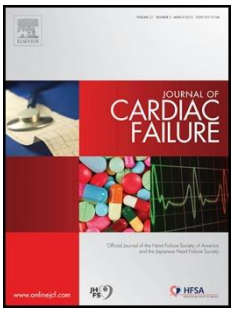
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Title: Pharmacotherapy Use in Older Patients with Heart Failure and Reduced Ejection Fraction after a Skilled Nursing Facility Stay

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Pharmacotherapy use in older patients with heart failure and reduced ejection fraction after a skilled nursing facility stay

Short title: Pharmacotherapy use in older HFrEF patients

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Highlights:

- Three quarters of SNF HFrEF patients used ACEIs/ARBs or evidence-based β-blockers.
- Advanced age was inversely associated with these treatment practices.
- Severe physical limitations were inversely associated with these treatment practices.
- Use of recommended treatments was low in HFrEF patients with multimorbidity.

Abstract

Background: Little is known about guideline-directed pharmacotherapy use in patients with heart failure and reduced ejection fraction (HFrEF) discharged to skilled nursing facilities (SNFs). This study aimed to describe the use of angiotensin-converting enzyme inhibitor (ACEI)/angiotensin receptor blocker (ARB) and evidence-based β-blocker (EBBB) among older patients with HFrEF within 90 days after the SNF admission and to identify factors associated with receipt of these medications.

Methods and Results: Using Minimum Data Set 3.0 cross-linked to Medicare data (2011-2012), we studied 35,792 Americans aged ≥ 65 years with HFrEF admitted to 10,333 SNFs. The median age was 82 years, 59% were women, 81% had at least moderate physical limitations, and 39% had moderate/severe cognitive impairment. Fifty-six percent received an ACEI/ARB and 53% an EBBB; one quarter received neither. In a multivariable log-binomial model, advanced age, severe physical limitations, and greater number of comorbid conditions not associated with heart failure were inversely associated with ACEI/ARB and EBBB receipt.

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Conclusions: Use of standard pharmacotherapy among patients with HFrEF after a SNF stay is higher than reported previously. In the absence of evidence demonstrating the effectiveness of ACEIs/ARBs and EBBBs in this population, whether or not improvements in prescribing are warranted remains unknown.

Keywords: heart failure with reduced ejection fraction, angiotensin-converting enzyme inhibitors, β-blockers, skilled nursing facility

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Introduction

Heart failure (HF) is the leading cause of hospitalization in Americans aged ≥65 years and median survival is approximately 2.5 years among elderly patients hospitalized with HF.[1,2] Many older Americans with HF are discharged from the hospital to skilled nursing facilities (SNFs);[3,4] these patients are at high risk for mortality and multiple hospitalizations.[4] The use of SNFs has increased nationally by more than one half between 1993 and 2006.[5] Yet, little is known about HF patient needs and care provision in this setting.

Approximately one half of patients with HF have a reduced ejection fraction (HFrEF),[6] although the proportion of patients with HF and preserved ejection fraction (HFpEF) in SNFs is likely greater. Patients with HF experience debilitating symptoms and functional limitations, and have substantial risk of morbidity and mortality.[7] Clinical trials have established that pharmacotherapy including receipt of angiotensin-converting enzyme inhibitors (ACEIs), angiotensin receptor blockers (ARBs), and β-blockers can prolong survival and reduce morbidity among patients with HFrEF, but not HFpEF.[8,9] The clinical recommendations have been

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primarily based on trial data of younger men with HFrEF, but nonetheless have generally been applied to both elderly men and women with this clinical syndrome.[8] None of the large HF trials included SNF patients who usually have significant functional disabilities and complex comorbidities.[10] Guideline-driven pharmacological therapy for HFrEF is recommended to be continued for select patients on a case by case basis in a SNF.[10]

Despite the growing importance of SNFs as a healthcare setting for those with HF, data on the characteristics and management practices of HFrEF patients discharged to SNFs after an acute hospitalization are limited. This study describes HFrEF patients' clinical and functional characteristics at the SNF admission, and medication utilization patterns after a SNF stay, and identifies patient factors associated with receipt of an ACEI/ARB or a β-blocker after a SNF stay, using a nationwide dataset including all residents of all Medicare/Medicaid certified SNFs in the United States in 2011-2012. Since the clinical complexity of older adults tends to increase with advanced age, this paper describes the characteristics of older patients with HFrEF in three age strata.

