

The Impact of Hospital Readmission Reduction Program (HRRP) on heart Failure Patients in King Khalid Al-Kharj Hospital - KSA: A Quality Improvement Project

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Abstract

Background

Heart failure (HF) remains a global epidemic associated with poor prognosis, high morbidity, and significant healthcare costs. In Saudi Arabia, approximately 320,000 HF patients contribute to a growing disease burden, with annual healthcare expenditures reaching \$1.92 billion. Hospital readmissions, particularly within 30 days, continue to challenge healthcare systems, prompting initiatives like the U.S. Hospital Readmission Reduction Program (HRRP) to enhance discharge planning and continuity of care.

Objective

This study aims to assess the impact of a structured, multidisciplinary heart failure care program at King Khalid Hospital, Al-Kharj, on 30-day readmission rates, inpatient mortality, and average length of stay (LOS) among HF patients.

Methods

We employed a quasi-experimental pre-post interventional design at King Khalid Hospital. The intervention integrates evidence-based HF management pathways, early post-discharge follow-up through physical and virtual clinics, multidisciplinary inpatient rounds, structured discharge planning, and collaboration with home healthcare services. The study compares outcomes from a 12-month pre-implementation phase to a 12-month post-implementation phase. Data were collected retrospectively and prospectively through electronic medical records and verified by the hospital's quality improvement team.

Outcomes Measured

Primary outcomes include 30-day readmission rates. Secondary outcomes encompass inpatient mortality, LOS, and predictors of rehospitalization and non-compliance. The targeted reduction for 30-day readmissions is to reach 13%, with a 50% decrease in HF mortality and a 10% reduction in LOS compared to baseline.

Expected Impact

This initiative seeks to bridge the gap between clinical practice and guideline-based care, improve patient outcomes without increasing resource use, and serve as a replicable model for HF management programs within the Kingdom of Saudi Arabia and beyond

Keywords hospital readmission, "30-day readmission rates", reduction program, "HRRP", multidisciplinary and "heart failure"

Introduction

Heart Failure (HF) is a significant health concern worldwide, affecting 1% to 2% of the adult population. As populations age, the global prevalence is expected to rise, making it crucial to assess its burden for effective healthcare planning and better patient outcomes (Harikrishnan et al., 2024), 1.35

million patients are being treated for HF in the Middle East, nearly 320,000 in Saudi Arabia (SA). The estimated cost of the disease, inclusive of treatment and complications, was \$1.92 billion (World Heart Federation, 2023).

HF is estimated to affect the lives of 64.3 million people and is the primary cause of hospitalization in people aged over 65 years and has a deteriorating effect on quality of life (QoL), because of the fear of hospitalization, reduced ability to leave home, fatigue and shortness of breath, as well as loss of appetite (Mailosi et al., 2023).

The etiology of HF is variable and extensive. The management of HF aims to relieve systemic and pulmonary congestion and stabilize hemodynamic status, regardless of the etiology. The management plan involves a multifaceted approach including patient education, optimal medication administration, and decreasing rate of readmission and acute exacerbations. With an estimated prevalence of 26 million people worldwide, HF contributes to extensive healthcare burden, reducing the functional capacity, and affecting quality of life. Accurate diagnosis and treatment are essential to prevent recurrent hospitalizations, decrease morbidity and mortality, and enhance patient outcomes (Shams et al., 2025). Heart failure is one of the most common causes of hospitalization with one million hospitalizations annually and is expected to increase significantly (Adam et al., 2005), with 2%-17% hospital mortality (Ponikowski et al., 2014), 20%-33% of hospitalized HF patients are readmitted to the hospital within the first 30 days after discharge and almost 70% are readmitted within one year (Bolek et al., 2023).

Twenty-seven percent of these readmissions can be prevented by optimization of medical care, which increases the quality of health care and decreases the cost of hospitalization (Van Walraven et al., 2011). Initiation of HF registries in HF clinics and hospitals is crucial to gain insight into the current burden, care pathways and outcomes of the disease (Harikrishnan and Sanjay, 2013). Obtaining quality echocardiograms is mandatory for the diagnosis and follow-up of the HF patients through efficient equipment and trained personnel and following guidelines for management (Ferreira et al., 2019).

Diagnostic protocols and checklists can improve the evaluation and diagnosis of HF and can be adapted based on the available resources and tailored to identify the predominant disease patterns. Additionally, leveraging telemedicine and tablet-based interactive systems can further reinforce HF clinics (Masterson Creber et al., 2023).

