2016 ACC/AHA/HFSA Focused Update on New Pharmacological Therapy for Heart Failure: An Update of the 2013 ACCF/AHA Guideline for the Management of Heart Failure

A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines and the Heart Failure Society of America

Developed in Collaboration With the International Society for Heart and Lung Transplantation

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Preamble

Incorporation of new study results, medications, or devices that merit modification of existing clinical practice guideline recommendations, or the addition of new recommendations, is critical to ensuring that guidelines reflect current knowledge, available treatment options, and optimum medical care. To keep pace with evolving evidence, the American College of Cardiology (ACC)/American Heart Association (AHA) Task Force on Clinical Practice Guidelines (“Task Force”) has issued this focused update to reassess guideline recommendations on the basis of recently published study data. This update has been subject to rigorous, multilevel review and approval, similar to the full guidelines. For specific focused update criteria and additional methodological details, please see the ACC/AHA guideline methodology manual (1).

Modernization—Processes have evolved over time in response to published reports from the Institute of Medicine (2, 3) and ACC/AHA mandates (4-7), leading to adoption of a “knowledge byte” format. This process entails delineation of a recommendation addressing a specific clinical question, followed by concise text (ideally <250 words) and hyperlinked to supportive evidence. This approach better accommodates time constraints on busy clinicians, facilitates easier access to recommendations via electronic search engines and other evolving technology, and supports the evolution of guidelines as “living documents” that can be dynamically updated as needed.

Guideline-Directed Evaluation and Management—The term guideline-directed evaluation and management (GDEM) refers to care defined mainly by ACC/AHA Class I recommendations. For these and all recommended drug treatment regimens, the reader should confirm dosage with product insert material and carefully evaluate for contraindications and interactions. Recommendations are limited to treatments, drugs, and devices approved for clinical use in the United States.

Class of Recommendation and Level of Evidence—The Class of Recommendation (COR) and Level of Evidence (LOE) are derived independently of each other according to established criteria. The COR indicates the strength of recommendation, encompassing the estimated magnitude and certainty of benefit of a clinical action in proportion to risk. The LOE rates the quality of scientific evidence supporting the intervention on the basis of the type, quantity, and consistency of data from clinical trials and other sources (Table 1). Recommendations in this focused update reflect the new 2015 COR/LOE system, in which LOE B and C are subcategorized for the purpose of increased granularity (1, 5, 8).

Relationships With Industry and Other Entities—The ACC and AHA exclusively sponsor the work of guideline writing committees without commercial support, and members volunteer time for this activity. Selected organizations and professional societies with related interests and expertise are invited to participate as partners or collaborators. The Task Force makes every effort to avoid actual, potential, or perceived conflicts of interest that might arise through relationships with industry or other entities (RWI). All writing committee members and reviewers are required to fully disclose current industry relationships or personal interests, beginning 12 months before initiation of the writing effort. Management of RWI involves selecting a balanced writing committee and requires that both the chair and a majority of writing committee members have no relevant RWI (see Appendix 1 for the definition of relevance). Members are restricted with regard to writing or voting on sections to which RWI apply. Members of the writing
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committee who recused themselves from voting are indicated and specific section recusals are noted in Appendix 1. In addition, for transparency, members’ comprehensive disclosure information is available as an Online Supplement (http://circ.ahajournals.org/lookup/suppl/doi:10.1161/CIR.0000000000000435/-/DC1), and reviewers’ RWI disclosures are included in Appendix 2. Comprehensive disclosure information for the Task Force is also available at http://www.acc.org/about-acc/leadership/guidelines-and-documents-task-forces.aspx The Task Force strives to avoid bias by selecting experts from a broad array of backgrounds representing different geographic regions, genders, ethnicities, intellectual perspectives, and scopes of clinical activities.

Intended Use—Guidelines provide recommendations applicable to patients with or at risk of developing cardiovascular disease. The focus is on medical practice in the United States, but guidelines developed in collaboration with other organizations may have a broader target. Although guidelines may be used to inform regulatory or payer decisions, the intent is to improve quality of care and align with patients’ interests. The guidelines are reviewed annually by the Task Force and are official policy of the ACC and AHA. Each guideline is considered current unless and until it is updated, revised, or superseded by a published addendum.

Related Issues—For additional information pertaining to the methodology for grading evidence, assessment of benefit and harm, shared decision making between the patient and clinician, structure of evidence tables and summaries, standardized terminology for articulating recommendations, organizational involvement, peer review, and policies regarding periodic assessment and updating of guideline documents, we encourage readers to consult the ACC/AHA guideline methodology manual (1).

Jonathan L. Halperin, MD, FACC, FAHA
Chair, ACC/AHA Task Force on Clinical Practice Guidelines
Introduction

The ACC, the AHA, and the Heart Failure Society of America (HFSA) recognize that the introduction of effective new therapies that potentially affect a large number of patients presents both opportunities and challenges. The introduction of an angiotensin receptor–neprilysin inhibitor (ARNI) (valsartan/sacubitril) and a sinoatrial node modulator (ivabradine), when applied judiciously, complements established pharmacological and device-based therapies and represents a milestone in the evolution of care for patients with heart failure (HF). Accordingly, the writing committees of the “2016 ACC/AHA/HFSA Focused Update on New Pharmacological Therapy for Heart Failure” and the “2016 ESC Guideline on the Diagnosis and Treatment of Acute and Chronic Heart Failure” concurrently developed recommendations for the incorporation of these therapies into clinical practice. Working independently, each writing committee surveyed the evidence, arrived at similar conclusions, and constructed similar, but not identical, recommendations. Given the concordance, the respective organizations simultaneously issued aligned recommendations on the use of these new treatments to minimize confusion and improve the care of patients with HF.

Members of the ACC/AHA/HFSA writing committee without relevant RWI voted on the final recommendations. These were subjected to external peer review by 25 official, organizational, and content reviewers before approval by the Task Force and the leadership of the ACC, AHA, and HFSA, as well as endorsement by the International Society for Heart and Lung Transplantation. The statements issued by the European Society of Cardiology writing committee went through a similarly rigorous process of external review before endorsement by the societal leadership.

No single clinical trial answers all pertinent questions, nor can trial results be perfectly replicated in clinical practice. Several critical questions remain unanswered, and further experience in both ongoing trials and clinical therapeutics may require modification of these initial recommendations. On the basis of the currently available evidence, however, the recommendations that follow reflect our assessment of how best to proceed today.
Table 1. Applying Class of Recommendation and Level of Evidence to Clinical Strategies, Interventions, Treatments, or Diagnostic Testing in Patient Care* (Updated August 2015)

**CLASS (STRENGTH) OF RECOMMENDATION**

**CLASS I (STRONG)**

Benefit >>> Risk

- Suggested phrases for writing recommendations:
  - Is recommended
  - Is indicated/useful/effective/beneficial
  - Should be performed/administered/other
  - Comparative-Effectiveness Phrases:
    - Treatment/strategy A is recommended(indicated in preference to treatment B
    - Treatment A should be chosen over treatment B

**CLASS IIa (MODERATE)**

Benefit >> Risk

- Suggested phrases for writing recommendations:
  - Is reasonable
  - Can be useful/effective/beneficial
  - Comparative-Effectiveness Phrases:
    - Treatment/strategy A is probably recommended(indicated in preference to treatment B
    - It is reasonable to choose treatment A over treatment B

**CLASS IIb (WEAK)**

Benefit ≈ Risk

- Suggested phrases for writing recommendations:
  - May/might be reasonable
  - May/might be considered
  - Usefulness/effectiveness is unknown/unclear/uncertain or not well established

**CLASS III: No Benefit (MODERATE)**

(Generally, LOE A or B use only)

Benefit = Risk

- Suggested phrases for writing recommendations:
  - Is not recommended
  - Is not indicated/useful/effective/beneficial
  - Should not be performed/administered/other

**CLASS III: Harm (STRONG)**

Risk > Benefit

- Suggested phrases for writing recommendations:
  - Potentially harmful
  - Causes harm
  - Associated with excess morbidity/mortality
  - Should not be performed/administered/other

**LEVEL (QUALITY) OF EVIDENCE‡**

**LEVEL A**

- High-quality evidence† from more than 1 RCT
- Meta-analyses of high quality RCTs
- One or more RCTs corroborated by high-quality registry studies

**LEVEL B-R**

(Randomized)

- Moderate-quality evidence† from 1 or more RCTs
- Meta-analyses of moderate-quality RCTs

**LEVEL B-NR**

(Nonrandomized)

- Moderate-quality evidence† from 1 or more well-designed, well-executed nonrandomized studies, observational studies, or registry studies
- Meta-analyses of such studies

**LEVEL C-LD**

(Limited Data)

- Randomized or nonrandomized observational or registry studies with limitations of design or execution
- Meta-analyses of such studies
- Physiological or mechanistic studies in human subjects

**LEVEL C-EO**

(Expert Opinion)

Consensus of expert opinion based on clinical experience

COR and LOE are determined independently (any COR may be paired with any LOE). A recommendation with LOE C does not imply that the recommendation is weak. Many important clinical questions addressed in guidelines do not lend themselves to clinical trials. Although RCTs are unavailable, there may be a very clear clinical consensus that a particular test or therapy is useful or effective.

* The outcome or result of the intervention should be specified (an improved clinical outcome or increased diagnostic accuracy or incremental diagnostic information).

† For comparative-effectiveness recommendations (COR I and IIa; LOE A and B only), studies that support the use of comparator verbs should involve direct comparisons of the treatments or strategies being evaluated.

‡ The method of assessing quality is evolving, including the application of standardized, widely used, and preferably validated evidence grading tools; and for systematic reviews, the incorporation of an Evidence Review Committee.

COR indicates Class of Recommendation; EO, expert opinion; LD, limited data; LOE, Level of Evidence; NR, nonrandomized; R, randomized; and RCT, randomized controlled trial.
7.3. Stage C

7.3.2. Pharmacological Treatment for Stage C HF With Reduced Ejection Fraction: Recommendations

7.3.2.10. Renin-Angiotensin System Inhibition With Angiotensin-Converting Enzyme Inhibitor or Angiotensin Receptor Blocker or ARNI: Recommendations

See the Online Data Supplement (http://circ.ahajournals.org/lookup/suppl/doi:10.1161/CIR.0000000000000435/-/DC2) for evidence supporting these recommendations.

