**Left Ventricular Assist Devices (LVAD) in 2015: UPDATE**

Rick Thompson, MD

Photo Courtesy of Thoratec Corporation, Inc

Disclosures

- Together+Clinic
  - Co-Founder
- CR Bard
  - Consultant

Objectives

- Overview of Bryan Health VAD Program
- Identify indications for Ventricular Assist Device Therapy
- Discuss mechanism and function of Ventricular Assist Device
- Review current LVAD data (keeping in mind initial trial data)
- Up and coming NEWS for LVADs
**Bryan Heart VAD Team (as a recap…)**
- Dr. Richard Thompson, Cardiothoracic Surgeon and Surgical Director
- Dr. Mathue Baker, Heart Failure Cardiologist and Medical Director
- Sarah Schroeder, ACNP-BC, MSN RN, VAD Nurse Practitioner and Program Coordinator
- M. Candice Wild, APRN-CNS for VAD Program
- Tiffany Arndt, RN, Director of Critical Care
- Donovan Lempka, Biomed Technician III
- Vic Grdina, Perfusionist
- Andrew Lundstrom, BSN RN, VAD Coordinator

**Bryan Health VAD Program and Outcomes**
- Joint Commission Certified in Destination Therapy implants
- First Destination Therapy implant September 2012 (56 year old Male)
  - Developed Driveline Infection, LVAD bought time with his cancer history and went to Transplant November 2014
- Have implanted 14 patients (11 males, 3 females)
  - 14 thus far with at least 3 more planned this year minimum
  - 2012: 1
  - 2013: 3
  - 2014: 5
  - 2015: 5 (still ongoing)
- **30 day Mortality**: 7.7% (1 patient/13 patients; 14th patient not 30 days out yet)

**Bryan Health VAD Program and Outcomes…**
- **Mean Length of Stay**: 22.8 days (goal is 21 days) and **Median Length of Stay**: 17.5 days (shortest 8 days, longest 57 days)
- **Number of Driveline Complications**: 1 (changed technique and dressing style)
- **Number of Patients Currently on Therapy**: 9 (includes one inherited from UNMC)
- **Number of Patients implanted at UNMC in part of Transplant/VAD Partnership**: 4
- **Length of devices**: Longest on device 793 days (next is 779 days and feels stronger than ever)
- **Bryan Heart Failure Quality of Life Measurements**: (Goal is 80% by 6 months)
  - Average Pre Measurement: 60.9%
  - Average 3 month Measurement: 80%
  - Average 6 month Measurement: 86.7% (4 patients not to 6 months yet)
Heart Failure Treatments based on NYHA Class

Heart Failure is EXPENSIVE!!

- Currently:
  - "Heart failure costs the nation an estimated $32 billion each year. This total includes the cost of health care services, medications to treat heart failure, and missed days of work" (CDC, 2015).

- The PROJECTION?
  - "By 2030, >8 million people in the United States (1 in every 33) will have HF. Between 2012 and 2030, real (2010$) total direct medical costs of HF are projected to increase from $21 billion to $53 billion. Total costs, including indirect costs for HF, are estimated to increase from $31 billion in 2012 to $70 billion in 2030" (Heidenreich et al., 2013).
Who should be referred? (The sooner the better)...

- NYHA Class IIIb or IV with more than one of the following:
  - Unable to walk < 1 block without dyspnea
  - LVEF <35%
  - 1 Heart Failure admission in the past 6 months
  - Intolerance to ACE/ARB/Beta Blockers
  - Furosemide dose >1.5 mg/kg/day
  - CRT non-responder Worsening renal function with diuresis
  - Na <136, BUN >40, Cr >1.5
  - Inotrope dependent

True LVAD Indications (Destination Therapy)

- NYHA Class 4 symptoms (“3B” depending on insurance type)
- Ejection Fraction <25%
- Failed Optimal Medical Management for Heart Failure (BB, ACE/ARB, Diuretics, Aldactone, BIV AICDs) for 45 of the last 60 days
  - ie: Any recurrent hospitalizations? Worsening Kidney Function?
- Inotrope Dependency
- Functional Limitation with a peak MVO2 <14 ml/kg/min
- Intolerance to one or more of the traditional HF medication treatments
- Balloon Pump Support

INTERMACS helps in determining outcomes...

<table>
<thead>
<tr>
<th>INTERMACS</th>
<th>DESCRIPTION</th>
<th>NYHA CLASS</th>
<th>TIME TO MCS THERAPY</th>
<th>AHA/ACC STAGING</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Crash and Burning</td>
<td>IV Within HRS</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Progressive Decline on Inotropic Support</td>
<td>IV Within a few DAYS</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Stable but on Inotropic Support</td>
<td>IV Within a few WEEKS</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Recurrent advanced Heart Failure; resting symptoms at home on oral therapy</td>
<td>Administration of Anticoagulation*</td>
<td>Written in WEEKS to MONTHS</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>Early referrals are key in how the patient will do after surgery... Our goal is INTERMACS 3, 4, or 5</td>
<td>Exertion Intolerance</td>
<td>Variable</td>
<td>C-D</td>
</tr>
<tr>
<td>6</td>
<td>Exertion Limited or Walking Wounded</td>
<td>Exertion Intolerance</td>
<td>Variable</td>
<td>C-D</td>
</tr>
<tr>
<td>7</td>
<td>Advanced HF III</td>
<td>108</td>
<td>Variable</td>
<td>C-D</td>
</tr>
</tbody>
</table>
Class 3B Heart Failure Symptoms Vs Class 4: Does it Really Make a Difference? ABSOLUTELY!!

