Heart failure: etiology, signs symptoms, treatment, and patient education

Heart failure (HF) is defined as a collection of symptoms that result from the heart being unable to pump an adequate amount of blood to fulfill the metabolic demands of peripheral tissues. It is estimated that 5. 7 million Americans over the age of 20 have had heart failure. In 2012, the total monetary cost of heart failure in the United States was approximately $30. 7 billion, with 68% of that total comprised of direct medical costs. Projections indicate that by 2030, the total cost of heart failure will increase to $69. 7 billion. [1]

The most common cause of heart failure is ischemic heart disease subsequent to acute or chronic myocardial ischemia and/or coronary artery disease. Nonischemic cardiomyopathies and structural heart disease are also common etiologies of heart failure. It is helpful to identify and address cardiomyopathies in order to appropriately manage heart failure. In the 2001 update of the National Health and Nutrition Examination Survey (NHANES), it was reported that male sex, lower education level, low physical activity, cigarette smoking, obesity, diabetes mellitus, hypertension, valvular heart disease, and coronary heart disease were significant independent risk factors for heart failure. [2] It was noted in the 2015 ADHERE and ASCEND trials that renal dysfunction was a predictor for progressing heart failure. [3] In 2018, Tanai, et al, also mention chronic pulmonary disease as a risk factor. [4]

The diagnosis of heart failure is made clinically with the history and physical, based on the Framingham Criteria, with fulfillment of at least two major criteria or a major criterion in combination with at least two minor criteria. Major criteria include paroxysmal nocturnal dyspnea, basilar rales (crackles),

S3 gallop, cardiomegaly, increased central venous pressure (> 12 mmH $_2$ O in the right atrium), jugular venous distension, acute pulmonary edema, hepatojugular reflux, weight loss of greater than 4. 5 kilograms/5 days in response to treatment. Minor criteria include bilateral ankle edema, dyspnea on exertion, tachycardia of greater than 120 bpm, nocturnal cough, hepatosplenomegaly, pleural effusion, reduction in vital capacity by one-third from maximum. Regarding imaging, an echocardiogram can be used to calculate ejection fraction and identify structural abnormalities of the heart. A chest X-ray may be helpful in identifying cardiomegaly. B-Natriuretic Peptide (BNP), released by the ventricles during times of volume overload as a physiological inhibitor of the RAAS system activation, can be used as a lab value to evaluate congestive heart failure, with attention to the patient's " baseline". It must be noted that BNP is less reliable (chronically elevated) as a marker in patients with renal failure and can be decreased in obese patients. [4]

Heart failure can be described using a variety of terminology – left-sided versus right-sided (part of the circulatory system affected), systolic versus diastolic (cardiac function), high output versus low output, and acute versus chronic (onset and disease timeline). These classifications can be used in conjunction with one another – acute on chronic left-sided diastolic dysfunction, as an example. Notably, the most common cause of right-sided (pulmonary circulatory system) heart failure is left-sided (systemic circulatory system) heart failure, and patients commonly present with a combination of the two. In personally observed clinical practice and for the purpose of Guideline-Directed Medical Treatment, it has been of highest

importance to differentiate between systolic (heart failure with reduced ejection fraction or HFrEF) versus diastolic (heart failure with preserved ejection fraction or HFpEF) dysfunction. Reduced ejection fraction (EF) is defined as an EF of less than or equal to 40% whereas preserved ejection fraction is defined as an EF greater than or equal to 50%. In 2016, the European Society of Cardiology introduced the terminology of heart failure with mid-range ejection fraction (HRmrEF). [5]