<table>
<thead>
<tr>
<th>COR</th>
<th>LOE</th>
<th>Recommendations</th>
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<tbody>
<tr>
<td>I</td>
<td>ACE: A</td>
<td>The clinical strategy of inhibition of the renin-angiotensin system with ACE inhibitors (Level of Evidence: A) (9-14), OR ARBs (Level of Evidence: A) (15-18), OR ARNI (Level of Evidence: B-R) (19) in conjunction with evidence-based beta blockers (20-22), and aldosterone antagonists in selected patients (23, 24), is recommended for patients with chronic HF to reduce morbidity and mortality.</td>
</tr>
<tr>
<td></td>
<td>ARB: A</td>
<td></td>
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<tr>
<td></td>
<td>ARNI: B-R</td>
<td>Angiotensin-converting enzyme (ACE) inhibitors reduce morbidity and mortality in heart failure with reduced ejection fraction (HFrEF). Randomized controlled trials (RCTs) clearly establish the benefits of ACE inhibition in patients with mild, moderate, or severe symptoms of HF and in patients with or without coronary artery disease (9-14). ACE inhibitors can produce angioedema and should be given with caution to patients with low systemic blood pressures, renal insufficiency, or elevated serum potassium. ACE inhibitors also inhibit kininase and increase levels of bradykinin, which can induce cough but also may contribute to their beneficial effect through vasodilation. Angiotensin receptor blockers (ARBs) were developed with the rationale that angiotensin II production continues in the presence of ACE inhibition, driven through alternative enzyme pathways. ARBs do not inhibit kininase and are associated with a much lower incidence of cough and angioedema than ACE inhibitors; but like ACE inhibitors, ARBs should be given with caution to patients with low systemic blood pressure, renal insufficiency, or elevated serum potassium. Long-term therapy with ARBs produces hemodynamic, neurohormonal, and clinical effects consistent with those expected after interference with the renin-angiotensin system and have been shown in RCTs (15-18) to reduce morbidity and mortality, especially in ACE inhibitor–intolerant patients. In ARNI, an ARB is combined with an inhibitor of neprilysin, an enzyme that degrades natriuretic peptides, bradykinin, adrenomedullin, and other vasoactive peptides. In an RCT that compared the first approved ARNI,</td>
</tr>
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</table>

See Online Data Supplements 1, 2, 18-20.
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| I | ACE: A | valsartan/sacubitril, with enalapril in symptomatic patients with HF\(_r\)EF tolerating an adequate dose of either ACE inhibitor or ARB, the ARNI reduced the composite endpoint of cardiovascular death or HF hospitalization significantly, by 20% (19). The benefit was seen to a similar extent for both death and HF hospitalization and was consistent across subgroups. The use of ARNI is associated with the risk of hypotension and renal insufficiency and may lead to angioedema, as well. |
| See Online Data Supplement 18. | | The use of ACE inhibitors is beneficial for patients with prior or current symptoms of chronic HF\(_r\)EF to reduce morbidity and mortality (9-14, 25). |

| I | ARB: A | ARBs have been shown to reduce mortality and HF hospitalizations in patients with HF\(_r\)EF in large RCTs (15-18). Long-term therapy with ARBs in patients with HF\(_r\)EF produces hemodynamic, neurohormonal, and clinical effects consistent with those expected after interference with the renin-angiotensin system (27, 28). Unlike ACE inhibitors, ARBs do not inhibit kininase and are associated with a much lower incidence of cough and angioedema, although kininase inhibition by ACE inhibitors may produce beneficial vasodilatory effects. Patients intolerant to ACE inhibitors because of cough or angioedema should be started on ARBs; patients already tolerating ARBs for other |
| See Online Data Supplements 2 and 19. | | The use of ARBs to reduce morbidity and mortality is recommended in patients with prior or current symptoms of chronic HF\(_r\)EF who are intolerant to ACE inhibitors because of cough or angioedema (15-18, 27, 28). |
indications may be continued on ARBs if they subsequently develop HF. ARBs should be started at low doses and titrated upward, with an attempt to use doses shown to reduce the risk of cardiovascular events in clinical trials. ARBs should be given with caution to patients with low systemic blood pressure, renal insufficiency, or elevated serum potassium (>5.0 mEq/L). Although ARBs are alternatives for patients with ACE inhibitor–induced angioedema, caution is advised because some patients have also developed angioedema with ARBs.

Head-to-head comparisons of an ARB versus ARNI for HF do not exist. For those patients for whom an ACE inhibitor or ARNI is inappropriate, use of an ARB remains advised.

<table>
<thead>
<tr>
<th>I</th>
<th>ARNI: B-R</th>
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<tr>
<td>In patients with chronic symptomatic HFrEF NYHA class II or III who tolerate an ACE inhibitor or ARB, replacement by an ARNI is recommended to further reduce morbidity and mortality (19).</td>
<td></td>
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</table>

See Online Data Supplements 1 and 18.

Benefits of ACE inhibitors with regard to decreasing HF progression, hospitalizations, and mortality rate have been shown consistently for patients across the clinical spectrum, from asymptomatic to severely symptomatic HF. Similar benefits have been shown for ARBs in populations with mild-to-moderate HF who are unable to tolerate ACE inhibitors. In patients with mild-to-moderate HF (characterized by either 1) mildly elevated natriuretic peptide levels, BNP [B-type natriuretic peptide] >150 pg/mL or NT-proBNP [N-terminal pro-B-type natriuretic peptide] ≥600 pg/mL; or 2) BNP ≥100 pg/mL or NT-proBNP ≥400 pg/mL with a prior hospitalization in the preceding 12 months) who were able to tolerate both a target dose of enalapril (10 mg twice daily) and then subsequently an ARNI (valsartan/sacubitril; 200 mg twice daily, with the ARB component equivalent to valsartan 160 mg), hospitalizations and mortality were significantly decreased with the valsartan/sacubitril compound compared with enalapril. The target dose of the ACE inhibitor was consistent with that known to improve outcomes in previous landmark clinical trials (10). This ARNI has recently been approved for patients with symptomatic HFrEF and is intended to be substituted for ACE inhibitors or ARBs. HF effects and potential off-target effects may be complex with inhibition of the neprilysin enzyme, which has multiple biological targets. Use of an ARNI is associated with hypotension and a low-frequency incidence of angioedema. To facilitate initiation and titration, the approved ARNI is available in 3 doses that include a dose that was not tested in the HF trial; the target dose used in the trial was 97/103 mg twice daily (29). Clinical experience will provide further information about the optimal titration and tolerability of ARNI, particularly with regard to blood pressure, adjustment of concomitant HF medications, and the rare complication of angioedema (30).

<table>
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<tr>
<th>III: Harm</th>
<th>B-R</th>
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<tr>
<td>ARNI should not be administered concomitantly with ACE inhibitors or within 36 hours of the last dose of an ACE inhibitor (31, 32).</td>
<td></td>
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</table>

See Online Data Supplement 3.

Oral neprilysin inhibitors, used in combination with ACE inhibitors can lead to angioedema and concomitant use is contraindicated and should be avoided. A medication that represented both a neprilysin inhibitor and an ACE inhibitor,
Omapatrilat, a neprilysin inhibitor (as well as an ACE inhibitor and aminopeptidase P inhibitor), was associated with a higher frequency of angioedema than that seen with enalapril in an RCT of patients with HF (31). In a very large RCT of hypertensive patients, omapatrilat was associated with a 3-fold increased risk of angioedema as compared with enalapril (32). Blacks and smokers were particularly at risk. The high incidence of angioedema ultimately led to cessation of the clinical development of omapatrilat (34, 35). In light of these observations, angioedema was an exclusion criterion in the first large trial assessing ARNI therapy in patients with hypertension (36) and then in the large trial that demonstrated clinical benefit of ARNI therapy in HFrEF (19). ARNI therapy should not be administered in patients with a history of angioedema because of the concern that it will increase the risk of a recurrence of angioedema.

7.3.2.11. Ivabradine: Recommendation

See the Online Data Supplement (http://circ.ahajournals.org/lookup/suppl/doi:10.1161/CIR.0000000000000435/-/DC2) for evidence supporting this recommendation.

### Recommendation for Ivabradine

<table>
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<th>COR</th>
<th>LOE</th>
<th>Recommendation</th>
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<tr>
<td>IIa</td>
<td>B-R</td>
<td>Ivabradine can be beneficial to reduce HF hospitalization for patients with symptomatic (NYHA class II-III) stable chronic HFrEF (LVEF ≤35%) who are receiving GDEM, including a beta blocker at maximum tolerated dose, and who are in sinus rhythm with a heart rate of 70 bpm or greater at rest (37-40).</td>
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</table>

Ivabradine is a new therapeutic agent that selectively inhibits the If current in the sinoatrial node, providing heart rate reduction. One RCT demonstrated the efficacy of ivabradine in reducing the composite endpoint of cardiovascular death or HF hospitalization (38). The benefit of ivabradine was driven by a reduction in HF hospitalization. The study included patients with HFrEF (NYHA class II-IV, albeit with only a modest representation of NYHA class IV HF) and left ventricular ejection fraction (LVEF) ≤35%, in sinus rhythm with a resting heart rate of ≥70 beats per minute. Patients enrolled included a small number with paroxysmal atrial fibrillation (<40% of the time) but otherwise in
sinus rhythm and a small number experiencing ventricular pacing but with a predominant sinus rhythm. Those with a myocardial infarction within the preceding 2 months were excluded. Patients enrolled had been hospitalized for HF in the preceding 12 months and were on stable GDEM for 4 weeks before initiation of ivabradine therapy. The target of ivabradine is heart rate slowing (the presumed benefit of action), but only 25% of patients studied were on optimal doses of beta-blocker therapy (20-22, 38). Given the well-proven mortality benefits of beta-blocker therapy, it is important to initiate and up titrate these agents to target doses, as tolerated, before assessing the resting heart rate for consideration of ivabradine initiation (38).

The remainder of the “2016 ACC/AHA/HFSA Focused Update on the Management of Heart Failure: An Update of the 2013 ACCF/AHA Guideline for the Management of Heart Failure” will be forthcoming.

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Key Words: AHA Scientific Statements; ■ Heart Failure ■ Focused Update ■ Angiotensin Receptor-Nephrilysin Inhibitor ■ Ivabradine ■ Angiotensin Receptor Blockers ■ Angiotensin-Converting Enzyme Inhibitors ■ Beta blockers ■ Angioedema ■ Natriuretic Peptides
References


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Appendix 1. Author Relationships With Industry and Other Entities (Relevant)—2016 ACC/AHA/HFSA Focused Update on New Pharmacological Therapy for Heart Failure (December 2015)

<table>
<thead>
<tr>
<th>Committee Member</th>
<th>Employment</th>
<th>Consultant</th>
<th>Speakers Bureau</th>
<th>Ownership/Partnership/Principal</th>
<th>Personal Research Institutional, Organizational, or Other Financial Benefit</th>
<th>Expert Witness</th>
<th>Voting Recusals By Section*</th>
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<td>• Amgen (DSMB)†</td>
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<td>• DCR/Otsuka • UptoDate</td>
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This table represents the relationships of committee members with industry and other entities that were determined to be relevant to this document. These relationships were reviewed and updated in conjunction with all meetings and/or conference calls of the writing committee during the document development process. The table does not necessarily reflect relationships with industry at the time of publication. A person is deemed to have a significant interest in a business if the interest represents ownership of $\geq 5\%$ of the voting stock or share of the business entity, or ownership of $\geq 50,000$ of the fair market value of the business entity, or if funds received by the person from the business entity exceed $5\%$ of the person’s gross income for the previous year. Relationships that exist with no financial benefit are also included for the purpose of transparency. Relationships in this table are modest unless otherwise noted.

According to the ACC/AHA, a person has a relevant relationship IF: a) The relationship or interest relates to the same or similar subject matter, intellectual property or asset, topic, or issue addressed in the document; or b) the company/entity (with whom the relationship exists) makes a drug, drug class, or device addressed in the document, or makes a competing drug or device addressed in the document; or c) the person or a member of the person’s household has a reasonable potential for financial, professional, or other personal gain or loss as a result of the issues/content addressed in the document.

*Writing committee members are required to recuse themselves from voting on sections to which their specific relationships with industry and other entities may apply.
†Significant relationship.

