RIGHT VENTRICULAR FAILURE AFTER LVAD IMPLANTATION

Matteo POZZI, MD, PhD

Department of Cardiac Surgery (Pr. Obadia)

“Louis Pradel” Cardiologic Hospital

Lyon - France

HeartMate 3 Training Course
Istituto Clinico Sant’Ambrogio - Milano
03/05/2019

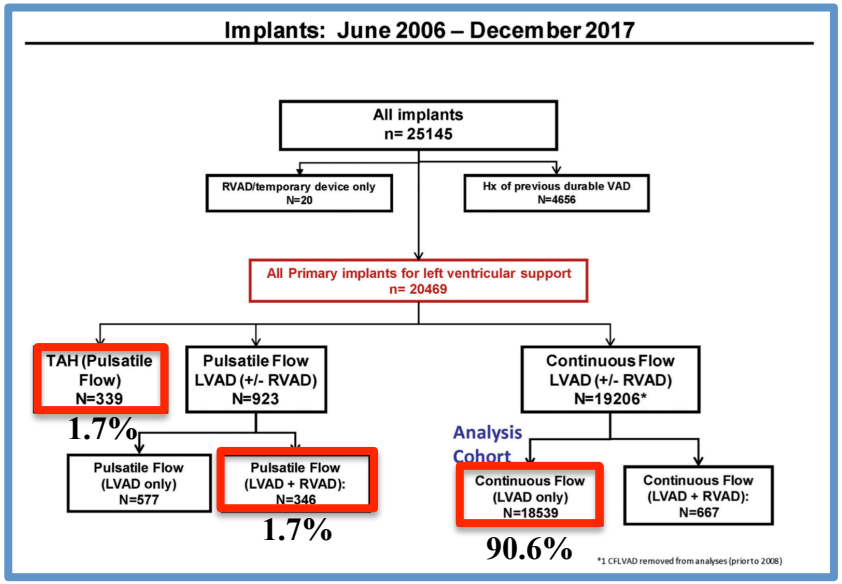
CONFLICT OF INTEREST DISCLOSURE

CONFLICT OF INTEREST TO DISCLOSE:

