Trattamento aggressivo delle miocarditi

Le diverse forme di supporto meccanico al circolo: quando e come

Ugolino LIVI, FECTS
Dip.to CardioToracico
Azienda Ospedaliero - Universitaria
Udine

Natural History of Myocarditis

Clinical presentation

Left Ventricular dysfunction

	mild	*moderate*	*severe*
LVEF	**> 40 %**	**40 – 30 %**	**< 30 %**

25% spontaneous improvement

50% chronic dysfunction

25% death

HTx / VAD

HTx for myocarditis

Udine experience *

	ID	Age *(yrs)*	Sex	Myocarditis	Pre-HTx treatment	HTx year	Immunosuppression		Rejections		Infections	F-U *(mos.)*
							early	late	All	/3A		
1	A.I.	12	F	Chronic (Borderline)	ICD	2006	CsA + MMF + Pred	Tac + MMF + Pred	1	0		45
2	M.S.	42	M	Chronic (Borderline)	ICD	2006	CsA + MMF + Pred	CsA + MMF + Pred	3	1	CMV	49
3	C.S.	33	M	Active (Eosinophilic)	ICD	2005	CsA + MMF + Pred	CsA + MMF	5	0		60
4	RDE	27	F	Chronic (Borderline)	ICD	2005	CsA + Evl + Pred	CsA + Evl	3	0		56
5	G.L.	39	M	Active (Granulomatous)	ICD + Dobu	2004	CsA + MMF + Pred	CsA + MMF + Pred	3	1	CMV, VZV	67
6	MCR	40	F	Chronic (Borderline)		2003	CsA + MMF + Pred	CsA + MMF	2	0	HSV, VZV	86
7	T.B.	28	M	Chronic (Borderline)	IABP BVAD	2000	CsA + MMF + Pred	CsA + MMF	5	0	VZV	119

* = On 176 hearts 1999 - 2007

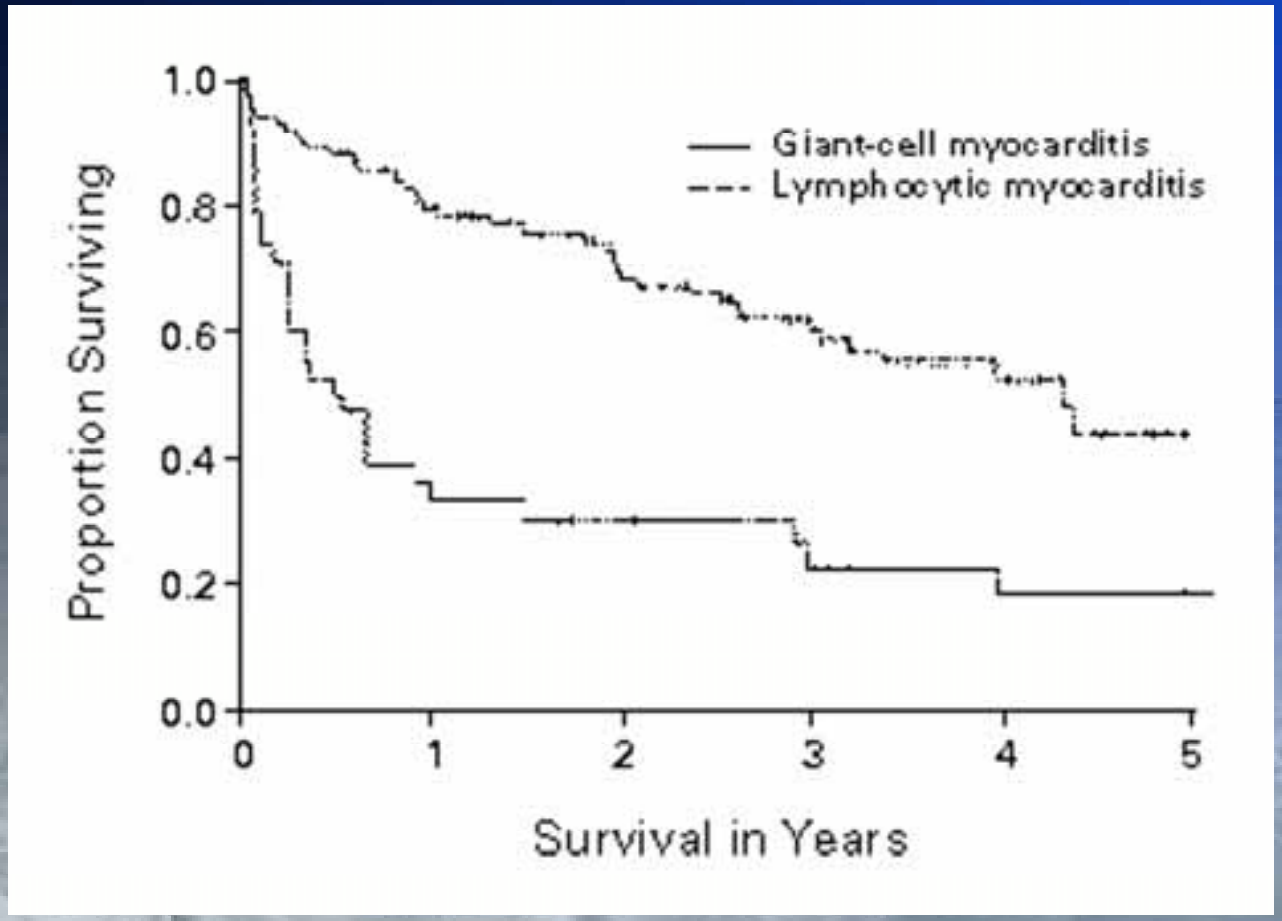
Natural History of Myocarditis

The New England Journal of Medicine

IDIOPATHIC GIANT-CELL MYOCARDITIS — NATURAL HISTORY AND TREATMENT

LESLIE T. COOPER, JR., M.D., GERALD J. BERRY, M.D., AND RALPH SHABETAI, M.D.,
FOR THE MULTICENTER GIANT CELL MYOCARDITIS STUDY GROUP INVESTIGATORS*

Cooper LT et al *N Engl J Med* 1997; 336: 1860 - 6



Giant Cell Myocarditis (GCM)
role of HTx

- BTT with ECMO or VAD
- triple-drug immunosuppression
- aggressive post-HTx surveillance *(⬆ biopsies)*
- long-term outcome

ECMO = ExtraCorporeal Membrane Oxygenation **BTT = Bridge-To-Transplant**
VAD = Ventricular Assist Device

WHEN TO IMPLANT

- Rapid Progression to Shock
- Refractory to Intensive Medical Treatment
- Major Ventricular Arrhythmias or Cardiac Arrest
- Profound Cardiac Dysfunction by ECHO
- Confirmed Diagnosis by EMB (if possible)