ACC indicates American College of Cardiology; AHA, American Heart Association; DCRI, Duke Clinical Research Institute; DSMB, data safety monitoring board; HFSA, Heart Failure Society of America; UCLA, University of California, Los Angeles; and VA, Veterans Affairs.
Appendix 2. Reviewer Relationships With Industry and Other Entities (Comprehensive)—2016 ACC/AHA/HFSA Focused Update on New Pharmacological Therapy for Heart Failure (March 2016)

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<td>Dipti Itchhaporia</td>
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<td>Mary Norine Walsh</td>
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<td>St Vincent Heart Center of Indiana—Medical Director, Heart Failure and Cardiac Transplantation</td>
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<td>David A. Baran</td>
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<td>Newark Beth Israel Medical Center—Director of Heart Failure and Transplant Research</td>
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Yancy CW, et al
Heart Failure Focused Update on Pharmacological Therapy
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<td>Kenneth W. Lin</td>
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<td>Oregon Health &amp; Science University—Clinical Professor of Medicine</td>
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<td>Lee A. Fleisher</td>
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<td>University of Pennsylvania Health System—Robert Dunning Dripps Professor of Anesthesiology and Critical Care; Chair, Department of Anesthesiology &amp; Critical Care</td>
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<td>Samuel S. Gidding</td>
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<td>Nemours/Alfred I. duPont Hospital for Children—Chief, Division of Pediatric Cardiology</td>
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<td>James L. Januzzi</td>
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- ACC/AHA†
- AHA†
- ASA†
- Catheterization and Cardiovascular Intervention†
- NIH
- Portland Metro Area AHA (President)†
- SCAI Quality Interventional Council†
- FH†
- FH Foundation†
- International FH Foundation†
- NQF†
- Johns Hopkins (DSMB)
- Association of University Anesthesiologists†
- Blue Cross/Blue Shield*
- FH Foundation*
- International FH Foundation*
- NIH*
- Novartis*
- Phillips
- Roche
- Amgen (DSMB)
- Boeringer Ingelheim (DSMB)*
- Janssen
## Yancy CW, et al
**Heart Failure Focused Update on Pharmacological Therapy**

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<tr>
<th>Name</th>
<th>Content Reviewer—ACC/AHA Task Force on Clinical Practice Guidelines</th>
<th>UT Southwestern Medical Center—Professor of Internal Medicine; Clinical Cardiac Electrophysiology—Program Director</th>
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<td>José A. Joglar</td>
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<td>Edward K. Kasper</td>
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| Wayne C. Levy         | Content Reviewer—ACC/AHA Task Force on Clinical Practice Guidelines | University of Washington—Professor of Cardiology                                               | • Abbott Laboratories  
• GE Healthcare  
• HeartWare  
• PharminIN | None                   |
| Judith E. Mitchell    | Content Reviewer—ACC/AHA Task Force on Clinical Practice Guidelines | SUNY Downstate Medical Center—Director/Heart Failure Center; SUNY Downstate College of Medicine—Associate Professor of Medicine | None         | None                   |
| Sean P. Pinney        | Content Reviewer—ACC/AHA Task Force on Clinical Practice Guidelines | Mount Sinai School of Medicine—Associate Professor of Medicine, Cardiology                     | • Acorda Therapeutics  
• Thoratec  
• XDx | None                   |
| Randall C. Starling   | Content Reviewer—ACC/AHA Task Force on Clinical Practice Guidelines | Cleveland Clinic Department of Cardiovascular Medicine—Vice Chairman, Department of Cardiovascular Medicine; Section Head, Heart Failure & Cardiac Transplant | • BioControl  
• Medtronic  
• Novartis | None                   |

* | NIH  
| Amgen*  
| AHA  
| HeartWare*  
| Novartis*  
| Resmed*  
| Thoratec |

† Association of Black Cardiologists

None
This table represents the relationships of reviewers with industry and other entities that were disclosed at the time of peer review, including those not deemed to be relevant to this document. The table does not necessarily reflect relationships with industry at the time of publication. A person is deemed to have a significant interest in a business if the interest represents ownership of ≥5% of the voting stock or share of the business entity, or ownership of ≥$5,000 of the fair market value of the business entity, or if funds received by the person from the business entity exceed 5% of the person’s gross income for the previous year. A relationship is considered to be modest if it is less than significant under the preceding definition. Relationships that exist with no financial benefit are also included for the purpose of transparency. Relationships in this table are modest unless otherwise noted. Names are listed in alphabetical order within each category of review.

American College of Physicians did not provide a peer reviewer for this document.

*Significant relationship.
†No financial benefit.

AAFP indicates American Academy of Family Physicians; ACC, American College of Cardiology; AHA, American Heart Association; ASA, American Stroke Association; CHEST, American College of Chest Physicians; CIHR, Canadian Institutes of Health Research; DSMB, data safety monitoring board; FH, familial hypercholesterolemia; GWTG, Get With The Guidelines; HFSA, Heart Failure Society of America; ISHLT, International Society for Heart and Lung Transplantation; NIH, National Institutes of Health; NHLBI, National Heart, Lung, and Blood Institute; NQF, National Quality Forum; PCORI, Patient-Centered Outcomes Research Institute; SCAI, Society for Cardiac Angiography and Interventions; SUNY, State University of New York; UT, University of Texas; and VA, Veterans Affairs.
Author Relationships With Industry and Other Entities (Comprehensive)—2016 ACC/AHA/HFSA Focused Update on New Pharmacological Therapy for Heart Failure (December 2015)

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<tr>
<td>Clyde W. Yancy (Chair)</td>
<td>Northwestern University Feinberg School of Medicine, Division of Cardiology—Professor of Medicine and Chief, Diversity and Inclusion—Vice Dean</td>
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<td>Mariell Jessup (Vice Chair)</td>
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| Mark H. Drazner | University of Texas Southwestern Medical Center—Professor, Internal Medicine | None | None | None | Trevena* | AHA* | None | None |

| Gerasimos S. Filippatos | National and Kapodistrian University of Athens; Attikon University Hospital, Department of Cardiology, Heart Failure Unit—Professor of Cardiology | None | None | None | None | None | None | None |

| Gregg C. Fonarow | Ahmanson-UCLA Cardiomyopathy Center—Director; UCLA Division of Cardiology—Co-Chief | Amgen | Janssen Pharmaceuticals | Medtronic | Novartis* | None | None | None |

<p>| | | None | None | None | Medtronic–IMPROVE-HF (Steering Committee)* | NHLBI* | NIH/NIAID* | Novartis* | ACC/AHA Task Force on Data Standards† | ACC/AHA Task Force on Performance Measures (Chair-Elect)† | ACTION Registry GWTG Steering Committee (Chair)† | AHA Consumer Health | None |</p>
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<td>Michael M. Givertz</td>
<td>Brigham and Women's Hospital—Professor of Medicine</td>
<td>• Cardioxyl • Merck • Novartis</td>
<td>None</td>
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<td>Steven M. Hollenberg</td>
<td>Cooper University Hospital—Director, Coronary Care Unit, Professor of Medicine</td>
<td>None</td>
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<td>JoAnn Lindenfeld</td>
<td>Vanderbilt Heart and Vascular Institute—Director, Advanced Heart Failure and</td>
<td>• Abbott • Boston Scientific • Cardiomems* • CVRx • Janssen Pharmaceuticals</td>
<td>None</td>
<td>None</td>
<td>AstraZeneca† • Novartis*• St.</td>
<td>JACC HF (Deputy Editor)</td>
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<td>Transplant Section—Professor of Medicine</td>
<td>• Novartis • Relypsa* • RESMED*</td>
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<tr>
<td>Frederick A. Masoudi</td>
<td>University of Colorado, Denver—Associate Professor of Medicine, Division of Medicine</td>
<td>• ABIM</td>
<td>None</td>
<td>None</td>
<td>ACC* • ACC-NCDR* • AHRQ*</td>
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<td>Cardiology</td>
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<td>Circulation (Associate Editor)</td>
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<tr>
<td>Patrick E. McBride</td>
<td>University of Wisconsin School of Medicine and Public Health—Professor of Medicine and Family Medicine; Associate Director, Preventive Cardiology</td>
<td>None</td>
<td>None</td>
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<tr>
<td>Pamela N. Peterson</td>
<td>University of Colorado, Denver Health Medical Center—Associate Professor</td>
<td>• ACC*</td>
<td>None</td>
<td>None</td>
<td>JAHA (Associate Editor)*</td>
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<tr>
<td>Lynne W. Stevenson</td>
<td>Brigham and Women’s Hospital Cardiovascular Division—Director, Cardiomyopathy and Heart Failure Program</td>
<td>• St. Jude Medical</td>
<td>None</td>
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<td>• Novartis—PARENT (PI)</td>
<td>• NHLBI</td>
<td>• NHLBI—INTERMACS (Co–PI)†</td>
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<tr>
<td>Cheryl Westlake</td>
<td>Azusa Pacific University—Professor and Associate Dean, International and Community Programs</td>
<td>None</td>
<td>None</td>
<td>None</td>
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*Significant relationship.
†No financial benefit.

ACC indicates American College of Cardiology; AHA, American Heart Association; ABIM, American Board of Internal Medicine; AHRQ, Agency for Healthcare Research and Quality; DCRI, Duke Clinical Research Institute; DSMB, data safety monitoring board; GWTG, Get With The Guidelines; HF, heart failure; HFSA, Heart Failure Society of America; HRSA, Heath Resources and Services Administration; HSAG, Health Services Advisory Group; IMPROVE-HF, Registry to Improve the Use of Evidence-Based Heart Failure Therapies in the Outpatient Setting; INTERMACS, Interagency Registry for Mechanically Assisted Circulatory Support; JAHA, Journal of the American Heart Association; PCORI, Patient-Centered Outcomes Research Institute; PI, principal investigator; PRT, pharmaceutical round table; NIDDK, National Institute of Diabetes and Digestive and Kidney Diseases; NIH, National Institutes of Health; NHLBI, National Heart, Lung, and Blood Institute; NIAID, National Institute of Allergy and Infectious Diseases; UCLA, University of California, Los Angeles; and VA, Veterans Affairs.
### Data Supplement 1. RCTs Comparing ARNI (Section 7.3.2.10)

<table>
<thead>
<tr>
<th>Study Acronym; Author; Year Published</th>
<th>Aim of Study; Study Type; Study Size (N)</th>
<th>Patient Population</th>
<th>Study Intervention (# patients) / Study Comparator (# patients)</th>
<th>Endpoint Results (Absolute Event Rates, P values; OR or RR; &amp; 95% CI)</th>
<th>Relevant 2° Endpoint (if any); Study Limitations; Adverse Events</th>
</tr>
</thead>
<tbody>
<tr>
<td>PARAMOUNT Solomon et al. 2012 (1) 22932717</td>
<td>Aim: To address safety and efficacy of LCZ696 (ARNI) in pts with HFpEF</td>
<td>Inclusion criteria: Pts ≥40 y of age, LVEF ≥45%, NYHA class II-III HF, NT-pro BNP &gt;400 pg/mL.</td>
<td>Intervention: LCZ696 (149) target dose 200 mg BID achieved in 81%</td>
<td>1° endpoint: • Change from BL at 12 wk for NT-proBNP</td>
<td>• No difference in change in NT-proBNP from BL at 36 wk • BP reduced in the LCZ696 group vs. valsartan at 12 wk (p=0.001 for SBP and p=0.09 for DBP) • Change in BP correlated poorly with the change in pro-BNP • No difference in improvement in NYHA class at 12 wk (p=0.11) and 36 wk (p=0.05). • No difference in KCCQ scores • Trial not powered to ascertain clinical efficacy</td>
</tr>
<tr>
<td></td>
<td>Exclusion criteria: Right HF due to pulmonary disease, dyspnea due to noncardiac causes, valvular/myocardial disease, CAD or CVD needing revascularization within 3 mo of screening.</td>
<td>Comparator: Valsartan (152) target dose 160 mg BID achieved in 78%</td>
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<tr>
<td>Study type: RCT</td>
<td>Size: 308</td>
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</tbody>
</table>

