Advanced Heart Failure

Naveen Saha, MD
Advanced Heart Failure and Transplant Cardiology
Physician, Mechanical Circulatory Support Program at RMH

Patient LJ

- 52 y/o female with breast Ca
- 5/18 Started chemotherapy including Adriamycin
- 7/18 EF 35% (from 60%), minimally tolerated GDMT
- 8/18 Presented to RMH with decompensated HF, repeat Echo EF 20%, discharged
- Admitted soon after at CCF, low output by PAC, BB discontinued, vasodilators titrated
- 9/2018 despite close follow up: presented with nausea, fatigue, hypotension and signs of CS
- RHC on milrinone 0.125 mcg/kg/min:
  - RA 12, PA 29/18 (22), PCWP 17, CO/CI 3.2/1.7 by Fick, 2.7/1.4 by Thermo
  - SVR 1800, PVR 127, PAPi 0.92, CVP/PCWP 0.7

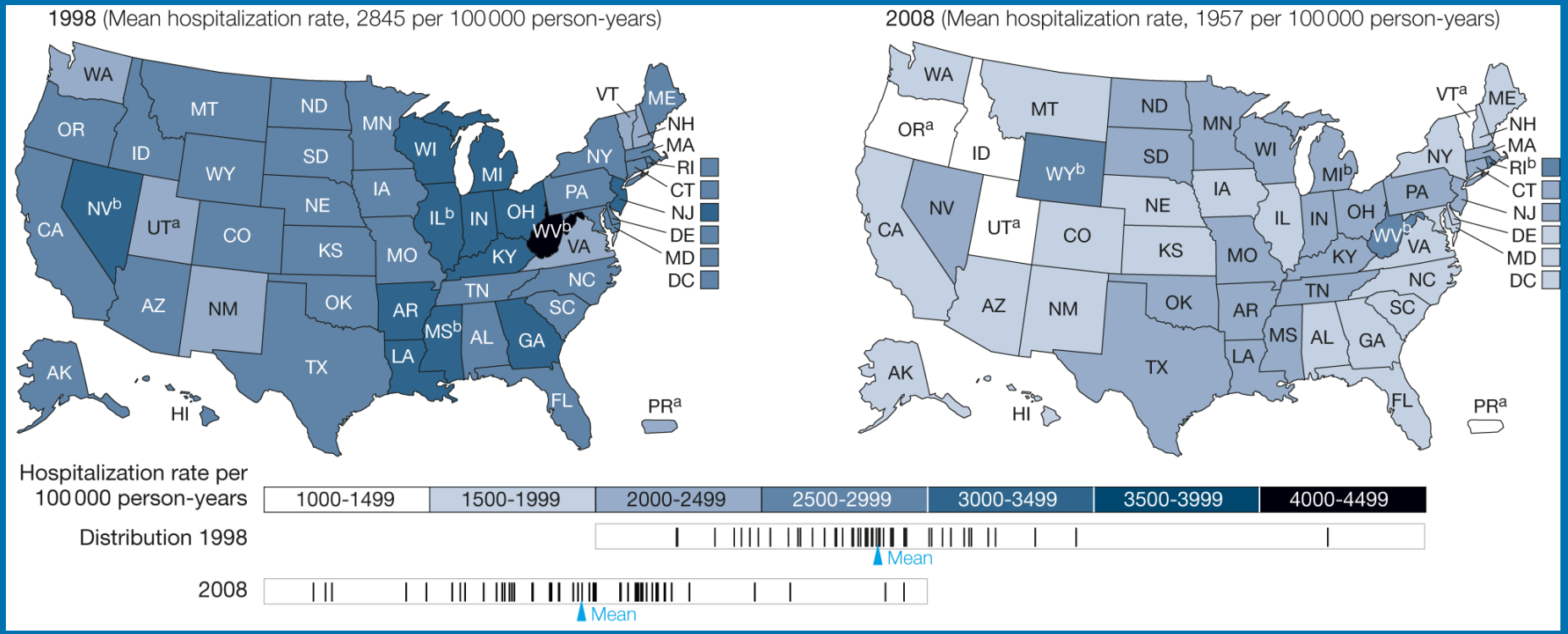
Thoughts:

- Persistent low output despite maximally tolerated inotrope (limited by recurrent VT)
- End stage heart failure, non dischargeable (IABP and nipride are not homegoing options)
- Not a transplant candidate due to recent breast Ca (needs 5 years in remission)
- *What now?*

Proceed with DT VAD therapy:

- Received HMIII that admission
- Post op course complicated by RV failure (expected, concerning preop R heart indices: PAPi 0.92, CVP/PCWP 0.7)
- Managed with dual inotropes and iNO (no VT post VAD)
- Patient at our holiday party: Ambulating, NYHA I-II, discussed how she bought her teenage son a new video game chair for Christmas

