Non Pharmacologic Treatment of Acute and Chronic Heart Failure

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Objectives:
1. Introduction to heart failure
2. Heart transplantation as the “gold” therapy
3. Cardiac Resynchronization Therapy (CRT) improving outcomes
4. Evidence supporting the use of Left Ventricular Assist Devices (LVAD)
5. Perioperative management of LVAD’s
6. Surgical Ventricular Reconstruction (SVR)
7. Understanding Ventricular Restraint Devices

Heart failure is the only cardiac disease that continues to grow in prevalence despite our vast advances in cardiac care. The increased incidence of heart failure relates to a patient population of advanced age and the improved management of coronary heart disease. Patients who survive a cardiac insult are at an increased risk of developing heart failure later in life. There is an estimated 5 million U.S. residents who suffer from heart failure with 70% of them being over 60 years of age. The National Center for Health Statistics estimates a tripling of the population 80 years old by 2030. And the cost to our society for managing the disease is approximately $35 billion a year. It is paramount, given these staggering numbers, to understand all the treatment options available to patients suffering from heart failure. As anesthesiologist we will continue to encounter this group of patients with increasing frequency.

The pathophysiology of heart failure is an extremely complex set of events. It is marked by the initial insult (ischemic, valvular, idiopathic, etc), which leads to increasing cardiac dysfunction. This dysfunction leads to increasing ventricular wall stress and results in a compensatory dilatation. At this point the ventricle has lost its normal elliptical form and has taken on a spherical appearance. The symptoms of heart failure present secondary to the heart’s inability to produce the output for the patient’s level of activity. This mismatch results in shortness of breath and overall patient discomfort. The fatality rate at 1 year is approximately 20% and at 5 years 50% and is much higher with more advanced disease. It is therefore important to reverse the downward spiral of heart failure by decreasing wall stress and preventing cardiac remodeling.

On December 3, 1967, South African Christiaan Barnard performed the first heart transplant. With advances in immunosuppressive drugs, the survival of patients who undergo heart transplant makes it the most successful intervention that end stage heart failure patients can undergo. The one year postoperative survival following cardiac transplant is just over 80%, which is very impressive, considering the critical nature of this patient population. Heart transplantation, however, has been limited by number of donors available and has reached a plateau at less than 4500 patients a year. Even with expanded inclusion criteria for heart donors it is unlikely that the number of transplants will be able to serve the needs of so many patients with heart failure. It is therefore the goal of all heart failure treatment to mimic the survival rate observed with heart transplantation.

Approximately 30 percent of patients with chronic heart failure have conduction pathway defects manifested by ventricular dyssynchrony. This abnormality presents on
electrocardiogram as a QRS interval lasting for more than 120 msec. Intraventricular conduction delay and ventricular dyssynchrony have been associated with clinical instability from a mechanically inefficient heart and an increased risk of death in patients with heart failure. In cardiac-resynchronization therapy (CRT), biventricular pacing resynchronizes left and right ventricular contraction thus eliminating the electrical delay. In patients with moderate-to-severe heart failure and intraventricular conduction delay, early studies on CRT demonstrate associated reduction in mitral regurgitation and improvement in cardiac function, ejection fraction, functional capacity, exercise capacity, and quality of life. More recent studies demonstrate fewer hospitalizations and a decreased risk of morbidity and mortality.

In the Mid 1990’s Dr. Randas Batista of Brazil attempted to reconstruct the heart of cardiac failure patients utilizing surgical manipulation. He surmised that by surgically removing a portion of the ventricle, and restoring a more normal heart shape, he could improve the patient’s overall survival. His concept was based on Laplace’s law for reducing wall stress. While early observational work showed promise, more complete studies failed to show benefit. His surgery, however, is applauded for its unique approach to heart failure and has served as a model for other surgical ventricular restoration (SVR) operations. The Dor procedure is a second surgery that provides surgical reshaping of a diseased heart. Where the Batista operation took a portion of viable muscle from the lateral wall of the heart, the Dor procedure removed a diseased dyskinetic or aneurismal portion of the heart. The Dor procedure aimed at removing dead heart muscle from a ventricle and restoring a more natural elliptical cardiac shape. The heart was then patched or closed primarily and early studies have shown an improvement in patient symptoms as well as cardiac indices (i.e. ejection fraction, LVEDD, etc). Further studies are being examined and most importantly the STITCH trial (surgical treatment of ischemic heart failure) will hopefully answer some important questions regarding SVR.