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| PARADIGM-HF | Aim: To compare survival rates with the use of LCZ696 with enalapril in HF | Inclusion criteria: ≥18 y of age, NYHA class II, III, IV; EF ≤35%, BNP of at least 150 pg/mL, hospitalized for HF ≤12 mo (≥BNP100 pg/mL), on ACE inhibitors or ARBs ≥4 wk before screening, required to take stable dose of beta blockers and an ACE inhibitor (or ARB) equal to 10mg of enalapril. Prior to randomization pts were required to complete 2 wk each of enalapril 10 mg BID and LCZ 100 BID. | Intervention: LCZ696 (4,187) target dose 200 mg BID (mean 375±71 mg daily) Comparator: Enalapril (4,212) target 10 mg BID (mean 18.9±3.4 mg daily) | 1° endpoint: • Composite of death (CV causes) or a first hospitalization for HF • Results: Composite less in LCZ696 group vs. enalapril, 914 (21.8%) vs. 1,117 (26.5%) HR: 0.80 (95% CI: 0.73–0.87; p<0.001) • Less CV death in LCZ696 arm (558 vs. 693) HR: 0.8 (95% CI: 0.71–0.89; p<0.001) • Less HF hospitalizations in LCZ696 arm (537 vs. 658) HR: 0.79 (95% CI: 0.71–0.89; p<0.001) • Less death from any cause in LCZ696 arm (711 vs. 835), HR: 0.84 (95% CI: 0.76–0.93; p<0.001) • The change from baseline to 8 mo in the score on the KCCQ in LCZ696 arm (2.99 points reduction vs. 4.63 points), HR: 1.64 (95% CI: 0.63–2.65; p=0.001) | 15% in LCZ696 vs. 20% in valsartan group outcomes. Further studies needed to assess safety and efficacy in HFpEF pts. |
| Study type: RCT | Size: 8,442 | 1° endpoint: • Composite of death (CV causes) or a first hospitalization for HF • Results: Composite less in LCZ696 group vs. enalapril, 914 (21.8%) vs. 1,117 (26.5%) HR: 0.80 (95% CI: 0.73–0.87; p<0.001) | | |
| Study type: RCT | Size: 8,442 | Exclusion criteria: Symptomatic hypotension, SBP <95 mm Hg, eGFR <30 mL/min/1.73m² of body surface area, serum K level >5.2 mmol/L, angioedema history, unacceptable side effects of ACE inhibitors or ARBs | | |

AF indicates atrial fibrillation; ARNI/LCZ696, angiotensin receptor-neprilysin inhibitor; ACE, angiotensin-converting enzyme; ARB, angiotensin-receptor blocker; BL, baseline; BID; twice a day; BNP, plasma B-type natriuretic peptide; BP, blood pressure; CAD, coronary artery disease; CI, confidence interval; CVD, cardiovascular disease; CV, cardiovascular; EF, ejection fraction; eGFR, estimated glomerular filtration rate; HF, heart failure; HFpEF, heart failure with preserved ejection fraction; HR, hazard ratio; KCCQ, Kansas City Cardiomyopathy Questionnaire; LVEF, left ventricular ejection fraction; N/A, not available; NT-proBNP, N-terminal pro-B-type natriuretic peptide; NYHA, New York Heart Association; PARAMOUNT, Prospective Comparison of ARNI With ARB on Management of Heart Failure With Preserved Ejection Fraction; PARADIGM-HF, Prospective Comparison of ARNI With ACE to Determine Impact on Global Mortality and Morbidity in Heart Failure; pts, patients; RCT, randomized controlled trial; and SBP, systolic blood pressure.

Search Terms and Date: 3 trials identified by chairs in December 2015.
### Data Supplement 2. RCTs Comparing RAAS Inhibition (Section 7.3.2.3)

<table>
<thead>
<tr>
<th>Study Acronym; Author; Year Published</th>
<th>Aim of Study; Study Type; Study Size (N)</th>
<th>Patient Population</th>
<th>Study Intervention (# patients) / Study Comparator (# patients)</th>
<th>Endpoint Results (Absolute Event Rates, P values; OR or RR; &amp; 95% CI)</th>
<th>Relevant 2° Endpoint (if any); Study Limitations; Adverse Events</th>
</tr>
</thead>
</table>
| ONTARGET ONTARGET Investigators et al. 2008 (3) 18378520 | **Aim:** Compare ACE (ramipril), ARB (telmisartan), and combination ACE/ARB in pts with CVD or high-risk DM | **Inclusion Criteria:** Pts >55 y of age, CAD, PVD, previous stroke, or high-risk DM with end-organ damage  
**Exclusion Criteria:** HF at trial entry, ACE or ARB intolerance, revascularization planned or <3 mo | **Intervention:** Runin, then randomization to ramipril (8,576) target dose 10 mg daily, telmisartan (8,542) target dose 80 mg daily or combination (8,502), titrated to BP  
**1° endpoint:**  
- Composite of CV death, MI, stroke, or HF hospitalization at 5 y  
**Results:** No difference in outcome (16.5% ACE, 16.7% ARB, 16.3% combination; CI: ARB RR: 1.01 (95% CI: 0.94–1.09)  
**Compared to the ramipril arm:**  
- Telmisartan had more hypotensive symptoms (p<0.001); less cough (p<0.001) and angioedema (p=0.01); same syncope.  
- Combination arm had more hypotensive symptoms (p<0.001); syncope (p=0.03); and renal dysfunction (p<0.001)  
- BP fell by 6.4/7.4/9.8 mm Hg  
- Less angioedema with telmisartan |
| TRANSCEMD Yusuf et al. 2008 (4) 10757085 | **Aim:** To assess the effectiveness of ARB in ACE-intolerant pts with CVD or high-risk DM  
**Study Type:** RCT  
**Size:** 5,926 | **Inclusion Criteria:** ACE-intolerant pts with CAD, PVD, previous stroke, or high-risk DM with end-organ damage  
**Exclusion Criteria:** HF at trial entry, revascularization planned or <3 mo | **Intervention:** Runin, then randomization to telmisartan titrated to 80 mg as tolerated (2,954)  
**Comparator:** Titration of other medications as needed to control BP (2,944)  
**1° endpoint:**  
- Composite of CV death, MI, stroke, or HF hospitalization at 5 y  
**Results:** No significant difference RR: 0.92 (95% CI: 0.81–1.05); p=0.216  
**No difference in 2° outcomes:** ARB was safe in this pt population - no angioedema |
| SUPPORT Sakata et al. 2015 (5) 25637937 | **Aim:** Discover whether addition of ARB to ACE and beta blockers in pts with chronic HF will improve clinical outcomes  
**Study Type:** Open label blinded endpoint  
**Size:** 1,147 | **Inclusion Criteria:** Pts 20–79 y of age with hypertension, NYHA class II-IV, stable on ACE ± beta blockers  
**Exclusion Criteria:** Creatinine >3.0, MI or, revascularization within 6 mo | **Intervention:** Randomization to olmesartan (578) titrated up to 40 mg as tolerated (578) (mean dose achieved at 5 y, 17.9 mg/d)  
**Comparator:** Titration to control BP without use of an ARB (568)  
**1° endpoint:**  
- Composite of all-cause death, MI, stroke, or HF hospitalization at 4.4 y  
**Results:** No significant difference RR: 1.18 (95% CI: 0.96–1.46); p=0.11  
**Pts on triple therapy with ACE/ARB/Beta blocker had more of 1° composite outcome, 38.1% vs. 28.2%. HR: 1.47 (95% CI: 1.11–1.95; p=0.006); all-cause death, 19.4 vs. 13.5%, HR: 1.50 (95% CI: 1.01–2.23; p=0.046); and renal dysfunction (21.1 vs. 12.5%, HR: 1.85 (95% CI: 1.24–2.76; p=0.003). |

Mineralocorticoids Antagonist
<table>
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<tr>
<th>Study</th>
<th>Aim</th>
<th>Inclusion Criteria</th>
<th>Intervention</th>
<th>1° endpoint</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>EMPHASIS subgroup analysis Eschalier et al. 2013 (6) 23810881</td>
<td><strong>Aim:</strong> Investigate the safety and efficacy of eplerenone in pts at high risk for hyperkalemia.</td>
<td>Pts enrolled in EMPHASIS at high risk for hyperkalemia of worsening renal function (&gt;75 y, DM, eGFR &lt;60, or SBP &lt;123)</td>
<td>Randomization to eplerenone Comparator: Placebo</td>
<td><strong>1° endpoint:</strong> Efficacy: Hospitalization for HF or worsening renal failure. Safety: K &gt;5.5, &gt;6.0, &lt;3.5, hospitalization for significant hyperkalemia, hospitalization for worsening renal function</td>
<td><strong>Results:</strong> Efficacy: reduced composite endpoint. Safety: increased risk of K+ &gt;5.5 mmol/L, hospitalization for hyperkalemia or discontinuation of study medication due to adverse events. No differences from the main trial results in the high-risk subgroups. K &gt;5.5 was increased in the whole cohort and the subgroups, but K &gt;6.0, clinically significant hyperkalemia, and change in eGFR were not substantially higher.</td>
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<tr>
<td>RALES Pitt et al. 1999 (7) 10471456</td>
<td><strong>Aim:</strong> To investigate the effect of spironolactone on mortality and morbidity in pts with severe HF.</td>
<td>NYHA class III, IV; HF≤6 mo, Left EF≤35%, On ACE inhibitors, loop diuretic. Digitalis and vasodilators allowed.</td>
<td>Spironolactone 25 mg daily (822) Comparator: Placebo (841)</td>
<td><strong>1° endpoint:</strong> Death from all causes</td>
<td><strong>Results:</strong> Placebo vs. Spironolactone group (46% vs. 35%; RR: 0.70; 95% CI: 0.60–0.82; p&lt;0.001) Trial stopped early due to favorable results at 24 mo. Reduction in death from cardiac causes and Hospitalization for cardiac causes (p&lt;0.001) Improvement in NYHA class (p&lt;0.001) No clinically important safety concerns for electrolytes. Gynecomastia/breast pain more frequent in the spironolactone group (p&lt;0.001)</td>
</tr>
</tbody>
</table>

1° indicates primary; 2°, secondary; ACE, angiotensin-converting enzyme; ARB, angiotensin-receptor blockers; ACHD, adult congenital heart disease; BP, blood pressure; CAD, coronary artery disease; CI, confidence interval; CVD, cardiovascular disease; CV, cardiovascular; DM, diabetes mellitus, eGFR, estimated glomerular filtration rate; EMPHASIS, Eplerenone in Mild Patients Hospitalization and Survival Study in Heart Failure; HF, heart failure; MI, myocardial infarction; NNH, number needed to harm; NYHA, New York Heart Association; ONTARGET, The Ongoing Telmisartan Alone and in Combination With Ramipril Global Endpoint Trial; pts, patients; PVD, peripheral vascular disease; RCT, randomized controlled trial; RR, relative risk; SBP, systolic blood pressure; SUPPORT, Supplemental Benefit of ARB in Hypertensive Patients With Stable Heart Failure Using Olmesartan; TRANSCEND, the Telmisartan Randomised Assessment Study in ACE Intolerant Subjects With Cardiovascular Disease; and VHD, valvular heart disease.

