



# **CONGESTIVE HEART FAILURE**

**ACOI IM BOARD REVIEW 2017**

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# DISCLOSURES

- I AM PRINCIPAL INVESTIGATOR AND RECEIVE GRANTS FOR HEART FAILURE TRIALS FROM BOSTON SCIENTIFIC, MEDTRONIC AND ST JUDE MEDICAL INVESTIGATING CARDIAC RESYNCHRONIZATION THERAPY IN SYSTOLIC DYSFUNCTION RELATED CHF
- I HAVE RECEIVED CONSULTING FEES AND CONTRACTS FROM BOSTON SCIENTIFIC

# **CONGESTIVE HEART FAILURE DEFINITION**

- **IMPAIRED CARDIAC PUMPING SUCH THAT HEART IS UNABLE TO PUMP ADEQUATE AMOUNT OF BLOOD TO MEET METABOLIC NEEDS**
- **NOT A DISEASE BUT A “SYNDROME”**
- **OFTEN ASSOCIATED WITH LONG-STANDING HTN AND CAD**

# TYPES OF HEART FAILURE

- **HEART FAILURE WITH REDUCED EJECTION FRACTION (HFrEF)**
- **HEART FAILURE WITH PRESERVED EJECTION FRACTION (HFpEF)**
- **HIGH OUTPUT (NON CONGESTIVE) HEART FAILURE**
  - **THIAMINE (VITAMIN) DEFICIENCY- WET BERIBERI**
  - **PAGET'S DISEASE; HEREDITARY HEMORRHAGIC TELANGIECTASIA (HHT)**
  - **LARGE AV FISTULA**
  - **THYROTOXICOSIS**
  - **SEPTIC SHOCK**
  - **ANEMIA**

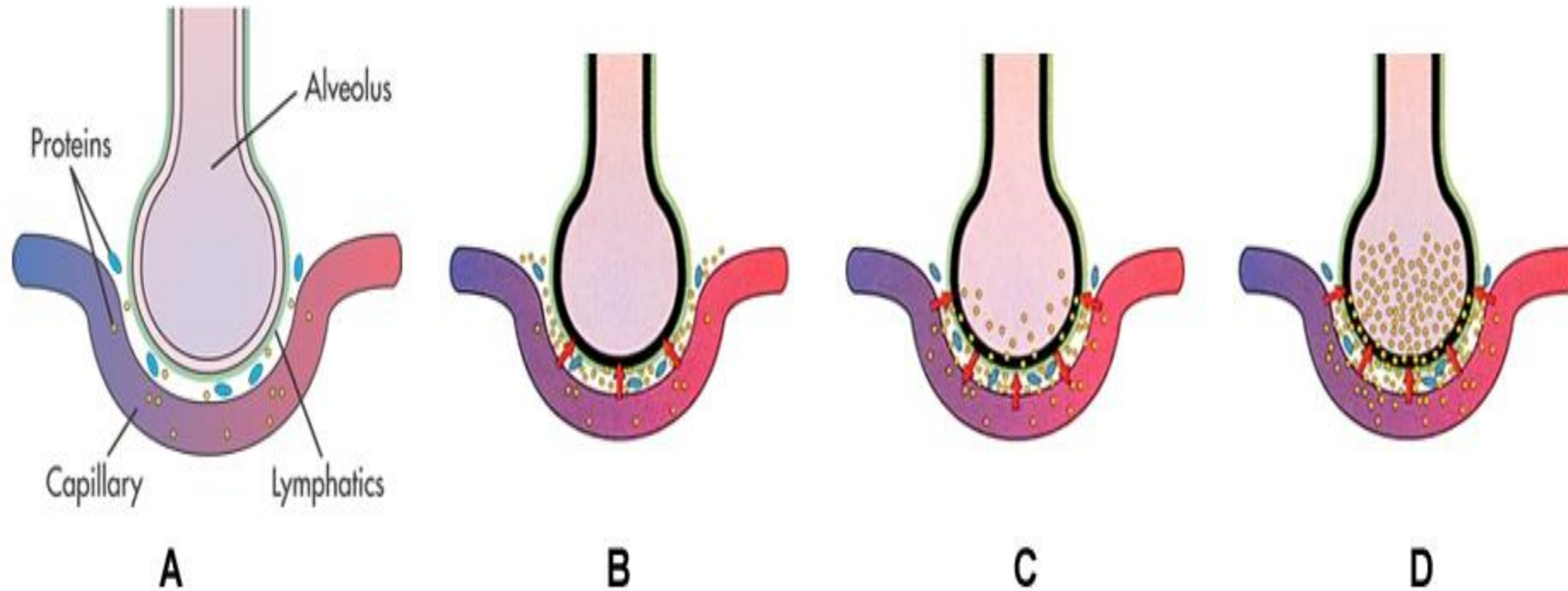
# CLINICAL FEATURES

- CHF IS NOT A LOW EJECTION FRACTION BUT A FAILURE OF CARDIAC OUTPUT TO MEET THE NEEDS OF THE BODY.
- CHF IS A CLINICAL DIAGNOSIS INCLUDING JVD, RALES & S3 +/- SYMPTOMS AND TO AN EXTENT ARRHYTHMIA (ATRIAL AND VEN.)
- CHF IS A PREVALENT CLINICAL PROBLEM OF WHICH THE MOST COMMON CAUSE IS ISCHEMIC HEART DISEASE
- CHF TREATMENTS RANGE FROM PHARMA TO DEVICES TO ORTHOTOPIC HEART TRANSPLANTATION.

# **ACUTE CONGESTIVE HEART FAILURE CLINICAL MANIFESTATIONS**

- **PULMONARY EDEMA (WHAT WILL YOU HEAR?)**
  - **AGITATION**
  - **PALE OR CYANOTIC**
  - **COLD, CLAMMY SKIN**
  - **SEVERE DYSPNEA**
  - **TACHYPNEA**
  - **PINK, FROTHY SPUTUM**