Methods

Data sources

We obtained Minimum Data Set (MDS) 3.0 data cross-linked to Medicare Parts A and D data via a cross-referenced beneficiary individual identifier recorded in the Medicare Beneficiary Summary Files. The MDS is a federally-mandated comprehensive clinical assessment of all residents in Medicare/Medicaid certified nursing homes. It captures resident-level information on an extensive array of variables including demographics, comorbidities, and physical and cognitive functioning on admission, quarterly, annually, or following a significant change in the resident's status.[11,12] Medicare Part A contains uniform administrative and clinical elements

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obtained from discharge abstracts for acute hospital stays of all fee-for-service beneficiaries. Patient-level records include principal and secondary diagnoses and/or procedures classified by the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) codes. Medicare Part D is a prescription drug insurance benefit intended to improve access to essential medications to Medicare beneficiaries. This study was approved by the institutional review board at the University of Massachusetts Medical School.

Study population

This is a cross-sectional study. We used MDS data from April 1, 2011, to September 30, 2012 to ensure that residents had antecedent Part A coverage before the initial nursing home admission to assess an inpatient diagnosis of HF and subsequent Part D coverage after the initial nursing home admission to assess drug utilization. Among 349,216 non-comatose residents with an active diagnosis of HF and continuous co-enrollment in Parts A and D at their initial nursing home admission, we identified 229,915 residents who had an inpatient HF diagnosis at a hospital (with a stay ≤ 60 days) within 3 months preceding their nursing home admission. Of these, we further identified 35,792 residents with HFrEF based on a diagnosis of either systolic HF or combined systolic and diastolic HF (ICD-9-CM: 428.2 or 428.4) from 10,333 SNFs for the final analysis, who met all of the following inclusion criteria: aged ≥ 65 years, admitted to a SNF (not long-stay nursing home), with ≥ 3 months of Part D coverage after the initial SNF admission, and with complete data on covariates of interest. We excluded 5,681 HFrEF patients who died within the 90-day time period after the initial SNF admission because they did not have ≥ 3 months of Part D coverage (see Figure 1 for patient selection process). In a validation study of Medicare beneficiaries, 77% of beneficiaries with an ICD-9-CM code for either systolic HF

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(428.2) or combined systolic and diastolic HF (428.4) had an ejection fraction < 45% based on medical record review.[13]

Standard pharmacotherapy for HFrEF

Because an ACEI should be considered in HFrEF patients admitted to a SNF, and an ARB is an alternative for patients intolerant to ACEIs,[10] we selected use of ACEIs/ARBs as standard pharmacotherapy for effective HFrEF management. For SNF patients with stable underlying disease, evidence-based β-blockers (EBBBs, including bisoprolol, carvedilol, and metoprolol succinate extended release) are likely an appropriate treatment; for patients with a poor prognosis and a primary goal of improving quality of life rather than extending length of life, avoidance of EBBBs would be reasonable because the effect of these drugs on quality of life is variable.[10] Therefore, factors associated with EBBB use were examined separately. Medications administered during a SNF stay are bundled into the per diem cost of the SNF and are not billed to Part D. For this reason, evidence of the use of ACEIs/ARBs or EBBBs was based on the consideration of Part D claims dates and days' supply. If a Part D claim for ACEIs/ARBs or EBBBs was present within 90 days after the initial SNF admission, the resident was considered to be using these medications after a SNF stay. Use during this period reflects prevalent use, including a mixture of prescribing done after discharge to community, or transfer to long-term care, or another setting.

Other medications used for the management of HFrEF

Based on published guidelines, we also considered the following cardiac-related medications that may be used for the management of patients with HFrEF: diuretics (including loop diuretics, thiazides, and potassium-sparing diuretics with the exception of spironolactone

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and eplerenone), aldosterone receptor antagonists (including spironolactone and eplerenone), nitrates, hydralazine, digoxin, anticoagulants, and statins.[8-10] We also considered non-evidence-based β-blockers because they were widely used during the study period in part due to lower cost. The use of each medication was also defined as having at least one Part D claim filled within 90 days after the initial SNF admission, which was considered as after-a-SNF-stay use for the reason stated above.

