Left Ventricular Assist devices in non-cardiac surgery

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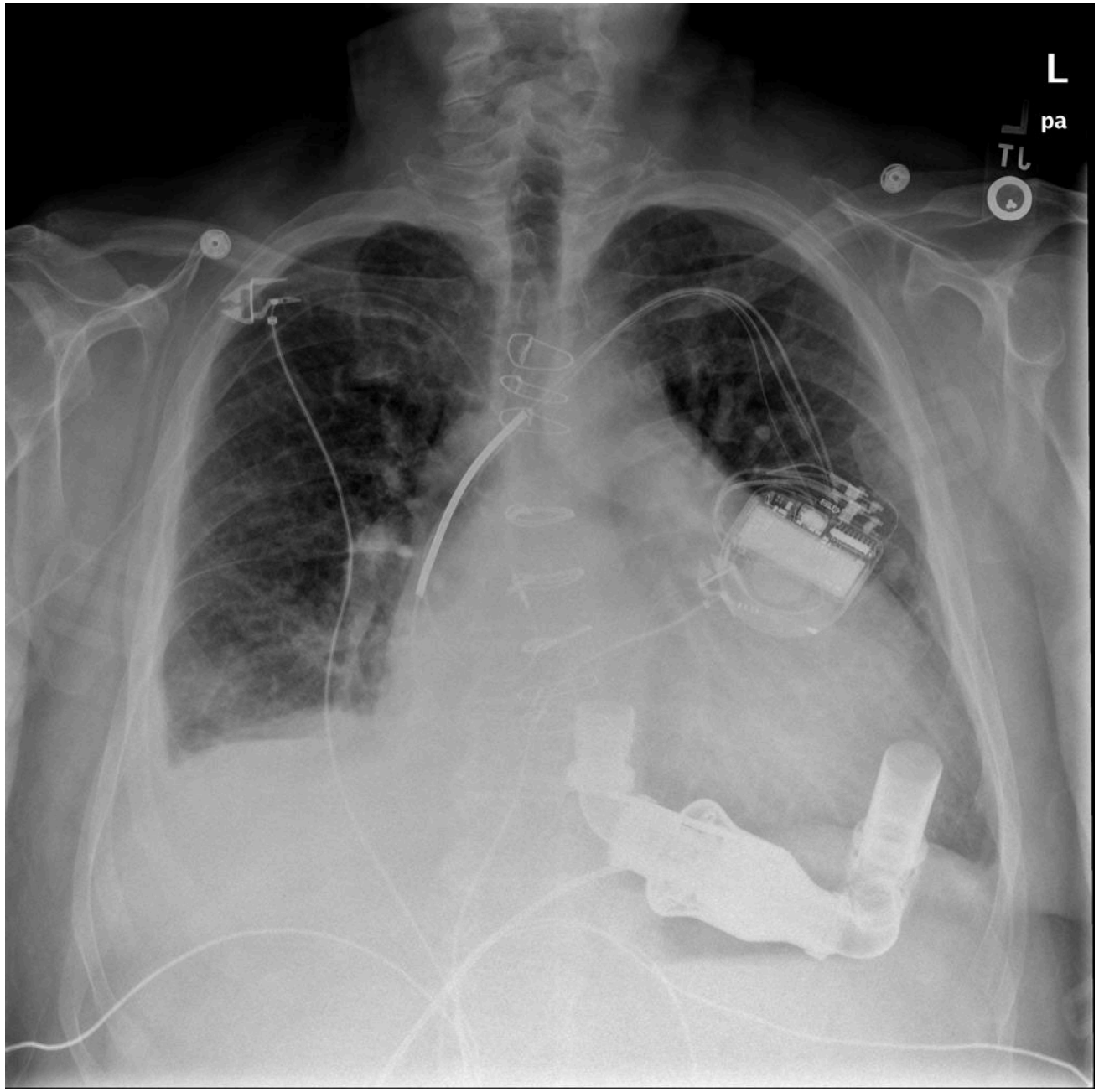
- 68-year-old male, hx of CABGx4
- On going GI bleed
- Here for colonoscopy and EGD

- 38-year-old G3P3 female, peripartum cardiomyopathy
- Persistent RUQ post prandial pain
- Here for cholecystectomy

- 62-year-old female, family history of sudden cardiac death
- Slipped and fell on ice
- Here for ORIF of tibia

THEY ALL HAVE END STAGE HEART FAILURE

THEY ALL HAVE AN LVAD



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Left Ventricular assist device

- Initially approved as a short term support device to bridge patients to heart transplant
- 3 indications, Bridge to transplant, Bridge to decision, Destination therapy
- Goal of the device is to unload the LV, improve hemodynamics, end-organ function and exercise tolerance
- 2-year survival is between 70-80%, similar to heart transplant survival rates

REMATCH trial was RCT of 129 patients, randomized to receive LVAD or medical therapy

Rose EA, Gelijns AC, Moskowitz AJ, Heitjan DF et al. Long-term use of a Left Ventricular assist device for end-stage heart failure. New England Journal of Medicine, 2001; 345(20):1435-1443

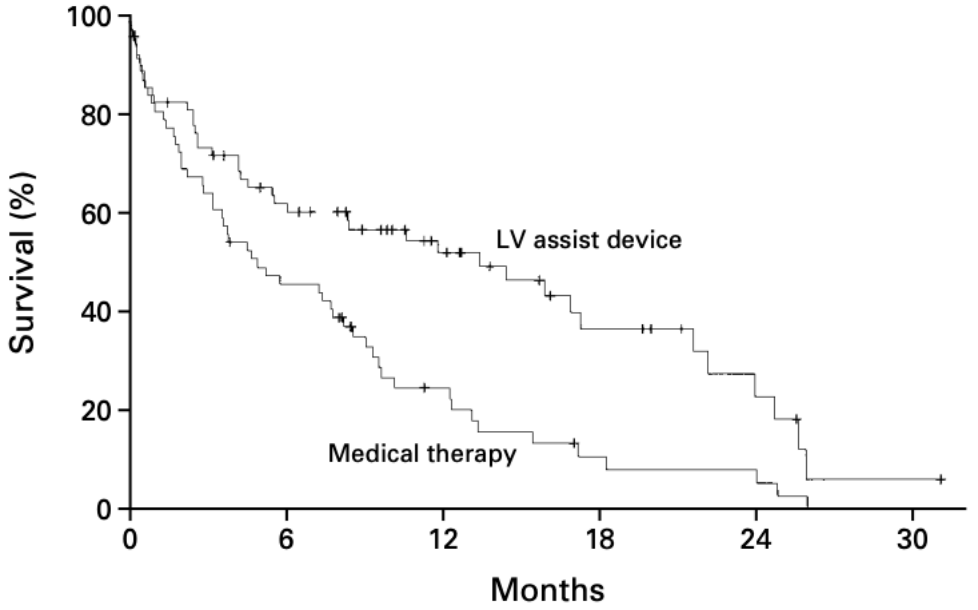
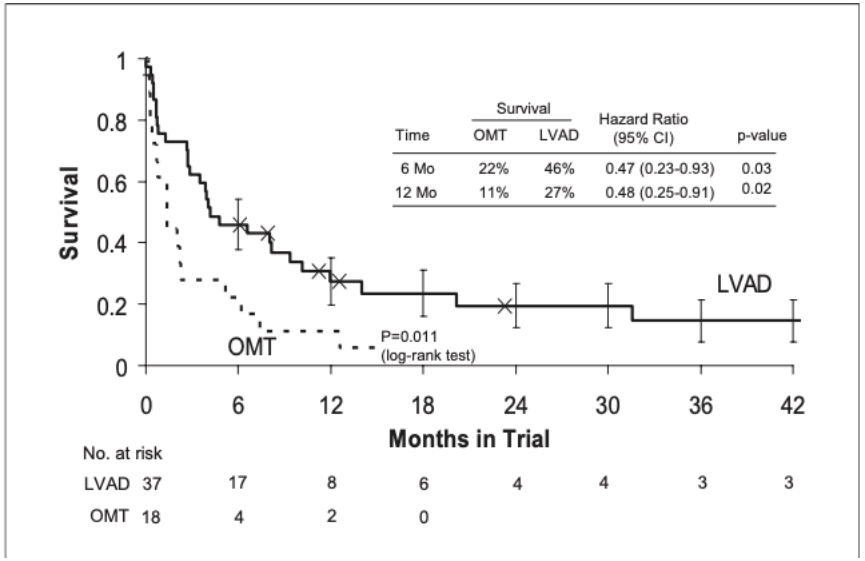