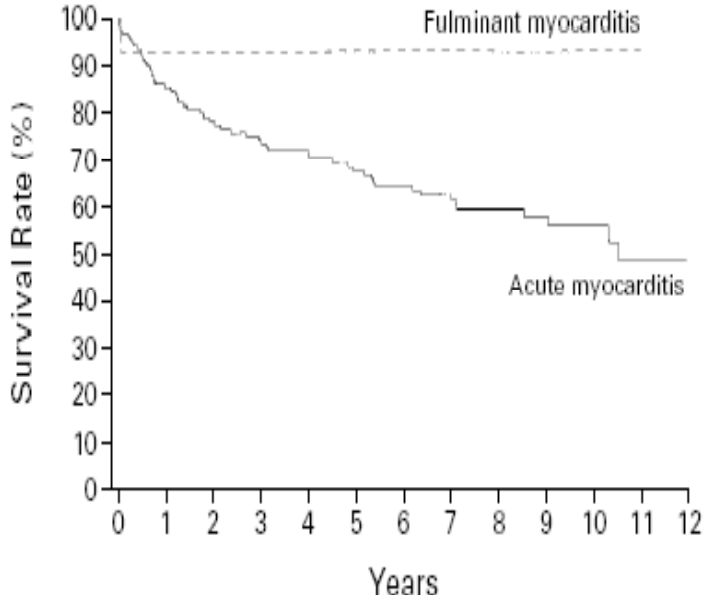
EMB = EndoMyocardial Biopsy

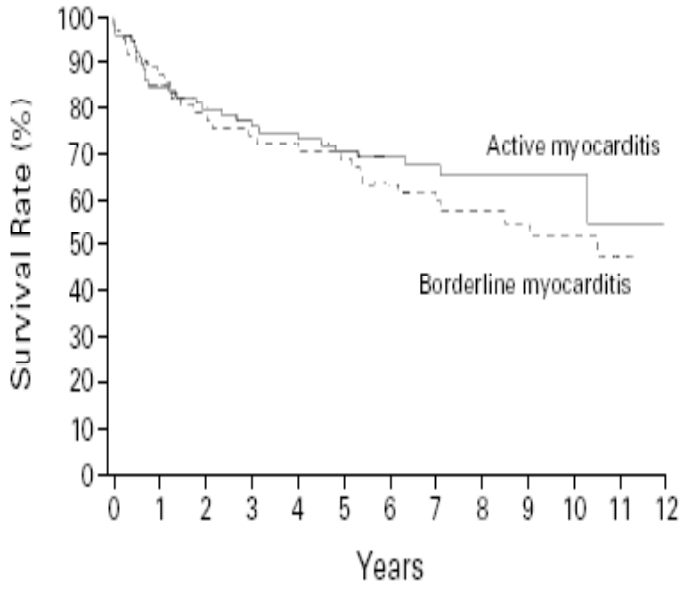
The New England Journal of Medicine

LONG-TERM OUTCOME OF FULMINANT MYOCARDITIS AS COMPARED WITH ACUTE (NONFULMINANT) MYOCARDITIS

Robert E. McCarthy III, M.D., John P. Boehmer, M.D., Ralph H. Hruban, M.D., Grover M. Hutchins, M.D., Edward K. Kasper, M.D., Joshua M. Hare, M.D., and Kenneth L. Baughman, M.D.

McCarthy RE et al *N Engl J Med* 2000; 342: 690 - 5





No. at Risk

Acute myocarditis	132	110	98	91	84	79	73	59	41	28	18	3	0
Fulminant myocarditis	15	12	12	10	10	9	7	5	4	3	2	0	0
Active myocarditis	82	68	61	58	53	50	47	34	22	13	6	1	0
Borderline myocarditis	65	54	47	43	40	38	33	30	23	18	14	2	0

Mechanical Support for Acute Myocarditis

- ECMO *vs* VAD
- Univentricular (LVAD) *vs* Biventricular (BVAD)
- Atrial *vs* Apical cannulation
- Pulsatile *vs* Non-Pulsatile flow
- BTR *vs* BTT

ECMO = ExtraCorporeal Membrane Oxygenation
VAD = Ventricular Assist Device

BTR = Bridge-To-Recovery
BTT = Bridge-To-Transplant

Mechanical Support for Recovery of Cardiac Function

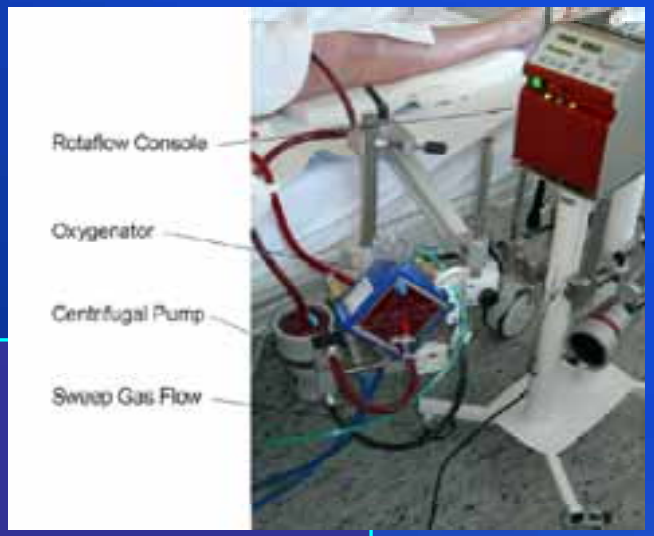
Reversal of Shock is Flow & Pressure Dependent

- ECMO → infants & children
  → "bridge to decision"
- PF > CF → low flows/pressures
- CF = PF → flow > 90 ml/kg/min
- BVAD > LVAD → MOF or BV compromise

ECMO = ExtraCorporeal Membrane Oxygenation
VAD = Ventricular Assist Device

PF = Pulsatile Flow
CF = Continuous Flow

ECMO



SET-UP

Venous access

Circuit

Centrifugal pump

Membrane oxygenator

Arterial access

CANNULATION SITE

Femoral Vessels

Cervical Vessels

Axillary / Brachial artery

Additional procedures

Distal femoral artery perfusion

LV Transthoracic / Impella

Septostomy

ECMO

ADVANTAGES	Rescue procedure for CPR
	Full biventricular support, ↑ systemic oxygenation
	Sufficient for short-term support, easy weaning
	Readily available in ICU, quick set-up
	No need for OR or cath-lab, no sternotomy & general anesthesia
	Mobile VAD ⇨ transportability
DISADVANTAGES	No LV unloading ⇨ ↑ pulmonary congestion
	↑ LV afterload
	Complications (leg ischemia, thromboembolism, infections)
	Limited duration of support
	Bleeding, hemolysis, ↓ platelet count
	No deambulation ⇨ limited rehabilitation
LIMITATIONS	Vessels quality/size (peripherally)
	Need for high-flow rate (60-80 ml/kg)
	Flow volume & afterload dependent

Long-distance bridging

Out-of-Udine

(days)	IABP	IMPELLA	ECMO	LVAD	Mech Vent	CVVH / Dyalisis	Distance (km)
G.B.	13	-	8	-	11	-	110
I.M.	3	-	5	-	3	-	130
E.C.	17	6	-	-	23	-	1100
A.E.	16	6	-	43	20	47	1100

In-Udine

(days)	Trans port	Mech Vent	IABP	IMPELLA	LVAD	CVVH / Dyalisis	Out come	F-U
G.B.		-	1	-	-	-	HTx	A/W
I.M.		20	1	-	75	35	HTx	A/W
E.C.	 	18	-	4 + 8	5	16	†	
A.E.	 	-	-	-	2	-	HTx	A/W

VADs

Peripheral

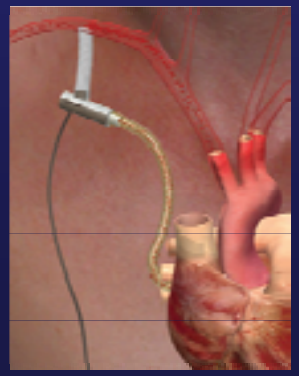
Femoral vein — TandemHeart

Femoral artery — Impella

Hybrid

LV apex →
Axillary/Femoral artery — Levitronix, Biomedicus, Maquet

LA →
Axillary artery — CircuLite



Percutaneous VADs (pVADs)

ADVANTAGES

- Immediate assistance, even during CPR
- No ECC & blood transfusions, no sternotomy & general anesthesia
- Partial LV unloading
- No risk for bleeding ⇨ high-risk, redo pts
- Potential for recovery or decision
- Simple to manage; easy weaning
- Less costly

DISADVANTAGES

- Limited flow (max 5.0 lt/min)
- Displacement pump risk; need for inotropes to sustain RV
- Complications (leg ischemia 25%; cannulation site bleeding 30%)
- Short duration of support (max 7 days ⇨ 14-20 days)
- Need for cath-lab for insertion
- Transportability ?