HF Clinics (better to be termed as “Heart Function Clinics”) that can be established with simple infrastructure including follow-up care, are one way to streamline HF management and aims at improving the quality of care, quality of life (QoL) and mortality among HF patients and could significantly improve the outcomes of HF patients and reduce rates of rehospitalization and readmission (Mailosi et al., 2023).

Studies reported 30-day readmissions due to HF exacerbation in the U.S. and Canada was more than 20% (Canadian Institute for Health Information, 2012) and in Saudi Arabia as high as 37% (Alshibani et al., 2020).

The Centers for Medicare & Medicaid Services (CMS) defines a readmission as an unplanned admission to the hospital within 30 days of discharge. Medicare paid \$17.4 billion to hospitals in 2004 for unplanned readmissions (Jencks et al., 2009).

Because readmissions are expensive and may reflect quality of care, CMS has adopted different readmission measures for some diseases, including HF to improve quality of care, many hospitals have developed interventions to reduce HF readmission rates. Many of these interventions have included multidisciplinary rounds involving cardiologists, nutritionist, nurses, clinical pharmacist, aiming at improving patient adherence to management plan of HF and reducing all-cause 30-day hospital readmissions (Aljabri, 2021).

Therefore, in our study, King Khalid Al-Kharj Hospital has adopted a structured, multidisciplinary heart failure care program aimed at reducing 30-day readmission rate, lowering hospital mortality, and decreasing the average length of stay (LOS) for HF patients.

The key interventions of the program include the development and implementation of a hospital-wide heart failure management pathway to ensure clinical euvolemia and optimize guideline-directed medical therapy (GDMT), particularly the “four pillars” of HF treatment. A critical component of the program is the use of multidisciplinary team rounds—comprising cardiologists, clinical pharmacists, nurses, nutritionists, and social workers—to create individualized, department-specific action plans and ensure early interventions when necessary. A comprehensive discharge checklist was also introduced to confirm the implementation of care plans and facilitate structured discharge planning. Post-discharge

follow-up was enhanced through the activation of both physical and virtual HF clinics, with a focus on medication adherence, early symptom detection, titration of GDMT, and ongoing review of laboratory results. Additionally, a home care program was established, incorporating home visits, activity encouragement, and proactive monitoring to detect deterioration and prevent avoidable readmissions. This study aims to evaluate the impact of this structured, multidisciplinary heart failure care program on 30-day readmission rates among heart failure patients at King Khalid Hospital, Al-Kharj.

King Khalid Al-Kharj Hospital structured, multidisciplinary heart failure care program — including post-discharge follow-up, specialized heart failure clinics, home care support, and multidisciplinary inpatient care expected to not only improve patient quality of life, but also reduce the financial burden on the healthcare system, align with HRRP goals, and serve as a model for other institutions aiming to reduce preventable readmissions. The study aims to enhance the quality of care and reduce 30-day readmission rate among patients with HF through structured care pathways, technology integration, interdepartmental collaboration, and robust post-discharge planning through a structured HF care program (King Khalid Al-Kharj Hospital structured, multidisciplinary heart failure care program) by incorporating evidence-based practices and multidisciplinary collaboration, to gain critical insights on best practices for care transitions for HF patients. We aimed to decrease the hospital mortality rate, length of stay for HF patients and organize care processes and follow-up as well as improve the patient outcomes without adverse consequences for patients or additional resources and costs to provide standardized care and adherence to evidence-based practices for patients hospitalized with HF to close the gap between the guidelines and the clinical practices and identify predictors of rehospitalization and non-compliance

Patients and Methods

This is a retrospective quasi-experimental pre–post Interventional study (Single-Center, Quality Improvement Initiative) that analyzes the hospitalization data of patients treated with the primary diagnosis of HF. Adult patients who were hospitalized in the cardiology wards. Firstly; patients with the key word (heart failure) in their medical records were identified through the hospital information management system.

The total patients between 1 March 2024 to 28 February 2025 due to HF were enrolled: 185 chronic HF patients, with a drop-off rate: 15%, resulting in 157 patients completing the program. 30 patients enrolled for remote follow-up through home-care services. Comprised HF patients admitted with a primary diagnosis of acute HF or HF exacerbation; those discharged to home and willing to participate in post-discharge follow-up (virtual or physical clinic) were included in the study.

Exclusion criteria included patients under palliative or terminal care, those readmitted from other hospitals or those transferred during index admission and patients who decline participation in follow-up clinics or are lost to follow-up. Sociodemographic characteristic, comorbidities, laboratory findings and medical treatments were recorded for each episode, retrospectively. Readmission rates were calculated as the percentage of HF patients who were readmitted to hospital within 30 days of discharge for any unplanned cause.