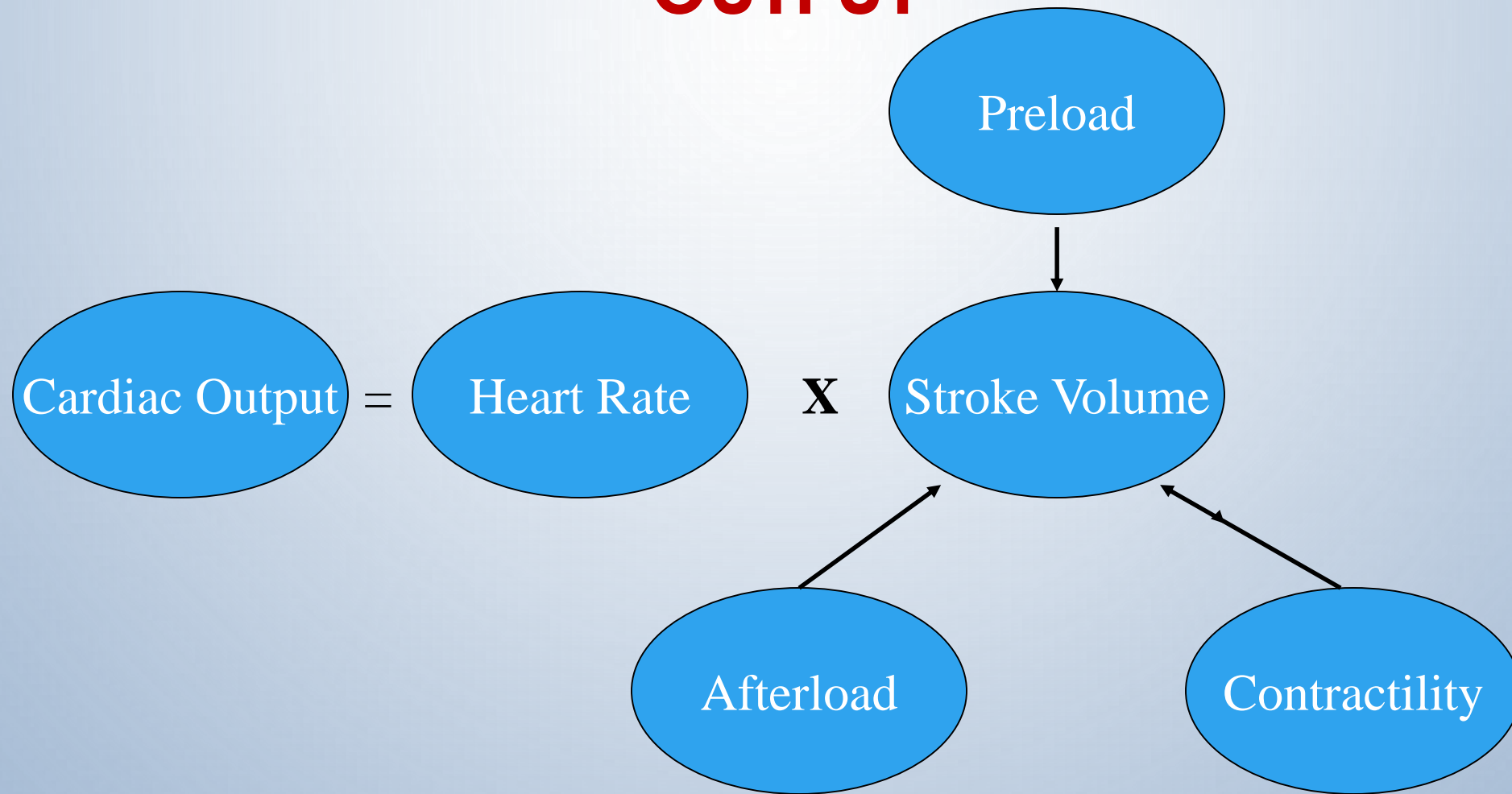
# PULMONARY EDEMA



Redrawn from Urden LD, Stacy KM, Lough ME: *Thelan's critical care nursing: diagnosis and management*, ed 4, St Louis, 2002, Mosby.

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# FACTORS AFFECTING CARDIAC OUTPUT





# FACTORS AFFECTING CARDIAC OUTPUT

- HEART RATE

- IN GENERAL, THE HIGHER THE HEART RATE, THE HIGHER THE CARDIAC OUTPUT

- E.G.  $HR \times SV = CO$

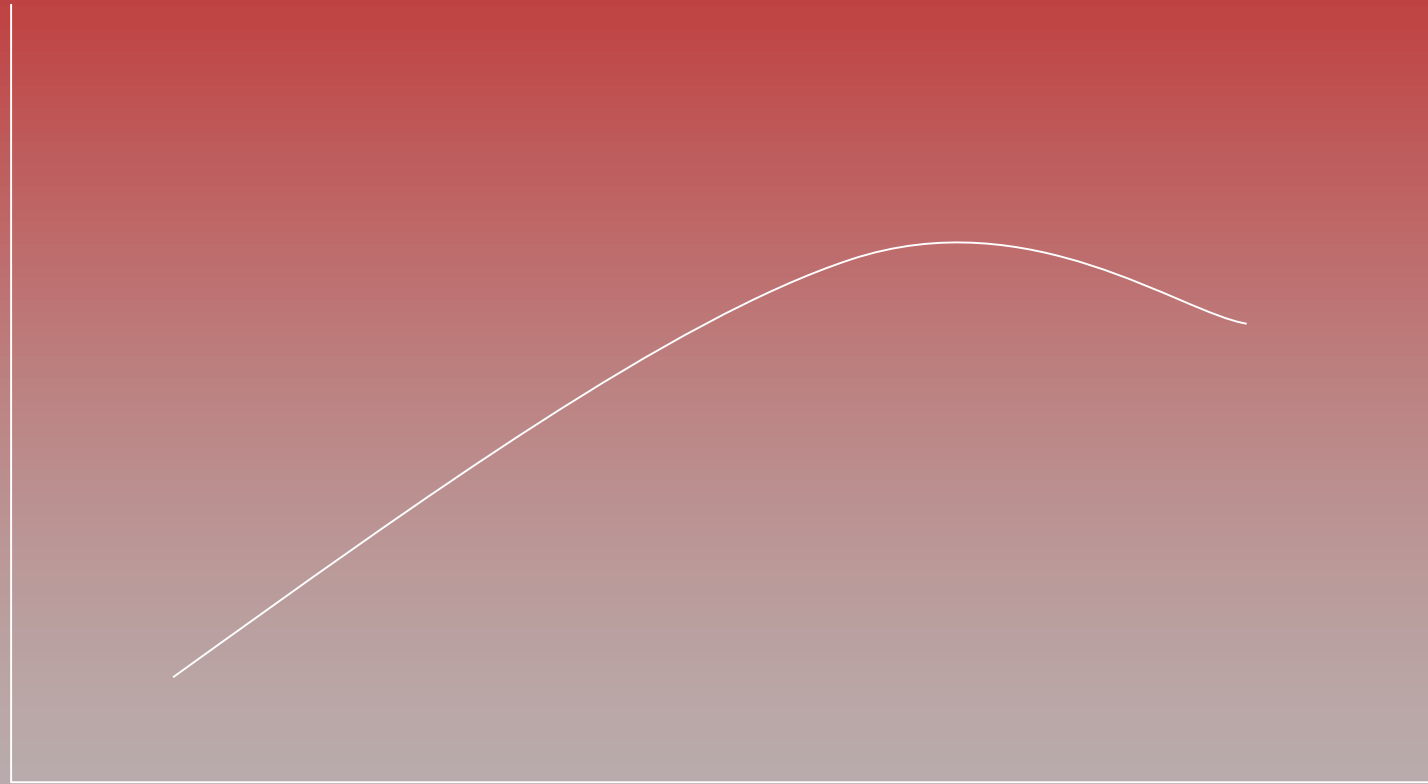
- $60/\text{MIN} \times 80 \text{ ML} = 4800 \text{ ML}/\text{MIN} \text{ (4.8 L}/\text{MIN)}$