None

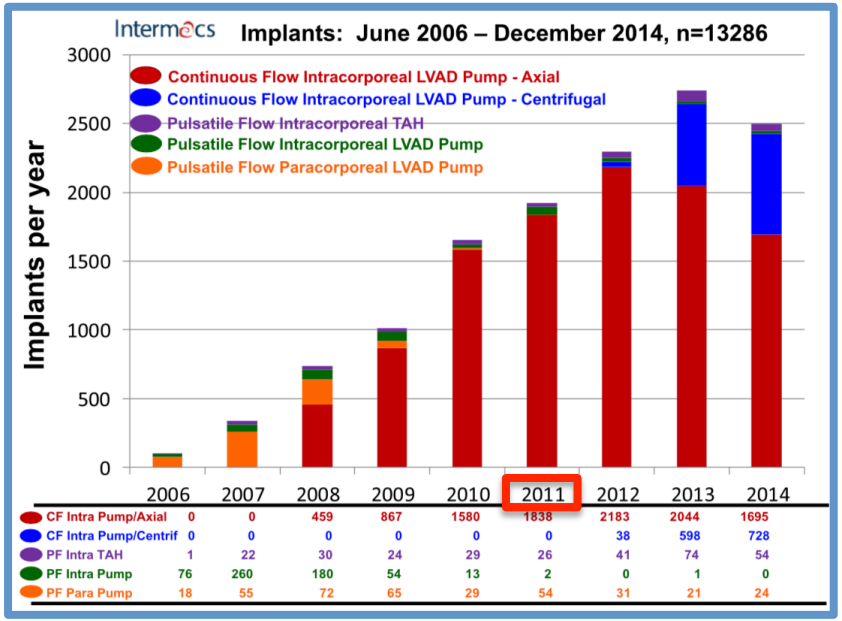
INTRODUCTION

Intermacs



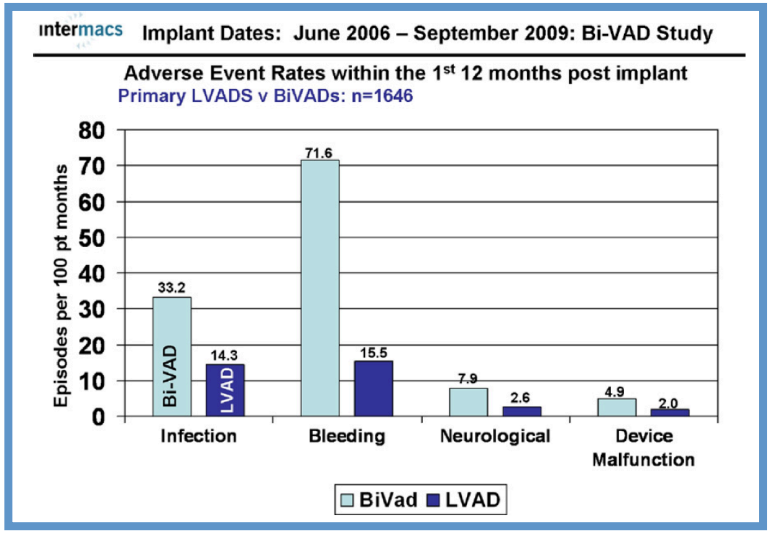
Ann Thorac Surg 2019;107:341-354

J Heart Lung Transplant 2015;34:1495-504



INTRODUCTION

Intermacs

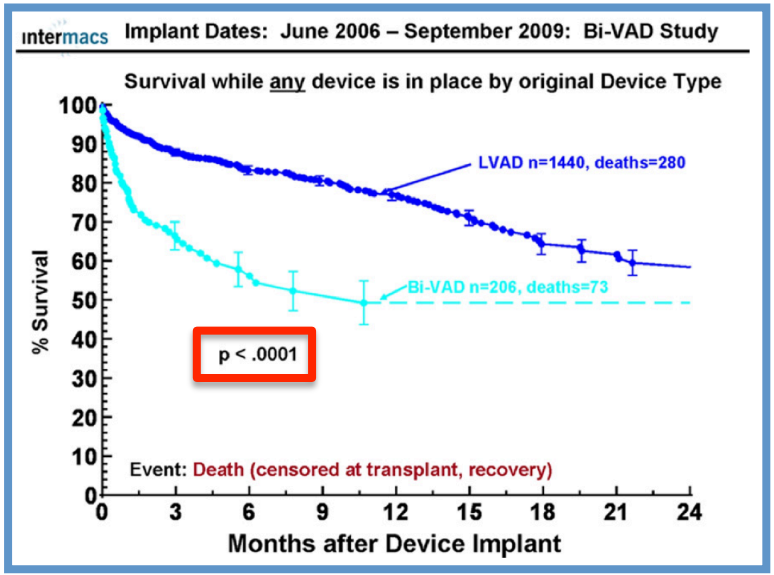


J Heart Lung Transplant 2011;30:862-869

Clinical data have shown that **BiVAD** patients

- are **more severe** in the preoperative period
- experience **more postoperative complications**
- have a **worse survival**

as compared to **LVAD** patients



RVF AFTER LVAD IMPLANTATION

Definition

Right Heart Failure:

Definition: Symptoms or findings of persistent right ventricular failure characterized by **both** of the following:

- Documentation of elevated central venous pressure (CVP) by:
  - Direct measurement (e.g., right heart catheterization) with evidence of a central venous pressure (CVP) or right atrial pressure (RAP) > 16 mmHg.
    or
  - Findings of significantly dilated inferior vena cava with absence of inspiratory variation by echocardiography,
    or
  - Clinical findings of elevated jugular venous distension at least half way up the neck in an upright patient.

- Manifestations of elevated central venous pressure characterized by:
  - Clinical findings of peripheral edema (≥2+ either new or unresolved),
    or
  - Presence of ascites or palpable hepatomegaly on physical examination (unmistakable abdominal contour) or by diagnostic imaging,
    or
  - Laboratory evidence of worsening hepatic (total bilirubin > 2.0 mg/dl) or renal dysfunction (creatinine > 2.0 mg/dl).

RVF AFTER LVAD IMPLANTATION

Severity grade

Mild Right Heart Failure

VAD Implant Admission

Patient meets both criteria for RHF plus:

- Post-implant inotropes, inhaled nitric oxide or intravenous vasodilators not continued beyond post-op day 7 following VAD implant

AND

- No inotropes continued beyond post-op day 7 following VAD implant

Moderate Right Heart Failure

VAD Implant Admission

Patient meets both criteria for RHF plus:

- Post-implant inotropes, inhaled nitric oxide or intravenous vasodilators continued beyond post-op day 7 and up to post-op day 14 following VAD implant

Severe Right Heart Failure

VAD Implant Admission

Patient meets both criteria for RHF plus:

- Central venous pressure or right atrial pressure greater than 16mm Hg

AND

- Prolonged post-implant inotropes, inhaled nitric oxide or intravenous vasodilators continued beyond post-op day 14 following VAD implant

Severe-Acute Right Heart Failure

VAD Implant Admission

Patient meets both criteria for Right Heart Failure plus:

- Central venous pressure or right atrial pressure greater than 16 mmHg

AND

- Need for right ventricular assist device at any time following VAD implant

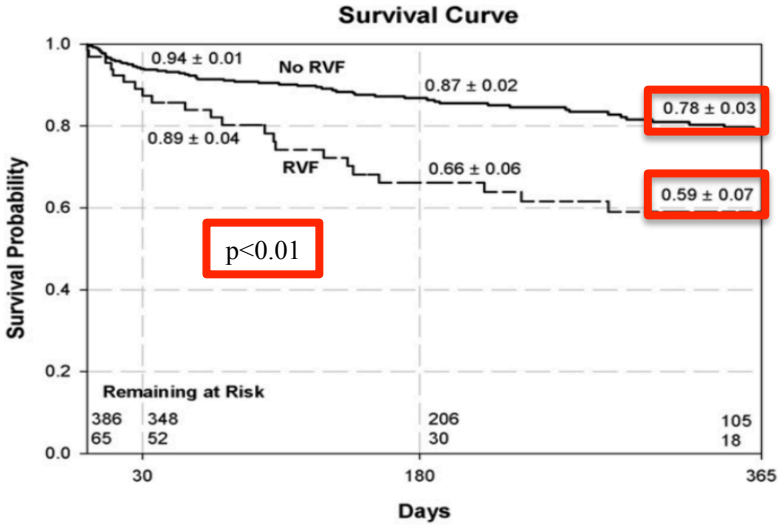
OR

- Death during the VAD implants hospitalization with RHF as the primary cause.