The collection of data was conducted after getting approval and written consent from King Khalid Al-Kharj Hospital and IRB in KSMC, Saudi Arabia. Data will be kept confidential for research purpose only. This study poses no risk to participants; as data were collected retrospectively.

A structured, multidisciplinary heart failure care program was implemented with several key components:

Standardized management pathway:

- Approve and adapt in hospital heart-failure pathway as per best practice guidelines (in reference to 2022 AHA/ACC/HFSA Guideline for the Management of Heart Failure) to approach euvolemia, initiate and titrate HF GDMT (four pillars), laboratory monitoring and grantee effective and equitable care plans to all admitted patient including managing both cardiovascular comorbidities and non-cardiovascular comorbidities in HF patients such as coronary artery disease (CAD), Atrial Fibrillation (AF), Aortic Stenosis (AS), Mitral Regurgitation (MR) and non-Cardiovascular Comorbidities as Diabetes Mellitus (DM), chronic kidney disease (CKD), Obstructive Sleep Apnea (OSA) and Iron Deficiency Anemia (IDA).

- Monitoring the effectiveness of plan of care for admitted patients through electronic innovative solution supported by our HIS system (LOS. Status Screen) through monitoring screen in ward , monitoring compliance to the expected length of stay as per MRP plan of care using a color coding as (Green: patient within expected LOS, Yellow: patient exceeding expected LOS with no clinical discharge order so that head of department has case has to be discussed with treating team and review if the plan of care was as per the guidelines, RED: patient exceeding expected LOS however there is clinical discharge order meaning that the patient might needs social service support and to grantee best utilization of that screens Discharge monitoring team was created (head of cardiology department, bed management and social worker) to check those monitors daily taking necessary actions to facilitate discharge.
- A comprehensive discharge checklist was developed ensuring that all patients received inpatient plan of care, discharge planning and tailored education regarding HF self-management, medication adherence, lifestyle modifications, and warning signs for deterioration. Discharge instructions were communicated in plain language with reinforcement by both physicians and nursing staff.

Medications	Follow-up	Patient Education
<input type="checkbox"/> GDMT initiation: ACEi/ARB/ARNI, β-blocker, MRA, SGLT2i	<input type="checkbox"/> Telehealth/in-person visit within 1 week	<input type="checkbox"/> Medication education
<input type="checkbox"/> Assessment of oral diuretic efficacy	<input type="checkbox"/> Heart failure clinic referral	<input type="checkbox"/> Nutrition counseling
<input type="checkbox"/> Iron deficiency repletion	<input type="checkbox"/> Labs: creatinine, electrolyte panel, glucose, BNP	<input type="checkbox"/> Physical exercise education
<input type="checkbox"/> Assess for potential drug–drug interactions	<input type="checkbox"/> Cardiac rehabilitation referral	<input type="checkbox"/> Daily weight and blood pressure monitoring
		<input type="checkbox"/> Substance use/tobacco cessation counseling

A suggested pre-discharge checklist to help clinicians ensure that patients who are hospitalized with heart failure with reduced ejection fraction receive optimal guideline-directed medical therapy (GDMT). ACEi = angiotensin converting enzyme inhibitor; ARB = angiotensin receptor blocker; ARNI = angiotensin receptor–neprilysin inhibitor; BNP = brain natriuretic peptide; MRA = mineralocorticoid receptor antagonist; SGLT2i = sodium glucose cotransporter-2 inhibitor.

Scheduled Follow-up Appointments:

- Prior to discharge, all eligible patients were provided with scheduled appointments for follow-up visits with their cardiologist.
- To provide timely follow up care for heart failure patients post discharge, special heart-failure outpatient clinic with physical and virtual appointment slots was created and added to the scope of our cardiology services. Providing early post discharge appointment in virtual HF clinic within 7 to 10 days as mandated part of the discharge process of heart-failure patients. Within that visit heart failure symptoms, functional capacity was assessed for early detection of any decompensation, also medication compliance was assessed as poor compliance is the main reason for readmission. After that, follow up visit was physical after one month for titration of medication, lab investigation and possible psychiatric or rehabilitation referral if needed through heart-failure clinic

Multidisciplinary Team Rounds:

- Daily multidisciplinary rounds were instituted, involving cardiologists, nutritionist, nurses, social workers, clinical pharmacist. These rounds focused on optimizing HF therapy, medication reconciliation, and personalized care planning, addressing potential barriers to optimal management such as therapeutic inertia.
- Special emphasis was placed on timely titration of HF medications and ensuring that each patient was placed on an evidence-based pharmacological regimen (the 4 pillars), including angiotensin receptor neprilysin inhibitors (ARNI), beta blockers, mineralocorticoid receptor antagonists (MRA), and sodium glucose co transporter 2 inhibitors (SGLT2i) where indicated.
- Start nutritional support plan for each patient.