Factors associated with receipt of standard pharmacotherapy for HFrEF

We evaluated the association of sociodemographic characteristics including age (65-74, 75-84, and ≥85 years), gender, and race/ethnicity (non-Hispanic White, non-Hispanic African American, Hispanic of any race, and a residual category of all others) in relation to receipt of an ACEI/ARB or an EBBB. We also considered the role of lifestyle risk factors including body mass index (BMI) (<18.5, 18.5-<25, 25-<30, and ≥30 kg/m^2), and current smoking status (yes or no). Physical function was measured based on the activities of daily living score[14] and categorized as normal or minimal limitations (0-2), moderate limitations (3-4), or severe limitations/dependent in activities of daily living (5-6). Cognition was measured based on the Centers for Medicare & Medicaid Services definition integrating the self-reported Brief Interview for Mental Status (BIMS) or a staff-reported Cognitive Performance Scale (CPS), and categorized as normal or minimal impairment (BIMS 13-15 or CPS 0-2), moderate impairment (BIMS 8-12 or CPS 3-4), or severe impairment (BIMS 0-7 or CPS 5-6).[15-17] The reliability and validity of the activities of daily living, BIMS, or CPS scores have been demonstrated in comparison with those of other research instruments.[18,19] We considered diagnoses related to HF, and risk factors for HF, including hypertension, atherosclerotic disease (including coronary artery disease, cerebrovascular disease, and peripheral vascular disease), hyperlipidemia, and

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diabetes. We also evaluated other common comorbid conditions including atrial fibrillation, anemia, chronic obstructive pulmonary disease/asthma, depression, renal impairment, arthritis, thyroid disorder, dementia (including vascular-type dementia and Alzheimer's disease), and cancer. All the comorbid conditions examined, with the exception of atrial fibrillation, were based on a diagnosis present at the initial admission MDS assessment. Because atrial fibrillation was not assessed in MDS, it was based on a discharge diagnosis claimed in Part A within 3 months preceding the initial SNF admission. Urinary incontinence, falls in the previous 180 days, and dyspnea symptoms were all defined based on MDS 3.0 items.

Data analysis

We presented all variables as percentages stratified by age (65-74, 75-84, and ≥85 years). We used log-binomial models to estimate prevalence ratios for factors associated with receiving an ACEI/ARB or an EBBB separately.[20] On the basis of our crude analyses, we identified each factor associated with ACEI/ARB use or EBBB use separately. Before construction of the final log-binomial model, the selected variables were evaluated (and ruled out) for potential multicollinearity by examining the stability of standard errors for the estimated parameters by adding the selected variables one by one and by estimating correlation matrix by putting all the selected variables all at once. No multicollinearity between any two selected variables was detected. We subsequently derived adjusted prevalence ratios and corresponding 95% confidence intervals (CIs) by fitting SAS PROC GENMOD's log-binomial models with multiple covariates.[20]

Because valsartan and candesartan are guideline-directed ARBs for HFrEF, we conducted a sensitivity analysis to examine factors associated with ACEI/ARB use where ARB use was restricted to both drugs. Although the guidelines list losartan as an ARB used in the

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treatment of HFrEF,[8,9] losartan is not approved for this indication in the United States. We also conducted a sensitivity analysis to examine factors associated with any β-blocker use (including EBBB and non-evidence-based β-blockers).

Results

The median age of our study population was 82 years (interquartile range 76 to 88 years), 59.4% were women, and 84.3% were White. A majority of the study population (80.8%) suffered from at least moderate limitations in performing basic activities of daily living, and 38.7% had moderate to severe cognitive impairment. The proportion of patients with greater severity of functional disability increased with advancing age. Hypertension was the most common condition present. While atherosclerotic disease, hyperlipidemia, and diabetes were also prevalent, the prevalence of these conditions decreased with advancing age (Table 1). Overall, 46.3% of the patients had three or more important comorbid conditions/risk factors for HF present, and 39.6% had three or more other common comorbid conditions.

More than one half of the patients were prescribed ACEIs/ARBs (55.9%) or EBBBs (52.6%) during 90 days after the initial SNF admission. One third of patients used both ACEIs/ARBs and EBBBs, and one quarter used neither. The proportion of patients treated with ACEIs or with EBBBs, but not with ARBs, decreased with advancing age (Table 2). Diuretics were the most commonly used cardiac medication (76%) in the study patients. A majority of either ACEI/ARB users or EBBB users (84%) also used diuretics. The proportion of patients prescribed with aldosterone receptor antagonists, hydralazine, thiazide, anticoagulants, or statins decreased with advancing age, while the proportion of patients treated with loop diuretics and non-evidence-based β-blockers increased with advancing age.

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ACEIs/ARBs were marginally less likely to be used in patients ≥75 years, but more likely to be used in women. Lower ACEI/ARB use was seen in residents with severe limitations or dependency in physical function. Patients at all levels of cognitive impairment had similar rates of receiving ACEIs/ARBs. While the greater number of cardiac-related comorbid conditions/risk factors for HF was associated with an increased likelihood of receiving ACEIs/ARBs, the greater number of other common comorbid conditions was associated with a decreased likelihood of receiving these medications (Table 3). The findings did not materially change when we restricted ARB use to valsartan and candesartan (Supplemental Table 1).

