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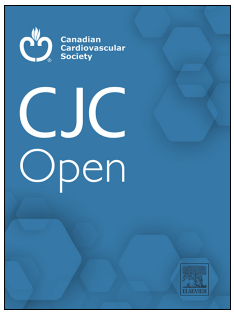


# An innovative patient-centred approach to heart failure management: the Best Care heart failure integrated disease management program

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**Title:** An innovative patient-centred approach to heart failure management: the Best Care heart failure integrated disease management program

**Short Title:** Integrated disease management for heart failure

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## Abstract

**Background:** The management of heart failure (HF) is challenging because of the complexities in recommended therapies. Integrated disease management (IDM) is an effective model, promoting guideline directed care, however, the impact of IDM in the community setting requires further evaluation.

**Methods:** A retrospective evaluation of community-based IDM. Patient characteristics were described, and evaluation of outcomes using a pre- and post-intervention design were HF-related health service use, quality of life, and concordance with guideline-directed medical therapy (GDMT).

**Results:** 715 patients were treated in the program (2016 to 2023), 219 in a community specialist clinic and 496 in 25 primary care clinics. The overall cohort was predominantly male (60%), mean age of 73.5 years (±10.7), and 60% with HF reduced ejection fraction.

In patients with ≥6 months of follow-up (N=267), pre vs post annualized rates of HF-related acute health services decreased from 36.3 to 8.5 hospitalizations/100 patients/year, p<0.0001, 31.8 to 13.1 ED visits/100 patients/year, p<0.0001, and 152.8 to 110.0 urgent physician visits/100 patients/year, p=0.0001. GDMT improved; patients receiving triple therapy and quadruple therapy increased by 10.1% (95%CI;2.4%,17.8%) and 19.6% (95%CI;12.0%,27.3%), respectively. Within these groups optimal dosing was achieved in 42.5% (95%CI;32.0%,53.6%) and 35.0% (95%CI;23.1%,48.4%), respectively. In patients with at least one follow-up (N=286) over 50% experienced a clinically relevant improvement in quality of life.

**Conclusion:** A community-based IDM program for HF, may reduce HF-related acute health service use, improve quality of life and GDMT. These encouraging preliminary outcomes from a real-world program evaluation require confirmation in a randomized controlled trial.

## Introduction

Heart failure (HF) is a chronic progressive syndrome, the second most common reason for admission to hospital for Canadians over 65 years of age and the leading cause of cardiovascular morbidity and mortality.[1-3] In Canada the number of people over the age of 40 living with HF has increased, from 467,940 in 2000 to 798,675 in 2020.[4] The personal and health system ramifications of HF in Canada are substantial. Despite improved therapies over the past decade, high health system utilization and expenditure remains constant.[3]

HF management is complex and resource intensive. Meta-analyses have demonstrated that multi-disciplinary integrated disease management (IDM) programs characterized by self-management strategies, education, guideline-directed medical therapy (GDMT) optimization, and case management reduce all cause and HF-related mortality and hospitalizations rates.[5-9] There is currently very limited access to HF-related IDM in Canada. Thus, implementing integrated clinical pathways for people with HF has been identified as a priority within health systems in Canada.[10] Although most patients with HF are managed in the community by their primary care provider, of the studies identified by systematic reviews, only 5 were conducted in Canada and none in a Canadian primary care HF cohort.[2,5-9] Despite an emerging consensus that enhanced involvement of primary care in HF management is key to managing this growing patient population, there is a lack of evidence to fully support this strategy.[9,11,12]

Pharmacological therapies are a pivotal component of HF management. There are four identified pillars for GDMT for patients with HF, reduced ejection fraction (HFrEF): 1) angiotensin-converting enzyme inhibitor (ACEi)/ angiotensin II receptor blocker (ARB)/ angiotensin receptor-neprilysin inhibitor (ARNI); 2) beta-blockers; 3) mineralocorticoid receptor antagonists (MRA); and 4) sodium glucose cotransporter 2 inhibitors (SGLT2i).[13-17] GDMT is based on results from major landmark clinical trials and the greatest clinical benefits (improved mortality and reduced hospital admissions) are seen when all four pillar drugs are used together and titrated to an optimal dose.[11,13,15,17] However, despite the strong evidence base, a minority of individuals with HFrEF are receiving all four drugs

concurrently and at optimal dosing.[14,18] Approximately half of patients with the signs and symptoms of HF in the community have a preserved ejection fraction (HFpEF).[19] Therapeutic strategies for this population have focused on the treatment of comorbidities and symptom management.[15] However, similar to patients with HFrEF, more recent studies have demonstrated that GDMT including SGLT2i's reduce the risk of cardiovascular death or hospitalization in patients with HFpEF.[20,21] In selected patients with HFpEF the use of a MRA and an ARB may reduce clinical events.[15]

There is limited access to IDM and a lack of evidence that community-based IDM programs are effective. Best Care HF is an IDM program embedded within primary care clinics and a community specialist clinic in Ontario, Canada. The purpose of this study was to evaluate the Best Care HF program, by identifying the population that it serves and investigating changes in HF-related health service use, health-related quality of life (QoL) and pharmacological management.

## Methods

*Study Design and Objectives*

Using a pre-post study design, we conducted a retrospective evaluation of the Best Care program using patients managed in primary care and a community-based specialist clinic in Ontario, Canada between the 31st May 2016 and 28th February 2023. The objectives were to: 1) characterise the community-based population with HF enrolled in the program; 2) investigate change in pre- program and post-program HF-related hospital admissions, emergency department (ED) visits and urgent family physician visits; 3) assess change in QoL; and 4) examine change in GDMT in patients with HFrEF. Veritas Independent Review Board approved the study (Ref. Number 2023-3218-14132-2).

