



Predictors of early heart failure rehospitalization among older adults with preserved and reduced ejection fraction: A review and derivation of a conceptual model

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ABSTRACT

Background: Heart failure (HF) is prevalent among older adults who suffer with either heart failure preserved ejection fraction (HFpEF) or heart failure reduced ejection fraction (HFrEF) and have a high rate of early HF rehospitalization. Preventing early rehospitalization is complex because of major differences between the two subtypes of HF as well as inadequate predictive models to identify key contributing factors.

Objective: To present research addressing relationships between selected clinical, hemodynamic, social factors, and early (≤ 60 -day) HF rehospitalization in older adults with HFpEF and HFrEF, derive a conceptual model of predictors of rehospitalization, and understand to what extent the literature addresses these predictors among older women.

Methods: Four computerized databases were searched for research addressing clinical, hemodynamic, and social factors relevant to early HF rehospitalization and older adults post index hospitalization for HF.

Results: 21 full-text articles were included in the final review and organized thematically. Most studies focused on early (≤ 30 -day) HF rehospitalizations, with limited attention given to the 31 to 60-day period. Specific clinical, hemodynamic, and social factors which influenced early HF rehospitalization were identified. The existing literature confirms that risk predictors or their combinations which influence early (≤ 60 -day) HF rehospitalization after an index HF hospitalization remains inconsistent. Further, the literature fails to capture the influence of these predictors solely among older women. A conceptual model of risk predictors is proposed for clinical intervention.

Conclusion: Further evaluation to understand risk predictors of early (31 to 60-day) HF rehospitalizations among older women is needed.

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Introduction

Heart failure (HF) is a complex clinical syndrome that affects approximately 60 to 65 million persons worldwide, and is associated with an increased rate of early HF rehospitalization in individuals 65 years and older.^{1–3} Despite overall declines in new incidences of HF, statistical models often fail to predict HF specific rehospitalization among older adults suffering with multiple comorbidities who differ from each other according to HF etiology and subtype.^{4–7} Developing models of risk predictors to reduce HF rehospitalization in older adults remains challenging because of disparities in the epidemiology of HF, with African-American (AA) individuals showing the highest HF risk,

and a 48% higher risk of hospitalization compared to Caucasians and Asians.⁸ Further, the two main subtypes of HF, HF with preserved ejection fraction (HFpEF; LVEF $\geq 50\%$) and HF with reduced ejection fraction (HFrEF; LVEF $\leq 50\%$), vary according to comorbidity, patient type, prevalence, and clinical outcome.^{9–11} Clinical studies also show that a substantial portion of older women suffer from HFpEF, which accounts for 40 to 50% of all HF related hospitalizations and subsequent rehospitalizations.^{12,13} Patients with HFpEF also appear more likely to suffer with hypertension, higher body mass indexes, less coronary heart disease, and suffer from all or several components of the metabolic syndrome (MetS).¹³ In addition, different underlying etiologies and cardiac remodeling all contribute to major differences between the two main subtypes of HF, HFpEF and HFrEF.

Effective strategies to reduce early HF rehospitalizations involve understanding relationships between the subtypes of HF and clinical

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and hemodynamic factors in the contributing patient (eg, sociodemographic and physiologic determinants), and environmental/system factors (eg, social support, knowledge).¹⁴ In addition, evaluating the timeframe when HF rehospitalization occurs after discharge, whether 0 to 30-day or 31 to 60-day, may contribute to trends and causes of rehospitalization in older adults, since the majority of early HF rehospitalizations occur < 60 days after an index HF hospitalization.¹⁵ There is limited data on HF rehospitalization within the 31 to 60-day timeframe after discharge, which is an important period since it involves rehabilitative/recovery care and services provided by health-care workers, home health organizations, and at skilled nursing homes to prevent rehospitalization. A focused awareness of differing subtypes of HF impact on rehospitalization during this under examined period after an index HF hospitalization may contribute to understanding disparities in expected outcomes and the persistent higher prevalence in HF rehospitalizations among older adults.

The purpose of this literature review was to examine predictors of early HF rehospitalization in older adults suffering with either HFpEF or HFrEF, and to develop a conceptual model of predictors which may influence rehospitalization 31 to 60-day after discharge. Further, we sought to understand the extent to which the literature captures the influence of these predictors among older women.

