Prognóstico na IC – uso otimizado do Teste Cardiopulmonar

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HOSPITAL SANTA IZABEL

Cárdio Pulmonar

INSTITUTO PROCARDÍACO

Declaro não haver conflito de interesse com o tema

VARIÁVEIS PROGNÓSTICAS NA ICC

- VO2 pico
- VO2 no LA
- VE/VCO2 slope
- Pulso de O2 (VO2/FC)
- “Oxigen uptake efficiency slope” – OUES
- Ventilação periódica
- Recuperação da FC
- Pet CO2 em repouso
- “CPX score”

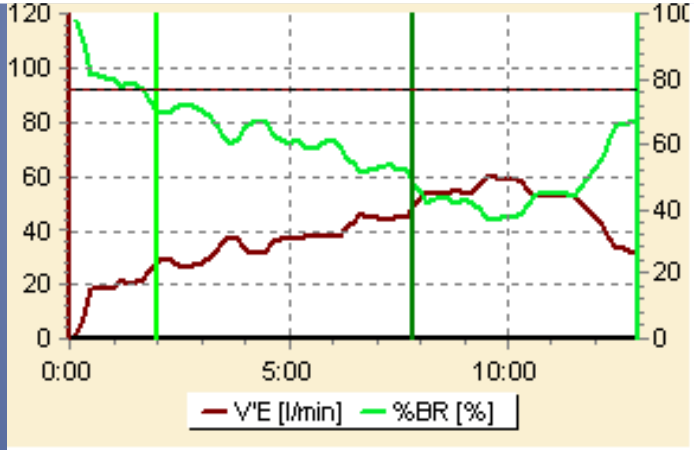
2016 ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure

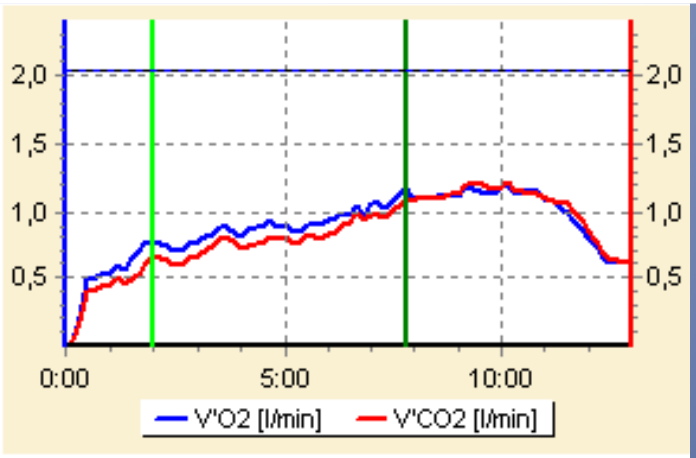
The Task Force for the diagnosis and treatment of acute and chronic heart failure of the European Society of Cardiology (ESC)

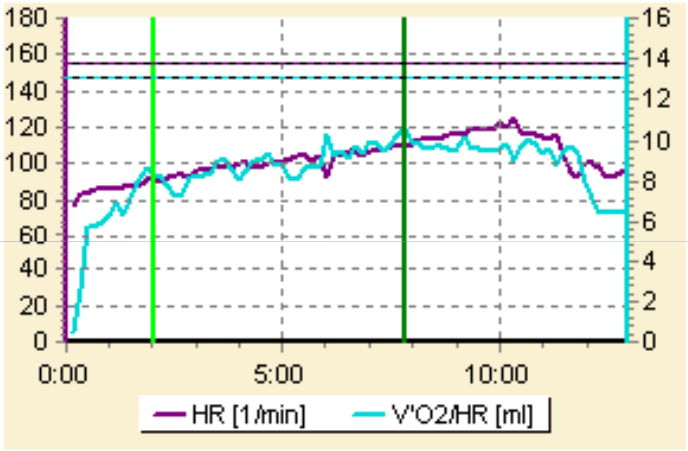
Exercise testing in patients with HF:	
- is recommended as a part of the evaluation for heart transplantation and/or mechanical circulatory support (cardiopulmonary exercise testing);	I
- should be considered to optimize prescription of exercise training (preferably cardiopulmonary exercise testing);	IIa
- should be considered to identify the cause of unexplained dyspnoea (cardiopulmonary exercise testing).	IIa
- may be considered to detect reversible myocardial ischaemia.	IIb

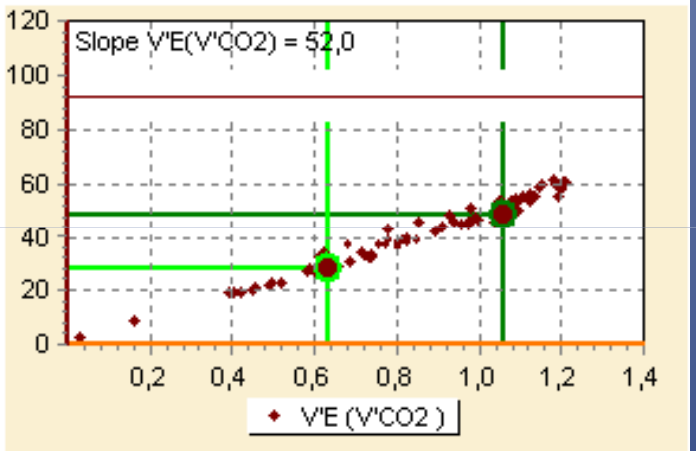
CASO

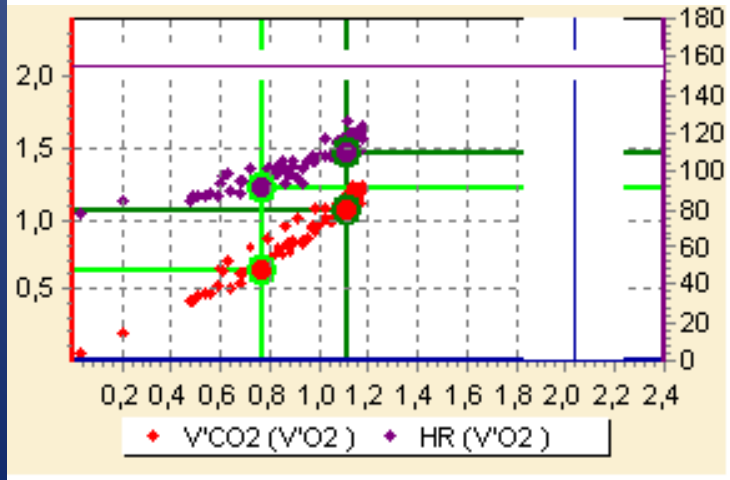
- Masc. 65 anos
- Miocardiopatia Isquemica (IAM há 60 dias)
- FE 30%
- CF III NYHA