RVF AFTER LVAD IMPLANTATION

Clinical implications

Right ventricular failure in patients with the HeartMate II continuous-flow left ventricular assist device: Incidence, risk factors, and effect on outcomes



J Thorac Cardiovasc Surg 2010;139:1316-24

J Heart Lung Transplant 2015;34:1495-504

Risk factors for death	Early hazard ratio	*p*-value
Demographics		
Age (older)	1.03	<0.0001
Female	1.32	<0.0001
BMI (higher)	1.10	<0.0001
Blood type not O		
Clinical status		
History of stroke	1.33	0.03
Ventilator	1.25	0.02
ICD	1.30	0.0001
INTERMACS Level 1	1.55	<0.0001
INTERMACS Level 2	1.37	<0.0001
NYHA Class IV		
Destination therapy	1.23	<0.0001
Non-Cardiac Systems		
Albumin (lower)	1.14	0.0007
Creatinine (higher)	1.06	0.04
Dialysis	2.34	<0.0001
BUN (higher)	1.05	<0.0001
Right heart dysfunction		
Right atrial pressure (higher)	1.13	0.0004
RVAD in same operation	2.57	<0.0001
Bilirubin (higher)	1.48	<0.0001
Surgical complexities		
History of cardiac surgery	1.24	0.003
History of CABG	1.17	0.04
Concomitant cardiac surgery	1.26	<0.0001

Seventh INTERMACS annual report: 15,000 patients and counting

RVF AFTER LVAD IMPLANTATION

Challenging issue

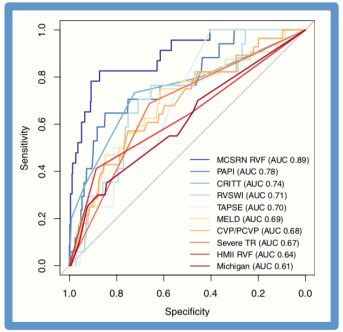
Complex physiopathology

Multifactorial etiology

Several predictive score

Mechanical Circulatory Support Research Network (MCSRN)

Artif Organs 2018 [Epub ahead of print]



TEMPORARY RVAD AFTER LVAD IMPLANTATION

Rationale

Clinical consequences of RVF on LVAD outcomes

+

Difficult prediction of RVF after LVAD implantation

=

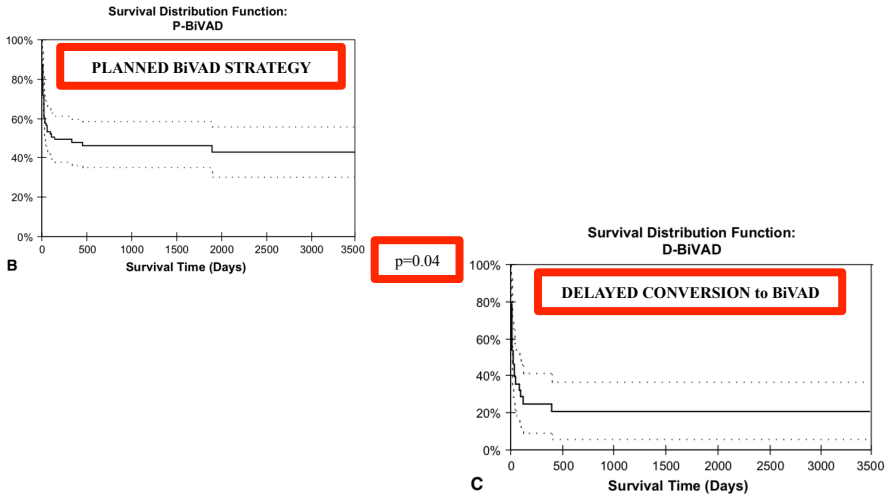
Liberal use of tRVAD after LVAD implantation

