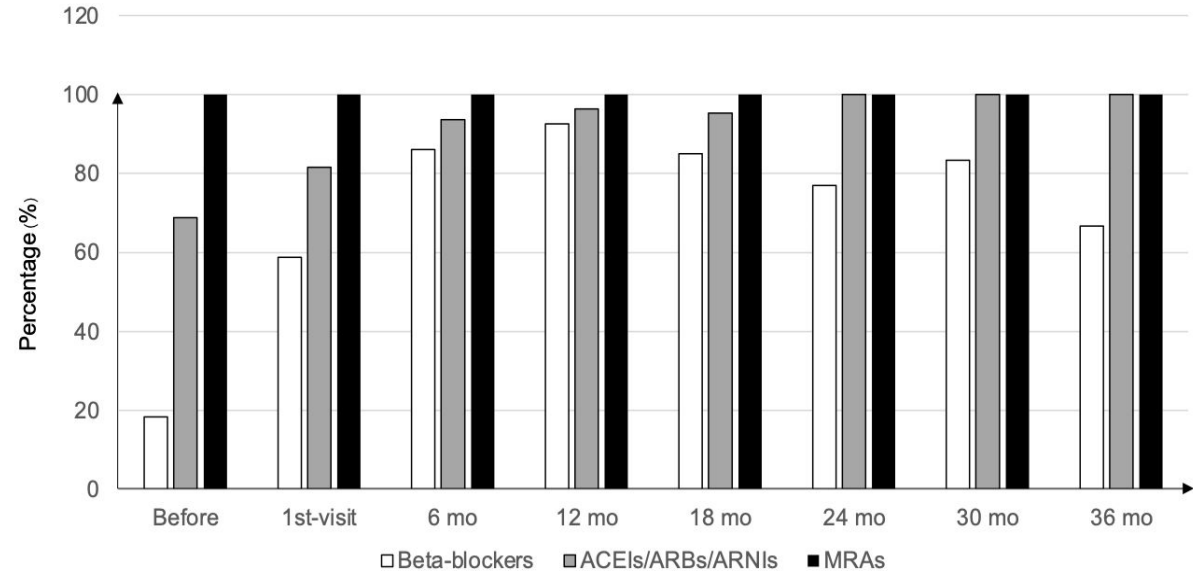
This study provided comprehensive care and clinical outcomes by a multidisciplinary care team for patients with HF from a single tertiary care center at Chonburi Hospital, Thailand. The primary outcome of HF hospitalization rate among 82 patients at baseline, which was 1.4 times/person-year was seven times reduced to 0.2 times/person-year after complete follow-up to the clinic for 12<sup>th</sup> months. The secondary outcomes of clinical improvement, including cardiac function improvement, monitored by LVEF (%), were found to continue increasing from the 6<sup>th</sup> month onwards to the 12<sup>th</sup> month. Other clinical outcomes were the 6 minute walk test MWT, which significantly increased from the 6<sup>th</sup> month and 12<sup>th</sup> month after entering the HF clinic, and the HF self-education knowledge also increased after the 12<sup>th</sup> month. Apart from the clinical outcomes, this study also assessed the treatment cost of HF hospitalization, which was reduced from 1,831,660 Baht to 105,129 Baht or 17 time reduction of the HF hospitalization cost. This substantial reduction in HF hospitalization significantly reduced the healthcare burden, saving more than 1,500,000 Baht within 6<sup>th</sup> - 12<sup>th</sup> months.

Eighty-two percent of patients attending the HF clinic had a history of previous admission from acute decompensated HF; this demonstrated that these patients in this cohort were high-risk patient groups. Data from Shan KS, *et al.* demonstrated that patient prognosis remained particularly poor after hospitalization; the 5 year survival rate after hospitalization for HFrEF was 24.7%.<sup>(8)</sup> Despite the high rate of previous admission from acute