*Inclusion Criteria*

In order to describe the largest possible cohort, all patients enrolled in the Best Care HF program (May 31st 2016 to 28th February 2023) were included. To capture acute health services utilization, patients in the Best Care HF program cohort with a minimum of 6-months of follow-up post-intervention were included in the analysis. A minimum of 6

months was chosen to reduce bias associated with rate estimates for patients with only a few months follow-up data. Patients in the cohort with a minimum of one follow-up appointment post intervention were included in the analysis for QoL. Patients from the cohort with HFrEF and a minimum of 6-months of follow-up post-intervention were included to assess change in GDMT. Reasons for exclusion were investigated and reported.

*Best Care HF*

The goal of Best Care HF is to deliver all elements of evidence-based best practices. The most common configuration of the program has been one that is embedded within a primary care clinic, either within a group practice or alongside a solo practitioner. However, since 2020 the Best Care HF program has also provided support to a community-based specialist run cardiology clinic and data from both primary care and the specialist clinic have been included in this study. Details of the Best Care HF program have been described previously.[22] In brief, Best Care HF utilizes a team-care triad consisting of the patient, cardiac educator-case manager (CEC), and health-care practitioner. The health-care practitioner in this study was the primary care practitioner in primary care or a cardiologist in the specialist clinic.

Patients were identified by practice audit using electronic health record (EHR) searches or were referred to the program by their health-care practitioner. Patients included were those with a clinical diagnosis of HF differentiated as HFpEF or HFrEF by an echocardiogram or another clinically accepted technique to measure left ventricular ejection fraction (LVEF).

Patients referred to the program were comprehensively evaluated, in person, by the CEC during an initial visit of 60 to 90 minutes, on site at their primary care or specialist clinic. Follow-up visits were arranged depending on patients' needs, averaging 3 to 4 appointments per year (30-45 minutes). The CEC assessment included diagnostic confirmation, case management, medication management (review, titration, and optimization), skills training, and self-management education including a diuretic action-

plan. The CEC then consulted with the patient's health-care practitioner in real-time to finalize, approve and implement needed pharmacological and non-pharmacological interventions and to determine if specialty referral was required. Best Care HF is not a time limited intervention but is a continuous chronic disease care program. The Best Care program intervention is standardized by a custom designed electronic health record (EHR) which has embedded program standards, is integrated into clinical work-flow to guide every patient encounter, and collects and stores patient data.

*Data Collection*

Baseline demographic and clinical characteristics were collected at the initial visit for all patients on the program. Data collected were age, sex, racial group, body mass index (BMI), smoking status, age adjusted Charlson Comorbidity Index (CCI), New York Heart Association functional classification (NYHA), prior year acute HF-related health service use (hospital admissions, ED visits and urgent family physician visits), comorbidities, and current HF medications.[23-28] In the earlier years of Best Care HF, the Minnesota Living with HF Questionnaire (MLHFQ), was used to measure QoL but was changed to the Kansas City Cardiomyopathy Questionnaire (KCCQ) in 2018. KCCQ is a validated 23-item disease-specific questionnaire, scored from 0 to 100 where higher scores indicate better health status or QoL.[26] The MLHFQ is a validated 21-item disease specific questionnaire, scored from 0 to 105 where higher scores indicate poorer health status or QoL.[28] For both tools a change of 5 points is considered the minimum clinically important difference (MCID).[26-28] The NYHA and a QoL measurement (MLHFQ/KCCQ) were collected at most patients encounters.

*Outcomes*

We predefined clinically relevant outcomes including acute HF-related health service use, disease specific QoL (KCCQ or MLHFQ) and concordance of pharmacological management with GDMT. Acute HF-related health service use was self-reported, validated by medical record audit and included hospital admissions, ED visits and urgent family physician visits. Urgent family physician visits refer to non-routine appointments required for HF symptoms. Hospital admissions and ED visits were mutually exclusive (if

an ED visit led to a hospital admission it was recorded as a hospital admission only). The change in mean QoL scores over the follow-up interval were compared to the baseline value. GDMT for patients with HFrEF compared the medications at the initial visit to the medications at the most recent appointment. Patients were categorised according to whether target doses were achieved as; optimized to guidelines, optimized to tolerance, actively titrating, and not optimized.

*Statistical Analyses*

Baseline characteristics were presented as continuous variables (mean and ±standard deviation) and categorical variables (frequency and percentage) for the overall study population and classified by primary care IDM and specialist care IDM. Pre-post differences in outcomes were investigated for normalcy in distribution and compared using a paired t-test, a Wilcoxon signed rank test, or McNemar test as appropriate. A p value <0.05 was considered statistically significant with a Holm correction applied to account for multiple testing, 95% confidence intervals (CIs) are reported.[29] Hospital admission, ED visit and urgent family physician visit rates (events per 100 patients per year) were calculated using the number of events in the year prior and compared to the annualised number of events over the follow-up period.

Change in QoL measured by KCCQ or MLHFQ was determined by the baseline score minus the mean of all documented follow-up scores (within patient measurements included only one QoL tool). Patients were grouped (improved, stable, or worsening QoL) by level of change using a 5-point MCID for both tools. Stratification by baseline QoL category quartiles (good, moderate, poor and very poor QoL) was performed to further explore change in QoL. GDMT at baseline was compared to the last follow-up visit. Pharmacological optimization was investigated by comparing target dosing of HF medications at initial visit with target dosing at the most recent visit.

*Sensitivity Analyses*

Asymmetric recruitment, the COVID-19 pandemic, combined with the retrospective real-world design of the evaluation meant that 35-40% of the total cohort were eligible for the

outcome analysis. To ascertain any selection bias that may have been present, we performed two sensitivity analyses. In the first analysis baseline characteristics of patients excluded from the HSU outcome analyses with <6months of follow-up were compared to those included. In the second sensitivity analysis baseline characteristics of patients excluded due to incomplete QoL data were compared to the patients included in the QoL outcome analysis. Patients recently enrolled in the program who simply had not had enough time in the study period to meet the inclusion criteria were not included in these sensitivity analyses as there was no reason to assume there were any systematic differences from the cohort included in the outcome analyses. Additional post hoc sensitivity analyses were performed to investigate if the setting (primary or specialist care) or HF type (HFrEF vs. HFpEF) were dominating the observed results, stratified analyses for acute health service use and QoL were repeated, firstly, by setting, and secondly, by HF type.

