Cas cliniques en Cardiologie du sport et en réadaptation

Réadaptation avec LVAD

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Conflict of interest

None

CHLO’s Cardiac Rehab Unit 6th anniversary (2022)

2016 -

ESC HEART FAILURE
ESC Heart Failure 2021; **8**: 4394–4408
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ESC AND HFA PAPER

HFA of the ESC Position paper on the management of LVAD supported patients for the non LVAD specialist healthcare provider Part 1: Introduction and at the non-hospital settings in the community

Binyamin Ben Avraham[1], Marisa Generosa Crespo-Leiro[2], Gerasimos Filippatos[3,4], Israel Gotsman[5], Petar Seferovic[6], Tal Hasin[7], Luciano Potena[8], Davor Milicic[9], Andrew J.S. Coats[10], Giuseppe Rosano[11], Frank Ruschitzka[12], Marco Metra[13], Stefan Anker[14], Johann Altenberger[15], Stamatis Adamopoulos[16], Yaron D. Barac[17], Ovidiu Chioncel[18], Nicolaas De Jonge[19], Jeremy Elliston[20], Maria Frigeiro[21], Eva Goncalvesova[22], Avishay Grupper[23,24], Righab Hamdan[25], Yoav Hammer[1], Loreena Hill[26], Osnat Itzhaki Ben Zadok[1], Miriam Abuhazira[17], Jacob Lavee[24,27], Wilfried Mullens[28], Sanemn Nalbantgil[29], Massimo F. Piepoli[30], Piotr Ponikowski[31], Arsen Ristic[32], Arjang Ruhparwar[33], Aviv Shaul[1], Laurens F. Tops[34], Steven Tsui[35], Stephan Winnik[36,37], Tiny Jaarsma[38], Finn Gustafsson[39] and Tuvia Ben Gal[1]*

HM-3

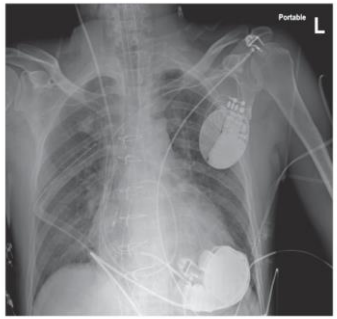
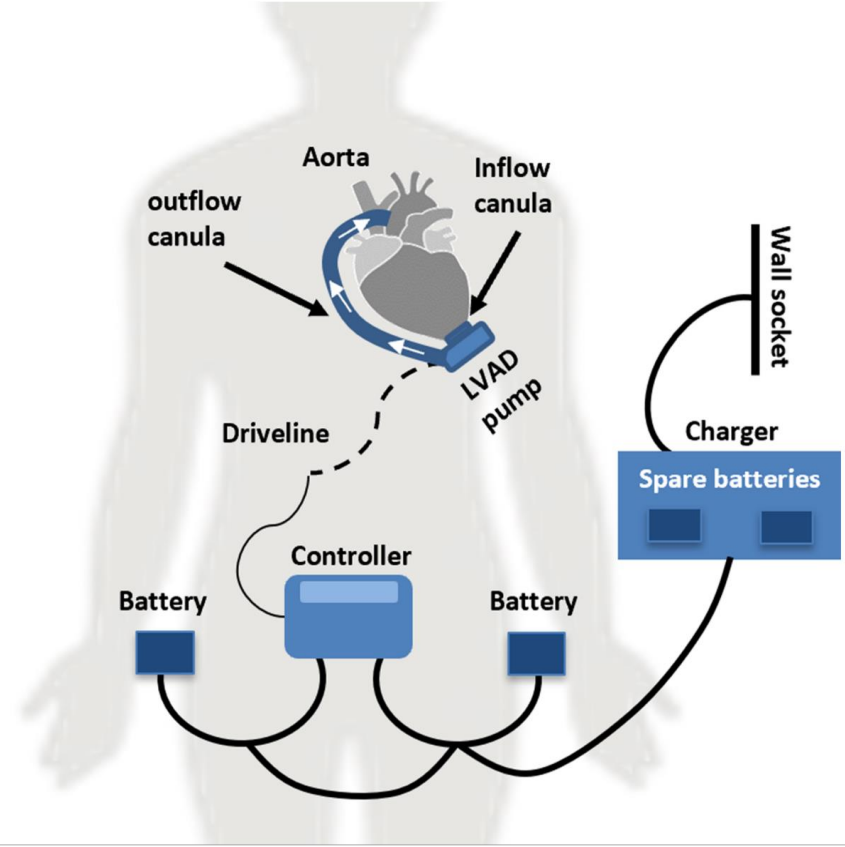