TABLE 3. QUALITY OF LIFE AND FUNCTIONAL STATUS OF PATIENTS AT ONE YEAR.*

SCALE†	ONE YEAR		P VALUE
	NO. ASSESSED/ TOTAL NO. (%)	SCORE	
SF-36			
Physical function			0.01
LVAD group	23/24 (96)	46±19	
Medical-therapy group	6/11 (55)	21±21	
Emotional role			0.03
LVAD group	23/24 (96)	64±45	
Medical-therapy group	6/11 (55)	17±28	
Minnesota Living with Heart Failure			0.11
LVAD group	23/24 (96)	41±22	
Medical-therapy group	6/11 (55)	58±21	
Beck Depression Inventory			0.04
LVAD group	22/24 (92)	8±7	
Medical-therapy group	5/11 (45)	13±7	
Median NYHA class			<0.001
LVAD group	24/24 (100)	II	
Medical-therapy group	7/11 (64)	IV	

INTrEPID trials prospective cohort study comparing LVAD to inotrope therapy

Rogers JG, Butler J, Lansma S, Glass A et al. Chronic Mechanical circulatory support for inotrope-dependent heart failure patients who are not transplant candidates, Results of the INTrEPID Trial. JACC, 2007; 50(8):741-747



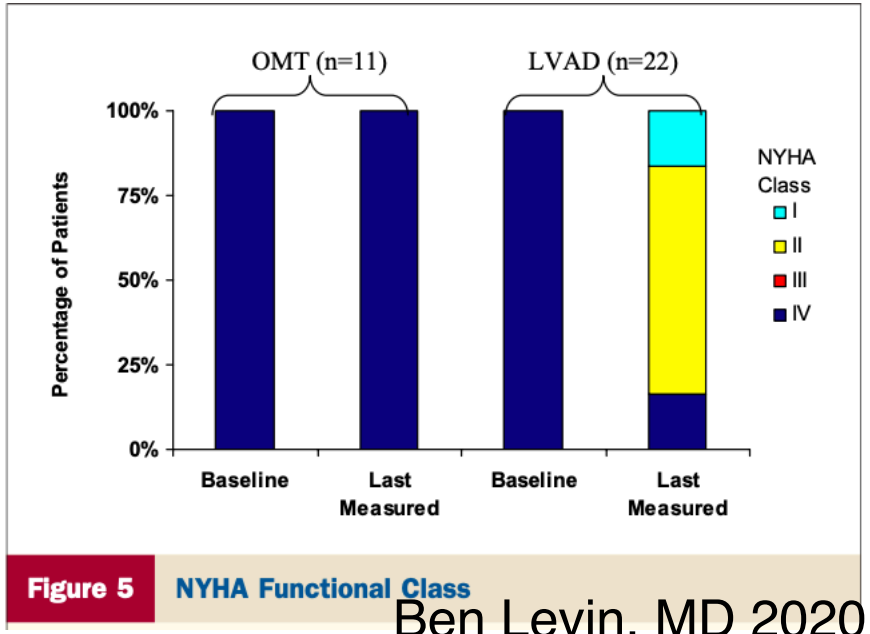


Figure 5 NYHA Functional Class

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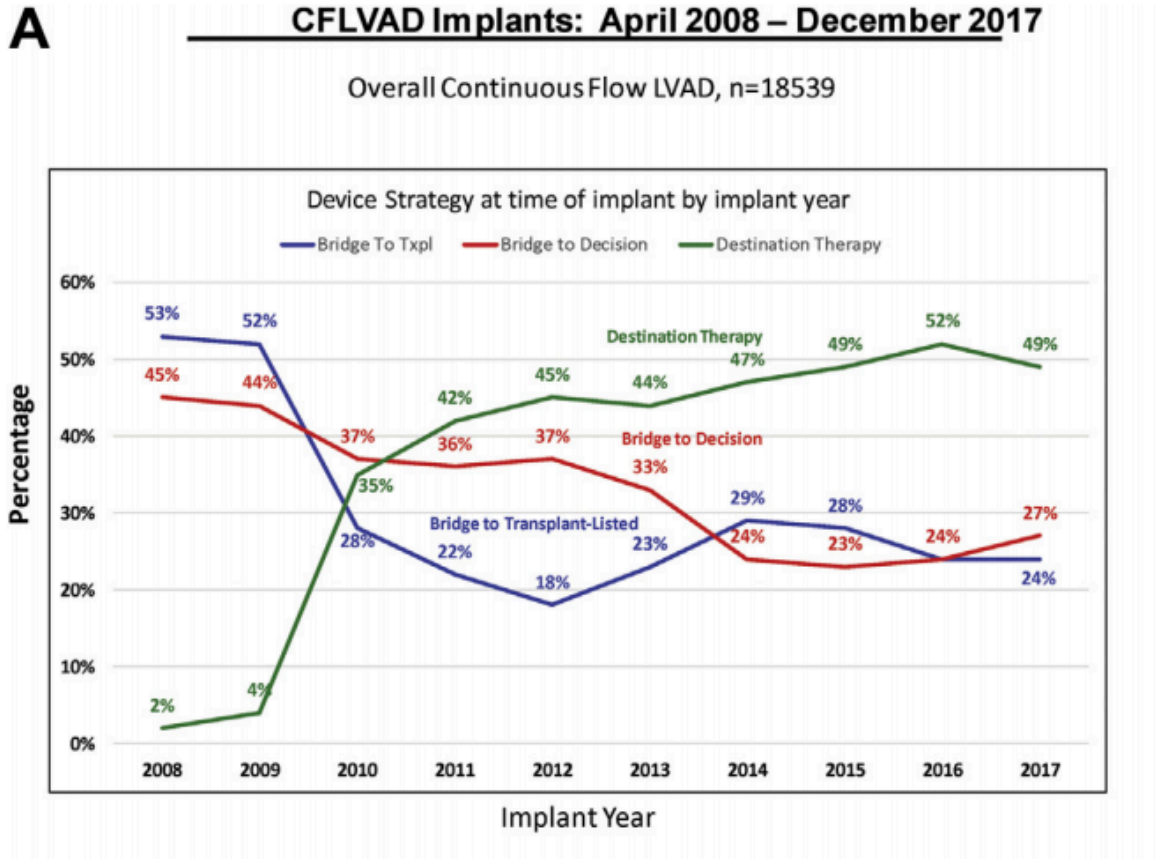