TEMPORARY RVAD AFTER LVAD IMPLANTATION

1

Rationale

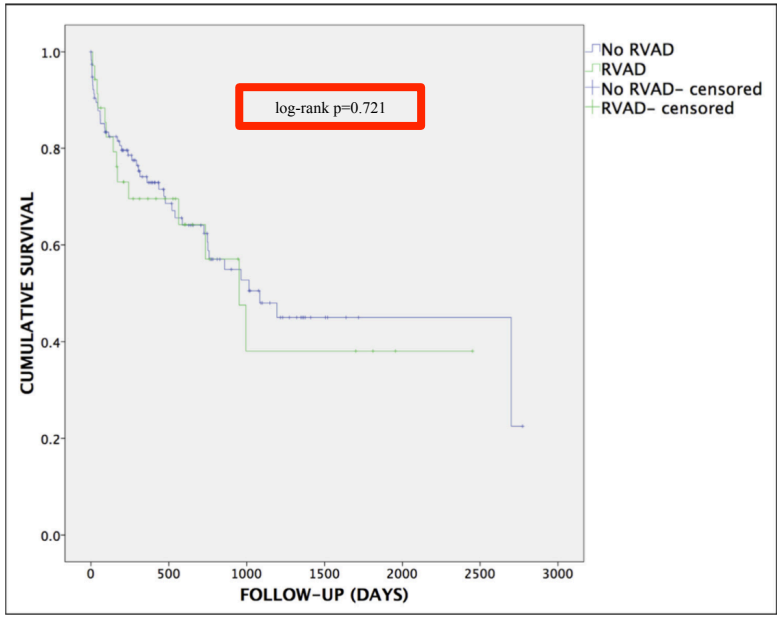
Early planned institution of biventricular mechanical circulatory support results in improved outcomes compared with delayed conversion of a left ventricular assist device to a biventricular assist device



J Thorac Cardiovasc Surg 2009;137:971-7

J Heart Lung Transplant 2014;33:141-8

J Thorac Cardiovasc Surg 2015;150:1651-8

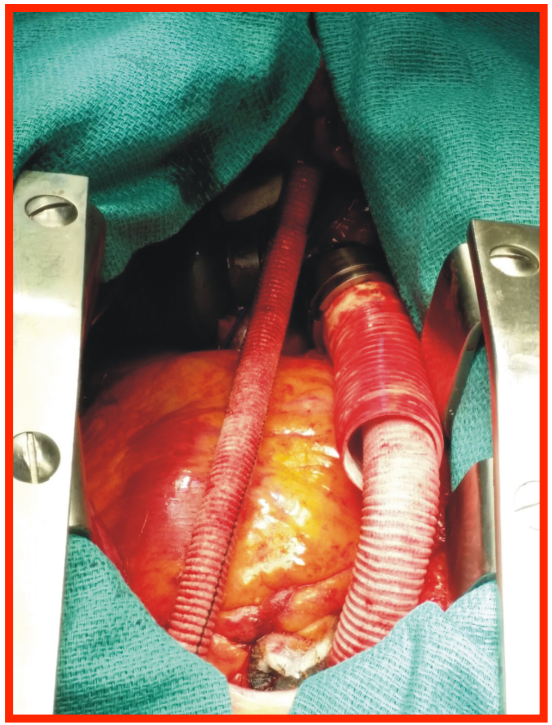


Preoperative predictors and outcomes of right ventricular assist device implantation after continuous-flow left ventricular assist device implantation

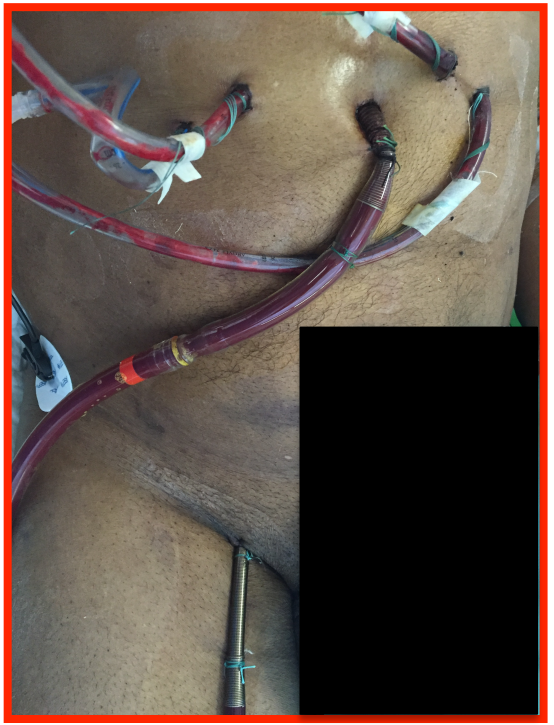
2

TEMPORARY RVAD AFTER LVAD IMPLANTATION

Surgical technique



Heart Lung Circ 2012;21:218-220
Eur J Cardiothorac Surg 2012;41:219-223
Heart Surg Forum 2013;16:E152-4