Table 1 Typical left ventricular assist device operating parameters

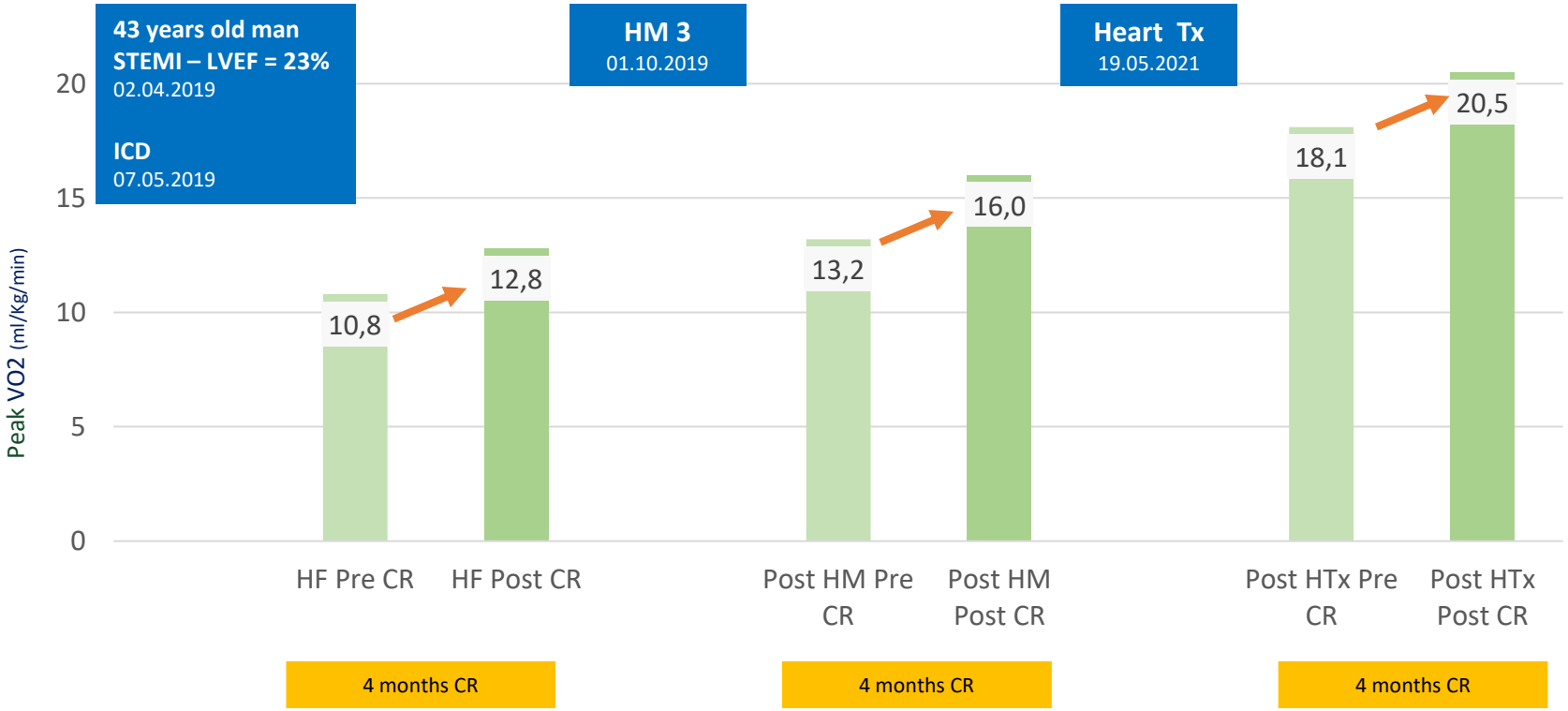
	HeartMate II	HeartMate 3	HeartWare
Typical speed, rpm	8000–10 000	5000–6000	2400–3200
Speed adjustment increment, Rpm/increment	200	100	20
Flow, Litre per minute	4–7	4–6	4–6
Power, Watts	5–8	4.5–6.5	3–7
Pulsatility index (PI) (peak to trough)	5–8	3.5–5.5	2–4



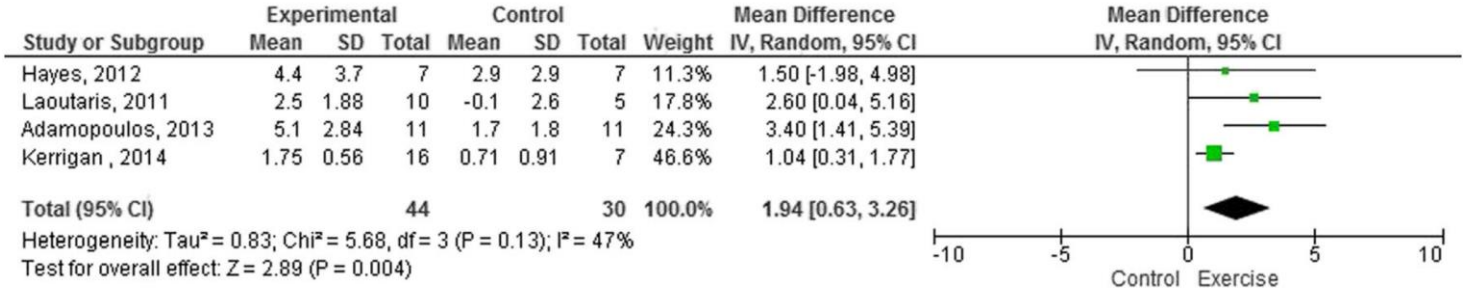
Cardiac rehab for all when present one or more of the following conditions…

- Physical limitation (HF, cardiac surgery, frailty...)
- Need of support to adopt a healthy lifestyle
- Insufficient information about the disease
- Psychological impairment (depression, anxiety...)

Peak VO2 changes from HF post STEMI to LVAD and Cardiac Tx through Cardiac Rehab



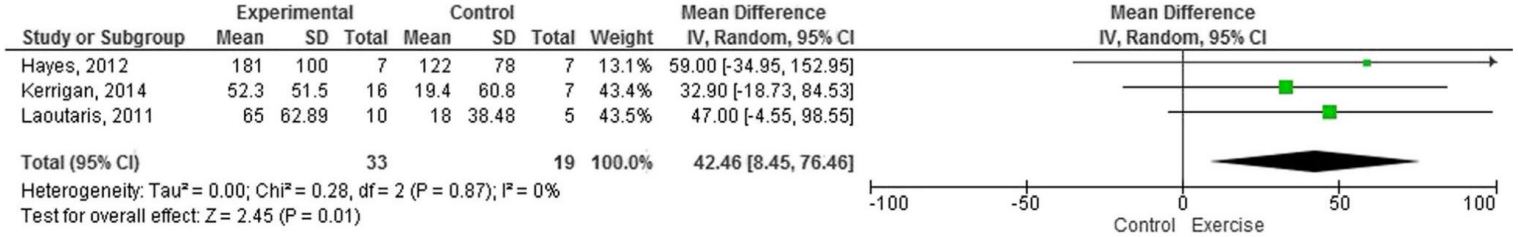
CR program improves aerobic capacity on LVAD pts