- $70/\text{MIN} \times 80 \text{ ML} = 5600 \text{ ML}/\text{MIN} \text{ (5.6 L}/\text{MIN)}$

- BUT ONLY UP TO A POINT. WITH EXCESSIVELY HIGH HEART RATES, DIASTOLIC FILLING TIME BEGINS TO FALL, THUS CAUSING STROKE VOLUME AND THUS CO TO FALL

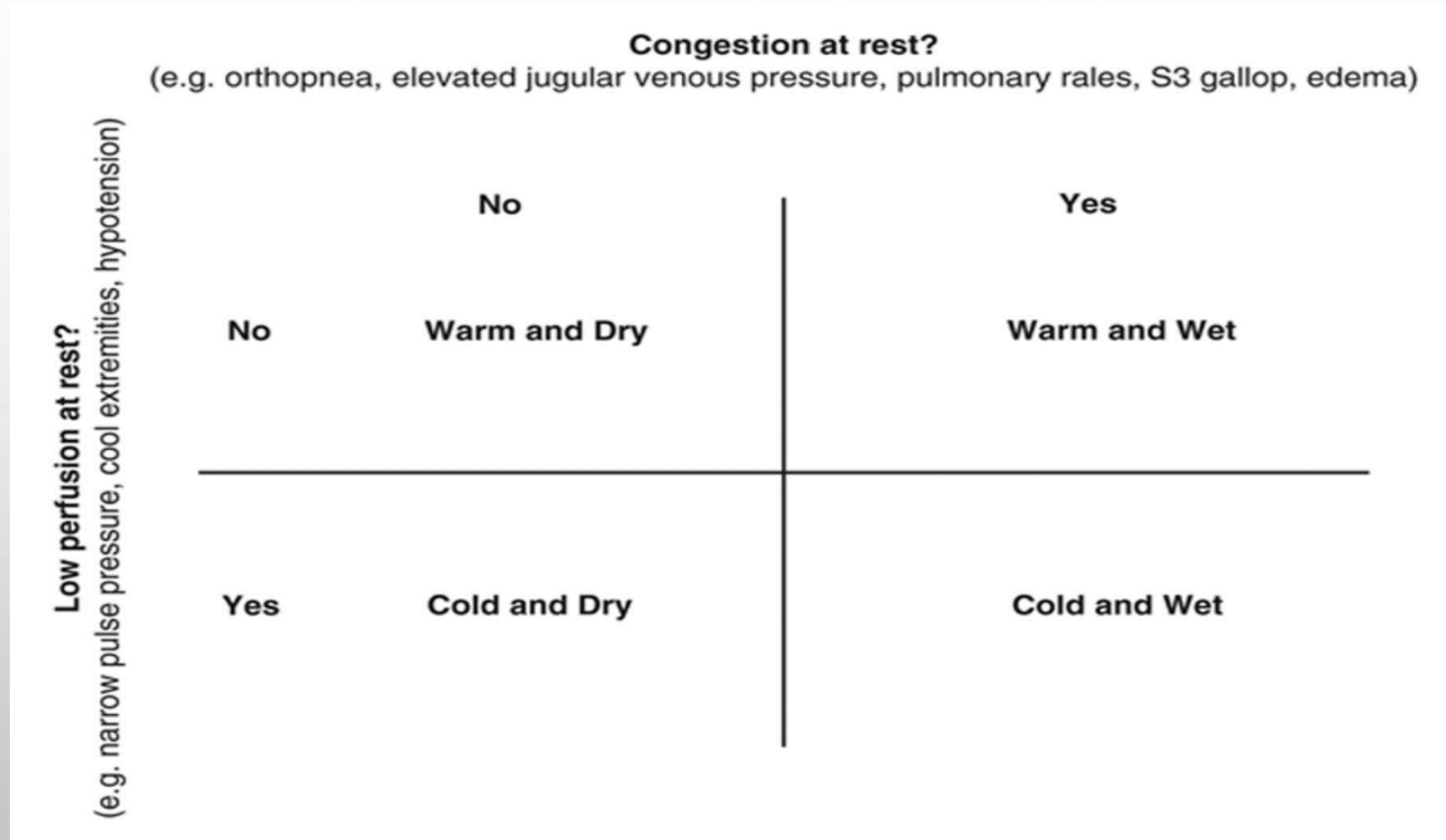
$$VR = CO$$

Cardiac  
Output



End Diastolic Volume  
(preload)

## Classification of patients presenting with acutely decompensated heart failure.



# **2013 ACCF/AHA Guideline for the Management of Heart Failure**

*by Clyde W. Yancy, Mariell Jessup, Biykem Bozkurt, Javed Butler, Donald E. Casey, Mark H. Drazner, Gregg C. Fonarow, Stephen A. Geraci, Tamara Horwich, James L. Januzzi, Maryl R. Johnson, Edward K. Kasper, Wayne C. Levy, Frederick A. Masoudi, Patrick E. McBride, John J.V. McMurray, Judith E. Mitchell, Pamela N. Peterson, Barbara Riegel, Flora Sam, Lynne W. Stevenson, W.H. Wilson Tang, Emily J. Tsai, and Bruce L. Wilkoff*

*Circulation*  
*Volume 128(16):e240-e327*  
*October 15, 2013*

# Recommendations for Biomarkers in HF.

Biomarker, Application	Setting	COR	LOE	References
<b>Natriuretic peptides</b>				
Diagnosis or exclusion of HF	Ambulatory, Acute	I	A	212, 217–223, 245–250
Prognosis of HF	Ambulatory, Acute	I	A	222, 224–229, 248, 251–258
Achieve GDMT	Ambulatory	IIa	B	230–237
Guidance for acutely decompensated HF therapy	Acute	IIb	C	259, 260
<b>Biomarkers of myocardial injury</b>				
Additive risk stratification	Acute, Ambulatory	I	A	238–241, 248, 253, 256–267
<b>Biomarkers of myocardial fibrosis</b>				
Additive risk stratification	Ambulatory	IIb	B	242–244
	Acute	IIb	A	248, 253, 256, 258–260, 262, 264–267

COR indicates Class of Recommendation; GDMT, guideline-directed medical therapy; HF, heart failure; and LOE, Level of Evidence.

