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Research Article

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Utilisation of Digital Monitoring System for Heart Failure Patients: Experience from a Tertiary Healthcare in Bangladesh

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ABSTRACT

Background: Digital monitoring aims to improve early detection of HF decompensation and prevent readmissions. However, evidence of its effectiveness, particularly from lower- and middle-income countries like Bangladesh, is limited. To evaluate the association between the use of a digital monitoring (DM) platform and healthcare utilization among patients with heart failure (HF) at a tertiary care center in Bangladesh.

Methods: We conducted a prospective study at a single tertiary HF clinic between April and October 2024. The study compared outcomes for patients who opted into a DM program (DM group) versus those receiving conventional physical visits (PV group). The primary outcome was all-cause hospitalization. A multivariable logistic regression model was used to adjust for baseline differences between the groups.

Results: A total of 1,536 patients were included: 43 in the DM group and 1,490 in the PV group. The DM group was younger, had a higher monthly income, and a lower baseline NYHA classification compared to the PV group. In the unadjusted analysis, the DM group had a significantly lower rate of all-cause hospitalization (10% vs. 40%; p=0.01) and fewer emergency care visits (mean 0.7 vs. 1.3; p=0.001). After adjusting for baseline demographic and clinical differences, participation in the DM program remained associated with lower odds of hospitalization.

Conclusions: In this single-center study, participation in a DM program was associated with lower healthcare utilization among HF patients. A randomized controlled trial is required to establish a causal relationship and confirm the benefits of telemonitoring in this population.

Keywords: Heart failure, Telemonitoring, Hospitalization, Bangladesh

Background

The prevalence of heart failure (HF) and its associated costs are increasing worldwide, largely due to an aging population [1]. HF often leads to decompensation requiring repeated and prolonged hospitalizations, which are strong predictors of poor outcomes and account for approximately 80% of HF-related healthcare costs [2,3].

Self-monitoring of symptoms is a cornerstone of HF management [4]. Digital monitoring (DM), or telemonitoring, aims to enhance this by using technology to transmit patient data such as body weight, blood pressure, and symptoms to healthcare professionals for timely review and intervention [5]. While structured telephone support has been shown to reduce HF-related hospitalizations, the effect of more comprehensive, non-invasive DM has yielded mixed results in clinical trials [6,7]. A recent meta-analysis suggested that telemonitoring can reduce all-cause mortality and hospitalizations, but highlighted

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that outcomes may vary based on the DM model, healthcare system, and patient population [8].

While numerous studies have explored DM in developed countries, there is a critical lack of evidence from Bangladesh [9-13]. This knowledge gap hinders the development of national policies for telehealth and strategies to manage the growing burden of cardiovascular disease. Therefore, this study aimed to assess the association between the implementation of a novel DM program and healthcare utilization in a real-world clinical setting in Bangladesh.

Methods

Study Design and Settings

This was a prospective, non-randomized, single-center cohort study conducted at the HF unit of United Hospital, a large tertiary care hospital in Dhaka, Bangladesh. The study enrolled patients from April to October 2024 and compared outcomes between two groups: patients who opted to participate in a new DM program and patients who continued with standard in-person physical visits.

Participants and Survey Procedures

Patients receiving active treatment for HF at the clinic were eligible. Inclusion criteria were: at least one clinic visit in the past 12 months, self-reported New York Heart Association (NYHA) class I-IV, and the ability to manage the DM devices and digital platform. Patients were excluded if they had terminal renal failure, cancer with a prognosis of less than one-year, severe cognitive impairment, terminal cirrhosis, or were receiving palliative care.

During the study period, eligible patients were offered enrollment in the DM program. Those who consented and met the technical requirements formed the DM group. Patients who declined or did not meet the technical requirements but otherwise met all eligibility criteria continued with standard care and formed the physical visit (PV) group. This allocation was non-randomized and based on patient choice and capability, a known potential source of selection bias.

A total of 1,765 patient records were initially screened. After excluding 229 records due to incomplete information, 1,536 patients were included in the final analysis (Figure 1).