Patients ≥75 years, in particular those ≥85 years, and those who had severe physical function limitations or who were dependent were less likely to have been prescribed EBBBs in the 90 days after the initial SNF admission. Severe cognitive impairment was marginally inversely associated with receipt of an EBBB. While marginally higher EBBB use was seen in patients with three or more cardiac-related comorbid conditions/risk factors for HF, marginally lower EBBB use was seen in those with three or more other common comorbid conditions (Table 3). In the sensitivity analysis, advanced age ≥85 years and severe limitations or dependency in physical function were only marginally negatively associated with any β-blocker use, while severe cognitive impairment was not associated with any β-blocker use. The associations between any β-blocker use and the numbers of cardiac-related or other common comorbid conditions remain the same (Supplemental Table 2).

Discussion

Our study documented that 56% of patients were taking ACEIs/ARBs and 53% were taking EBBBs in the 90 days after the initial SNF admission; one quarter were taking neither. Advanced age, severe limitations or dependency in physical function, and greater number of

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other common comorbid conditions (which were not risk factors for HF) were inversely associated with receipt of these therapies, whereas the frequency of use was marginally higher among those with three or more cardiac-related comorbid conditions/risk factors for HF.

Characteristics of patients with HFrEF admitted to SNFs

Our findings are consistent with previous research documenting the clinical complexity of elderly Medicare patients with HFrEF with a median age of 79 years in the Get With The Guidelines (GWTG)-HF program (2005-2011, no nursing home information)[21] and a random sample of Medicare beneficiaries with a mean age of 77 years (2007-2011, which included 16% of nursing home residents).[22] In our study population, hypertension was highly prevalent (81%), which was comparable to that reported in a national Medicare sample (80%)[22] but higher than that noted in participants of the GWTG-HF program (73%).[21] The magnitude of previously diagnosed coronary artery disease observed in our study (52%) was similar to estimate from the GWTG-HF program (58%),[21] but lower than was noted in the Medicare sample (71%).[22] Our study patients were older and were more likely to be women and Whites compared with those included in prior studies.[21,22] In our study, the prevalence of each comorbid condition (except atrial fibrillation) was estimated using a 7-day look-back period before admission to a SNF. Thus, differences in the frequency of previously diagnosed conditions may have been due in part to the manner in which previous comorbidities were defined.

Treatment patterns of standard pharmacotherapy for HFrEF

Previously, we reported in a multi-state study that one in four nursing home residents with HF had ACEI use documented within a 7-day look-back period during their nursing home stay,[23] but the data pre-dated the availability of ARBs in the United States (1992-1996). This

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prior study did not select HF patients receiving post-acute care, nor stratify by whether the patient's ejection fraction findings were reduced or preserved. In another early study of elderly participants in the GWTG-HF program (2005-2006), ACEIs/ARBs were prescribed for 25% of patients discharged to SNFs among whom 31% had a left ventricular ejection fraction <40%.[4] While differences in the patient population and the longer window (90 days after the initial SNF admission) in the current study may account for the higher ACEI/ARB use observed, other important changes including implementation of Medicare Part D in 2006 and available generic formulations may have given rise to the higher prevalence of ACEI/ARB use.[24,25] Despite improvements in the frequency of use, a considerable proportion of HFrEF patients do not receive ACEIs/ARBs. Our findings are consistent with more recent data from the GWTG-HF program in elderly Medicare patients (40.3% on ACEIs and 14.6% on ARBs),[21] but lower than reports from another Medicare sample (50.9% on ACEIs, no data for ARBs).[22] Neither of these studies estimated ACEI/ARB use according to age.

In the current study, the proportion of patients (53%) receiving an EBBB is considerably higher compared with our previous report (4%) in nursing home patients with HF.[23] This is not surprising given the time frame of β-blockers in HF trials and that the use of β-blockers remained investigational during that study period (1992-1996).[26] The prevalence of EBBB use in our study is consistent with more recent data from the GWTG-HF program (47%),[21] but higher than earlier data in participants discharged to SNFs from the same program (27%).[4] Generally, three-quarters of HFrEF patients received either ACEIs/ARBs or EBBBs which might reflect improvements in practice patterns in SNFs as physicians prepare these patients for discharge to community or transfer to long-term care facilities.