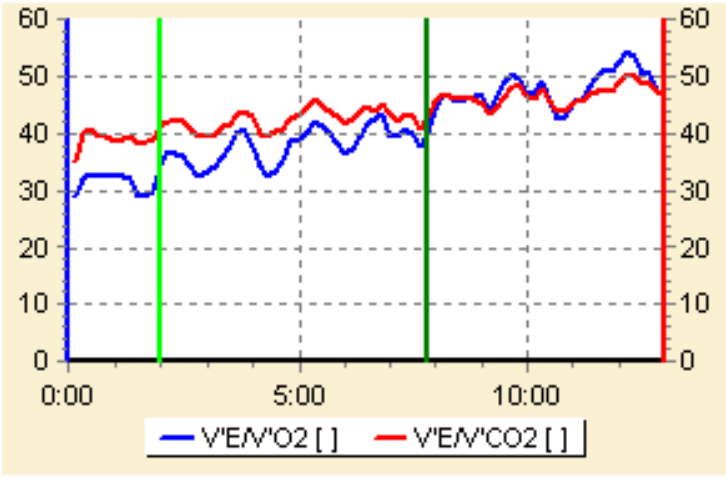

V'E [l/min]
%BR [%]
0:00
5:00
10:00


V'O2 [l/min]
V'CO2 [l/min]
0:00
5:00
10:00


HR [1/min]
V'O2/HR [ml]
0:00
5:00
10:00

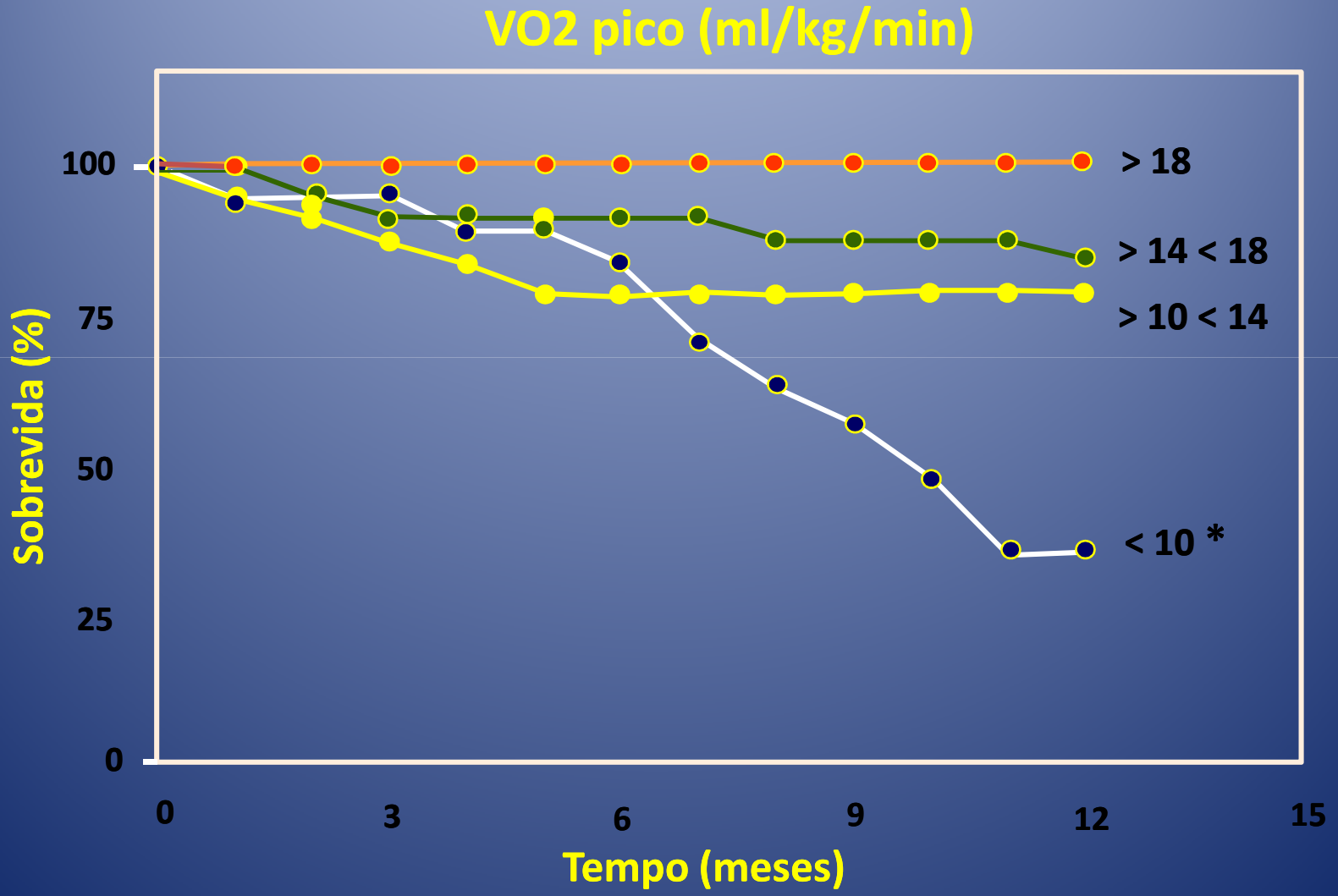

Slope V'E(V'CO2) = 52,0
V'E (V'CO2)


V'CO2 (V'O2)
HR (V'O2)


V'E/V'O2 [ ]
V'E/V'CO2 [ ]
0:00
5:00
10:00

	LA (2:00)	PCR (7:50)	VO2 pico (10:00)	Pred
VO2 (ml/kg/min)	10,66 (38%)	15,47 (96%)	16,06 (57%)	28,2
FC (bpm)	91 (76%)	110 (92%)	120 (77% da pred)	155
VO2/FC (ml/bt)	8,4	10,1	9,6 (74% do pred)	13,1
Vel/incli (Km/h e%)	2,4 km/h 0%	5,1 km/h 0%	5,3 km/h 1,0%	-
R	0,82	0,95	1,02	-

VALOR PROGNÓSTICO DO VO2 NA ICC



Mancini DM et al Circulation 1991;83:778-86

CLASSIFICAÇÃO DE WEBER

Classe A	> ou =	20 mL/kg^{-1} min^{-1}			
Classe B	<	20 mL/kg^{-1} min^{-1}	e	> ou =	15 mL/kg^{-1} min^{-1}
Classe C	<	15 mL/kg^{-1} min^{-1}	e	>	10 mL/kg^{-1} min^{-1}
Classe D	< ou =	10 mL/kg^{-1} min^{-1}			

Circulation 1982; 65:6

CLASSIFICAÇÃO WASSERMAN

Capacidade funcional normal
VO2 > 85% do predito

CF reduzida leve
60% < VO2 < 85% do predito

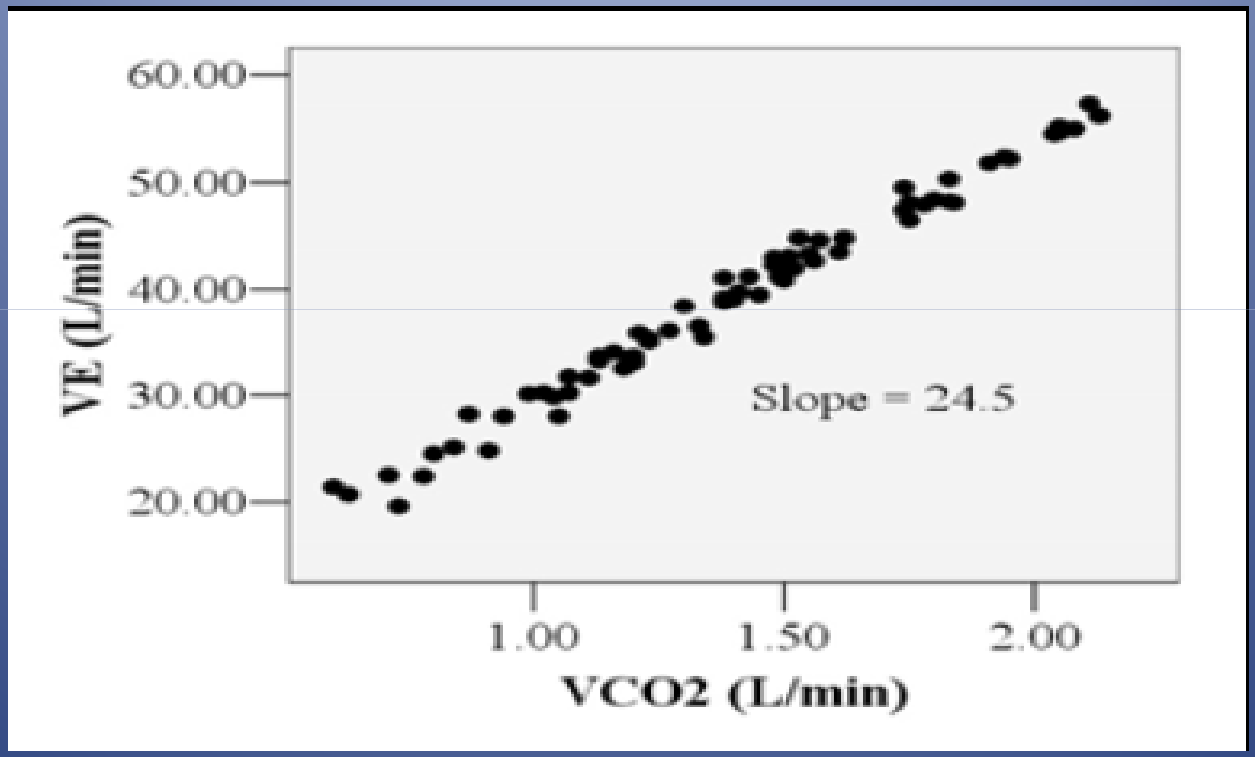
CF reduzida moderada
40% < VO2 < 60% do predito

