Sacubitril/valsartan: from the PARADIGM-HF trial results to heart failure patients in internal medicine. A narrative review

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ABSTRACT

Data regarding the treatment of heart failure (HF) patients derived from randomized, controlled clinical trials, which, with rare exceptions, appear to be distant from the real world of internal medicine. Many trials have been conducted in cardiology departments: however, the characteristics of patients admitted to cardiology wards are largely different from those of patients hospitalized in internal medicine wards. Recently, the PARADIGM-HF study established the efficacy of sacubitril-valsartan – the first drug of the angiotensin II receptor neprilysin inhibitor (ARNI) class - versus enalapril in increasing survival and reducing hospitalizations in a selected population of HF patients with reduced ventricular function. Although practical guidance on the use of ARNI has been published, it is not specific to HF patients admitted to internal medicine wards. In this review, we examine all available data in order to understand if the characteristics of HF patients followed in internal medicine departments hinder or contraindicate the use of sacubitril-valsartan and what indications appear more appropriate in this setting.

Introduction

Heart failure (HF) is one of the major causes of morbidity and mortality in industrialized countries1 and - after vaginal delivery - represents the leading cause of hospitalization in Italy.2 Despite an improvement in treatments, about 50% of patients diagnosed with HF die within 5 years,3 a worse statistic than those for prostate, breast, and bowel cancer.4-6 Its prevalence - which in the general population is between 1% and 2%, without any significant gender difference - increases with age, reaching 6.4% over the age of 65. Depending on the studies, the average age of HF patients varies between 74 and 78 years.7-10

Data regarding the treatment of HF patients derived from randomized, controlled clinical trials, which, with rare exceptions, appear to be distant from the real world of internal medicine. Patients enrolled are 70% males, around 62 years of age on average, and generally without comorbidities.

Recently, the PARADIGM-HF trial11 showed that treatment with sacubitril-valsartan - the first drug of the angiotensin II receptor neprilysin inhibitor (ARNI) class - in selected HF patients with reduced ventricular function reduced mortality by 20% and hospitalization for HF by 21% versus enalapril (Figure 1).

Although practical guidance on the use of ARNI has been published, it is not specific to HF patients admitted to internal medicine wards.12,13 Indeed, HF patients’ hospitalization occurs for the majority of cases in internal medicine wards, while only 25% of them are treated in cardiology wards.14,15

The matter is not only quantitative but also qualitative because the characteristics of patients admitted to cardiology wards are substantially different from those of patients hospitalized in internal medicine wards.

In order to understand whether the characteristics of HF patients treated in internal medicine wards hinder or contraindicate the use of sacubitril-valsartan and to determine whether the indications appear more appropriate in this setting, we performed a Medline search. The search was limited to articles in English in the last 17 years and adult populations. We used the Title/Abstracts with the term ‘Sacubitril Valsartan’ and the following search strings: (‘Sacubitril Valsartan’) AND (‘Internal Medicine OR ‘Geriatric’); (‘Heart Failure’) AND (‘Internal Medicine’) AND (‘Cardiol-
The literature search was completed by the analysis of related articles and a manual search.

Heart failure in internal medicine: patients’ characteristics

The TEMISTOCLE study, conducted in Italy in 2000, showed that 76.2% of HF patients in internal medicine departments were >70 years of age, vs 56.3% in cardiology departments (P<0.0001) and that they presented a significantly greater incidence of comorbidities (73.6% vs 64.5%; P<0.0001). In a more recent Spanish study, HF patients admitted to internal medicine wards were remarkably older than those in cardiology wards (74 years vs 68.5 years; P=0.001), had longer hospital stays (10.8 days vs 8.7 days; P=0.001), and had more comorbidities, in particular atrial fibrillation (43.6% vs 30.7%; P=0.002), chronic obstructive pulmonary disease (COPD) (26.6% vs 10.4%; P<0.001), renal failure (30.3% vs 19.3%; P<0.01), and anemia (41.9% vs 33.4%; P<0.05). In a Canadian study, HF patients admitted to internal medicine wards were older and had a greater number of comorbidities than those hospitalized in cardiology wards. In the SMIT study (an observational study performed on 770 patients admitted for HF to 32 departments of internal medicine in Tuscany, a region of central Italy), there was a female prevalence (F 55%, M 45%) and an average age of 82.5 years; 71.5% had at least three comorbidities, and 40.2% at least four comorbidities, in particular arterial hypertension, renal impairment, atrial fibrillation, COPD, and diabetes mellitus.