Search Terms and Date: angiotensin-receptor blockers, ARBs, angiotensin-receptor blocker, ARB, angiotensin-receptor antagonists, angiotensin receptor antagonist, candesartan, irbesartan, losartan, telmisartan, valsartan, olmesartan, AND heart failure or congestive heart failure or CHF or HFrEF AND clinical trial, January 2016.
The ARB evidence table from the 2013 Heart Failure Guideline is included at the end of this document.

The ACE inhibitor evidence table from the 2013 Heart Failure Guideline is also included at the end of this document.

The Beta Blocker evidence table from the 2013 Heart Failure Guideline is included at the end of this document.

Data Supplement 3. RCTs Comparing Pharmacological Treatment for of ARNI With ACE (Section 7.3.2.10)

<table>
<thead>
<tr>
<th>Study Acronym; Author; Year Published</th>
<th>Aim of Study; Study Type; Study Size (N)</th>
<th>Patient Population</th>
<th>Study Intervention (# patients) / Study Comparator (# patients)</th>
<th>Endpoint Results (Absolute Event Rates, P values; OR or RR; &amp; 95% CI)</th>
<th>Relevant 2° Endpoint; Study Limitations; Adverse Events</th>
</tr>
</thead>
</table>
| IMPRESS Rouleau et al. 2000 (8) 10968433 | Aim: Determine if inhibition of neutral endopeptidase and ACE with the vasopeptidase inhibitor omapatrilat is better than ACE inhibition alone with lisinopril  
**Study type:** Double blind RCT  
**Size:** 573 pts | Inclusion criteria:  
- Informed consent  
- Age ≥18  
- Stable (>3 mo) symptomatic HF (NYHA class II–IV HF)  
- Decreased LVEF ≤40  
- ≥4 wk dose of ACE inhibitors  
- Seated SBP ≥90 mm Hg  

**Exclusion criteria:**  
- Uncontrolled hypertension  
- Acute coronary events within 3 mo  
- Revascularization within 3 mo  
- Serum potassium <3.5 or >5.3 mmol/L  
- Creatinine >221 mcmmol/L  
- Transaminases >2 upper limit of normal  
- Leucocytes <3.0x109/L, neutrophils <1.  
5x109/L, or platelets <120x109/L  
- Use of beta blockers <6 mo  
- Calcium channel blockers for use other than AF  
- Pts included in previous RCTs of omapatrilat  

**Intervention:** Omapatrilat (289) target dose 40 mg daily  
**Comparator:** Lisinopril (284) target dose 20 mg daily  
1° endpoint: Change in exercise duration from baseline to wk 12  
Results:  
- Similar exercise duration at 12 wk (p=0.45)  

2° endpoint:  
- No difference in combined endpoint of death and admission for worsening HF (p=0.52)  
- Combined endpoint of death and comorbidity for worsening HF was better for omapatrilat HR: 0.52 (95% CI: 0.28–0.96; p=0.035)  
- Angioedema occurred in no pts taking omapatrilat vs. 1 taking enalapril  

**Comments:** Vasopeptidase inhibitor omapatrilat did not improve exercise tolerance compared with ACE inhibitor lisinopril |
| OVERTURE Packer et al. 2002 (9) 12186794 | Aim: Determine dual ACE and NEP inhibitors provides greater benefit in pts with HF than ACE inhibitors alone  
**Inclusion criteria:**  
- NYHA class II–IV HF due to non/ischemic cardiomyopathy for ≥2 mo, or  
- LVEF ≤30% and hospitalized for HF within 12 mo  

**Exclusion criteria:**  
- Pts included in previous RCTs of omapatrilat  

**Intervention:** Omapatrilat (2,886), target dose 40 mg daily  
**Comparator:** Enalapril (2,884) target dose 10  
1° endpoint: Combined risk of death or hospitalization for HF requiring IV treatment  
Results: No significant difference HR: 0.94 (95%  
- Omapatrilat reduced risk of death and hospitalization for chronic HF HR: 0.89 (95% CI: 0.82–0.98; p=0.012). For this analysis, pts were treated with intensification of oral medications. |

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| **OCTAVE**  
Kostis et al. 2004  
(10)  
14751650 |
<table>
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<tbody>
<tr>
<td><strong>Aim:</strong> Compare safety and efficacy of dual ACE and NEP inhibitors to ACE inhibitors alone</td>
</tr>
<tr>
<td><strong>Study type:</strong> Double blind RCT</td>
</tr>
<tr>
<td><strong>Size:</strong> 25,302 pts</td>
</tr>
<tr>
<td><strong>Inclusion criteria:</strong></td>
</tr>
<tr>
<td>• Age ≥18</td>
</tr>
<tr>
<td>• 3 separate BP criteria for 3 groups: Group 1 untreated hypertension (SBP ≥140 mm Hg or DBP ≥90 mm Hg); Group 2 hypertension and persistent mild hypertension (trough SBP 140–159 mm Hg and DBP &lt;100 mm Hg, or trough DBP 90–99 mm Hg and SBP &lt;160 mm Hg); Group 3 hypertension with persistent moderate to severe hypertension (trough SBP 160–179 mm Hg and DBP &lt;110 mm Hg, or trough DBP 100–109 mm Hg and SBP &lt;180 mm Hg)</td>
</tr>
<tr>
<td><strong>Exclusion criteria:</strong></td>
</tr>
<tr>
<td>• Contraindication to therapy with ACE inhibitors or angiotensin II receptor antagonists</td>
</tr>
<tr>
<td>• Hx of angioedema, anaphylaxis, drug-induced or chronic urticarial, or multiple drug sensitivities</td>
</tr>
<tr>
<td>• Recent hospitalization for MI, unstable angina, stroke, TIA or COPD</td>
</tr>
<tr>
<td>• Recent treatment for malignancy, chronic renal</td>
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<tr>
<td><strong>Intervention:</strong></td>
</tr>
<tr>
<td>Omapatrilat target dose 80 mg daily</td>
</tr>
<tr>
<td>Comparator: Enalapril target dose 40 mg daily</td>
</tr>
<tr>
<td><strong>1° endpoints:</strong></td>
</tr>
<tr>
<td>• Reduction in SBP at wk 8</td>
</tr>
<tr>
<td>• Need for new adjunctive antihypertensive therapy by wk 24</td>
</tr>
<tr>
<td><strong>2° endpoints:</strong></td>
</tr>
<tr>
<td>• Reduction in DBP at wk 8</td>
</tr>
<tr>
<td>• Reduction in SBP and DBP at wk 24</td>
</tr>
<tr>
<td>• BP control (SBP &lt;140 mm Hg and DBP &lt;90 mm Hg) at wk 8 and 24</td>
</tr>
<tr>
<td><strong>Comments:</strong></td>
</tr>
<tr>
<td>• Greater reductions in BP in omapatrilat within each study (p&lt;0.001)</td>
</tr>
<tr>
<td>• Overall mean reduction in SBP ≥3.6 mm Hg</td>
</tr>
<tr>
<td>• Larger reductions in BP in black pts with omapatrilat than with enalapril. But overall reduction smaller with both drugs than in other subgroups.</td>
</tr>
<tr>
<td>• Adverse events, serious adverse events, and deaths were the same for omapatrilat and enalapril</td>
</tr>
</tbody>
</table>


disease 2° to autoimmune disease, or end-stage renal disease of any etiology

- Hypertensive pts treated with ACE inhibitors whose BP placed them in study group 3

- More angioedema with omapatrilat (2.17% vs. 0.68%)

- More angioedema in blacks with omapatrilat (5.54% vs. 1.62%) and current smokers (3.93% vs. 0.81%)

1° indicates primary; 2°, secondary; ACE, angiotensin converting enzyme; ACS, acute coronary syndrome; BP, blood pressure; CI, confidence interval; COPD, chronic obstructive pulmonary disease; DPB, diastolic blood pressure; HF, heart failure; Hx, history; IV, intravenous; IMPRESS, Comparison of Vasopeptidase Inhibitor, Omapatrilat, and Lisinopril on Exercise Tolerance and Morbidity; LVEF, left ventricular ejection fraction; MI, myocardial infarction; NYHA, New York Heart Association; NEP, neutral endopeptidase; OVERTURE, Omapatrilat Versus Enalapril Randomized Trial of Utility in Reducing Events; OCTAVE, The Omapatrilat Cardiovascular Treatment vs. Enalapril; pts, patients, RCT, randomized controlled trial; RR, relative risk; SBP, systolic blood pressure; TIA, transient ischemic attack.

Search Terms and Date: March 2016, angioedema, neprilysin inhibitors, omapatrilat.