Statistical analyses were performed using Stata/MP 17.0 (StataCorp, College Station, TX, USA).

## Results

*Characteristics of the study population*

From May 2016 to February 2023 there were 715 individuals enrolled in the Best Care HF program (Figure 1A). Of these, 219 (30.6%) were enrolled in the community specialist clinic involving 2 cardiologists and 496 (69.4%) were enrolled in 25 primary care clinics involving 141 primary care practitioners. The follow-up period, in patients with more than one appointment, ranged from 3 months to over 6 years (median 7.5 months).

The overall HF population (N=715) were predominantly male, 59.6%, with a mean age of 73.5 years (±10.7), a BMI of 31.6 (±7.8) and a smoking prevalence of 9.0% (Table 1). The mean age-adjusted CCI was 5.4 (±1.9) and 81% had more than two comorbidities. There were a greater number of patients with HFrEF (60.0%) than HFpEF (38.3%) and over 80% were categorised as NYHA II or III. There were 263 hospital admissions (36.8/100

patients/year), 214 ED visits (29.9/100 patients/year), and 924 urgent family physician visits (129.2/100 patients/year) related to HF in the year prior to the initial visit.

Comparing baseline patient characteristics in the specialist clinic to primary care clinics, patients were on average younger (71.6 (±11.9) vs. 74.3 (±10.0) years), had a numerically worse QoL score (KCCQ 63.0 (±25.8) vs. 70.0 (±22.9) and there were a higher proportion of patients with HFrEF (87.2% vs. 48.0%). The specialist clinic cohort had a similar proportion of hospitalizations (29.7% vs. 27.6%) and ED visits (19.2% vs. 22.6%) but a higher number of urgent family physician visits in the year prior (58.4% vs. 39.3%). Primary and specialist care clinics were managing patients with equal comorbidities (mean CCI: 5.4(±2.1) vs. 5.3(±1.7)). Overall, concordance with GDMT for HFrEF was higher in the specialist clinic group (beta-blocker (92.7% vs. 67.9%), MRA (53.9% vs. 27.4%), and SGLT2i (40.2% vs.16.1%). ARNI use was higher in the HFrEF specialist clinic patients (61.8% vs. 28.6%) and by corollary the ACEi/ARB use (27.4% vs. 47.0%) was lower (Table 1).

*Acute HF Related Health Service Use*

There were 267 (37.3%) individuals meeting the inclusion criteria of at least 6 months of follow-up included in these analyses (Figure 1B). In the year prior to enrolling in the Best Care program, there were 97 hospital admissions (36.3/100 patients/year), 85 ED visits (31.8/100 patients/year), and 408 urgent family physician visits (152.8/100 patients/year) (Figure 2). Annualised event rates post Best Care enrollment were significantly lower; 23 hospital admissions (8.5/100 patients/year, $p<0.0001$), 35 ED visits (13.1/100 patients/year, $p<0.0001$) and 293 urgent family physician visits (110.0/100 patients/year, $p=0.0001$). Stratified analyses confirmed consistent findings within all subgroups including specialist and primary care, HFrEF and HFpEF (Supplemental Figures S1 to S8).

*Health Related QoL*

There were 286 (40.0%) individuals meeting the inclusion criteria, having a QoL score at the initial visit and at least one follow-up score (Figure 1C). Mean change from baseline

for KCCQ and for MLHFQ showed improvement surpassing the MCID of 5 points, KCCQ 8.6 points (CI;5.32,11.96) and MLHFQ -7.3 points (CI;-9.70,-4.85). Baseline categorization of QoL scores demonstrated that 45% of individuals had a good QoL score, 34% had a moderate baseline QoL and nearly 20% had a poor or very poor QoL score. Change in QoL was the greatest for patients with poor or very poor baseline QoL scores, with a clinically relevant improvement in 75% and 88% of patients respectively (Figure 3). Stratified analyses confirmed consistent findings within all subgroups including specialist and primary care, HFrEF and HFpEF (Supplemental Figures S1 to S8).

*Pharmacological Management by Pillar Category*

Pharmacological management outcomes were analysed for 168 (23.5%) patients meeting the inclusion criteria of HFrEF and at least 6 months of follow-up (Figure 1D). The proportion of patients on an ARNI increased by 15.4% (CI;8.3%,22.7%), MRA 11.3% (CI;3.8%,18.8%), SGLT2i 19.0% (CI;11.7%,26.4%), triple therapy by 10.1% (CI;2.4%, 17.8%) and quadruple therapy by 19.6% (CI;12.0%,27.3%) (Table 2). The proportion of patients on an ACEi /ARB decreased -15.4% (CI;-22.9%,-8.1%) indicating a within class switch from ACEi/ARB to ARNI). There was no significant change in the proportion on beta-blockers.

*Pharmacological Optimization Within Each Pillar*

Pharmacological optimization increased for all four pillar HF drugs for individuals with HFrEF (Figure 4). The percentage of patients on ARNIs taking the optimal dosage (guideline target or to dose tolerance) increased from 29.2% (CI;18.6%,41.8%) at baseline to 64.8% (CI;54.1%,74.6%) at the most recent visit, beta-blocker optimization from 28.8% (CI;21.5%,36.8%) to 54.4% (CI;46.0%,62.5%), MRA from 39.0% (CI;28.4%,50.4%) to 58.4% (CI;48.2%,68.1%), SGLT2i from 45.2% (CI;29.8%,61.3%) to 81.1% (CI;70.3%,89.3%), triple therapy from 10.0% (CI;4.1%,19.5%) to 42.5% (CI;32.0%,53.6%), and quadruple therapy none optimized at baseline to 35.0% (CI;23.1%,48.4%).

