Title
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Journal
Circulation Cardiovascular Quality and Outcomes, 11(4)

ISSN
1941-7713

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Publication Date
2018-04-01

DOI
10.1161/circoutcomes.118.004668

Peer reviewed

HHS Public Access

Author manuscript

Circ Cardiovasc Qual Outcomes. Author manuscript; available in PMC 2019 April 01.

Published in final edited form as:

Circ Cardiovasc Qual Outcomes. 2018 April ; 11(4): e004668. doi:10.1161/CIRCOUTCOMES.118.004668.

Health Status Variation Across Practices in Outpatients with Heart Failure: Insights from the CHAMP-HF Registry

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Abstract

Background—While a key treatment goal for patients with heart failure and reduced ejection fraction (HFrEF) is to optimize their health status (their symptoms, function, and quality of life), the variability across outpatient practices in achieving this goal is unknown.

Methods and Results—In the CHAMP-HF registry, associations between baseline practice characteristics and Kansas City Cardiomyopathy Questionnaire overall summary (KCCQ-OS) and Symptom Frequency (KCCQ-SF) scores were assessed in 3,494 patients across 140 US practices using hierarchical regression after accounting for 23 patient and 11 treatment characteristics. We then calculated an adjusted median odds ratio (aMOR) to quantify the average difference in likelihood that a patient would have excellent (KCCQ-OS ≥75) health status *or* minimal (monthly or fewer) symptoms (KCCQ-SF≥75) when treated at one practice versus another, at random. The mean (±SD) KCCQ-OS and KCCQ-SF were 64.2±24 and 68.9±25.6, with 40% (n=1,380) and 50% (n= 1,760) having KCCQ scores ≥ 75, respectively. The aMOR across practices, for KCCQ-OS ≥ 75, was 1.70 (95% CI 1.54, 1.99; $p < 0.001$) indicating a median 70% higher odds of a

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patient having good to excellent health status when treated at one random practice versus another. In regard to KCCQ-SF, the aMOR for KCCQ-SF ≥75 was 1.54 (95% CI 1.41, 1.76; p = 0.001).

Conclusions—In a large, contemporary registry of outpatients with chronic HFrEF, we observed significant practice-level variability in patients' health status. Quantifying patients' health status as a measure of quality should be explored as a foundation for improving care.

Clinical Trial Registration—URL: https://www.centerwatch.com; Unique Identifier: TX144901

Journal Subject Terms

Heart Failure; Quality of Life; Patient Reported Outcome Measures; Site Variability

Introduction

A key goal of heart failure (HF) management is to optimize patients' health status[1] – their symptoms, function, and quality of life.[2–4] While prior studies have used HF-related morbidity and mortality to describe variations between healthcare systems (i.e. resource utilization[5, 6] and patient volume[7]) and providers[8, 9], to date there have been no studies describing health status differences across outpatient practices. Identifying practice-level differences in the successful management of patients' health status could provide novel insights into the current state of HF management across the United States and identify potential opportunities to improve care and patient-centered outcomes.

To address this gap in knowledge, we compared the health status of HF patients with reduced ejection fraction (HFrEF) across a heterogeneous sample of outpatient practice sites in the Change the Management of Patients with Heart Failure (CHAMP-HF) registry.[10] CHAMP-HF is a multicenter, prospective registry of outpatients with HFrEF that captures patients' health status using the short form of the disease-specific Kansas City Cardiomyopathy Questionnaire (KCCQ-12).[11] Importantly, as payers and other stakeholders begin to explore the use of patient-reported outcomes (PRO) measures to measure providers' care quality,[12] it is essential to define the extent of health status variability and identify opportunities to improve clinical outcomes for patients with HFrEF, if such performance measures are to have the potential to improve care.

Methods

Study Design

The data, methods used in the analysis, and materials used to conduct the research will not be made available to any researcher for purposes of reproducing the results or replicating the procedure. For this analysis, we used data from the CHAMP-HF registry: a prospective, observational study of outpatients with HFrEF at 149 US practice sites that has been previously described.[10] Patients eligible for enrollment met the following criteria: (1) age ≥ 18 years, (2) primary diagnosis of HFrEF (LVEF ≤ 40% within twelve months of enrollment), (3) prescribed oral pharmacotherapy for HF at the time of enrollment, and (4) willingness to complete protocol requirements for study visits, procedures, and

questionnaires. Patients were excluded if participating in any interventional clinical research study, receiving comfort care measures only or enrolled in a hospice program, had a life expectancy of less than one year, and had a history of, or planned, heart transplant, left ventricular assist device implantation, or dialysis. Data collected on enrollment included patient-level demographics and clinical characteristics, medical history, laboratory results, use of HF medications and devices, and patient-reported health status. Eligible sites were identified based upon the completion of a feasibility survey, which provided investigators with the opportunity to ensure broad geographic and provider specialty representation. Study coordinators at each site were responsible for identification and enrollment of subjects during the course of a scheduled outpatient visit, with this analysis being limited to only those patients enrolled between December 2015 and March 2017. CHAMP-HF was sponsored by Novartis Pharmaceuticals Corporation, and all participating sites obtained local or central institutional review board approval prior to patient enrollment as well as informed consent from each participant.