Methods

Search strategy

Our search strategy utilized a systematic approach to perform a scoping review of relevant articles from empirical resources.¹⁶ We conducted a review of the literature by using a modified Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) approach. Thus, the combined searches of databases began with manual exploration of key topics in printed papers, which set up a larger strategy for automated searching of electronic databases through cross-referencing of key words and Medical Subject Headings (MeSH) terms.¹⁶ The 2010 start date was chosen to capture current and relevant data related to HF rehospitalization in the selected population, since HF associations, predictors, and therapy are dynamic and constantly evolving. Moreover, the epidemiology, prevalence, incidence, and discriminating clinical features of HFpEF and HFrEF became clearer as they evolved based on population-based studies in the past and current decades.^{17,18} Four electronic computerized databases were systematically searched for relevant studies published in the last 10 years (2010–2020): Cumulative Index of Nursing in Allied Health Literature (CINAHL), MEDLINE (accessed through PubMed),

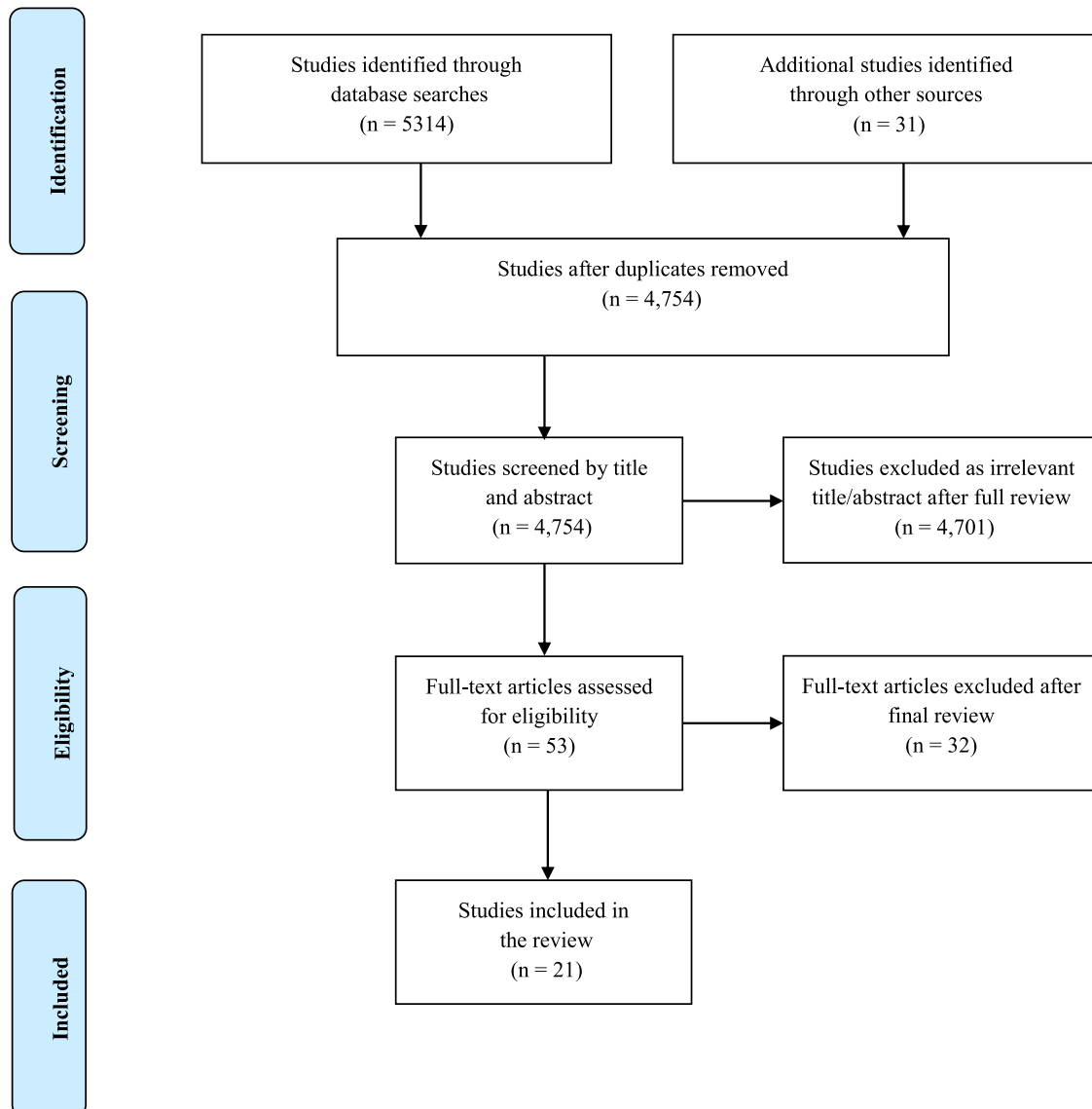


Fig. 1. PRISMA flow diagram of studies.

CMS website, and Google Scholar. The databases were thoroughly searched for key terms or topics, namely, “older women,” “metabolic syndrome,” “obesity,” “high blood pressure,” “diabetes mellitus,” “hyperlipidemia,” “pulmonary hypertension,” “heart failure with preserved ejection fraction (HFpEF),” “heart failure with reduced ejection fraction (HFrEF),” “socioeconomic status,” “social factors,” and “early HF rehospitalization.”