Preserved left systolic ventricular function is more frequent in internal medicine wards than in cardiology wards. In the TEMISTOCLE study, 40.8% of patients admitted to internal medicine had ejection fraction (EF) >40%, vs 28.4% of those admitted to cardiology. In the Canadian study, EF >55% was found in 51% of the patients in internal medicine and 34.8% of those in cardiology. However, severe impairment of the left ventricular function (EF<35%) was reported in approximately 20% of patients admitted to internal medicine wards.

Figure 1. Kaplan-Meier curves for key study outcomes: PARADIGM-HF results. From: McMurray et al., 2014 with permission.
Angiotensin II receptor neprilysin inhibitor: mechanism of action and guidelines

The mechanism of action of the ARNI is twofold. Valsartan blocks angiotensin AT1 receptors, thereby inhibiting the effects of the activation of the renin-angiotensin system (RAAS). Sacubitril, which is rapidly converted to its active form, inhibits neprilysin, an enzyme that fragments natriuretic peptides (ANP, BNP, and CNP), that increases their circulating concentrations. The block of the negative actions of angiotensin (e.g., vasoconstriction), together with the positive actions of the natriuretic peptides (e.g., vasodilation, natriuresis, RAAS modulation), are the basis of the efficacy of the drug (Figure 2).

Based on the results of the PARADIGM-HF study, the guidelines of the European Society of Cardiology (ESC) recommended the substitution of angiotensin-converting enzyme inhibitors (ACEI) or angiotensin receptor blockers (ARB) with sacubitril-valsartan in all patients with symptomatic heart failure (New York Heart Association [NYHA] classes II-IV), despite a therapy with ACEI or ARB, beta-blockers and mineralocorticoid receptor antagonist (MRA) and EF ≤35% (recommendation class I level A).20 The guidelines of the American College of Cardiology (ACC), the American Heart Association (AHA), and the Heart Failure Society of America recommend the substitution of the ACEI or ARB with sacubitril-valsartan in symptomatic HF patients with reduced ventricular function (recommendation class I level B).21 The level B of the recommendation depends on the fact that the results come from a single trial, although it has been reported that the statistical significance of the PARADIGM-HF study (P=0.0000004) was equivalent to 4-5 trials with P<0.05.22

Angiotensin II receptor neprilysin inhibitor and elderly patients

Patients with HF are increasingly older due to the progressive increase in average life expectancy and the efficacy of therapies.

In the PARADIGM-HF trial, despite the average age being 63.8 years, 1563 patients (18.6%) were ≥75 years old, and 587 (7.0%) were ≥80 years old. Com-

![Figure 2. Mechanism of sacubitril-valsartan action. From: Vardeny et al. J Am Coll Cardiol HF 2014;2:663-70 with permission.](image-url)
pared with younger patients, the elderly were more frequently female, had more comorbidities, higher values of systolic blood pressure, creatinine, natriuretic peptide, and higher mean EF values; in other words, they more closely approximated the real-world setting of internal medicine. A retrospective analysis classified the entire cohort from the PARADIGM-HF trial based on age groups and found that also in the group of patients aged 65 to 74 years there was a significant risk reduction of 20% [hazard ratio (HR) 0.80; 95% confidence interval (CI) 0.68-0.93] for patients receiving sacubitril-valsartan versus enalapril in relation to the primary outcome (cardiovascular death or hospitalization for HF). Although it did not reach statistical significance, in the subgroup of patients ≥75 years old, there was a trend towards risk reduction for the primary outcome (HR 0.86; 95% CI 0.72-1.04) and the secondary outcomes (Figure 3).

Concerning safety, compared to younger patients, older patients showed a higher frequency of symptomatic hypotension both in the enalapril arm and in the sacubitril-valsartan arm. However, even in patients ≥75 years of age, treatment discontinuation, for this reason, was minimal (1.3% in the enalapril arm and 1.8% in the sacubitril-valsartan arm). In patients ≥75 years old, discontinuation of treatment due to worsening renal function was lower in the sacubitril-valsartan arm (0.6%) than in the enalapril arm (2.1%).

These data are encouraging for the use of sacubitril-valsartan in elderly and very elderly patients. However, in the absence of large trials involving this type of population, we must use caution. Starting with small doses and ensuring close clinical checks should be considered.

Polypharmacy is another problem that internists must manage in elderly patients. Sacubitril-valsartan does not add to, but instead replaces ACEI or ARB, and this could have a favorable effect on compliance.