TEMPORARY RVAD AFTER LVAD IMPLANTATION

Surgical technique

ADVANTAGES

Technically simple

No sternal re-opening for decannulation

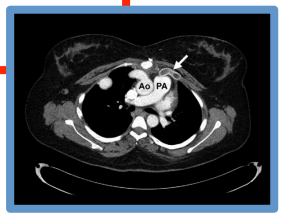
Physiological transpulmonary flow

Reasonable cost

DRAWBACKS

Infection of the Dacron graft

Pulmonary embolism



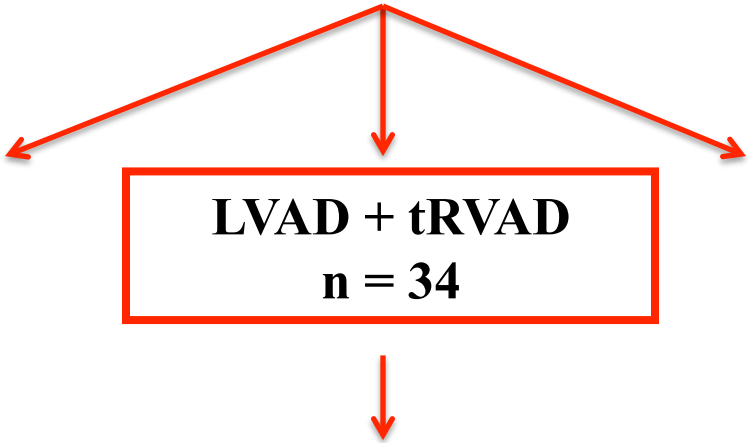
J Heart Lung Transplant 2012;31:672-3

TEMPORARY RVAD AFTER LVAD IMPLANTATION

Patient population

01/01/2010 – 03/05/2019

98 Long-term MCS



TAPSE < 16 mm and/or S' < 10 cm/s

BTB strategy

Destination Therapy

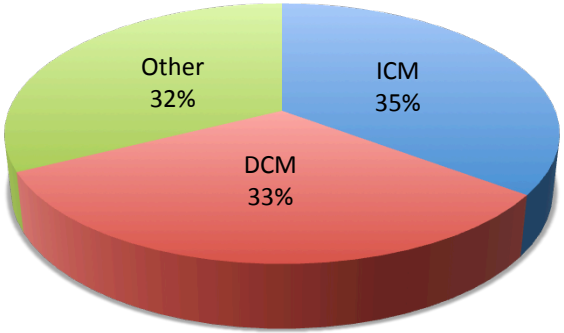
TEMPORARY RVAD AFTER LVAD IMPLANTATION

Patient population

34 patients

Mean age: 54.1 ± 12.9 (24 - 71) years

28 M (82.4%) / 6 F (17.6%)



INTERMACS Profile

2	35.2% (n=12)
3	32.4% (n=11)
4	32.4% (n=11)

Device Strategy

BTT	44.1%	(n=15)
BTC	29.4%	(n=10)
DT	26.5%	(n=9)

TEMPORARY RVAD AFTER LVAD IMPLANTATION

Patient population

INTERMACS Profile

2 35.2% (n=12)
3 32.4% (n=11)
4 32.4% (n=11)

Intermacs

Intermacs patient profile, %

Level 1	14.3
Level 2	36.5
Level 3	32.8
Level 4	12.9
Level 5	2.2
Level 6	0.86
Level 7	0.39

Ann Thorac Surg 2019;107:341-354

euromacs
European Registry for Patients with Mechanical Circulatory Support e.V.

INTERMACS patient profile	*n* (%)
Level 1: Critical cardiogenic shock	424 (14)
Level 2: Progressive decline	896 (30)
Level 3: Stable but inotrope dependent	733 (25)
Level 4: Resting symptoms	472 (16)
Level 5: Exertion intolerant	104 (4)
Level 6: Exertion limited	49 (2)
Level 7: Advanced NYHA Class 3	43 (1)
Unknown	226 (8)
Total	2947

Eur J Cardiothorac Surg 2017 [Epub ahead of print]

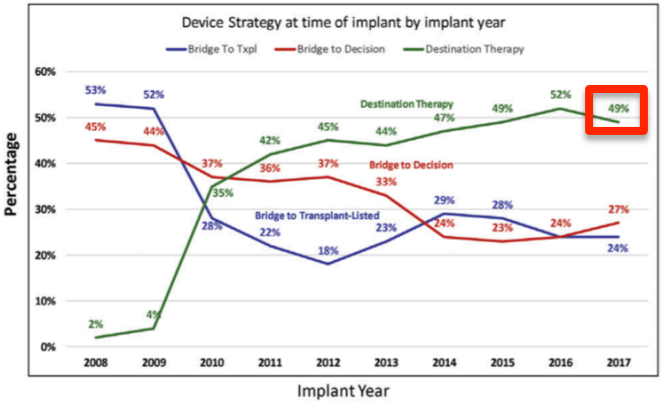
TEMPORARY RVAD AFTER LVAD IMPLANTATION

Patient population

Device Strategy

BTT	**44.1%**	**(n=15)**
BTC	**29.4%**	**(n=10)**
DT	**26.5%**	**(n=9)**

Intermacs



Ann Thorac Surg 2019;107:341-354

euromacs
European Registry for Patients with Mechanical Circulatory Support e.V.