Burden of Heart Failure



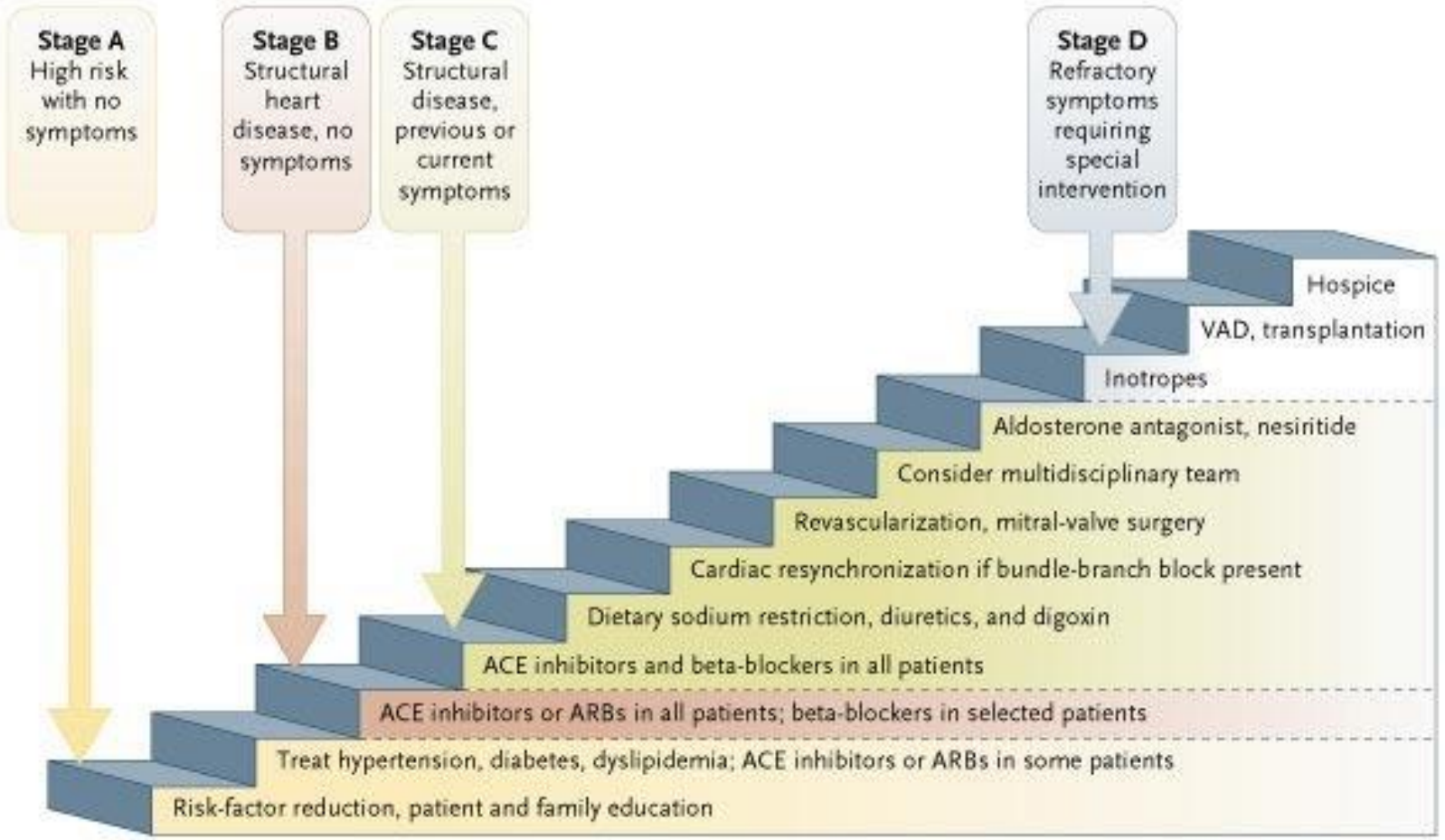
JAMA 2011

BELIEVE IN WE™ OhioHealth

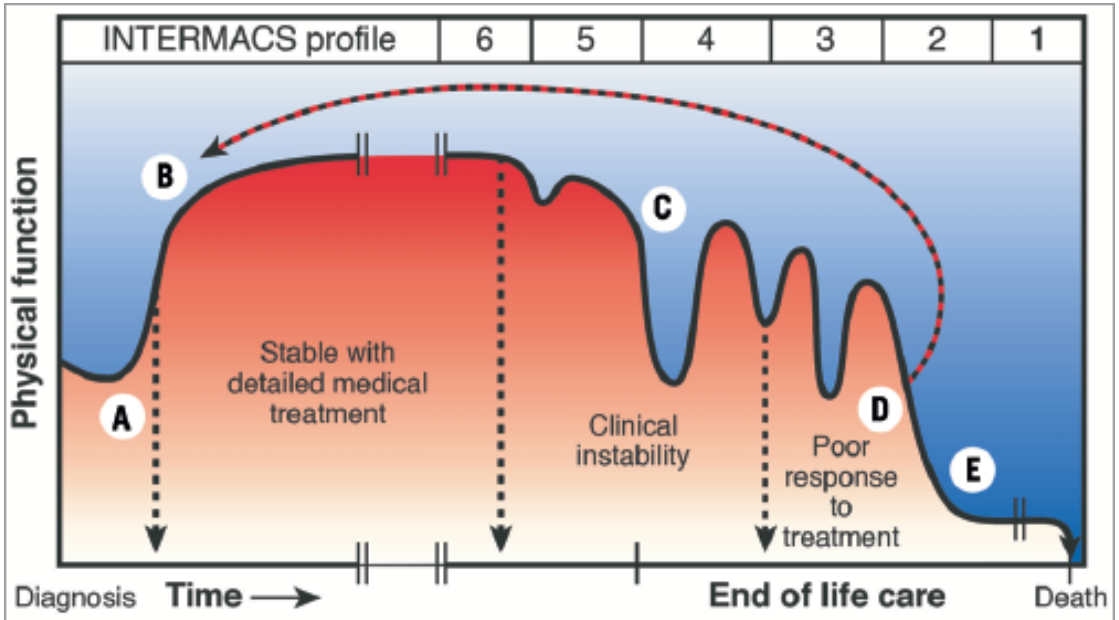
- 26 million patients with heart failure globally
- Prevalence of approximately 6 million in the US alone (2% of the population)
- Almost 4 million hospitalizations in 2004
- Cost/hospitalization of roughly $11000
- ***Advanced Heart Failure:*** 5% is often quoted (estimates vary due to heterogeneous definitions)

1. Ponikowski et al. ESC Heart Fail 2014; 1: pp. 4-25
2. Chaudry SP, Heart Failure Clinics 2016; 12: pp. 323-3333
3. Komanduri et. al JCHIP March 2017

Recognizing Advanced Heart Failure

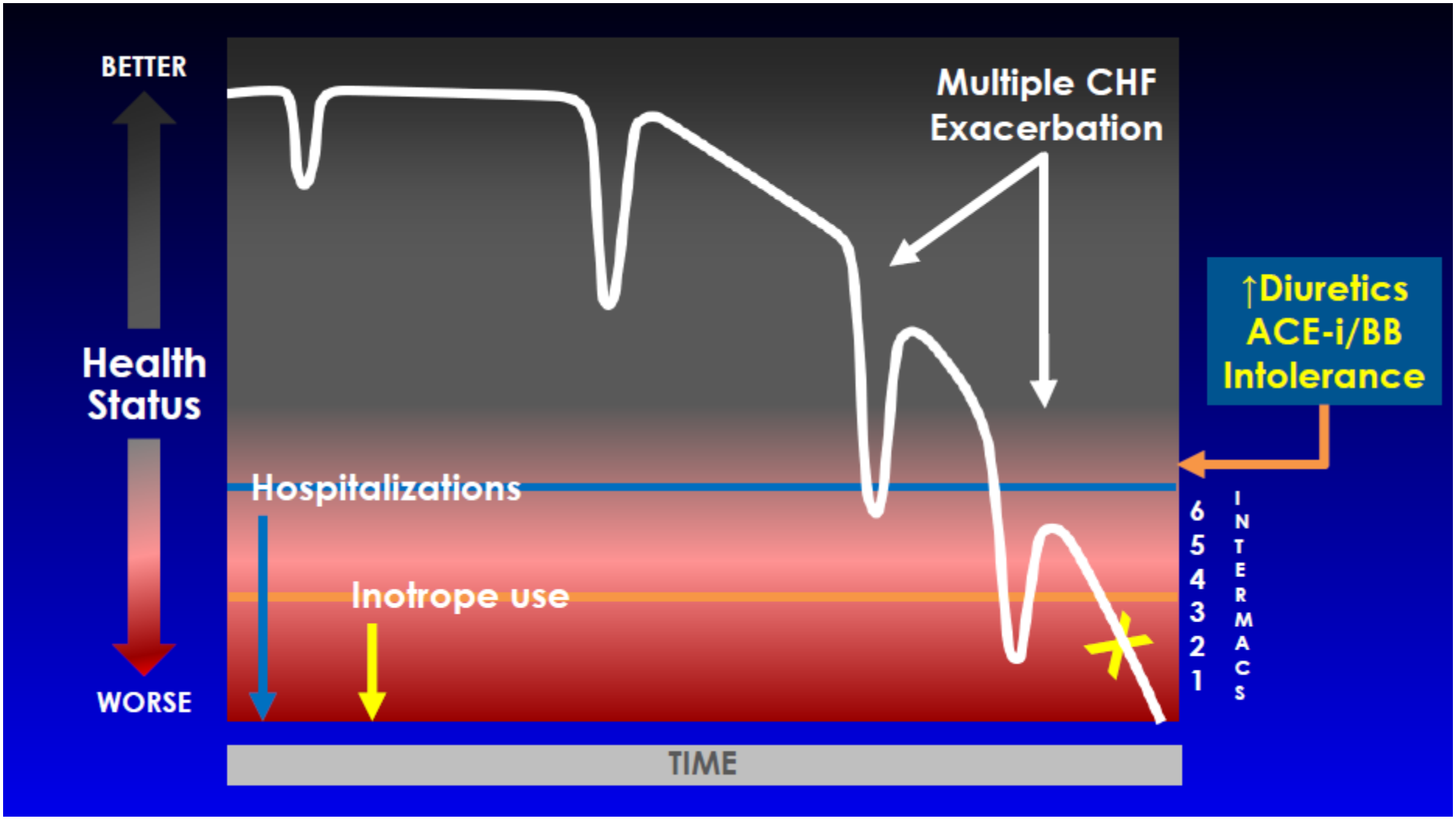


Jessup, NEJM 2003

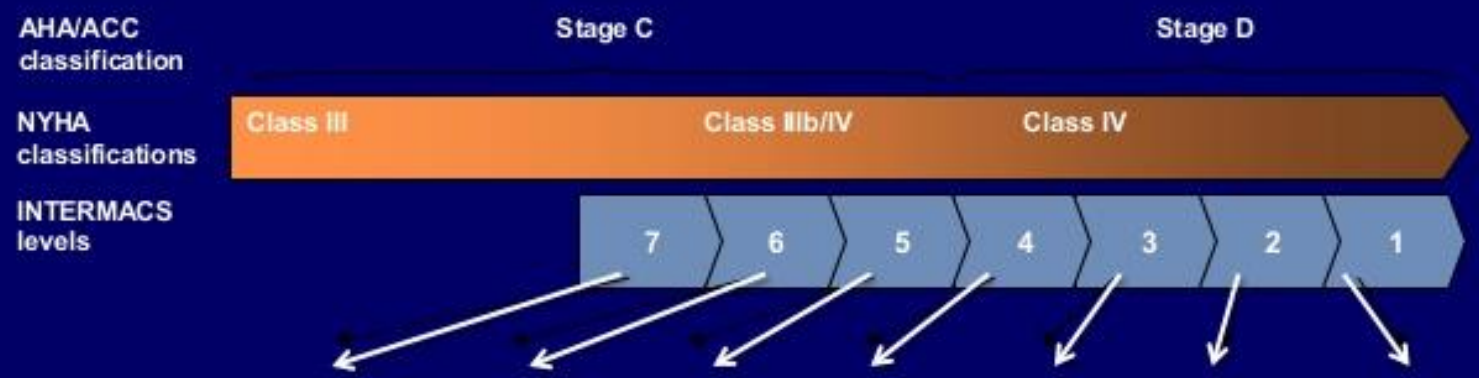


INTERMACS profile	Patient characteristics	VAD implants % (2009-2010, ref 5)
1	Critical cardiogenic shock despite escalating support	17
2	Progressive decline despite inotropes	45
3	Inotrope dependent, but stable	20
4	Recurrent, not refractory, advanced heart failure	12
5	Exertion intolerant, comfortable at rest	3
6	Exertion limited, able to perform mild activity	2
7	Advanced NYHA Class III	1

Goodlin


BETTER
Health Status
WORSE
Multiple CHF Exacerbation
↑Diuretics
ACE-i/BB
Intolerance
Hospitalizations
Inotrope use
6 5 4 3 2 1
INTERMACS
TIME

Timeframe for Definitive Interventions based on INTERMACS classifications



Brief descriptions	Advanced NYHA Class III	Exertion limited/ "Walking wounded"	Exercise intolerant/ "House-bound"	Recurrent decompen-sation/ "Frequent flyer"	Stable but inotrope-dependent/ "Dependent stability"	Progressive decline/ "Sliding on inotropes"	Critical cardiogenic shock/ "Crash and burn"
Timeframe for definitive intervention	Transplan-tation or circulatory support not currently indicated	Variable, depends upon nutrition, organ function, and activity	Variable, depends upon nutrition, organ function, and activity	Elective over weeks to months as long as treatment of episodes restores stable baseline, including nutrition	Elective over a few weeks	Needed within a few days	Needed within hours