A few organizations have developed systems for classifying severity of heart failure. The New York Heart Association (NYHA) functional classification is based on clinical symptoms. NYHA Class I indicates that there is " no limitation of ordinary physical activity." Class II coincides with " slight limitation of physical activity" where the patient is comfortable at rest, but ordinary physical activity leads to shortness of breath, fatigue, or palpitations. Class III specifies " marked limitation of physical ability", where the patient is comfortable at rest but " less than ordinary physical activity" results in dyspnea, fatigue, or palpitations. Patients under Class IV are " unable to carry on any physical activity without discomfort" – symptoms may be present at rest and any physical increases discomfort. The American College of Cardiology Foundation (ACCF) and the American Heart Association (AHA) devised a classification system (Stages A through D) that considers clinical signs and symptoms and incorporates existing risk factors and comorbidities to stage disease outcomes. Stage A HF patients have no structural heart disease but have increased risk of heart failure due to existing risk factors and comorbidities. Stage B patients present with structural disease such as history of myocardial infarction or valvular disease

though there are no clinical manifestations of heart failure. Stage C corresponds to symptomatic heart failure. Stage D signifies end-stage, refractory heart failure. [4]

In 2013, the American College of Cardiology Foundation and American Heart Association released an extensive set of guidelines for the treatment and management of heart failure, and in subsequent years has released updates to the guidelines. For Stage A HF, the standing recommendation is to control the comorbidities and risk factors that could lead to heart failure by adhering to current guidelines for managing hypertension and hyperlipidemia. For Stage B HF management, Stage A recommendations of controlling high blood pressure and high cholesterol still apply. In addition, it is recommended that ACEi or ARBs and beta-blockers should be used with patients with a history of myocardial infarction (MI) and reduced EF. ACEi and beta-blockers should be used in patients with a reduced EF, regardless of MI history. An implantable cardioverter-defibrillator (ICD) is a reasonable consideration for Stage B HF patients who have asymptomatic ischemic cardiomyopathies given that they are at least 40 days out from an MI, have a reduced left ventricular ejection fraction of less than 30%, and are likely survive for at least one more year with reasonably good functional capacity. Notably, non-dihydropyridine calcium channel blockers, which reduce myocardial contractility, were shown to be harmful in asymptomatic patients with low left ventricular ejection fraction. [6]

Stage C (symptomatic) HF management is the most complicated, and it is within this stage that the NYHA classifications (Classes II-IV, namely) are

integrated. It is advised that patients receive specific education regarding heart failure signs and symptoms and the lifestyle changes that come along with the diagnosis. Sodium restriction is deemed to be reasonable to reduce the congestive symptoms of heart failure. Continuous positive airway pressure (CPAP) can improve functional status in heart failure patients with comorbid sleep apnea. Exercise training is safe and effective means for patients as tolerated to improve functional status; cardiac rehabilitation can be used in stable patients to aid in physical stamina, increased health-related quality of life (HRQOL), and mortality. AHA recommendations at this stage are divided into separate advisements for HFrEF and HFpEF. Pharmacological therapy for Stage C HFrEF is complex. Diuretics are recommended for symptomatic relief in patients with fluid retention. Bisoprolol, carvedilol, and sustained release metoprolol succinate are three beta-blockers shown to improve mortality, and thus, it is recommended that one of these are incorporated into a HFrEF patient's pharmacotherapy. [6] The 2016 update to these guidelines recommends utilizing an angiotensin receptor-neprilysin inhibitor (ARNI), specifically the recently approved valsartan/sacubitril, in the place of an ACEi/ARB for patients (first-line treatments in the 2013 recommendations) along with a sinoatrial node modulator (ivabradine) to complement pharmacological and device management of the disease. [7] The 2017 update elaborates further indicating that ARNIs should not be used concurrently with ACEi and should be started after a 36 hour washout period of any existing ACEi regimen. [8] Aldosterone receptor antagonists should be prescribed in the treatment of patients with NYHA Class II-IV HF and who have a LVEF of 35% or less. Renal function,