# Recommendations for Non-invasive Cardiac Imaging.

Recommendations	COR	LOE
Patients with suspected, acute, or new-onset HF should undergo a chest x-ray	I	C
A 2-dimensional echocardiogram with Doppler should be performed for initial evaluation of HF	I	C
Repeat measurement of EF is useful in patients with HF who have had a significant change in clinical status or received treatment that might affect cardiac function or for consideration of device therapy	I	C
Noninvasive imaging to detect myocardial ischemia and viability is reasonable in HF and CAD	IIa	C
Viability assessment is reasonable before revascularization in HF patients with CAD	IIa	B <sup>281-285</sup>
Radionuclide ventriculography or MRI can be useful to assess LVEF and volume	IIa	C
MRI is reasonable when assessing myocardial infiltration or scar	IIa	B <sup>286-288</sup>
Routine repeat measurement of LV function assessment should not be performed	III: No Benefit	B <sup>289,290</sup>

CAD indicates coronary artery disease; COR, Class of Recommendation; EF, ejection fraction; HF, heart failure; LOE, Level of Evidence; LV, left ventricular; LVEF, left ventricular ejection fraction; and MRI, magnetic resonance imaging.

# Recommendations for Invasive Evaluation.

Recommendations	COR	LOE
Monitoring with a pulmonary artery catheter should be performed in patients with respiratory distress or impaired systemic perfusion when clinical assessment is inadequate	I	C
Invasive hemodynamic monitoring can be useful for carefully selected patients with acute HF with persistent symptoms and/or when hemodynamics are uncertain	Ia	C
When ischemia may be contributing to HF, coronary arteriography is reasonable	Ia	C
Endomyocardial biopsy can be useful in patients with HF when a specific diagnosis is suspected that would influence therapy	Ia	C
Routine use of invasive hemodynamic monitoring is not recommended in normotensive patients with acute HF	III: No Benefit	B <sup>305</sup>
Endomyocardial biopsy should not be performed in the routine evaluation of HF	III: Harm	C

COR indicates Class of Recommendation; HF, heart failure; and LOE, Level of Evidence.

# Recommendations for Treatment of Stage B HF.

Recommendations	COR	LOE	References
In patients with a history of MI and reduced EF, ACE inhibitors or ARBs should be used to prevent HF	I	A	314, 342–345
In patients with MI and reduced EF, evidence-based beta blockers should be used to prevent HF	I	B	346–348
In patients with MI, statins should be used to prevent HF	I	A	104, 349–354
Blood pressure should be controlled to prevent symptomatic HF	I	A	27, 94, 311–313
ACE inhibitors should be used in all patients with a reduced EF to prevent HF	I	A	65, 344
Beta blockers should be used in all patients with a reduced EF to prevent HF	I	C	N/A
An ICD is reasonable in patients with asymptomatic ischemic cardiomyopathy who are at least 40 d post-MI, have an LVEF $\leq$ 30%, and on GDMT	IIa	B	355
Nondihydropyridine calcium channel blockers may be harmful in patients with low LVEF	III: Harm	C	N/A

ACE indicates angiotensin-converting enzyme; ARB, angiotensin-receptor blocker; COR, Class of Recommendation; EF, ejection fraction; GDMT, guideline-directed medical therapy; HF, heart failure; ICD, implantable cardioverter-defibrillator; LOE, Level of Evidence; LVEF, left ventricular ejection fraction; MI, myocardial infarction; and N/A, not available.



# Stage C HFrEF: evidence-based, guideline-directed medical therapy.

		SIZE OF TREATMENT EFFECT													
		<b>CLASS I</b> <i>Benefit &gt;&gt;&gt; Risk</i> Procedure/Treatment <b>SHOULD</b> be performed/administered	<b>CLASS IIa</b> <i>Benefit &gt;&gt; Risk</i> Additional studies with <i>focused objectives</i> needed <b>IT IS REASONABLE</b> to perform procedure/administer treatment	<b>CLASS IIb</b> <i>Benefit ≥ Risk</i> Additional studies with <i>broad objectives</i> needed; additional <i>registry data</i> would be helpful Procedure/Treatment <b>MAY BE CONSIDERED</b>	<b>CLASS III No Benefit or CLASS III Harm</b>										
				<table border="1" style="font-size: small;"> <thead> <tr> <th></th> <th style="text-align: center;">Procedure/ Test</th> <th style="text-align: center;">Treatment</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">COR III: No benefit</td> <td style="text-align: center;">Not Helpful</td> <td style="text-align: center;">No Proven Benefit</td> </tr> <tr> <td style="text-align: center;">COR III: Harm</td> <td style="text-align: center;">Excess Cost w/o Benefit or Harmful</td> <td style="text-align: center;">Harmful to Patients</td> </tr> </tbody> </table>		Procedure/ Test	Treatment	COR III: No benefit	Not Helpful	No Proven Benefit	COR III: Harm	Excess Cost w/o Benefit or Harmful	Harmful to Patients		
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ESTIMATE OF CERTAINTY (PRECISION) OF TREATMENT EFFECT	<b>LEVEL A</b> Multiple populations evaluated* Data derived from multiple randomized clinical trials or meta-analyses	<ul style="list-style-type: none"> <li>■ Recommendation that procedure or treatment is useful/effective</li> <li>■ Sufficient evidence from multiple randomized trials or meta-analyses</li> </ul>	<ul style="list-style-type: none"> <li>■ Recommendation in favor of treatment or procedure being useful/effective</li> <li>■ Some conflicting evidence from multiple randomized trials or meta-analyses</li> </ul>	<ul style="list-style-type: none"> <li>■ Recommendation's usefulness/efficacy less well established</li> <li>■ Greater conflicting evidence from multiple randomized trials or meta-analyses</li> </ul>	<ul style="list-style-type: none"> <li>■ Recommendation that procedure or treatment is not useful/effective and may be harmful</li> <li>■ Sufficient evidence from multiple randomized trials or meta-analyses</li> </ul>										
	<b>LEVEL B</b> Limited populations evaluated* Data derived from a single randomized trial or nonrandomized studies	<ul style="list-style-type: none"> <li>■ Recommendation that procedure or treatment is useful/effective</li> <li>■ Evidence from single randomized trial or nonrandomized studies</li> </ul>	<ul style="list-style-type: none"> <li>■ Recommendation in favor of treatment or procedure being useful/effective</li> <li>■ Some conflicting evidence from single randomized trial or nonrandomized studies</li> </ul>	<ul style="list-style-type: none"> <li>■ Recommendation's usefulness/efficacy less well established</li> <li>■ Greater conflicting evidence from single randomized trial or nonrandomized studies</li> </ul>	<ul style="list-style-type: none"> <li>■ Recommendation that procedure or treatment is not useful/effective and may be harmful</li> <li>■ Evidence from single randomized trial or nonrandomized studies</li> </ul>										
	<b>LEVEL C</b> Very limited populations evaluated* Only consensus opinion of experts, case studies, or standard of care	<ul style="list-style-type: none"> <li>■ Recommendation that procedure or treatment is useful/effective</li> <li>■ Only expert opinion, case studies, or standard of care</li> </ul>	<ul style="list-style-type: none"> <li>■ Recommendation in favor of treatment or procedure being useful/effective</li> <li>■ Only diverging expert opinion, case studies, or standard of care</li> </ul>	<ul style="list-style-type: none"> <li>■ Recommendation's usefulness/efficacy less well established</li> <li>■ Only diverging expert opinion, case studies, or standard of care</li> </ul>	<ul style="list-style-type: none"> <li>■ Recommendation that procedure or treatment is not useful/effective and may be harmful</li> <li>■ Only expert opinion, case studies, or standard of care</li> </ul>										
Suggested phrases for writing recommendations		should is recommended is indicated is useful/effective/beneficial	is reasonable can be useful/effective/beneficial is probably recommended or indicated	may/might be considered may/might be reasonable usefulness/effectiveness is unknown/unclear/uncertain or not well established	<table style="font-size: x-small;"> <tr> <td style="text-align: center;">COR III: No Benefit</td> <td style="text-align: center;">COR III: Harm</td> </tr> <tr> <td style="text-align: center;">is not recommended</td> <td style="text-align: center;">potentially harmful</td> </tr> <tr> <td style="text-align: center;">is not indicated</td> <td style="text-align: center;">causes harm associated with excess morbidity/mortality</td> </tr> <tr> <td style="text-align: center;">should not be performed/administered/other</td> <td style="text-align: center;">should not be performed/administered/other</td> </tr> <tr> <td style="text-align: center;">is not useful/beneficial/effective</td> <td></td> </tr> </table>	COR III: No Benefit	COR III: Harm	is not recommended	potentially harmful	is not indicated	causes harm associated with excess morbidity/mortality	should not be performed/administered/other	should not be performed/administered/other	is not useful/beneficial/effective	
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should not be performed/administered/other	should not be performed/administered/other														
is not useful/beneficial/effective															
Comparative effectiveness phrases*		treatment/strategy A is recommended/indicated in preference to treatment B treatment A should be chosen over treatment B	treatment/strategy A is probably recommended/indicated in preference to treatment B it is reasonable to choose treatment A over treatment B												