### Angiotensin II receptor neprilysin inhibitor and quality of life

Improvement in quality of life and functional capacity, especially in elderly patients, is a reasonable outcome, even when it is impossible to expect a significant impact on mortality. This consideration is frequent in internal medicine wards. Furthermore,
Angiotensin II receptor neprilysin inhibitor and renal impairment

Renal failure is a major comorbidity in HF patients, particularly in those admitted to internal medicine wards. In a large cohort study of patients hospitalized for HF, 43.5% had stage III kidney failure (moderate renal dysfunction), and 13.1% had stage IV (severe renal dysfunction). In the aforementioned SMIT study, 71.9% of patients admitted to the internal medicine wards for HF had estimated glomerular filtration rate (eGFR) values <60 mL/min/1.73 m² and 25.3% had eGFR values <30 mL/min/1.73 m². We know that valsartan alone showed to have positive effects on renal function. Several studies have shown a reduction in albuminuria in patients with renal insufficiency treated with valsartan, and this effect was independent of the lowering of blood pressure values. Natriuretic peptides, in turn, determine an increase in eGFR values due to vasodilation of the afferent arteriole and concomitant vasoconstriction of the efferent arteriole. With ARNI it is, therefore, possible to potentially obtain a twofold favorable nephroprotective effect.

Indeed, in the PARAMOUNT study, sacubitril-valsartan in HF patients with preserved EF resulted in a lower renal function reduction compared to that achieved by valsartan alone. In the TITRATION study, differences in creatinine level were negligible between more or less aggressive treatment with sacubitril-valsartan.

In PARADIGM-HF, approximately 30% of enrolled patients had baseline eGFR values <60 mL/min/1.73 m². The analysis of this subgroup of patients confirmed the greater efficacy of sacubitril-valsartan compared to enalapril to prevent clinical events, which was true for all endpoints. While not reaching statistical significance, there were fewer acute deterioration of renal function in the sacubitril-valsartan arm, and fewer episodes of hyperkalemia. The values of eGFR were also higher than those in the enalapril arm. The increase in urinary albumin excretion detected in the sacubitril-valsartan arm tended to stabilize over time and did not influence the clinical outcomes.

Angiotensin II receptor neprilysin inhibitor and diabetes mellitus

In internal medicine departments, diabetes mellitus is present in about one-third of patients hospitalized for HF. Also, in the PARADIGM-HF study, 34.7% of patients in the sacubitril-valsartan arm and 34.6% of those in the enalapril arm had diabetes. A post hoc analysis of these patients demonstrated significant advantages of the ARNI treatment. After 12 months of treatment, glycated hemoglobin was reduced by 0.26% in the sacubitril-valsartan arm, versus 0.16% in the enalapril arm (P=0.002), with similar results at Year 2 and 3. Moreover, the switch to - or the initiation of - insulin therapy was 29% lower in the sacubitril-valsartan arm, and the use of oral anti-diabetics was also lower. The reason for this beneficial effect on diabetes mellitus is not clear. Better cardiac performance may provide a beneficial global effect on the metabolism, and, more directly, the inhibition of neprilysin modulates its circulating substrates, including glucagon-like peptide 1, increases insulin sensitivity.

Angiotensin II receptor neprilysin inhibitor and systolic blood pressure

HF patients often have low values of systolic blood pressure (SBP). Hypotension is a negative prognostic factor, and internists are generally concerned about prescribing medications that tend to further lower SBP, particularly in elderly patients. Analyses of the PARADIGM-HF data concerning the efficacy and safety of sacubitril-valsartan versus enalapril, according to SBP baseline levels and SBP values after randomization, showed that sacubitril-valsartan improved the clinical outcomes for all SBP values. Even in patients with persistent low SBP values after treatment, sacubitril-valsartan was superior to enalapril in reducing mortality and morbidity. While it is true that patients with lower SBP values had a greater number of adverse events, this occurred regardless of the assigned treatment arm. Pa-
patients who showed a higher frequency of hypotensive episodes in the PARADIGM-HF trial were older and had lower pressure values upon randomization; however, the benefits of sacubitril/valsartan were similar to those of patients who had not experienced symptomatic hypotension.40

Hypotension is one of the main side effects of sacubitril-valsartan, and treatment should not be initiated with SBP values <100 mmHg (criterion of exclusion from the PARADIGM-HF trial). Considering the beneficial effects of sacubitril-valsartan also in persistent low SBP value, if the SBP values reduce during treatment, the other possible determining conditions should be evaluated before stopping the medication. We should consider that treatment with sacubitril-valsartan frequently allows individualized dose reductions of loop diuretics.41 In case of hypotension risk, the use of bisoprolol as the beta-blocker of choice, the suspension of calcium-antagonists and nitrates, and tamsulosin substitution with finasteride (in case of treatment for prostatic hypertrophy) should be considered.