LIMITATIONS

- Small or diseased peripheral vessels
- Mechanical Ao prosthesis, calcified AS, moderate AR
- Advanced cardiogenic shock (Impella 2.5 LP)
- Small LV-EDV, children

Blood Pump Technology

Blood Pumps

Pulsatile

- Thoratec PVAD
- HeartMate XVE
- WorldHeart, Novacor
- Thoratec IVAD
- AbioMed, AB5000
- Berlin Heart EXCOR
- Medos HIA
- WorldHeart, HeartSaver

Rotary

Axial

- MicroMed DeBakey*
- Berlin Heart INCOR
- Jarvik 2000
- HeartMate II

Centrifugal

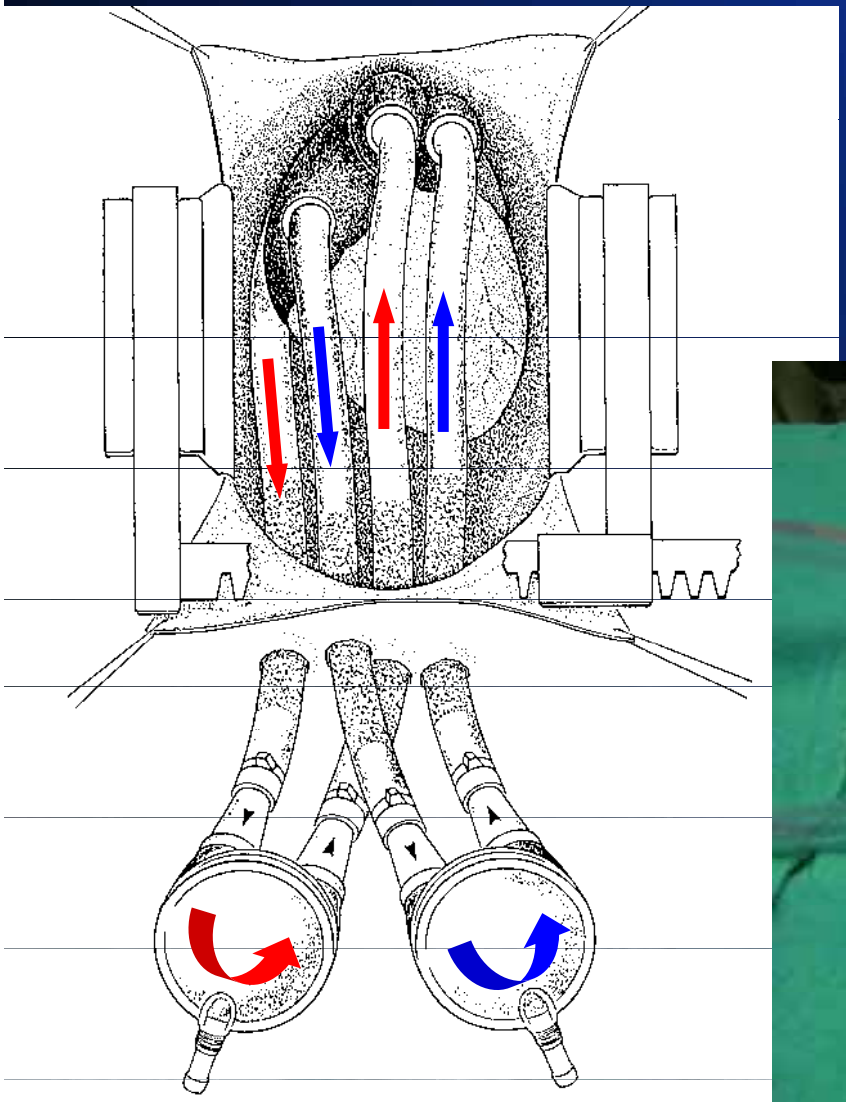
- VentraCor, VentrAssist
- HeartMate III
- Terumo, DuraHeart
- WorldHeart/MedQuest, HeartQues
- Arrow, CorAide

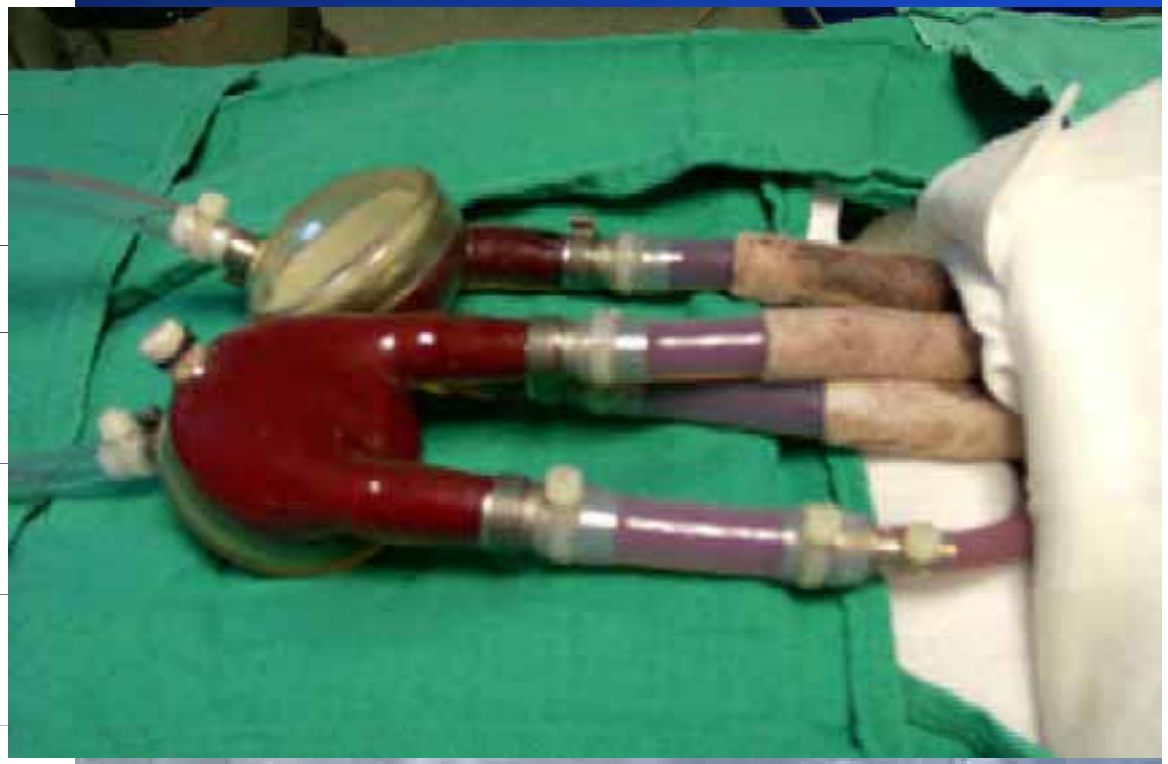
TAH

- CardioWest
- Abiomed, AbioC

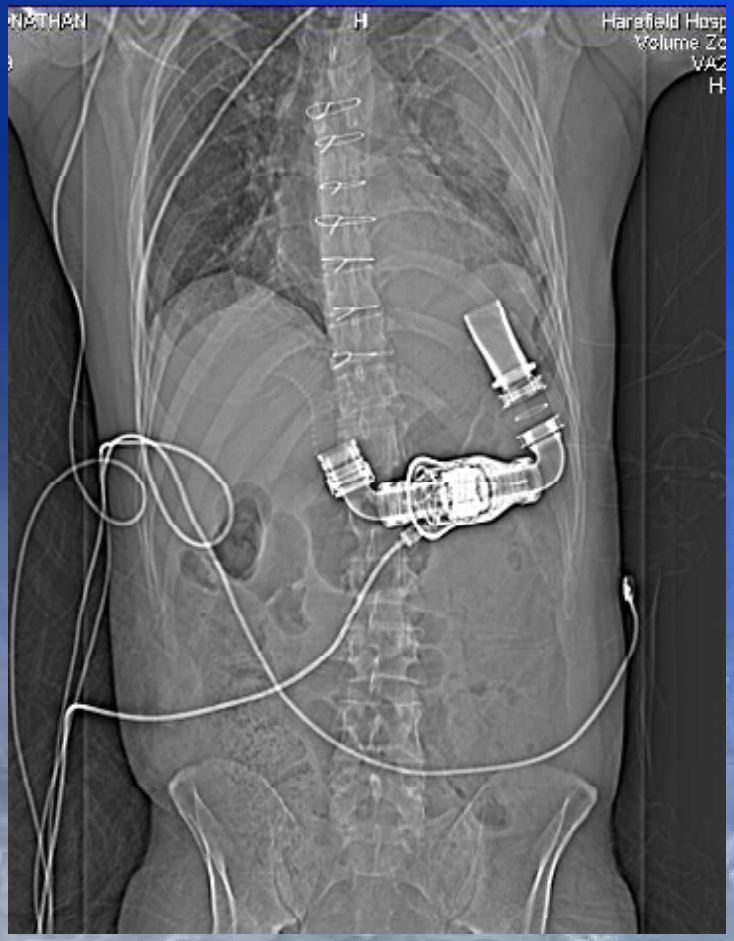
White font = FDA/CE
Orange font = CE Mark (* US clinical trial)
Green font = in clinical trials