Bridge to recovery	57 (2)
Bridge to candidacy	1052 (36)
Bridge to transplant	813 (28)
Destination therapy	458 (16)
Rescue therapy	210 (7)
Other	11 (0)
Unknown	346 (12)
Total	2947

Eur J Cardiothorac Surg 2017 [Epub ahead of print]

TEMPORARY RVAD AFTER LVAD IMPLANTATION

Baseline characteristics

ECHOCARDIOGRAPHY

LVEF	21.1 ± 6.9%
TAPSE	15.1 ± 3.0 mm
S'	9.3 ± 1.9 cm/s

RV Systolic Dysfunction 47.1%

RIGHT HEART CATHETERIZATION

CVP	8.8 ± 5.4 mmHg	IC	1.9 ± 0.4 l/min/m^2
mPAP	34.5 ± 13.0 mmHg	Wedge	22.7 ± 8.4 mmHg
	PVR	305.3 ± 207.5 dynes*s*cm^{-5}	

Inotropes	67.6% (n=23)	IABP	20.6% (n=7)	ECLS	26.5% (n=9)

TEMPORARY RVAD AFTER LVAD IMPLANTATION

Outcomes

34 LVAD + tRVAD

Death on LVAD + tRVAD
n=8 (23.5%)

4 MOF / 3 Intestinal ischemia / 1 Hemorrhagic stroke
5 Destination therapy

Surgical re-exploration for bleeding
n=8 (23.5%)

Extubation on LVAD + tRVAD
n=17 (50%)

tRVAD WEANING
n=26 (76.5%)
6.1 ± 2.7 (2 - 14) days

Death after weaning
n=4 (4.3%)

2 MOF
2 Septic (DSWI / Pneumonia)

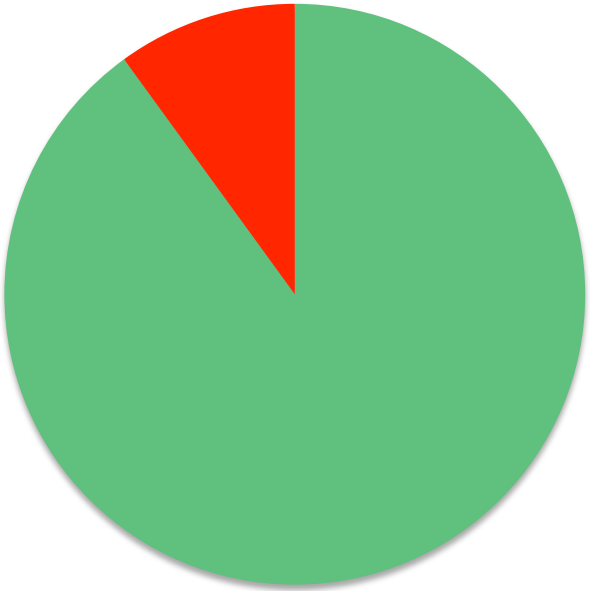
IN-HOSPITAL SURVIVAL
n=22 (64.7%)

TEMPORARY RVAD AFTER LVAD IMPLANTATION

Outcomes

2018 → 10 LVAD

1 Jarvik 2000



9 HM3

Mean age: 49.7 ± 9.3 years
8 M / 2 F
6 FV-PA ECMO

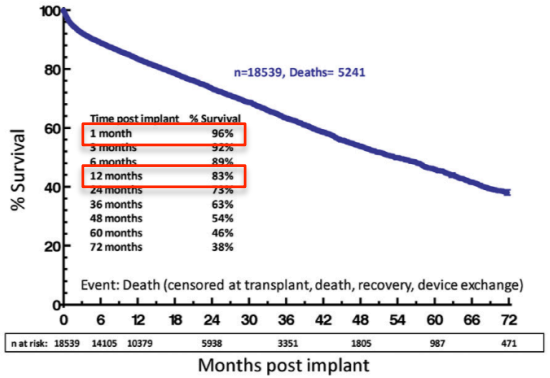
IN-HOSPITAL SURVIVAL

80%

TEMPORARY RVAD AFTER LVAD IMPLANTATION

Outcomes

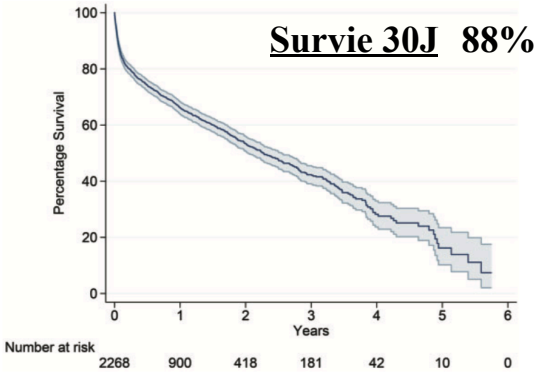
Intermacs



J Heart Lung Transplant 2019;38:114-126

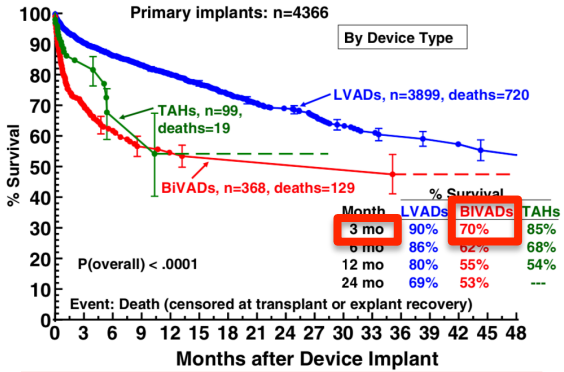
euromacs
European Registry for Patients with Mechanical Circulatory Support e.V.