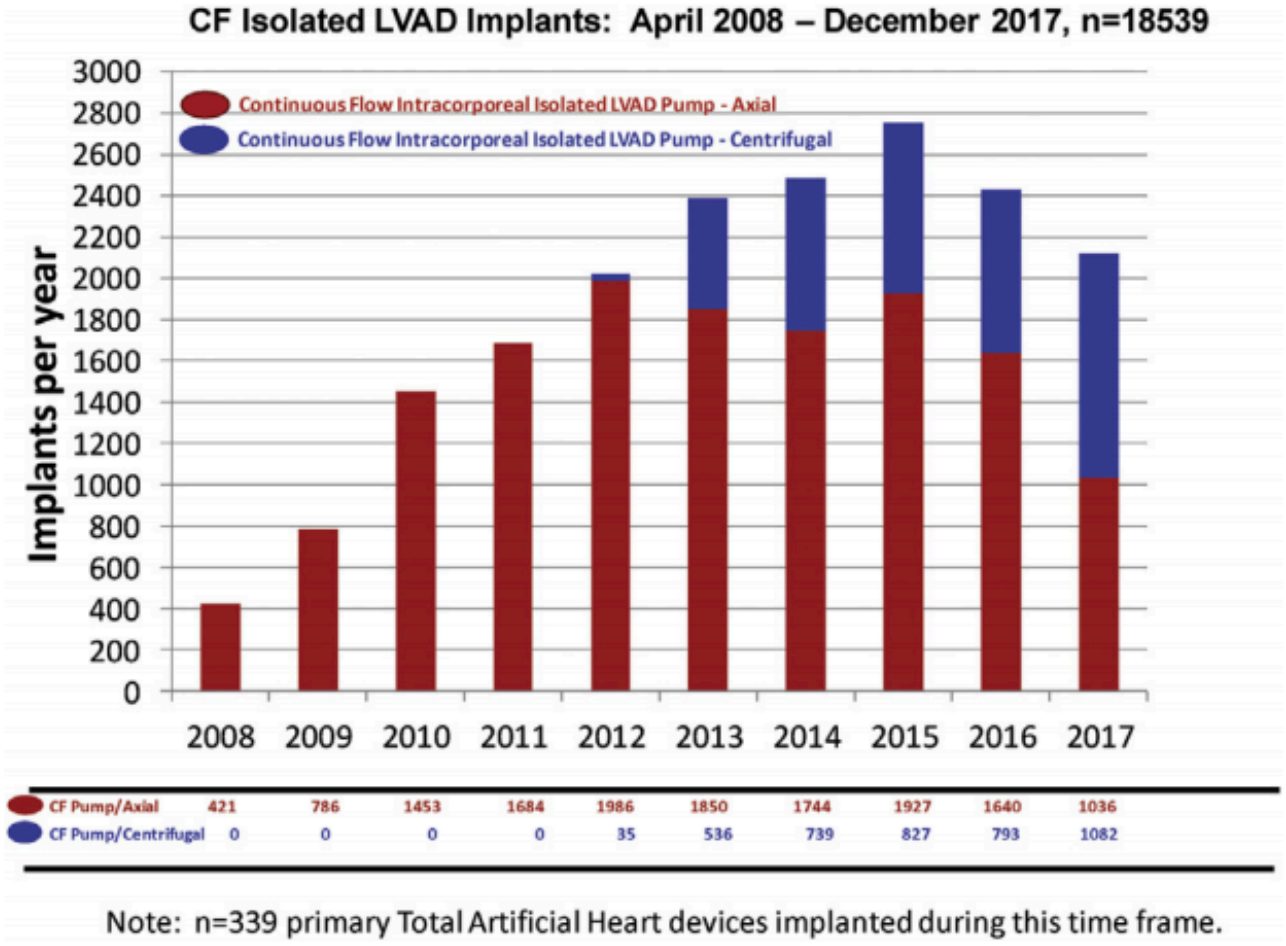

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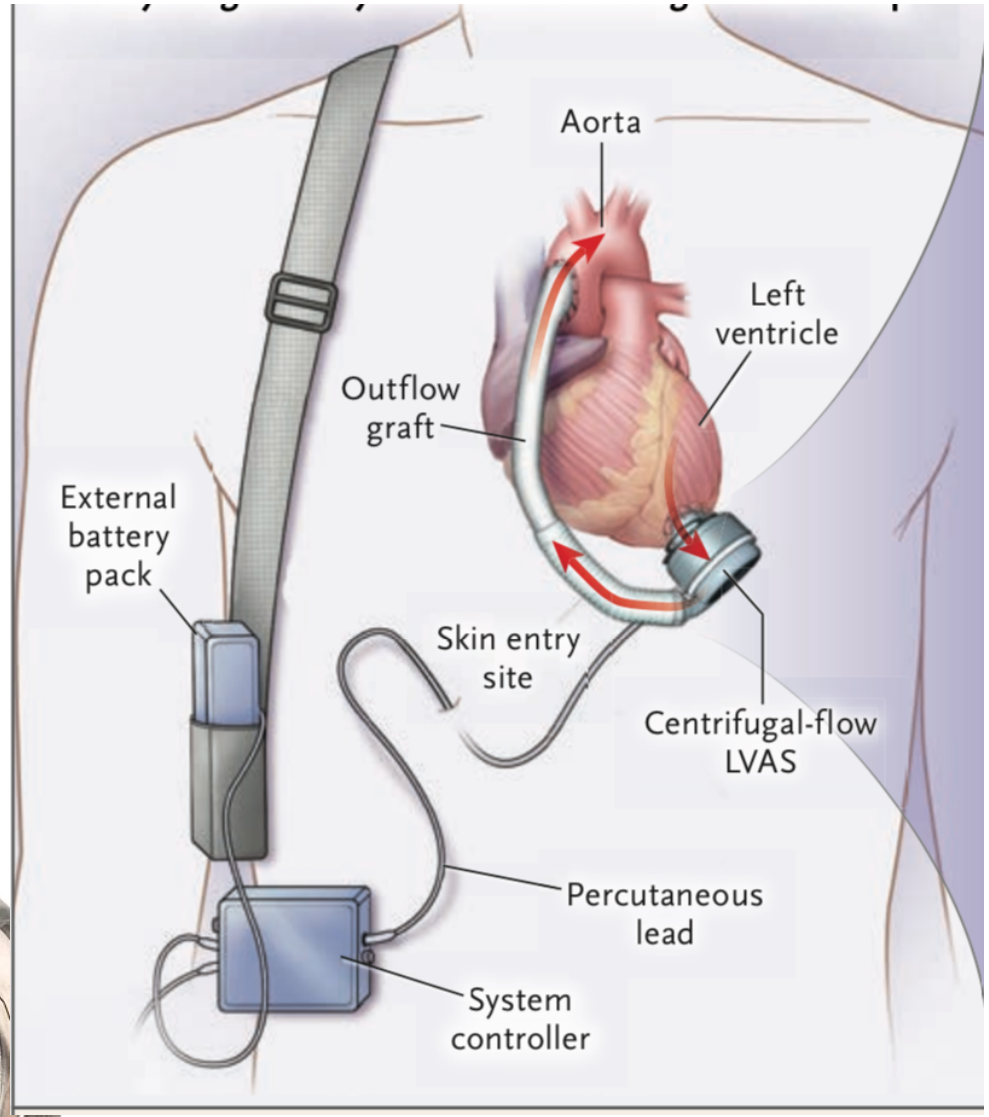
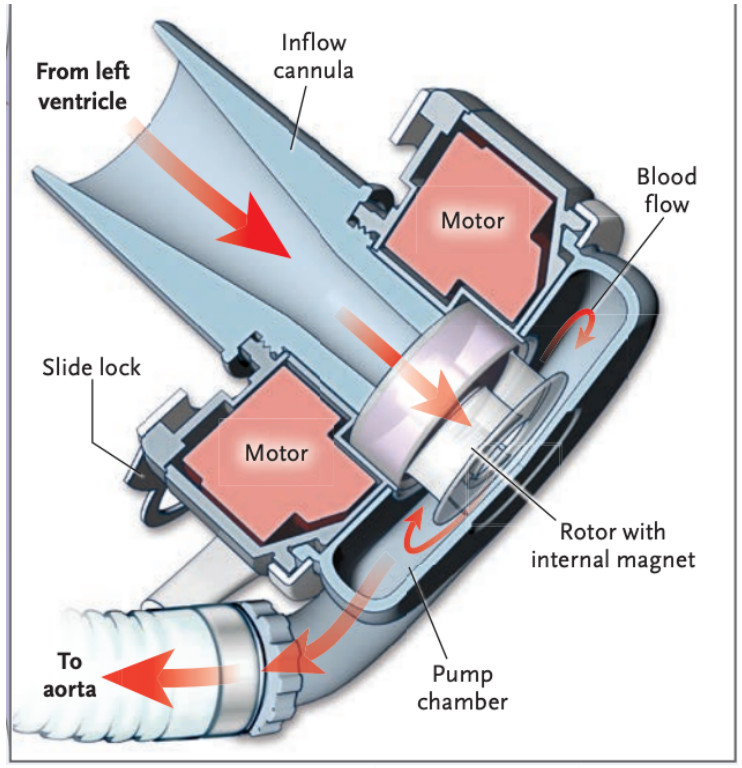
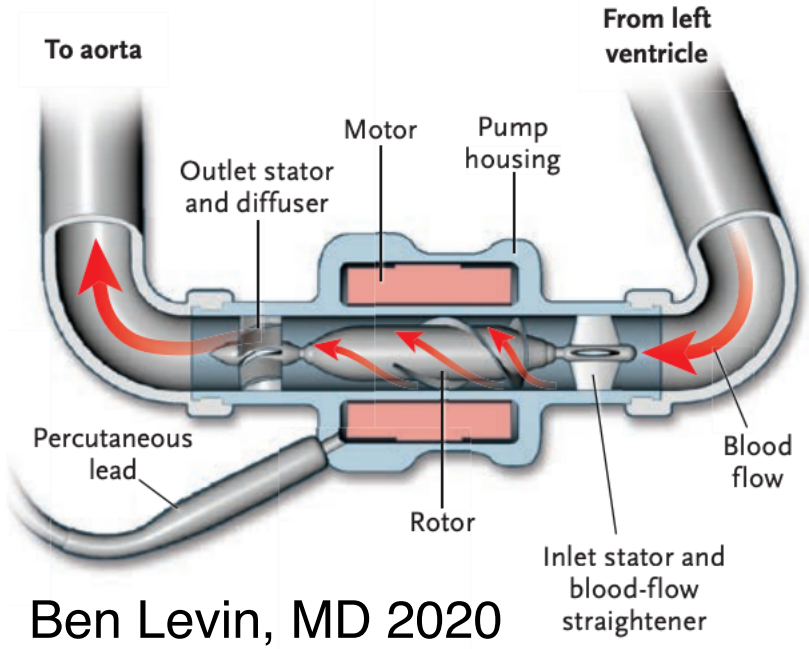