CF reduzida grave
VO2 < 40% do predito

TCP E ICC

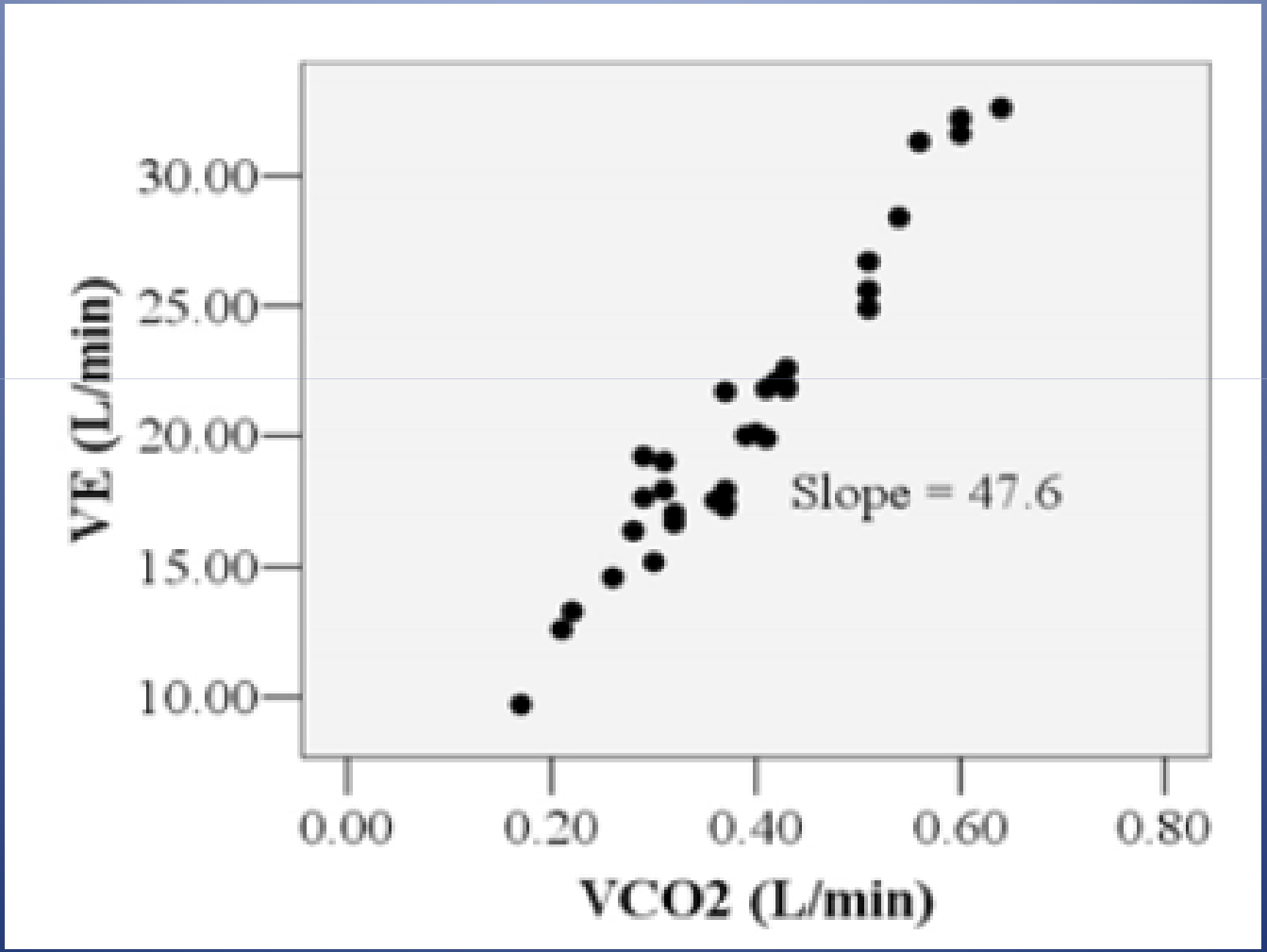
ALÉM DO VO2

VE/VCO2 SLOPE



Y = m * b X

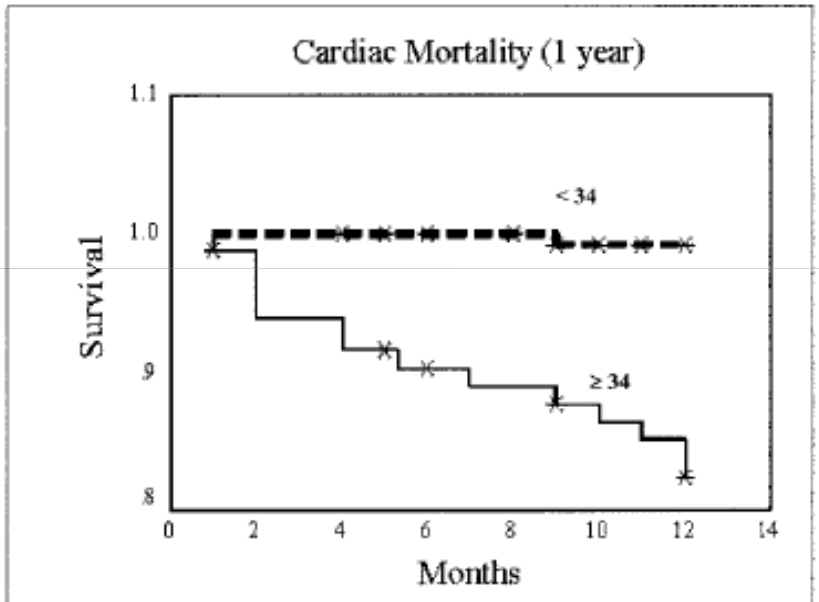
VE/VCO2 SLOPE



Peak VO_2 and VE/VCO_2 slope in patients with heart failure: A prognostic comparison