### Data Supplement 4. RCTs Comparing Pharmacological Treatment for Stage C HFrEF (Section 7.3.2.11)

<table>
<thead>
<tr>
<th>Study Acronym; Author; Year Published</th>
<th>Aim of Study; Study Type; Study Size (N)</th>
<th>Patient Population</th>
<th>Study Intervention (# patients) / Study Comparator (# patients)</th>
<th>Endpoint Results (Absolute Event Rates, P values; OR or RR; &amp; 95% CI)</th>
<th>Relevant 2° Endpoint (if any); Study Limitations; Adverse Events</th>
</tr>
</thead>
<tbody>
<tr>
<td>SHIFT HF Böhm et al. 2015 (11) 26508709</td>
<td><strong>Aim:</strong> To assess influence of comorbidities on outcomes and ivabradine treatment effect of heart rate reduction in stable HF. <strong>Study type:</strong> Post hoc analysis of RCT <strong>Size:</strong> 6,505</td>
<td><strong>Inclusion criteria:</strong> Pts ≥18 y of age in sinus rhythm, heart rate at rest ≥70 bpm, MTD for HF meds <strong>Exclusion criteria:</strong> N/A</td>
<td><strong>Intervention:</strong> Ivabradine <strong>Comparator:</strong> Placebo</td>
<td>1° endpoint: • CV death or HF hospitalization rate increased with the comorbidity load (p&lt;0.0001) with most events in pts with &gt;3 comorbidities for both drug and placebo. • Hospitalization rate lower for comorbidity loads of ivabradine</td>
<td>• Number of comorbidities was related to outcomes • Heart rate reduction with Ivabradine is conserved at all comorbidity loads</td>
</tr>
<tr>
<td>SHIFT Swedberg K et al. 2010 (12) 20801500</td>
<td><strong>Aim:</strong> To assess the effect of heart rate reduction by the selective sinus-node inhibitor ivabradine on outcomes in HF <strong>Study type:</strong> randomized,</td>
<td><strong>Inclusion criteria:</strong> Over 18 y of age, in sinus rhythm, resting heart rate of ≥70 bpm, stable symptomatic chronic HF (NYHA class II-IV) for ≥4 wk, previous admission to the hospital for HF within 12 mo, LVEF ≤35%</td>
<td><strong>Intervention:</strong> Ivabradine <strong>Comparator:</strong> Placebo</td>
<td>1° endpoint: • Composite of CV death or hospital admission for worsening HF • Primary endpoint: Ivabradine better. Event rate 24% vs. 29%. HR 0.82 (0.75–0.90); p&lt;0.0001</td>
<td>• Composite of CV death or hospital admission for worsening HF among those receiving at least 50% of target beta blocker dose at time of randomization. All cause death; any CV death; HF hospitalization; all-cause hospitalization; any CV hospitalization; death from HF; composite of CV death HF hospitalization, nonfatal MI. • No difference in all-cause mortality or CV mortality</td>
</tr>
<tr>
<td>Study</td>
<td>Aim</td>
<td>Inclusion criteria</td>
<td>Exclusion criteria</td>
<td>Intervention</td>
<td>1\textsuperscript{st} endpoint</td>
</tr>
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<tr>
<td>SIGNIFY Fox et al. 2014 (13) 25176136</td>
<td>Assess the mortality-morbidity benefits of Ivabradine in pts with stable CAD without clinical HF</td>
<td>Stable CAD without clinical HF and heart rate of ≥70 bpm and in sinus rhythm, persistence and confirmation of ≥1 CV risk factors</td>
<td>Serum creatinine &gt;200 mcmol/L, significant anemia, ALT or AST &gt;3 times upper normal value, unstable CV condition, LVEF ≤40%; MI, coronary revascularization, stroke ≤3 mo.</td>
<td>Ivabradine (n=9,550)</td>
<td>Composite of CV death and nonfatal MI</td>
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<td>serum levels of fibrinogen, D-dimer and CRP, serum levels of troponin I, CK-MB, creatine kinase (CK) and myoglobin, and ventricular ejection fraction (LVEF) ≤40%</td>
<td>Placebo (n=9,552)</td>
<td>Results: No significant difference in incidence of 1\textsuperscript{st} endpoint (HR: 1.08; 95% CI: 0.96–1.20; p=0.20), death from CV causes (HR: 1.10; 95% CI: 0.94–1.28; p=0.25), nonfatal MI (HR: 1.04; 95% CI: 0.90–1.21; p=0.60) and rate of death (HR: 1.06; 95% CI: 0.94–1.21; p=0.35)</td>
</tr>
</tbody>
</table>
| **BEAUTIFUL** Fox et al. 2008 (14) | **Aim:** Assess the mortality-morbidity benefits of Ivabradine in pts with CAD and LV systolic dysfunction  
**Study type:** Randomized, double-blind, placebo-controlled  
**Size:** 10,917  
5,479 ivabradine  
5438 placebo | **Inclusion criteria:**  
• Pts ≥55 y of age with stable CAD defined as: previous MI, previous revascularization (PCI or surgery), or angiographic evidence of ≥1 stenosis of ≤50% AND LVEF <40% and end diastolic internal dimension of >56 mm. Sinus rhythm with resting heart rate of ≥60 bpm.  
• Angina and HF symptoms stable for 3 mo  
• Appropriate conventional CV medication for 1 mo.  
**Exclusion criteria:** MI or coronary revascularization within the previous 6 mo; stroke or TIA within 3 mo, PPM or ICD, valvular disease likely to need surgery within 3 y, SSS, sinoatrial block, congenital long QT, complete AV block, severe or uncontrolled hypertension, NYHA class IV HF | **Intervention:** Ivabradine  
n=5,479  
**Comparator:**  
• Placebo in addition to appropriate CV medication  
n=5,438 | **1° endpoint:**  
• Composite of CV death, admission for MI and admission for HF  
• No difference in composite 1° endpoint (22.5% vs. 22.8%; HR: 1.00; 0.91–1.1; p=0.94)  
• No differences in any prespecified subgroup.  
**2° endpoints:**  
1) All-cause mortality  
2) Cardiac death (death from MI or HF or related to a cardiac procedure)  
3) CV death (death from a vascular procedure, presumed arrhythmic death, stroke death, other vascular death or sudden death of unknown cause) or admission for HF,  
4) Composite of admission for fatal and nonfatal MI or UA  
5) Coronary revascularization  
6) CV death  
7) Admission for HF  
8) Admission for MI  
• No differences in 2° endpoints in overall population.  
• In subgroup with heart rate of ≥70, ivabradine reduced  
1) admission for AMI (fatal and nonfatal) (HR 0.64; 0.49–0.84; p=0.001)  
2) composite of admission for AMI or UA (HR 0.78; 0.62–0.97; p=0.023)  
3) coronary revascularization (HR 0.7; 0.52–0.93; p=0.16)  
• 28% in Ivabradine group discontinued medication (vs. 16%), largely due to bradycardia (13% vs. 2%)  
• No difference in significant adverse effects (23% vs. 23%; p=0.70)  

1° indicates primary; 2°, secondary; AV, atrioventricular; AF, atrial fibrillation; AST, aspartate transaminase; ALT, alanine aminotransaminase; AMI, acute myocardial infarction; CAD, coronary artery disease; CI, confidence interval; CRT, cardiac resynchronization therapy; CV, cardiovascular; CCB, calcium channel blocker; BEAUTIFUL, Morbidity-Mortality Evaluation of the If Inhibitor Ivabradine in Patients With Coronary Disease and Left-Ventricular Dysfunction; bpm, beats per minute; GDEM, guideline-directed evaluation and management; HF, heart failure; HR, hazard ratio; ICD, implantable cardioverter-defibrillator; LVEF, left ventricular ejection fraction; MI, myocardial infarction; MTD, maximal tolerated dose; N/A, not available; NYHA, New York Heart Association; pts, patients; PCI, percutaneous coronary intervention; PPM, permanent pacemaker; RCT, randomized controlled trial; SIGNIFY, Study Assessing the Morbidity–Mortality Benefits of the If Inhibitor Ivabradine in Patients with Coronary Artery Disease; SHIFT, Systolic Heart Failure Treatment with the If Inhibitor Ivabradine Trial; SSS, sick sinus syndrome; TIA, transient ischemic attack; and UA, unstable angina.

Search Terms and Date: studies identified by chairs in December 2015, one study added by Jan 2016.

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### 2013 HF Guideline Data Supplement 18. ACE Inhibitors (Section 7.3.2.2)

<table>
<thead>
<tr>
<th>Study Name, Author, Year</th>
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<th>Study Type</th>
<th>Background Therapy</th>
<th>Study Size</th>
<th>Etiology</th>
<th>Patient Population</th>
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<th>Mortality</th>
<th>Trial Duration (Years)</th>
<th>Absolute Benefit</th>
<th>P Values &amp; 95% CI:</th>
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<tr>
<td><strong>CONSENSUS 1987</strong></td>
<td>To Evaluate influence of enalapril on prognosis of NYHA class IV HF</td>
<td>RCT</td>
<td>Diuretics (spironolactone 53%, mean dose 80mg), digoxin (93%), other vasodilators, except ACEI (ie, nitrates 46%)</td>
<td>253, 127, 126</td>
<td>CAD 73%</td>
<td>Severe HF symptoms at rest (NYHA class IV); Increased heart size &gt;600 mL; BP: 120/75; HR: 80; AF 50%</td>
<td>APE; hemodynamically important aortic/MV stenosis; MI within prior 2 mo; Unstable angina; planned cardiac surgery; right HF b/c of pulm disease; Cr &gt;300 mmol/L</td>
<td>Mortality</td>
<td>Change in NYHA-FC, LV size, Cr level</td>
<td>0.51 y</td>
<td>N/A</td>
</tr>
<tr>
<td><strong>10 y FU of CONSENSUS 1999</strong></td>
<td>Report on the survival at the 10-y follow up of the pts randomized in CONSENSUS. (1st study to show prognostic improvement by an ACEI. Pts in NYHA class IV HF treated with enalapril or placebo. After study completion all pts were offered open-label enalapril therapy).</td>
<td>10-y open-label follow-up study (via completion of a questionnaire) on the survival status of pts in CONSENSUS - a RCT.</td>
<td>315, 77, 58</td>
<td>253 randomized pts included in analysis of time from randomization to death; Survivors (135) of the double-blind period included in analysis of the time from end of double-blind period to death; Severe, NYHA IV</td>
<td>All pts were offered open-label enalapril therapy</td>
<td>Mortality</td>
<td></td>
<td>10 y</td>
<td>5 pts, all in the enalapril group, were long-term survivors (p=0.004). Averaged over the trial (double-blind plus open-label extension) risk reduction was 30% (p=0.008), 95% CI: 11% - 46%. At end of double-blind study period, mortality considerably higher among pts not receiving open ACEI therapy</td>
<td></td>
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</tr>
<tr>
<td><strong>SOLVD 1991</strong></td>
<td>Study the effect of enalapril on mortality and hospitalization in pts with chronic HF and EF &lt;35%</td>
<td>RCT</td>
<td>Diuretics + Digoxin</td>
<td>2569, 1285, 1284</td>
<td>Ischemic heart disease 72%</td>
<td>LV EF &lt;35%; MI to severe (11% class I vs 4% class IV); LV EF 25%; BP: 125/77; HR: 80; AF: 8-12%</td>
<td>Age &gt;65 y; Unstable angina; MI within past mo; Cr&gt;2.0 mg/dL</td>
<td>Mortality</td>
<td>Hospitalizations; Incidence of MI; Mortality by specific causes; Combined mortality and morbidity from both SOLVD+SOLOD-</td>
<td>2.70 y</td>
<td>Treating 1000 SOLVD+ pts with enalapril for ~3 y would save ~50 premature deaths and 350 hospitalizations. Reduced mortality by 16%; (95% CI, 5-26%; p=0.0036)</td>
</tr>
</tbody>
</table>

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### SOLVD 1992

| Study effect of ACEIs on total mortality and mortality from CV causes, the development of HF, and hospitalization for HF in pts with EF ≤35% |
|---|---|---|---|
| RCT | No drug treatment for HF | 4228; 2111; 2117 | EF ≤35%; Asymptomatic; NYHA class I (67%) + 1; EF: 28%; BP: 126/78; HR: 75; AF: 4% |
|  |  |  | As per SOLVD+ |
|  |  |  | Mortality; Combined mortality and the incidence of HF and rate of hospitalization for HF |
|  |  |  | Incidence of HF and hospitalization for HF |
|  |  |  | 3.12 y |
|  |  |  | Reduced mortality: p=0.30; 95% CI: -8-21% |

### SOLVD FU 2003

| 12-y FU of SOLVD to establish if the mortality reduction with enalapril among pts with HF was sustained, and whether a subsequent reduction in mortality would emerge among those with asymptomatic ventricular dysfunction. |
|---|---|---|---|
| RCT | No drug treatment for HF | 4228; 2111; 2117 | EF ≤35%; Asymptomatic to severe; NYHA-HV |
| Participation in SOLVD+ and SOLVD- |
|  |  |  | N/A |
|  |  |  | 3.12 y |
|  |  |  | Enalapril extended median survival by 9.4 mo in the combined trials (95% CI: 2.8–16.5, p=0.004). |