LVAD

- Three common LVADs used in US
  - Heartmate II, Heartmate III
  - Heartware HVAD







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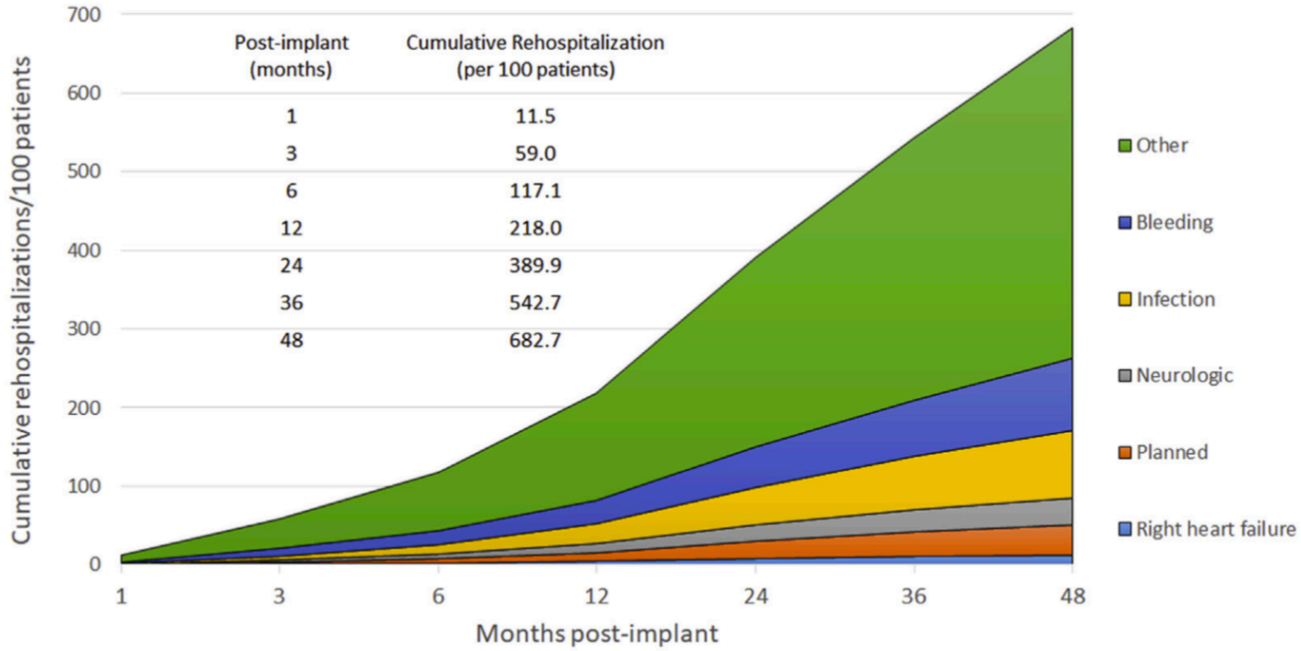
Nothing is without risks