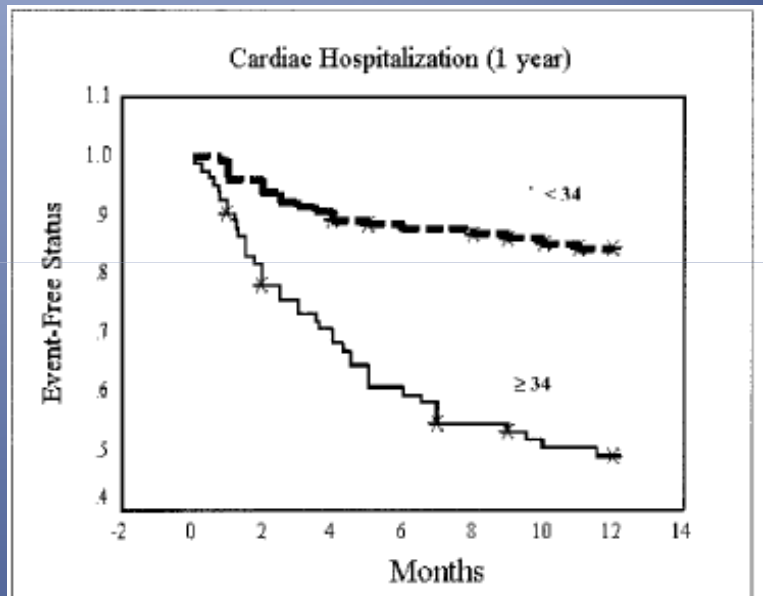
Ross Arena, PhD, PT,[a] Jonathan Myers, PhD,[b] Syed Salman Aslam, MD,[b] Elsa B. Varughese, MD,[b] and Mary Ann Peberdy, MD, FACC[a] *Richmond, Va, and Palo Alto, Calif*

Am Heart J 2004;147:354–60



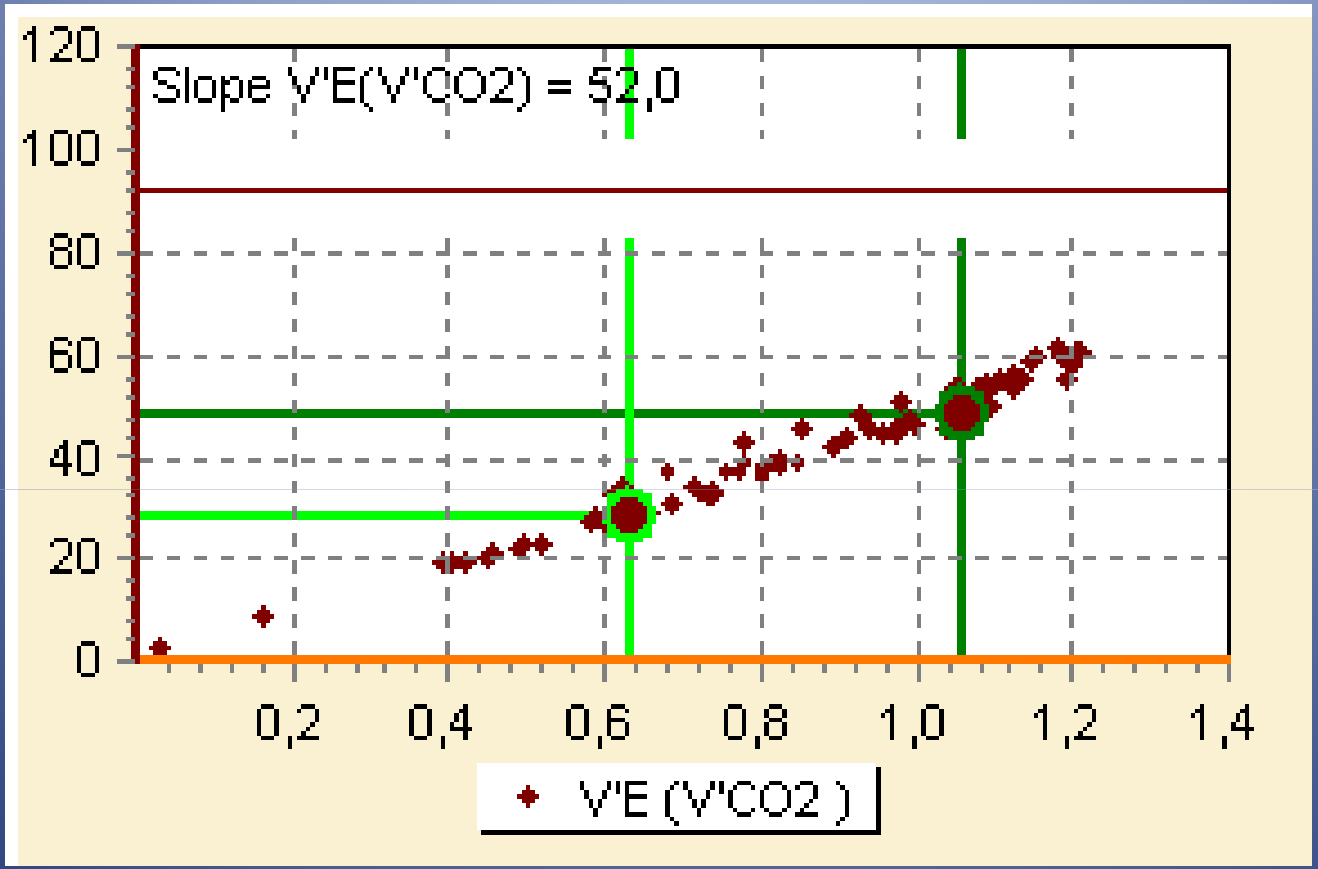
	Subjects	Deaths	Percent Survival
VE/VCO_2 slope < 34	130	1	99.2%
VE/VCO_2 slope ≥ 34	83	14	83.1%