Eligibility

All studies evaluated for this review included adults (males or females) 18 years or older, peer-reviewed articles, written in English language, and published between 2010 and 2020, since studies addressing HFpEF or HFrEF and older women exclusively were non-existent. Selected studies were extracted and stored in the Endnote software where duplicates were removed. Studies were initially screened by title and abstract and later studies that met the above inclusion criteria were included for a complete evaluation. Two independent reviewers analyzed all articles to determine whether selected studies should be included in the review.

Data reduction and extraction

Database searches identified a total of 5345 relevant studies for review. We then separated the studies according to themes which represented clinical and novel factors discussed in the extant literature that contribute to early HF rehospitalization. After removal of (1) duplicate articles; (2) papers with only abstracts or editorial comments; (3) papers not related to HF or early HF rehospitalization; and (4) papers excluded based on the inclusion criteria, a total of 21 articles were selected for final review. Fig. 1 outlines the PRISMA flow diagram outlining details of the selection and extraction process.

Data display and analysis

Articles selected for review and analysis were arranged according to themes as identified in the literature addressing early HF rehospitalization. We reviewed each study with respect to the following main features: (1) general descriptive features (e.g., author/year), (2) sample size/characteristics (e.g., % older women, characteristics of women, and subtype of HF), (3) study design/ purpose (e.g., descriptive), (4) key findings. Tables 1–5 outlines the complete set of extracted data which allowed for comparison and synthesis of studies within themes according to the specific aims of this review.

Results

Five major themes emerged from the review: Early Heart Failure Rehospitalization among Older Adults with Multiple Comorbidities; Early Heart Failure Rehospitalization: HFpEF versus HFrEF; Early Heart Failure Rehospitalization and Features of Metabolic Syndrome; Early Heart Failure Rehospitalization and Pulmonary Hypertension; and Early Heart Failure Rehospitalization and Social Factors.

Early heart failure rehospitalization among older adults with multiple comorbidities

Table 1 shows the characteristics of the samples and key findings of six selected studies that examined the cumulative effects of comorbid conditions and cardiac risk factors such as frailty, chronic kidney disease, hypertension, diabetes, anemia, obesity, and atrial fibrillation and early (\leq 60-day) HF rehospitalizations among older adult men and women.^{19–24} Older women (mean age \geq 70 years) represented the predominant study group in only three studies, and in these

studies the percentage of women ranged between 50 and 60%.^{19,22,23} Attention to ethnicity was highlighted in two studies to reflect a unique patient population contribution on early HF rehospitalization.^{19,24} Davis et al.¹⁹ reported that 65.4% of their cohort were Caucasian, but this ethnic group did not independently affect early HF rehospitalization. In contrast, AA ethnicity played an important role among other clinical factors, and this variable was utilized to develop a risk stratification protocol to target high-risk patients.²⁴ Regardless of gender, advanced age, or ethnicity, all studies clearly indicated that associated comorbidities were the important common denominators that influenced outcomes after discharge. These studies presented data related to older adults and early (\leq 30-day) rehospitalization, primarily linked to quality measures and reimbursement. None of the studies addressed older women exclusively, the 31 to 60-day HF rehospitalization time-frame, HF subtypes and their relationship to early HF rehospitalization, or identified specific risk factor predictors for HF rehospitalizations.

Early heart failure rehospitalization: HFpEF versus HFrEF

Older adults with HFpEF or HFrEF usually exhibit identical signs and symptoms, making subtype differentiation challenging at the time of initial presentation with HF.²⁵ As such, the relationships between HFpEF or HFrEF and rehospitalizations remain uncertain. Five studies (Table 2) examined the influence of HFpEF or HFrEF on rehospitalization after an index HF hospitalization within one year.^{26–30} Studies which identified patients with HFpEF noted that these patients left ventricular ejection fraction (LVEF) exceeded 50%. Three studies evaluated 30-day rehospitalization rates in Medicare patients with HFpEF or HFrEF.^{26,28,30} The data showed no statistical significance between rehospitalization rates and either subtype of HF. However, when patients had prior HF hospitalizations, rehospitalization rates were higher for patients with HFpEF.²⁷ Moreover, race/ethnic differences also affect outcomes since African-American patients suffering with HFpEF were rehospitalized more frequently even after adjusting for patient characteristics, social status, and hospital factors.³⁰ These studies illustrate the complex and diverse clinical factors that impact early HF rehospitalization among older adults (male or female), and the need to address other novel factors. Further, the 31 to 60-day period received limited attention.