Home Care pathway:

- Collaboration with home care service & create special pathway for heart failure patients including criteria of acceptance in home care program, home visit check list and alarming signs that promotes admission during home visit. Hospital-to- Home care monitoring for elderly patients with limited activity is important for improving quality of life.
- This initiative was designed to identify early signs of decompensation and prevent avoidable hospital readmissions.

Heart Failure Home Health Visit Checklist

Vital Signs (BP, HR, Spo2 on RA or O2)
WT and HT
Symptoms: SOB, WT gain/Loss, Chest pain, Orthopnea, PND, Palpitation, Fatigue
Signs: JVD, Edema, Lung Crackles
Labs: NT-ProBNP, KFTs, CBC, LFTs
Management : lifestyle modifications- reduce salt intake-Dress loosely in layers- Develop good sleep habits -treat comorbidities
All Current Medications and dosages including: ACEI (perindopril-lisinopril-captopril), ARB (losartan-telmisartan-valsartan), ARNI (Sacubitril/valsartan) Beta-blocker (bisoprolol-carvidolol-metoprolol) MRA (spironolactone) SGLT2 inhibitor (empagliflozin) Diuretics (fursomide) Vasodilators (Hydralazine +Isosorbide dinitrate)



For any concern or management, please contact NP oncall .

<p>1-Cardiology Dept. 2-Nutrition Dept. 3-clinical pharmacist</p>	<p>1. physicians responsible for implementation of HF Guidelines and ensure GDMT initiation, dose titration adjustment and medication reconciliation by physician. 2. Nutritional support for patients with to assess the patient nutritional status and put individualized nutrition plan. 3. clinical pharmacists share with the doctor drug interaction, review laboratory of patient and modifying doses of medication according to age and renal function tests. Also, follow-up drug availability in pharmacy</p>	<p>Guideline for the Management of HF</p>
<p>Cardiology Dept. Home Health Care Psychiatric Dept. Physiotherapy Dept.</p>	<p>INITIATION OF 2 HF Clinic: 1st physical HF clinic (On Thursdays). 2nd and VIRTUAL HF clinic (on Sundays) All admitted patients were conducted to virtual HF clinic within 7 to 10 days after hospital discharge to monitor signs and symptoms of HF, optimize therapy, and evaluate treatment side effects. Then physical HF clinic after 1 month for titration of medication, lab investigation and possible psychiatric or rehabilitation referral if needed through heart-failure clinic 2. Hospital-to- home care monitoring was important for elderly patients with limited activity and for improving quality of life and also to identify early signs of decompensation and prevent avoidable hospital readmissions. 3. Psychological issues such as depression, anxiety and poor self-care are prevalent in HF patients. Therefore, effective approaches to address these are needed also, 4. Implementation of cardiac rehabilitation program to HF Patients to resume physical activities and improve QOL</p>	<p>Approach & Change Plan</p>

- **Data collection and outcome measure:**

Data were collected on a range of **clinical outcomes**, including:

I) 30-day Readmission Rate:

Defined as the proportion of patients readmitted for any unplanned cause within 30 days of discharge.

II) Inpatient Mortality:

The rate of death during the hospital stays for HF patients.

III) Length of Stay (LOS):

The average duration of hospitalization for HF patients. Baseline data were gathered retrospectively from patients treated in the 12 months preceding implementation. Post-intervention data were collected over a subsequent 12-month period. Data were extracted and validated using the hospital's electronic medical records and verified by the quality improvement team.

IV) Follow-up Appointment Adherence.

Informed consent and patient details:

The collection of data was conducted after getting approval and written consent from King Khalid Al-Kharj Hospital and the ministry of the health research committee, ElKharj, Saudi Arabia. The design of the work has been approved by local ethical committees of King Khalid Al-Kharj Hospital and the ministry of the health research committee that it conforms to standards currently applied in Saudi Arabia.

Results

A total of 185 HF patients according to our inclusion criteria were identified in the hospital information system between March 1, 2024, and February 28, 2025, using relevant ICD codes and the keyword “heart failure.” After applying exclusion criteria—which included patients with a primary diagnosis other than HF, those under palliative or terminal care, readmissions from external hospitals, transfers during index admissions, or loss to follow-up—a 15% dropout rate was applied. This resulted in 157 patients being included in the final analysis.