A

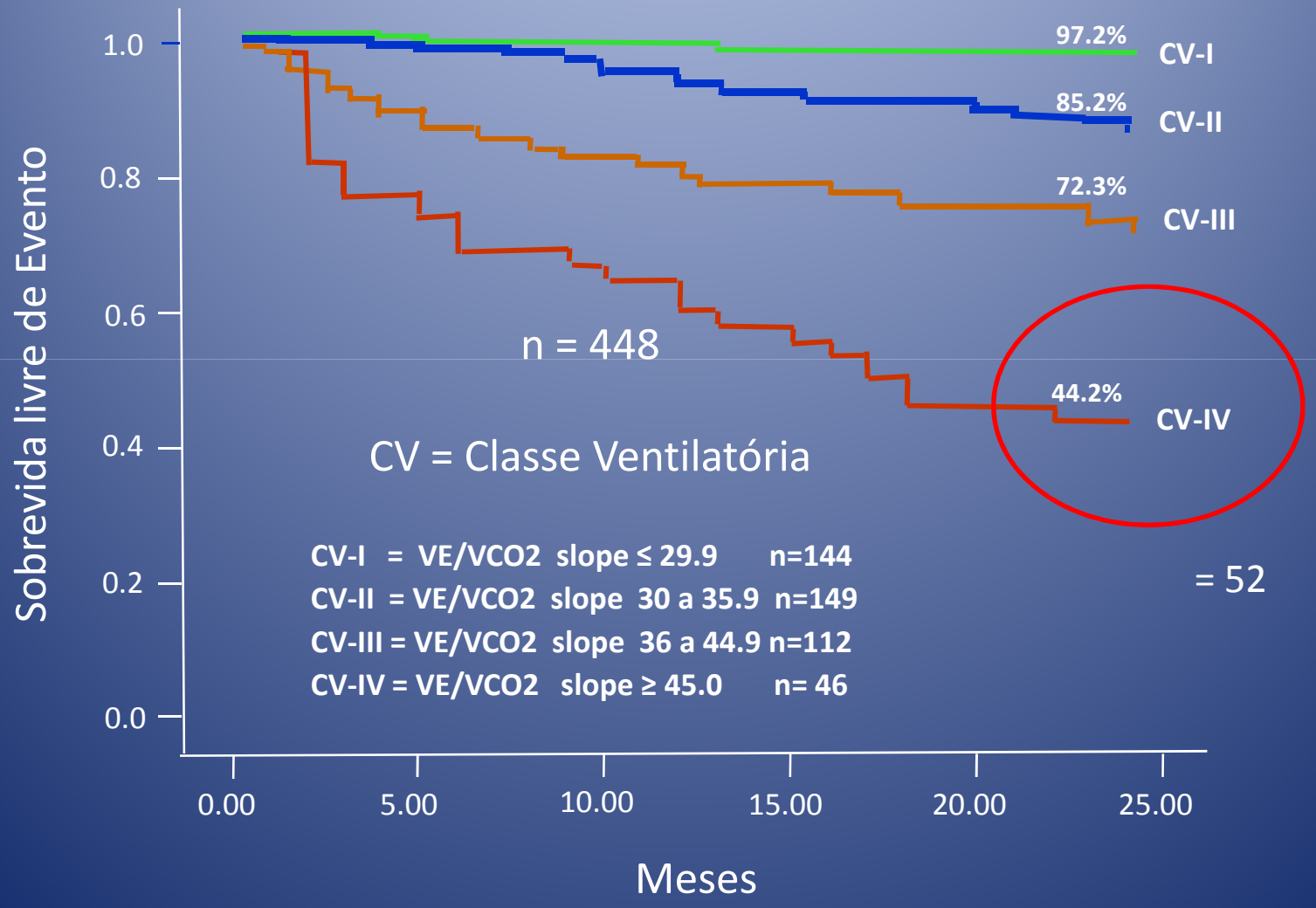


	Subjects	Cardiac Hospitalizations	Percent Survival
VE/VCO_2 slope < 34	130	20	84.6%
VE/VCO_2 slope ≥ 34	83	41	50.6%

B


Slope V'E(V'CO2) = 52,0
120
100
80
60
40
20
0
0,2
0,4
0,6
0,8
1,0
1,2
1,4
V'E (V'CO2)

Classes Ventilatórias: VE/VCO2 Slope



Arena R et al Circulation 2007;115 april 23

LE2

Jornal	Ano	N	FU	Parâmetros	Resultados	End point	Análise
JACC (ICC pre TX)	1997	173	2 anos	VE/VCO2 slope	+	morte	Cox/Kaplan
Eur H J (ICC)	2000	303	2 anos	pVO2 e VE/VCO2 slope	+	morte	Cox
Circulation (ICC pVO2>18)	2001	123	3 anos	VE/VCO2 slope	+	Morte	Cox
Circulation (ICC)	2002	223	6 meses	pVO2 e VE/VCO2 slope	+	Morte	Cox
Chest (ICC)	2003	188	2 anos	VE/VCO2 to peak x VE/VCO2 to AT	=	Morte	Cox
Am H J (ICC)	2004	213	8 anos	pVO2 + VE/VCO2 slope	+	Morte e Hospitalização	Cox
Circulation (ICC)	2007	448	2 anos	pVO2 e VE/VCO2 slope	+ (classificação ventilatória 4 quartis)	Morte	Cox
Int J Card (ICC)	2008	520	4 anos	Delta HR, HRR1, VE/VCO2 slope	Delta HR – HRR1 +	Morte	Cox

Slide 17

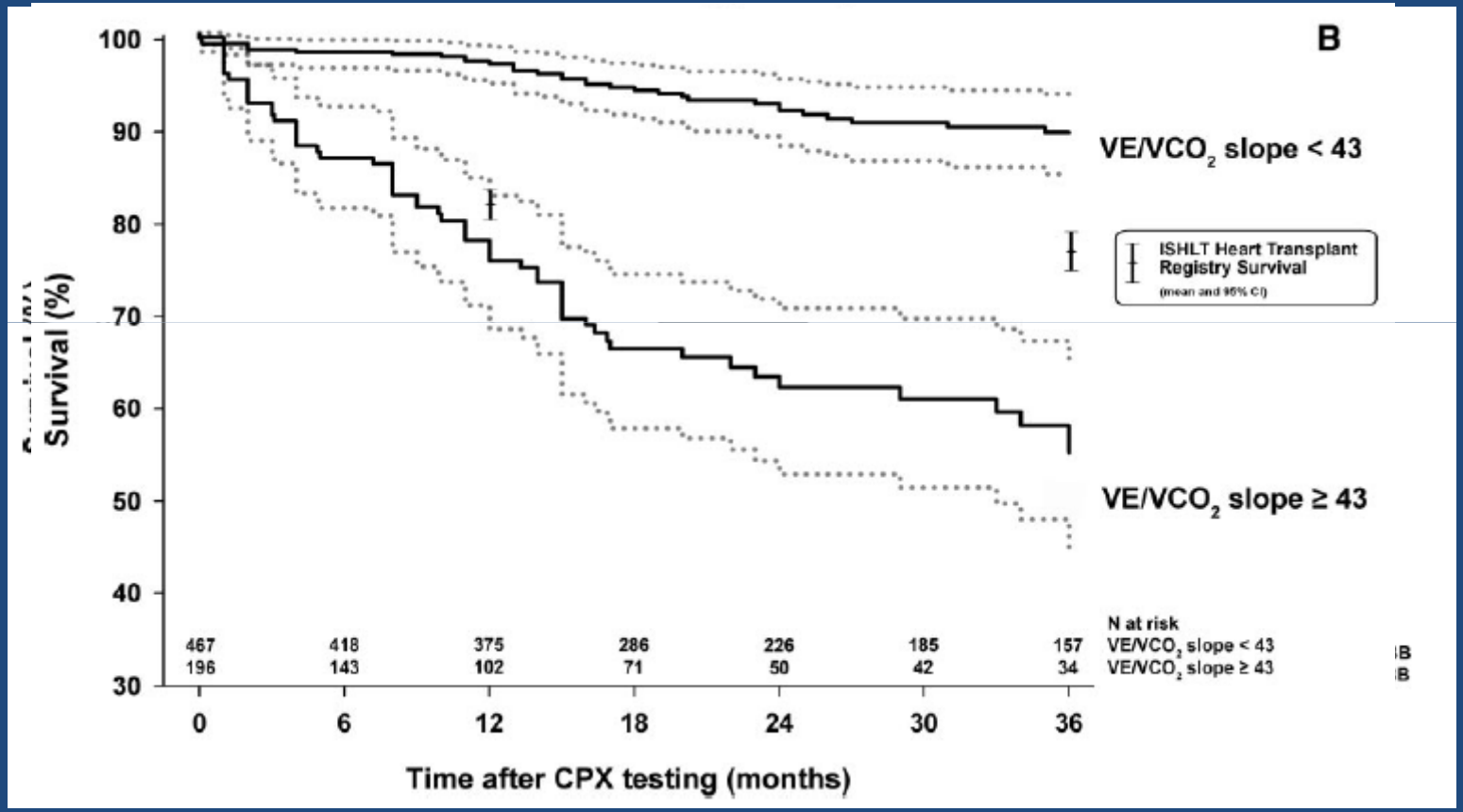
LE2 Renato neste slide a idéia é só mostrar que diversos autores estudaram esta variável, na realidade não pretendo parar muito nele.