*Sensitivity Analyses*

**Less than 6 Months of Follow-up:** There were 153 (21.4%) patients excluded from the acute HSU outcome analyses due to insufficient follow-up that was not related to recent program enrollment (67 mortality, 44 stopped participating in the program, 21 discharged from the specialist clinic, 8 left their primary care practice, 8 admitted to a long-term care facility, and 5 were followed up in the Best Care COPD program) (Figure 1). This excluded group had a higher female predominance (51.6% vs. 38.6%), a higher proportion of HFpEF (50.3% vs 36.6%) and higher rates (events/100patients/year) of hospital admissions and ED visits (46.4 vs 36.3 and 40.5 vs 31.8, respectively) when compared to the 267 patients included in the outcome analysis (Supplemental Table S1).

**Missing QoL data:** There were 232 (32.4%) patients who had missing QoL scores at baseline and/or over their follow-up period. There were no notable differences observed between individuals with missing QoL scores and the 287 patients included in the outcome analysis (Supplemental Table S2). The 197 patients who did not have missing data but only had an initial visit were not included in this sensitivity analyses (Figure 1 for a full breakdown of exclusions).

## Discussion

We identified and characterized more than 700 patients with HF in a Canadian community practice setting including nearly 500 from primary care practices. The primary care population was an elderly comorbid cohort, with a moderately reduced QoL, exercise limiting dyspnea, almost equal proportions of HFrEF and HFpEF, and high rates of hospitalization in the prior year. Although the community specialist population had a poorer baseline QoL and a higher proportion of HFrEF, the populations were remarkably similar. Both community clinical settings were managing complex co-morbid patient populations with a high mean CCI that was similar in both groups. Annualised rates of hospitalizations, ED visits, and unscheduled urgent family physician visits for heart failure were significantly reduced following Best Care HF implementation. Similarly, there were marked improvements in QoL. In patients with HFrEF there was increased concordance with GDMT. Stratified subset analyses confirmed consistent findings in all of the main outcomes within all subgroups including specialist and primary care, HFrEF and HFpEF.

The spoke-hub-node model describes a system of HF care with vertical integration from primary care to quaternary care with provider roles that are defined based on services provided according to their patients' medical complexity.[12] In the spoke, patients of lower complexity can be effectively managed without involvement of a multidisciplinary team. The node manages the most complex patients with a multidisciplinary HF team. The hub manages patients of moderate complexity such as those included in this study. The findings of this study suggest that the Best Care program can support a primary care or a community specialist clinic to effectively function as a hub to manage moderately complex patients with HF.[12]

IDM is an accepted standard of care in the management of HF. In a recent systematic review, Takeda and colleagues, evaluated IDM implemented after a patient hospitalization.[7] They included 47 RCTs with 10,869 participants and found moderate quality evidence that case management and multidisciplinary interventions reduce heart failure readmissions (RR 0.64, 95% CI 0.53 to 0.78 or 36% risk reduction and RR 0.68, 95% CI 0.50 to 0.92 or 32% risk reduction, respectively).These interventions included key elements that are also central to the Best Care program; they used case managers to actively manage care and featured coordinated healthcare interventions, such as self-management strategies.[7] Acknowledging the different methodologies, in this study we demonstrated a 76% relative risk reduction in hospitalization events. It is notable that most IDM programs evaluated to date are reactive, targeting patients discharged from hospital. This study adds to the literature by examining an "upstream" approach, whereby patients with HF were proactively identified and managed in an outpatient community setting. Also similar to our study, and using pre-post data, Liljeroos and colleagues, found that nurse-led primary care HF clinics in Sweden, reduced ED visits and the need for inpatient care by 24% and 27% respectively.[30] Likewise, in an RCT, Agvall and colleagues found that a HF disease management program involving family physicians and HF nurses in primary care significantly reduced ED visits and hospital admissions as compared to the usual care group.[31]

GDMT is uniformly recommended in HF guidelines, but despite this universal recommendation patients with HF remain undertreated.[14,32,33] In this study we use GDMT as an indicator of the therapeutic care gap in HFrEF and as a marker of change in guideline concordance post-intervention. Guideline directed triple therapy for HFrEF was recommended in Canada in 2017 and quadruple therapy in 2021.[1,7] Less than 45% of our HF patients were receiving triple GDMT and of those patients, 10% were optimized to guidelines or to tolerance at baseline. A minority (16.1%) were on quadruple GDMT therapy at baseline, and none were optimized to target or to tolerance. The care gap identified in our population has been observed in other studies.[32-34] This finding further emphasizes the importance of identifying management strategies that can effectively optimize GDMT.

The Best Care CECs support medication up titration as a program standard, adopting coordinated titration strategies encouraging well-timed optimization.[35] This study reports marked improvements in GDMT to target or tolerance after the Best Care intervention. Related to the real-world retrospective study design, a high proportion of patients were still having their medications actively titrated at the time of data analysis. In a Canadian hospital based multi-disciplinary HF clinic study, the proportion of patients receiving HFrEF pharmacological therapies after 6 months of enrollment were, 52% ARNI, 97% Beta-blockers, and 85% MRA.[36] In our study cohort the proportions were 54%, 89% and 60%, respectively. In the same study population medication optimization (to target or tolerance) was reported within these drug groups at 63% for ARNIs, 68% for beta-blockers and 59% for MRAs, comparatively in our study a respective 65%, 54% and 58% were optimized.[34] When looking at pharmacological combination therapy these authors report 77% receiving triple therapy with 33% medically optimized, we found 52% on triple therapy and 43% of these were medically optimized.[34,36] The substantial improvements reported in the Best Care community program align with the magnitude of improvement in GDMT observed in a multidisciplinary hospital-based HF clinic. This is noteworthy in that it reinforces the important role that primary care and community-based specialist clinics, with the support of the Best Care intervention, can play in narrowing the system-wide gap in achieving GDMT.