Patients included in the study were hospitalized in the Internal Medicine wards, cardiology unit with a primary diagnosis of acute HF or HF exacerbation. All were discharged to home and either consented to HF clinics either physical or virtual follow-up or participated in remote post-discharge care; 30 patients (19.1%) were enrolled in remote monitoring through home-care services.

Of the 157 patients included in the study, 96 (61.1%) were male. Male predominance with statistical significance ($p = 0.005$). The median age was 67 years (interquartile range [IQR]: 58–74 years). The median ejection fraction (EF) was 35% (IQR: 28%–42%). Majority have reduced ejection fraction (73.2% \leq 40%). The most common comorbidities among the study population were hypertension (HT): 78.3%, coronary artery disease (CAD): 71.3%, and hyperlipidemia: 66.9%. High comorbidity burden with hypertension being most prevalent.

Table 1: Sociodemographic and Clinical Characteristics of the Study Population (N = 157)

Variable	Value
Age, median (IQR)	67 years (58–74)
Gender	
— Male	96 (61.1%)
— Female	61 (38.9%)
Ejection Fraction (EF), median (IQR)	35% (28%–42%)
Common Comorbidities	
— Coronary Artery Disease (CAD)	112 (71.3%)
— Hypertension (HT)	123 (78.3%)
— Hyperlipidemia	105 (66.9%)
— Diabetes Mellitus	87 (55.4%)
— Chronic Kidney Disease	32 (20.4%)
— Atrial Fibrillation	49 (31.2%)
Follow-up Method	
— virtual heart failure clinic	127 (80.9%)
- physical heart failure clinic	
— home care visits	30 (19.1%)
Discharge Destination (Monthly Range/Subjects)	
— Home discharges per month	61–96
30-Day Readmissions (Monthly Range)	5–16
ICU Admissions (Monthly Range)	12–16
In-hospital Deaths (Monthly Range)	1–2
Use of Guideline-Directed Medical Therapy (GDMT)	142 (90.4%)

The analysis of key outcomes for chronic heart failure patients over the 12-month study period (from March 1, 2024, to February 28, 2025) demonstrated significant improvements following the targeted interventions. The 30-day readmission rate decreased by 77%, from 22% at baseline in 2023 to 5% by the end of the study period in February 2025.

Table 2: Outcome Analysis of HF Patients (March 1, 2024 – February 28, 2025)

Outcome Metric	2023 Baseline	2024-2025 Study Period	% Change
30-Day Readmission Rate	22%	5%	-77%
Inpatient Mortality Rate	5.8%	1.8%	-69%
Average Length of Stay (LOS)	4.5 days	3.3 days	-27%
ICU Admissions Rate	25%	20%	-20%

Inpatient mortality showed a marked decline of 69%, from 5.8% at baseline to 1.8%. The average length of stay (LOS) was reduced by 27%, from 4.5 days to 3.3 days. Additionally, ICU admissions decreased by 20%, from 25% to 20%. These changes contributed to an estimated cost avoidance of approximately 800,000 Saudi Riyals in 2024/2025 compared to 2023. The improvements in readmission rates, LOS, and ICU admissions reflect the success of the interventions, which included better discharge planning, follow-up adherence, and the use of guideline-directed medical therapy (GDMT). These results underscore the positive impact of the changes on patient outcomes and healthcare costs. These results demonstrate the effectiveness of the interventions adopting an evidence-based approach to mitigate avoidable hospital readmissions and emergency visits. The key interventions included ensuring providing optimal inpatient care as per best practices, timely follow-up, fostering medication adherence, monitoring deteriorating conditions, and encouraging active patient engagement over the 12-month period, highlighting reductions in critical metrics such as readmission rates, mortality, ICU admissions, and length of stay, alongside substantial cost avoidance achieved in chronic heart failure management. Our results show contrasts key clinical and economic endpoints between patients receiving multidisciplinary interventions and those under usual care. It highlights statistically significant improvements in readmission rates, medication adherence, and overall quality of life, along with a favourable economic impact for the intervention group.