Data Collection

Site coordinators interviewed patients to collect their sociodemographic characteristics and health status while abstracting information from the medical record regarding medical history and medications at enrollment. Data collected from site feasibility surveys included practice specialty, annual patient volume, and availability of the following ancillary HF services: access to cardiac rehabilitation, dedicated HF clinic, multidisciplinary clinic, routine collection of patient reported outcomes (PROs), and telemonitoring resources. The primary outcome for this cross-sectional analysis was the 12-item Kansas City Cardiomyopathy Questionnaire Short Form (KCCQ-12) on enrollment – a reliable, sensitive, heart failure-specific PRO that measures patients' HF symptoms, physical and social limitations, and quality of life – that was completed by patients at each site through an electronic tablet.[11] The KCCQ-12 overall summary score and symptom frequency domain score were the primary outcomes for this study, to capture a summary of all clinically relevant HF domains (KCCQ-OS; the average of all 4 subscales) and symptoms alone (KCCQ-SF; the domain most likely to be optimized due to changes in diuretic and other cardiovascular therapies). Scores range from 0 to 100, where higher scores reflected better health status (fewer symptoms, fewer social or physical limitations, and better quality of life). A 5-point difference in KCCQ scores is considered to be clinically meaningful from both patients' and providers' perspectives.[13, 14]

Statistical Analysis

The enrollment characteristics of the CHAMP-HF cohort were assessed with descriptive statistics, using proportions for categorical variables and means with standard deviations or medians with quartiles for continuous variables. Differences in patient and site-level characteristics across health status categories (poor (<25), fair (25–49), good (50–74), and excellent (≥75)) were assessed, with chi-square tests for categorical variables and Kruskall-Wallis tests for continuous variables. To improve clinical interpretability for both the KCCQ-OS and KCCQ-SF scores, we categorized the scores. For the KCCQ-OS, patients were categorized as having very poor to good (<75) and excellent (≥75) health status. For the

KCCQ-SF, scores were dichotomized into daily to weekly (<75) versus monthly to no (≥75) symptoms.

We used hierarchical logistic regression, with site as a random effect to account for clustering within sites, to identify site variability in achieving excellent health status or monthly to no symptoms. As a secondary analysis, to describe site characteristics associated with better health status (and the magnitude of these mean differences by KCCQ score), we added site characteristics as fixed effects to the hierarchical model. To describe site-level variability in health status across participating sites, we plotted the site-specific proportion of patients exhibiting baseline KCCQ-OS or KCCQ-SF scores of ≥75 with 95% CI. To quantify the magnitude of these differences, we then calculated an adjusted median odds ratio (aMOR),[15] which estimates the median relative difference in two statistically identical patients having excellent health status *or* monthly to no symptoms when receiving treatment at two random sites within the CHAMP-HF registry. Finally, we used multivariable logistic regression to examine the proportional change in site-level variance after sequential adjustment for (i) patient, (ii) patient and treatment, and (iii) patient, treatment, and site characteristics for both KCCQ-OS and KCCQ-SF scores. For each sequential model, we obtained an estimate of the random site effect variance on the log-odds scale. The incremental proportional change in variance (PCV) was calculated as PCV = (Va−Vb)/Va, where “Va” represents the variance of the prior model and “Vb,” the variance of the model with added covariates. To better quantify the differences across practices as a secondary analysis, we constructed adjusted linear regression analyses to more accurately describe the mean differences in KCCQ scores explained by site characteristics.

Our regression models accounted for 34 patient and treatment characteristics previously shown to be significant,[16] where patient characteristics included sociodemographics (age, gender, ethnicity, and race), socioeconomic status (employment status, insurance provider, highest level of education, and total annual household income) clinical comorbidities (body mass index, atrial fibrillation, chronic obstructive lung disease, chronic kidney disease, coronary disease, depression, diabetes mellitus, hypertension, hyperlipidemia, and smoking status) and heart failure severity (systolic blood pressure, pulse, left ventricular ejection fraction, history of ventricular arrhythmias, and number of hospitalizations in the prior 12 months). Additionally, eleven HFrEF treatment characteristics (cardiac resynchronization therapy, angiotensin converting-enzyme inhibitor or angiotensin receptor blocker, beta-blocker, angiotensin-neprilysin inhibitor, mineralocorticoid receptor blocker, hydralazine, loop diuretic, digoxin, ivabradine, inotrope, and total number of HF therapies) were included. Non-linear variables were handled by fitting piece-wise linear splines. In order to examine the association between site characteristics and mean health status differences by KCCQ scores, we added seven practice characteristics: annual heart failure patient volume, access to cardiac rehabilitation, access to telemonitoring services, dedicated heart failure clinic, physician specialty, routine use of PROs, and location (urban, suburban, or rural).

Rates of missing data for patient-level variables, overall, were small (less than 8%), except for household income (~24% of patients). We applied multiple imputation to impute missing values of each variable. Five imputations were created using fully conditional specification method. The results across 5 imputed data sets were then combined by averaging, and SEs

were adjusted to reflect both within-imputation variability and between-imputation variability. All estimates were reported using 95% confidence intervals and a p-value ≤0.05 was considered statistically significant. All analyses were performed using SAS software (version 9.4 SAS Institute, Cary, NC). Analyses were performed independently by the Duke Clinical Research Institute, and the lead author takes responsibility for guiding data analysis and interpretation.