This is a retrospective observational study with a pre-intervention, post-intervention design. Without a randomized comparator arm we are unable to attribute a causal relationship between the Best Care program and the reported outcomes. We cannot exclude that regression to the mean bias impacted our results, however we identified patients in a non-acute outpatient setting, to some extent mitigating this factor. We performed the pre-post analysis on patients with available data (QoL, N=286) and who had at least 6 months of follow-up (HSU N=267 and pharmacological management N=168). Therefore, to investigate potential selection bias we assessed baseline characteristics of patients with missing QoL data and those patients not completing at least 6 months of follow up and minimal differences between groups were mostly observed. The excluded population had some features of increased severity in that mortality was the predominant reason for exclusion and this group had a higher baseline rate of acute HSU (hospital admissions and ED visits). Thus, if included this group may have moderated the measured impact. Further, we cannot exclude that other interventions have impacted our results, but we are not aware of other interventions available to our cohort outside of usual care. To confirm that our results were not dominated by the outcomes of Best Care HF embedded in the specialist clinic, we stratified the analyses separating the community specialist and primary care practices and found consistent pre/post improvements in both strata. This finding supports an equal impact regardless of practitioner type (primary care versus specialist). We included patients that were enrolled in the program during the COVID-19 pandemic and cannot exclude that the pandemic impacted the outcomes. Despite the identified limitations, our study provides an important empirical evaluation in favour of Best Care HF; evidence that is otherwise absent in relation to the Canadian health care system. Areas for future research include a cluster randomized controlled trial currently underway to establish if a causal relationship between IDM and improved outcomes does indeed exist.[22]

## Conclusion

This study describes a pre-post evaluation of the Best Care IDM program used in community-based primary and specialist care to manage patients with HF. In this

preliminary investigation of the Best Care HF program we observed reductions in hospitalizations, ED visits and urgent physician visits, with improvements in QoL and GDMT. These findings support the implementation of IDM in primary and specialist care settings.

## Ethics Statement

The research reported has adhered to the relevant ethical guidelines.

## Patient Consent Statement

The authors confirm that patient consent is not applicable to this article. This is a retrospective study using de-identified data; therefore, the IRB did not require consent from the patient.

## Disclosures

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**Table 1** Baseline demographic and clinical characteristics of all patients at time of entry into Heart Failure integrated disease management.

**Baseline Demographic and Clinical Characteristics**

| | | Complete Cohort N=715 | Specialist Clinic N=219 | Primary Care Clinic N=496 |
|---|---|---|---|---|
| **Sex** | Male | 426 (59.6%) | 143 (65.3%) | 283 (57.1%) |
| | Female | 289 (40.4%) | 76 (34.7%) | 213 (42.9%) |
| **Age (years)** | *Mean (SD)* | 73.5 (10.7) | 71.6 (11.9) | 74.3 (10.0) |
| **Body mass index (kg/m$^2$)** | *Mean (SD)* | 31.5 (7.7) | 30.9 (7.5) | 31.8 (7.8) |
| **Racial Group** | Caucasian | 695 (97.2%) | 209 (95.4%) | 486 (97.9%) |
| **Smoking Status** | Current smoker | 64 (9.0%) | 19 (8.7%) | 45 (9.1%) |
| **Quality of Life** | **KCCQ (score 0-100)**[1] *Mean (SD)* | 66.6 (24.6) | 63.0 (25.8) | 70.0 (22.9) |
| | **MLHFQ (score 0-105)**[2] *Mean (SD)* | 29.1 (20.2) | *NR*[5] | 28.8 (19.9) |
| | *Missing* | *84 (11.7%)* | *15 (6.8%)* | *72 (14.6%)* |
| **Comorbidities** | 0 | 10 (1.4%) | 2 (0.9%) | 8 (1.6%) |
| | 1-2 | 125 (17.5%) | 28 (12.8%) | 97 (19.6%) |
| | >2 | 580 (81.1%) | 189 (86.3%) | 391 (78.8%) |
| **Charlson Comorbidity Index**[3] | *Mean (SD)* | 5.4 (1.9) | 5.4 (2.1) | 5.3 (1.7) |
| | ≥5 | 328 (69.5%) | 151 (69.6%) | 177 (69.4%) |
| **Seen by Specialist** | Cardiologist | 454 (63.5%) | 219 (100%) | 235 (47.4%) |
| | Internal Medicine | 124 (17.3%) | 24 (11.0%) | 100 (20.2%) |
| | None | 185 (25.9%) | - | 185 (37.2%) |
| **HFrEF** | LVEF ≤45% | 429 (60.0%) | 191 (87.2%) | 238 (48.0%) |
| **HFpEF** | LVEF >45% | 274 (38.3%) | 28 (12.8%) | 246 (49.6%) |
| | *Missing* | *12 (2.0%)* | - | *12 (2.4%)* |
| **Echocardiogram year prior** | | 616 (86.2%) | 211 (96.4%) | 405 (81.7%) |
| **NYHA** | I | 119 (16.6%) | 47 (21.5%) | 72 (14.5%) |
| | II | 356 (49.8%) | 98 (44.8%) | 258 (52.0%) |

| | | | | |
|---|---|---|---|---|
| | III | 221 (30.9%) | 70 (32.0%) | 151 (30.4%) |
| | IV | 19 (2.7%) | 4 (1.8%) | 15 (3.0%) |
| **Heart failure related health service use (year prior)** | | | | |
| **Hospital admissions** | Number of events | 263 | 88 | 175 |
| | Number of individuals | 202 (28.3%) | 65 (29.7%) | 137 (27.6%) |
| | Rate of events/100 patients/year | 36.8 | 40.2 | 35.2 |
| **Emergency department visits** (not leading to admission) | Number of events | 214 | 63 | 151 |
| | Number of individuals | 154 (21.5%) | 42 (19.2%) | 112 (22.6%) |
| | Rate of events/100 patients/year | 29.9 | 28.8 | 30.4 |
| **Urgent family physician visits** | Number of events | 924 | 219 | 705 |
| | Number of individuals | 323 (45.2%) | 128 (58.4%) | 195 (39.3%) |
| | Rate of events/100 patients/year | 129.2 | 100.0 | 142.1 |
| **Medications** | ARNI (HFrEF only)[4] | 186 (43.4%) | 118 (61.8%) | 68 (28.6%) |
| | ACEi/ARB | 293 (41.0%) | 60 (27.4%) | 233 (47.0%) |
| | Beta-blocker | 540 (75.5%) | 203 (92.7%) | 337 (67.9%) |
| | MRA | 254 (35.5%) | 118 (53.9%) | 136 (27.4%) |
| | SGLT2i | 168 (23.5%) | 88 (40.2%) | 80 (16.1%) |
| | Diuretic | 496 (69.4%) | 149 (68.0%) | 347 (70.0%) |

