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Original article

Instant Messaging-Based mHealth for Integrated Care in Chronic Heart Failure: Impact on Emergency Visits, Hospitalizations, and Quality of Life in Thailand

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Keywords: Chronic heart failure, integrated care, mHealth, quality of life, self-care

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Abstract:

Objective: To evaluate the impact of an instant messaging-based mobile health (mHealth) application integrated with heart failure (HF) clinic care on emergency department (ED) visits, hospitalizations, and quality of life (QoL) in HF patients over one year.

Material and Methods: A retrospective cohort study was conducted at Songklanagarind Hospital, Thailand, including 88 HF patients who used an instant messaging-based HF application for self-care monitoring between 2021 and 2025. ED visits, hospitalizations, and Minnesota Living with Heart Failure Questionnaire (MLHFQ) scores were compared before and after the intervention using zero-inflated Poisson regression and paired t-tests. High usage was defined as ≥100 data submissions/year. Logistic regression analysis was performed to identify the factors associated with a favorable treatment response.

Results: Post-intervention, ED visits decreased from 2.01 ± 1.80 to 0.75 ± 1.20 events/year (IRR=0.37, 95% CI [0.28, 0.49], $p < 0.001$), while hospitalizations decreased from 1.69 ± 1.00 to 0.56 ± 0.92 events/year (IRR=0.33, 95% CI [0.24, 0.45], $p < 0.001$). MLHFQ scores improved from 50.8 ± 22.6 to 31.9 ± 24.3 (mean difference=18.9, 95% CI [14.8, 23.0], $p < 0.001$). High-usage patients demonstrated greater QoL improvement ($p = 0.01$). Patient clinical status, particularly functional severity, was associated with treatment response.

Conclusion: Integration of an instant messaging-based mHealth application with HF clinic care significantly reduced healthcare utilization and improved QoL in Thai HF patients. Patient clinical status may influence responsiveness to the intervention, highlighting the importance of individualized care. These findings support mHealth adoption in Thailand's healthcare system.

Keywords: Heart failure, mobile health, integrated care, quality of life, self-care

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Introduction

Chronic heart failure (CHF), hereafter referred to as heart failure (HF), is a major public health challenge in Thailand, contributing to high hospitalization rates and economic costs[1,2]. Annual HF-related hospital admissions in Thailand range from 1.2% to 1.5%, with a high risk of readmission within 180 days post-discharge[1]. The annual cost per patient, driven primarily by

hospitalizations, ranges from USD 1,443 to USD 4,513 across Asian countries[3]. The increasing prevalence of heart failure with preserved ejection fraction (HFpEF), particularly in Thailand, complicates disease management[4]. Social determinants, such as low education and income levels, further exacerbate HF outcomes, highlighting the need for innovative care strategies[5].

Integrated care combining systematic disease management with patient self-care is effective in improving HF outcomes[6,7]. Mobile health (mHealth) applications facilitate symptom monitoring and communication between patients and healthcare providers[8], enhancing integrated care[9,10]. In Thailand, the instant messaging-based mHealth (Line platform), widely used for communication, offers a culturally relevant tool for mHealth interventions. However, evidence on the effectiveness of instant messaging-based mHealth integrated with clinical care remains limited[5], particularly in rural areas with variable digital literacy and technology access[11,12].

The objectives of this study were to evaluate the effectiveness of an instant messaging–based mHealth application integrated with HF clinic care in reducing emergency department visits and hospitalizations, and to assess its impact on quality of life measured by the Minnesota Living with Heart Failure Questionnaire (MLHFQ) over a year. This study was guided by Riegel's Middle-Range Theory of Self-Care of Chronic Illness, which emphasizes self-care maintenance, monitoring, and management as the key mechanisms influencing clinical and patient-reported outcomes.

Material and Methods

Study Design

This study was approved by Songklanagarind Hospital's Institutional Review Board (REC 68-224-24-7). A retrospective cohort study was conducted at Songklanagarind Hospital's Heart Failure (HF) Clinic, Thailand, from February 2021 to May 2025, using a single-group pre-post design to compare outcomes over one year before and after instant messaging-based HF application use. Both pre- and post-intervention periods were matched for one year (12 months) and accounted for seasonality to minimize time-related bias.