# Recommendations for Pharmacological Therapy for Management of Stage C HFrEF.

Recommendations	COR	LOE	References
<b>Diuretics</b>			
Diuretics are recommended in patients with HF/EF with fluid retention	I	C	N/A
<b>ACE inhibitors</b>			
ACE inhibitors are recommended for all patients with HF/EF	I	A	343, 412–414
<b>ARBs</b>			
ARBs are recommended in patients with HF/EF who are ACE inhibitor intolerant	I	A	108, 345, 415, 450
ARBs are reasonable as alternatives to ACE inhibitors as first-line therapy in HF/EF	IIa	A	451–456
Addition of an ARB may be considered in persistently symptomatic patients with HF/EF on GDMT	IIb	A	420, 457
Routine combined use of an ACE inhibitor, ARB, and aldosterone antagonist is potentially harmful	III: Harm	C	N/A
<b>Beta blockers</b>			
Use of 1 of the 3 beta blockers proven to reduce mortality is recommended for all stable patients	I	A	346, 416–419, 448
<b>Aldosterone receptor antagonists</b>			
Aldosterone receptor antagonists are recommended in patients with NYHA class II–IV who have LVEF ≤35%	I	A	425, 426, 478
Aldosterone receptor antagonists are recommended in patients following an acute MI who have LVEF ≤40% with symptoms of HF or DM	I	B	446
Inappropriate use of aldosterone receptor antagonists may be harmful	III: Harm	B	479, 480
<b>Hydralazine and isosorbide dinitrate</b>			
The combination of hydralazine and isosorbide dinitrate is recommended for African Americans with NYHA class III–IV HF/EF on GDMT	I	A	423, 424
A combination of hydralazine and isosorbide dinitrate can be useful in patients with HF/EF who cannot be given ACE inhibitors or ARBs	IIa	B	449
<b>Digoxin</b>			
Digoxin can be beneficial in patients with HF/EF	IIa	B	484–491
<b>Anticoagulation</b>			
Patients with chronic HF with permanent/persistent/paroxysmal AF and an additional risk factor for cardioembolic stroke should receive chronic anticoagulant therapy*	I	A	508–514
The selection of an anticoagulant agent should be individualized	I	C	N/A
Chronic anticoagulation is reasonable for patients with chronic HF who have permanent/persistent/paroxysmal AF but are without an additional risk factor for cardioembolic stroke*	IIa	B	509–511, 515–517
Anticoagulation is not recommended in patients with chronic HF/EF without AF, a prior thromboembolic event, or a cardioembolic source	III: No Benefit	B	518–520
<b>Statins</b>			
Statins are not beneficial as adjunctive therapy when prescribed solely for HF	III: No Benefit	A	533–538
<b>Omega-3 fatty acids</b>			
Omega-3 PUFA supplementation is reasonable to use as adjunctive therapy in HF/EF or HFpEF patients	IIa	B	539, 540
<b>Other drugs</b>			
Nutritional supplements as treatment for HF are not recommended in HF/EF	III: No Benefit	B	544, 545
Hormonal therapies other than to correct deficiencies are not recommended in HF/EF	III: No Benefit	C	N/A
Drugs known to adversely affect the clinical status of patients with HF/EF are potentially harmful and should be avoided or withdrawn	III: Harm	B	546–557
Long-term use of an infusion of a positive inotropic drug is not recommended and may be harmful except as palliation	III: Harm	C	N/A
<b>Calcium channel blockers</b>			
Calcium channel-blocking drugs are not recommended as routine treatment in HF/EF	III: No Benefit	A	551, 574, 575

\*In the absence of contraindications to anticoagulation.  
ACE indicates angiotensin-converting enzyme; AF, atrial fibrillation; ARB, angiotensin-receptor blocker; COR, Class of Recommendation; DM, diabetes mellitus; GDMT, guideline-directed medical therapy; HF, heart failure; HFpEF, heart failure with preserved ejection fraction; HF/EF, heart failure with reduced ejection fraction; LOE, Level of Evidence; LVEF, left ventricular ejection fraction; MI, myocardial infarction; N/A, not available; NYHA, New York Heart Association; and PUFA, polyunsaturated fatty acids.