Study or Subgroup	Experimental Mean	SD	Total	Control Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Hayes, 2012	4.4	3.7	7	2.9	2.9	7	11.3%	1.50 [-1.98, 4.98]
Laoutaris, 2011	2.5	1.88	10	-0.1	2.6	5	17.8%	2.60 [0.04, 5.16]
Adamopoulos, 2013	5.1	2.84	11	1.7	1.8	11	24.3%	3.40 [1.41, 5.39]
Kerrigan , 2014	1.75	0.56	16	0.71	0.91	7	46.6%	1.04 [0.31, 1.77]
Total (95% CI)			44			30	100.0%	1.94 [0.63, 3.26]

Heterogeneity: Tau² = 0.83; Chi² = 5.68, df = 3 (P = 0.13); I² = 47%
Test for overall effect: Z = 2.89 (P = 0.004)

Fig. 2 Significant improvement in peak VO2 with exercise rehabilitation compared to usual care



Study or Subgroup	Experimental Mean	SD	Total	Control Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Hayes, 2012	181	100	7	122	78	7	13.1%	59.00 [-34.95, 152.95]
Kerrigan, 2014	52.3	51.5	16	19.4	60.8	7	43.4%	32.90 [-18.73, 84.53]
Laoutaris, 2011	65	62.89	10	18	38.48	5	43.5%	47.00 [-4.55, 98.55]
Total (95% CI)			33			19	100.0%	42.46 [8.45, 76.46]

Heterogeneity: Tau² = 0.00; Chi² = 0.28, df = 2 (P = 0.87); I² = 0%
Test for overall effect: Z = 2.45 (P = 0.01)

Fig. 3 Significant improvement in 6-min walk distance with exercise rehabilitation compared to usual care

Heart Failure Reviews
https://doi.org/10.1007/s10741-018-9695-y

Exercise rehabilitation in ventricular assist device recipients: a meta-analysis of effects on physiological and clinical outcomes

Liza Grosman-Rimon[1] · Spencer D. Lalonde[2] · Nina Sieh[3] · Maureen Pakosh[1] · Vivek Rao[4,5] · Paul Oh[1] · Sherry L. Grace[1,3,4]

JACC: HEART FAILURE VOL. 6, NO. 2, 2018

Association of Cardiac Rehabilitation With Decreased Hospitalizations and Mortality After Ventricular Assist Device Implantation

Justin M. Bachmann, MD, MPH,[a] Meredith S. Duncan, MA,[a] Ashish S. Shah, MD,[b] Robert A. Greevy, Jr., PhD,[c] JoAnn Lindenfeld, MD,[a] Steven J. Keteyian, PhD,[d] Randal J. Thomas, MD, MS,[e] Mary A. Whooley, MD,[f] Thomas J. Wang, MD,[a] Matthew S. Freiberg, MD, MSc[a]

ABSTRACT

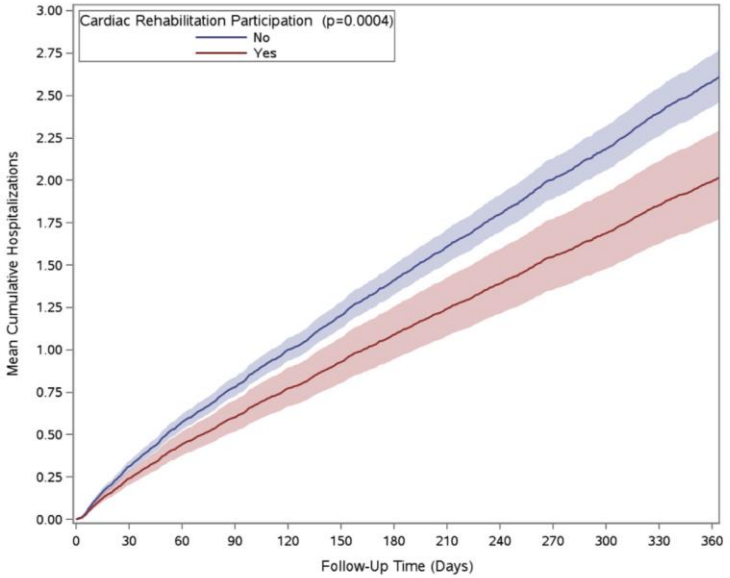
OBJECTIVES This study characterized cardiac rehabilitation (CR) use in ventricular assist device (VAD) recipients in the United States and the association of CR with 1-year hospitalization and mortality by using the 2013 to 2015 Medicare files.

BACKGROUND Exercise-based CR is indicated in patients with heart failure with reduced ejection fraction, but no data exist regarding CR participation after VAD implantation.

METHODS The study included Medicare beneficiaries enrolled for disability or age >65 years. The investigators identified VAD recipients by diagnosis codes and cumulated CR sessions occurring within 1 year after VAD implantation. Multivariable-adjusted Andersen-Gill models were used to evaluate the association of CR with 1-year hospitalization risk, and Cox regression was used to evaluate the association of CR with 1-year mortality.

RESULTS There were 1,164 VADs implanted in Medicare beneficiaries in the United States in 2014. CR use was low, with 348 patients (30%) participating in CR programs. The Midwest had the highest proportion of VAD recipients who began CR (38%), whereas the Northeast had the lowest proportion of CR participants (25%). Each 5-year increase in age was associated with attending an additional 1.6 CR sessions (95% confidence interval [CI]: 0.7 to 2.5; $p < 0.001$). CR participation was associated with a 23% lower 1-year hospitalization risk (95% CI: 11% to 33%; $p < 0.001$) and a 47% lower 1-year mortality risk (95% CI: 18% to 66%; $p < 0.01$) after multivariable adjustment.

CONCLUSIONS Approximately one-third of VAD recipients attend CR. Although it is not possible to account fully for unmeasured confounding, VAD recipients who participate in CR appear to have lower risks for hospitalization and mortality. (J Am Coll Cardiol HF 2018;6:130–9) © 2018 the American College of Cardiology Foundation. Published by Elsevier. All rights reserved.