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Participants

The study included 88 HF patients who were diagnosed according to the standard criteria and attended the HF Clinic at Songklanagarind Hospital, where all patients were provided access to the instant messaging-based HF application as part of the routine clinic protocol to promote self-care. This approach minimized self-selection bias by ensuring universal application assignment within the clinic. Inclusion criteria were: (1) confirmed HF diagnosis. Heart failure diagnosis was confirmed according to the 2021 European Society of Cardiology (ESC) guidelines, based on the presence of typical symptoms and signs of HF combined with the objective evidence of cardiac structural and/or functional abnormalities. Both heart failure with reduced ejection fraction (HFrEF; LVEF ≤40%), heart failure with mildly reduced ejection fraction (HFmrEF; LVEF 41–49%), and heart failure with preserved ejection fraction (HFpEF; LVEF ≥50%) were eligible. Left ventricular ejection fraction (LVEF) was assessed using transthoracic echocardiography. Natriuretic peptide levels (e.g., NT-proBNP) were measured when clinically indicated as part of routine care but not mandatory for study inclusion, (2) access to a smartphone or caregiver support, (3) continuous clinic attendance for one-year pre-intervention, and (4) complete data on emergency department (ED) visits, hospitalizations, and Minnesota Living with Heart Failure Questionnaire (MLHFQ) scores. Exclusion criteria included: (1) application usage <50% of the study period, (2) death or transfer during the study, or (3) severe comorbidities, including end-stage renal disease requiring dialysis (CKD stage 5), active malignancy under systemic treatment, advanced liver disease (Child-Pugh class C), or other terminal conditions limiting life expectancy to less than one year. (4) Patients who were unable to use a smartphone and had no caregiver support were excluded. Patients and caregivers received training to ensure accessibility. The sample size (n=88) was calculated based on detecting a mean difference in the primary outcome (MLHFQ score) using paired mean comparisons[13,14], with 80% power and α=0.05. An additional 10% was added to account for potential data loss. The study was not specifically powered for secondary outcomes (ED visits and hospitalizations), which were analyzed as exploratory outcomes.

Intervention

The intervention integrated an instant messaging-based HF application with HF clinic care. The application, hosted on a Line Official Account, supported self-care maintenance (e.g., nutrition

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and exercise guidance), monitoring (e.g., weight, edema, fatigue logging), and management (e.g., alerts for abnormal symptoms, provider communication), based on Riegel's self-care theory. Clinicians used application data during visits to adjust medications and provide counseling. Patients and caregivers received training in application use and ongoing technical support. High usage was defined as ≥100 daily data submissions/year for subgroup analysis, based on prior mHealth studies indicating significant engagement thresholds[15].

The application required patients to submit daily data, including body weight, symptoms (e.g., dyspnea, edema, fatigue), and self-assessment questionnaires. Automated alerts were generated when predefined thresholds were exceeded (e.g., weight gain ≥2 kg in 3 days, worsening dyspnea). A dedicated HF nurse reviewed submissions on weekdays and responded via the instant messaging-based mHealth platform. Clinical concerns were escalated to a cardiologist for medication adjustment when necessary. Education materials on diet, fluid restriction, and exercise were provided weekly through structured messages. Communication was primarily asynchronous, with additional phone calls arranged if clinically indicated.

Outcome Measures

The primary outcome was the pre-post MLHFQ score difference, assessing quality of life. Secondary outcomes were HF-related ED visits and hospitalizations (ICD-10: I50, I47.2, I20, R00.2) over one year post-intervention. ED visits were counted as distinct episodes recorded in hospital records, verified by ICD-10 codes specific to HF-related complaints among the 88 study participants.

Data Collection

Data were retrieved from hospital records and the HF application database for one year pre- and post-intervention, including ED visits, hospitalizations, MLHFQ scores, and application usage (Daily Data Sent, self-assessment Data Sent). Data completeness was ensured through strict inclusion criteria and hospital record verification. Missing data were handled using listwise deletion.

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Statistical Analysis

Baseline characteristics were summarized using descriptive statistics (mean, S.D., median, IQR). Zero-inflated Poisson regression analyzed ED visits and hospitalizations. MLHFQ differences were assessed using paired t-tests or Wilcoxon signed-rank tests, based on normality. Subgroup analysis compared high-usage (n=7) and low/moderate-usage (n=81) groups. Sensitivity analysis in stable New York Heart Association (NYHA) Class II–III patients (n=82) confirmed robustness. Potential confounders (e.g., age, NYHA Class, left ventricular ejection fraction (LVEF), comorbidities) were adjusted for in the regression models. Statistical significance was set at $p < 0.05$.

A favorable response was defined as a reduction in MLHFQ score of ≥5 points. Logistic regression analysis was performed to identify the factors associated with treatment response. Variables included in the model were age, left ventricular ejection fraction (LVEF), NYHA functional class, and application usage level.