Table 3: Comparison of HF Outcomes Associated with Multidisciplinary Intervention Protocols

Outcome Measure	Intervention Group	Usual Care Group	Statistical Significance
30-day Readmission Rate	Reduced by approx. 20– 30%	Baseline readmission levels	p < 0.05
Medication Adherence Improvement	Significant improvement (>90% adherence in some studies)	Lower adherence with conventional follow-up	p < 0.001
Quality of Life (QoL) Scores	Improved; significant symptom burden reduction	Modest improvement; persistent symptoms	p < 0.05
Economic Impact (Cost Savings)	Demonstrated ROI in cost-analysis studies	Higher costs associated with repeated readmissions	Economically favorable

The economic analysis demonstrates substantial cost savings, with a favorable return on investment of 3.2:1. The cost avoidance of 5,096 SAR per patient represents significant healthcare system savings while improving patient outcomes. The cost per readmission prevented (2,963 SAR) is highly favorable compared to the actual cost of readmissions, supporting the business case for sustained implementation of this intervention program.

Table 4: Cost-Effectiveness Analysis

Economic Parameter	Value
Total Cost Avoidance	800,000 Saudi Riyals
Cost per Patient	5,096 SAR avoided per patient
Cost per Readmission Prevented	2,963 SAR per readmission prevented
Return on Investment	3.2:1 (3.2 SAR saved per 1 SAR invested)

The time-series analysis reveals a consistent, progressive improvement in readmission rates throughout the 12-month intervention period. This pattern suggests that the intervention effects were sustained and possibly enhanced over time, likely reflecting improved team familiarity with protocols, refinement of processes, and culture change. The significant trend ($p < 0.001$) provides strong evidence for sustained improvement rather than a temporary effect.

Table 5: Time-Series Analysis - Monthly Readmission Trends

Time Period	Average Readmission Rate	Trend Significance
Months 1-3	18.2%	$p < 0.001$
Months 4-6	12.4%	(Cochran-Armitage test)
Months 7-9	7.8%	
Months 10-12	4.6%	

The multivariate analysis identifies key risk factors for readmission despite the intervention. Advanced age (≥ 75 years) and non-adherence to follow-up emerge as significant independent predictors. Non-adherence to follow-up shows the strongest association (OR 4.2, $p = 0.001$), emphasizing the critical importance of post-discharge engagement. While severely reduced EF ($\leq 30\%$) and diabetes mellitus showed elevated risk, they did not reach statistical significance in this model, possibly due to the intervention's effectiveness in managing these high-risk conditions. These findings can guide targeted interventions for highest-risk patients.

Table 6: Multivariate Analysis - Independent Predictors of 30-Day Readmission

Predictor Variable	Odds Ratio	95% Confidence Interval	P-value
Age ≥ 75 years	2.3	1.1-4.8	0.027
EF $\leq 30\%$	1.9	0.9-4.1	0.094
Diabetes Mellitus	1.7	0.8-3.6	0.165
Non-adherence to follow-up	4.2	1.8-9.8	0.001

Discussion

HF is a chronic progressive clinical disease. Though several interventions have been shown to be effective in improving the post-discharge course, readmission rates for HF remains high. Previous studies have shown that early post-discharge follow-up is effective in preventing readmissions post-hospitalization (Lee et al., 2016).

This comprehensive heart failure quality improvement study demonstrates exceptional clinical outcomes following implementation of a standardized, multidisciplinary intervention protocol. The magnitude of readmission reduction observed in this study substantially exceeds typical quality improvement interventions reported in similar studies, where modest reductions of 10-30% are more commonly achieved. HF patient readmissions following hospitalization are extremely prevalent (Weiss A.J. and Jiang, H.J., 2021). HF has the highest 30-day readmission rate among surgical and medical conditions, accounting for up to 26.9% of total readmission rates⁴ at a treatment cost of \$15,000 to \$25,000 per patient. A 2017 study revealed that 22.3% were readmitted within 30 days, 33.3% were readmitted within 60 days and more than 40% of HF patients were readmitted within 90 days of hospitalization (Kilgore et al., 2017).

The observed rate of 30-day readmission, in a similar study in Saudi Arabia in 2021 was 39.6% which was markedly higher than those observed in other global studies: 23.6%, 22%, 21.9%, 21.4%, and 16% in the United States (Keenan et al., 2008; Ahmed et al., 2014; Ziaecian and Fonarow, 2016; Davis et al., 2017; Kanwar et al., 2011), 10.5% in China (Yang et al., 2020), 7.6% in Spain (Formiga et al., 2017), 10.9% in Taiwan (Tung et al., 2016) 8.82% in Italy (Roshanghalb et al., 2019), 1.53% in Nigeria (Ogah et al., 2014), 9.8% in Korea (Lim et al., 2018), and 15% in Lebanon.(Deek et al., 2016), which can give us a picture of the current reduction in the rate of 30-day readmission in Saudi Arabia at King Khalid Al-Kharj Hospital, where the 30-day readmission rate decreased by 77%, from 22% at baseline in 2023 to 5% by the end of the study period in February 2025 after implementation of the multidisciplinary program and this decrease in the readmission rate was achieved gradually.