Berlin Heart® EXCOR VAD

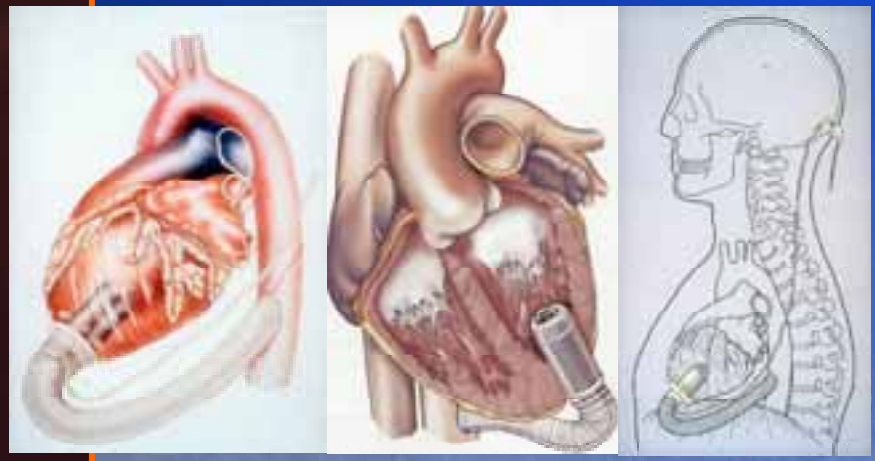




Thoratec HeartMate II



JARVIK 2000



VADs (LVAD, BVAD)

ADVANTAGES	LV unloading ⇨ prevent pulmonary edema ⇨ better for cardiac recovery
	Higher flow
	More efficacy to reverse profound shock
	Pulsatile flow
	Long-term support
	Pt mobilized / discharged home
DISADVANTAGES	Costs
	Longer time of assistance before weaning
	High risk of infection
	Need for general anesthesia, full sternotomy, ECC
	Thromboembolic / bleeding complications
	Need for OR and personnel facilities
LVADs *vs.* BVADs	Cannulation site (LV apex *vs.* LA roof)
	LV unloading
	RV function
	Organ function recovery

When a BiVAD may be preferred?

- Low PA pressure with poor RVEF
- Cardiogenic shock with end-organ dysfunction
- Giant cell myocarditis
- Re-transplant candidate
- Pulmonary edema despite max medical therapy
- Ischemic CM where surgery threatens RV

LVAD *vs.* BVAD

Echo predictors of good RV function after LV implant	Echo predictors of RV failure after LV implant
RV wall hypokinesia light or absent	RV wall akinesia
	++ or +++ TR
	RV-EDD >> LV-EDD
	RV-EDD > 85 mm
	RV-EDV > 200 ml
RV-RA pressure drop 30-50 mmHg	RV-RA pressure drop < 30 mmHg
RV-FAC > 20%	RV-FAC < 25%
TAPSE > 10 mm	TAPSE < 10 mm
RVOT fs% > 20%	RVOT fs% < 20%

Catena E et al J Cardiothorac Vasc Anesth. 2009; 23: 87-94

Fulminant myocarditis

Udine experience

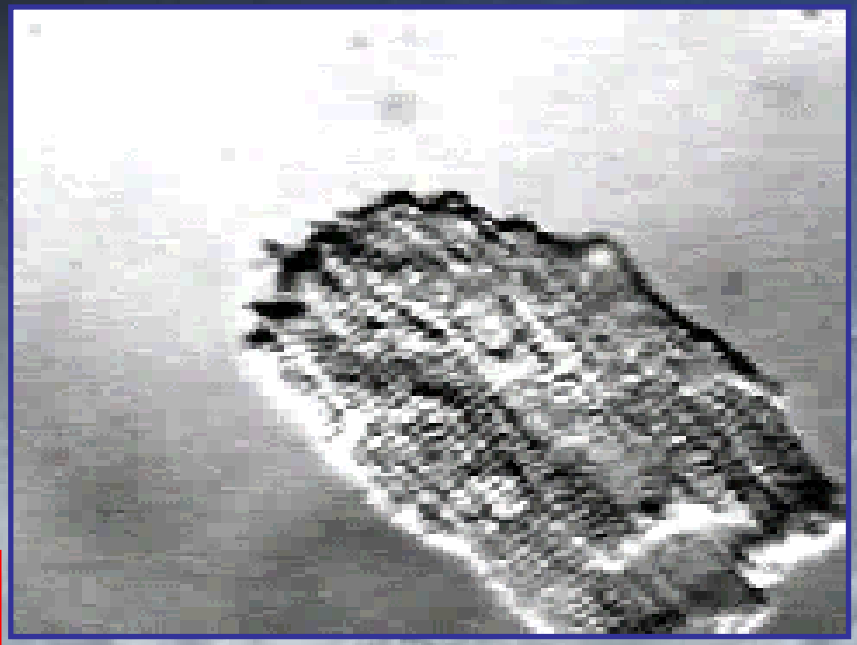
	ID	Age *(yrs)*	Sex	LVEF *(%)*	Treatment (MCS)		Duration *(days)*	Outcome	LVEF *(%)*	F-U *(mos.)*
1	T.B.	28	M	20	IABP	BVAD	28	HTx		120
2	M.A.	38	M	15	-	BVAD	15	Weaned	63	46
3	G.R.	52	M	15	ECMO + IABP	BVAD	16	Weaned	70	46
4	F.R	20	M	20	-	BVAD	12	Weaned	70	40
5	R.R.	66	M	10	IABP	ECMO	8	†		
6	G.G.	28	F	<10	-	ECMO	6	Weaned	65	11

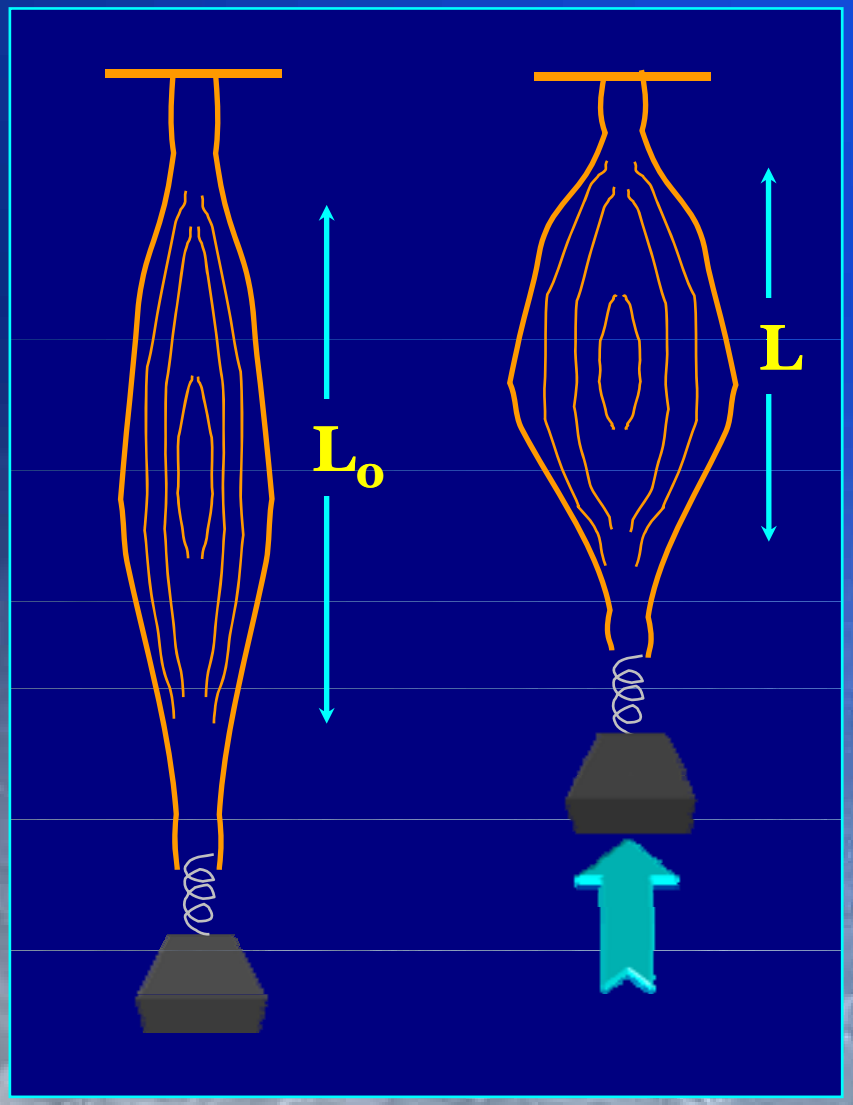
Myocardial Strain: What is It??