Survie 30J 88%



Eur J Cardiothorac Surg 2017 [Epub ahead of print]

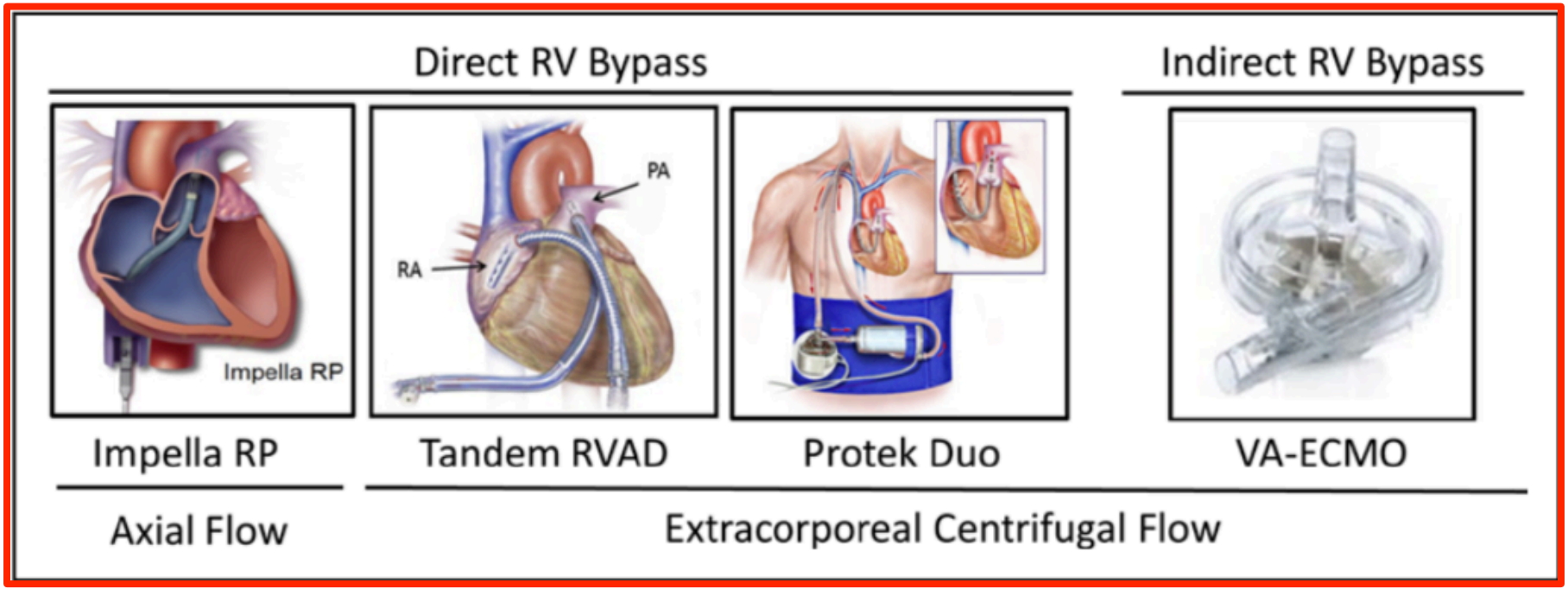
Intermacs



J Heart Lung Transplant 2012;31:117-26

TEMPORARY RVAD AFTER LVAD IMPLANTATION

Other techniques



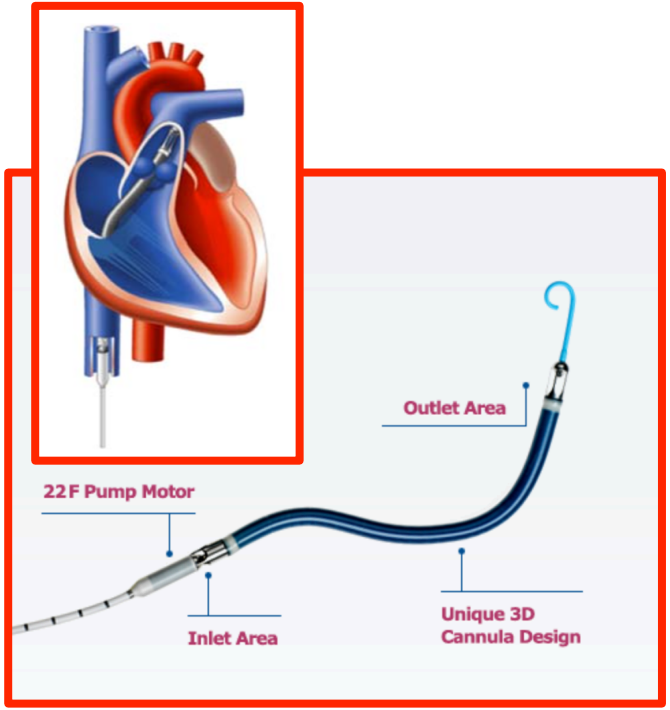
Kapur et al.