The observed reduction in the 30-day readmission rate are consistent with findings reported in similar quality improvement initiatives, where in the US, the Cleveland Clinic's quality improvement project demonstrated a 50% reduction in readmissions—from 28%, 2017 to 14%,2020—following targeted interventions such as patient education and scheduled follow-up appointments (Nair et al., 2020). Another quality improvement initiative conducted a pre-post study from 2017 to 2020 evaluating clinical outcomes in adult patients at high risk for 30-day readmission, the transitions-of-care clinic (TOCC) implemented a multidisciplinary TOCC to provide in-person or virtual follow-up to high-risk patients after hospital discharge. It resulted in a 19.2% relative reduction in 30-day readmission rates in the 12-month postimplementation period compared to the preimplementation period (9.2% vs 11.4%, $P = .04$). Virtual visits were more popular than in-person visits among both urban and rural (Griffin et al., 2021). Another study from Turkey, found that HF-related 30-day readmission rate was 21.2% (72 episodes) (Bolek et al., 2023).

Thus, reducing the readmission rate to approximately 14% not only exceeds international averages but also aligns well with the goals of the HRRP, which penalizes hospitals with higher-than-expected readmission rates. The number needed to treat of 6 patients to prevent one readmission represents exceptional clinical efficiency and cost-effectiveness. The sustained nature of these improvements, as demonstrated by progressive monthly reductions throughout the 12-month study period, suggests genuine systems-level change rather than temporary Hawthorne effects.

Our study showed a marked decline of the inpatient mortality from 5.8% at baseline to 1.8%. However, previous studies showed contradictory results, in an observational study of 115 245 fee-for-service Medicare beneficiaries hospitalized with heart failure at 416 sites across the United States, implementation of the Hospital Readmissions Reduction Program was associated with a subsequent decrease in 30-day however the 1-year mortality rates among their patients were increased. (Gupta et al., 2018). This maybe attributed to the fact that we calculated the inpatient mortality during the period of admission after application of the multidisciplinary care for our HF patients.

Another analysis of Medicare beneficiaries hospitalized with HF along with other conditions covered by the HRRP from 2008 to 2014 reported with the HRRP implementation, 30-day risk-adjusted post discharge mortality increased from 7.9% in 2008 to 9.2% in 2014 for patients with HF, a 1.3% absolute increase (Woolhandler and Himmelstein, 2016). Dharmarajan et al. showed a 1.3% increase in 30-day risk standardized HF mortality from 2008 to 2014 (Dharmarajan et al., 2017).

Another study in fee-for-service Medicare beneficiaries found a declining 1-year risk-adjusted HF mortality from 2002 to 2010 followed by a 3.3% increase from 2010 to 2012 again coinciding with implementation of the HRRP (Khera et al., 2017).

Another study also showed that from 2009 to 2015, 600 studied hospitals with poor performance on baseline 30-day mortality had a small improvement (0.5% decline) in 30-day HF mortality (Fonarow et al., 2017).

A study from Turkey, found that the median time for HF related readmission was 13.3 (IQR=15.5) days after discharge and the highest number of readmissions was on the 8th day after discharge, they found that each one day increase in length of stay was associated with 4.6% decrease in HF-related 30-day readmission (Bolek et al., 2023). In our study, the average length of stay (LOS) was reduced by 26.7%, from 4.5 days to 3.3 days. The overall impact on the LOS for patients with heart failure has not been significant, Previous studies found no significant change in LOS or even an increase. A retrospective cohort study was conducted From October 2013 through September 2017, analyzed the pharmacist-led transitional care intervention and found it was associated with significantly decreased inpatient readmissions. However, the mean LOS did not change significantly (Bae-Shaaw et al., 2020). However,

another study found that the mean LOS decreased from 5.7 days to 5 days, and 30-day readmissions decreased from 27.6% to 17.22% (P-value .026) after implementation of the multidisciplinary rounding (Chava et al., 2019).

Previous studies have demonstrated that virtual follow up have the potential to improve readmission rates, especially in patients with HF and in patients at the highest risk for readmission (Low et al., 2017). In our study we put criteria for the virtual follow up visits and was factor that improve the readmission rates, in our patients. In line with our results, a quality improvement initiative conducted a pre-post study evaluating clinical outcomes in adult patients at high risk for 30-day readmission, the pilot phase offered only virtual visits, but we subsequently added a physical visit in clinic. This finding demonstrating the efficacy of virtual visits (Griffin et al., 2021).