Factors associated with receipt of standard pharmacotherapy for HFrEF

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Age

In the current study advanced age ≥75 years was marginally associated with less ACEI/ARB use. Although no large clinical trials have been conducted specifically to investigate the benefits of ACEIs/ARBs in elderly patients with HFrEF, a small trial showed that six-minute walking distance was considerably improved by treatment with perindopril compared with placebo in 66 elderly patients with HFrEF (mean age 81 years).[27] Further, ACEI use was reported to be associated with reduced functional decline compared with digoxin use among nursing home HF residents (mean age 85 years),[28] and a significant survival benefit in either hospitalized older HF patients even with perceived contraindications[29] or octogenarian outpatients with HFrEF.[30] Thus, even though the benefits of ACEIs/ARBs are less certain among older patients, available evidence points out that ACEIs/ARBs should be considered in all patients including the oldest ones. Yet, in a recent publication on inappropriate prescribing in community-dwelling adults aged ≥80 years, the absence of an ACEI in patients with systolic HF was the most prevalent criterion for underuse.[31] Elderly patients may be more likely to be intolerant to ACEIs/ARBs than young adults, although only 3% of patients had allergy/intolerance to ACEIs/ARBs in the Worcester Heart Failure Study 2004 patient cohort (mean age 76 years).[32] Our findings that the proportions of patients treated with ACEIs decreased with advancing age, and the proportions of patients treated with ARBs slightly increased with advancing age, suggest that older adults may be more likely to be intolerant to ACEIs.

Advanced age, in particular ≥85 years, was associated with less EBBB use, not any β-blocker use, which is consistent with a previous report.[32] Although the benefits of EBBBs, like ACEIs/ARBs, are also less certain in older age groups, a meta-analysis of >12,000 clinical trial

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subjects which included elderly patients showed no difference in mortality benefit between elderly and non-elderly HF patients treated with EBBBs.[33] Because the effects of EBBBs on day-to-day quality of life is variable,[10] if clinicians' uncertainty about the risk-benefit ratios of EBBBs increases with advanced age, we may be observing appropriate clinical judgment, rather than under-treatment.

Physical limitations and cognitive impairment

Previously, we reported that physical dependency and cognitive impairment were each associated with a decreased likelihood of receiving ACEIs.[23] In the present study, physical dependency was associated with decreased use of ACEIs/ARBs and EBBBs, but severe cognitive impairment was only marginally associated with a decreased likelihood of receiving an EBBB, not an ACEI/ARB. In a prospective cohort study of 282 older adults hospitalized with HF at two Connecticut Hospitals in 2008-2010 (46% with a left ventricular ejection fraction <50%), there were no differences in the prescribing of either ACEIs/ARBs or β-blockers at discharge between patients with and without cognitive impairment.[34] In light of the fact that small studies have shown a benefit of ACEI use on functionality in older HF patients,[27,28] and our findings that physical dependency, not cognitive impairment, was associated with decreased ACEI/ARB use, further data is needed to investigate the appropriateness of these prescribing patterns in the SNF setting.

Comorbid conditions

The findings that cardiac-related comorbid conditions/risk factors for HF and other common comorbid conditions present have opposite impacts on use of ACEIs/ARBs and EBBBs are interesting. The fact that nearly half of HFrEF patients had 3 or more cardiac-related

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comorbid conditions/risk factors for HF might explain the improved use of ACEIs/ARBs and EBBBs in our population. On the other hand, because most clinical trials have excluded HF patients with multiple comorbid conditions, evidence-based treatment for HFrEF is largely unknown in the context of multiple comorbidities.[9,35] SNF patients tend to have a higher comorbidity burden, which may predispose these individuals to an increased risk for adverse drug effects. Our findings suggest that given these and other concerns, clinicians and patients may prioritize which treatments are likely to have favorable risk-benefit profiles for a given patient and various treatment approaches may be selected.

Study strengths and limitations

This study provides a national evaluation of an increasingly important health care setting with extensive information on patient demographic and clinical characteristics based on a reliable, valid, and comprehensive assessment.[36-38] The only other cross-sectional study on medication use among American HF patients in nursing homes was our previous study which was based on multi-state data from more than 20 years ago.[23] Since that time, results from clinical trials have changed the recommended guidelines for patients with HFrEF. Despite these strengths, there are several limitations in our study. Our study was cross-sectional in nature, and is restricted to patients who survived the 90-day period after the SNF admission, perhaps selecting patients with milder forms of this clinical syndrome. That the proportions of patients with some comorbid conditions decreased with advancing age, could be explained by survival bias. Furthermore, if non-receipt of standard pharmacotherapy is associated with mortality, the prevalence use of these medications is likely overestimated after exclusion of patients who died shortly after the SNF admission. We did not have direct measurements of ejection fraction to validate the HFrEF diagnosis; therefore, some patients with HFpEF might have been classified as

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having HFrEF or vice versa. We did not consider the dosages of the drug used; therefore, it is unclear whether or not patients actually took the "target" dosages to attain the benefits of these guideline-directed therapies. We could not evaluate reasons for not prescribing ACEIs/ARBs and EBBBs because the data were not available. Evaluation of the associations between ACEI/ARB and EBBB use and clinical outcomes was beyond the scope of the current study.