# KEY POINTS FOR MEDICAL TX FOR HF<sub>r</sub>EF

- ALDOSTERONE IS CLASS I IN POST MI PATIENTS WITH HF OR DM
- ARB USE AS FIRST LINE PRIOR TO INTOLERANCE OF ACEI IS CLASS IIA
- SYSTEMIC ANTICOAGULATION IS CLASS I IN HF WITH ATRIAL FIBRILLATION AND ONE MORE RISK OF THROMBOEMBOLISM
- MORE AGGRESSIVE SYSTEMIC ANTICOAGULATION IS CLASS I OR IIA IN SYMPTOMATIC HF WITH REDUCED EF WITH AF, PRIOR STROKE OR THROMBOEMBOLISM
- UNINDICATED OR HARMFUL :
  - STATINS AS STAND ALONE THERAPY
  - SUPPLEMENTS
  - CHRONIC INOTROPES
  - CALCIUM BLOCKADE

# Recommendations for Treatment of HFpEF.

Recommendations	COR	LOE
Systolic and diastolic <b>blood pressure</b> should be controlled according to published clinical practice guidelines	I	B <sup>27,91</sup>
<b>Diuretics should be used for relief of symptoms due to volume overload.</b>	I	C
Coronary <b>revascularization</b> for patients with CAD in whom angina or demonstrable myocardial ischemia is present despite GDMT	IIa	C
<b>Management of AF</b> according to published clinical practice guidelines for HFpEF to improve symptomatic HF	IIa	C
Use of beta-blocking agents, ACE inhibitors, and ARBs for hypertension in HFpEF	IIa	C
ARBs might be considered to decrease hospitalizations in HFpEF	IIb	B <sup>589</sup>
Nutritional supplementation is not recommended in HFpEF	III: No Benefit	C

ACE indicates angiotensin-converting enzyme; AF, atrial fibrillation; ARBs, angiotensin-receptor blockers; CAD, coronary artery disease; COR, Class of Recommendation; GDMT, guideline-directed medical therapy; HF, heart failure; HFpEF, heart failure with preserved ejection fraction; and LOE, Level of Evidence.

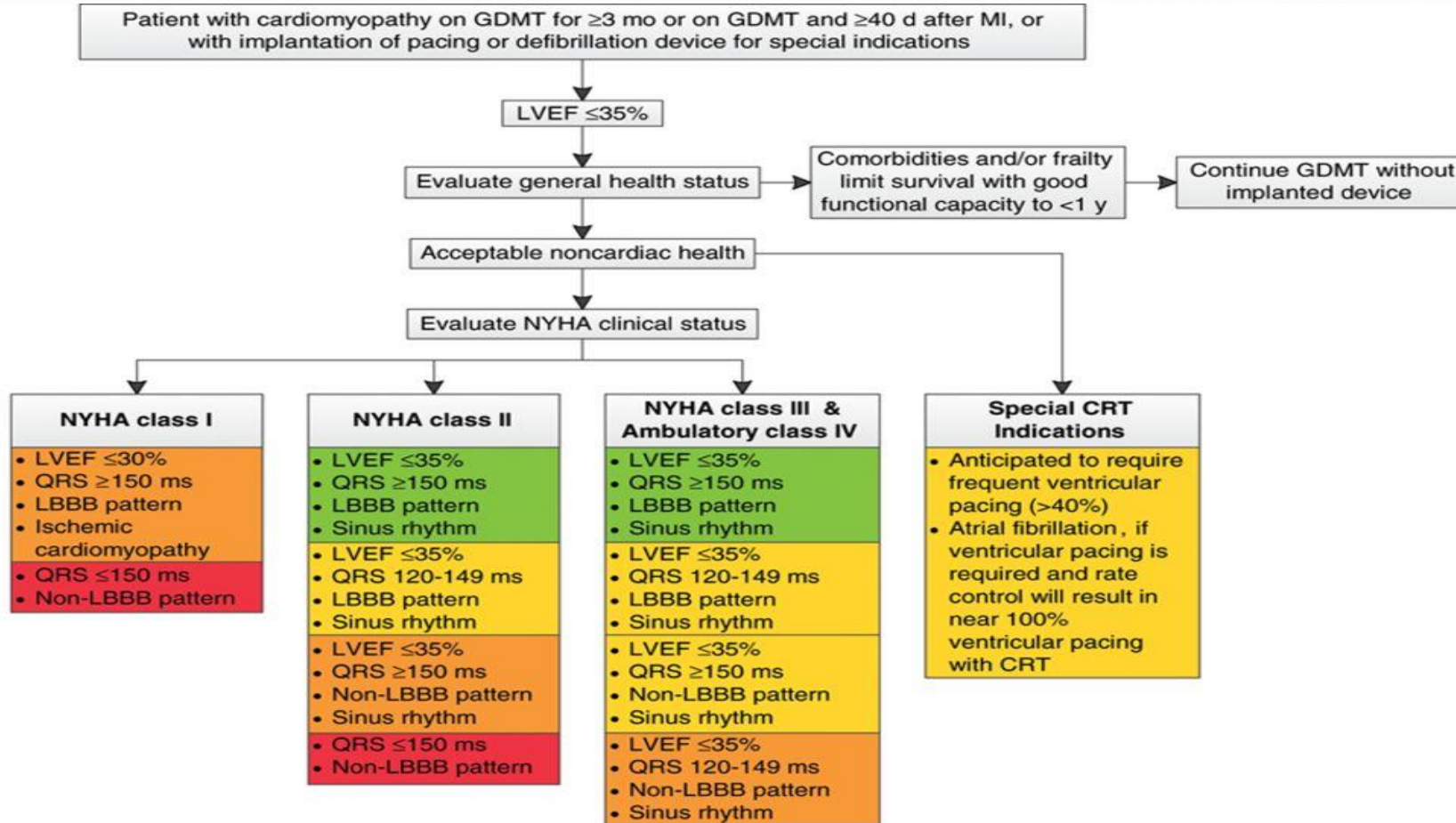
# Recommendations for Device Therapy for Management of Stage C HF.

Recommendations	COR	LOE	References
ICD therapy is recommended for primary prevention of SCD in selected patients with HF/EF at least 40 d post-MI with LVEF ≤35% and NYHA class II or III symptoms on chronic GDMT, who are expected to live >1 y*	I	A	355, 593
CRT is indicated for patients who have LVEF ≤35%, sinus rhythm, LBBB with a QRS ≥150 ms, and NYHA class II, III, or ambulatory IV symptoms on GDMT	I	A (NYHA class III/IV)	38, 78, 116, 594
		B (NYHA class II)	595, 596
ICD therapy is recommended for primary prevention of SCD in selected patients with HF/EF at least 40 d post-MI with LVEF ≤30% and NYHA class I symptoms while receiving GDMT, who are expected to live >1 y*	I	B	362, 597, 598
CRT can be useful for patients who have LVEF ≤35%, sinus rhythm, a non-LBBB pattern with QRS ≥150 ms, and NYHA class III/ambulatory class IV symptoms on GDMT	IIa	A	78, 116, 594, 596
CRT can be useful for patients who have LVEF ≤35%, sinus rhythm, LBBB with a QRS 120 to 149 ms, and NYHA class II, III, or ambulatory IV symptoms on GDMT	IIa	B	78, 116, 594–596, 599
CRT can be useful in patients with AF and LVEF ≤35% on GDMT if a) the patient requires ventricular pacing or otherwise meets CRT criteria and b) AV nodal ablation or rate control allows near 100% ventricular pacing with CRT	IIa	B	600–605
CRT can be useful for patients on GDMT who have LVEF ≤35% and are undergoing new or replacement device implantation with anticipated ventricular pacing (>40%)	IIa	C	155, 602, 606, 607
An ICD is of uncertain benefit to prolong meaningful survival in patients with a high risk of nonsudden death such as frequent hospitalizations, frailty, or severe comorbidities*	IIb	B	608–611
CRT may be considered for patients who have LVEF ≤35%, sinus rhythm, a non-LBBB pattern with a QRS duration of 120 to 149 ms, and NYHA class III/ambulatory class IV on GDMT	IIb	B	596, 612
CRT may be considered for patients who have LVEF ≤35%, sinus rhythm, a non-LBBB pattern with QRS ≥150 ms, and NYHA class II symptoms on GDMT	IIb	B	595, 596
CRT may be considered for patients who have LVEF ≤30%, ischemic etiology of HF, sinus rhythm, LBBB with QRS ≥150 ms, and NYHA class I symptoms on GDMT	IIb	C	595, 596
CRT is not recommended for patients with NYHA class I or II symptoms and non-LBBB pattern with QRS <150 ms	III: No Benefit	B	595, 596, 612
CRT is not indicated for patients whose comorbidities and/or frailty limit survival to <1 y	III: No Benefit	C	38