Most common complications requiring readmission

- Bleeding
- Heart failure
- Neurologic events
- Arrythmia
- Infection
- Thrombosis or hemolysis



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LVAD in non-cardiac surgery

1

Between 20-50% of patients with LVAD will present for non-cardiac surgery

2

Common procedures include EGD/Colonoscopy, I&D of driveline

Table 2: Procedural characteristics (74 procedures in 31 patients)

Procedural characteristics	*n* (%) of patients
Number of procedures per patient (range)	2.39±1.48 (1-6)
Urgency of procedure (%)	
Elective	70 (94)
Emergent	4 (6)
Type of procedure	
Endoscopy	
EGD	33
Colonoscopy/sigmoidoscopy	15
Bronchoscopy	2
Laryngoscopy	1
LVAD driveline debridement	13
Urological	
Cystoscopy	3
TURP	1
General surgery	
Laparoscopic exploration	1
Calf hematoma debridement	1
Inguinal hernia repair (open)	1
Vascular	
Femoral artery thrombectomy	1
Neurosurgical	
Burr hole, hematoma evacuation	1
Gynecological	
Endometrial ablation	1

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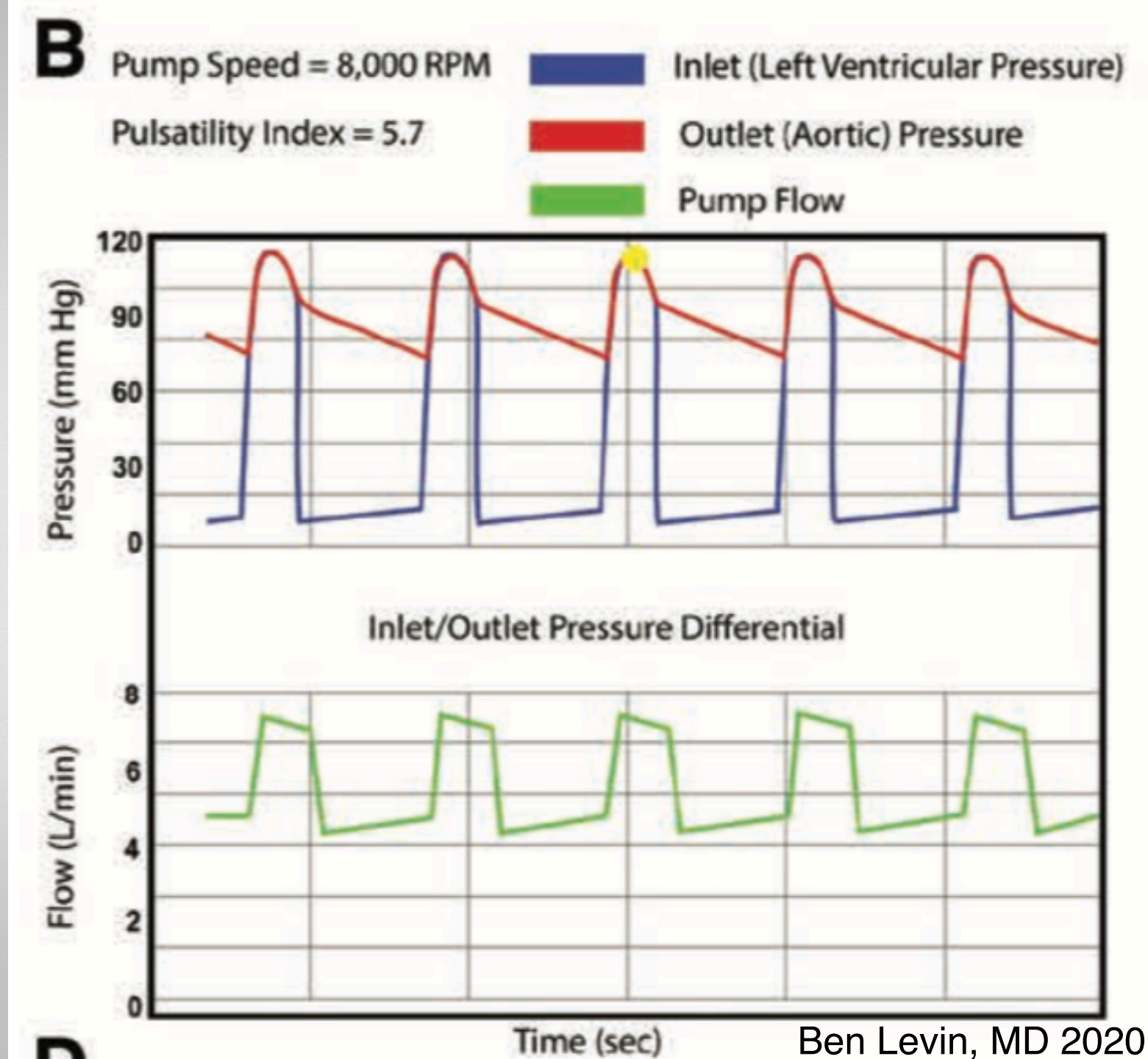
Degnan M, Brodt J, Rodriguez-Blanco Y. Perioperative management of patients with left ventricular assist devices undergoing noncardiac surgery. Annals of Cardiac Anesthesia 2016; 19:676-682

Cardiac output

- Cardiac output is determined by
  - Preload
  - Afterload
  - Contractility
- LVAD flow is determined by
  - Preload
  - Afterload
  - Speed

LVAD physiology

- Flow through LVAD is based on pressure gradient across the pump
  - Flow is inversely related to pressure gradient between the left ventricle and aorta
- Variation in flow between systole and diastole