Strain: dimensionless index of change in length

$$\text{Strain } (\varepsilon) = (L - L_o) / L_o$$

LV strain may offer a pure index of regional LV function but is difficult to measure

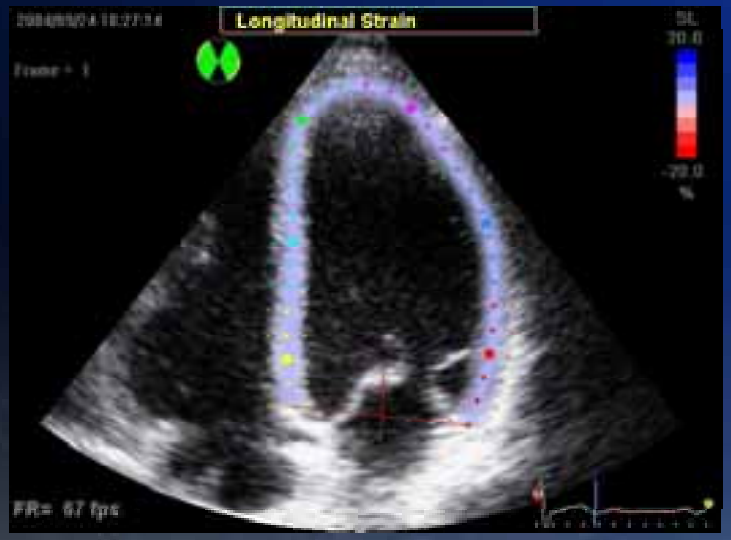


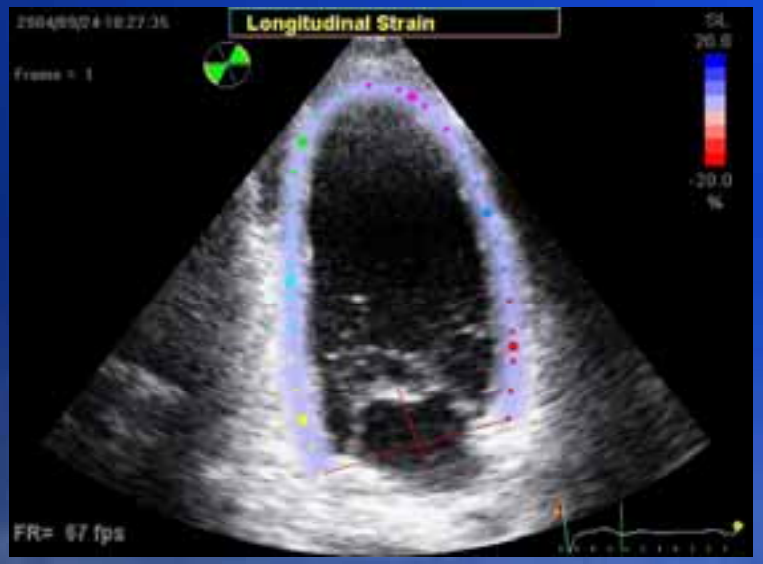


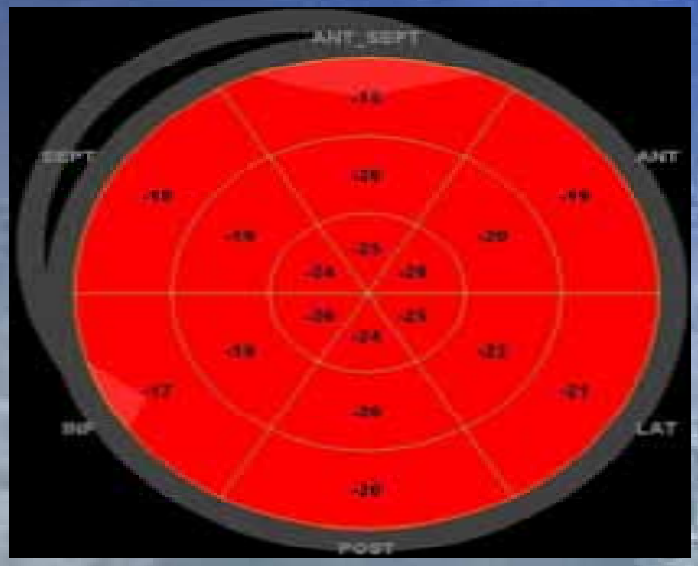
Courtesy by **JD Thomas, MD**

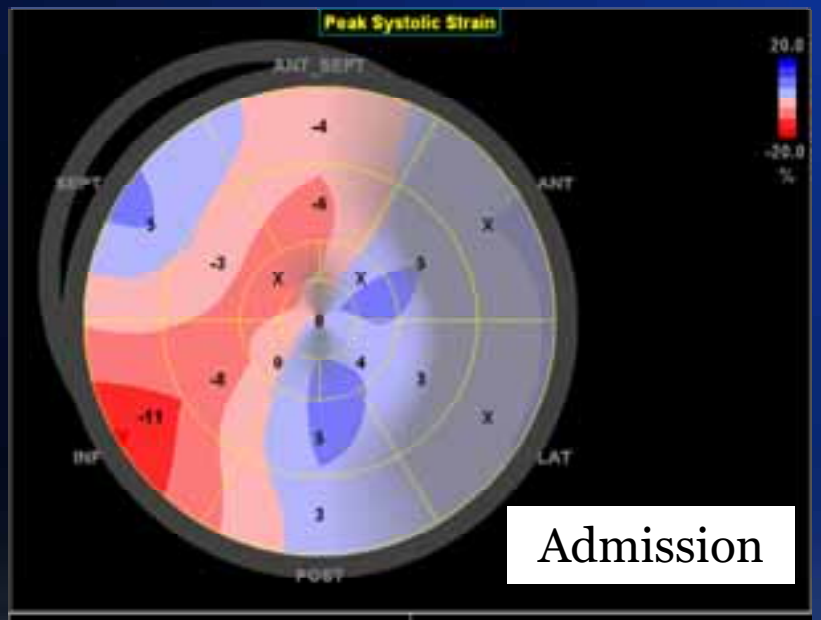
AUTOMATIC FUNCTION IMAGING