Note: This grid was based on the best interpretation of the information provided in the sources listed below

Sources: "Heart Failure". NEJM 2003; 348:2007-18. "On the Fledgling Field of Mechanical Circulatory Support". JACC 2007; (50) 8. "Characteristics of Stage D heart failure: Insights from the Acute Decompensated Heart Failure National Registry Longitudinal Module (ADHERE LM)". Am J Heart 2008; 155:341-9. INTERMACS Manual of Operations version 2.2, User's Guide

ESC AHF Definition

- ***NYHA Class III-IV Symptoms***
- ***Episodes of volume overload and/or peripheral hypoperfusion***
- ***Objective evidence of severe cardiac dysfunction***
(EF<30%, Doppler Pseudonormal or Restrictive filling pattern, PCWP>16mmHg or RAP> 12 mmHg)
- ***Severely impaired functional capacity***
(Inability to exercise, 6MWD<300m, Peak VO2<12-14 ml/kg/min)
- ***HF Hospitalizations***
(≥1 in past 6 months)
- ***Above occurring despite attempts to optimize diuretics, RAAS antagonists, BB, CRT or in the setting of intolerance to OMT***

Identifying the Advanced Heart Failure Patient:

I-NEED-HELP (also see *Table 6*)

I: IV inotropes

N: NYHA IIIB/IV or persistently elevated natriuretic peptides

E: End-organ dysfunction

E: Ejection fraction ≤35%

D: Defibrillator shocks

H: Hospitalizations >1

E: Edema despite escalating diuretics

L: Low blood pressure, high heart rate

P: Prognostic medication – progressive intolerance or down-titration of GDMT

Yancy et. al, Optimization of Heart Failure Treatment, Expert Concensus; JACC 2017

Once Stage D is Recognized:
Early Referral is Always Preferred

-hemodynamically profound RV failure, pulmonary hypertension or profound renal insufficiency often limit advanced therapies

AHF Services

- Pre VAD and Transplant Evaluation
- Mechanical Circulatory Support (temporary, percutaneous, extracorporeal, and durable)
- Cardiogenic Shock Team
- CPET (Cardiopulmonary exercise testing) for risk stratification
  - Peak VO2 < 14 (or <12 on a beta blocker) have 20% mortality risk at 1 year
- Endomyocardial biopsy
- CardioMEMS
- Clinical trials
- Palliative care services/Hospice transition
- Genetic testing
- AVAILABILITY – Staffed to allow q2week (between physician and APP) follow ups for sick patients
- Easy integration with additional advanced programs (CMR/PET, structural heart, VT ablation)

Our Team:

- 3 AHF Physicians
- 1 VAD Surgeon
- 4 AHF NPs
- 2 VAD coordinators
- HF Pharmacist
- HF coordinator
- HF Clinic RN team
- Social worker
- Dietician
- Palliative Care
- Finance

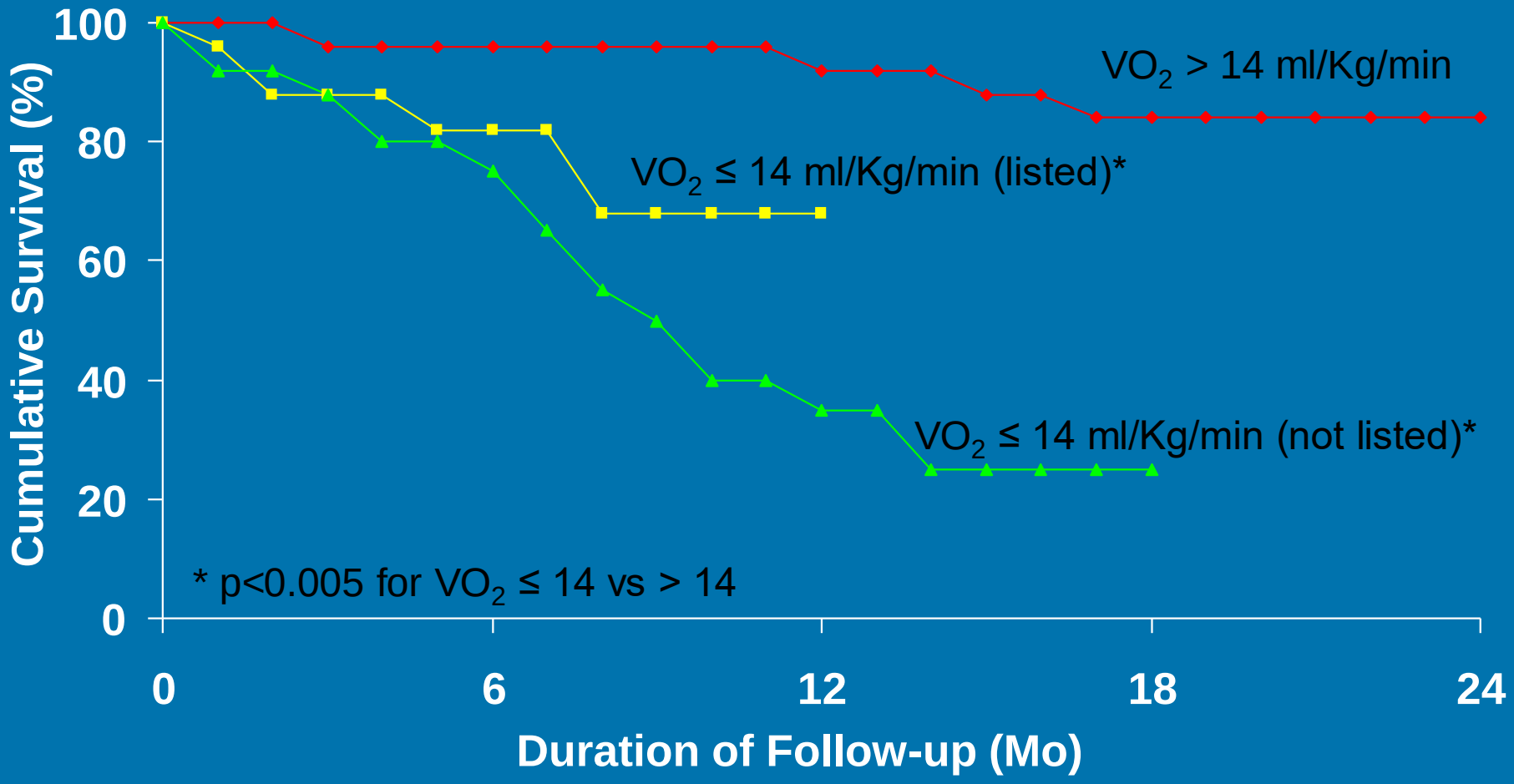
TABLE 1. Functional Impairment During Incremental Treadmill Testing in Heart Failure: The Weber Classification

Class	Severity	Peak $\dot{V}o_2$ mL · kg^{-1} · min^{-1}	VT	CI max, L · min^{-1} · m^{-2}
A	Mild to none	>20	>14	>8
B	Mild to moderate	16–20	11–14	6–8
C	Moderate to severe	10–16	8–11	4–6
D	Severe	6–10	5–8	2–4
E	Very severe	<6	<4	<2

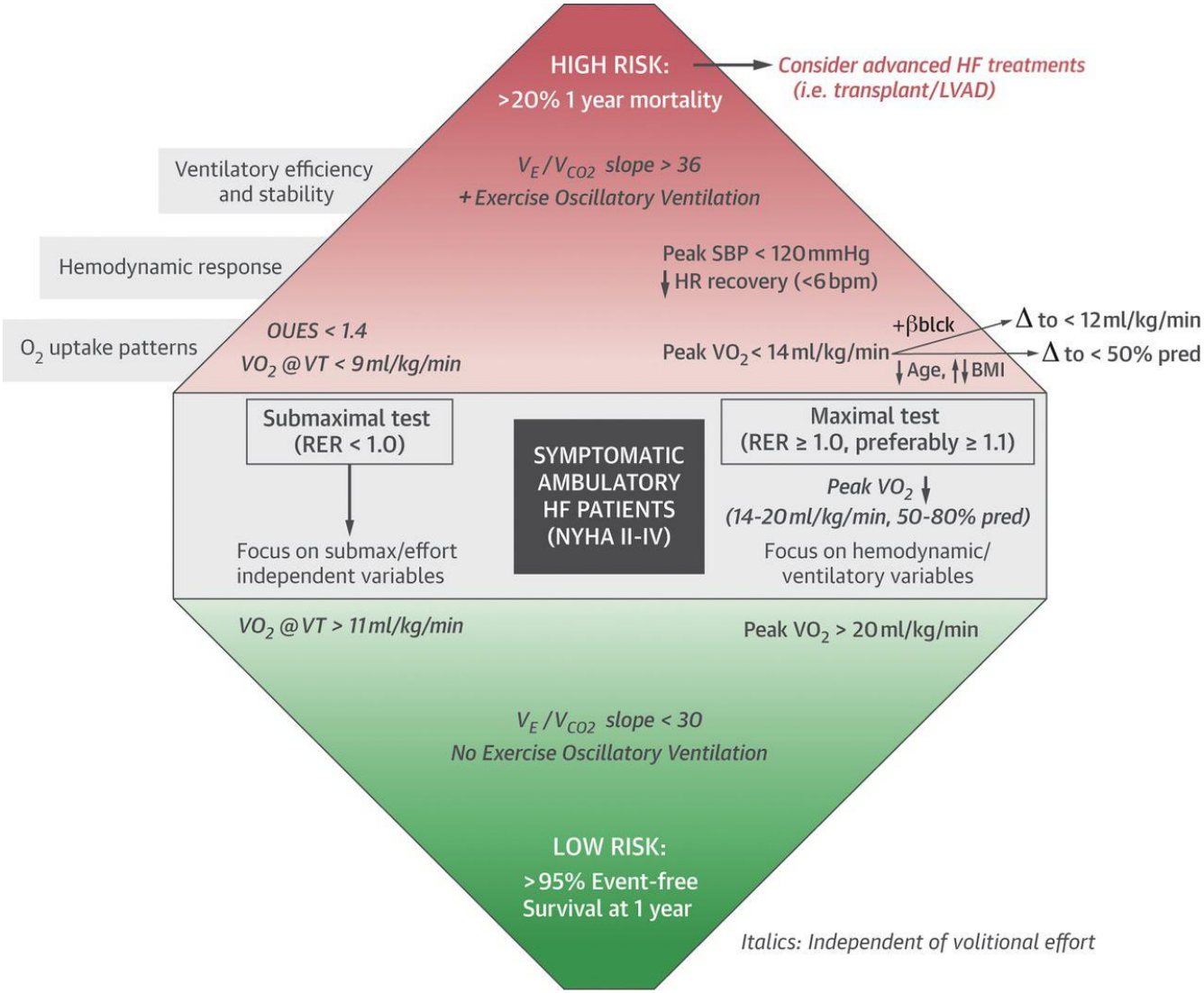
VT indicates ventilatory threshold; CI max, maximum cardiac index.