Results

A total of 3,552 patients were enrolled across 149 outpatient practice sites in the CHAMP-HF registry. After excluding patients who were ineligible per the study protocol (n = 34) and those with missing KCCQ-12 (n = 14) or sociodemographic (n = 10) data, 3,494 were included in the final analyses (Figure 1). Baseline patient characteristics are described in Table 1.

Site Characteristics and Patient Health Status Distributions

The characteristics of all enrolling practice sites are described in Table 2. Most sites were general cardiology practices (60.9%), followed by heart failure specialists (23.1%), internal medicine (7.8%), and family medicine (6.3%) practices. The majority of sites offered cardiac rehabilitation (62.1%) and telemonitoring (65.4%) services, with less than half routinely collecting PRO measures (30.2%) or possessing a dedicated HF clinic (39.7%). Finally, more patients were treated at a suburban (40.5%), rather than urban (32.9%) or rural (26.6%) location.

The overall mean (±SD) KCCQ-OS was 64.2 (±24), with the following distributions of patient health status observed: poor (<25; n = 228, 6.5%), fair (25–49; n = 785, 22.5%), good (50–74; n = 1101, 31.5%), and excellent (≥75 n = 1380, 39.5%). The overall mean KCCQ-12-SF score was 68.9 (±25.6), with the following distributions of symptom frequency: daily (<40; n = 548, 15.7%), weekly (40–74; n = 1,186, 33.9%), monthly (75–99; n = 1,219, 34.9%), and no symptoms (100; n = 541, 15.5%).

Health Status Variability Across Sites – Adjusted Median Odds Ratio (aMOR)

The proportion of CHAMP-HF patients at each site that had KCCQ-OS or KCCQ-SF scores ≥75 are shown in Figures 2 and 3, respectively. There was a wide range in the proportion of patients with excellent health status (0–77%) and monthly or fewer symptoms (8–82%). The aMOR across sites was large, after adjusting for 24 patient and treatment characteristics, suggesting substantial variability across sites. For overall health status (KCCQ-OS), the aMOR was 1.70 (95% CI 1.54, 1.99; p < 0.001) indicating an average 70% (95% CI 54–99%) higher odds of having excellent health status if the same patient were treated at one random site versus another (p < 0.0001). For good to excellent symptom control, the aMOR was 1.54 (95% CI 1.41, 1.76) indicating that for any two randomly selected practices, the median odds that a patient would have minimal symptoms was 54% (95% CI 41%–76%) higher at one site versus another (p = 0.001). Site variability was substantially reduced after adjusting for patient characteristics (PCV = 38.9%). However, subsequent adjustments were not associated with further reductions (PCV of −2.9% with the addition of medical therapies

and −0.2%, with added site characteristics). A different pattern was seen for KCCQ-SF, where adjustment for patient characteristics reduced observed variability by 21%, no further reduction was observed after adjusting for medical therapies, and an incremental 23.5% reduction was observed with the addition of site characteristics.

Differences in Health Status by Site Characteristics –Fully-Adjusted Linear Regression Models

Marked site-level differences were observed, by KCCQ-OS score, in fully adjusted linear regression analyses. Compared to patients enrolled at family practices, those at HF (+6.5 points; 95% CI 0.5, 12.4; p = 0.033) and general cardiology (+6.5 points; 95% CI 1.4, 11.7; p = 0.012) practices had significantly higher scores, while those enrolled at internal medicine (+3.7; 95% CI −2.3, 9.7; p = 0.228) clinics had similar scores. Patients enrolled at a suburban setting, also, had higher health status compared with those at an urban setting (+3.2; 95% CI 0.2, 6.1; p = 0.034). There were no other practice characteristics associated with patients' health status (Table 3).

Similar findings were observed for KCCQ-SF assessments where, compared with patients treated by family practices: those treated at heart failure (+5.4 points; 95% CI −1.0, +11.9; p = 0.10), general cardiology (+5.0 points; 95% CI −0.5, +10.6; p = 0.074), and internal medicine (+5.4 points; 95% CI −1.0, +11.9; p = 0.10) practices had a non-statistically significant trend for fewer symptoms. Those enrolled at a suburban setting had significantly better symptom control than those treated in an urban setting (+3.3; 95% CI +0.1, +6.4; p = 0.043).

Discussion

Examining health status variability across practices is an important next step to establishing the suitability of PROs for quality assessment, as currently being developed by the Centers for Medicare and Medicaid Services, and for defining the potential to improve patient-centered outcomes. This is the first study, of which we are aware, to ever examine the outpatient practice variability in health status and symptom control. Substantial practice-level differences highlighted a potential opportunity for improvement, which persisted after adjustment for numerous patient and treatment characteristics – and where patient characteristics were most important in explaining the unadjusted variation in practices' mean KCCQ scores. We found that, after full adjustment, there was a 70% median odds of a statistically identical patient having excellent health status at one random practice versus another and a 54% difference in average likelihood of having minimal symptoms. Identifying and disseminating the management styles of "high-performing" practices has the potential to reduce practice variability and improve the symptoms, function, and quality of life of outpatients with HFrEF. Moreoever, our study results emphasize the potential of a PRO-based performance measure to incentivize practices to optimize the health status of their HFrEF patients in the outpatient setting,[17] which can complement current efforts focusing upon inpatient and early post-discharge outcomes.

