VADS; How far have we come?
Most Recent Period Estimates of Relative Survival Rates for Prostate and Breast Cancer

<table>
<thead>
<tr>
<th></th>
<th>Relative Survival Rate, % (SE)*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5 Years</td>
</tr>
<tr>
<td>Breast cancer</td>
<td>86.4 (0.4)</td>
</tr>
<tr>
<td>Prostate cancer</td>
<td>98.8 (0.4)</td>
</tr>
</tbody>
</table>

*Rates derived from SEER 1973–1998 database (both sexes, all ethnic groups).

HEART FAILURE SURVIVAL

NEJM 2009;361(23):2241-51.
Heart failure is in first place

- 300,000 deaths in US per year
- 500 deaths per 100,000 people per year in central Florida
- 20,000 deaths in central Florida each year
- Progresses rapidly
Heart Failure Options

- Optimal medical management
- Transplantation
- Ventricular assist devices
  - Rescue
  - Bridge
  - Destination
History

- **First heart transplant - 1905**
  - Alexis Carrel
  - Canine model
  - Brief survival due to lack of immunosuppression
- **First human heart transplant......**
Christian Barnard?
James Hardy

- University of Mississippi Medical Center
- 90 minute survival
First human to human heart transplant

- December, 1967
- Groot de Schoor Hospital, South Africa
- Louis Washkansky
- 18 day survival
Potential Problems

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Potential Problems

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“All right, so he dropped the heart. The floor is clean.”
Potential Problems

"OK, the old one's in my right hand, the donor's in my left. Right?"
- Donor limited
- Graft failure
- Transplant CAD
- Immunosuppression
- Cancer
- 10.6 year mean survival
NOTE: This figure includes only the heart transplants that are reported to the ISHLT Transplant Registry. As such, this should not be construed as evidence that the number of hearts transplanted worldwide has declined in recent years.
300,000 Heart Failure Deaths Per Year in U.S.

- 2500 transplants per year
History

- D. C. is a 53 year-old male with progressive congestive heart failure secondary to ischemic cardiomyopathy
- CABG 9 years prior to presentation
- Mitral valve replacement (St. Jude prosthesis) 3 years prior
- Biventricular pacer/AICD placed 8 months prior
- Being maintained on milrinone infusion
Exam

- WDWN male with mild dyspnea
- Bilateral distended neck veins
- Lungs- bibasilar rales
- Heart- RRR crisp valve click
- Ext- 1-2+ edema
53 year old male with severe worsening CHF, ischemic cardiomyopathy, two previous median sternotomies, and a prosthetic mitral valve
Operation

- Jarvik 2000 LVAD implanted through left thoracotomy
- Inflow/pump placed in left ventricular apex
- Outflow placed in descending aorta
- Device adjusted intra-operatively to ensure prosthetic mitral valve opening and closure
Post Operative Course

- Placed on aspirin, clopidogrel, and coumadin
- No thrombo-embolic events
- Had a barely palpable pulse, and no evidence of peri-valvular thrombosis
- Transplanted 1 year later
- Runs a barn building business
“It’s been a pleasure to be able to help people and maybe you folks learned something” 1982
Pulsatile VADs

Pr [alive]

0.0 0.2 0.4 0.6 0.8 1.0

Time (months)

0 6 12 18 24 30 36

OMM (n=61)

LVAD (n=68)

Transplantation

What has changed since REMATCH?
Fluid Dynamic Blood Pumps

Axial flow

Centrifugal flow
More is not better.
Overflowing an LVAD leads to right ventricular failure

- septum bows left
- RV architecture changes
- The RV is thin walled, so changes in volume lead to large changes in wall stress
- Propofol can exacerbate right heart failure
In acute RV failure, unloading almost always leads to recovery

- post MI
- post PE
- post cardiotomy
The heart can recover*.
Acute Recovery with Ventricular assistance