\*Counseling should be specific to each individual patient and should include documentation of a discussion about the potential for sudden death and nonsudden death from HF or noncardiac conditions. Information should be provided about the efficacy, safety, and potential complications of an ICD and the potential for defibrillation to be inactivated if desired in the future, notably when a patient is approaching end of life. This will facilitate shared decision making between patients, families, and the medical care team about ICDs.<sup>30</sup>

AF indicates atrial fibrillation; AV, atrioventricular; COR, Class of Recommendation; CRT, cardiac resynchronization therapy; GDMT, guideline-directed medical therapy; HF, heart failure; HF/EF, heart failure with reduced ejection fraction; ICD, implantable cardioverter-defibrillator; LBBB, left bundle-branch block; LOE, Level of Evidence; LVEF, left ventricular ejection fraction; MI, myocardial infarction; NYHA, New York Heart Association; and SCD, sudden cardiac death.

# CRT therapy algorithm in Stage C HF



Colors correspond to the class of recommendations in the ACCF/AHA Table 1.

Benefit for NYHA class I and II patients has only been shown in CRT-D trials, and while patients may not experience immediate symptomatic benefit, late remodeling may be avoided along with long-term HF consequences. There are no trials that support CRT-pacing (without ICD) in NYHA class I and II patients. Thus, it is anticipated these patients would receive CRT-D unless clinical reasons or personal wishes make CRT-pacing more appropriate. In patients who are NYHA class III and ambulatory class IV, CRT-D may be chosen but clinical reasons and personal wishes may make CRT-pacing appropriate to improve symptoms and quality of life when an ICD is not expected to produce meaningful benefit in survival.

# Recommendations for Therapies in the Hospitalized HF Patient.

Recommendations	COR	LOE	References
HF patients hospitalized with fluid overload should be treated with intravenous diuretics	I	B	737, 738
HF patients receiving loop diuretic therapy should receive an initial parenteral dose greater than or equal to their chronic oral daily dose; then dose should be serially adjusted	I	B	739
HF/EF patients requiring HF hospitalization on GDMT should continue GDMT except in cases of hemodynamic instability or where contraindicated	I	B	195, 735, 736
Initiation of beta-blocker therapy at a low dose is recommended after optimization of volume status and discontinuation of intravenous agents	I	B	195, 735, 736
Thrombosis/thromboembolism prophylaxis is recommended for patients hospitalized with HF	I	B	21, 770–774
Serum electrolytes, urea nitrogen, and creatinine should be measured during titration of HF medications, including diuretics	I	C	N/A
When diuresis is inadequate, it is reasonable to	IIa	B	38, 739
a. give higher doses of intravenous loop diuretics; or			
b. add a second diuretic (eg, thiazide)		B	740–743
Low-dose dopamine infusion may be considered with loop diuretics to improve diuresis	IIb	B	744, 745
Ultrafiltration may be considered for patients with obvious volume overload	IIb	B	752
Ultrafiltration may be considered for patients with refractory congestion	IIb	C	N/A
Intravenous nitroglycerin, nitroprusside, or nesiritide may be considered an adjuvant to diuretic therapy for stable patients with HF	IIb	A	760–763
In patients hospitalized with volume overload and severe hyponatremia, vasopressin antagonists may be considered	IIb	B	787, 788

COR indicates Class of Recommendation; GDMT, guideline-directed medical therapy; HF, heart failure; HF/EF, heart failure with reduced ejection fraction; LOE, Level of Evidence; and N/A, not available.

# Recommendations for Inotropic Support, MCS, and Cardiac Transplantation.

Recommendations	COR	LOE	References
<b>Inotropic support</b>			
Cardiogenic shock pending definitive therapy or resolution	I	C	N/A
BTT or MCS in stage D refractory to GDMT	IIa	B	647, 648
Short-term support for threatened end-organ dysfunction in hospitalized patients with stage D and severe HF/rEF	IIb	B	592, 649, 650
Long-term support with continuous infusion palliative therapy in select stage D HF	IIb	B	651–653
Routine intravenous use, either continuous or intermittent, is potentially harmful in stage D HF	III: Harm	B	416, 654–659
Short-term intravenous use in hospitalized patients without evidence of shock or threatened end-organ performance is potentially harmful	III: Harm	B	592, 649, 650
<b>MCS</b>			
MCS is beneficial in carefully selected* patients with stage D HF in whom definitive management (eg, cardiac transplantation) is anticipated or planned	IIa	B	660–667
Nondurable MCS is reasonable as a “bridge to recovery” or “bridge to decision” for carefully selected* patients with HF and acute profound disease	IIa	B	668–671
Durable MCS is reasonable to prolong survival for carefully selected* patients with stage D HF/rEF	IIa	B	672–675
<b>Cardiac transplantation</b>			
Evaluation for cardiac transplantation is indicated for carefully selected patients with stage D HF despite GDMT, device, and surgical management	I	C	680

\*Although optimal patient selection for MCS remains an active area of investigation, general indications for referral for MCS therapy include patients with LVEF <25% and NYHA class III–IV functional status despite GDMT, including, when indicated, CRT, with either high predicted 1- to 2-year mortality (eg, as suggested by markedly reduced peak oxygen consumption and clinical prognostic scores) or dependence on continuous parenteral inotropic support. Patient selection requires a multidisciplinary team of experienced advanced HF and transplantation cardiologists, cardiothoracic surgeons, nurses and ideally, social workers and palliative care clinicians.

BTT indicates bridge to transplant; COR, Class of Recommendation; CRT, cardiac resynchronization therapy; GDMT, guideline-directed medical therapy; HF, heart failure; HF/rEF, heart failure with reduced ejection fraction; LOE, Level of Evidence; LVEF, left ventricular ejection fraction; MCS, mechanical circulatory support; N/A, not applicable; and NYHA, New York Heart Association.