Our findings extend prior studies' descriptions of specialty-level differences in cardiovascular outcomes in patients with HFrEF. However, while those analyses focused on

traditional endpoints, including guideline-directed medical therapy,[18] hospitalization,[19] and mortality,[20, 21] we found substantial variations in patient-reported health status – an evolving benchmark of patient care. Nonetheless, while our findings suggest that patients treated by cardiovascular providers were more likely to experience better health status as compared with those treated by primary practitioners, future studies are needed to better understand the subtleties of clinical practice, regardless of specialty, associated with optimizing patients' health status.[22]

The discovery that patients enrolled and treated at suburban, as opposed to urban or rural, settings exhibit improved health status is not novel. However, our work extends prior studies' reporting on patient access to healthcare and hospitalization rates across developed settings[23] to that of health status. The finding that patients receiving care at suburban practices demonstrated better quality of life is logical given our current understanding of the positive relationship between socioeconomic status and heart failure-related quality of life.[24–27] Importantly, these health status differences remained after adjusting for multiple indicators of patient socioeconomic status.

Our findings must be interpreted in context of the following limitations. First, although CHAMP-HF represents one of the largest registries capturing disease-specific health status of HFrEF patients in routine clinical care, it was conducted in voluntary participating sites committed to clinical research and might therefore not be fully generalizable to the entire country. Second, while patients were enrolled at a singular designated clinic, it was not recorded whether they received care from other providers in regard to their heart failure management. However, the fact that our findings were comparable to other specialty-level differences in HFrEF outcomes supports our findings. Third, our analysis was cross-sectional and further work to address patients' health status trajectories over time, and whether site-level variability in titration of medical therapies contributes to health status differences, is needed. Moreover, we were unable to collect the duration or frequency by which a patient had been seen by a provider and whether there was a difference in the duration of care across clinics that might have influenced our findings. Fourth, the associations we observed might have been influenced by residual measured or unmeasured confounders. Some may believe that we should not have adjusted for treatment, as that is one of the key mediators of health status benefit, but including these adjustments underscored the magnitude of variability and the need to better understand such variations (including whether the doses and tailoring of treatments is optimal). Finally, this analysis was not able to formally test mediators of observed difference in health status across vulnerable groups nor define practice patterns to reduce these disparities. This is particularly relevant in that we know that, overall, the routine collection of PROs was 30.2%, but do not know what PROs were routinely used in the practices nor whether the patients with the greatest potential to benefit from telemonitoring or cardiac rehabilitation services were receiving these therapies.

Conclusions

In leveraging data from a unique, observational registry of stable outpatients with HFrEF, we found substantial site-level variability in patients having excellent health status or monthly to

no symptoms. These findings support the use of PROs as a measure of healthcare quality in HFrEF and inform the need to develop novel strategies to improve patient outcomes, thereby reducing differences in outpatient care quality.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

Sources of Funding: CHAMP-HF is funded by Novartis Pharmaceuticals Corporation

Disclosures: Drs. Y. Khariton and M. Nassif are supported by the National Heart, Lung, and Blood Institutes of Health Under Aware Number T32HL110837; the content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health. Dr. John A. Spertus discloses grant funding from NIH, PCORI, Novartis, Abbott Vascular. He serves on a Scientific Advisory Board for United Healthcare and as a consultant for Novartis, Bayer, V-Wave, AstraZeneca, Jansssen, Corvia and Bayer. He has intellectual property rights for the Kansas City Cardiomyopathy Questionnaire and an equity interest in Health Outcomes Sciences. Dr. Laine Thomas reports research funding from Novartis Pharmaceuticals Corporation. Dr. Gregg C. Fonarow reports research support from the NIH, consulting for Amgen, Janssen, Medtronic, Novartis, and St Jude Medical, and serving on the Get-With-The-Guidelines Steering Committee. Dr. Adam D. DeVore receives research Support from the American Heart Association, Amgen, NIH, and Novartis; he provides consulting services for Novartis. Dr. Adrian F. Hernandez reports research support from AstraZeneca, Bristol-Myers Squibb, GlaxoSmithKline, Luitpold Pharmaceuticals, Merck, and Novartis as well as honoraria from Bayer, Boston Scientific, and Novartis. Dr. Javed Butler has received research support from the National Institutes of Health and the European Union and serves as a consultant for Amgen, Bayer, Boehringer Ingelheim, Cardiocell, CVRx, Gilead, Janssen, Medtronic, Merck, Novartis, Relypsa, and ZS Pharma. Dr. Nancy M. Albert reports consulting for Novartis and Boston Scientific and receiving honoraria from Novartis.

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What is Known

- A primary goal of heart failure management is to optimize patients' health status – their symptoms, function, and quality of life
- Prior studies have used heart failure morbidity and mortality as a means to describe variations between healthcare systems and providers

What the Study Adds

- This is the first study to ever examine outpatient practice variability in the health status and symptom control of heart failure patients
- We observed significant practice-level variability in patients' health status
- Our findings emphasize the potential of a PRO-based performance measure to incentivize practices to optimize the health status of their heart failure patients in the outpatient setting