Results

Baseline Characteristics

Among 88 heart failure (HF) patients, 72.7% were male, with a mean age of 62.1 ± 14.7 years and body mass index (BMI) of 22.2 ± 3.7 kg/m². Most patients were classified as New York Heart Association (NYHA) Class II (56.8%) or III (36.4%), with a mean left ventricular ejection fraction (LVEF) of 24.0 ± 8.8%. Median application usage was 120 Daily Data Sent submissions/year (IQR 96–120) and 120 self-assessment Data Sent accesses/year (IQR 108–120). Baseline characteristics are summarized in Table 1

Clinical Outcomes

Among the 88 HF patients, emergency department (ED) visits decreased from 2.01 ± 1.8 to 0.75 ± 1.20 events/year (incidence rate ratio [IRR]=0.37, 95% confidence interval [CI] [0.28, 0.49], $p < 0.001$) and hospitalizations were reduced from 1.69 ± 1.0 to 0.56 ± 0.92 events/year (IRR=0.33, 95% CI [0.24, 0.45], $p < 0.001$). Minnesota Living with Heart Failure Questionnaire (MLHFQ)

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scores improved from 50.8 ± 22.6 to 31.9 ± 24.3 (mean difference=18.9, 95% CI [14.8, 23.0], p < 0.001), indicating better quality of life. Clinicians utilized application data for medication adjustments and counseling, contributing to these outcomes (Table 2). Figure 1 illustrates trends in ED visits and hospitalizations. Subgroup analysis of high-usage patients (n=7, ≥100 Daily Data Sent/year) (Table 3) showed greater MLHFQ improvement (mean difference = 25.0 ± 15.1 vs 18.6 ± 23.4 in low/moderate-usage patients, p = 0.01). No significant differences were observed in ED visits (0.86 ± 1.07 vs 0.74 ± 1.22, p = 0.75) or hospitalizations (0.57 ± 0.79 vs 0.56 ± 0.94, p=0.95) (Table 3). Sensitivity analysis in stable NYHA Class II–III patients (n=82) confirmed the primary findings (ED visits: IRR=0.38, 95% CI [0.29, 0.50], p < 0.001; hospitalizations: IRR=0.34, 95% CI [0.25, 0.47], p < 0.001; MLHFQ: mean difference=19.1, 95% CI [14.9,23.3], p < 0.001).

Logistic regression analysis identified age as a significant predictor of favorable response (OR 1.044, 95% CI 1.004–1.085, p = 0.029) (Table 4). LVEF and NYHA functional class showed trends toward significance, while application usage level was not significantly associated with treatment response.

Discussion

This retrospective study demonstrates that integrating an instant messaging-based mobile health (mHealth) application with heart failure (HF) clinic care significantly reduces emergency department (ED) visits (IRR=0.37, 95% CI [0.28, 0.49], p < 0.001), hospitalizations (IRR=0.33, 95% CI [0.24, 0.45], p < 0.001), and improves quality of life (Minnesota Living with Heart Failure Questionnaire (MLHFQ), mean difference=18.9, 95% CI [14.8, 23.0], p < 0.001) among 88 HF patients in Thailand. These findings align with prior studies, such as Ni et al. (2024)[14] and Padayachee et al. (2022)[13], which reported reduced healthcare utilization and enhanced quality of life with mHealth interventions in HF populations. The integration supports self-care maintenance, monitoring, and management, as outlined in Riegel's Middle-Range Theory of Self-Care of Chronic Illness[16,17], with clinicians leveraging application data for timely medication adjustments and counseling[6].

The instant messaging–based mHealth platform, widely adopted in Thailand[18], likely enhanced accessibility and engagement, particularly among patients with varying digital literacy

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levels[5,11,12]. This is consistent with Jin et al. (2024)[19], who highlighted the efficacy of context-adapted mHealth platforms in Asian HF cohorts. Subgroup analysis revealed that high-usage patients (n=7, Daily Data Sent ≥100 times/year) experienced greater MLHFQ score reductions ($p = 0.01$), underscoring the role of sustained engagement in improving self-care and quality of life[5,15]. The high-usage cutoff (≥100 submissions/year) was selected to reflect sustained engagement (approximately ≥2 submissions per week), and was consistent with the engagement thresholds reported in prior mHealth studies[15]. The subgroup comparison between high-usage (n=7) and low/moderate-usage (n=81) patients was markedly unbalanced. This disproportion may limit statistical power and increase the risk of type II error. Therefore, subgroup findings should be interpreted with caution, as the imbalance may be an underestimation of the application's impact on ED visits and hospitalizations, which showed no significant differences ($p=0.75$ and $p=0.95$, respectively).