Quantitative Results in a Bull's Eye Display

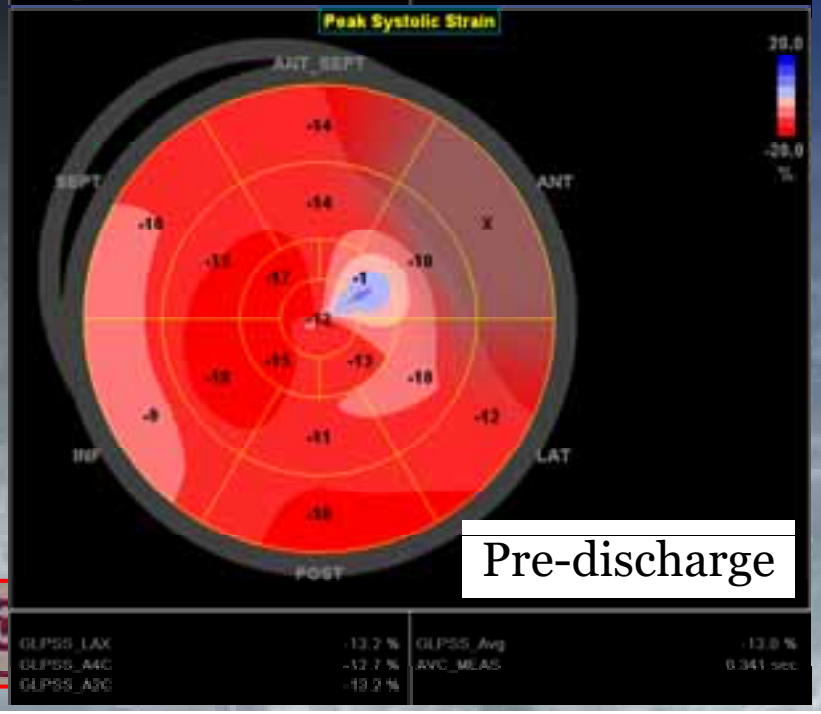




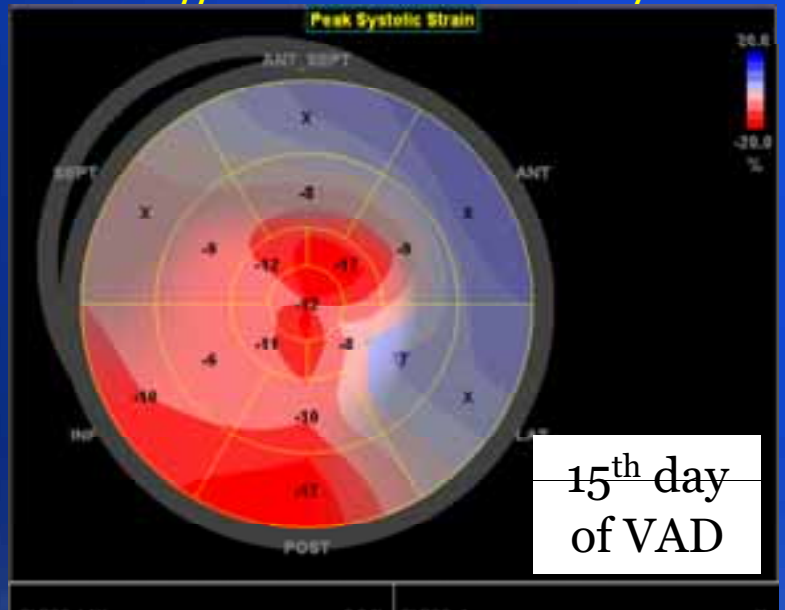




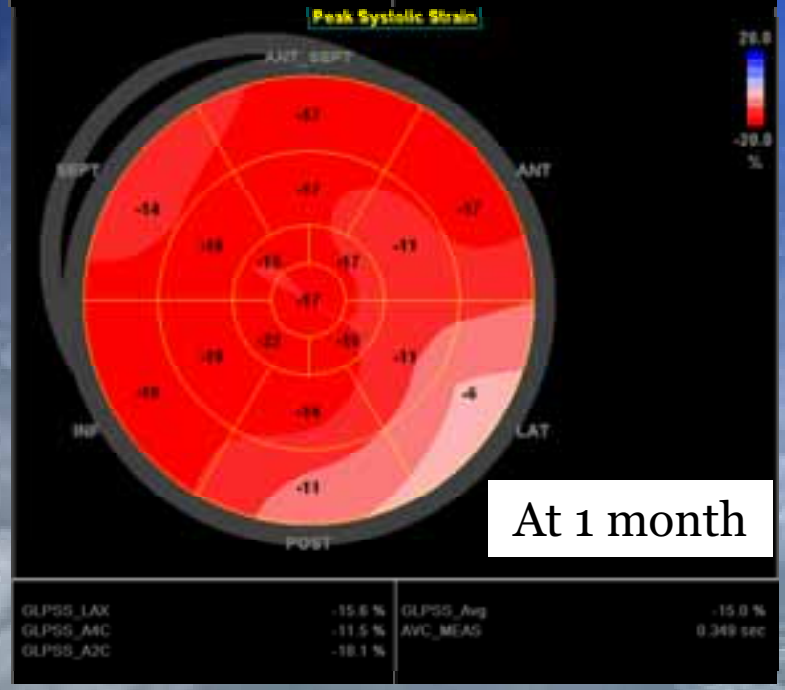
Admission



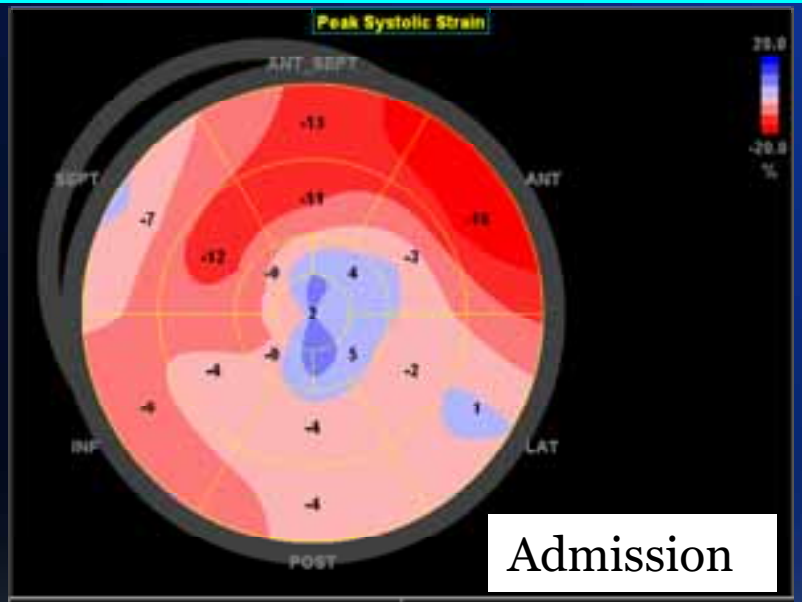
Pre-discharge



15th day of VAD



At 1 month



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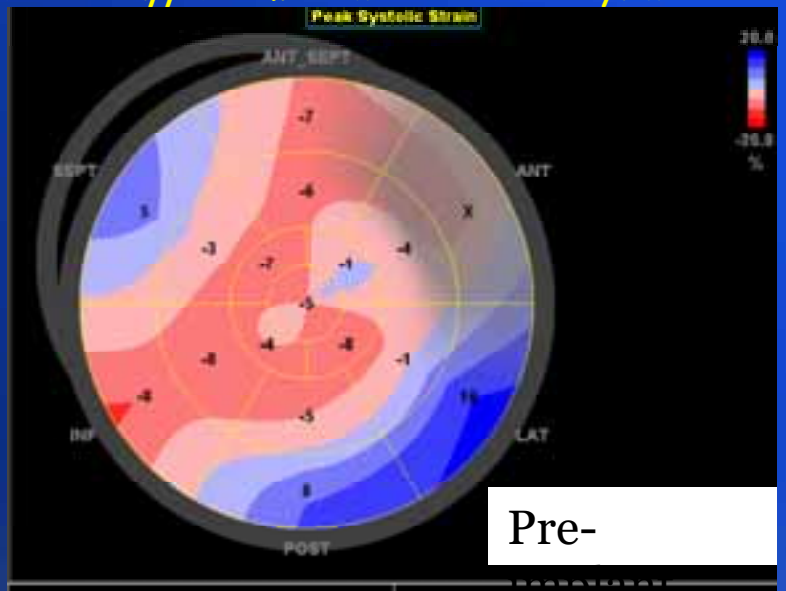
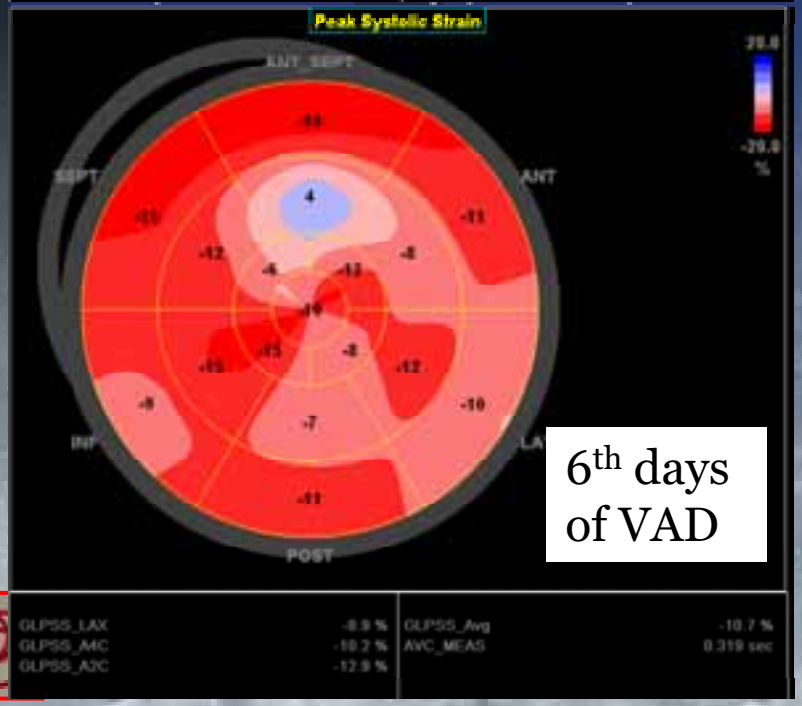
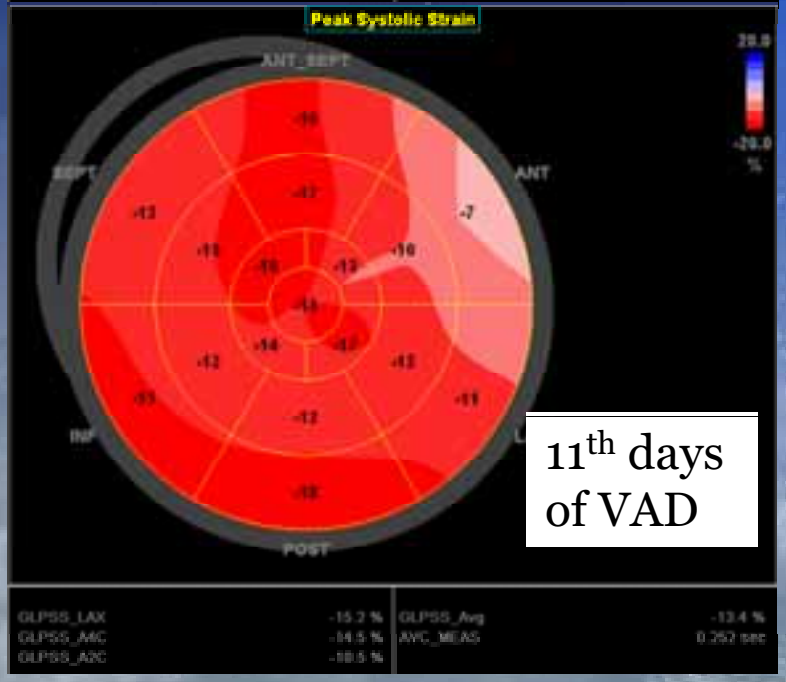