**NEW YORK HEART ASSOCIATION NYHA CLASSES:**

<table>
<thead>
<tr>
<th>NYHA Class</th>
<th>Symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class I</td>
<td>No symptoms on physical exertion</td>
</tr>
<tr>
<td>Class II</td>
<td>Fatigue on physical activity</td>
</tr>
<tr>
<td>Class III</td>
<td>Fatigue on ordinary activity</td>
</tr>
<tr>
<td>Class IV</td>
<td>Fatigue at rest</td>
</tr>
</tbody>
</table>

60 year old male (NICM), INTERMACS 3-4
- Combined HF since 1990s, Paracor restrictive device 2008
- Hosp early 2015 for CP->Stents, worsening Ejection Fraction (EF 10-15%)
- “Tired of being tired” - very common statement
- Referred to VAD service, alternating between Class 3B-Class 4; saw on a weekly basis by VAD Coordinator
- Admitted 2 days before with Creatinine of 2.24; placed on Dobutamine; Creatinine on OR day 1.95
- Discharged on Post op Day #13 with more energy and Creatinine of 1.25

73 year old male (ICM), INTERMACS 2-1
- CABG in 2007, with combined HF since 2011
- Declined last 6-8 months with worsening SOB and edema, so hospitalized (EF 20%)
- Referred to VAD service when deemed Inotrope dependent (Dopa5/Dobu5), SBPs 80-90s and breathless still at rest
- Expedited work up but decompensated twice
- Required emergent intubation, four different pressors (Dopa/Dobu/Vaso/ Norepi), Impella temporary LVAD and urgent transport to UNMC

**Mechanism of LVAD Function**

- LVAD decompresses the overstretched ventricle and resets forward blood flow
- Angi Inflow Cannula: receives oxygenated blood from the aorta
- Impeller: blurs through the impeller inside the pump with an average speed of 9000-10000 rpm
- Blood then expelled through the Outflow cannula that is attached to the top part of the aorta
VAD Nuances...

- Tend to only fix the Aortic Valve if regurgitation present
- Will fix patent foramen ovale if present
- Generally don’t touch the Mitral Valve regurgitation as this will improve with therapy
- WATCH INR’s closely with general goal range of 2-3 (but prefer 2-2.5)
- May not feel a pulse or get an automatic cuff pressure
- Three major side effects always to watch for:
  - Bleeding (GI Bleeds, Epistaxis, Brain Bleeds)
  - Clotting (Strokes, Clots in the pump)
  - Infection (most specifically at the driveline site)

Previous Studies Presented

1. REMATCH (HeartMate XVE versus Medical Therapy)² (2001)
   - 1 year survival: Device group 52% versus Medical Therapy group 25%
   - 2 year survival: Device group 23% versus Medical Therapy group 8%
   - 48% reduction in death in Device Group

2. HeartMate II Destination Therapy Pivotal Trial³ (2005)
   - Randomized to HeartMate XVE versus HeartMate II
   - Goal was to determine safety of HeartMate II as destination therapy in advanced HF
   - Survival 68% and 58% (1 year and 2 year respectively...)
   - 80% of patients were restored to Class I or II NYHA symptoms
   - Doubled six minute walks lengths
Major clinical studies have shown HeartMate II to provide high survival rates of long-term support for both BTT and DT patients. Survival rates are up to 7 times greater than previously reported outcomes with medical therapy alone.\(^7,8\)

**Survival Results continually improving**

**Worldwide HeartMate II Clinical Experience**

Over 20,000 patients worldwide have now been implanted with the HeartMate II LVAD.

Over 7,600 patients on ongoing support

<table>
<thead>
<tr>
<th>Category</th>
<th>1st year</th>
<th>2nd year</th>
<th>3rd year</th>
<th>4th year</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>LVADs</td>
<td>5,000</td>
<td>2,000</td>
<td>1,000</td>
<td>500</td>
<td>9,500</td>
</tr>
<tr>
<td>LVADs</td>
<td>3,100</td>
<td>1,200</td>
<td>600</td>
<td>300</td>
<td>5,200</td>
</tr>
<tr>
<td>LVADs</td>
<td>2,400</td>
<td>1,000</td>
<td>500</td>
<td>200</td>
<td>4,100</td>
</tr>
<tr>
<td>LVADs</td>
<td>1,800</td>
<td>800</td>
<td>400</td>
<td>200</td>
<td>3,200</td>
</tr>
<tr>
<td>LVADs</td>
<td>1,400</td>
<td>600</td>
<td>300</td>
<td>100</td>
<td>2,200</td>
</tr>
</tbody>
</table>