Adapted with permission from Weber et al, "Determination of aerobic capacity and the severity of chronic cardiac and circulation failure." (*Circulation.* 1987;76[suppl VI]:VI-40–VI-45.)

Prognostic Value of peak VO_2



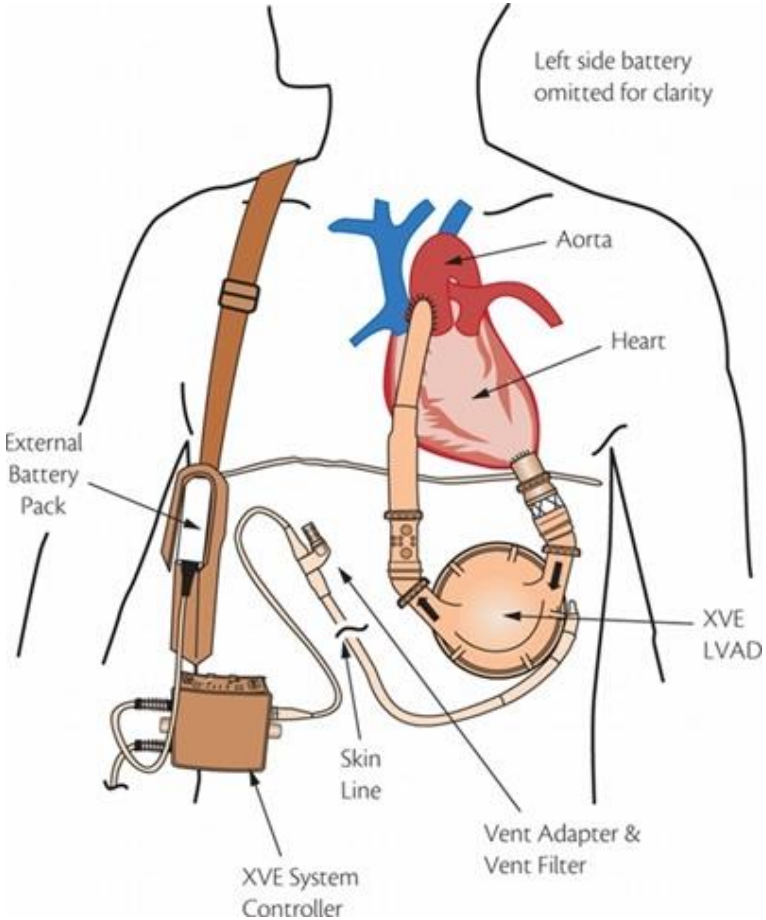
Circulation 1991;83:778-786



JACC HF 2018

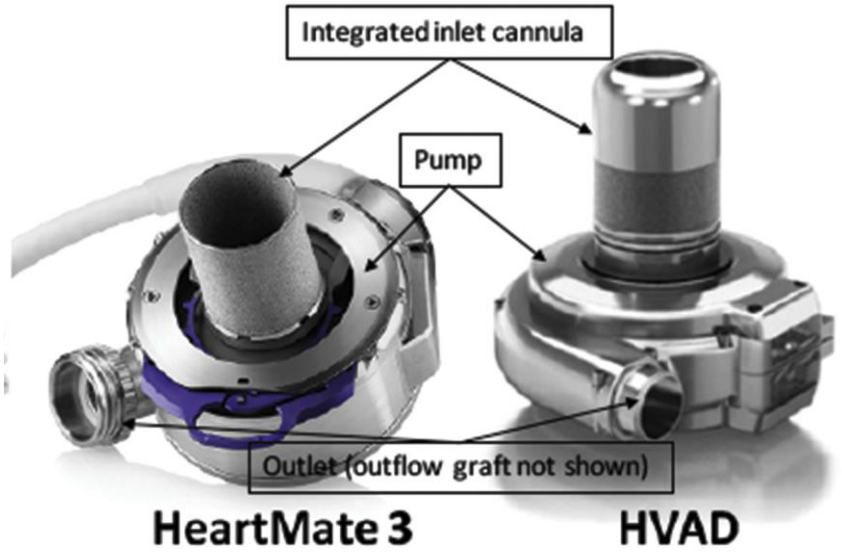
VAD Therapy

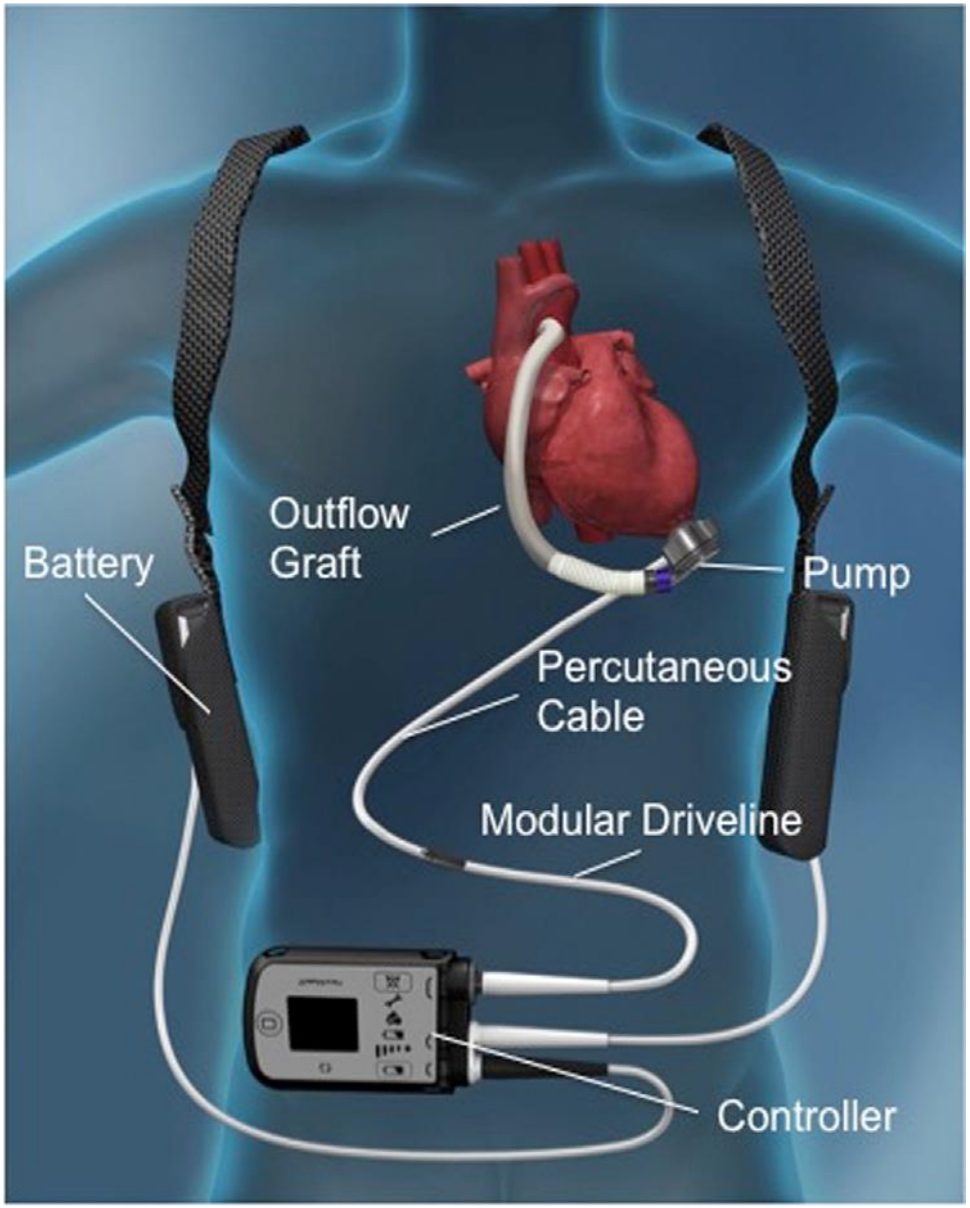
1st Generation VAD: Heartmate HVE