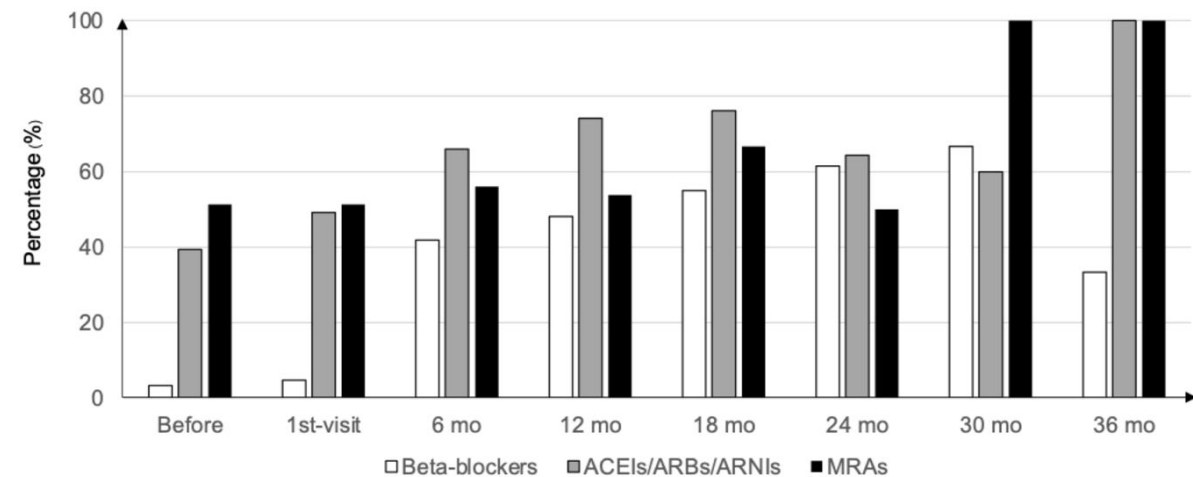
A



B



C



**Figure 3.** Percent of patients (A) receiving guideline-directed therapy; (B) receiving 50.0% target dose of standard medications for HF; (C) receiving 50.0% target dose of standard medications for HF



decompensated HF, the mean level of NT-pro BNP in this study was more than 1,000 pg/mL at the first clinic measurement. Jannuzzi JL Jr, *et al.* showed that a decrease in NT-pro BNP to 1,000 pg/mL during treatment of chronic HFrEF is associated with a significantly lower risk of subsequent heart failure hospitalization, cardiovascular death or all-cause death compared with patients with a constant level of NT-pro BNP at 1,000 pg/mL.<sup>(9)</sup> Similar SGLT-2 inhibitor results were shown from the Emperor reduced study<sup>(10)</sup> and DAPA-HF study<sup>(11)</sup> with a median NT-pro BNP level of 1,887 and 1,428 pg/mL.

The majority of the population in this study was high-risk HF, resulting in a 9.6% mortality rate during the monitoring period between 1 - 3 years. Patients most often die in the last eight months after entering the clinic, but this study found that the rate of HF hospitalization was reduced significantly. Before entering the clinic, HF admissions of 112 times were reduced to 8 times, and most were re-admitted with HF at 6<sup>th</sup> - 12<sup>th</sup> months after clinic attendance. In contrast with these findings, Desai As, *et al.*<sup>(12)</sup> found that after patient discharge from HF hospitalization, the rehospitalization rate within 30 days was 24.0% and more than 50.0% within six months. The reason for a marked reduced HF rehospitalization in this study may be due to the efficient patient care by a multidisciplinary solid team. In addition, other possible causes should be proposed, including the difference in HF severity among this population and the effect of the small sample size.

When comparing the standard dose of HF medication treatment, registry data showed that more than one-quarter of eligible patients were not prescribed an angiotensin-converting enzyme (ACE) inhibitor, angiotensin II receptor blocker (ARB), or an angiotensin receptor-neprilysin inhibitor (ARNI), more than one-third were not prescribed a  $\beta$ -blocker and more than one-half were not prescribed a mineralocorticoid receptor antagonist (MRA).<sup>(13)</sup> The rate of achieving a 50.0% target dose of beta-blocker was at 86.1% and 92.6% at 6<sup>th</sup> and 12<sup>th</sup> months, respectively and for ACEI/ARB/ARNI was 93.6% and 96.3% at 6 and 12 months respectively. There was no change in MRA before 6<sup>th</sup> and 12<sup>th</sup> month clinic visits, similar to other studies.

These positive impacts of the HF clinic on mortality and morbidity were the combined consequences of GDMT optimization, effective follow-up and monitoring, patients' HF knowledge

improvement and better self-care augmented by the multidisciplinary care team of the HF clinic.