Over 12 million days of HeartMate II support.
Newer Studies (not a common thing…)

1. HeartMate II Studies
   - Multicenter Trial (Park et al, 2012)
   - ROADMAP Trial (Estep et al, 2015)

2. HVAD Studies
   - ENDURANCE Destination Therapy Trial (Pagani et al, 2012)
   - HVAD LATERAL Study (ongoing)
   - ENDURANCE Supplemental Trial (2013 to present)

Multicenter Trial (Park et al, 2012)

- 1 year survival in Mid Trial group (MT) 73% versus Early Trial group (ET) 68%
- Reduced adverse events in MT group for bleeding requiring transfusions (1.13 events per patient year vs 1.66), sepsis (0.27 vs 0.38), device-related infections (0.27 vs 0.47) and hemorrhagic strokes (0.03 vs 0.07)

ROADMAP Trial (Estep et al, 2015)

- Risk Assessment and Comparative Effectiveness Of Left Ventricular Assist Device and Medical Management in Ambulatory Heart Failure Patients
- Observational NON-randomized study looking at effectiveness of HeartMate II LVAD versus Optimal Medical Management (OMM) in AMBULATORY NYHA Class 3B/4 Heart Failure (not inotrope dependent)
- Higher depression scores and lower Quality of Life scores in LVAD group at baseline
- RESULTS:
  - 80% survival at one year in LVAD group compared to 64% in OMM group (BEST data we have yet!)
  - Significant improvement in 6 minute walk distance (59% vs 21%)
  - Significant improvement in NYHA Class to I or II (77% vs 29%) (HUGS)
  - Significant improvement in HF QOL and Depression scales (55% vs 23%; and 44% vs 16% respectively)
ENDURANCE (HVAD) Destination Therapy Trial

- August 2010-May 2012 (446 enrollees) (presented at ISHLT 2015)
- HVAD versus “other LVAD”
- Ineligible for transplant
- *Primary endpoint was free of disabling stroke 2 years post implant*
  - 55% versus 57.4% reaching primary endpoint (HVAD versus Other LVAD)-NON-inferiority
- HVAD improvements made (sintering the inflow cannula—increase to 57.5% achieving primary endpoint)
- Improvements in HF Quality of Life and NYHA classification
- Worries of strokes evident in the trial prior to changes in the device
  - Thought to be due to inappropriate blood pressure monitoring leading to more embolic strokes
  - Led to Supplemental Trial

LATERAL (HVAD) Clinical Trial

- Multicenter study enrolling up to 140 patients underway
- End stage heart failure, failing medical therapy and are eligible for cardiac transplantation
- Comparing thoracotomy approach to sternotomy approach for HVAD (HeartWare) placement
- Evaluating differences between survival, adverse event rates, quality of life metrics, bleeding and requirements of transfusions, length of stay and cardiopulmonary bypass time
- Endpoint is six months post implant
- MORE to come on this trial as it is completed

ENDURANCE (HVAD) Supplemental Trial

- Began late 2013
- Planning to enroll up to 310 patients with same criteria of initial ENDURANCE DT trial
- Designed to confirm clinical observations that “Sites adhering to more regular monitoring and management of patient blood pressure witnessed a notably lower incidence of neurological events”2
- MORE to come on this trial as it is completed
Newer Ventricular Assist Devices coming down the pipeline...

- HeartWare Inc.
  - HeartWare (HVAD)
- Thoratec (soon to be St. Jude Medical)
  - HeartMate III*** (in trials currently with BTT and DT arms)
  - HeartMate PHP (in trials)

HeartWare (HVAD)

- For small-framed patients
- Can place by thoracotomy approach if needed
- No pump pocket
- More driveline exit site options (right, left, even cranial for swimmers)
- In trials for DT populations

HeartMate III

Features
- Fully Magnetically Levitated
- Large pump gaps designed to reduce blood trauma
- Artificial pulse
- Textured blood contacting surfaces
- Wide range of operation
- Full support (2 – 10 L/min)
- Advanced Design for Surgical Ease
- Engineered apical attachment
- Modular Driveline
- Designed for an Active Lifestyle
- Pocket Controller
HeartMate III
* Rotary pumps have determined that a pulse is not needed for survival
* Augmenting pulsatility that is generally diminished in rotary pump patients may have benefit for some patients or in certain circumstances
  * May address adverse events such as aortic insufficiency, bleeding, and thrombogenesis
* The HeartMate III centrifugal blood pump is capable of very sharp speed changes
* “Artificial pulse” feature initiated and has so far in pre-clinical studies proved to contribute negligible hemolysis and require low incremental power consumption

---

Heartmate PHP (Percutaneous Heart Pump)

- Can deliver up to 4 liters of flow per minute to allow for hemodynamic stability
- Inserted through the femoral artery

---

Questions???
References