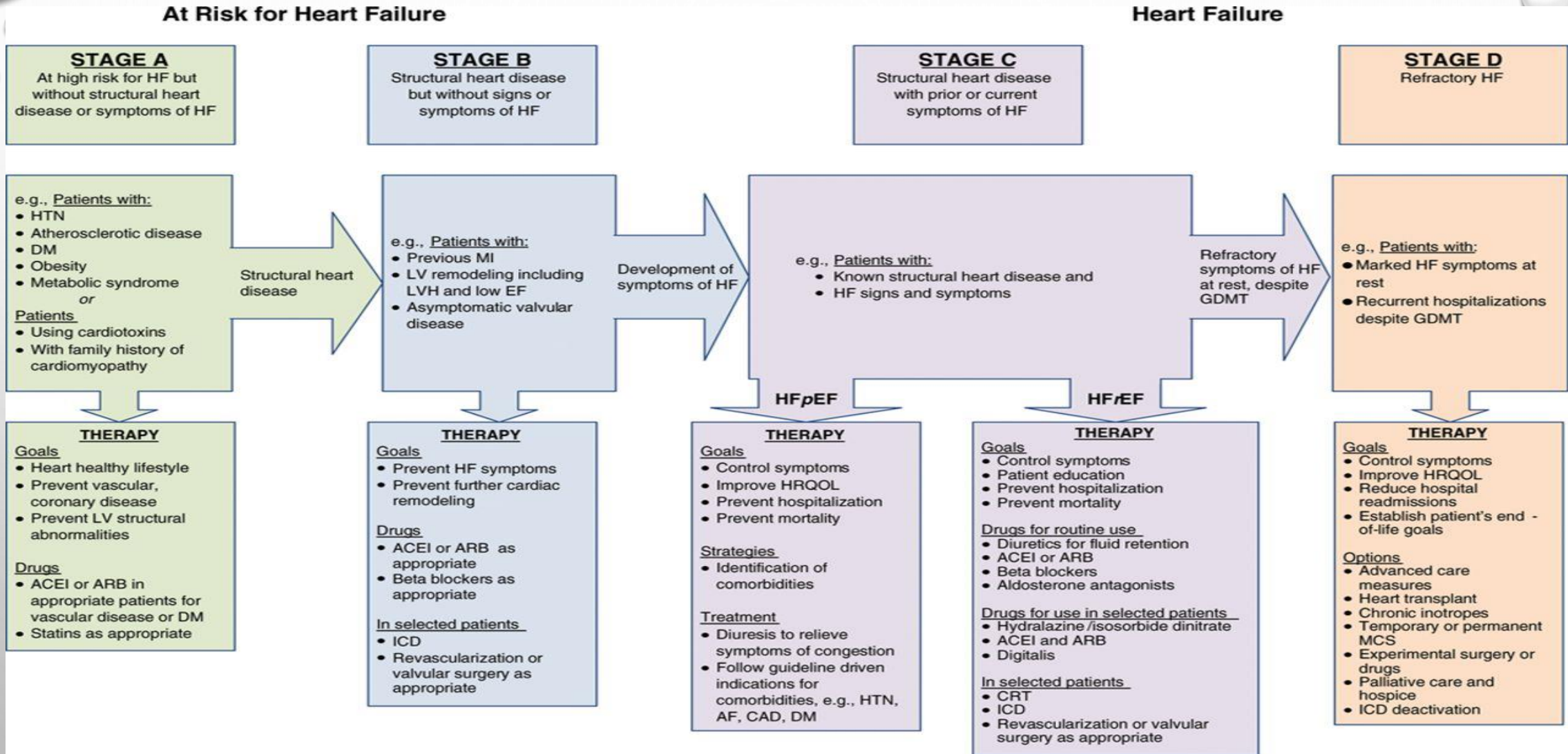


## Recommendations for Surgical/Percutaneous/ Transcatheter Interventional Treatments of HF.

Recommendations	COR	LOE	References
CABG or percutaneous intervention is indicated for HF patients on GDMT with angina and suitable coronary anatomy, especially significant left main stenosis or left main equivalent	I	C	10, 12, 14, 848
CABG to improve survival is reasonable in patients with mild to moderate LV systolic dysfunction and significant multivessel CAD or proximal LAD stenosis when viable myocardium is present	IIa	B	848–850
CABG or medical therapy is reasonable to improve morbidity and mortality for patients with severe LV dysfunction (EF <35%), HF, and significant CAD	IIa	B	309, 851
Surgical aortic valve replacement is reasonable for patients with critical aortic stenosis and a predicted surgical mortality of no greater than 10%	IIa	B	852
Transcatheter aortic valve replacement is reasonable for patients with critical aortic stenosis who are deemed inoperable	IIa	B	853
CABG may be considered in patients with ischemic heart disease, severe LV systolic dysfunction, and operable coronary anatomy whether or not viable myocardium is present	IIb	B	307–309
Transcatheter mitral valve repair or mitral valve surgery for functional mitral insufficiency is of uncertain benefit	IIb	B	854–857
Surgical reverse remodeling or LV aneurysmectomy may be considered in HF/EF for specific indications, including intractable HF and ventricular arrhythmias	IIb	B	858

CABG indicates coronary artery bypass graft; CAD, coronary artery disease; COR, Class of Recommendation; EF, ejection fraction; GDMT, guideline-directed medical therapy; HF, heart failure; HF/EF, heart failure with reduced ejection fraction; LAD, left anterior descending; LOE, Level of Evidence; and LV, left ventricular.

# Stages in the development of HF and recommended therapy by stage.



# Recommendations for Hospital Discharge.

Recommendations or Indications	COR	LOE	References
Performance improvement systems in the hospital and early postdischarge outpatient setting to identify HF for GDMT	I	B	82, 365, 706, 792–796
Before hospital discharge, at the first postdischarge visit, and in subsequent follow-up visits, the following should be addressed: <ul style="list-style-type: none"> <li>a. initiation of GDMT if not done or contraindicated;</li> <li>b. causes of HF, barriers to care, and limitations in support;</li> <li>c. assessment of volume status and blood pressure with adjustment of HF therapy;</li> <li>d. optimization of chronic oral HF therapy;</li> <li>e. renal function and electrolytes;</li> <li>f. management of comorbid conditions;</li> <li>g. HF education, self-care, emergency plans, and adherence; and</li> <li>h. palliative or hospice care</li> </ul>	I	B	204, 795, 797–799
Multidisciplinary HF disease-management programs for patients at high risk for hospital readmission are recommended	I	B	82, 800–802
A follow-up visit within 7 to 14 d and/or a telephone follow-up within 3 d of hospital discharge are reasonable	IIa	B	101, 803
Use of clinical risk-prediction tools and/or biomarkers to identify higher-risk patients are reasonable	IIa	B	215

COR indicates Class of Recommendation; GDMT, guideline-directed medical therapy; HF, heart failure; and LOE, Level of Evidence.