Early heart failure rehospitalization and features of metabolic syndrome

Metabolic syndrome is another important consideration and novel factor because it predicts structural changes of the left or right ventricles, which often lead to increased cardiovascular events, incident HF, and rehospitalization.^{31,32} Review of the literature yielded no studies which addressed the MetS and early HF rehospitalization in older adults. However, features of the MetS such as abdominal obesity or obesity remain major independent risk factor for index HF and rehospitalization and were included in the search.³³ Our literature review identified only two studies (Table 3) which addressed components of the MetS and early HF rehospitalization.^{34,35} One study addressed type II diabetes as one of the predictors which was associated with an increased 30-day HF rehospitalization after an index HF hospitalization.³⁴ This disease entity affected 47.1% of patients who were rehospitalized for HF.³⁴ A second study showed that reduction of body mass index (BMI) after an index HF hospitalization correlated with recurrence HF rehospitalizations in patients with both HFpEF and HFrEF.³⁵ Neither study specifically addressed women nor women represented $>$ 50% of the study population. These results exposed a gap in the literature regarding the associations between MetS or its features and early HF rehospitalization.

Table 1
Summary of studies (2010–2020) examining older adults and early HF rehospitalization.

Authors/Year	Sample Size/ Characteristics	Study Design/Purpose	Key Findings
Davis et al. (2017) ¹⁹	n = 547,068 mean age = 74.7 years women = 50.7% Caucasian = 65.4%	Secondary analysis using the Healthcare Cost and Utilization Databases (2007–2011) 30-day HF rehospitalization rates	30% of 30-day rehospitalizations were for HF causes. Previous HF admission common as a secondary diagnosis Comorbid conditions contributed to rehospitalization burden Median time to rehospitalization was 12 days 60% of early rehospitalizations related to recurrent HF.
Di Tano et al. (2015) ²⁰	n = 1520 men age = 72 ± 11 years women = 40%	Unplanned HF rehospitalizations using secondary data from IN—OUT Outcome registry 30-day metric rates	Inotropes during admission, length of stay, and renin-angiotensin system inhibitors at discharge independently predicted rehospitalization Study included patients with both HFpEF and HFrEF, but proportion of HFpEF patients were small (21%)
Eastwood et al. (2014) ²¹	n = 18,590 mean age = 76.4 years women = 49.8%	Retrospective data analysis (2004–2012) HF rehospitalization status determined at 7 and 30 days	2.0% HF related rehospitalizations Risk factors (advanced age, comorbid conditions, and discharge home care services) contributed to HF rehospitalizations Rehospitalization rates within 7 to 30 days increased significantly with age Study did not distinguish subtype of HF
Freund et al. (2020) ²²	n = 503 median age = 87 years women = 59%	Stepped-wedge cluster Randomized trial (2018–2019) with care bundle intervention 30-day HF rehospitalization metric	14.3% unscheduled HF rehospitalizations No significant differences between intervention and control groups at 30 days
Pacho et al. (2018) ²³	n = 522 mean age = 82 ± 8.7 years women = 57.1% Women with predominant HFpEF	Prospective single-center investigation (2014–2016) HF-related rehospitalization at 30 days	Important gaps in guidelines remain for older women with multiple comorbidities which contribute to HF rehospitalizations Comorbidities important common denominators that influence outcomes. Predictive biomarkers such as ST2, a surrogate marker of inflammation, outperformed NT-proBNP for predicting risk of HF-related rehospitalization
Pierre-Louis et al. (2016) ²⁴	n = 685 mean age = 63.7 ± 15.2 years women = 47.4% African-American (AA) = 91.9%	Retrospective study (2009–2012) ≤ 60-day HF rehospitalization	HIV infection, chronic obstructive pulmonary disease, advanced renal disease, atrial fibrillation, and African-American ethnicity independently affect early HF rehospitalization Systolic HF played a pivotal role in early HF rehospitalizations

Early heart failure rehospitalization and pulmonary hypertension

Patients with both HFpEF and HFrEF frequently suffer with PH, which contributes to exercise intolerance, symptoms of right-sided HF, and poor long-term outcomes.³⁶ Although factors contributing to a relationship between PH and HF remain poorly understood, previous studies demonstrate a close association between PH and subtypes of HF.^{37,38} This association was demonstrated in four studies (Table 4) which examined relationships between PH, HF rehospitalization, and HFpEF or HFrEF.^{39–42} Two studies were conducted prospectively and all studies included older men and women. Data showed that higher pulmonary artery systolic pressures correlated with an increase in HF rehospitalizations, especially in patients who suffered with HFpEF.^{40,42} In both of these studies where data demonstrated an important risk relationship between PH and HFpEF, older women remained the predominant study participants.^{40,42} These studies demonstrated that PH associated with other comorbid risk factors predispose patients to early HF rehospitalizations.