Vc acha necessário dividí-lo?
Luiz Ritt; 6/7/2010

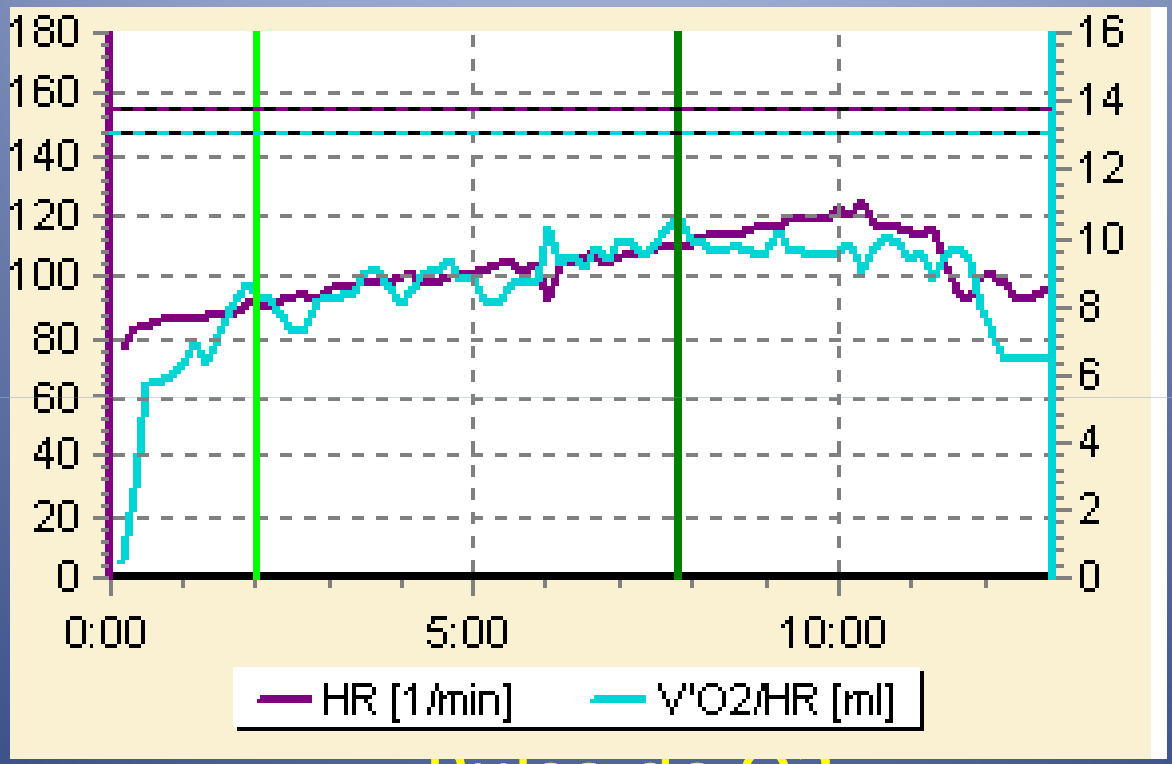
Ventilatory Efficiency and the Selection of Patients for Heart Transplantation

António M. Ferreira, Jean-Yves Tabet, Lutz Frankenstein, Marco Metra, Miguel Mendes, Christian Zugck, Florence Beauvais and Alain Cohen-Solal

Circ Heart Fail 2010;3;378-386; originally published online February 22, 2010;



TCP - Informações Hemodinâmicas

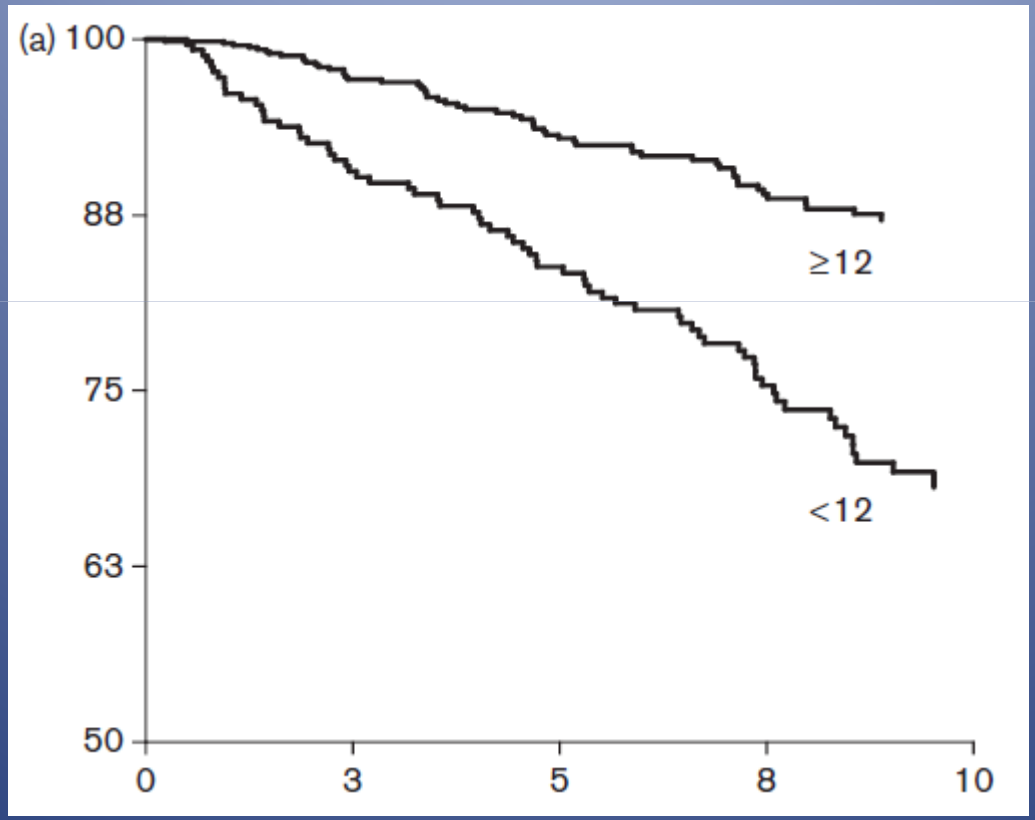


Pulso de O2

VO2/FC = VS.(CaO2-CvO2)

Maximal exercise oxygen pulse as a predictor of mortality among male veterans referred for exercise testing

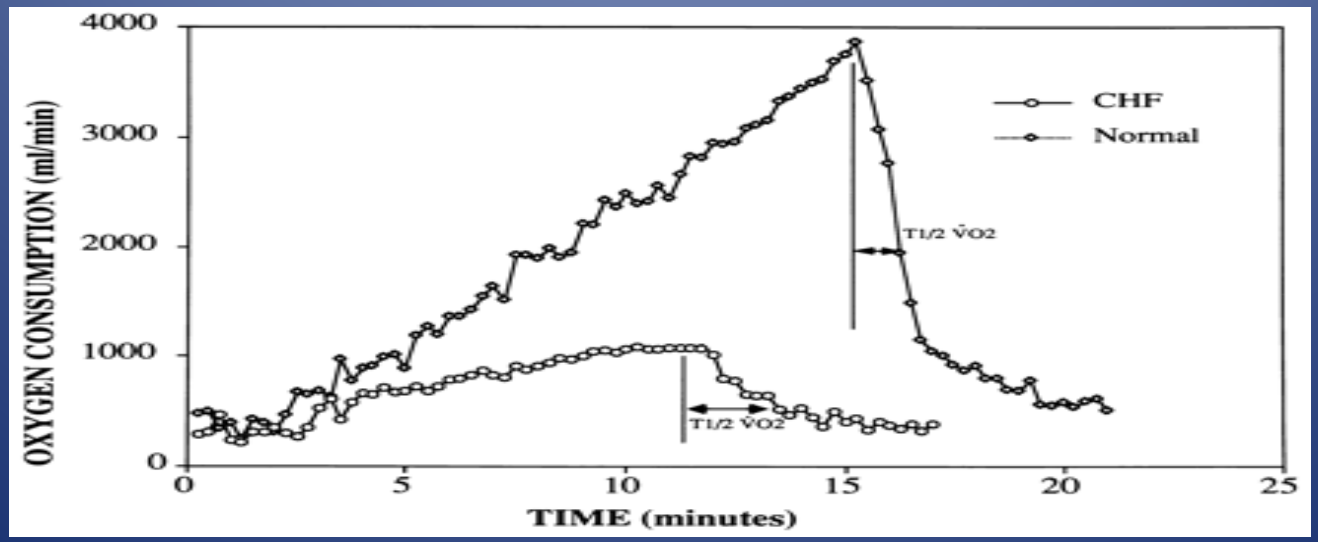
Ricardo B. Oliveira[a,c], Jonathan Myers[c], Claudio Gil S. Araújo[a,b], Joshua Abella[c], Sandra Mandic[c] and Victor Froelicher[c]