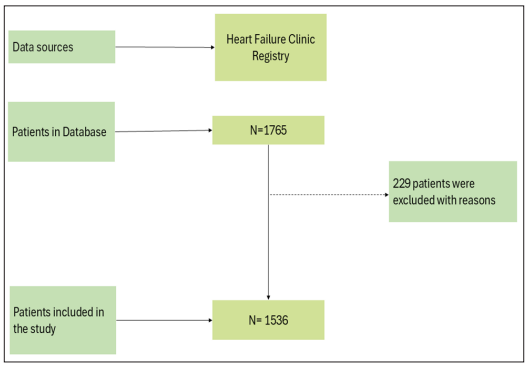

Figure 1: Flow chart for patients' selection

The Digital Monitoring Intervention

The DM intervention consisted of three components managed by trained nurses:

Predischarge HF education: Patients received structured education on medication adherence, diet, fluid monitoring, exercise, and daily self-checks.

Home telemonitoring: Patients were equipped with a digital scale and blood pressure monitor. They transmitted daily measurements to a secure digital platform (United Hospital's remote patient monitoring platform) via their personal electronic devices.

Nurse-Led Monitoring and Triage: Nurses monitored the incoming data on the digital platform. Based on the patient's health status and alerts generated by the system, nurses would conduct follow-up telephone coaching. If needed, nurses would refer the patient to a cardiologist for medication optimization or other interventions, with a required response time of 24 hours. For urgent alerts, patients were advised to seek emergency care.

Data Collection and Outcomes

Baseline sociodemographic and clinical characteristics were collected from the hospital registry. The primary outcome was the rate of all-cause hospitalization during the 6-month follow-up period. Secondary outcomes included the number of inpatient days and the number of emergency care visits.

Statistical Analysis

Data were analyzed using SPSS version 23. Baseline characteristics of the DM and PV groups were compared using the independent samples t-test for continuous variables and the Pearson chi-square test for categorical variables. To account for the non-randomized design and baseline differences between the groups, we performed a multivariable logistic regression analysis. The model assessed the association between group assignment (DM vs. PV) and the primary outcome of all-cause hospitalization, while adjusting for potential confounding variables, including age, gender, monthly income, and baseline NYHA class. Results are presented as unadjusted and adjusted odds ratios (aOR) with 95% confidence intervals (CI). A two-sided P-value <0.05 was considered statistically significant. This adjusted analysis is crucial for interpreting outcomes in observational studies where baseline characteristics may differ between groups.

Results

Baseline Characteristics of Study Participants

Of the 1,536 patients included, 43 (3%) enrolled in the DM group and 1,490 (97%) were in the PV group. There were significant baseline differences between the two groups. Patients in the DM group were, on average, younger, had a significantly higher monthly income, and were more likely to be in a lower NYHA functional class at baseline compared to patients in the PV group (Table 1).

Table 1: Baseline Characteristics of Patients by Study Group

Characteristic	DM Group (n=43)	PV Group (n=1490)	P-value
Age in years, mean (SD)	48.5 (5.9)	53.4 (6.5)	<0.001
Gender, n (%)			0.650
Male	35 (81.4)	1257 (84.4)	
Female	8 (18.6)	233 (15.6)	
Monthly Income >60000 BDT, n (%)	28 (65.1)	568 (38.1)	<0.001
NYHA Classification, n (%)			<0.001
Class I/II	41 (95.3)	1338 (89.8)	
Class III/IV	2 (4.7)	152 (10.2)	
HFrEF (EF <40%), n (%)	30 (69.8)	1093 (73.3)	0.580

Note: This table is illustrative. Data are presented as mean (SD) or n (%). P-values are from t-tests or chi-square tests

Healthcare Resource Utilization

In the unadjusted analysis, the DM group had significantly lower healthcare utilization compared to the PV group (Table 2). The proportion of patients with at least one all-cause hospitalization was four times lower in the DM group (10% vs. 40%, P=0.01). The mean number of emergency care visits was also significantly lower in the DM group (0.7 vs. 1.3, P=0.001).