There are several potential limitations in this study. Firstly, the retrospective type of study caused incomplete data and selection bias. Second, the small sample size and the only single site of the study center that effect was conducted in this study. Third, some contemporary HF treatments that affect HFrEF and mortality were limited, for instance, AICD or CRT-D and newer medications (ARNI, SGLT-2 inhibitor) because of implant facility and financial issues, respectively. Fourth, the landscape of some patients was outside of the urban area of Muang District. Therefore, some of the information was not completed, especially the cost of HF hospitalization outside of Chonburi Hospital, including before and after entering the clinic. However, HF rehospitalization occurred in Chonburi Hospital. Lastly, the number of patients and follow-up period may not be enough because this study data was collected over 3 years during which the HF clinic just opened. Nevertheless, more than 95.0% of the patients in this study were followed up for at least 3 months.

A multidisciplinary approach to the management of high-risk HF patients can substantially reduce rehospitalization rate, motility and cost. These programs improve LVEF, symptoms, quality of life, and HF knowledge and also help achieve the treatment to target dose of HF standard medications.

### Acknowledgements

The authors would like to express deep gratitude to all of the subjects who were involved in this study.

### Conflicts of interest statement

The authors have each completed an ICMJE disclosure form. None of the authors declare any potential or actual relationship, activity, or interest related to the content of this article.

### Data sharing statement

The present review is based on the references cited. Further details, opinions, and interpretations are available from the corresponding authors upon reasonable request.

### References

1. Savarese G, Becher PM, Lund LH, Seferovic P, Rosano GMC, Coats AJS. Global burden of heart failure: a comprehensive and updated review of epidemiology. *Cardiovasc Res* 2023;118:3272-87.

2. Hill E, Taylor J. Chronic heart failure care planning: Considerations in older patients. *Card Fail Rev* 2017;3:46-51.
3. Reyes EB, Ha JW, Firdaus I, Ghazi AM, Phrommintikul A, Sim D, et al. Heart failure across Asia: Same healthcare burden but differences in organization of care. *Int J Cardiol* 2016;223:163-7.
4. Scardi S, Humar F, Di Lenarda A, Mazzone C, Giansante C, Sinagra G. [Disease management system in patients with chronic heart failure]. *G Ital Cardiol (Rome)* 2007;8:83-91. Italian
5. Jaarsma T. Health care professionals in a heart failure team. *Eur J Heart Fail* 2005;7:343-9.
6. Rector TS, Cohn JN. Assessment of patient outcome with the minnesota living with heart failure questionnaire: reliability and validity during a randomized, double-blind, placebo-controlled trial of pimobendan. Pimobendan Multicenter Research Group. *Am Heart J* 1992;124:1017-25.
7. Tangsatitkiat W, Sakthong P. Thai version of the minnesota living with heart failure questionnaire: Psychometric testing using a longitudinal design. *Asian Biomedicine* 2010;4:877-84.
8. Shah KS, Xu H, Matsouaka RA, Bhatt DL, Heidenreich PA, Hernandez AF, et al. Heart failure with preserved, borderline, and reduced ejection fraction: 5-year outcomes. *J Am Coll Cardiol* 2017;70:2476-86.
9. Januzzi JL, Jr., Ahmad T, Mulder H, Coles A, Anstrom KJ, Adams KF, et al. Natriuretic Peptide Response and Outcomes in Chronic Heart Failure With Reduced Ejection Fraction. *J Am Coll Cardiol* 2019;74:1205-17.
10. Packer M, Anker SD, Butler J, Filippatos G, Pocock SJ, Carson P, et al. Cardiovascular and renal outcomes with Empagliflozin in heart failure. *N Engl J Med* 2020;383:1413-24.
11. McMurray JJV, Solomon SD, Inzucchi SE, Køber L, Kosiborod MN, Martinez FA, et al. Dapagliflozin in patients with heart failure and reduced ejection fraction. *N Engl J Med* 2019;381:1995-2008.
12. Desai AS, Stevenson LW. Rehospitalization for heart failure: predict or prevent? *Circulation* 2012;126:501-6.
13. Greene SJ, Butler J, Albert NM, DeVore AD, Sharma PP, Duffy CI, et al. Medical therapy for heart failure with reduced ejection fraction: The CHAMP-HF registry. *J Am Coll Cardiol* 2018;72:351-66.