Eur J Cardiovasc Prev Rehabil 2009

Recuperação do VO2 - T ½ VO2

- Tempo necessário para queda de 50% do VO2 pico na recuperação
- Valor de corte = 90s
- Mediana em pctes com ICC



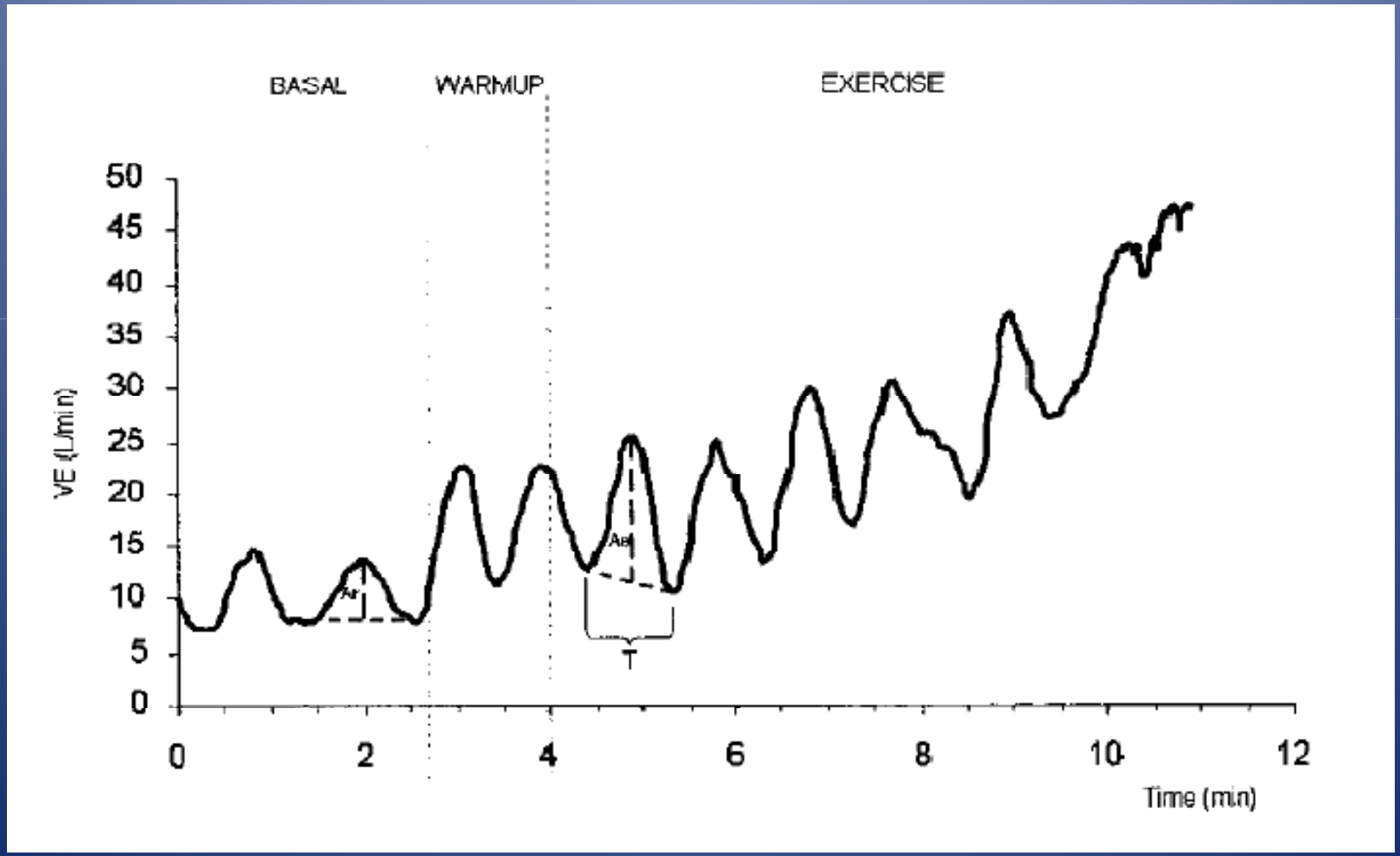
Recuperação do VO2 - T ½ VO2

Table 2. Cardiopulmonary Exercise Test Results in 55 Control Subjects and 153 Patients With Dilated Cardiomyopathy

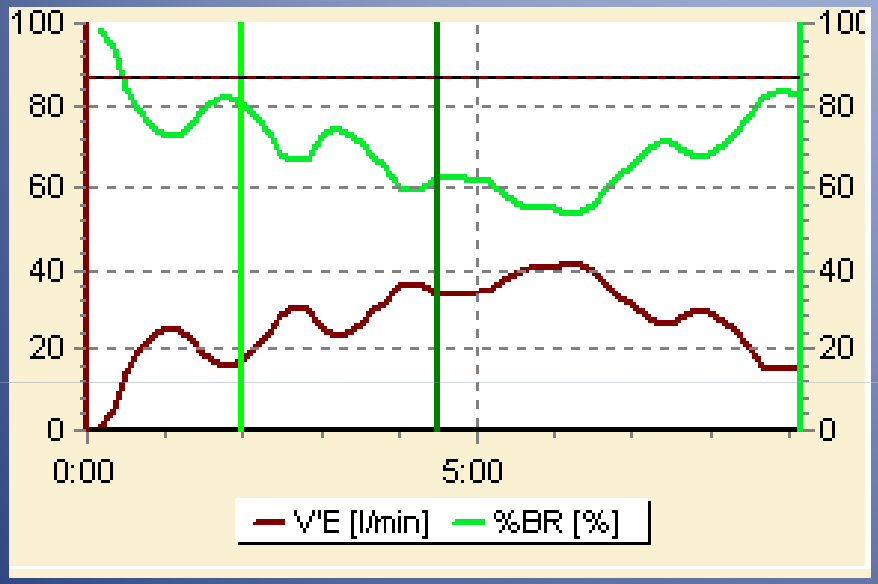
	Control Subjects		Patients With Dilated Cardiomyopathy			
	Young (n = 30)	Old (n = 25)	Group 1 (peak Vo_2 ≥15 ml/min per kg) (n = 79)	Group 2 (peak Vo_2 >10 ml/min per kg) (n = 49)	Group 3 (peak Vo_2 ≤10 ml/min per kg) (n = 25)	p Value Between Groups (by ANOVA)
Age (yr)	25 ± 5.5	48.3 ± 11.2*	46 ± 11	53.4 ± 9‡	56.8 ± 11.5†,‡‡	< 0.0001
Duration of exercise (s)	1,350 ± 306	1,070 ± 493	856 ± 169†	619 ± 109‡,‡	445 ± 111#,‡‡,‡	< 0.0001
Rest heart rate (beats/min)	82.2 ± 13.8	73.6 ± 9.6	89 ± 18	83 ± 19	96 ± 19#,##	< 0.0001
Peak heart rate (beats/min)	184 ± 11.7	157 ± 22*	157 ± 24	137 ± 26§,‡	135 ± 28**,‡‡	< 0.0001
Recovery heart rate (beats/min)	112 ± 15.9	105 ± 18	106 ± 21.5	96 ± 22.5	100 ± 18.4	0.009
Vo_2 at rest (ml/min)	216 ± 77	244 ± 70	212 ± 74	184 ± 75§	179 ± 71**	0.005
Vo_2 at AT (ml/min)	1,708 ± 733	1,444 ± 643	930 ± 353†	713 ± 202‡,‡	429 ± 145#,‡‡,‡	< 0.0001
Peak Vo_2 (ml/min)	2,798 ± 863	2,198 ± 865	1,536 ± 344†	1,010 ± 153‡,‡	631 ± 173#,‡‡,‡	< 0.0001
Peak Vo_2 (ml/min per kg)	41.6 ± 9.9	31.4 ± 11.8*	19.6 ± 3.2†	13 ± 1‡,‡	8.8 ± 1.5#,‡‡,‡	< 0.0001
% predicted value Vo_2	106 ± 19.7	102 ± 19.2	64.4 ± 13†	47.6 ± 9.6‡,‡	33.7 ± 7.4#,‡‡,‡	< 0.0001
Peak RER	1.26 ± 0.1	1.2 ± 0.11	1.26 ± 0.13	1.25 ± 0.12	1.28 ± 0.13	0.99
Peak V_E (liters/min)	107 ± 32	89.6 ± 37.8	76.7 ± 19.5	58.7 ± 12.8‡,‡	51.3 ± 14#,‡‡	< 0.0001
Peak V_E/Vco_2	31.4 ± 5.5	34.3 ± 5	40 ± 6.7†	47 ± 8.2‡,‡	65 ± 11#,‡‡,‡	< 0.0001
RVo_2	5.77 ± 2.34	4.81 ± 2.8	2.9 ± 0.9†	2 ± 0.63‡,‡	1.38 ± 0.64#,‡‡,‡	< 0.0001
½pVo_2 (s)	67.7 ± 26.5	89 ± 39	108 ± 44.6	137 ± 58.7‡¶	176 ± 75#,‡‡	< 0.0001
RT (s)	431 ± 135	465 ± 173	522 ± 169	531 ± 159	555 ± 201	0.024
RRT	3.5 ± 1.61	2.98 ± 2.28	1.78 ± 0.6†	1.27 ± 0.46‡,‡	0.95 ± 0.53#,‡‡,**¶	< 0.0001
Vo_2 at RT (ml/min)	375 ± 215	303 ± 169	251 ± 110	198 ± 61‡,¶	175 ± 71**,§§	< 0.0001
tRec (s)	76.5 ± 26.4	68.9 ± 36	127 ± 121	140 ± 72‡	209 ± 156#,§§	< 0.0001