N= 1.164 LVAD Medicare pts

Risk reduction at 1-year of:

- Hospitalizations: 23%
- Mortality: 47%

Independently of the comorbidities

JPF, 29 years old male , Mar 2021

HCM (MYBPC3 mutation) in burnout phase – NYHA IV

- **Biventricular dysfunction:** LVEF ~ 20-25%; RVEF ~ 34%; TAPSE 17
- **Pulmonary arterial hypertension**
- **CKD G3a, cardiorenal syndrome type 2** (creatinine =1,8 mg/dL)
- Normal coronary arteries (CT scan, 05/04/2021)
- Paroxysmal AF
- **ICD implanted in 2019 (secondary prevention)**
- CVDRF: smoker till Dec 2020 (11 UPY), dyslipidaemia
- Polyglobulia
- Mild depressive syndrome
- Blood group 0 Rh –

JPF, 29 years old male , Mar – Mai 2021

- **NYHA III-IV/ INTERMACS 4, under medication**:
  - bisoprolol (2,5mg, od), ivabradine (5mg, bid), ramipril (5mg, bid); dapagliflozin (10 mg, od), spironolactone (25mg, od); furosemide (40 + 20mg/day), sildenafil (20mg, tid), amiodarone (100mg, od), aspirin (100mg, od), warfarin (qb for INR >2.0<3.0), sertraline (50mg, od), pantoprazole (20mg, od).

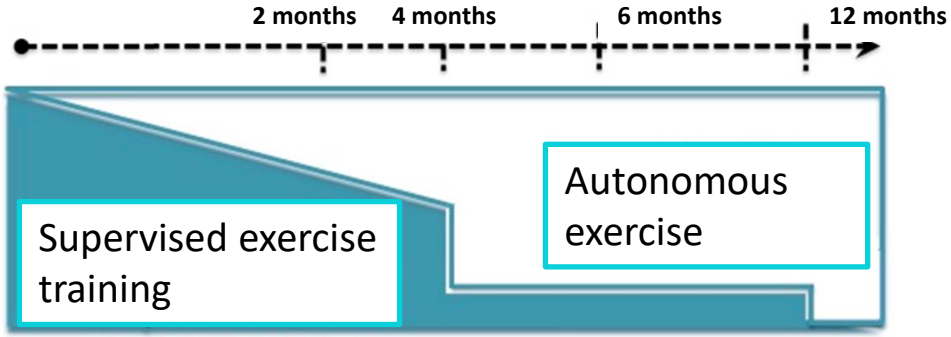
    - **CPET, 26/03/2021**
      - **Peak VO2 = 7,6 ml/Kg/min (19% predicted)**
      - VE/VCO2 slope = 94
      - RER = 1,22

    - **TTE, 30/03/2021:**
      1. Dilated LV (VTDi 149 mL/m2); **LVEF = 20-25%. Low CO: 2.3 L/min**; SVi 16 mL/m2.
      2. Moderate mitral regurgitation (functional).
      3. Dilated RV (95 mL/m2); RVEF : 34%; FAC 40%; TAPSE 17mm.
      4. PA systole ~ 43 mmHg.

- **Heartmate 3 implantation: 11/05/2021 (Bridge to transplant?)**

HF program

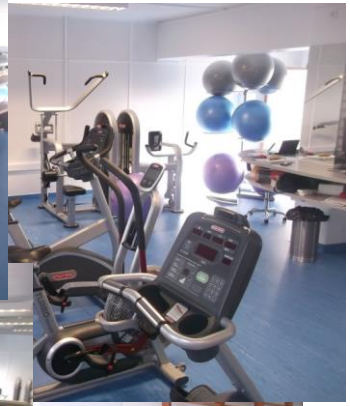
HF program



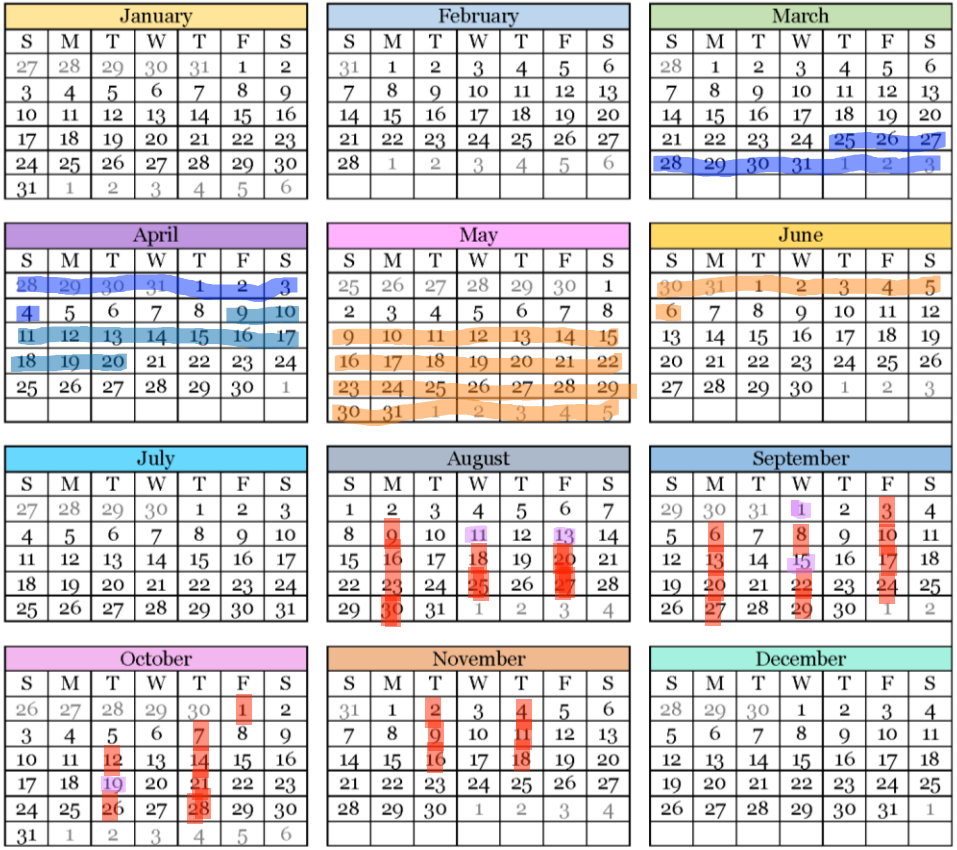
Exercise session structure

60-90min

- Monitorization
- Warm up
- Aerobic training
- Resistance training
- Functional training
- Cool down