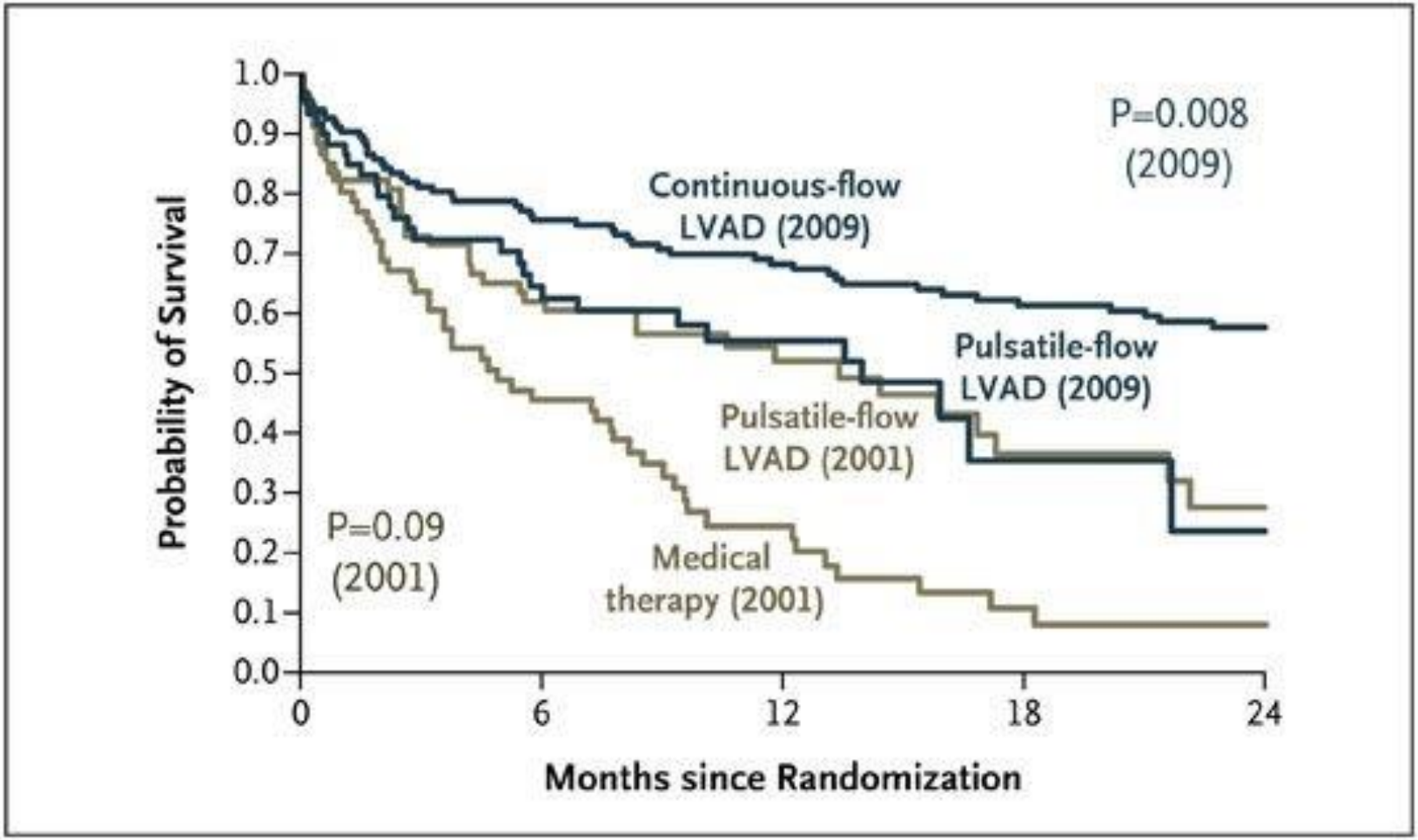
2nd Generation: Heartmate II

3rd Generation: HVAD and HMIII



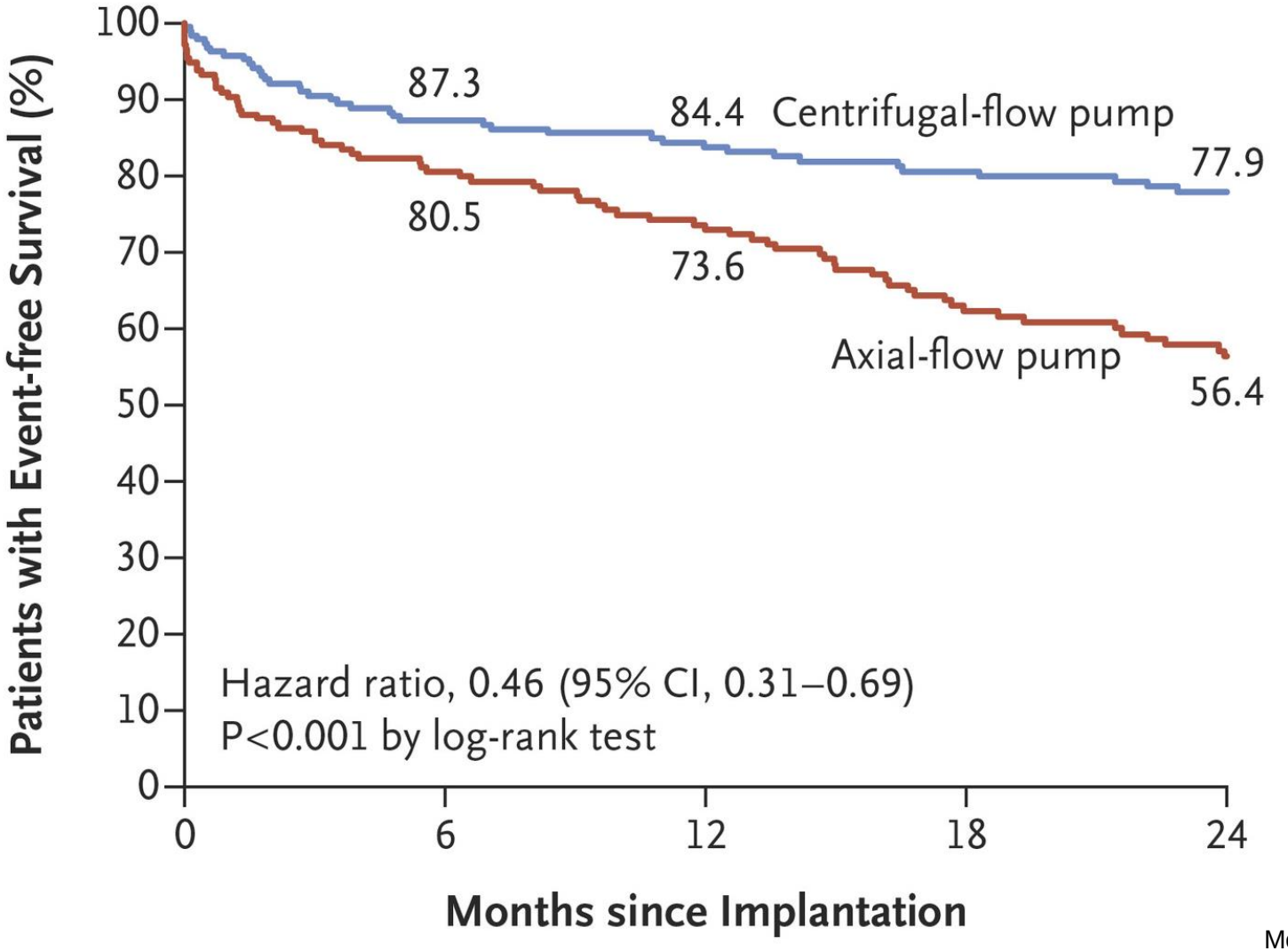

Outflow
Graft
Battery
Pump
Percutaneous
Cable
Modular Driveline
Controller

OMT vs CF LVAD



Fang NEJM 2009

HMII vs HMIII



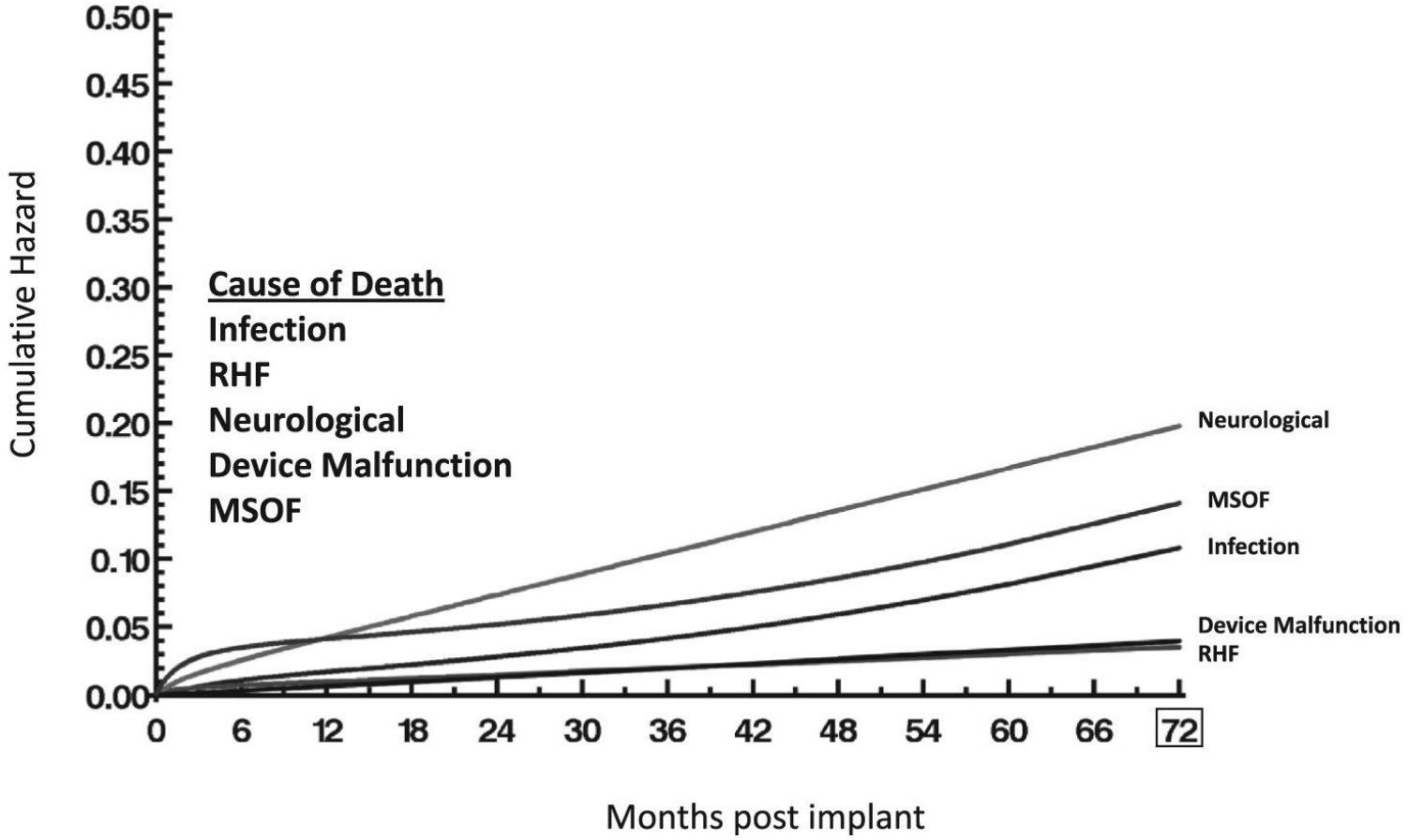
Mehra NEJM 2018

Adverse Effects – SIGNIFICANT AND MANY:

- GI Bleed
- Stroke
- Infection (including chronic driveline)