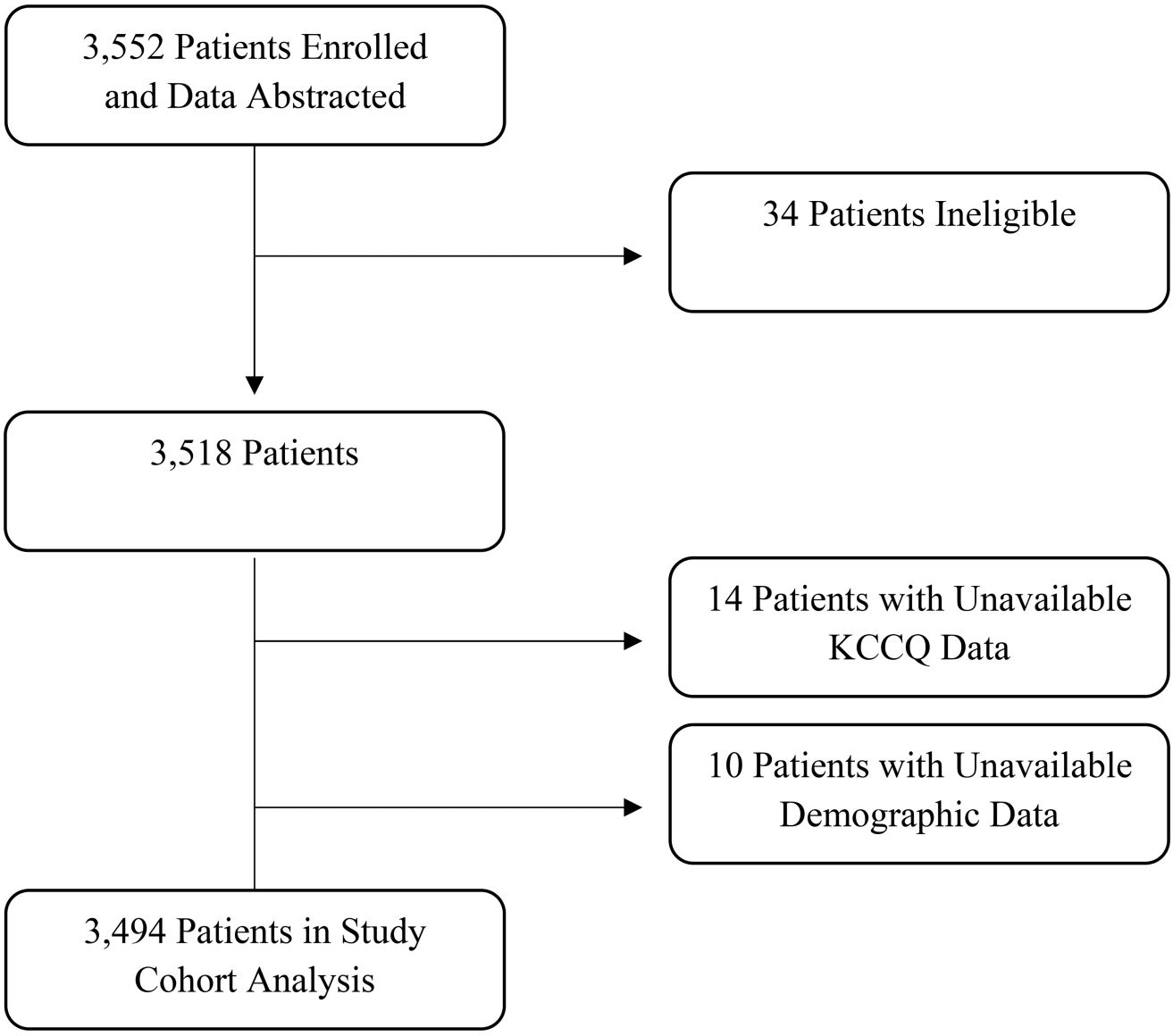

Figure 1.
Patient Exclusion Flowsheet

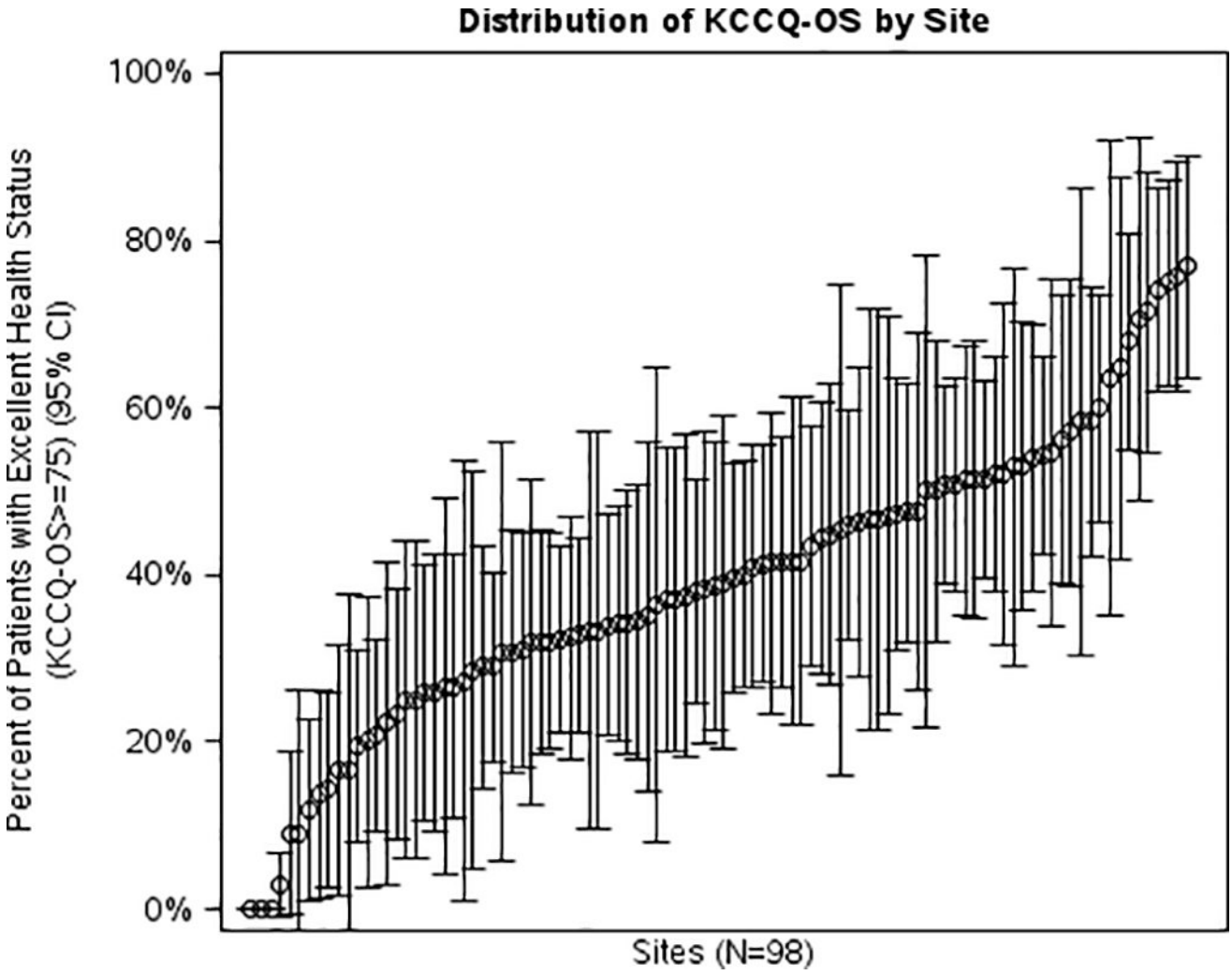

Figure 2.

Unadjusted KCCQ-OS Site Variability (Site