Conclusions

Increased use of SNFs among older HF patients has been taking place in the United States during the past several decades.[5,39] Patients with HFrEF admitted to SNFs often suffer declines in physical and cognitive function, have multiple comorbid conditions, and use many cardiac and non-cardiac medications. Despite this, use of standard pharmacotherapy among patients with HFrEF after a SNF stay is higher than reported previously. Yet, given the paucity of outcome data for patients with HFrEF who reside in SNFs, whether or not the use of ACEIs/ARBs and EBBBs are effective and safe in this vulnerable population remains unclear.

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Disclosures

None.

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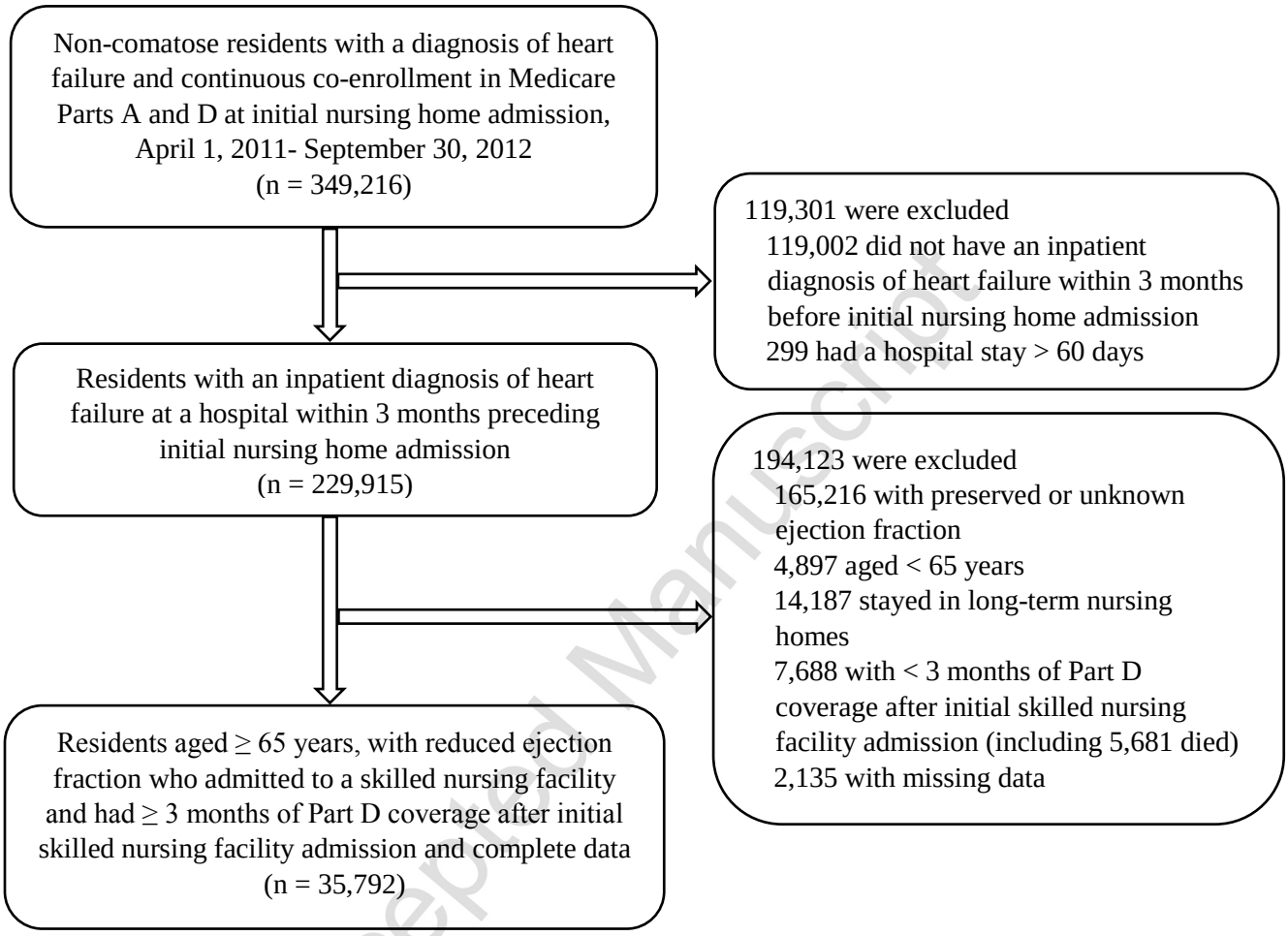
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Figure 1. Selection of skilled nursing facility residents with heart failure and reduced ejection fraction