Early heart failure rehospitalization and social factors

Social factors, most notably socioeconomic status (SES), remain powerful predictors of HF rehospitalization and cardiovascular health.⁴³ Four studies (Table 5) examined and documented relationships between social factors/ SES and HF rehospitalization among older adults.^{44–47} All studies showed that both social factors or SES contributed to frequent HF rehospitalizations. Social factors such as

lower income, home instability, lack of social support, unmarried status, risky behaviors (smoking, medication non-adherence), health literacy, knowledge, and lower SES all contributed to more HF rehospitalizations.^{44–47} Only one study addressed a specific subtype of HF. In this study, low income strongly contributed to early HF rehospitalizations among patients suffering with HFrEF.⁴⁷ Concordant data also demonstrated that older adults affected by lower SES or adverse social factors engage in poor self-care which contribute to worse outcomes in HF patients and resulted in HF rehospitalizations.^{48,49} When patients neglected self-care or failed to comply with taking prescribed medications, HF and/or HF rehospitalizations increased.^{8,48} None of the selected studies addressed the impact of social factors on HF rehospitalization among older women within independent subgroups.

Discussion

The effort to address clinical, hemodynamic, and social/SES factors that influenced early (≤ 60-day) rehospitalization after an index HF hospitalization among older adults yielded five overarching themes. Under these themes, studies evaluated various clinical and socioeconomic factors as well as certain hemodynamic parameters which influenced early HF rehospitalizations. The majority of studies analyzed retrospective data which identified independent specific impacts on the pathophysiology and outcomes of HF therapeutic management. Each theme discussed risk predictors that contributed to HF rehospitalizations within 60 days of discharge. Among the older

Table 2
Summary of studies (2010–2020) examining HF ejection fraction subtypes and early HF rehospitalization.

Authors/Year	Sample Size/Characteristics	Study Design/Purpose	Key Findings
Loop et al. (2016) ²⁶	n = 19,477 mean age = 78 ± 12 years women = 63% Medicare patients with reduced versus preserved ejection fraction	Retrospective analysis (2007–2011) Length of stay and 30-day rehospitalization rates	All models were adjusted for HF severity, comorbidities, and demographics HF rehospitalization rates were as high in either HFpEF or HFrEF Comparable length of stay in the hospital among the two subtypes
Malik et al. (2020) ²⁷	n = 5536 mean age = 78 ± 11 years women = 69% 1848 matched patients with HFpEF 3688 matched patients with HFrEF	Secondary analysis of data from The Organized Program to Initiate Lifesaving Treatment in Hospitalized Patients with Heart Failure (OPTIMIZE-HF) registry (2003–2004) Effect of a prior history of HF on early HF rehospitalization	In patients with HFpEF or HFrEF, rehospitalization rates were high HF rehospitalization rates were higher for patients with HFpEF when compared to patients with HFrEF
Nichols et al. (2015) ²⁸	n = 6513 mean age (HFpEF) = 75.9% mean age (HFrEF) = 71.4% women (HFpEF) = 65% women (HFrEF) = 36%	Observational cohort design of Medicare beneficiaries (2008–2011) 30-day HF rehospitalization	Patients with HFpEF and HFrEF experienced similar rates of HF rehospitalization HFpEF patients incurred more emergency room visits Differences in demographic and clinical characteristics between patients with HFrEF and HFpEF did not result into meaningful resource utilizations
Santas et al. (2017) ²⁹	n = 2013 mean age = 72.8 ± 11.2 years women = 51% ischemic etiology = 36.9% Hospitalized for prior acute HF = 48.4%	Prospective study at a tertiary teaching hospital (2004–2013) 30-day to 2 years HF rehospitalizations	Rehospitalization burden for acute HF were similar for both entities Patients with HFpEF were more likely to be rehospitalized for non-cardiovascular causes
Ziaiean et al. (2017) ³⁰	n = 53,065 median age (Black) = 77 years; Caucasian = 83 years women = 66% Medicare patients with HFpEF Higher incidence of diabetes in AA (Black) patients	Retrospective analysis of the Get with the Guidelines–Heart Failure registry (2006–2014) Race/Ethnic differences evaluated among Medicare patients 30-day all-cause rehospitalization rates	Black patients with a higher risk for all-cause rehospitalization at 30 days Risk persisted after adjusting for patient and hospital characteristics 30-day HF rehospitalization in Caucasian patients = 6.44% 30-day HF rehospitalization in Black patients = 7.3%

adult population, these risk predictors were mainly comorbidities. None of the studies examining older adults and early HF rehospitalizations utilized single disease prognostic models to determine the impact of a specific comorbidity. Moreover, HF ejection fraction subtypes also failed to consistently predict rehospitalization rates, even among different ethnic groups.³⁰ In contrast, patients suffering with PH or those troubled with abnormal social factors experienced higher HF rehospitalization. The studies under each theme yielded inconsistent results, possibly related to the changing characteristics of the sample and variable study designs. In addition, since the majority of studies evaluated the ≤ 30-day timeframe after a HF hospitalization,

perhaps addressing other timeframes such as 31–60 days after discharge, an important period which involves rehabilitative/recovery care and services provided by health-care workers, may provide answers to develop an emerging paradigm for risk stratification. Furthermore, none of the studies addressed older women, prior hospitalizations, or a frailty index as independent risk predictors. Older women exceeded 50% of the study population in many studies in the review, and a substantial portion of older women suffered from HFpEF, which accounts for 40 to 50% of all HF related hospitalizations and subsequent rehospitalizations.^{11,12,26,29} Yet, the studies in the review failed to capture the influence of risk predictors exclusively

Table 3
Summary of studies (2010–2020) examining features of the metabolic syndrome and early HF rehospitalization.