Time line 2021



January						
S	M	T	W	T	F	S
27	28	29	30	31	1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31	1	2	3	4	5	6

February						
S	M	T	W	T	F	S
31	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	1	2	3	4	5	6

March						
S	M	T	W	T	F	S
28	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31	1	2	3

April						
S	M	T	W	T	F	S
28	29	30	31	1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	1

May						
S	M	T	W	T	F	S
25	26	27	28	29	30	1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31	1	2	3	4	5

June						
S	M	T	W	T	F	S
30	31	1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	1	2	3

July						
S	M	T	W	T	F	S
27	28	29	30	1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

August						
S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31	1	2	3	4

September						
S	M	T	W	T	F	S
29	30	31	1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	1	2

October						
S	M	T	W	T	F	S
26	27	28	29	30	1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31	1	2	3	4	5	6

November						
S	M	T	W	T	F	S
31	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	1	2	3	4

December						
S	M	T	W	T	F	S
28	29	30	1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	1

1st admission: HF
25/03 - 06/04/2021

2nd admission: HF
09/04 - 20/04/2021

3rd admission:
HM3 implantation
09/05 - 06/06/2021

CR program
09/08 - 18/11/2021

Participation on 78% of the exercise sessions

Aerobic training

	Ergometer	Borg	Speed/W	%	Distance (m)	Duration (min)	Kcal
Start 16.08.2021	Treadmill	12	2,0	0	500	15	55
	Bike	13	55		2600	15	24
Month #1 17/09/2021	Treadmill	14	3,7	1,5	1120	20	94
	Bike	14	59		4260	20	95
Month #2 14/10/2021	Treadmill	14	3,8	2,5	1020	20	95
	Bike	13	55		4700	20	119
Month #3 16/11/2021	Treadmill	14	3,2	2,5	850	20	86
	Bike	13	66		4750	20	114

CPET, 20/07/2021 (Pre-CRP): Load @ VT1 = 2.1 Km/h & 0.5%

Strenght training

	Biceps curl			Arm abduction		
	Nr. series	Nr. repetitions	Load (Kg)	Nr. series	Nr. repetitions	Load (Kg)
Start 16.08.2021	3	10	1,0	3	10	1,0
Month #1 17/09/2021	3	10	1,0	3	10	1,0
Month #2 14/10/2021	3	10	1,5	3	10	1,5
Month #3 16/11/2021	3	10	2,0	3	10	2,0
Month #4 16/12/2021	3	10	2,0	3	10	2,0

CPET evolution (HM3 implantation 11/05/2021)

	26/03/2021	20/07/2021	19/10/2021	16/12/2021
	Hospital admission	Pre CR	CR 2 months	CR 4 months
Protocol	Ramp 3	Ramp 5	Ramp 5	Ramp 5
Duration	6:22	**7:00**	**8:08**	**8:20**
VO2 (ml/min)	556	**863**	**1046**	**1086**
VO2 (ml/kg/min)	7,6	**13,2**	**15,2**	**13,2**
% predicted	19	32	36	35
VT1 (ml/Kg/min)	6,1	10,3	11,2	9,1
VT2 (ml/Kg/min)	6,1	10,8	11,2	9,5
VE/VCO2 slope	94	**55**	**51,2**	**44,5**
Peak RER	1,22	1,21	1,10	1,16
EOVs	Absent	Present	Present	Absent
Weight (Kg)	76	**69**	**69**	**80**
Physical activity	None	None	78% participation CRP + home stationary bike	

CPET blood tests

	Before CR 19/07/2021	CR 2 months 20/10/2021	CR 4 months 16/12/2021
Haemoglobin	17,1	17,9	17,7
Haematocrit	53	52	52
Hb A1C	---	5,5	---
Creat	1,19	1,15	1,35
Na	139	138	140
K+	4,0	4,8	4,7
NTproBNP	2778	1548	1283
LDL	143	145	101
Triglycerides	99	87	80

Questionnaires

		Pre CRP 21/07/2021	End CRP 16/12/2021
IPAQ	**METs/week**	**420**	**1948**
HADS	**Depression**	6	0
	Anxiety	9	8
Heart QoL	Physical score	9	15
	Emotional score	4	8
	Total	**13**	**23**
Minnesota Living with HF	Physical score	31	14
	Emotional score	22	6
	Total	**83**	**38**

Right cath

	Pre HM3	Post HM3 (11/05/21)	
	30/03/2021	31/08/2021 HM3: 3 months	08/03/2022 HM3: 10 months
PVC	25	17	5
Mean PAP	39	35	20
PWP	31	25	9
Mean transpulmonary gradient	18	10	11
CO/CI – L/min HM3 ~ 5000 rpm, CO = 3,7L/min	2,7/1,5	3,0/1,7	3,5/1,8
Pulmonary resistance (W units)	**6,7**	**3,3**	**3,1**

JPF, 29 y - Clinical evolution during the CRP (09.08 – 16.12.2021)

- ✓ Functional class improvement from NYHA III-IV to class II
- ✓ Improvement on:
  - ✓ Aerobic and strength capacity
  - ✓ Questionnaires scores: IPAQ, HADS, Heart QoL & MLWHF
- ✓ During the program:
  - ✓ No HF decompensation or arrhythmias
  - ✓ No orthopaedic or muscle complications