Finally, as expected, sacubitril/valsartan versus enalapril benefits were also confirmed for patients with SBP ≥140 mmHg.

### Angiotensin II receptor neprilysin inhibitor and Alzheimer’s disease

There is considerable overlap between the populations suffering from HF and Alzheimer’s disease (AD).42 Cognitive defects were found in 30% of HF patients admitted to internal medicine wards.19 Neprilysin is responsible for the breakdown of peptides, including amyloid-beta peptide. It has been hypothesized that inhibiting neprilysin may elevate levels of this peptide in the brain.43 However, when sacubitril-valsartan was administered to healthy human volunteers for two weeks, no changes were noted in the cerebrospinal fluid levels of amyloid-beta.44 The PARADIGM-HF trial excluded patients with AD and did not evaluate cognitive function; however, the trial included reports of dementia-related adverse effects, and there were no differences reported between the treatment groups.

Nevertheless, it is difficult to say if the trial duration would have been sufficient to evaluate cognitive function. Currently, although some authors suggest that careful monitoring should occur in patients who may be affected by AD,45 there is no evidence as to the deleterious effects of sacubitril/valsartan on cognitive function or the progression of AD. Furthermore, we should consider that the cognitive decline in HF patients may not be the result of the only AD, but could also be due to vascular abnormalities and decreased cardiac function46 and that another contributor to the cognitive impairment in HF patients is unplanned hospital admission due to decompensation.47

### Angiotensin II receptor neprilysin inhibitor and hyperkalemia

The PARADIGM-HF trial showed no statistically significant difference in the frequency of hyperkalemia (serum potassium >5.5 mmol/L) in the sacubitril-valsartan arm versus the enalapril one. In both arms, hyperkalemia led to the discontinuation of treatment in rare cases (<1%). Although the guidelines recommend using MRAs in symptomatic HF patients with EF ≤35%, in clinical practice, this prescription occurs only in 18%-56% of eligible patients.48-52 In internal medicine departments, the prescription of MRAs upon discharge occurs in about 40% of the patients admitted for heart failure.53 The reason for this degree of under-treatment is not well known; however, the fear of hyperkalemia likely plays a predominant role, especially when renal insufficiency is present.54,55 However, a sub-analysis of the PARADIGM-HF trial found that severe hyperkalemia (serum potassium >6 mmol/L) was present more often in the enalapril arm than in the sacubitril-valsartan arm (3.1 vs 2.2 for 100 patient-years; HR 1.37 [95% CI 1.06-1.76]; P=0.02), suggesting that neprilysin would attenuate the risk of hyperkalemia when MRAs are combined with other inhibitors of the renin-angiotensin-aldosterone system.5

### Angiotensin II receptor neprilysin inhibitor and hyperuricemia

Although the effect of hyperuricemia on cardiovascular events is not yet well understood, an association between hyperuricemia and a worse prognosis has been reported in patients with chronic HF.57 and acute HF. An inverse relationship was also observed between serum uric acid levels and EF in elderly male patients with HF.58 In the PARADIGM-HF trial, patients with higher uric acid values had a worse prognosis than those with low values. Patients in the sacubitril-valsartan arm achieved a 24% reduction in serum uric acid compared to those in the enalapril arm, although the prognosis improvement was independent of such reduction.60

### Angiotensin II receptor neprilysin inhibitor and target dose

In the PARADIGM-HF trial, the benefits of treatment with sacubitril-valsartan were significant in patients who already took ACEI/ARB and beta-blockers at target doses. However, in internal medicine’s clinical practice, fewer patients are treated with ACEI or ARB than in cardiology practices.18 Furthermore, due to age and comorbidities, it is rare to reach the target dose. It is likely that some HF patients admitted to internal med-
Angiotensin II receptor nephrilysin inhibitor in hospitalized patients

The subjects enrolled in the PARADIGM-HF trial were outpatients; therefore, it is unclear whether the study results could be generalized to patients hospitalized for acute HF. Recently, the results of the PIONEER-HF study have been published.63 It enrolled a population of 881 patients hospitalized for HF with heart failure and reduced ejection fraction. After hemodynamic stabilization (SBP of at least 100 mmHg for the previous 6 hours, no dose increase of intravenous diuretics, no use of intravenous vasodilators in the previous 6 hours, and no intravenous use of inotropic agents during the previous 24 hours), patients were randomly assigned to receive sacubitril-valsartan or enalapril before hospital discharge. The results showed that the pre-discharge initiation of sacubitril-valsartan led to a more significant reduction in the concentration of N-terminal pro-B-type natriuretic peptide (NT-proBNP: a marker of both neuro-hormonal hyperactivity and congestion) compared to enalapril over an 8-week follow-up. The worsening renal function rate, hyperkalemia, symptomatic hypotension, and angioedema did not differ significantly between the two arms. A secondary combined clinical endpoint also demonstrated marked improvement in the sacubitril-valsartan arm compared to enalapril, mainly resulting from a robust reduction in the number of re-hospitalizations.