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Table 1. Sociodemographic, clinical characteristics, and comorbid conditions of elderly HFrEF patients admitted to a SNF, stratified by age

	Age group, in years		
	65-74 (n = 7,784)	75-84 (n = 13,957)	≥85 (n = 14,051)
Age (median, years)	70.0	80.0	89.0
Women (%)	50.7	56.5	67.1
Race/ethnicity (%)			
White	76.0	83.4	89.9
African American	17.6	10.9	6.0
Hispanic	4.6	4.1	2.7
BMI (kg/m^2, %)			
<18.5	4.4	5.2	7.3
18.5-<25	24.6	33.6	48.5
25-<30	24.2	29.9	28.7
≥30	46.8	31.3	15.5
Current smoking (%)	6.3	2.3	0.9
Physical function (%)			
Moderate limitations	57.5	61.0	63.5
Severe limitations/dependent	18.9	19.4	20.3
Cognitive status (%)			
Moderate impairment	19.4	25.0	29.7

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Severe impairment	7.1	11.7	17.7
Urinary incontinence (%)	19.4	24.6	29.0
Fall (previous 180 days, %)	30.6	35.0	40.2
Dyspnea (%)	37.0	35.3	31.9
Comorbid conditions/ risk factors for heart failure (%)			
Hypertension	80.2	81.4	80.5
Atherosclerotic disease	64.5	62.1	56.2
Coronary artery disease	55.4	54.2	48.1
Cerebrovascular disease	13.6	12.1	10.0
Peripheral vascular disease	15.8	12.6	9.3
Hyperlipidemia	50.5	50.3	43.3
Diabetes	63.4	48.0	30.0
Other common comorbid conditions (%)			
Atrial fibrillation	41.9	51.4	53.7
Anemia	34.5	34.6	33.1
Chronic obstructive pulmonary disease/asthma	42.9	35.1	25.2
Depression	32.8	29.1	25.1
Renal impairment	30.9	27.7	23.9
Arthritis	20.8	24.3	27.6
Thyroid disorder	18.6	22.0	26.0
Dementia	10.2	19.1	25.0
Cancer	5.6	6.8	5.8

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HFrEF, heart failure with reduced ejection fraction; SNF, skilled nursing facility; BMI, body mass index.

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Table 2. Pharmacological management of elderly HFrEF patients within 90 days after the initial SNF admission, stratified by age

	Age group, in years		
	65-74 (n = 7,784)	75-84 (n = 13,957)	≥85 (n = 14,051)
Standard pharmacotherapy (%)			
ACEI/ARB*	57.5	56.1	54.8
ACEI	46.2	43.0	41.0
ARB	13.7	15.3	15.9
EBBB	56.0	53.8	49.4
ACEI/ARB or EBBB*	75.9	75.2	73.8
Other cardiac medications used for HFrEF (%)			
Aldosterone receptor antagonist	19.8	17.8	14.9
Nitrates	24.3	24.3	24.5
Hydralazine	11.0	8.8	6.5
Digoxin	20.1	21.0	20.7
Diuretics	72.7	76.0	79.1
Loop diuretics	70.0	73.4	76.5
Thiazide	14.1	12.6	11.2
Anticoagulants	33.0	35.4	28.8
Statins	59.0	57.0	48.7

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Non-evidence-based β-blockers	26.4	28.4	30.2

HFrEF, heart failure with reduced ejection fraction; SNF, skilled nursing facility; ACEI, angiotensin-converting enzyme inhibitor; ARB, angiotensin receptor blocker; EBBB, evidence-based β-blocker.

*2.2% of patients had claims for both ACEIs and ARBs and were counted in both ACEI and ARB subcategories, so the sum of ACEI/ARB is not equal the sum of ACEI and ARB subcategories; 34% of patients had claims for both ACEIs/ARBs and EBBBs and were counted in both ACEI/ARB and EBBB categories, so the sum of ACE/ARB or EBBB is also not equal the sum of ACEI/ARB and EBBB categories. Thirty-six percent of the ARB use was evidence-based (i.e., use of valsartan or candesartan).