- ✓ Negative weight increase (11Kg)

What CR program after LVAD? – Phase II

ESC European Society of Cardiology
European Journal of Heart Failure (2019) 21, 3–13
doi:10.1002/ejhf.1352
POSITION STATEMENT

Exercise training in patients with ventricular assist devices: a review of the evidence and practical advice. A position paper from the Committee on Exercise Physiology and Training and the Committee of Advanced Heart Failure of the Heart Failure Association of the European Society of Cardiology

Stamatis Adamopoulos[1], Ugo Corrà[2], Ioannis D. Laoutaris[1], Massimo Pistono[2], Pier Giuseppe Agostoni[3], Andrew J.S. Coats[4], Maria G. Crespo Leiro[5], Justien Cornelis[6], Constantinos H. Davos[7], Gerasimos Filippatos[8], Lars H. Lund[9], Tiny Jaarsma[10], Frank Ruschitzka[11], Petar M. Seferovic[12], Jean-Paul Schmid[13], Maurizio Volterrani[4], and Massimo F. Piepoli[14]*

Table 2 Instruction to reduce the risk of adverse events when exercising ventricular assist device patients

1. Individualised assessment and prescription.
2. Pre-screening with risk stratification.
3. Prolonged graduated warm-up and cool-down.
4. Low-to-moderate intensity exercise training.
5. Avoiding breath holding and Valsalva manoeuvre.
6. Avoiding any trauma, as ventricular assist device recipients are anticoagulated and (some, not all) treated with antiplatelet drugs.
7. Adaptation for co-morbidities.
8. Monitoring and supervision.
9. Keeping the feet moving during active recovery, if appropriate.
10. Observation of patients for 15 min post-cessation of exercise.

What CR program after LVAD? – Early mobilization

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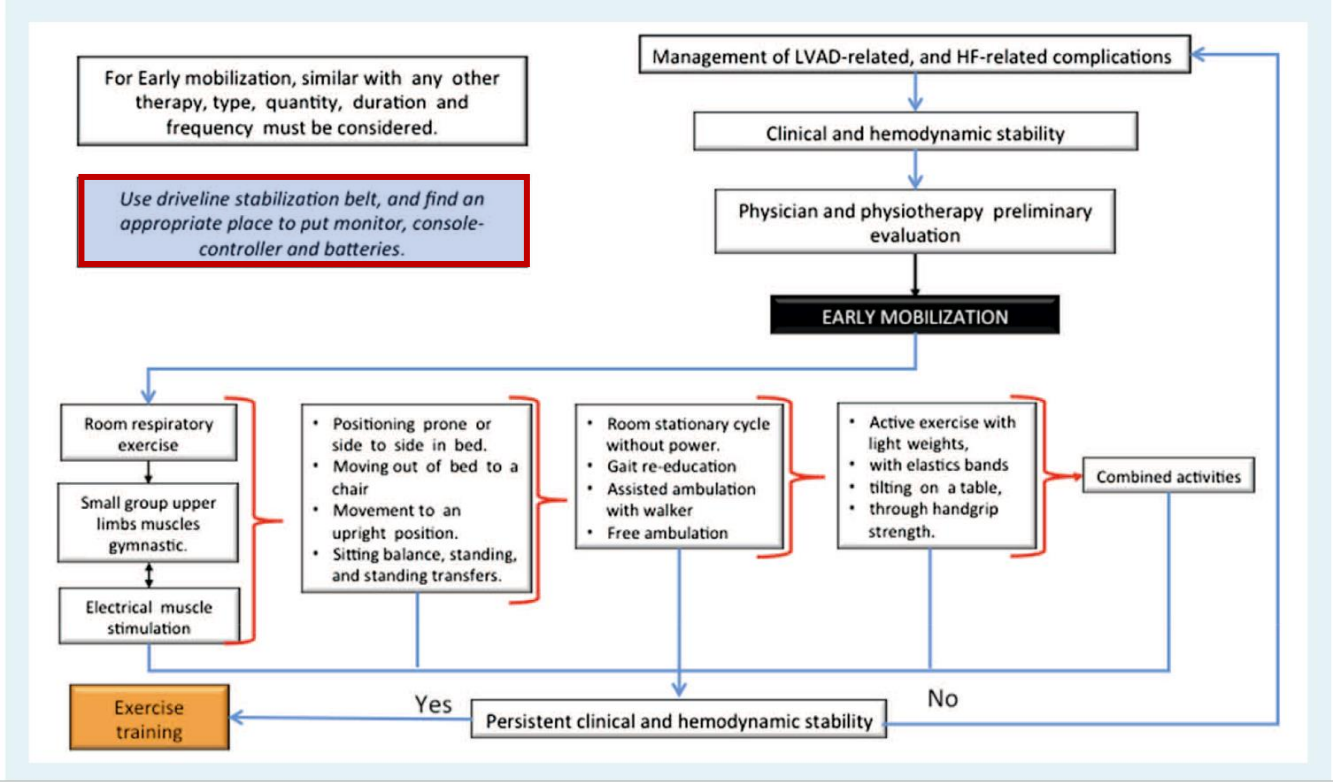