- Death
- RV failure – early and delayed
- Pump failure/pump thrombosis
- Costs

Intermacs **Continuous Flow LVAD/BiVAD Implants: 2008 – 2016, n=17633**

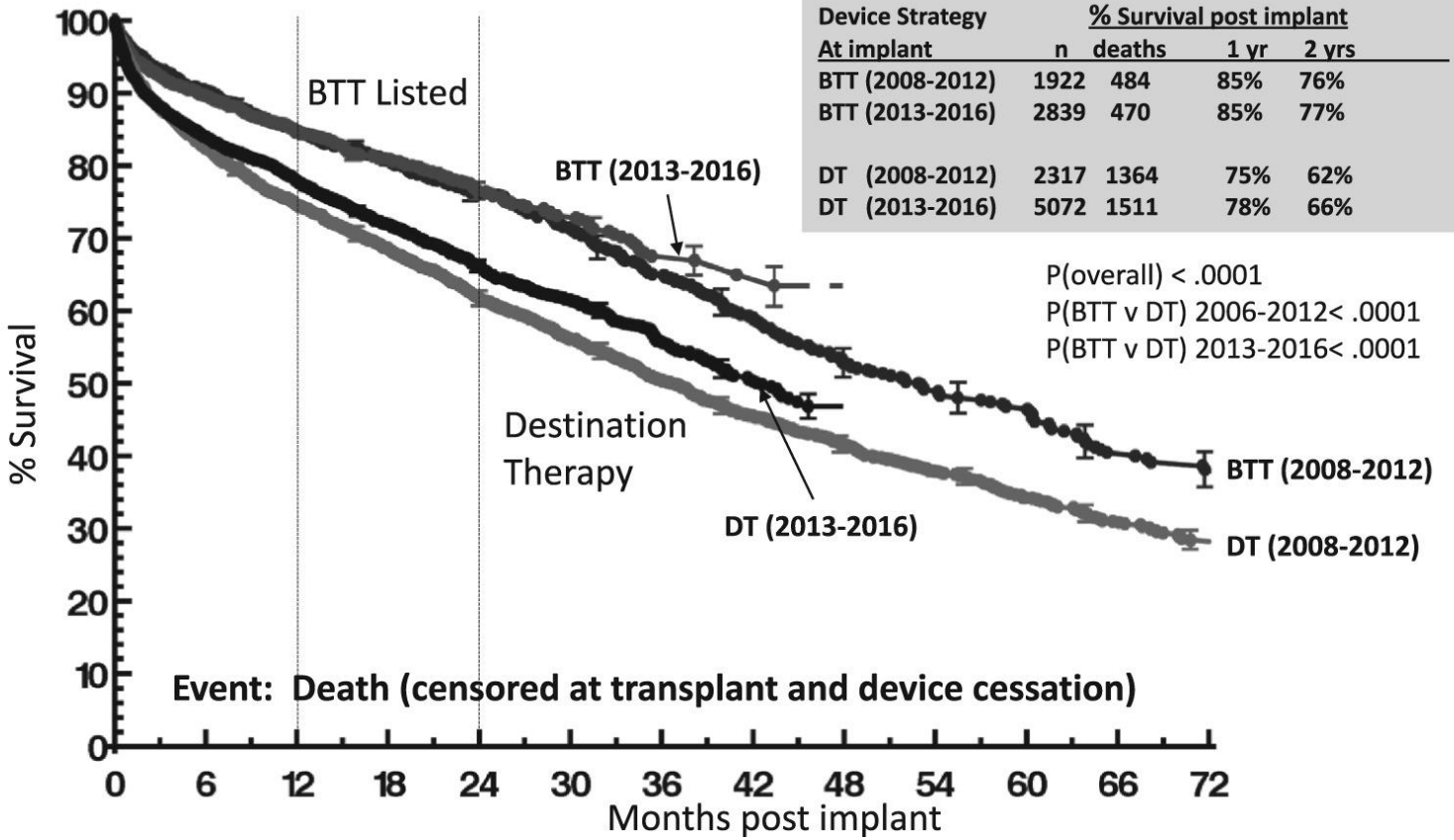
Cumulative Death Rate (Hazard) for selected causes



Kirklin JHLT 2017

Intermacs Continuous Flow LVAD/BiVAD Implants: 2008 – 2016, n=17633

Bridge to Transplant Listed and Destination Therapy by Era (n=12150)