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Table 3. Factors associated with receipt of an ACEI/ARB or an EBBB within 90 days after the initial SNF admission among elderly patients with HFrEF

	ACEI/ARB use			EBBB use		
Factor	Unadjusted prevalence	Crude prevalence ratio (95% CI)	Adjusted prevalence ratio* (95% CI)	Unadjusted prevalence	Crude prevalence ratio (95% CI)	Adjusted prevalence ratio† (95% CI)
Age (years)						
65-74	57.5	Referent group	Referent group	56.0	Referent group	Referent group
75-84	56.1	0.98 (0.95-1.00)	0.97 (0.95-0.99)	53.8	0.96 (0.94-0.99)	0.95 (0.93-0.98)
≥85	54.8	0.95 (0.93-0.98)	0.96 (0.93-0.98)	49.4	0.88 (0.86-0.91)	0.90 (0.88-0.92)
Sex						
Men	52.4	Referent group	Referent group	54.4	Referent group	Referent group

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Women	58.2	1.11 (1.09-1.13)	1.11 (1.09-1.14)	51.3	0.94 (0.93-0.96)	0.96 (0.94-0.98)
Race/ethnicity						
White	55.2	Referent group	Referent group	52.0	Referent group	Referent group
African American	58.2	1.05 (1.02-1.08)	1.04 (1.01-1.07)	55.4	1.06 (1.03-1.10)	1.09 (1.06-1.12)
Hispanic	62.0	1.12 (1.07-1.17)	1.12 (1.08-1.16)	55.1	1.06 (1.01-1.11)	1.06 (1.01-1.11)
Physical function						
Normal/minimal limitations	62.1	Referent group	Referent group	58.6	Referent group	Referent group
Moderate limitations	55.5	0.89 (0.87-0.91)	0.95 (0.93-0.97)	52.7	0.90 (0.88-0.92)	0.97 (0.94-0.99)
Severe limitations/dependent	50.9	0.82 (0.80-0.84)	0.92 (0.90-0.95)	46.3	0.79 (0.76-0.81)	0.91 (0.89-0.94)
Cognitive status						
Normal/minimal impairment	56.9	Referent group	Referent group	54.6	Referent group	Referent group

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Moderate impairment	54.8	0.96 (0.94-0.98)	1.01 (0.99-1.03)	50.9	0.93 (0.91-0.95)	0.98 (0.96-1.00)
Severe impairment	53.1	0.93 (0.91-0.96)	1.03 (1.00-1.06)	46.4	0.85 (0.82-0.88)	0.96 (0.93-0.99)
Urinary incontinence						
No	58.5	Referent group	Referent group	55.4	Referent group	Referent group
Yes	51.9	0.89 (0.87-0.91)	0.95 (0.93-0.97)	46.9	0.85 (0.83-0.87)	0.94 (0.92-0.97)
Fall (previous 180 days)						
No	56.7	Referent group	Referent group	53.9	Referent group	Referent group
Yes	55.0	0.97 (0.95-0.99)	1.00 (0.98-1.02)	51.0	0.95 (0.93-0.97)	0.99 (0.97-1.01)
Dyspnea						
No	56.9	Referent group	Referent group	53.0	Referent group	Referent group
Yes	53.9	0.95 (0.93-0.97)	0.97 (0.95-0.98)	51.7	0.98 (0.96-1.00)	0.98 (0.96-1.00)

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Number of comorbid conditions/risk factors for heart failure[‡]						
0-1	51.4	Referent group	Referent group	48.8	Referent group	Referent group
2	55.7	1.08 (1.06-1.11)	1.07 (1.05-1.10)	51.0	1.04 (1.02-1.08)	1.01 (0.98-1.04)
≥3	58.3	1.14 (1.11-1.16)	1.11 (1.08-1.13)	55.6	1.14 (1.11-1.17)	1.06 (1.03-1.08)
Number of other common comorbid conditions[§]						
0-1	60.3	Referent group	Referent group	54.1	Referent group	Referent group
2	57.0	0.95 (0.92-0.97)	0.94 (0.93-0.96)	53.2	0.98 (0.96-1.01)	0.99 (0.96-1.01)
≥3	51.5	0.85 (0.84-0.87)	0.85 (0.84-0.87)	50.9	0.94 (0.92-0.96)	0.95 (0.93-0.97)

ACEI, angiotensin-converting enzyme inhibitor; ARB, angiotensin receptor blocker; EBBB, evidence-based β blocker; SNF, skilled nursing facility; HFrEF, heart failure with reduced ejection fraction; CI, confidence interval.

[*] Adjusted for all variables included on the table and marital status, body mass index, smoking, and number of other cardiovascular medications for HFrEF except ACEIs/ARBs.

[†] Adjusted for all variables included on the table and marital status, body mass index, smoking, and number of other cardiovascular medications for HFrEF except EBBBs.

[‡] Include hypertension, atherosclerotic disease, hyperlipidemia, and diabetes.

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[§] Include atrial fibrillation, anemia, chronic obstructive pulmonary disease/asthma, depression, renal impairment, arthritis, thyroid disorder, dementia, and cancer.

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