n = 98). Each circle represents the Percentage of Patients with KCCQ-OS ≥75 for each site, with 95% confidence intervals.

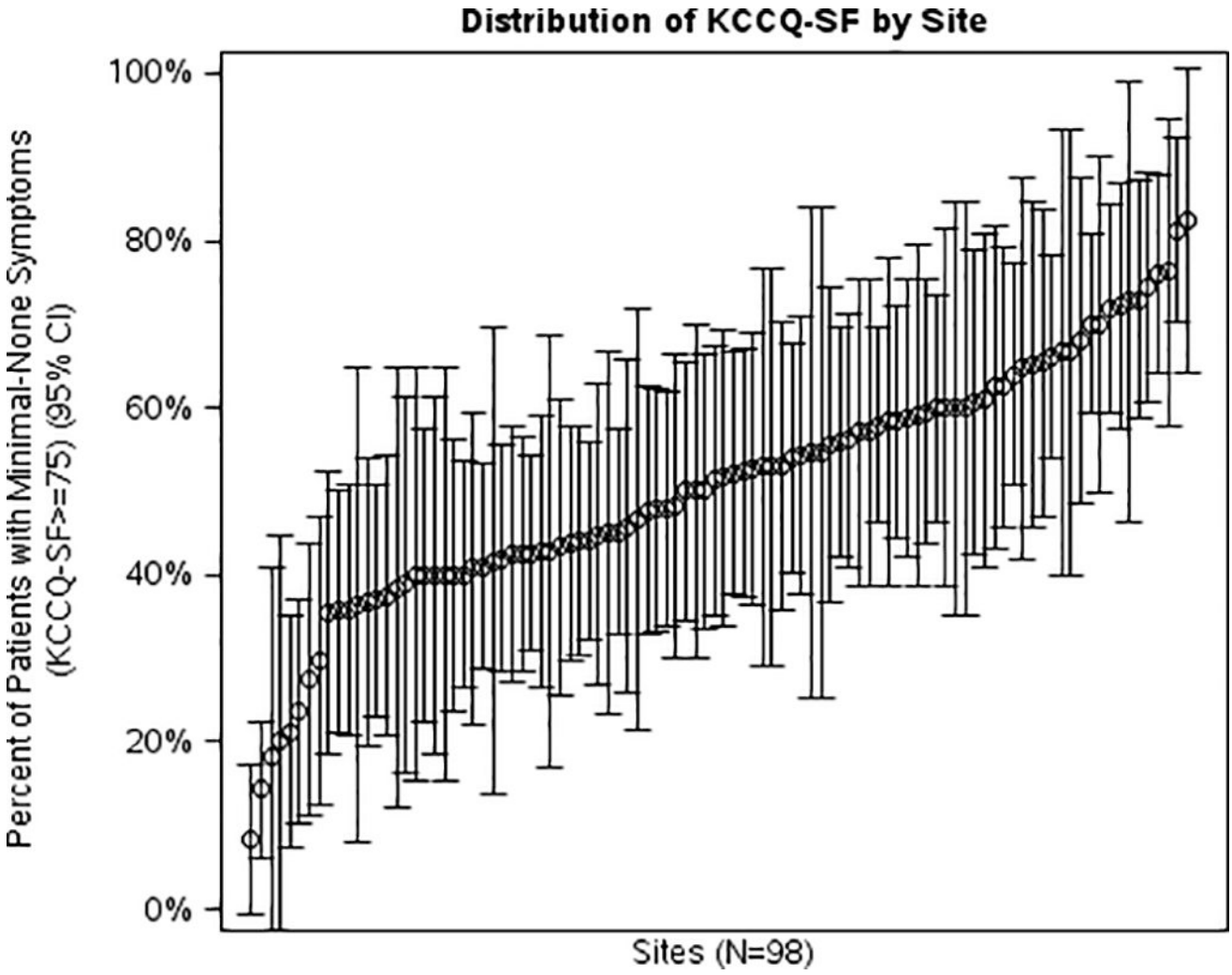

Figure 3.