potassium levels, and diuretic use should be monitored closely to avoid hyperkalemia and renal insufficiency. Hydralazine and isosorbide dinitrate show morbidity and mortality benefit for African American patients with NYHA Class III-IV HFrEF who are receiving appropriate and effective therapy with ACEi and beta-blockers. This combination also shows benefit in all patients with historically or currently symptomatic HFrEF who cannot be given an ACE or ARB due to intolerance, hypotension, or renal insufficiency. Digoxin can be helpful in reducing hospitalizations for this population unless otherwise contraindicated. Anticoagulation should be given to patients with chronic HF along with a history of atrial fibrillation and an additional risk factor for stroke (hypertension, diabetes, previous stroke or transient ischemic attack, age over 75). Statins solely prescribed in the context of treating HF shows no benefit unless it is indicated for treatment for existing comorbidities (hyperlipidemia). Nutritional supplements and hormone therapy (without other indications) show no benefit in treating HFrEF. Internal cardioverter defibrillator (ICD) therapy and cardiac resynchronization (CRT) are appropriate to prevent sudden cardiac death in some patients, as evaluated by a provider. Stage C HFpEF recommendations are somewhat more straightforward. Blood pressure control and diuretics for symptomatic relief are recommended. Coronary revascularization in patients with known coronary artery disease is a reasonable consideration for patients with symptomatic myocardial ischemia or angina. [6]

Stage D heart failure describes refractory heart failure symptoms at rest despite appropriate medical therapy along with recurrent hospitalizations. Mechanical circulatory support (MCS) – temporary or permanent- can be

considered as well as cardiac transplant eligibility. Chronic inotropic support (milrinone and dobutamine) can also be incorporated into care. For some patients receiving these drugs, the delivery of constant inotropic support as an outpatient via a PICC line can be a major adjustment or deterrent. It is important for patients at the stage and their caretakers to discuss and establish end-of-life goals and palliative care. [6]

Heart failure and its progression are a public health concern with life expectancy increasing with medical advances in developed countries – more than 80% of heart failure patients are over the age of 65. [9] It is important that the patient understands their role in their own care – for example, when to see their cardiologist or reporting to the Emergency Department during an exacerbation. As noted above, patient education is a standing recommendation from the AHA and ACC in treatment of heart failure. [8] It was observed during this rotation that symptomatic HF patients with heart failure diagnosis would be encouraged to attend a " Heart Failure Class" before discharge. Furthermore, the hospital system offered a free, four-week " Heart Failure Academy" at various locations and times in the Atlanta metro area for patients and their families. Many patients encountered on rotation were aware of when to come in but also had difficulty with medication compliance and adherence to lifestyle modifications. In a study conducted in rural China and published in *Rural and Remote Health* in 2019, it was shown that nurse-led patient education during and after a hospital stay improved patient self-management skills, medication compliance, and lifestyle modifications. The rate of rehospitalization within the next 12 months was

also significantly reduced. [10] A 2017 study conducted by Srisuk, et. al also showed that patients and caregivers who received structure education and telephone support post-discharge had improved knowledge and perceived self-control following diagnosis. [11] As noted in didactic curriculum and anecdotal experience, accessibility (physically, financially, or otherwise) can be a barrier to healthcare. Thus, it is a responsibility of providers to ensure that patients know where to find helpful information and are afforded different avenues to communicate with their care team. The American Heart Association provides a variety of tools are resources for patients and their caregivers on their website. There is an app available through the AHA called HF Path™, described as a " self-management tool that empowers heart failure patients to better manage and live with their condition". In the same vein, a mobile phone app called iHeartU with a " virtual human assistant" (the iHeartHelper) for heart failure education and management has been developed and is being studied in a small group of 10 subjects for usability. [12] There are also some clinical trials currently that incorporate the use of technology to assist in patient education and access to support – one incorporates the use of Amazon Alexa and a special heart failure " skill set" for the device and another investigates the outcomes of a virtual visit (versus in-office visit) for heart failure patients at their one-week follow up. [13, 14]

As is evident, the etiology of heart failure is complex, and its manifestations are systemic. The guideline-directed medical treatment of this diagnosis is ever-evolving, and it is important that both providers and patients

understand their roles and communication options during management and treatment.

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