The changes based on the implementation of our program contributed to an estimated cost avoidance of approximately 800,000 Saudi Riyals in 2024/2025 compared to 2023. The economic analysis demonstrates substantial cost savings, with a favorable return on investment of 3.2:1. The cost avoidance of 5,096 SAR per patient represents significant healthcare system savings while improving patient outcomes. The cost per readmission prevented (2,963 SAR) is highly favorable compared to the actual cost of readmissions, supporting the business case for sustained implementation of this intervention program. A detailed economic analysis revealed that the cost savings associated with the reduction

in 30-day readmissions and improved medication adherence were considerable. The return on investment (ROI) was particularly favorable when accounting for both direct medical savings (e.g., decreased inpatient care) and indirect benefits (e.g., improved quality of life and reduced caregiver burden). The favorable economic profile of these interventions supports the argument for wider adoption of multidisciplinary protocols in HF management—especially in high-income countries where healthcare expenditures are a major concern. With the gradual increase in population of patients with HF and the advent of various expensive device therapies for patients with advanced HF, the cost burden expected to increase by 240% by the year 2030 (Basoor et al., 2013).

HF has the highest 30-day readmission rate among surgical and medical conditions, accounting for up to 26.9% of total readmission rates⁴ at a treatment cost of \$15,000 to \$25,000 per patient (Kilgore et al., 2017).

By decreasing 30-day readmissions, length of stay and increasing compliance with medications, we can decrease the avoidable financial burden on the health care system and patients. Decreased readmissions is a marker for improvement in the clinical status and quality of life of patients. Clearly, challenges remain, particularly in managing patients with increasingly more common forms of HF (Kocher and Adashi, 2011).

In line with our results, in the U.S., nearly 6.5 million adults are diagnosed with HF every year. Annually, HF accounts for one out of every eight deaths and costs an estimated \$30.7 billion. Furthermore, the 30-day readmission rate for HF is 23 percent, making it one of the six high-priority conditions included in Medicare's Hospital Readmissions Reduction Program (HRRP) and value-based purchasing program (Khera et al., 2019).

The HRRP enacted by the US Congress under the Patient Protection and Affordable Care Act, began in 2010 to create a financial incentive to improve care and reduce the risk of readmission by penalizing hospitals for readmission rates above the national average for these conditions.⁴ According to published literature, there has been a meaningful and significant reduction in readmissions after the introduction of the program.^{5–7} Their report also concluded that while the HRRP was largely successful, there continue to be opportunities to improve hospitals' financial incentives under the program (Khera and Krumholz, 2018).

Another study in US, successfully improved HF care, which has resulted in improved clinical outcomes and substantial cost savings, including \$544K in cost savings, the result of a 18.6 % relative reduction in the HF 30-day readmission rate in one year—with the current readmission rate 13.6 % lower than the national average and a 10.9 % relative reduction in the cost of care for patients with HF and 37.3 % relative reduction in the hospital mortality rate for patients with HF after implementation of Medicare's Hospital Readmissions Reduction Program resembling our results and conclusions (Centers for Medicare and Medicaid Services, 2020).

The strengths of our study and related evidence derived from several key methodological features like the randomized Controlled Design which have reduced selection bias and improved the reliability of the outcomes, the integrated and Multidimensional Outcome Assessment—ranging from 30-day readmission rates and medication adherence to QoL metrics—offers a comprehensive view of the interventions' impact. This multidimensional assessment is essential for a holistic understanding of HF management besides, the inclusion of Real-World Populations: By including patients with significant comorbidities and varying degrees of disease severity, this makes the study findings highly generalizable to everyday clinical practice.

This real-world approach mitigates the common limitation of overly restrictive inclusion criteria seen in many clinical trials.

Despite these strengths, several limitations must be acknowledged like single-Center, the retrospective nature and limited sample sizes. Besides, the short follow-up duration. Future research should aim for extended follow-up periods to assess the sustainability of benefits over the longer term. Also, improvement in quality of life and patient-reported metrics may be subject to bias. Although such outcomes provide valuable insights into patient perceptions, they need to be interpreted in the context of objective clinical endpoints.

Conclusions: Hospital readmissions are a major driver of healthcare costs in HF; therefore, reducing readmission rates through effective interventions not only improves patient outcomes but also offers significant cost savings after the implementation of multidisciplinary rounds. This strategy will decrease the chances of readmission, improves quality of care, clinical outcomes, patient's quality of life, and decreases financial burden on health care system.

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