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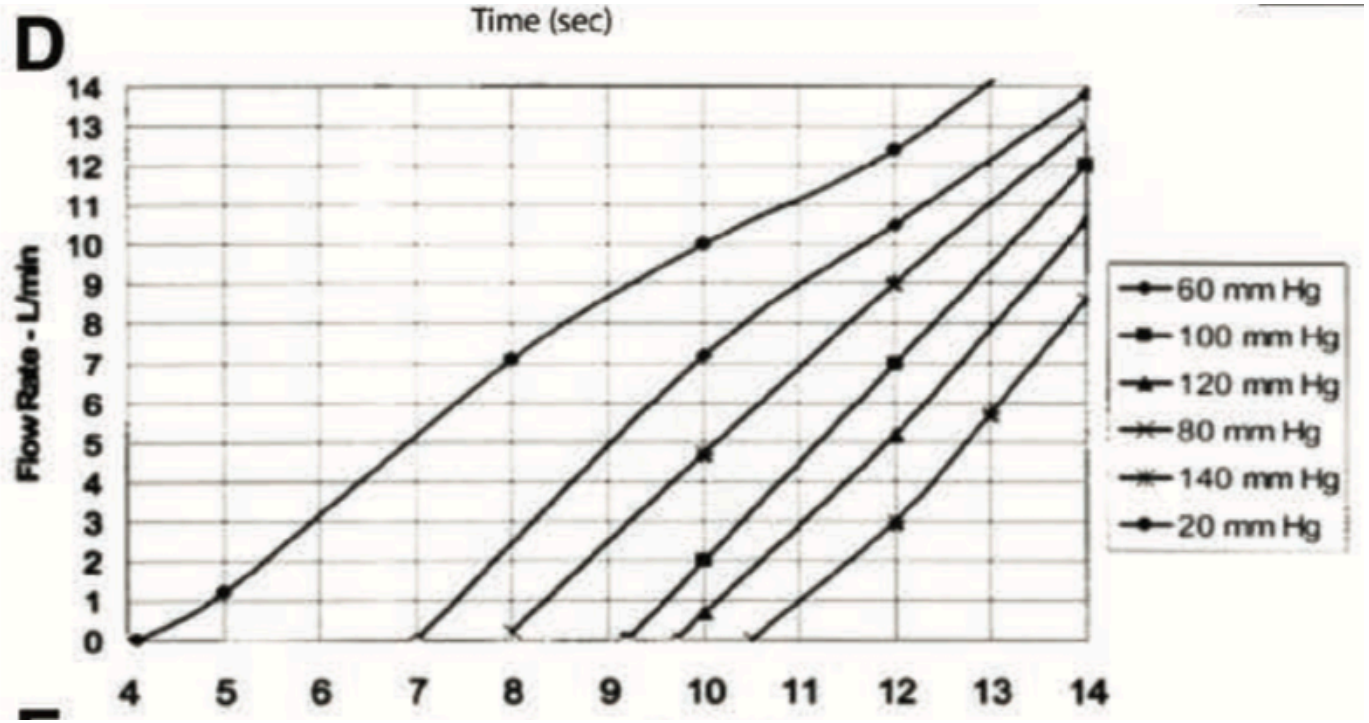
LVAD flow

- Pump speed affects flow
- Preload dependent and afterload sensitive
  - Pre-load is both LVEDP and RV function



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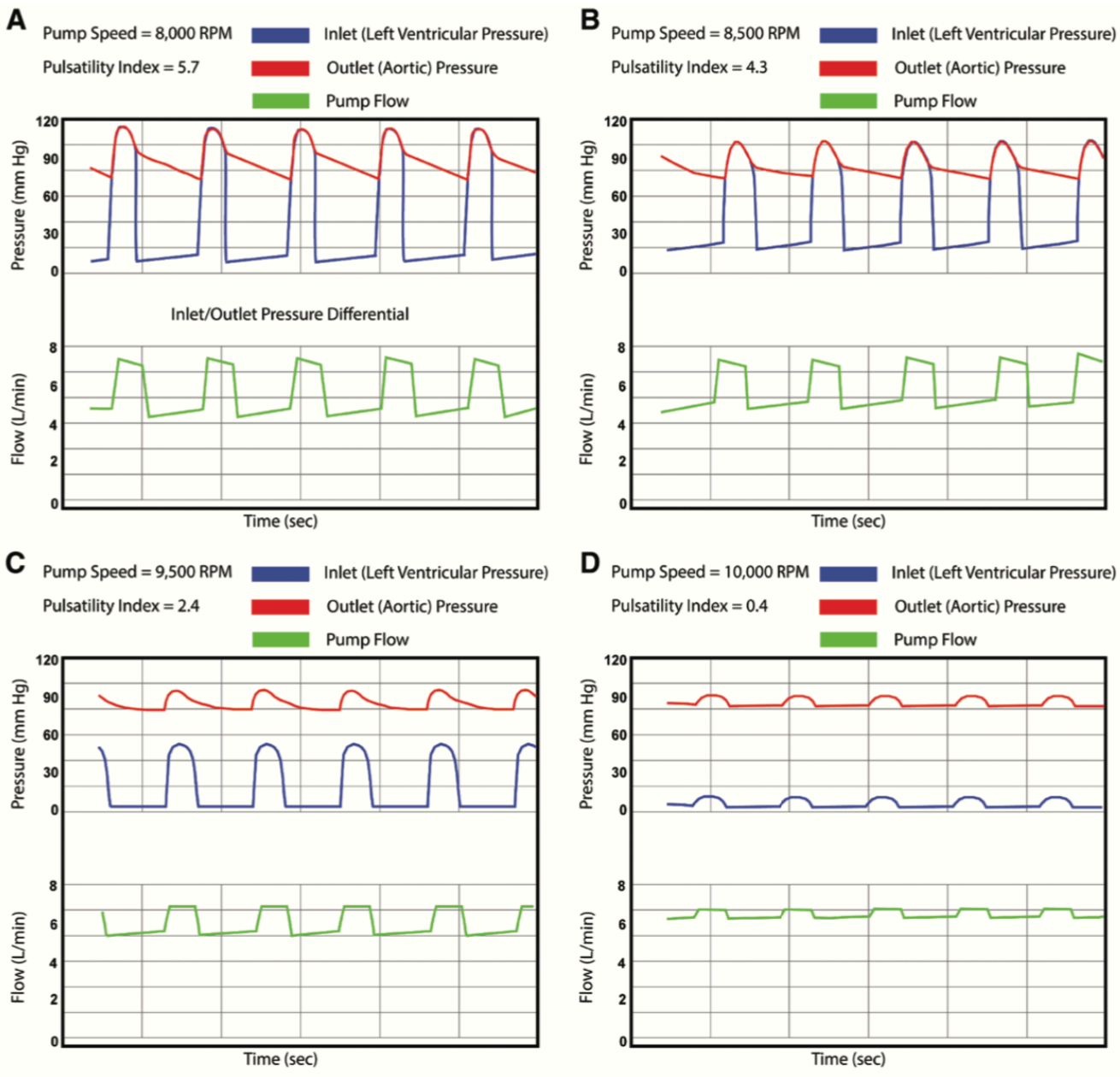
LVAD flow