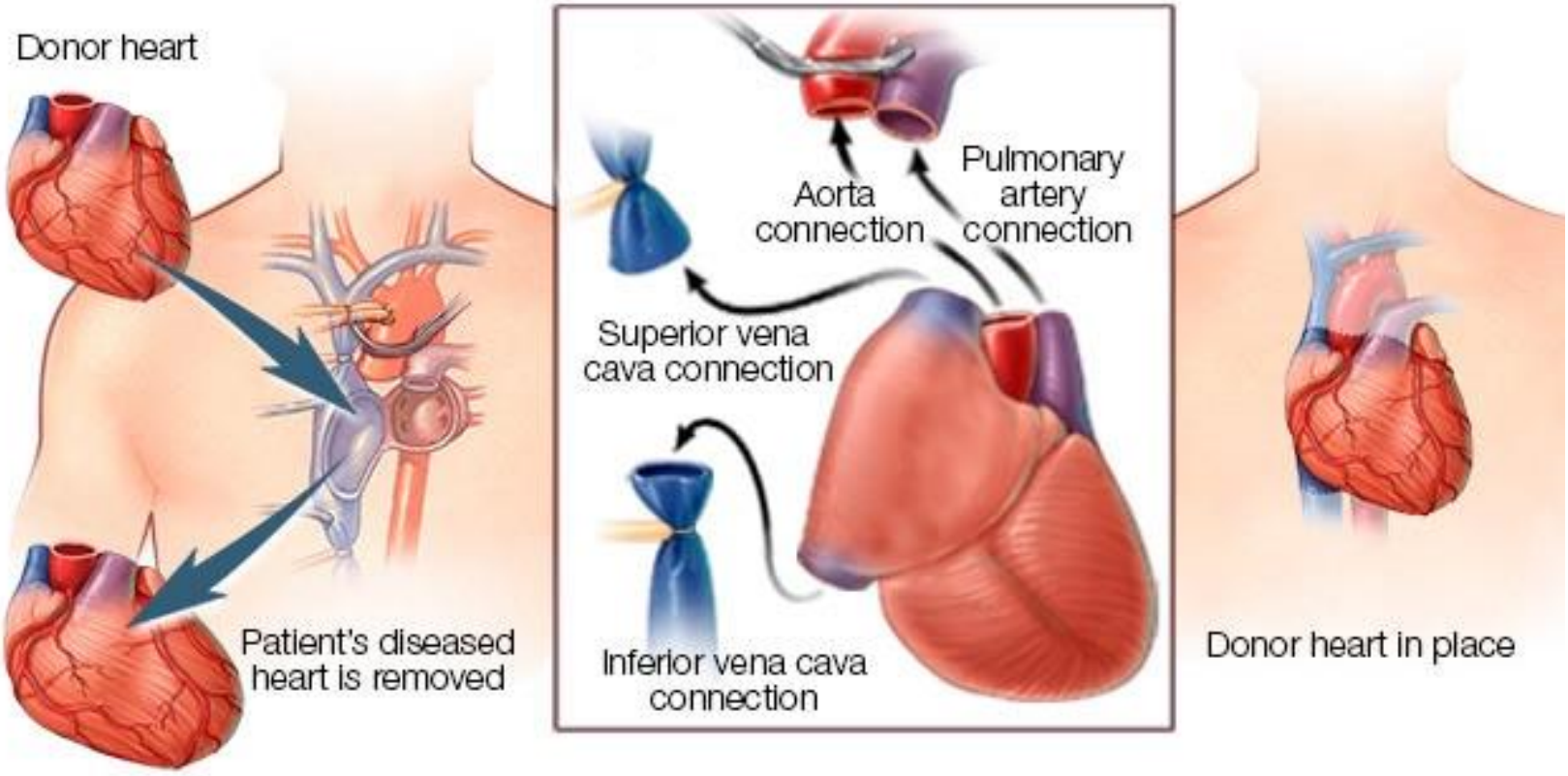
Device Strategy At implant	n	deaths	% Survival post implant 1 yr	2 yrs
BTT (2008-2012)	1922	484	85%	76%
BTT (2013-2016)	2839	470	85%	77%
DT (2008-2012)	2317	1364	75%	62%
DT (2013-2016)	5072	1511	78%	66%

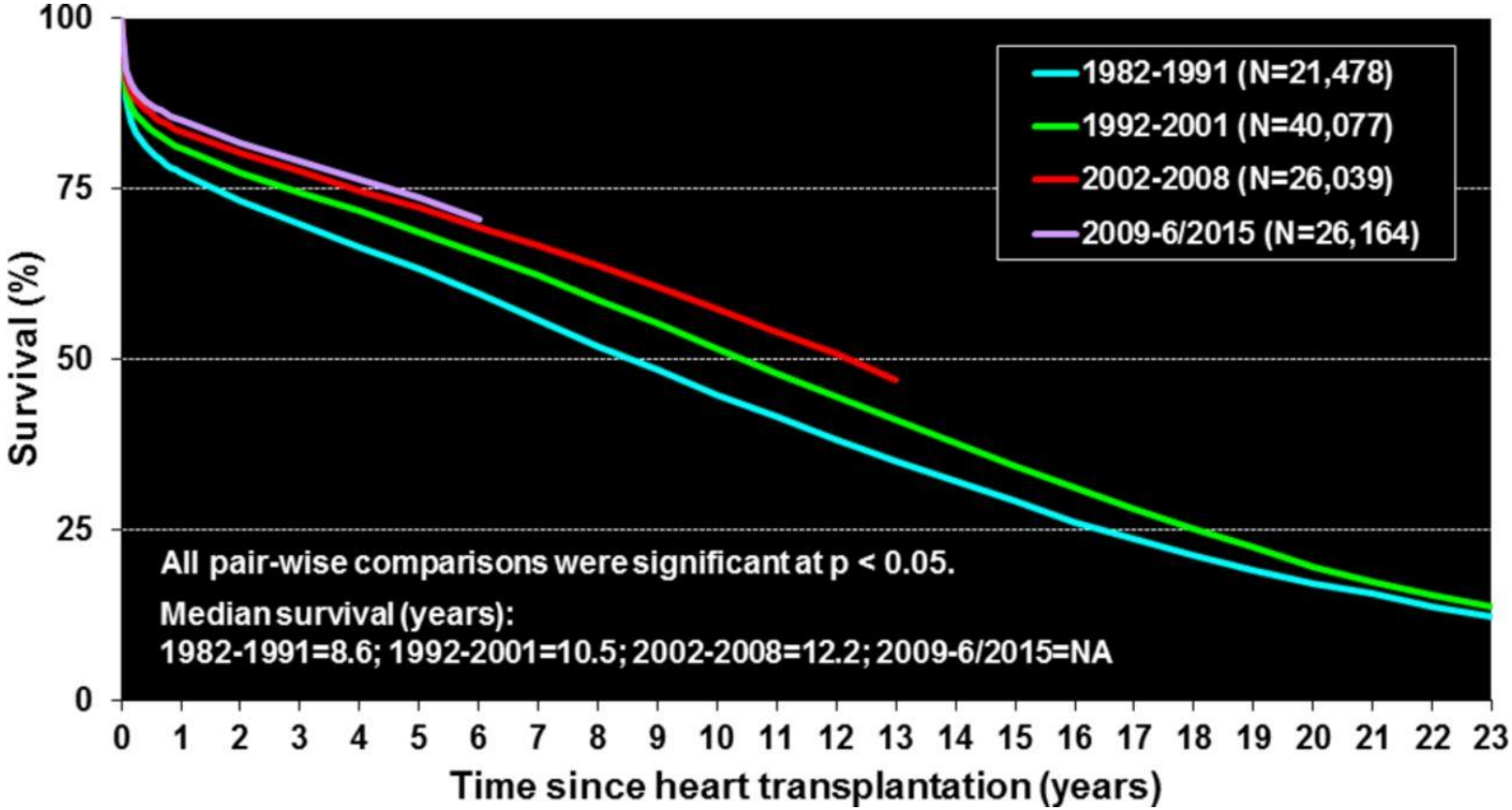
P(overall) < .0001
P(BTT v DT) 2006-2012< .0001
P(BTT v DT) 2013-2016< .0001