Potential confounders, such as differences in baseline characteristics (e.g., age, New York Heart Association [NYHA] Class, left ventricular ejection fraction [LVEF]), and comorbidities (e.g., diabetes, hypertension), were adjusted for in the regression models to minimize bias. However, unmeasured confounders, such as changes in guideline-directed medical therapy or patient behavior, may still influence outcomes. The absence of a control group limits causal inference, as improvements may partly reflect the advancements in standard care. Patient selection was based on the routine clinic protocol at Songklanagarind Hospital, where all attending HF patients were provided access to the instant messaging-based application, reducing self-selection bias. However, the requirement for smartphone access or caregiver support may have excluded patients with limited technological resources, particularly in rural or low-income settings, as noted by Janwanishstaporn et al. (2022)[11]. This limits the generalizability of findings to the broader Thai HF population, especially in community hospitals or areas with poor digital infrastructure. Future studies should explore strategies to include patients with limited technological access, such as offline application features or alternative delivery methods.

Logistic regression analysis suggested that patient clinical characteristics, particularly age and functional severity, may influence responsiveness to the intervention. Although the NYHA functional class did not reach statistical significance, the observed trend may warrant further investigation in larger studies.

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Despite these promising results, the study has limitations. Its retrospective design introduces potential confounding factors, as noted above. The absence of a control group and the small high-usage subgroup (n=7) constrain causal inference and subgroup analyses. Reliance on the instant messaging–based mHealth platform may restrict access in rural areas with poor internet connectivity[11], as noted by Janwanishstaporn et al. (2022)[11]. Sensitivity analyses in stable NYHA Class II–III patients (n=82) confirmed the robustness of primary findings but could not fully address these limitations.

Future research should employ randomized controlled trials (RCTs) to establish causality and include larger high-usage cohorts to better evaluate engagement effects. Incorporating qualitative data, such as patient or caregiver perspectives on application usability, could provide insights into barriers and facilitators of adoption, particularly in rural settings. Enhancing the application with offline functionality[11] or integration with artificial intelligence and wearable devices for real-time symptom monitoring could further improve outcomes, as suggested by Gautam et al. (2022)[20]. Moreover, scalability assessments are needed to explore the application's potential across Thailand and other Asian countries with similar digital infrastructures.

Conclusion

Integrating an instant messaging-based mHealth application with HF clinic care was associated with reduced emergency department visits and hospitalizations, and improved quality of life. Patient clinical status may influence responsiveness to the intervention, highlighting the need for individualized care. These findings support broader implementation in resource-limited settings.

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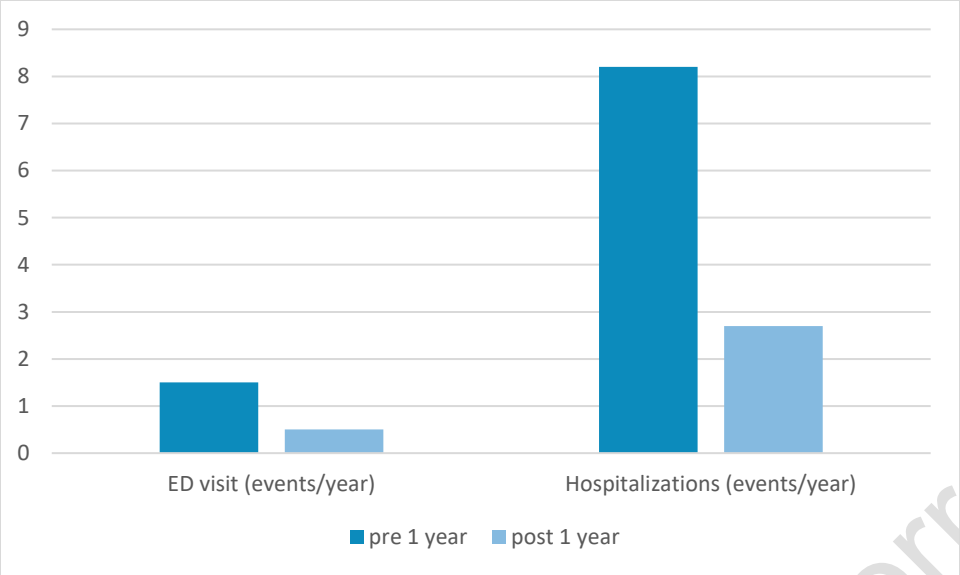


Figure 1: Trends in ED visits and hospitalizations (events/year) pre- and post-intervention (n=88)