### ATLAS 1999

| To compare the efficacy and safety of low and high doses of ACEI on the risk of death and hospitalization in chronic HF. than the large doses that have been shown to reduce morbidity and mortality in pts with HF. AIM: Investigate if low doses and high doses of ACEIs have similar benefits. |
|---|---|---|---|
| RCT | No drug treatment for HF | 3164; 1596 to the low-dose strategy and 1568 to the high-dose strategy. | LVEF <=30%; NYHA class II, III, or IV, despite treatment with diuretics for ≥2 mo (Treatment for HF in ED or hospital within 6 mo required for pts in class II); Prior use of digitalis, ACEIs, or vasodilators allowed but not mandated; NYHA II-V (mainly class II); LVEF 23%; SBP 126 mmHg; HR 80; NYHA class: II (few I and IV) |
|  |  |  | Asute coronary ischemic event or revascularization procedure within 2 mo; History of sustained or symptomatic ventricular tachycardia; Intolerant of ACEIs; ScI >2.5 mg/dL |
|  |  |  | Mortality from all causes |
|  |  |  | Combined risk of all-cause mortality and hospitalization for any reason; CV mortality, CV hospitalizations; All-cause mortality combined with CV hospitalizations; CV mortality combined with CV hospitalizations; Combined risk of fatal and nonfatal MI plus hospitalization for unstable angina |
|  |  |  | 5 y |
|  |  |  | High-dose group had 8% lower risk of all-cause mortality (p=0.128) and 10% lower risk of CV mortality (p=0.073) than low-dose group. Death or hospitalization for any reason, high-dose group had 12% lower risk than low-dose group, p=0.002. Total number of hospitalizations: high-dose group 13% fewer hospitalizations for any reason (p=0.021), 16% fewer hospitalizations for CV reason (p=0.05), and 24% fewer hospitalizations for HF (p=0.002). |

### Post-MI ACEI Use

| SAVE, 1992 | To test the hypothesis that the long-term administration of captopril to survivors |
|---|---|---|---|
| RCT | Beta-blockers 36%; Digitalis 26%; Nitrates 51% | 2231; 1115; 1116 | Alive 3 d after MI; LVEF ≤40%; >21 y of age, but Failure to undergo randomization within 16 d after the MI; Relative contraindication to |
|  |  |  | Mortality from all causes |
|  |  |  | Mortality from CV causes; Mortality combined with a decrease in the EF of at least 9 units in |
|  |  |  | 3.5 y |
|  |  |  | Mortality from all causes was significantly reduced in the captopril group (228 deaths, or 20%) as c/w the placebo group (275 deaths, or 25%); the RR: 19% |

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of acute MI who had baseline LV dysfunction but did not have overt HF requiring vasodilator therapy would reduce mortality, lessen deterioration in cardiac performance, and improve clinical outcome.

<p>| AIRE 1993 | Investigated the effect of therapy with ACEI ramipril, on survival in pts who had shown clinical evidence of HF at any time after an acute MI. Also, to compare the incidences of progression to severe or resistant HF, nonfatal reinfarction and stroke between the 2 groups. | RCT | 2006; 1014; 992 | Use of an ACEI considered to be mandatory | Mortality from all causes | 1.3 y | Mortality from all causes was significantly lower for pts on ramipril compared to pts on placebo. RR: 27%; 95% CI: 11-40%; p=0.002. Prespecified secondary outcomes: risk reduction of 19% for the 1st validated outcome—namely, death, severe/resistant HF, MI, or stroke (95% CI: 5% - 31%; p=0.008). |
| TRACE 1995 | To determine whether pts with LV dysfunction soon after MI benefit from long-term oral ACE inhibition. | RCT | Beta blocker 16%; Calcium antagonist 28%; Diuretic 66%; Nitrates 53%; Digoxin 28%. | Ischemic 100% | Consecutive pts &gt;18 y hospitalized with MI; Criteria for MI: chest pain or electrocardiographic changes, accompanied by &gt;2X increase in 17 cardiac enzymes; LV dysfunction (EF &lt;35%); NYHA class 1 - 43%; BP 121/76; HR 81 | Contraindication to ACEI or a definite need for them; Severe, uncontrolled DM; Hypotension (&lt;90 mmHg); Elevated SCR level (&gt;2.3 mg/dL) | Death from any cause | Death from a CV cause, sudden death; Progression to severe HF (hospital admission for HF, death due to progressive HF, or HF necessitating open-label ACEI); Recurrent infarction (total or nonfatal); Change in the wall-motion index (EF) | The mortality from all causes at 1 y was 24%. | 24 lives were saved after 1 mo of treating 1,000 pts During the study period, 304 pts in the trandolapril group died (34.7%), as did 369 in the placebo group (42.3%). RR: 0.78 (95% CI, 0.67 - 0.91; p=0.001). In every subgroup, treatment with trandolapril was associated with a reduction in risk. |</p>
<table>
<thead>
<tr>
<th>Study Name, Author, Year</th>
<th>Aim of Study</th>
<th>Study Type</th>
<th>Background Therapy</th>
<th>Study Size</th>
<th>Etiology</th>
<th>Patient Population</th>
<th>Severity</th>
<th>Endpoints</th>
<th>Secondary Endpoint</th>
<th>1st Y Mortality</th>
<th>Statistical Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHARM-Alternative: Granger et al; (2003) 13678870 (24)</td>
<td>Discover whether ARB could improve outcome in pts not taking an ACEI (intolerant)</td>
<td>RCT</td>
<td>Diuretics, Beta-blockers (55%), spironolactone 24%, Digoxin 45-46%</td>
<td>2028; 1013; 1015</td>
<td>Ischemic 67-70%</td>
<td>Symptomatic HF; EF &lt;40%, no ACEI (bid of intolerance)</td>
<td>NYHA II IV, mild to severe (&lt;4% class IV); EF: 30%; BP: 130/70; HR: 74-75; AF: 25-26%</td>
<td>Composite of CV death or hospital admission for CHF</td>
<td>CV death, hospital admission for CHF or nonfatal MI; CV death, CHF admission, nonfatal MI, nonfatal stroke, CV death, CHF admission, nonfatal MI, nonfatal stroke, coronary revascularization; Death (any cause): New DM</td>
<td>2.8 y</td>
<td>Absolute reduction of 7 major events per 100 pts treated - NNT 14 pts to prevent 1 CV death or hospitalization. HR: 0.77 (95% CI: 0.67-0.89); p=0.0004</td>
</tr>
<tr>
<td>CHARM-ACCEDE: McMurray et al; (2003) 13678869 (25)</td>
<td>To investigate if ARB + ACEI in pts with chronic HF improve clinical outcomes</td>
<td>RCT</td>
<td>Beta blocker-55%, spironolactone 17%, Digoxin 58-59%</td>
<td>2548; 1276; 1272</td>
<td>Ischemic 62-63%</td>
<td>Symptomatic HF; EF &lt;40%, Treatment with ACEI; Age &gt;18 y</td>
<td>NYHA class II-IV; EF: 38%; BP: 125/75; HR: 74; AF: 27%</td>
<td>Composite of CV death or hospital admission for CHF</td>
<td>CV death, hospital admission for CHF or nonfatal MI; CV death, CHF admission, nonfatal MI, nonfatal stroke, CV death, CHF admission, nonfatal MI, nonfatal stroke, coronary revascularization; Death (any cause): New DM</td>
<td>3.4 y</td>
<td>Absolute reduction of 4.4 pts with events per 100 pts treated - NNT 21 pts to prevent 1 first event of CV death or CHF hospitalization. RR: 0.85 (95% CI: 0.75-0.96); p=0.011</td>
</tr>
<tr>
<td>VALIANT: Pfeffer et al; (2003) 14610160 (26)</td>
<td>Compare the effect of an ARB, ACEI and the combination of the 2on mortality</td>
<td>Randomize d double blind multicenter trial</td>
<td>Beta-blockers, ASA</td>
<td>14,703 Valsartan 490 mg, Captopril-: 4909 VAL + CAP: 4985</td>
<td>Ischemic 100% (MI inclusion criteria)</td>
<td>Age &gt;18 y; Acute MI complicated by HF; LV systolic dysfunction (EF &lt;35%); (&lt;40% on radionuclide ventriculography); SBP &gt;100 mmHg; Cr &lt;2.5 mg/dL</td>
<td>Prior intolerance or contraindication to ACEI/ ARB</td>
<td>NYHA IV; asympotomatic-severe; EF: 35%; BP: 123/72; HR: 76</td>
<td>Death from any cause</td>
<td>12.5% VAL; 12.3% VAL-CAP; 13.2% CAP</td>
<td>2.1 y</td>
</tr>
<tr>
<td>Val-HeFT; Cohn et al. (2003) 1179645 (27)</td>
<td>Evaluate long-term effects of adding ARB to standard therapy for HF</td>
<td>RCT</td>
<td>Diuretics; Digoxin 67%; Beta blocker 35%; ACEI 51%</td>
<td>5010; 2511; 2499</td>
<td>Ischemic 57%</td>
<td>Age &gt;18 y; NYHA II, III, IV; At least 2 wk of background meds including ACEIs; EF &lt;40% and LVID &gt;2.9 cm/BSA</td>
<td>NYHA II-III, IV (only &lt;2% group IV); Mild to severe; EF:27%; BP: 123/76; AF: 12%</td>
<td>Mortality; Combined endpoint of mortality and morbidity</td>
<td>Change in EF; NYHA class, QoL scores; Signs and symptoms of HF</td>
<td>1.92 y</td>
<td>Mortality similar for the 2 treatment groups. RR: 0.87; 97.5% CI, 0.77-0.97; p=0.009</td>
</tr>
<tr>
<td>HECAAL study; Lancet 2009; 374: 1840-48. 13622995 (28)</td>
<td>Compared the effects of high-dose vs low-dose losartan on clinical outcomes in pts with HF.</td>
<td>RCT</td>
<td>Diuretic drugs (77%), beta blockers (72%), and ARBs (39%)</td>
<td>3846 losartan 150 mg (n=1927) or 50 mg daily (n=1929).</td>
<td>Ischemic 64%</td>
<td>NYHA class II-IV; LVEF &lt;40%, with stable CV medical therapy for at least 2 wk; Intolerance to ACEI; Investigators encouraged to start beta blocker and titrate to a maximum, whenever possible</td>
<td>NYHA I IV (70% I); EF: 33%; BP: 124/77; HR: 71; AF: 28%</td>
<td>Death or admission for HF</td>
<td>Composite endpoint of death or CV admission. Additional prespecified outcomes included: death, death or all-cause admission, CV death, all-cause admission, CV admission, admission for HF, and changes in the severity of heart disease</td>
<td>4.1 y</td>
<td>Median fU</td>
</tr>
<tr>
<td>Study Name, Author, Year</td>
<td>Aim of Study</td>
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<td>Mortality</td>
<td>Trial Duration</td>
<td>Statistical Results</td>
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<tr>
<td>CIBIS II CIBS II investigators and committee members (1999) 10023943 (30)</td>
<td>Investigate the efficacy of bisoprolol in decreasing all-cause mortality in chronic HF</td>
<td>RCT - multicenter double-blind randomised placebo controlled trial (Europe)</td>
<td>Diuretics + ACEI; [amilodaron allowed]-14-46%</td>
<td>2647; 1327; 1320</td>
<td>Documented ischaemic 50%</td>
<td>NYHA class II or IV EF: &lt;35% 18-80 y old</td>
<td>Uncontrolled HTN; MIUA with previous 3 mo; PTC/AIBG with previous 6 mo; AV-block &gt;1st degree with PPMB; Heart rate: &lt;60 bpm; resting SBP: &lt;100 mmHg; renal failure; Reversible obstruct lung disease; Use of beta blocker</td>
<td>Moderate to severe. Mean BP: 130/80; Mean EF: 28%; Mean LVEDD: 6.7 cm; AF: 20%</td>
<td>All-cause mortality</td>
<td>All-cause hospital admissions</td>
<td>Combined endpoints</td>
</tr>
<tr>
<td>MERIT-HF: MERIT study Group; (1999) 10376614 (31)</td>
<td>Investigate whether Metoprolol CR/XL lowered mortality in pts with decreased EF and symptoms of HF</td>
<td>RCT - multicenter double-blind randomised placebo controlled trial (Europe + USA)</td>
<td>Diuretics + ACEI [Amiodaron NOT allowed]</td>
<td>3991; 1991; 2001</td>
<td>Ischaemic 65%</td>
<td>NYHA II-IV; 40-80 y old; LVEF: &lt;40% [36-40 if 5-min walk &lt;450 m]; heart rate: &gt;68 bpm</td>
<td>MIUA with 28 8; Contra-indication or current use of beta blocker; PTC/AIBG with 4 mo Planned transplant or ICD; Heart block &gt;1st degree w/o PPMB; SBP &gt;100 mmHg</td>
<td>Mild to severe. Mean BP: 130/78; Mean EF: 28%; AF 16-17%</td>
<td>All-cause mortality</td>
<td>All-cause mortality in combination with all-cause admission to hospital</td>
<td>N/A</td>
</tr>
</tbody>
</table>