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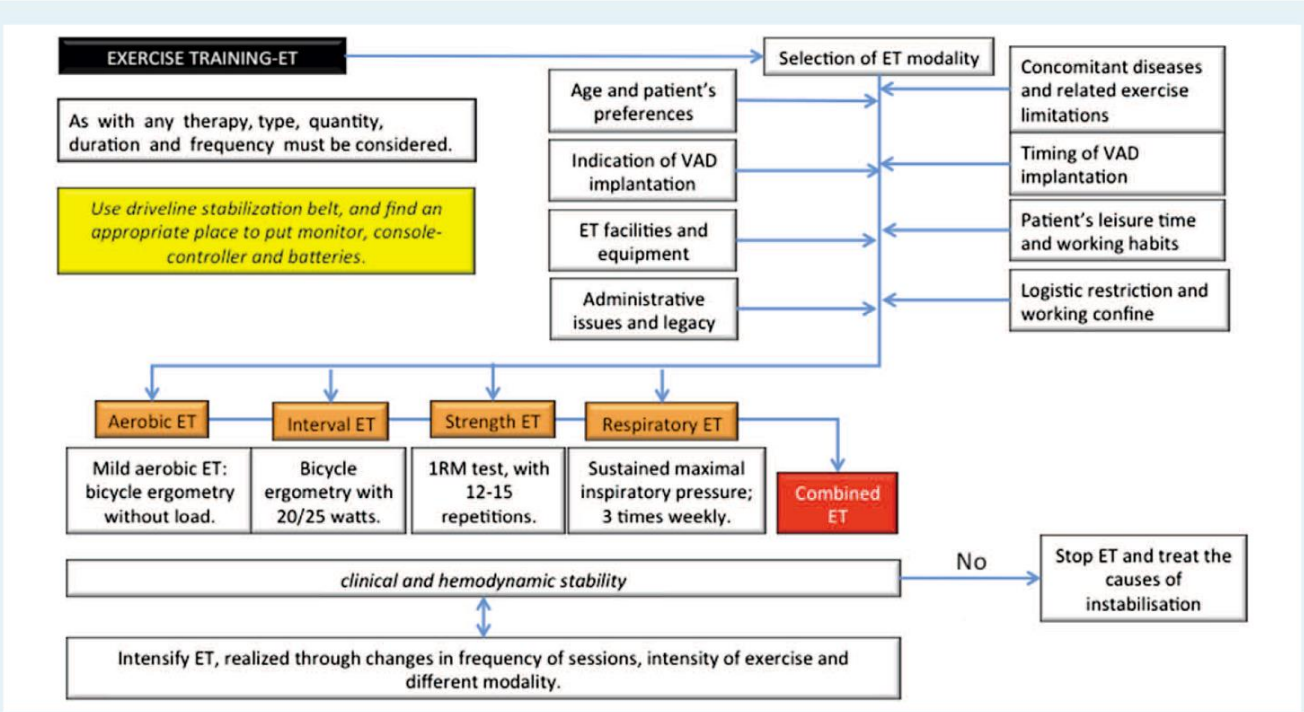

Figure 2 Ventricular assist device (VAD) recipients and exercise training. ET, exercise training.

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The Journal of Heart and Lung Transplantation

http://www.jhltonline.org

STATE OF ART

Exercise in heart failure patients supported with a left ventricular assist device

Mette Holme Jung, MD, and Finn Gustafsson, MD, PhD

From the Department of Cardiology, The Heart Center, University Hospital Rigshospitalet, Copenhagen, Denmark.

Potential factors contributing to exercise intolerance in CF-LVAD patients

- Fixed CF-LVAD pump speed
- Severely reduced left ventricular function
- Abnormal skeletal muscle metabolism
- Reduced oxygen extraction capacity and other pulmonary limitations
- Abnormal muscular response to vasodilation
- Obesity
- Low skeletal muscle mass
- Ventilation/perfusion (V/Q) mismatch
- Anemia with low oxygen-carrying capacity
- Reduced right ventricular function
- Aortic valve abnormalities

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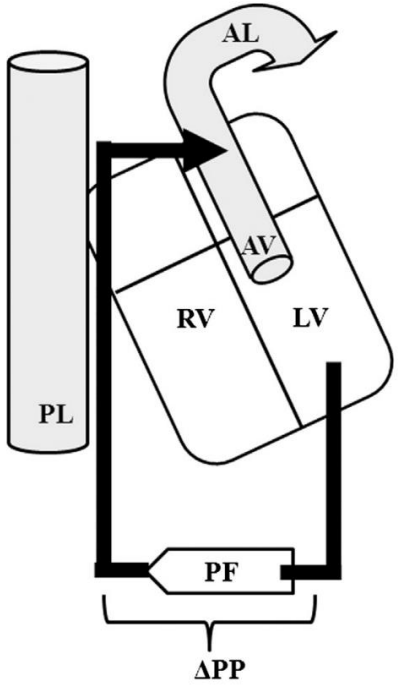
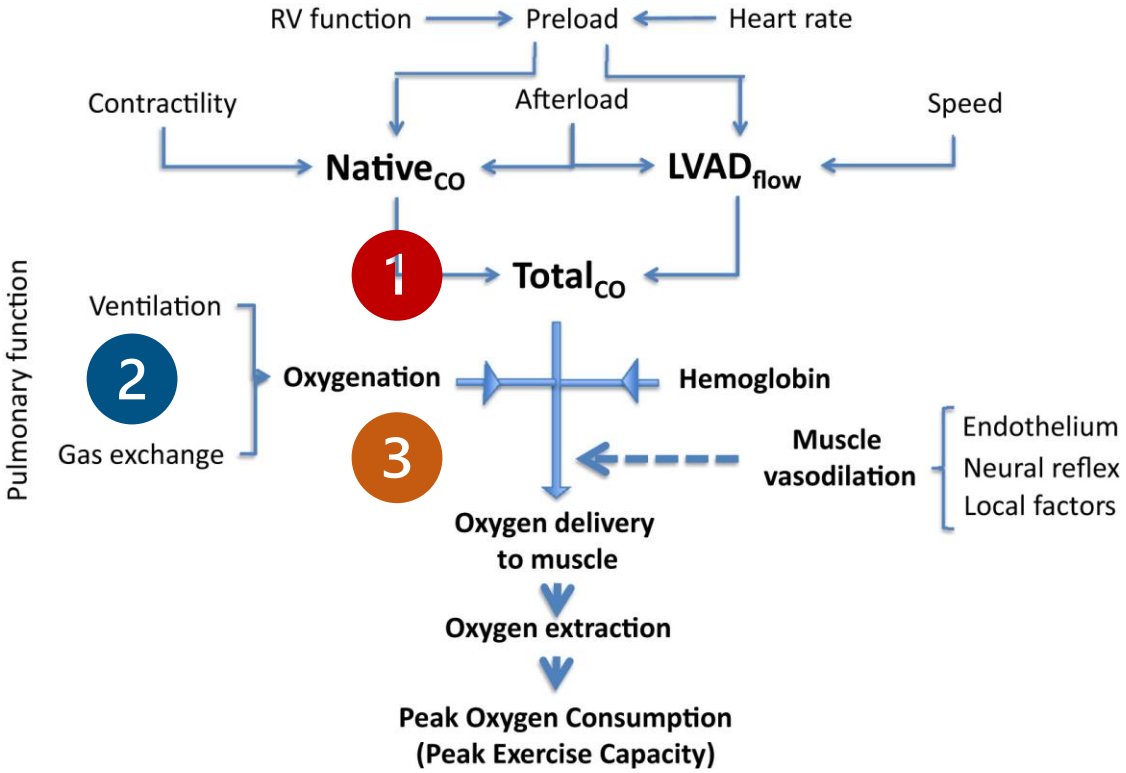