Unadjusted KCCQ-SF Site Variability (Site n = 98).: Each circle represents the Percentage of Patients with KCCQ-SF ≥75 for each site, with 95% confidence intervals.

Table 1

Distribution of Patient Characteristics (n = 3,494)

Demographics	**Overall (%) or Median (Q1–Q3)**
Age	68.0 (59.0–75.0)
<40	111 (3.2%)
40–64	1307 (37.4%)
65–80	1638 (46.9%)
>80	438 (12.5%)
Male	2473 (70.8%)
Caucasian	2616 (74.9%)
African American	572 (16.4%)
Hispanic	589 (16.9%)
BMI	29.2 (25.5–33.8)
Insurance Status	
Managed Care	574 (16.4%)
Private Insurance	330 (9.4%)
Medicare	2038 (58.3%)
Medicaid	317 (9.1%)
Highest Level of Education	
Less than High School	425 (12.2%)
High School	1187 (34.0%)
Some College	1094 (31.3%)
4-Year College	440 (12.6%)
Graduate or other Professional Degree	348 (10.0%)
Total Household Income	
Less than $25,000	1076 (30.8%)
$25,000–$49,999	685 (19.6%)
$50,000–$74,999	417 (11.9%)
$75,000–$99,999	212 (6.1%)
$100,000–$149,999	184 (5.3%)
$150,000 or More	95 (2.7%)
Employee Status	
Full-Time	496 (14.2%)
Part-Time	252 (7.2%)
Disability for Medical Reasons	877 (25.1%)
Not Employed for Other Reasons	1869 (53.5%)
Medical History	
COPD	1054 (30.2%)
CKD	693 (19.8%)
Depression	874 (25.0%)
Diabetes Mellitus	1426 (40.8%)
Tobacco Use/Smoking	689 (19.7%)

Demographics	Overall (%) or Median (Q1–Q3)
Atrial Fibrillation	1258 (36.0%)
Coronary Artery Disease	2177 (62.3%)
Hyperlipidemia	2643 (75.6%)
Hypertension	2872 (82.2%)
VT/VF	661 (18.9%)
CRT Therapy	234 (6.7%)
NYHA Classification	
I	344 (9.8%)
II	1914 (54.8%)
III	1004 (28.7%)
IV	87 (2.5%)
Unknown	145 (4.1%)
Number of Prior Hospitalizations within 12 Months of Screening	
0	2173 (62.2%)
1	886 (25.4%)
≥2	435 (12.4%)
Vital Signs on Enrollment	
Systolic (mmHg)	120 (110–131)
Diastolic (mmHg)	72 (64–80)
Heart Rate (bpm)	72 (66–81)
Clinical Measures and Lab Results	
LVEF (%)	30 (23–35)
NT-proBNP (pg/mL)	2013 (794–5490)
HA1c (%)	6.4 (5.8–7.6)
Hemoglobin (g/dL)	13.2 (11.8–14.4)
Serum Creatinine (mg/dL)	1.1 (0.9–1.4)
BUN (mg/dL)	20.0 (16.0–28.0)
Sodium (mmol)	139 (137–141)
eGFR (mL/min/m2)	
<30	122 (3.5%)
30–45	304 (8.7%)
45–60	491 (14.1%)
>60	1200 (34.3%)
Missing	1377 (39.4%)
Medication on Enrollment	
ACEi/ARB	2102 (60.2%)
Beta-Blocker	2894 (82.8%)
MRA	1161 (33.2%)
ARNI	451 (12.9%)
Loop Diuretic	2139 (61.2%)
Hydralazine	193 (5.5%)
Digoxin	475 (13.6%)

Demographics	Overall (%) or Median (Q1–Q3)
Ivabradine	42 (1.2%)
Inotrope	14 (0.4%)
Number of Medications	3.0 (2.0–4.0)
Site Characteristics	
Patients Enrolled per Site	22.5 (8.0–37.0)
Physician Specialty	
Family Practice	219 (6.3%)
Internal Medicine	273 (7.8%)
HF Specialist	807 (23.1%)
Other Cardiologist	2128 (60.9%)
Others *	67 (1.9%)
Number of HF Patients Managed Annually	1200 (480–3000)

Abbreviations: BMI (body mass index), COPD (chronic obstructive pulmonary disease), CKD (chronic kidney disease), VT/VF (ventricular tachycardia/ventricular fibrillation), CRT (cardiac resynchronization therapy), LVEF (left ventricular ejection fraction), BUN (blood urea nitrogen), eGFR (estimate glomerular filtration rate), ACEi (angiotensin-converting enzyme inhibitor), ARB (angiotensin receptor blocker), MRA (mineralocorticoid antagonist), ARNI (angiotensin II receptor blocker), HF (heart failure).