The TRANSITION study64 that enrolled about 1000 patients with a 10-week follow-up also demonstrated that the initiation of sacubitril-valsartan in patients hospitalized for HF after stabilization (SBP ≥110 mm Hg for at least 6 hours, not having received IV diuretics or vasodilators for at least 24 hours, except for nitrates or inotropic agents at the time of hospitalization), compared to a post-discharge initiation within two weeks, allowed the achievement of statistically equivalent percentages of the target dose (primary endpoint) or other dosages, with a limited drop-out rate that was equivalent in the two arms.

The results of the Pioneer-HF study and Transition-HF studies demonstrated safety in initiating sacubitril-valsartan during hospitalization in stable HF patients. In clinical practice, this approach is probably more appropriate when a post-discharge program is possible.

Table 1. Starting dose and dose titration for sacubitril-valsartan in a variety of patient populations with heart failure and reduced ejection fraction.

| Population with HFrEF | Starting dose of sacubitril/valsartan | Up titration and target dos |
|----------------------|--------------------------------------|-----------------------------|
| No patient characteristics requiring caution or dose reduction   | 49 mg/51 mg twice daily             | Uptitration by doubling of dose every 2-4 weeks until dose of 97 mg/103 mg twice daily is reached |
| Currently only taking a low target dose of ACE inhibitor or ARB*  | 24 mg/26 mg twice daily             |
| No ACE inhibitor or ARB in the past                             | 24 mg/26 mg twice daily             |
| eGFR <30 mL/min/m²°                                              | 24 mg/26 mg twice daily             |
| Moderate hepatic impairment (Child-Pugh class B)               | 24 mg/26 mg twice daily             |
| Elderly                                                          | 24 mg/26 mg twice daily             |

HFrEF: heart failure and reduced ejection fraction; ACE, angiotensin-converting enzyme; ARB, angiotensin receptor blocker; eGFR, estimated glomerular filtration rate. *Target doses of ACE inhibitors and ARBs are as follows: ACE inhibitors-captopril 50 mg three times a day, enalapril 10 mg twice daily, lisinopril 20 mg once a day, ramipril 5 mg twice daily, trandolapril 2 mg once a day ARBs-candesartan 32 mg once a day, losartan 150 mg once a day, valsartan 160 mg once a day; the European Medicines Agency also suggests that a dose of 24 mg/26 mg can be considered if eGFR is 30-60 mL/min/1.73 m². From Jhund and McMurray, 201660 Freely available from Creative Commons (CC BY/NC 4.0).
Conclusions

Recently, based on PARADIGM-HF trial results, European and American guidelines recommended the substitution of ACEIs or ARBs with ARNIs in symptomatic HF patients with reduced ventricular function. In that study, the administration of sacubitril-valsartan - the first drug of the ARNI class - demonstrated increased survival and reduced hospitalizations for HF compared to patients receiving enalapril. The population enrolled in the study had an overall average age of around 64 years, with 80% male patients. It included only stable outpatients treated with beta-blockers and ACEIs or ARBs and with eGFR >30 mL/min. Therefore, the transfer of the results to the real-world setting of HF patients, particularly those treated in internal medicine wards, has been the subject of discussion, and much research has been done to look for adequate answers.

The majority of HF patients are hospitalized in internal medicine departments. Observational studies show that they have different characteristics from those admitted to cardiology departments. In particular, they are older and have a more significant number of comorbidities.

All the post hoc analyses carried out have shown no contraindications to the use of sacubitril-valsartan in this type of patient. Indeed, beneficial aspects have been found in terms of both renal and metabolic function. In addition, even when long survival is not expected, sacubitril-valsartan versus enalapril showed significant improvements in quality of life.

The fact that results regarding HF patients mainly cared for by internists arise from sub-analysis of trials or studies with small populations should suggest caution. Pending broader and more specific trials in complex, frail, and elderly patients, it is prudent to start sacubitril-valsartan at low doses, with slower up-titration, modulation of concomitant treatment, and careful follow-up.

In conclusion, even in patients treated in internal medicine departments, the substitution of ACEIs or ARBs with ARNIs in symptomatic HF patients with reduced ventricular function appears to be safe and effective while offering benefits to the quality of life and some concomitant comorbidities. Special attention is required for frail and elderly patients.

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