The use of LVAD’s has become a cornerstone for the treatment of patients with refractory heart failure. The numerous devices available to support the failing heart have flooded the market. These devices are constantly undergoing adjustments to increase their efficiency. The LVAD’s available and approved by the FDA for use include both pulsatile and non-pulsatile flow pumps. The use of LVAD’s for the treatment of heart failure was highlighted in a study published in The New England Journal of Medicine (Rose, et al., 2001). The REMATCH trial (randomized evaluation of Mechanical Assistance for the Treatment of Congestive Heart failure) examined 129 patients, with end stage heart failure, who were not candidates for transplantation. These were the most critically ill patients to be enrolled in a clinical trial to date and they were randomized to best medical therapy versus implantation of a HeartMate XVE LVAD. The trial revealed the effectiveness of the LVAD in increasing patient’s survival. At one year the survival of the LVAD group doubled that of the medical group and at two years the survival was tripled. In addition, quality of life was improved among the LVAD population. After this study the FDA approved the use of the HeartMate for destination therapy.

In the REMATCH trial, deaths among those patients who had an LVAD were mainly from device failure and infection. The new LVAD’s continue to address these problems making the drive lines shorter and less abdominal exposure in an attempt to decrease infection. Limiting the number of moveable parts contained in the LVAD will also increase device longevity. The desire to improve the LVAD’s brought about the non-pulsatile flow pumps. These pumps either axial or centrifugal flow pumps provide a greater degree of reliability given fewer moving parts. An article published in New England Journal of Medicine (Miller, et al 2007) showed that continuous flow pumps provide excellent survival rates in patients who are awaiting transplantation.

In recent years there has been a growing interest in the use of mechanical support plus medication in the hope of recovering the failing heart. For years it has been noted that after unloading the ventricle with an LVAD, the myocardial cells improve their function. Clinically,
however, only 5-20% of patients go on to have their LVAD explanted. It has been theorized that complete unloading of the ventricle may lead to myocyte atrophy and for this reason patients become dependent on the LVAD. A recent study examined the use of LVAD with a B2 agonist Clenbuterol. This drug is currently approved in the United Kingdom for the treatment of asthma and is also a medication of abuse among athletes. In experimental models Clenbuterol has beneficial effects on the excitation-contraction coupling of the myocardium and myocardial metabolism. This property makes the drug desirable and will hopefully prevent the myocyte atrophy previously observed. Currently the HARPS trial (the Harefield Recovery Protocol Study) is examining the role for the potent combination of LVAD with Clenbuterol to recover the heart and eventual explantation of the LVAD.

Ventricular restraint devices have been used in various modifications for many years. Original cardiomyoplasty utilized the patient’s own muscle (latissimus Dorsi) to wrap the heart. It was thought that this would augment systolic contraction, but it actually worked by providing diastolic support. Patients with heart failure have loss of the normal geometric configuration of the heart. Parameters such as end diastolic diameter (EDD) have been shown to predict survival in patients. A large heart with an LVEDDi greater than 4cm/m_ has a greater 2-year mortality when compared with a smaller LVEDDi (Lee et al. 1993). This difference in survival is the driving force for the use of ventricular restraint devices especially if they lead to increased survival and patient freedom from heart failure hospitalizations. The Paracor system uses a mini left thoracotomy incision without the need for cardiopulmonary bypass. It is deployed using echocardiography and radiographic guidance. The device uses a nickel titanium alloy net, which provides ventricle support without restricting the heart or coronary blood flow. Initial studies have shown statistical significant changes in cardiac indices (i.e. LVEDD, ejection fraction, LVESD). An ongoing multicenter trial is currently underway to access the benefits of the device.

The future of heart failure treatment is certain to be expanding over the next decade. The number of patients who suffer from the disease is increasing and thus, innovative technology needs to be aggressively pursued. Given the rapid growth of this field it is clear that anesthesiologists will be responsible for the care to an increasing number of heart failure patients. It is critical that we understand the therapies being examined and the role that we will play in their management. As patients with heart failure survive longer they are sure to present to the operating room for all types of general surgical procedures. In order to optimize patient care, anesthesiologists need to have a working knowledge of these devices. In addition, the cardiac anesthesiologist will certainly observe an increasing number of patients with advanced disease and may provide care for the insertion of the previously discussed devices. As perioperative physicians, we optimize our ability to care for these patients if we have an understanding of the therapeutic goals.

References