Pre-



6th days of VAD



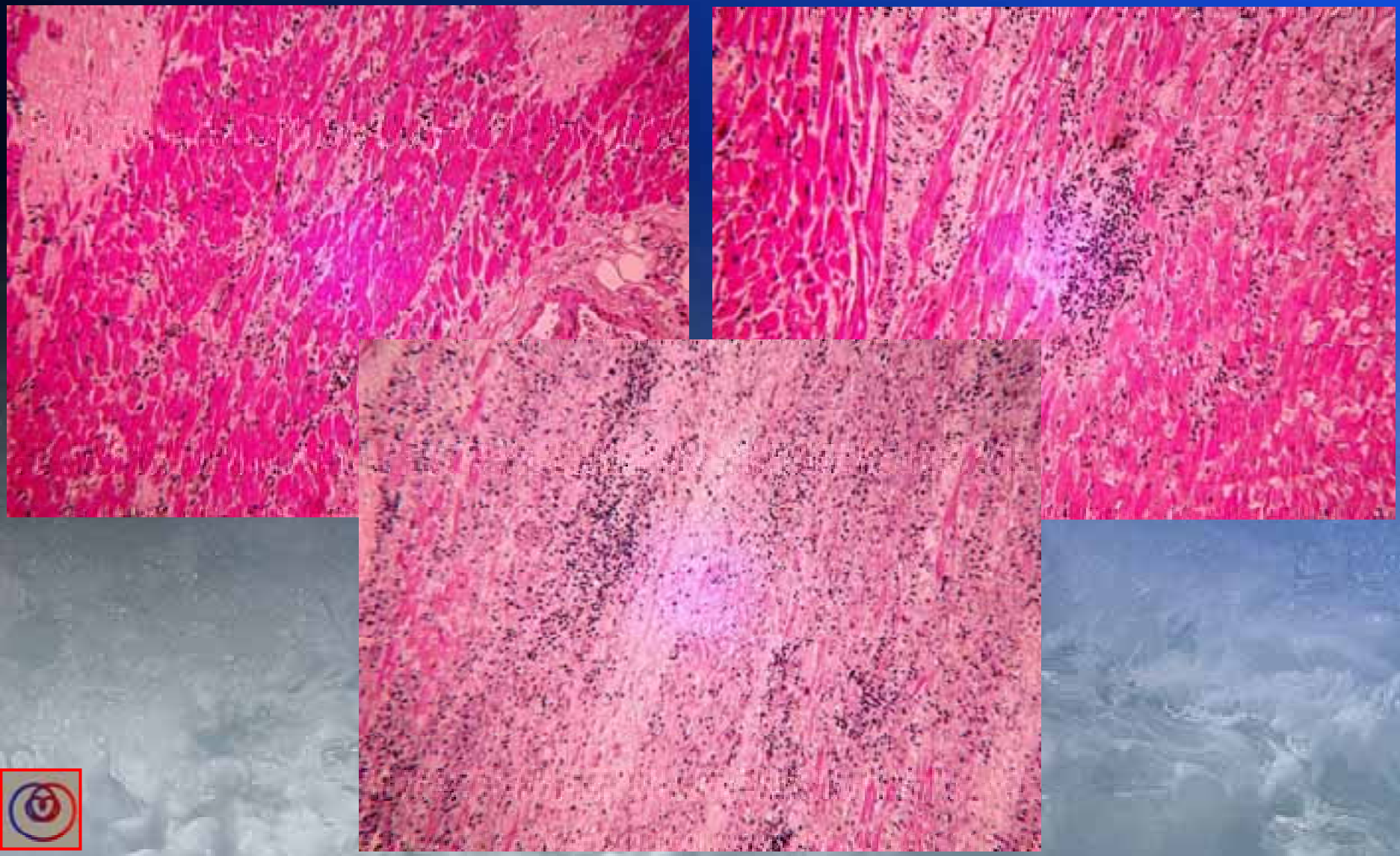
11th days of VAD

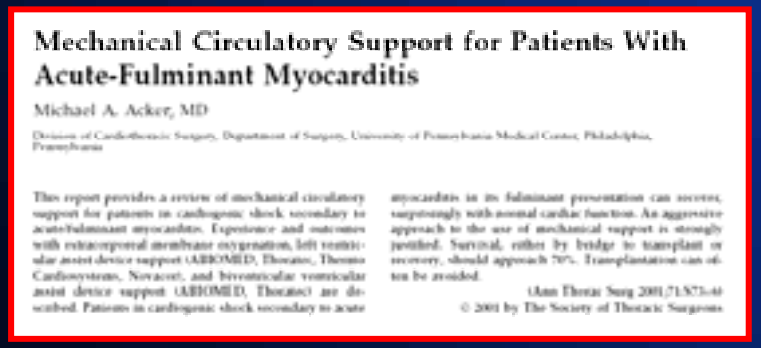
Predictability of Support Lenght

- by biopsy
- by clinical picture
- by echo
- by International experience

- by difference of device applied (ECMO *vs.* VAD)
- by difference for age (?) (children *vs.* adults)

Acute myocarditis:
is recovery always feasible?





Mechanical Circulatory Support for Patients With Acute-Fulminant Myocarditis

Michael A. Acker, MD

Division of Cardiothoracic Surgery, Department of Surgery, University of Pennsylvania Medical Center, Philadelphia, Pennsylvania

This report provides a review of mechanical circulatory support for patients in cardiogenic shock secondary to acute/fulminant myocarditis. Experience and outcomes with extracorporeal membrane oxygenation, left ventricular assist device support (ABIOMED, Thoratec, Thermo Cardiosystems, Novacor, and biventricular ventricular assist device support (ABIOMED, Thoratec) are described. Patients in cardiogenic shock secondary to acute myocarditis in its fulminant presentation can recover, surprisingly with normal cardiac function. An aggressive approach to the use of mechanical support is strongly justified. Survival, either by bridge to transplant or recovery, should approach 70%. Transplantation can often be avoided.