ACEI indicates angiotensin-converting-enzyme inhibitor; AF, atrial fibrillation; ARB, angiotensin receptor blockers; ASA, aspirin; BP, blood pressure; BSA, body surface area; CABS, coronary artery bypass graft; CHARM, Candesartan in Heart Failure: Assessment of Reduction in Mortality and Morbidity; CHD, chronic heart disease; CHF, congestive heart failure; Cr, creatinine; CV, cardiovascular; DM, diabetes mellitus; EF, ejection fraction; FU, follow-up; HEAAL, study, effects of high-dose versus low-dose losartan on clinical outcomes in patients with heart failure; HF, heart failure; HR, heart rate; IHD, ischemic heart disease; LV, left ventricular; LVD, left ventricular dilatation; MI, myocardial infarction; MV, mitral valve; N/A, not applicable; NNT, number needed to treat; NYHA, New York Heart Association; QoL, quality of life; pts, patients; SBP, systolic blood pressure; RCT, randomized control trial; Scr, serum creatinine; TIA, transient ischemic attack; UA, unstable angina; Val-HeFT, Valsartan Heart Failure Trial; and VALIANT, Valsartan in Acute Myocardial Infarction.
**COPERNICUS** : Packer et al; (2002) 12996947  
Investigate whether Carvedilol is beneficial in severe HF.  
RCT−double blind  
Diuretics (PO or IV) + ACEI (or ARB); [Amodarone allowed 17-19%]  
2288; 1136; 1113  
Ischemic 67%  
Euvolumic NYHA class IV; LV EF <25%; No positive inotropes or vasodilators w/in 4 d  
Pt requiring hospitalized intensive care; Use of positive inotropes or IV; vasodilators w/in 4 d;  
Coronary revascularization/MICVVA/ sign VT or VF w/in 2 mo; SBP < 85 mmHg; Heart rate <60; Cr >2.8 mg/dl.  
Severe Mean BP: 123/76; Mean HR: 82; Mean EF 20%;  
All-cause mortality  
Combined risk of death or hospitalization−any reason; Combined risk of death or hospitalization−CV reason; Combined risk of death or hospitalization−HF reason; PT global assessment  
19.7% placebo [24.0% in pts with recent or recurrent cardiac decompensations]  
18.5% in placebo group  
11.4% in Carvedilol group  
10.4 mo  
Treating 1000 pt for 1 y led to savings of 70 premature deaths p=0.0014

**SENIORS, Flather et al; (2005) 12642700  
Assess effects of the beta blocker Nebivolol in pts >70 y regardless of EF.  
RCT  
Diuretics + ACEI (+aldosterone antagonist in 29%)  
2128; 1067; 1001  
Prior mo CAD in 69%  
Age >70 CHF with 1 of the following: hospitalization with CHF w/in a year or EF <35% w/in the past 6 mo  
New HF therapy w/in 6 wk or change in drug therapy w/in 2 wk; Contraindication to beta blockers, current use of beta blockers, Significant renal dysfunction: CVA w/in 3 mo.  
Mild to severe Mean BP: 139/81; Mean HR: 79; Mean EF 36% (13 with EF >35%);  
Composite of all-cause mortality or CV hospital admission  
All-cause mortality Composite of all-cause mortality or all-cause hospital admissions  
All cause hospital admissions CV hospital admissions CV mortality Composite of CV mortality or CV hospital admissions NYHA class assessment; 6 MWT  
N/A  
N/A  
1.75 y  
Absolute risk reduction 4.2%; 24 pts would need to be treated for 21 mo to avoid one event RR: 0.86; 95% CI: 0.74-0.95; p=0.039

**A Trial of the Beta-Blocker Bucindolol in Pt with Advanced Chronic HF**  
**The Beta-Blocker Evaluation of Survival Trial Investigators 11396354  
Designed to determine whether bucindolol hydrochloride, a nonselective beta- adrenergic blocker and mild vasodilator, would reduce the rate of death from any cause among pt with advanced HF and to assess its effect in various subgroups defined by ethnic background and demographic criteria — specifically women and members of minority groups.  
RCT  
ACEI (if tolerated) [91% ACE; 7% ARB], for at least 1 mo. Before the publication of the results of the DIG trial, 12 digoxin therapies were required, but thereafter its use became discretionary [DIG 94%].  
2768; 1354; 1354  
Ischemic 59%  
NYHA class III or IV HF LV EF <35% >18 y  
Reversible cause of HF present Candidates for heart transplantation Cardiac revascularization procedure within the previous 60 d UA Heart rate <50 bpm, SBP <80mmHg  
Decompensated HF.  
NYHA II or IV (92% class III) EF 23%; HR 82; BP 117/71; AF 12%  
Death from any cause  
Death from CV causes (death due to pump failure or an ischemic event or sudden death) Hospitalization for any reason Hospitalization because of HF Composite of death or heart transplantation LV EF at 3 and 12 mo Ml; Qol, and any change in the need for concomitant therapy  
For pt in NYHA functional class III, the annual mortality rate was 26% in the placebo group; For pt with NYHA class IV, the annual mortality rate in the placebo group was 28% Overall: annual mortality of 17% in placebo group w/ 15% in the bucindolol group  
N/A  
N/A  
~2 y  
449 pt in placebo group (33%) died; 411 in the bucindolol group (38%; HR: 0.80; 95% CI: 0.78-1.02; unadjusted p=0.10; adjusted p=0.13)

**COMET, Poole-Wilson et al; (2003) 12851393  
To compare the effects of carvedilol and metoprolol on clinical outcome in pts with HF.  
RCT  
Diuretics, ACEIs  
3029; 1611 carvedilol; 1518 metoprolol farnate  
N/A  
NYHA class IV EF <35% Previous CV admission  
N/A  
Mild to severe  
All-cause mortality Composite endpoint of all-cause mortality, or all-cause admission  
N/A  
N/A  
4.8 y  
All-cause mortality 34% carvedilol and 40% metoprolol (HR: 0.83; 95% CI 0.74-0.93; p=0.0017)
Sufficient data do not currently exist to establish the optimum order of initiating chronic HF therapy (ACEI vs. beta blocker). This was the objective of the CIBIS III trial – it compared the effect on mortality and hospitalization of initial monotherapy with either bisoprolol or enalapril for 6 mo, followed by their combination for 6 to 24 mo.

| Multicenter, prospective, randomized, open-label, blinded endpoint evaluation (PROBE) trial with 2 parallel groups. | Diuretics 84%; Digoxin 32% | CAD 62% | >65 y, NYHA class II or III, and LVEF <35% (by echo within the 3 mo) | Clinically stable HF (without clinically relevant fluid retention or diuretic adjustment within 7 d) | Treatment with an ACEI, an ARB, or a beta blocker for >7 d during the 3 mo before randomization | Heart rate at rest <60 bpm without a functioning pacemaker | Supine SBP <100 mm Hg at rest | SCr ≥220 mmol/L | AV block >1° without a functioning pacemaker | Obstructive lung disease contraindicating bisoprolol treatment |
|---|---|---|---|---|---|---|---|---|---|---|---|
| NYHA II or III, mild to moderate CHF; LVEF 29%; Heart rate 79; SBP 134 | The primary endpoint was time-to-the-first event of combined all-cause mortality or all-cause hospitalization | Combined endpoint at the end of the monotherapy phase and the individual components of the primary endpoint, at study end and at the end of the monotherapy phase. | CV death | CV hospitalization | N/A | N/A | Mean of 1.22±0.42 y (maximum of 2.10 y). | In the ITT sample, 178 pt (35.2%) with a primary endpoint in the bisoprolol-1st group, and 186 (36.8%) in the enalapril-1st group (absolute difference -1.6%; 95% CI: -7.6 to 4.4%; HR: 0.94; 95% CI: 0.77–1.16; noninferiority for bisoprolol-first versus enalapril-1st treatment, p=0.019) |

ACEI indicates angiotensin-converting-enzyme inhibitor; AF, atrial fibrillation; ARB, angiotensin receptor blocker; AV, atrioventricular; BP, blood pressure; CABG, coronary artery bypass graft; CHF, congestive heart failure; CIBIS II, Cardiac Insufficiency Bisoprolol Study II; COMET, Carvedilol Or Metoprolol European Trial; COPERNICUS, carvedilol prospective randomized cumulative survival; Cr, creatinine; CR/XL, controlled release/extended release; CV, cardiovascular; CVA, cerebrovascular accident; c/w, compared with; DIG, Digitalis Investigation Group; EF, ejection fraction; HF, heart failure; h/o, history of; HR, hazard ratio; ICD, ICD, implantable cardioverter defibrillator; ITT, intent to treat; MERIT-HF, Metoprolol CR/XL Randomised Intervention Trial in Congestive Heart Failure; MI, myocardial infarction; MWT, minute walk test; NYHA, New York Heart Association; PPM, permanent pacemaker; PTCA, percutaneous transluminal coronary angioplasty; Pts, patients; QoL, quality of life; RCT, randomized control trial; RR, relative risk; SBP, systolic blood pressure; SCr, serum creatinine; USA, United States of America; VF, ventricular fibrillation; VT, ventricular tachycardia; and w/o, without.
References


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36. Willenheimer R, van Veldhuisen DJ, Silke B, et al. Effect on survival and hospitalization of initiating treatment for chronic heart failure with bisoprolol followed by enalapril, as compared with the opposite sequence: results of the randomized Cardiac Insufficiency Bisoprolol Study (CIBIS) III. Circulation. 2005;112:2426-35.