Older adults and early HF rehospitalization Authors/Year	Sample Size/ Characteristics	Study Design/Purpose	Key Findings
Arora et al. (2017) ³⁴	n = 301,892 73.5% age ≥ 65 years women = 49.2%	Study cohort was derived from the Health-care Cost and Utilization Project's National Readmission Data (2013) Features of the metabolic syndrome as predictors of HF rehospitalization 30-day HF rehospitalization after index HF hospitalization	30-day HF rehospitalization = 35.3% Diabetes a significant predictor for 30-day rehospitalization after index HF hospitalization 18.8% of rehospitalized patients with HF met criteria for obesity 71.2% of patients rehospitalized with HF suffered with hypertension
Nishikido et al. (2019) ³⁵	n = 971 mean age = 73.2 ± 11.2 years women = 30.9% Patients hospitalized with either HFpEF or HFrEF	Retrospective analysis (2009–2013) Non-obese patients Patients classified into four categories based on frequency of early HF rehospitalizations: twice, three times, four times, and > 5 times Correlate reduction in body mass index (BMI) with frequency of rehospitalizations	Reductions in BMI after index HF hospitalization signified repeat early HF rehospitalizations and poor outcomes in HF patients Greater reductions in BMI correlated with higher recurrences of HF rehospitalizations BMI reduction after discharge had a more profound effect on patients with HFpEF

Table 4
Summary of studies (2010–2020) examining pulmonary hypertension and early HF rehospitalization.

Older adults and early HF rehospitalization Authors/Year	Sample Size/ Characteristics	Study Design/Purpose	Key Findings
Adamson et al. (2016) ³⁹	n = 550 mean age = 72.8 ± 6.1 women = 24% NYHA class III HF patients Patients implanted with a permanent MEMS-based pressure sensor in the pulmonary artery.	Prospective randomized study analyzing data from the CHAMPION Trial Impact of pulmonary artery pressure-guided HF care on 30-day HF rehospitalization Medicare-eligible patients	Pulmonary artery pressure-guided management led to a 49% reduction in 30-day HF hospitalizations and a 58% reduction in all-cause HF rehospitalizations
Harmon et al. (2020) ⁴⁰	n = 492 mean age = 74 ± 16 women = 59.4% Patients with pulmonary hypertension (pH) = 44.3%	Retrospective study (2017–2018) Identify risk factors for early (30-day) HF rehospitalization in patients discharged with a diagnosis of HFpEF	15% of HF patients rehospitalized within 30 days after discharge pH is an important mechanism for HFpEF pH an important risk factor for early HF rehospitalization
Mene-Afejuket et al. (2019) ⁴¹	n = 351 women = 27.9% All patients with HFrEF 156 patients with pH had pulmonary artery systolic pressure (PASP) > 44.86	Retrospective study (2006–2016) Predictive value of pH on patients with HFrEF 30-day HF rehospitalization	10.5% patients rehospitalized within 30 days of discharge Higher PASP increased the odds of HF rehospitalization after discharge Negative correlation between body mass index (BMI) and PASP
Santas et al. (2019) ⁴²	n = 2343 mean age = 72.8 ± 11.2 years women = 50.5% HF patients whose PASP was estimated by echocardiography during index HF hospitalization	Prospective study design over 10 years (2004–2014) Relationship between pH and HF rehospitalization	Patients with severe pH at increased risk for HF rehospitalizations HFpEF was associated with severe pH, and this variable exhibited an independent higher risk for HF rehospitalizations

among older women. However, studies have reported on the effect of prior hospitalizations, which predicted 30-day rehospitalization for HF patients.^{49–51} One prior hospitalization carried a 50% higher risk (confidence interval [CI] 1.10–2.05, $p = 0.011$) for rehospitalization, while ≥ 2 prior hospitalizations carried a 3-fold increase in rehospitalization (CI 2.27–4.09, $p < 0.001$).⁵⁰ Since the risk for future adverse outcomes remains elevated in older and frail HF patients, further research is justified and requires tailored multidisciplinary interventions.⁵¹