**Notes:**
[1]KCCQ-23, scored 0-100 where 100 represents best quality of life. N=423, N=202 (specialist clinic), N=221 (primary care)
[2]MLHFQ, scored 0-105 where 105 represents the worst quality of life. N=208, N=206 (primary care)
[3]Charlson Co-morbidity Index self-reported since Sept 2020, N=472, N=217 (specialist clinic), N=255 (primary care) (Age adjusted index reported)
[4]Only HFrEF N=429, N=191(specialist clinic), N=238 (primary care)
[5]not reported as sample size too small.
**Abbreviations:** ACEi *angiotensin-converting enzyme inhibitor,* ARB *angiotensin receptor blockers,* ARNI *angiotensin receptor/neprilysin inhibitor,* HFrEF *heart failure with reduced ejection fraction,* HFpHF *heart failure with preserved ejection fraction,* KCCQ *Kansas City Cardiomyopathy Questionnaire,* LVEF *left ventricular ejection fraction,* MLHFQ *Minnesota Living with Heart Failure Questionnaire,* MRA *mineralocorticoid receptor antagonist,* SD *standard deviation,* SGLT2i *sodium-glucose cotransporter-2 inhibitor,* NYHA *New York Heart Association*

**Table 2** Pharmacological management of individuals with reduced ejection fraction heart failure at baseline versus their most recent follow-up.

| | **HFrEF** | | |
|---|---|---|---|
| | Initial Visit N=168 | Most Recent N=168 | % difference (95%CI)[1] |
| ARNI | 65 (38.7%) | 91 (53.9%) | **15.4% (8.3%,22.7%) p<0.0001** |
| ACEi/ARB | 66 (39.3%) | 40 (23.8%) | **-15.4% (-22.9%,-8.1%) p<0.0001** |
| ACEi/ARB/ARNI | 131 (78.0%) | 131 (78.0%) | 0% |
| Beta-blocker | 146 (87.0%) | 149 (88.7%) | 1.8% (-3.0%,6.6%) p=0.5811 |
| MRA | 82 (48.8%) | 101 (60.1%) | **11.3% (3.8%,18.8%) p=0.0026** |
| SGLT2i | 42 (25.0%) | 74 (44.1%) | **19.0% (11.7%,26.4%) p<0.0001** |
| Triple therapy[2] | 70 (41.7%) | 87 (51.8%) | **10.1% (2.4%, 17.8%)** p=0.0095 |
| Quadruple Therapy[3] | 27 (16.1%) | 60 (35.7%) | **19.6% (12.0%,27.3%) p<0.0001** |

**Notes:**
**This table shows the number and proportion of patients on key guideline-directed pharmacological therapies for HFrEF, the data in Figure 4 builds from these proportions. For example, 16% of patients are on quadruple therapy at initial visit (Table 2) and of those 0% are at target dose (Figure 4)**
[1]McNemars Chi Squared test used to compare pre-post differences for patients diagnosed with Here at initial visit N=168. P value refers to the exact McNemars significance probability.
[2] Triple Therapy included to reflect changing guidelines over the follow-up period. Patients on an ARNI, beta-blocker, and MRA, (ACEi/ARB instead of an ARNI also considered triple therapy)
[3]Patients on an ARNI, beta-blocker, MRA, and SGLT2i (ACEi/ARB instead of an ARNI also considered quadruple therapy)
Missing data for 2 individuals.
Only individuals with at least 6 months of follow-up were included.
Significance level 0.05, p values adjusted for multiple testing using the Holm correction, bold indicates significance.
**Abbreviations:** ACEi *angiotensin-converting enzyme inhibitor,* ARB *angiotensin receptor blockers,* ARNI *angiotensin receptor/neprilysin inhibitor,* HFrEF *heart failure with reduced ejection fraction,* HFpEF *heart failure with preserved ejection fraction,* MRA *mineralocorticoid receptor antagonist,* SGLT2i *sodium-glucose cotransporter-2 inhibitor*

**Figure 1** Flow diagram of the study showing the analyses groups.

**Figure 2** Acute health service use for heart failure, comparing the year prior to Best Care with the annualized year post Best Care.

**Figure 3** Change in health-related quality of life (QoL), stratified by baseline score, in the 286 individuals with documented QoL scores at initial and at least one follow-up visit.
**Abbreviations:** CI *confidence interval,* KCCQ *Kansas City Cardiomyopathy Questionnaire,* MLHFQ *Minnesota Living with Heart Failure Questionnaire,* QOL *quality of life,* SD *standard deviation*

**Figure 4** Optimization of the pharmacological management of individuals with reduced ejection fraction heart failure at baseline versus their most recent follow-up. **Note:** The numerator is the number of patients on the drug who are optimized to target or tolerance, the denominator is the number of people on the drug. **Abbreviations:** ARNI angiotensin receptor/neprilysin inhibitor, CI confidence interval, MRA mineralocorticoid receptor antagonist, SGLT2i sodium-glucose cotransporter-2 inhibitor

A.