A. CF-LVAD hemodynamics at rest.

Determinants of peak oxygen consumption on LVAD



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J Heart Lung Transplant 2015;34:1005–1016

Review article

I.F.C. Italian Federation of Cardiology

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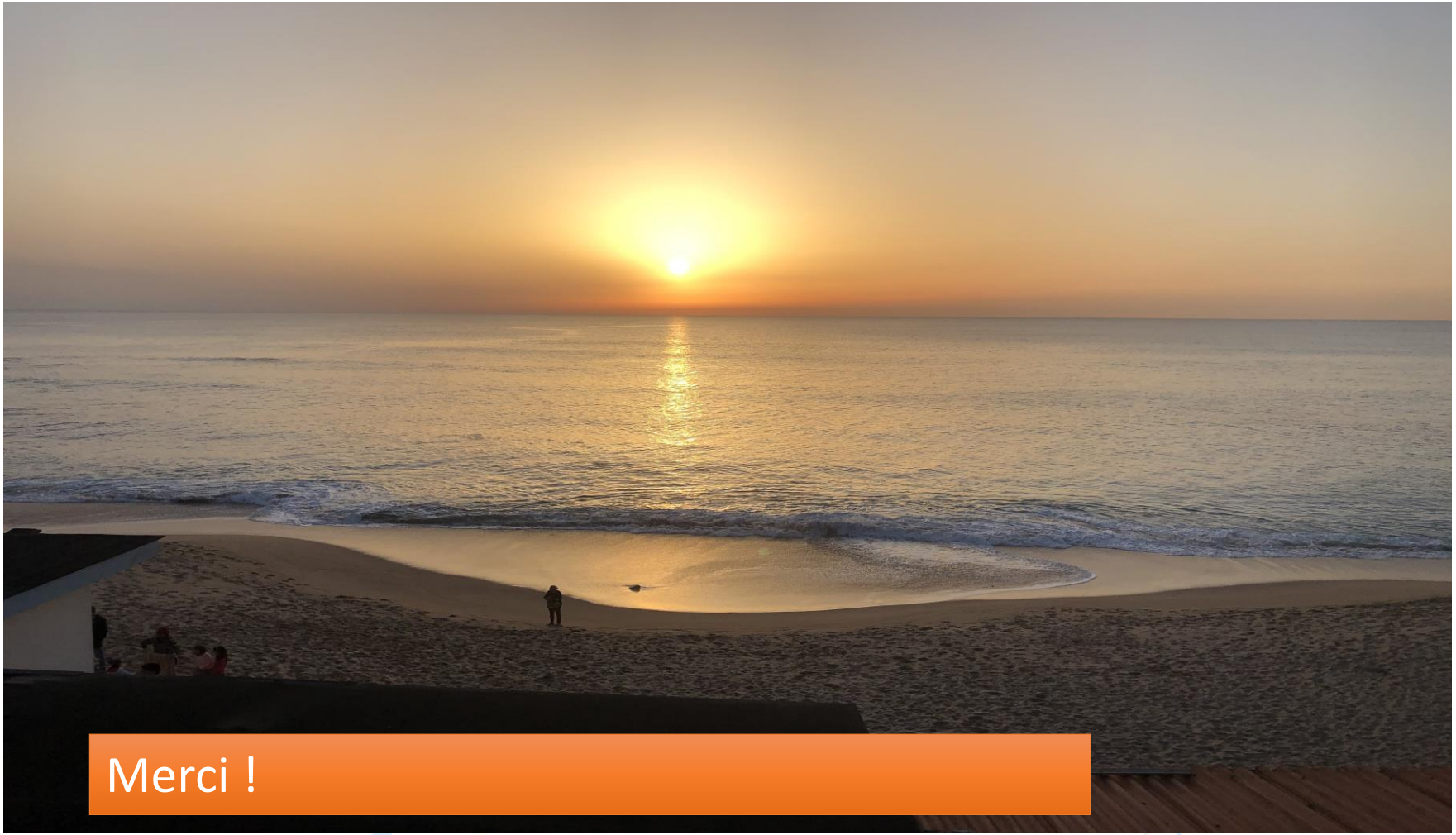
J Cardiovasc Med 2020, **21**:472–480

Potential therapeutic strategies to reduce exercise limitations on LVAD pts:

1. Maximizing LV unloading and improving native myocardial function in association with an automated ramp increase of LVAD speed;
2. Optimization of the RV function and aortic valve opening;
3. Implementation of exercise training protocols for the immediate postoperative period **and** for the long-term follow-up;
4. Treatment of potentially reversible extracardiac factors: anaemia (cause of low O^2 carrying capacity), muscle deconditioning, reduce afterload by drugs or by treating obesity.


Merci !