Acute Cardiogenic Shock
Cells “hibernate” before they die

Rest Heart for Recovery
Cells can recover

LAD occlusion WITHOUT ventricular unloading
Massive Myocardial Damage

LAD occlusion WITH ventricular unloading
Up to 5-times Reduction in Infarct Size

Flameng et al. JACC 2001
Acute Devices

- Impella

Centrimag
Acute Cardiogenic Shock

- G.C.
- 57 yo male
- presented with acute LAD MI, EF<10%
- PCI- Reflow but no improvement in LV function
- Multiple inotropes, pressors, Impella 2.5
- Transferred to our facility
Echo

QuickTime™ and a Microsoft Video 1 decompressor are needed to see this picture.
QuickTime™ and a Microsoft Video 1 decompressor are needed to see this picture.
Earlier is better
IABP Score

- Based on assessment one hour after implantation of IABP
- Assigns points for
  - High dose pressors (two points)
  - Low urine output
  - Low SVO2
  - High PCWP
- Circulation. 2002;106[suppl 1]:I-203-I-206
Temporary bridging can be important

- Preserve end organ function
- Salvage myocardium
- Allow for complete evaluation
FULL EVALUATION!

- THERE ARE NO EMERGENCY DURABLE VAD IMPLANTS!
- THERE ARE NO EMERGENCY CARDIAC TRANSPLANTS!
- If the patient is too sick to be bridged, they are too sick for advanced therapy.
Survival PRESENT DT HM II EXPERIENCE

Pr [alive] vs Time (months)

OMM (n=61)

HM II DT

Transplantation

Slaughter, et al NEJM 2009
Yale experience with Heartmate II

- November 2008- July 2011
- 15 patients
  - 13 bridge
  - 2 destination
Survival: Yale HM II EXPERIENCE

Pr [alive] vs Time (months)

Transplantation

HM II DT

OMM (n=61)

Slaughter, et al. NEJM 2009
Challenges

- Human factors
- Thromboembolism
- Mechanical/physiologic issues
- RV failure
- Bleeding
- Infection
- Power delivery
- Cost
Human Factors

- Changing and charging batteries
- Taking anticoagulants
- Driveline care
NATOPS

- 1950’s- 54 mishaps per 10,000 flight hours
- 1961- NATOPS established
- Current mishap rate- 2 per 10,000 flight hours
Mechanical/physiologic

- Axial flow pumps have not been pumped to failure
- Aortic valve issues
- Inflow conduit migration
Unusual Aortic Valve Demands

- Continuous coaptation = fusion
- Persistent high trans-mural gradient = AI

Continuous flow LVAD: Adverse Effects on the Aortic Valve

• This aortic insufficiency occurs throughout the cardiac cycle

• Potential solutions
  – lower the gradient
  – allow pulsatility
  – close the aortic valve
Inflow Conduit Migration
Our Solution
Thrombosis: Expect the unexpected
QuickTime™ and a Cinepak decompressor are needed to see this picture.
Infection and Thromboembolism are Tightly Coupled
Driveline infections

- Better now
- ?Iatrogenic?
Can we deliver power wirelessly?
Wardencllyffe 1901
Witricity
Thoratec Announces Development Agreement With WiTricity For Proprietary Energy Transfer Technology

By PR Newswire

05/10/11 - 04:30 PM EDT
Cost
Cost

• 1996- $50,000 per QALY
• 2008- $59,000
  – Bridge to transplant VAD- $48,000-$78,000
  – Destination/long term use VAD- $56,000
• Costs will decrease as competition hits the market
• Cost per QALY will improve as technology, knowledge and execution improve
Summary

• VAD technology is making rapid progress
• The remaining challenges have plausible solutions
• VADs will be in the next decade what coronary bypass was at the end of the twentieth century
Long Term

- **Heartmate II**
Resurrection Devices
It takes a village

• Multi-disciplinary team
  – Evaluation
  – Pre-op optimization
  – Peri-op management
  – Long term follow-up
The Future
Questions?