**715** patients enrolled on the Best Care Heart Failure program May 31st 2016 to 28th February 2023

**1** community-based specialist clinic
**2** cardiologists
**219 (31%)** patients with heart failure

**25** primary care clinics
**141** primary care practitioners
**496 (69%)** patients with heart failure

**Excluded:**
**448 (63%)** with <6 months of follow-up

**Breakdown: 295** recent enrollment; **67** mortality; **44** stopped participating; **21** discharged from specialist clinic; **8** admitted to long-term care facility; **8** moved from the area; **5** followed-up in Best Care COPD program

**Excluded:**
**232 (32%)** with missing QoL data
**197 (28%)** with an initial visit only

**Breakdown of patients with an initial visit only: 143** recent enrollment; **25** mortality; **12** stopped participating; **9** discharged from specialist clinic; **4** admitted to long-term care facility; **2** moved from the area; **2** followed-up in Best Care COPD program

**B. Pre-post analysis:**
**Acute health service utilisation**

A total of **267 (37%)** with ≥6 months of follow-up (**107** community-based specialist clinic and **160** primary care)

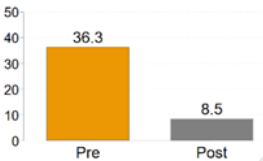
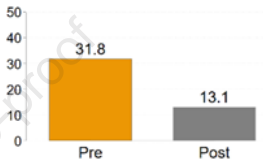
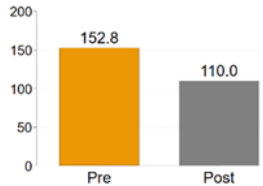
**C. Pre-post analysis:**
**Health-related quality of life**

A total of **286 (40%)** with at least one follow-up appointment (**92** community-based specialist clinic and **194** primary care)

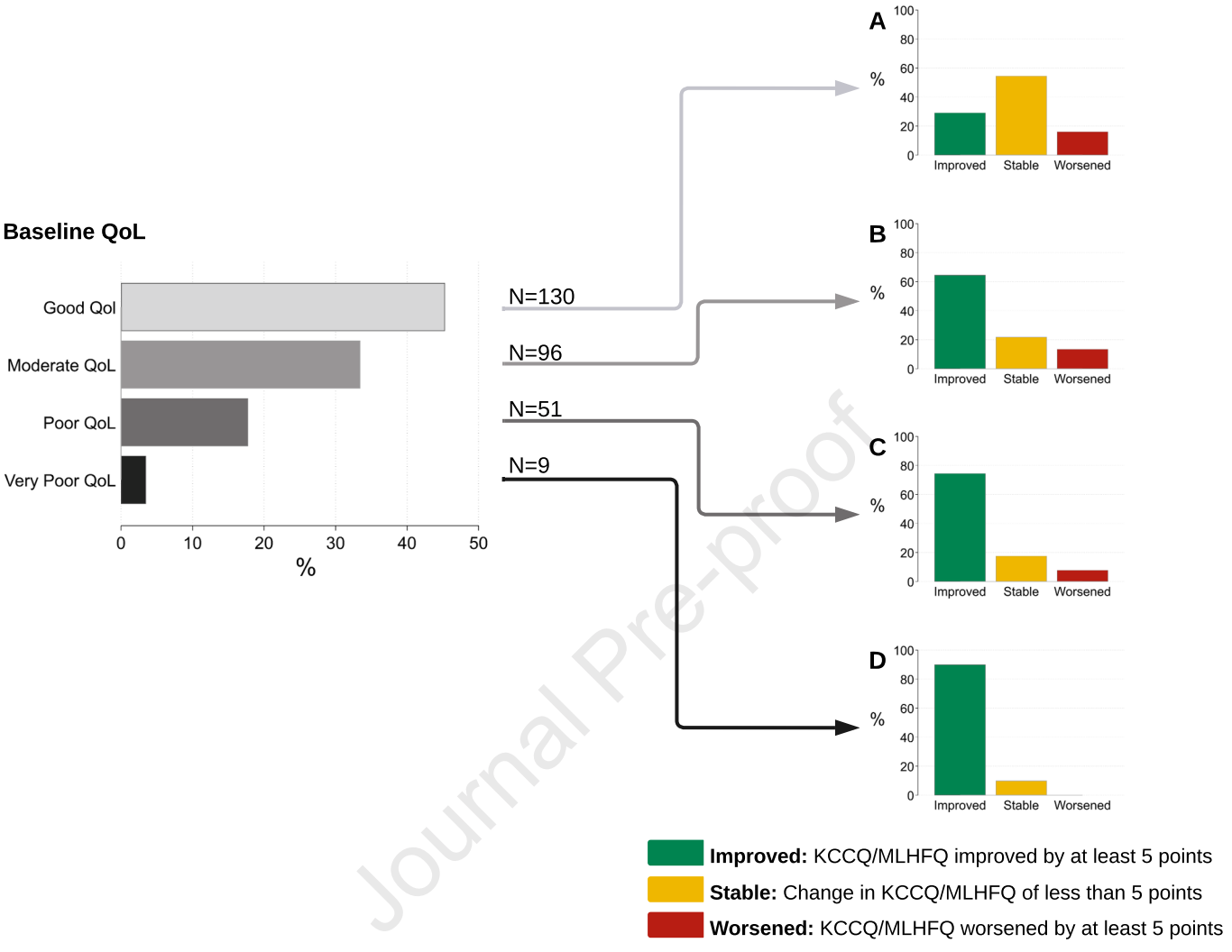
**Excluded:**
**97 (14%)** with preserved ejection fraction heart failure
**2 (<1%)** not classified

**D. Pre-post analysis:**
**Guideline directed medical therapy**

**168 (23%)** with reduced ejection fraction heart failure **(94** community-based specialist clinic and **74** primary care)

| **267** individuals with at least 6 months of follow-up | | **Heart Failure Related:** | | |
|---|---|---|---|---|
| | | **Hospital Admissions** | **Emergency Department Visits[1]** | **Urgent Family Physician Visits** |
| Rate of events per 100 individuals with heart failure per year | |  |  |  |
| *Wilcoxon signed-rank test* | | ***p<0.0001*** | ***p<0.0001*** | ***p=0.0001*** |
| **PRE** | Number of events | 97 | 85 | 408 |
| **POST** | Number of events | 23 | 35 | 293 |
| Relative Reduction | | 76% | 59% | 28% |