Circulation 2017;136:314-26

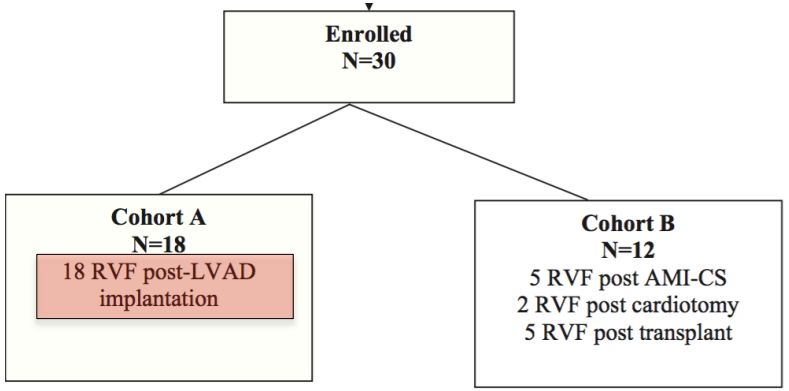
TEMPORARY RVAD AFTER LVAD IMPLANTATION

Other techniques

IMPELLA RP



Benefits of a novel percutaneous ventricular assist device for right heart failure: The prospective RECOVER RIGHT study of the Impella RP device



Cohort A (n = 18) % (No.)	Cohort B (n = 12) % (No.)	p-value
83.3 (15)	58.3 (7)	0.129
77.8 (14)	58.3 (7)	0.255
83.3 (15)	58.3 (7)	0.129
77.8 (14)	58.3 (7)	0.255

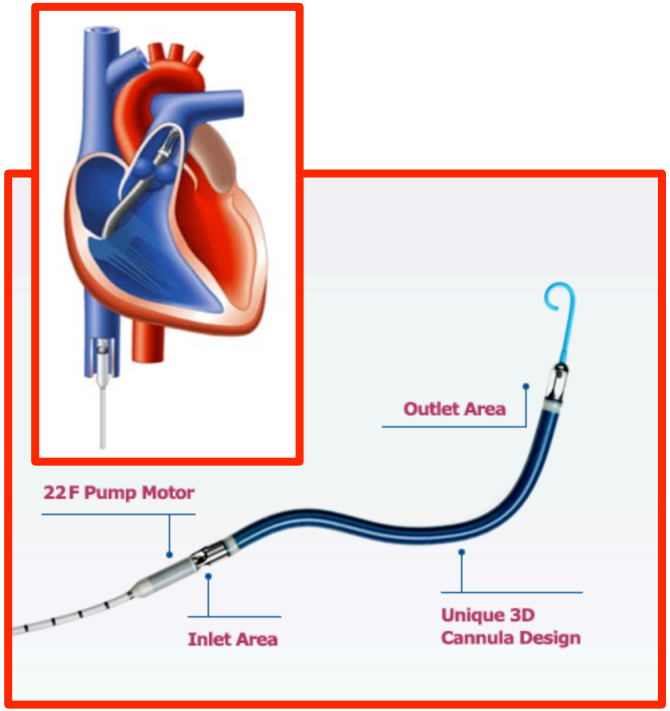
Anderson et al.

J Heart Lung Transplant 2015;34:1549-60

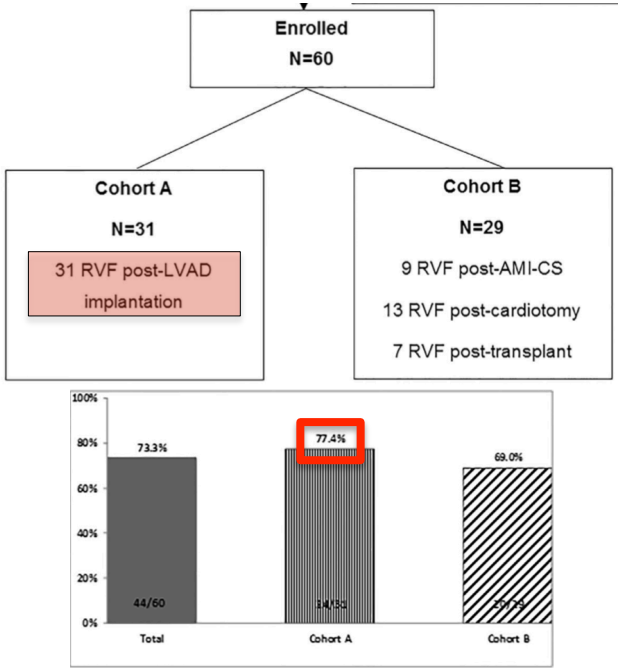
TEMPORARY RVAD AFTER LVAD IMPLANTATION

Other techniques

IMPELLA RP



Outcomes of patients with right ventricular failure requiring short-term hemodynamic support with the Impella RP device



Anderson et al.

J Heart Lung Transplant 2018;37:1448-58

CONCLUSIONS

A modified femoro-pulmonary tRVAD strategy shows encouraging results in the management of right ventricular failure after LVAD implantation

The survival rate was acceptable and the complication' rate was better as compared to BiVAD patients

The absence of a control group supported with another type of short-term right MCS limits the interpretation of our results

The ease of implantation, management in ICU and decannulation should probably expand the indications of tRVAD in LVAD patients