Kirklin JHLT 2017

Cardiac Transplantation

Heart transplant procedure





BMJ

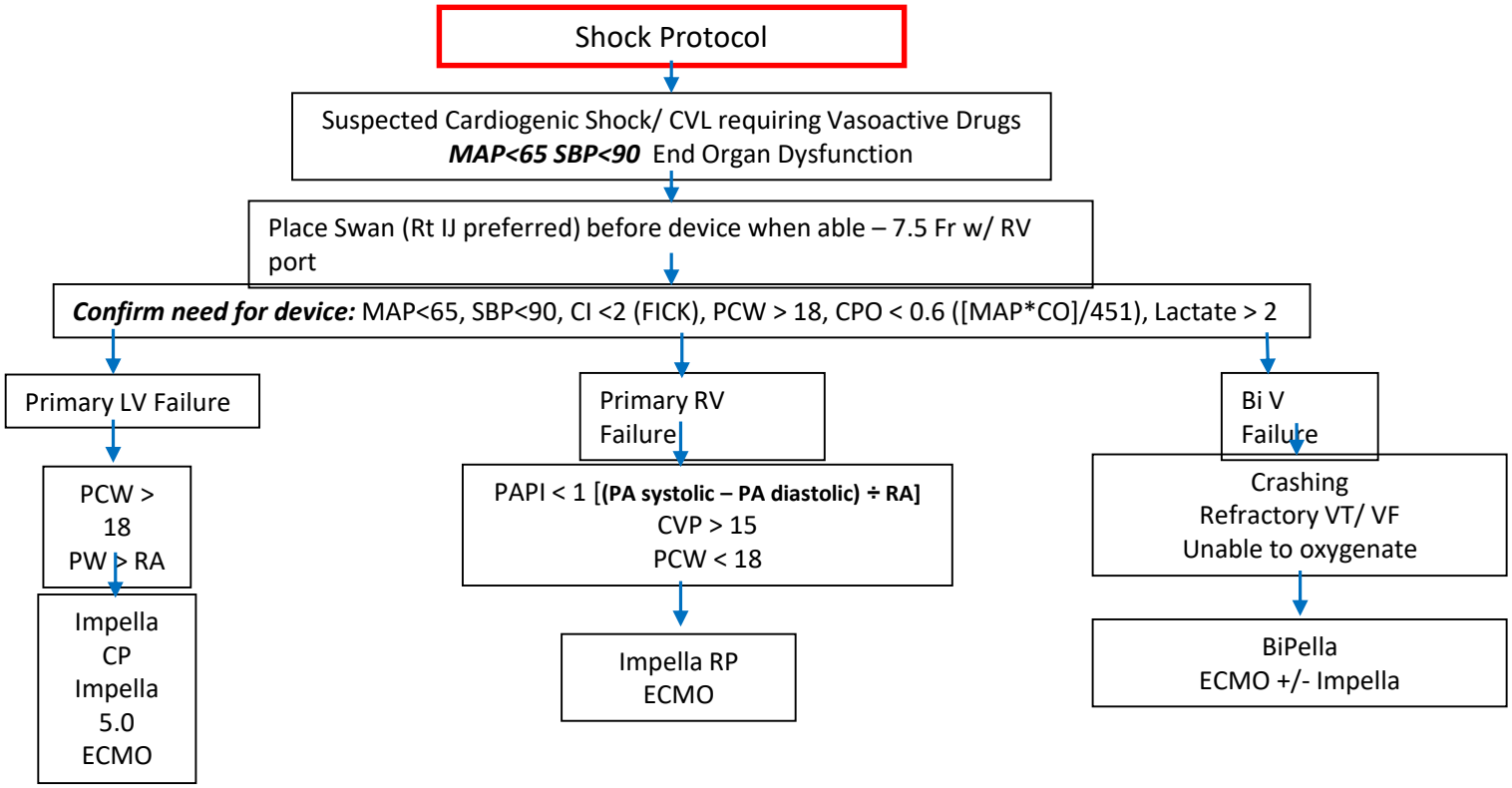
Complications

- Immunosuppression – infection, malignancy, renal failure
- Post op including stroke
- Cardiac allograft vasculopathy
- Cellular and antibody mediated rejection

Shock Program/Shock Team

Shock Team

- Multidisciplinary, involving combination of AHF physician, interventionalist, and CT surgery
- Structuralized approach to Cardiogenic Shock
- Temporary support devices available:
  - IABP
  - Impella CP and RP
  - ECMO
  - Centrimag



Post Device Placement

Recheck numbers post placement to determine need for device upgrade:

If MAP < 65 and CI < 2 look at PAPI and CPO

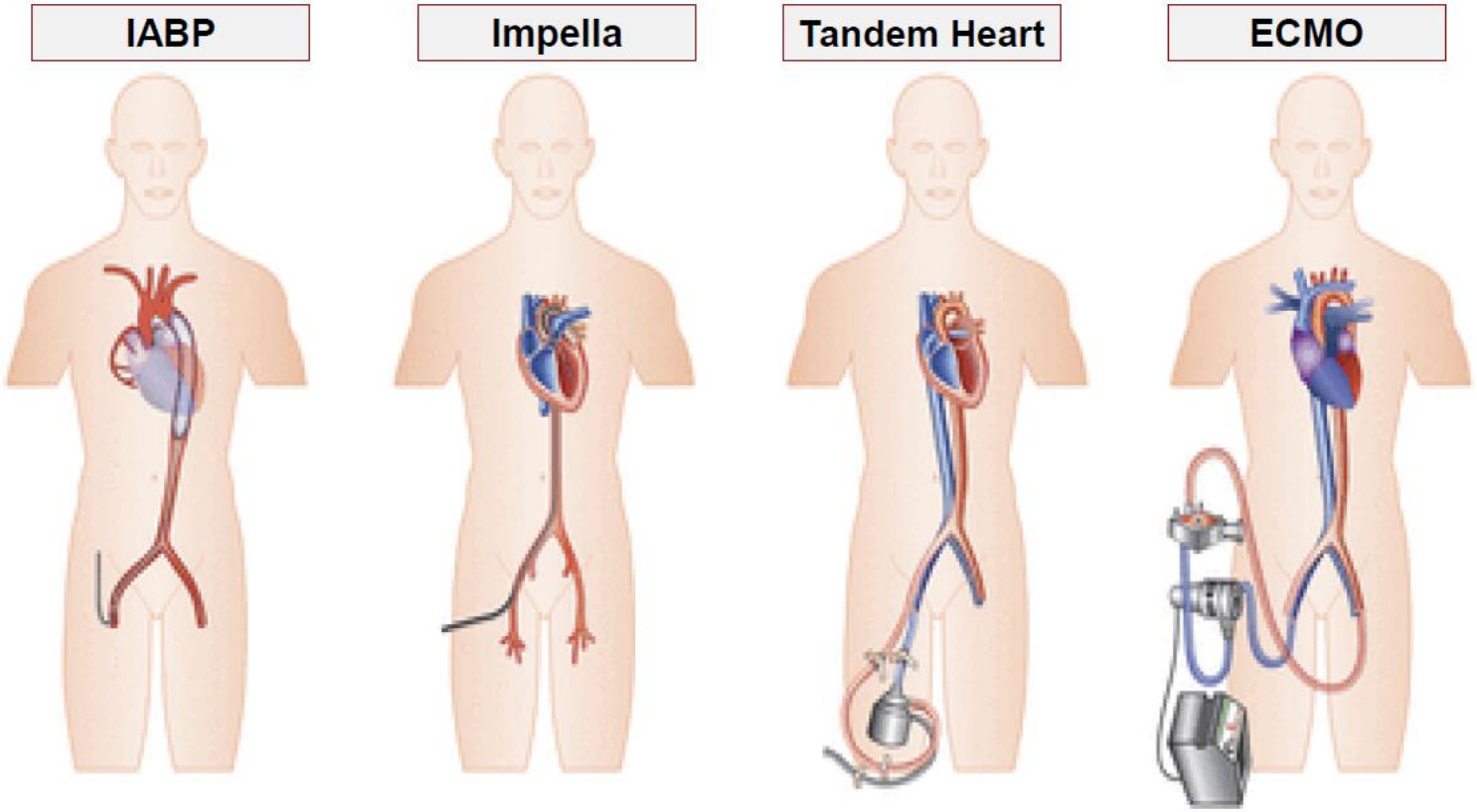
* If PAPI < 1 and CPO < 0.6 upgrade to RP or ECMO
* If CPO < 0.6 and PAPI >1 consider Impella 5 or ECMO

Impella 5.0

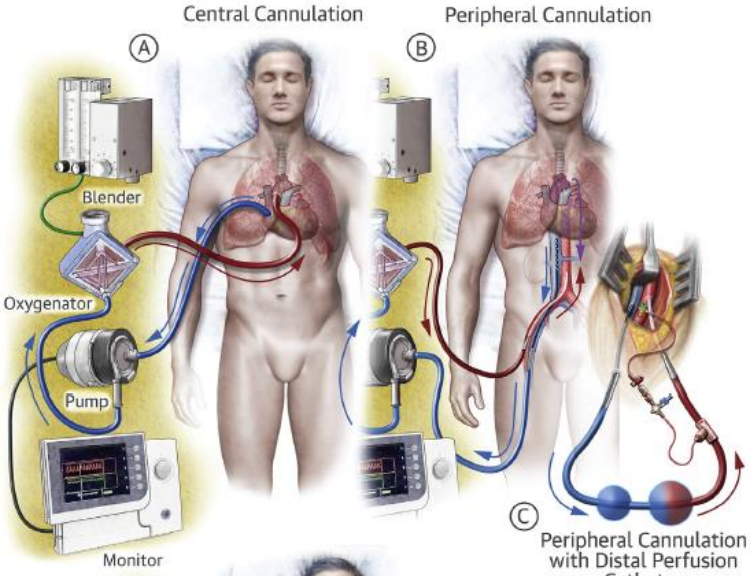
* Notify CTS (Surgeon notifies OR Team
* Notify Perfusion (in not already in CVL)

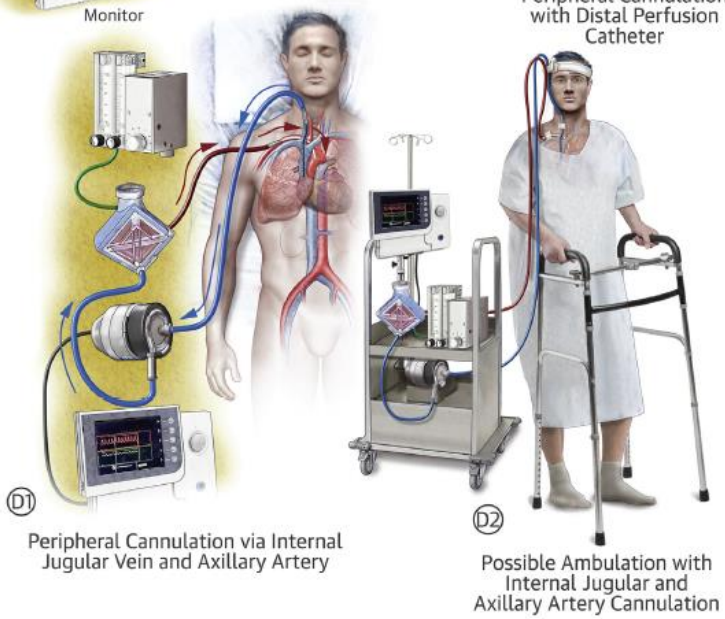
ECMO

* Initiate Mechanical Support Protocol



Werdan 2013, Eur Hrt J





Keebler, M.E. et al. J Am Coll Cardiol HF. 2018;6(6):503-16.

Palliative Options for the non Advanced Therapies Candidate:

- IV diuretics in the office
- Scheduled intermittent thiazide (metolazone)
- Continuous lasix infusion pumps
- Palliative inotrope home infusion therapy
- Digoxin
- Hospice care

Questions?