**Notes**:
**PRE**: year prior to commencing integrated disease management
**POST:** year after IDM enrolment. Number of events is calculated from the rate ((rate*number of patients)/100), Rate is annualised ((events/ months of follow-up) *12*100)
[1]Visits to the emergency department that did not result in a hospital admission.
Significance level 0.05, p values adjusted for multiple testing using the Holm correction, bold indicates significance




**E**

| | Baseline mean(SD) | Follow-up mean (SD) | Mean change | p value |
|---|---|---|---|---|
| **KCCQ N=138** | 64.3 (23.8) | 73.0 (22.9) | 8.6 (95% CI 5.32, 11.96) | **<0.0001** |
| **MLFQ N=148** | 29.1 (20.2) | 21.9 (16.3) | -7.3 (95% CI -9.70, -4.85) | **<0.0001** |

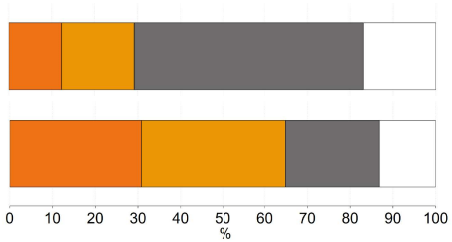
**Notes:**

**Baseline QoL score** categorized by quartile of questionnaire scoring range: Kansas City Cardiomyopathy Questionnaire [Good 75-100, Moderate 50-74, Poor 25-49, Very poor <25] and Minnesota Living with Heart Failure Questionnaire [Good <26, Moderate 26-52, Poor 53-79, Very poor 80-105]

**Change in QoL** is the proportion of individuals who experienced a clinically relevant change over the follow-up period. Results are stratified by QoL at baseline: **A** good , **B** moderate , **C** poor and **D** very poor. A change of 5 points or more was considered clinically relevant. A mean of all follow-up values was taken and subtracted from the baseline score.

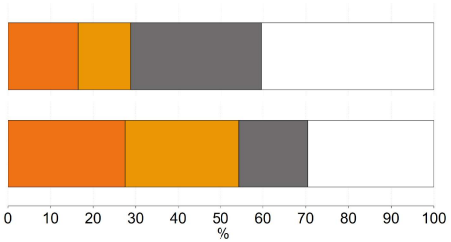
Data table **E** gives the mean change in QoL from baseline and a paired difference test of repeated measures (Wilcoxon signed-rank test). Significance level 0.05, p values adjusted for multiple testing using the Holm correction, bold indicates significance.

## ARNI



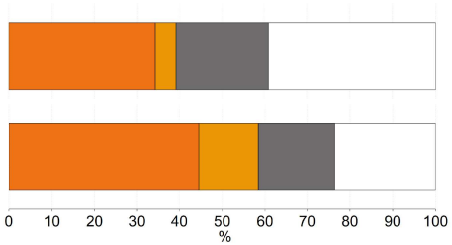

| | Number of patients on drug | Proportion optimized (95% CI) |
|---|---|---|
| Baseline | 19/65 | **29.2%** (18.6% to 41.8%) |
| Most Recent Follow-up | 59/91 | **64.8%** (54.1% to 74.6%) |

## Beta-blocker



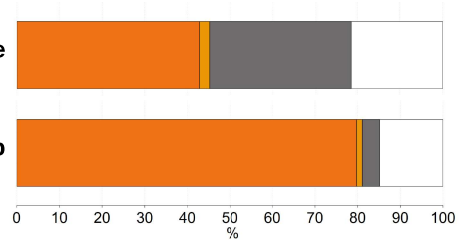

| | Number of patients on drug | Proportion optimized (95% CI) |
|---|---|---|
| Baseline | 42/146 | **28.8%** (21.5% to 36.8%) |
| Most Recent Follow-up | 81/149 | **54.4%** (46.0% to 62.5%) |

## MRA



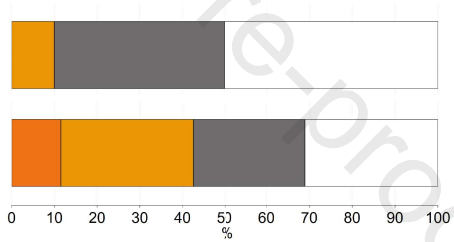

| | Number of patients on drug | Proportion optimized (95 ) |
|---|---|---|
| Baseline | 32/82 | **39.0%** (28.4% to 50.4 |
| Most Recent Follow-up | 59/101 | **58.4%** (48.2% to 68.1 |

## SGLT2i



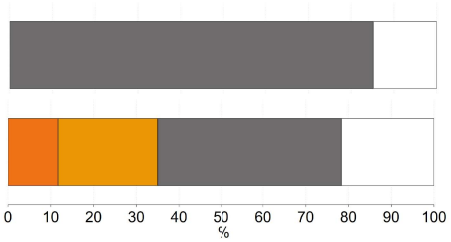

| | Number of patients on drug | Proportion optimized (95% CI) |
|---|---|---|
| Baseline | 19/42 | **45.2%** (29.8% to 61.3%) |
| Most Recent Follow-up | 61/74 | **81.1%** (70.3% to 89.3%) |

## Triple Therapy[1]




| | Number of patients on drug | Proportion optimized (95% CI) |
|---|---|---|
| Baseline | 7/70 | **10.0%** (4.1% to 19.5%) |
| Most Recent Follow-up | 37/87 | **42.5%** (32.0% to 53.6%) |

## Quadruple Therapy[2]




| | Number of patients on drug | Proportion optimized (95 ) |
|---|---|---|
| Baseline | 0/27 | 0 |
| Most Recent Follow-up | 21/60 | **35.0%** (23.1% to 48.4 |

Optimized to guidelines

Optimized to tolerance

Actively titrating



Journal Pre-proof