- As we increase pump speed we see increase in flow
  - Decrease in variation in flow as pump speed increases
  - Aortic valve opens only if LV pressure>Ao pressure
  - Under certain conditions no pulse will be present despite adequate cardiac output



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Pre-operative evaluation

- Standard pre-operative history and physical
- Blood pressure measurement
- Assessment of RV function is very important
  - RV provides pre-load to LV and LVAD
- Review recent echo, PA catheter data
- Anti-coagulation management
- Consideration for transfusion
  - Minimize transfusions for patients who are bridge to transplant
  - Transfusion rate is between 15% and 38%

Table 1 Perioperative approach to LVAD patients undergoing non-cardiac surgery

- Preoperative
  - Multidisciplinary team identified (primary surgical and anesthesia teams, cardiac surgery, heart failure cardiologist, VAD personnel)
  - Preoperative medical optimization when possible or necessary
  - Physical examination focused on the sequelae of heart failure
  - Baseline EKG, echocardiogram, and laboratory values
  - Manage pacemaker/AICD settings when indicated
  - Hold, bridge, or reverse anticoagulation when indicated
- Intraoperative
  - Standard ASA monitors
  - Cerebral tissue oxygenation, processed EEG, arterial line with ultrasound guidance, central venous catheter if fluid shifts are expected, PA catheter only if severe pulmonary hypertension, TEE available
  - Monitor VAD control console
  - External defibrillator pads in place
  - Optimize preload, support RV function, avoid increased in afterloa
  - Gradual peritoneal insufflations and position changes
- Postoperative
  - Standard PACU care unless ICU is otherwise indicated
  - Extubation criteria are unchanged
  - Avoid hypoventilation, optimize oxygenation
  - Resume heparin infusion when post-op bleeding risk is acceptable

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Hemodynamic monitoring

- Invasive hemodynamic monitoring
  - Based on patient specific factors
    - How is the patients blood pressure being monitored
    - NIBP via oscilometric
    - Manual with a doppler
  - Procedure specific factors
  - Ability to draw blood gas
- TEE
- CVP and PA Catheter

Table 2: Procedural characteristics (74 procedures in 31 patients)

Invasive monitors used (%)	
Arterial line	27 (36)
Central line	6 (8)
PICC line	26 (35)
Midline	6 (8)
TEE	1

- Usage of arterial lines varies, depending on series up to 72%
- One series of endoscopies had no usage of arterial lines

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Anesthetic choice

- Anesthetic choice depends on procedure
- MAC for endoscopies is a reasonable ch
- Regional is an option
  - Neuraxial depends on anticoagulation

Type of anesthesia (%)	
General endotracheal anesthesia	13 (18)
Monitored anesthesia care	60 (81)
Regional anesthesia	1 (1)

Table 2: Procedural characteristics (74 procedures in 31 patients)

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What comes with the patient?

- VAD nurse or advanced heart failure MD who will come with patient
- VAD cart which has controller screen and extra power packs on it

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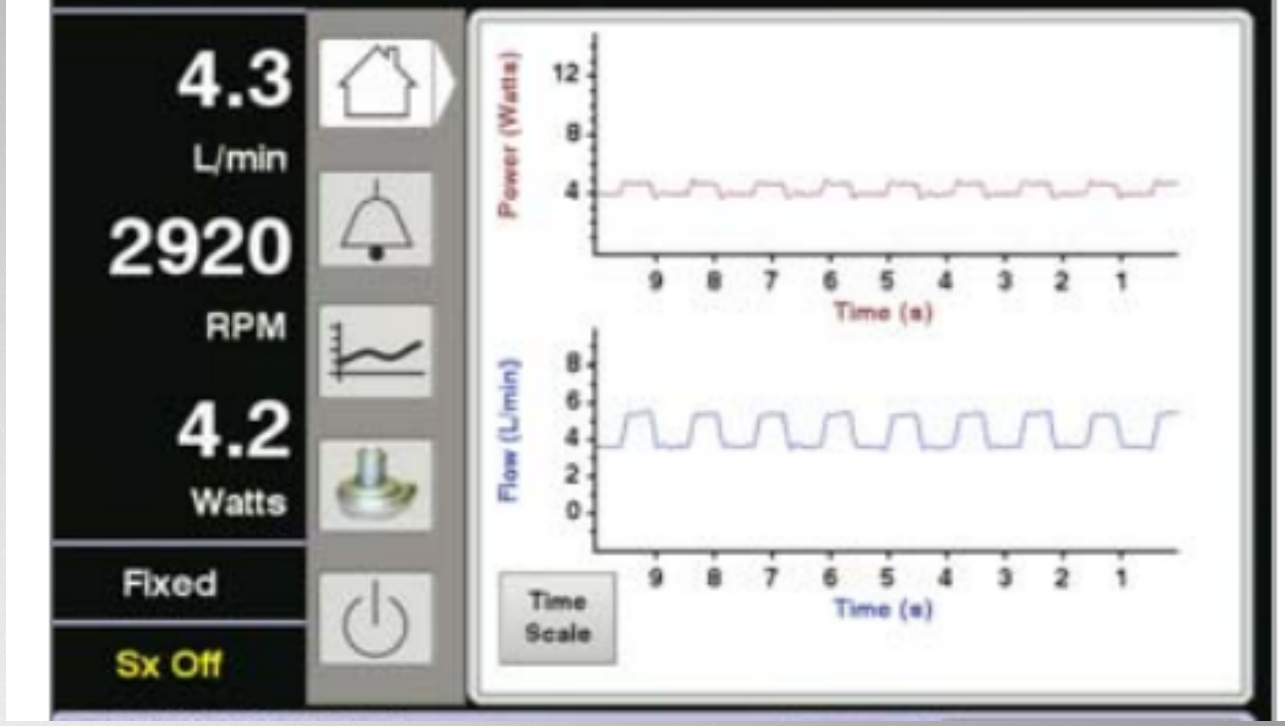
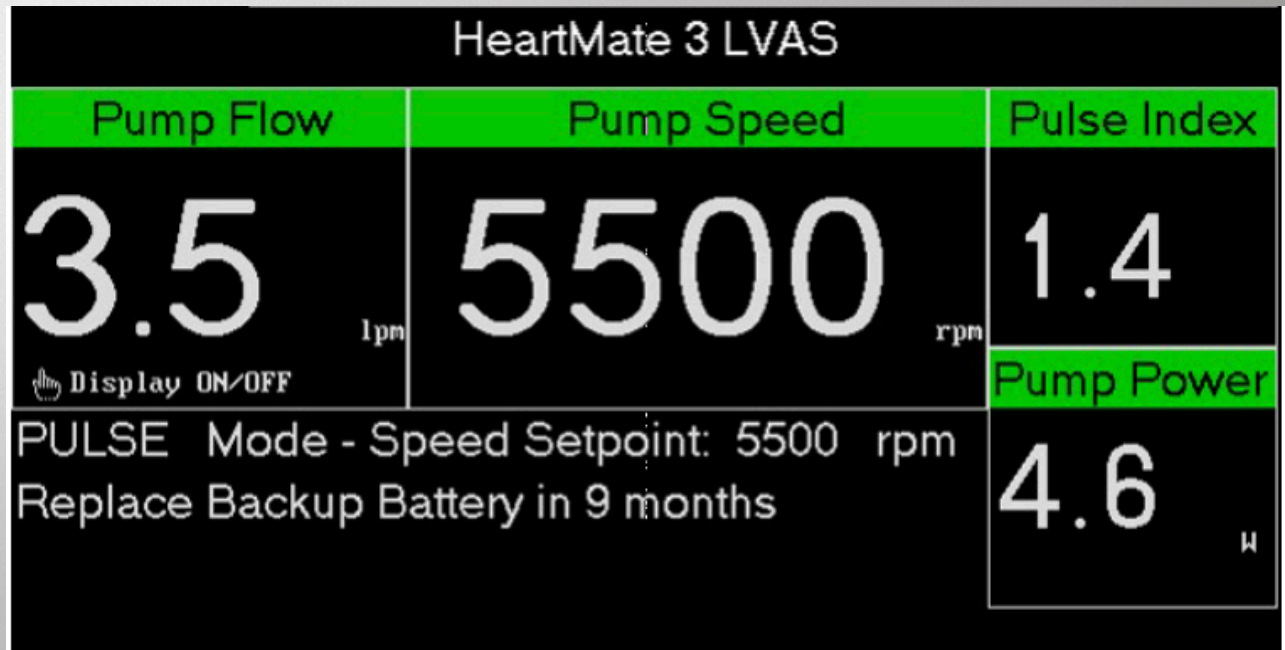
- Top screen is example for Heartware
- Bottom is example from HM3
- VAD nurse or HF doc can adjust LVAD settings to help manage hemodynamics during procedure