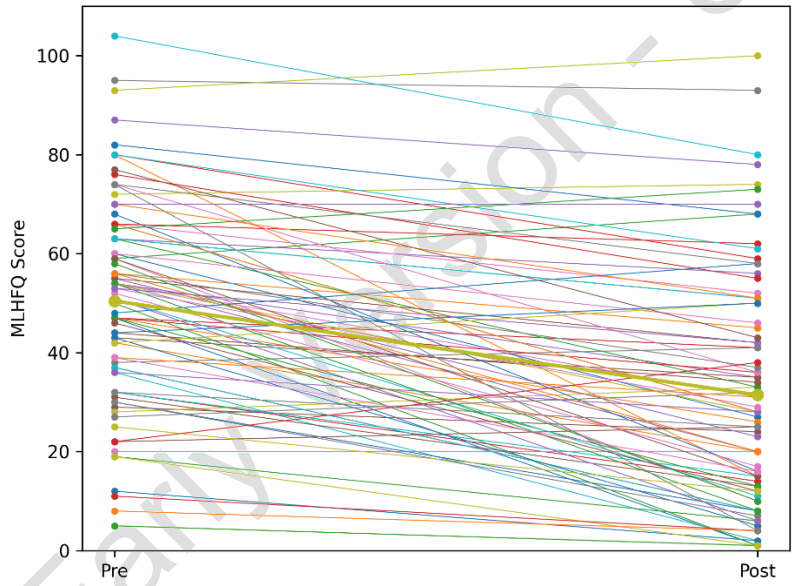


Figure 2: Paired dot plot of individual MLHFQ scores before and after the intervention (n=88)

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Table 1: Baseline Characteristics of Heart Failure (HF) Patients (n=88)

Variable	Value (n=88)
Sex: Male, n (%)	64 (72.7)
Age (years), Mean ± S.D.	62.1 ± 14.7
BMI (kg/m²), Mean ± S.D.	22.2 ± 3.7
NYHA Class, n (%)	I: 6 (6.8), II: 50 (56.8), III: 32 (36.4)
LVEF (%), Mean ± S.D.	24.0 ± 8.8
Daily Data Sent (times/year), Median (IQR)	120 (96–120)
Self-Assessment Data Sent (times/year), Median (IQR)	120 (108–120)

Note: S.D.= standard deviation, BMI=body mass index, NYHA=New York Heart Association, LVEF = left ventricular ejection fraction. IQR = interquartile range.

Table 2: Pre- and Post-Intervention Outcomes (n=88)

Variable	Pre (1 Year)	Post (1 Year)	Test statistics (Z or t)	p	IRR (ZIP)	95% CI
ED Visits (events/year)	2.01 ± 1.8	0.75 ± 1.20	Z = -5.2	< 0.001	0.37	[0.28, 0.49]
Hospitalizations (events/year)	1.69 ± 1.0	0.56 ± 0.92	Z = -4.8	< 0.001	0.33	[0.24, 0.45]
MLHFQ	50.8 ± 22.6	31.9 ± 24.3	t = 9.11	< 0.001		[14.8, 23.0]

Note: ZIP, zero-inflated Poisson regression used for emergency department (ED) visits and hospitalizations; paired t-test for Minnesota Living with Heart Failure Questionnaire (MLHFQ).

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Table 3. High vs Low/Moderate Usage Outcomes (n=88)

Variable	High Usage (n=7)	Low/Moderate Usage (n=81)	p
MLHFQ (mean difference ± S.D.)	25.0 ± 15.1	18.6 ± 23.4	0.01
ED Visits (mean ± S.D.)	0.86 ± 1.07	0.74 ± 1.22	0.75
Hospitalizations (mean ± S.D.)	0.57 ± 0.79	0.56 ± 0.94	0.95

Note: p-values derived from independent t-tests. ED = emergency department, MLHFQ = Minnesota Living with Heart Failure Questionnaire, S.D.= standard deviation.

Table 4. Logistic Regression Analysis of the Factors Associated with a Favorable Response (n = 88)

Variable	B (S.E.)	OR	95% CI	p
Age (years)	0.043 (0.020)	1.044	1.004–1.085	0.029
LVEF (%)	-0.061 (0.034)	0.941	0.880–1.006	0.072
NYHA class	-0.989 (0.511)	0.372	0.136–1.013	0.053
High usage*	0.209 (0.924)	1.233	0.202–7.542	0.821

OR = odds ratio; CI = confidence interval; LVEF = left ventricular ejection fraction; NYHA = New York Heart Association.

*High usage was defined as ≥100 submissions/year.

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