Table 2: Use of Health Care Per Patient in Physical Visit or Digital Monitoring Solution Adjusted Analysis of Hospitalization

Variables	PV	DM	Absolute change (relative change)	P-value for differences
All-cause hospitalizations (n=49)				
Patients with at least 1 event, n (%)	34(70.0)	15(30.0)	-19(-40.0)	0.080
Inpatient days, mean (95% CI)	2.9(1.6)	1.7(1.2)	-1.2(-41.0)	0.200
Hospitalizations for cardiovascular causes other than HF (n= 12)*				
Patients with ≥1 event, n (%)	7(58.0)	5(42.0)	-2(-16.0)	0.700
Inpatient days, mean (95% CI)	0.2(0.3)	0.02(0.05)	-0.16(-88.0)	0.400
Hospitalizations for HF (n=37)				
Patients with ≥1 event, n (%)	21(57.0)	16(43.0)	5(11.0)	0.020
Mean inpatient days, days (95% CI)	2.3(1.3)	1.2(1.1)	1.1(-48.0)	0.170
Mean number of emergency care visits for cardiovascular causes, n (95% CI)	1.3(0.4)	0.7(0.3)	-0.6(-44.0)	0.001
Mean number of secondary care visits (cardiology), n (95% CI)	1.8(0.5)	1.9(0.6)	0.1(+8.0)	0.800

Note: P-values calculated with the Pearson chi-square test.

After adjusting for the significant baseline differences in age, income, and NYHA class, participation in the DM program remained independently associated with lower odds of all-cause hospitalization (Adjusted Odds Ratio: 0.28; 95% CI: 0.10-0.79; P=0.016) (Table 3).

Table 3: Multivariable Logistic Regression Analysis of Factors

Characteristic	Adjusted Odds Ratio (95% CI)	P-value
Group Assignment		
DM Group (vs. PV Group)	0.28 (0.10 - 0.79)	0.016
Demographics		
Age (> 55 vs. ≤ 55 years)	1.35 (1.05 - 1.74)	0.020
Monthly Income >60000 BDT	0.75 (0.58 - 0.97)	0.030
Clinical Parameters		
NYHA Class III/IV (baseline)	2.10 (1.45 - 3.05)	<0.001

Discussion

In this prospective, non-randomized study, we found a significant association between participation in a digital monitoring program and reduced healthcare utilization among patients with HF in Bangladesh. Patients in the DM group had markedly lower rates of hospitalization and emergency visits compared to those receiving standard care. This association persisted after statistical adjustment for key baseline differences between the groups.

Our findings are consistent with some previous studies and meta-analyses that have shown a benefit of telemonitoring in reducing hospitalizations [14-18]. However, the results must be interpreted with significant caution due to the study's design. The two groups were not comparable at baseline; patients who opted for digital monitoring were younger, wealthier, and clinically less severe (lower NYHA class). While we attempted to control for these factors statistically, unmeasured confounding variables (such as health literacy, social support, or patient motivation) likely contributed to the better outcomes observed in the DM group. This high risk of selection bias is the primary limitation of the study.

The large difference in outcomes, even if partially explained by patient selection, suggests that the intervention may still hold promise. The proactive nature of the DM program, with nurse-led

monitoring and rapid physician response, may have contributed to the better management of early decompensation signs, preventing progression to full-blown emergencies. This aligns with studies where close collaboration between nurses and physicians was a key component of successful telemonitoring programs.

Conclusion

In conclusion, our results suggest a strong association between the use of a novel telemonitoring solution and reduced hospital admissions for a select group of HF patients in Bangladesh. However, given the significant limitations of the non-randomized study design, these findings should be considered hypothesis-generating. A large-scale, multicentre randomized controlled trial is urgently needed to definitively assess the effectiveness and cost-effectiveness of digital monitoring for improving HF outcomes in this region.

Declaration

Data Availability

Data can be shared with the corresponding author upon request and for a valid reason.

Funding

We did not receive any financial support to conduct this study.

Conflicts of Interest

The authors have no conflicts of interest.

Ethics Approval

To ensure compliance with ethical standards and participant confidentiality, we obtained ethical approval from the Bangladesh Medical Research Council (BMRC) (Ref-25003092019). The data were de-identified to maintain anonymity prior to analysis. Before data collection, the purpose of the study was fully clarified to the participants, and their informed written consent was taken. Each of the steps of this study was completed following the Helsinki Declaration (1964).

Authors' Contributions

All author contributed to the write up and editing.

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