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Intraoperative management

Goal is to maintain forward flow and perfusion

- Pump flow reported on screen is calculated and showed not be used as an absolute measure

Ensure pre-load

- RV provides pre-load to the LV
  - Increasing intrathoracic pressure
  - Decreasing venous return
  - hypovolemia

Close attention to afterload

- Decreased from anesthetic agents can increase LVAD flow
- To the extreme it can cause adverse events
- Increase in afterload from laryngoscopy or insufflation

Arrythmia management

- Ventricular or atrial arrythmias can occur
- Can affect LVAD loading and cardiac output
- May be a result of malperfusion of hypoxia

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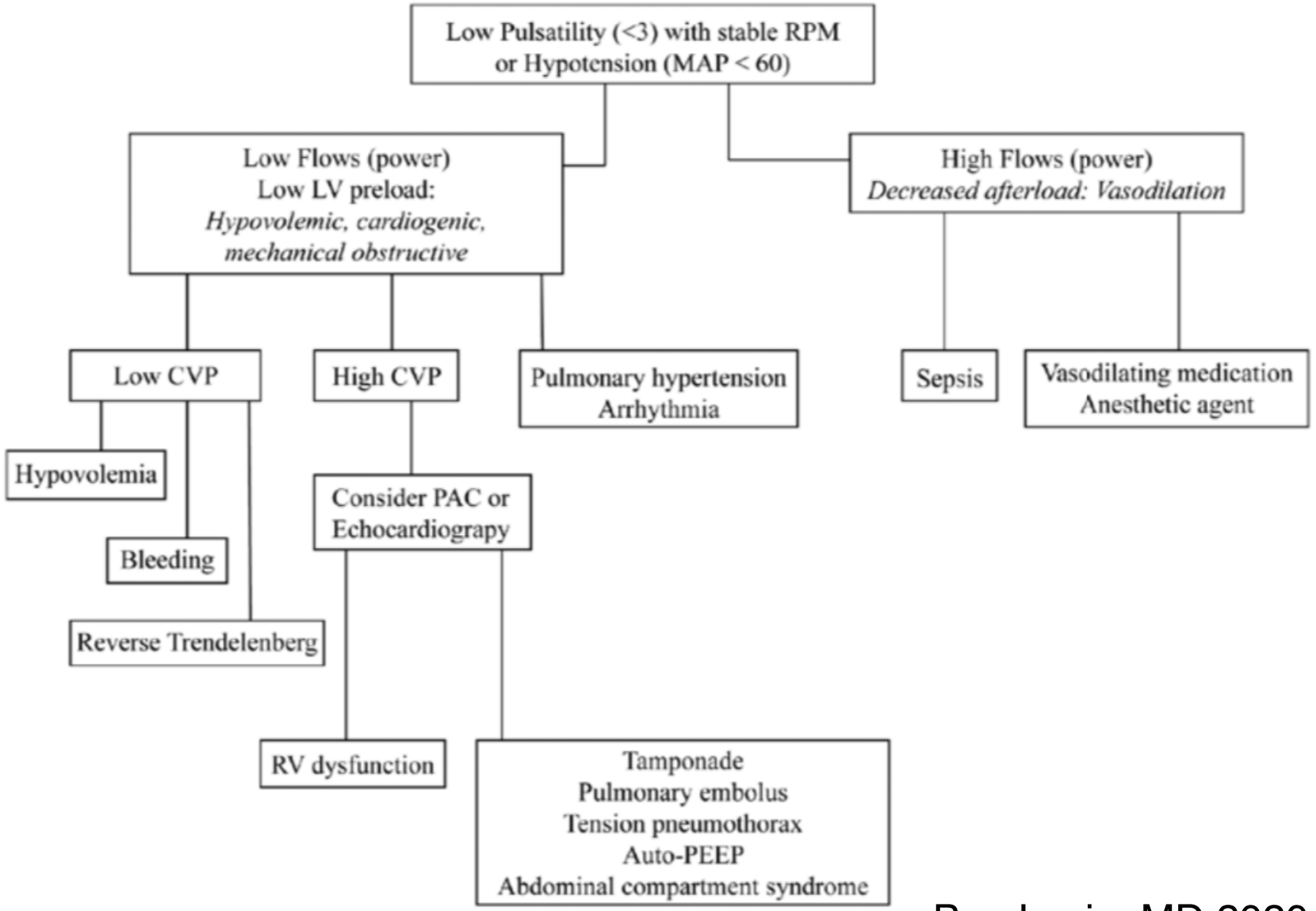
Intra-operative management cont.



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Post-operative care

- Post-operative disposition depends on case, patient stability
- PACU or ICU (that can take VAD patients)

Table 2: Contd...

Procedural characteristics	*n* (%) of patients
Postoperative ICU admission (%)	
No	33 (45)
Yes	41 (55)
Hospital length of stay postprocedure, days (range)	15 (0-129)

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Summary

- Continuous flow LVAD are a substitute to heart transplant in end stage heart failure
- Up to 50% will need non-cardiac surgery
- LVAD physiology has some subtle differences from normal physiology
- Special consideration for intra-operative monitoring

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