* Emergency Medicine/Urgent Care

Table 2

Distribution of Site Characteristics (Overall) and by KCCQ-OS Score Categories (n = 3,494)

	Site Characteristics					
	Overall (n =3,494)	**Poor (<25) (n=228) (6.5%)**	**Fair (25–49) (n =785) (22.5%)**	**Good (50–74) (n=1101) (31.5%)**	**Excellent (≥75) (n=1380) (39.5%)**	**P-Value**
Physician Specialty						<0.001
Family Practice	219 (6.3%)	16 (7.0%)	85 (10.8%)	68 (6.2%)	50 (3.6%)	
Internal Medicine	273 (7.8%)	19 (8.3%)	75 (9.6%)	124 (11.3%)	55 (4.0%)	
HF Specialist	807 (23.1%)	59 (25.9%)	179 (22.8%)	231 (21.0%)	338 (24.5%)	
Other Cardiologist	2,128 (60.9%)	133 (58.3%)	433 (55.2%)	653 (59.3%)	909 (65.9%)	
Others *	67 (1.9%)	1 (0.4%)	13 (1.7%)	25 (2.3%)	28 (2.0%)	
Number of HF Patients Managed Annually, Median (Q1,Q3)	1200 (480–3000)	1000 (350–2000)	1000 (350–2000)	1057 (310–2500)	1500 (500–3000)	<0.001
Access to Cardiac Rehabilitation	2,169 (62.1%)	151 (66.2%)	442 (56.3%)	680 (61.8%)	896 (64.9)	<0.001
Routine site collection of PROs	1,055 (30.2%)	77 (33.8%)	223 (28.4%)	362 (32.9%)	393 (28.5%)	0.041
Dedicated for patients with HF	1,388 (39.7%)	106 (46.5%)	309 (39.4%)	412 (37.4%)	561 (40.7%)	0.062
Patient Population						<0.001
Urban	1,148 (32.9%)	74 (32.5%)	292 (37.2%)	388 (35.2%)	394 (28.6%)	
Suburban	1,416 (40.5%)	88 (38.6%)	276 (35.2%)	399 (36.2%)	653 (47.3%)	
Rural	930 (26.6%)	66 (28.9%)	217 (27.6%)	314 (28.5%)	333 (24.1%)	
Patient Telemonitoring Resources	2,284 (65.4%)	134 (58.8%)	524 (66.8%)	710 (64.5%)	916 (66.4%)	0.120

Abbreviations: HF (heart failure); PROs (patient-reported outcome measures)

*Emergency Medicine/Urgent Care

Table 3

Linear Regression: Adjusted Mean KCCQ-OS and KCCQ-SF Score Differences by Provider Specialty, Developed Settlement, and Heart Failure Services[*]

	Point Estimate 95% CI	P Value
KCCQ-OS:		
Physician Specialty (ref: Family Practice)		
Internal Medicine	3.7 (−2.3, 9.7)	0.228
HF Specialist	6.5 (0.5, 12.4)	**0.033**
Other Cardiologist	6.5 (1.4, 11.7)	**0.012**
Others[†]	12.3 (4.0, 20.6)	**0.004**
HF Patients Managed Annually (Num.)	0.6 (−0.7, 2.0)	0.372
Access to Cardiac Rehabilitation	2.0 (−1.0, 5.0)	0.184
Dedicated for Patients with HF	−0.4 (−3.3, 2.5)	0.790
Routine Site Collection of PROs	0.0 (−2.6, 2.6)	0.992
Patient Population (ref: urban settlement)		
Suburban	3.2 (0.2, 6.1)	**0.034**
Rural	0.6 (−2.7, 4.0)	0.705
Patient Telemonitoring Resources	0.2 (−2.6, 2.6)	0.912
KCCQ-SF:		
Physician Specialty (ref: Family Practice)		
Internal Medicine	5.4 (−1.0, 11.9)	0.100
HF Specialist	5.4 (−1.0, 11.9)	0.100
Other Cardiologist	5.0 (−0.5, 10.6)	0.074
Others[*]	12.6 (2.7, 22.4)	**0.013**
HF Patients Managed Annually (Num.)	0.5 (−1.0, 1.9)	0.527
Access to Cardiac Rehabilitation	0.8 (−2.4, 4.0)	0.643
Dedicated for Patients with HF	−0.8 (−4.0, 2.3)	0.613
Routine Site Collection of PROs	−0.4 (−3.2, 2.4)	0.759
Patient Population (ref : urban settlement)		
Suburban	3.3 (0.1, 6.4)	**0.043**
Rural	1.4 (−2.2, 5.0)	0.457
Patient Telemonitoring Resources	−0.5 (−3.6, 2.5)	0.722

Abbreviations: HF (heart failure); Num. (number); PROs (patient-reported outcome measures)

[*] Model Variables: age, gender, race, ethnicity, body mass index, total annual household income, employment status, chronic obstructive lung disease, chronic kidney disease, depression, atrial fibrillation, number of prior heart failure hospitalizations within prior 12 months, pulse, left ventricular ejection fraction, ACEi/ARB, ARNI, loop diuretic, physician specialty, number of heart failure patients managed annually, access to cardiac rehabilitation, dedicated heart failure clinic, routine collection of PROs, availability of telemonitoring resources, and patient population.

[†] Emergency Medicine/Urgent Care