(Ann Thorac Surg 2001;71:S73-6)

Acker MA et al ***Ann Thorac Surg*** **2001; 71: S73 - 6**

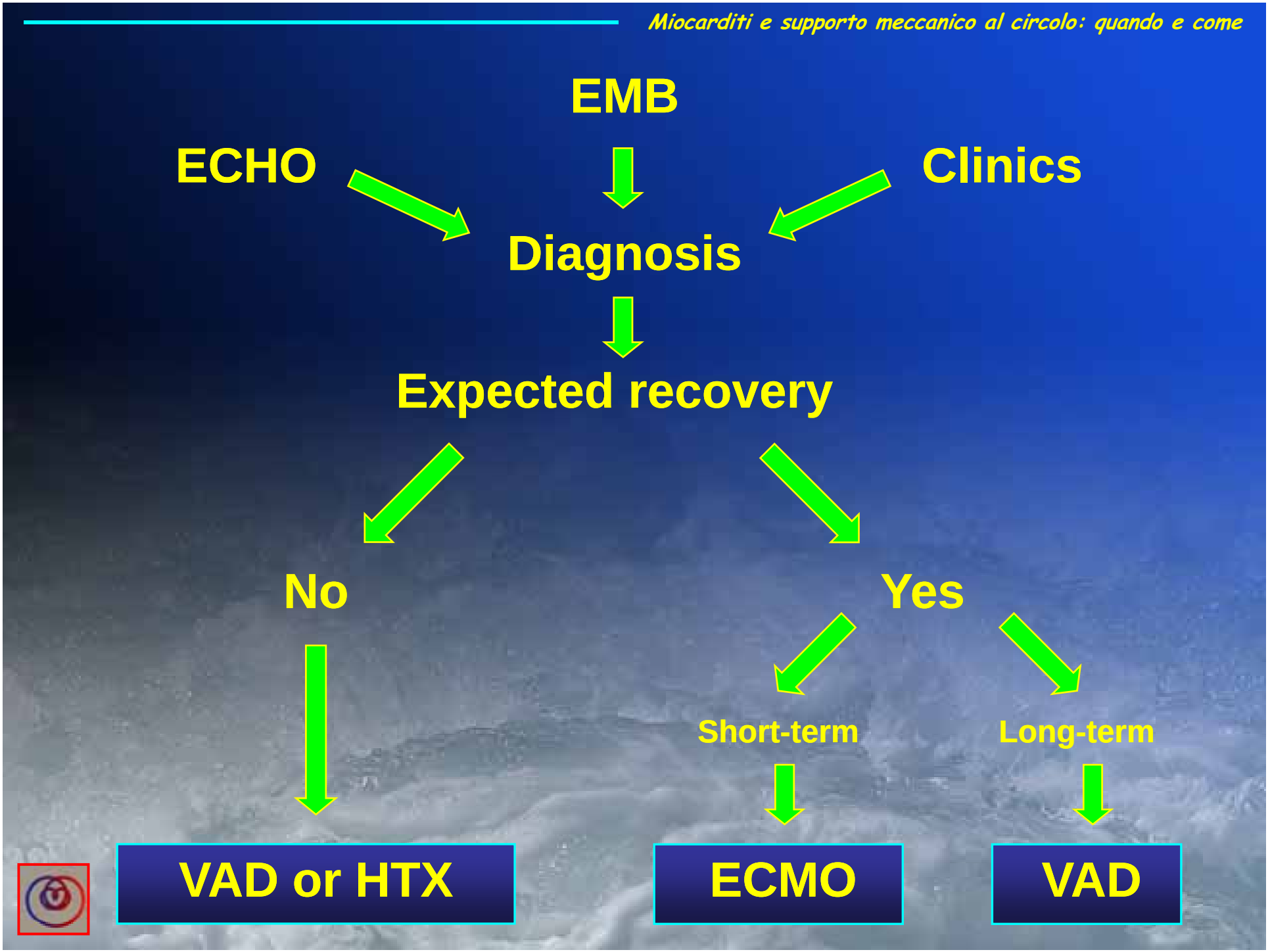
Mechanical Support for Acute Myocarditis and Cardiac Failure

Device	No. of Patients	Recovered Weaned	Recovered Discharged (% Weaned)	Transplants Transplanted	Transplants Discharged (% Transplanted)	Survival
ECMO	37	73% (27)	96% (26)	0	. . .	70% (26)
ABIOMED	32	56% (18)	67% (12)	19% (6)	83% (5)	53% (17)
Thoratec	40	40% (16)	88% (14)	45% (18)	94% (17)	78% (31)
TCI	17 (not including 6 ongoing)	12% (2)	. . .	35% (6)	. . .	47% (8)
Novacor	20	10% (2)	100% (2)	40% (8)	50% (4)	30% (6)

ECMO = extracorporeal membrane oxygenation; TCI = Thermo Cardiosystems.

	Year	Pts	Age *(yrs)*	VAD type	Duration *(days)*	Result	Outcome
1	1992	1	33	BVAD BVS 500 ABIOMED	8	Complete recovery	Weaned
2	1994	1	31	CENTRIMED + IABP	3	No recovery	Weaned
3	1996	1	30	BVAD MEDOS	17	Partial- Complete recovery	Weaned
4	1996	5	29 (15 – 55)	BIOMEDICUS, ECMO, THORATEC, ABIOMED	1 – 111	3 † 2 HTx	
5	1998	6	34	ECMO + IABP	8 ± 2.5 (1 – 16)	1 †	5 weaned *(83%)*
6	1998	4	1 – 6	BVAD Berlin Heart	11 – 21	1 HTx	3 weaned
7	1999	11	24 ± 10 (13 – 49)	4 LVAD, 7 BVAD BVS 5000 ABIOMED	1 – 62	2 † 2 HTx	7 weaned
8	1999	4	1 – 5	BVAD Berlin Heart	11 – 21	1 HTx	3 Weaned
9	1999	1	34	LVAD Thoratec	21	Complete recovery	Weaned
10	1999	5	15 ± 9 (6 – 29)	ECMO	6 ± 2.5	1 †	4 weaned
11	2000	1	14	ECMO	7	Complete recovery	weaned

	Year	Pts	Age *(yrs)*	VAD type	Duration *(days)*	Result	Outcome
1	2001	15	4.6 (1 d – 14)	12 ECMO, 2 LVAD 1 BVAD	6 (2 – 16)	6 HTx → 1 †	9 weaned → 2 †
2	2002	1	30	BVAD Thoratec	20	Complete recovery	Weaned
3	2002	1	12	BVAD Thoratec	68	Complete recovery	Weaned
4	2002	1	17	LVAD Thoratec	46	Complete recovery	Weaned
5	2004	1	29	LVAD HeartMate	100	Complete recovery	Weaned
6	2004	5	27 ± 6 (5 – 36)	BVAD MEDOS HIA-VAD	11 ± 6 (7 – 21)	Complete recovery	Weaned
7	2005	15	27 ± 19	ECMO	6 ± 3	1 †	14 *(93%)* weaned → 2 †
8	2006	7	5 – 66	ECMO	1 – 10	1 †	6 weaned
9	2006	5 (2 GCM)	19 – 61	LVAD HeartMate/Jarvik 2000	60	1 HTx 1 permanent 2 †	1 weaned
10	2006	3	28 – 41	Impella 5.0 (3x)	18	2 †	1 weaned
11	2007	4	14 – 57	ECMO	6 – 14	1 †	3 weaned
12	2007	4	n.d.	BVAD Levitronix	20 – 42	2 †	2 weaned
13	2007	2	38 / 63	TandemHeart	8 / 2		2 weaned
14	2008	1	16	LVAD Thoratec	96		weaned
15	2008	1	14	BVAD AB 5000	57		weaned
16	2008	1	26	ECMO	7		weaned
17	2009	1	25	ECMO	7		weaned
18	2009	1	44	ECMO → BVAD Levitronix → Thoratec	104		weaned
19	2009	1	0.66	ECMO → BVAD Excor	120		weaned
20	2009	5	32 ± 2	BVAD Thoratec	21 ± 5	1 HTx	4 weaned
21	2010	1	13	Impella 5.0	5		weaned


EMB
ECHO
Clinics
Diagnosis
Expected recovery
No
Yes
Short-term
Long-term
VAD or HTX
ECMO
VAD

The better targets …?

… for cardiac recovery	No touch the LV!
	Complete unloading & rest
	Normal coronary perfusion
	No arrhythmias
	Normal RV function
… for patient	Survival with normal cardiac function
	No complications
	Less invasive & thraumatic surgery
	No blood transfusions
… for physician	Successful procedure
	No repeated surgery
	Easy & simple to manage
	Respect cost / effective balance

MCS: Targets to recovery

Guarantee patient survival	⇨	**Time for decision**
Save organ integrity & function	⇨	**Prevention of complication**
Normalize hemodynamic parameters	⇨	**Optimization of tissue perfusion**
Preserve cardiac perfusion & metabolism	⇨	**Organ recovery**

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