As such, researchers developed computerized models at the time of admission to predict 30-day rehospitalization, looking at planned and unplanned rehospitalizations, disparities, older women, social culture, and SES. These models evaluated certain predictors (admission and discharge variables) that helped determine the risk of HF rehospitalizations within six months of discharge after an index HF hospitalization. Hamner and Ellison⁵² developed four models

composed of subsets of variables from a hospital data bank and tested them using logistic regression. The models composed of discharge variables stood out as the only models that predicted rehospitalization at a significant level.⁵² Anderson⁵³ also evaluated discharge clinical characteristics in patients rehospitalized for HF within 60 days after an index HF hospitalization. A predictive model derived from the study accurately predicted 77.4% of the cohort, 78.2% of those with subsequent rehospitalization along with 76.7% of subjects with no rehospitalization.⁵³ These two studies collectively illustrated that discharge parameters as well as other risk factors contribute to early HF rehospitalization, but they appear to be population specific, and neither evaluated older women exclusively. Therefore, developing a prediction model that addresses 31–60 day HF rehospitalization among older women may provide solutions to the discharge and rehospitalization cycles that currently perpetuates among older adults from different racial/ethnic backgrounds.⁵⁴

Table 5
Summary of studies (2010–2020) examining social factors and early HF rehospitalization.

Older adults and early HF rehospitalization Authors/Year	Sample Size/Characteristics	Study Design/Purpose	Key Findings
Eapen et al. (2015) ⁴⁴	n = 48,338 mean age = 80 years women = 54.5% AA patients = 10.26%	Retrospective analysis of data from Get With The Guidelines Heart Failure (GWTG-HF) registry and Centers for Medicare & Medicaid Services (CMS) (2005–2011) Impact of socioeconomic status (SES) on 30-day HF rehospitalizations	Modest association between 30-day rehospitalization and county-level SES among CMS beneficiaries No improvement in risk adjustment models when evaluating patient characteristics alone
Park et al. (2019) ⁴⁵	n = 58 median age = 62 years women = 33% Hospitalization in prior 12 months = 60% Single marital status = 55%	Prospective Heart Health study using a digital medicine software platform. Impact of digital health monitoring on HF rehospitalization among patients with index HF 30-day rehospitalization rate	Study showed a 10% 30-day rehospitalization rate after discharge. Single marital status influenced HF rehospitalizations Younger patients utilized the monitors more frequently than older patients
Saito et al. (2019) ⁴⁶	n = 148 mean age = 80 ± 8 years women = 49% Socially isolated patients = 49%	Prospective study (2014–2015) using the Lubben Social Network Scale (LSNS-6) Relationship between social isolation and HF rehospitalization within 90 days	50% of HF patients reported social isolation HF rehospitalization rate was significantly higher in patients with social isolation
Schijodt et al. (2019) ⁴⁷	n = 17,122 mean age = 65–80 years Patients with HFrEF	Retrospective study using data from the Danish Heart Failure Registry (DHFR) Relationship between socioeconomic factors (SEF) and HF rehospitalization	Low income was associated with increased HF rehospitalizations within 3 to 12 months after discharge among patients with HFrEF

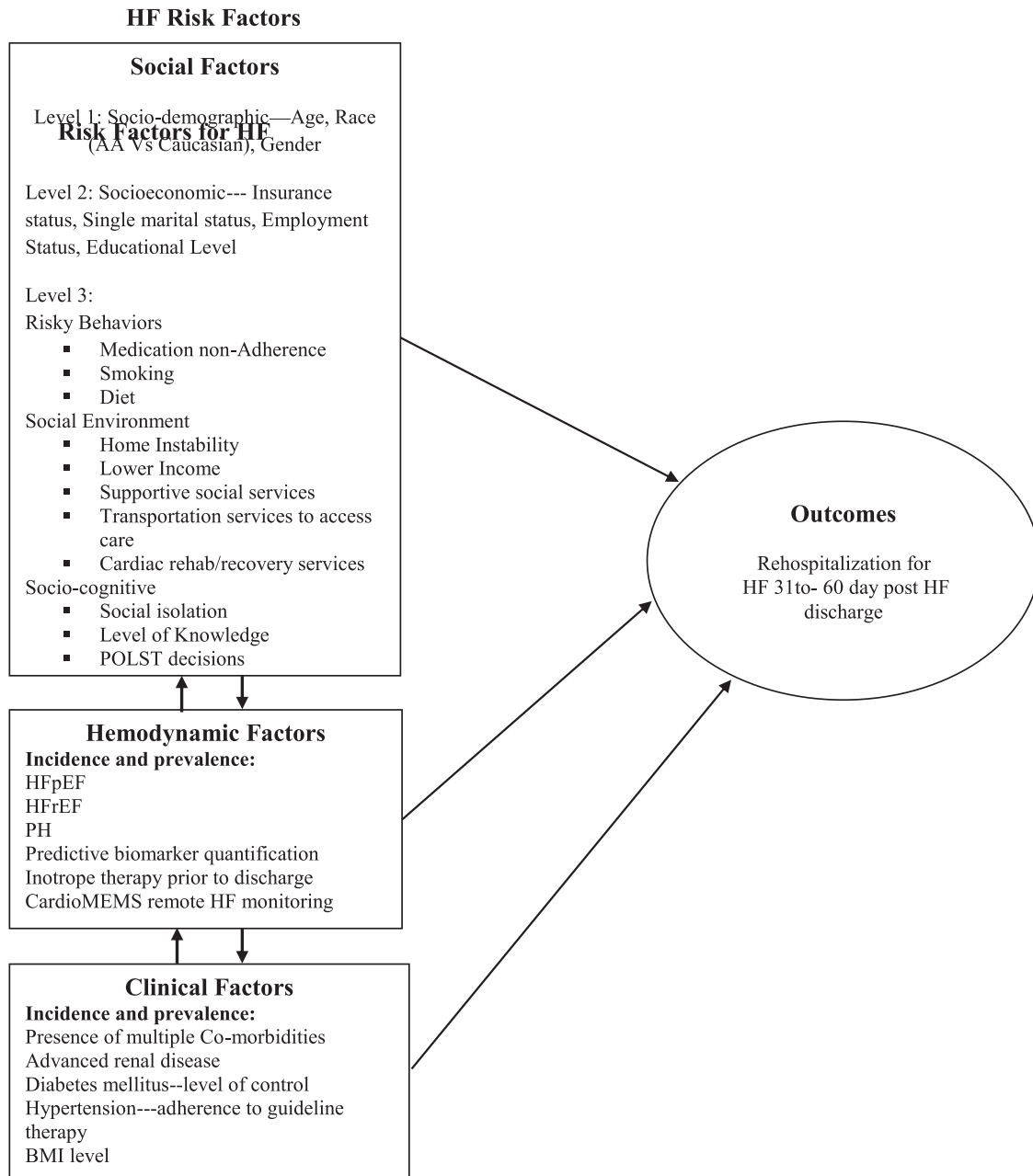


Fig. 2. Conceptualization of Relationships Between HF Risk Factors and Clinical Outcomes in Older Women with HF. Adapted from “Conceptual Model of How Social Factors May Influence Readmissions and Mortality” by L. Calvillo–King and D. Arnold K. J. Eubank, M. Lo, P. Yunyongying, H. Stieglitz, and E. A. Halm, 2013, *Journal of General Internal Medicine*, 28, p. 269.

We propose a conceptual model designed to address predictors of early HF rehospitalization exclusively among older women based upon synthesis of the existing research (Fig. 2). This model was designed to determine whether individual or a combination of clinical, hemodynamic, or social factors influenced 31 to 60-day HF rehospitalizations in older women hospitalized with index HF. The model postulates that following an index HF hospitalization, specific HF subtypes or PH associated with certain clinical or social factors contribute towards HF rehospitalizations in older women within the specified timeframe after discharge. Research supports relationships between older adults/ women with certain clinical or social factors, HF subtypes, and early (< 60 day) HF rehospitalization, though the data remain inconsistent (Tables 1–5). The identification of a specific HF subtype remains important because temporal trends of HF rehospitalizations vary according to HF subtypes.^{55–57} Furthermore, the

frequency of recurrent HF hospitalizations vary across the ejection fraction range which may affect the prognostic impact of associated comorbidities.^{58–60} Therefore, application of this model during clinical intervention may result in implications for implementation of emerging HFpEF and HFrEF therapy.

Implications for practice and future research

Healthcare team members such as physicians, advance practice registered nurses, case managers, rehabilitation specialists, and social support providers involved in health care delivery will benefit from the results of future research evaluating cardiac risk predictors, older women, and emerging HFpEF and HFrEF therapy. These health-care workers, home health organizations, and at skilled nursing homes provide holistic care across the spectrum during the 31 to 60-day

timeframe after discharge, which is an important period that involves rehabilitative/recovery care and other services to prevent rehospitalization. Since early HF rehospitalizations remain prevalent in our communities, strategies are needed to implement effective treatments that will reduce HF rehospitalizations. Physicians and advanced practice registered nurses need to communicate effectively using a patient-centered approach as they identify expected changes and mobilize resources. This novel predictive model of HF rehospitalization incorporates cardiac risk predictors at the point of care to optimize interventions and provide up-to-date standard of care.

Conclusion

Our search of the current and relevant literature found a total of 21 articles organized under five themes which investigated pertinent relationships between selected clinical, hemodynamic, and social factors and early HF rehospitalization among older adults. The existing literature regarding the factors or their combinations which predict early HF rehospitalization after an index HF hospitalization remains inconsistent. Furthermore, we can conclude that research addressing early (31 to 60-day) HF rehospitalizations or older women exclusively remain nonexistent. A conceptual model designed to address this gap in knowledge is proposed for clinical intervention and use in research.

Declaration of Competing Interest

The authors declare that there are no conflicts of interests

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