De Groote et al JACC 1996;28:168-75

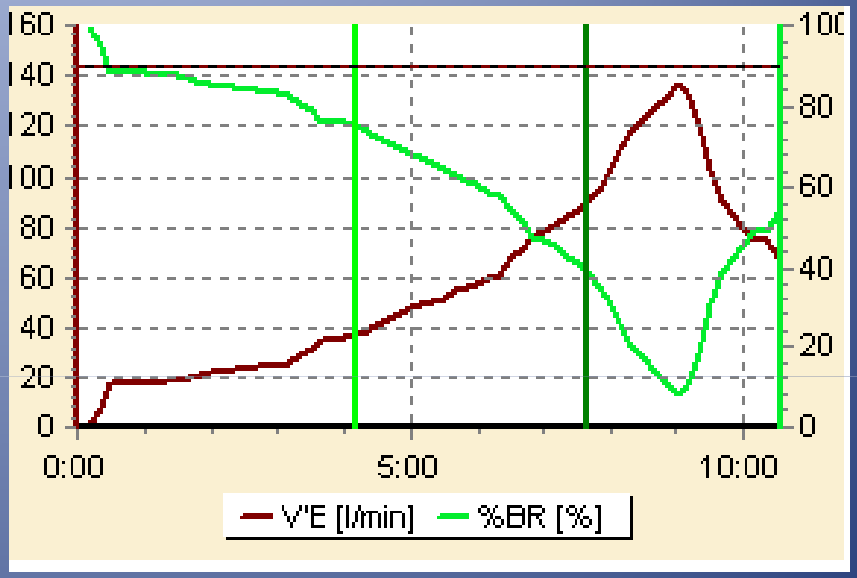
VENTILAÇÃO PERIÓDICA



VENTILAÇÃO PERIÓDICA

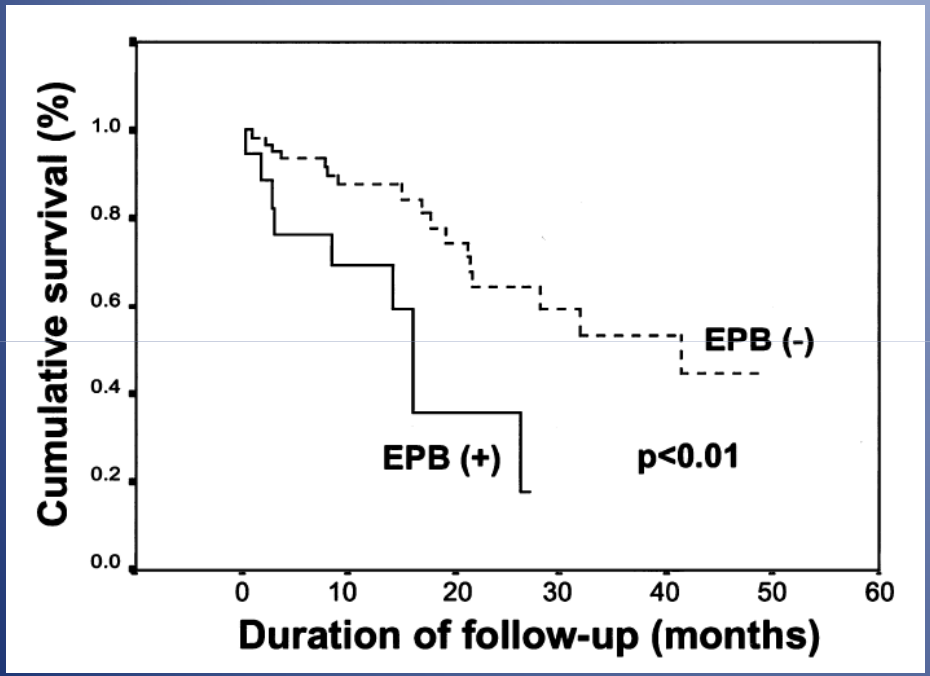


63 anos ICC CF III Chagas
FE 30% VO2 14 ml/kg/min

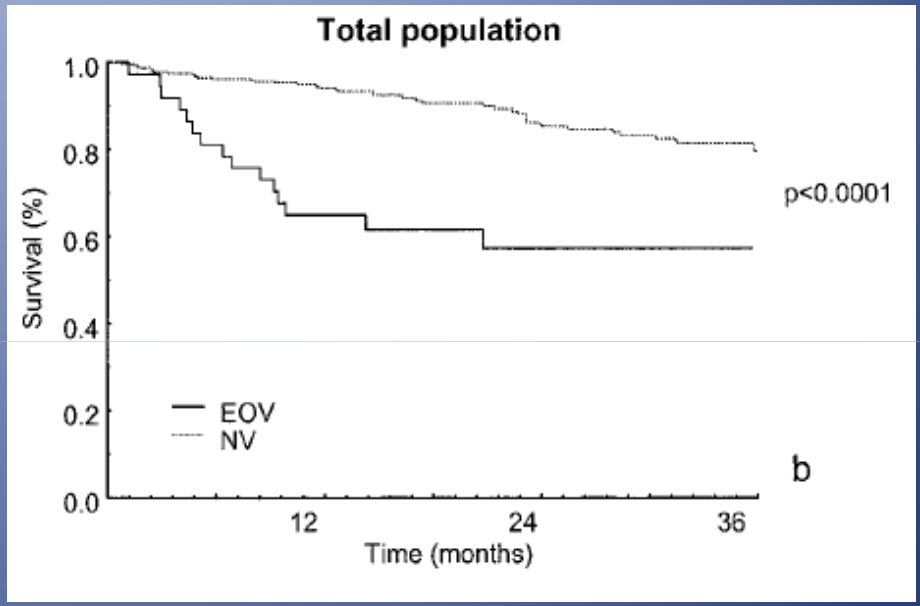


Atleta 26 anos

Oscillatory ventilation during exercise in patients with chronic heart failure



Leite JJ et al. J Am Coll Cardiol 2003 18:41:2182-4

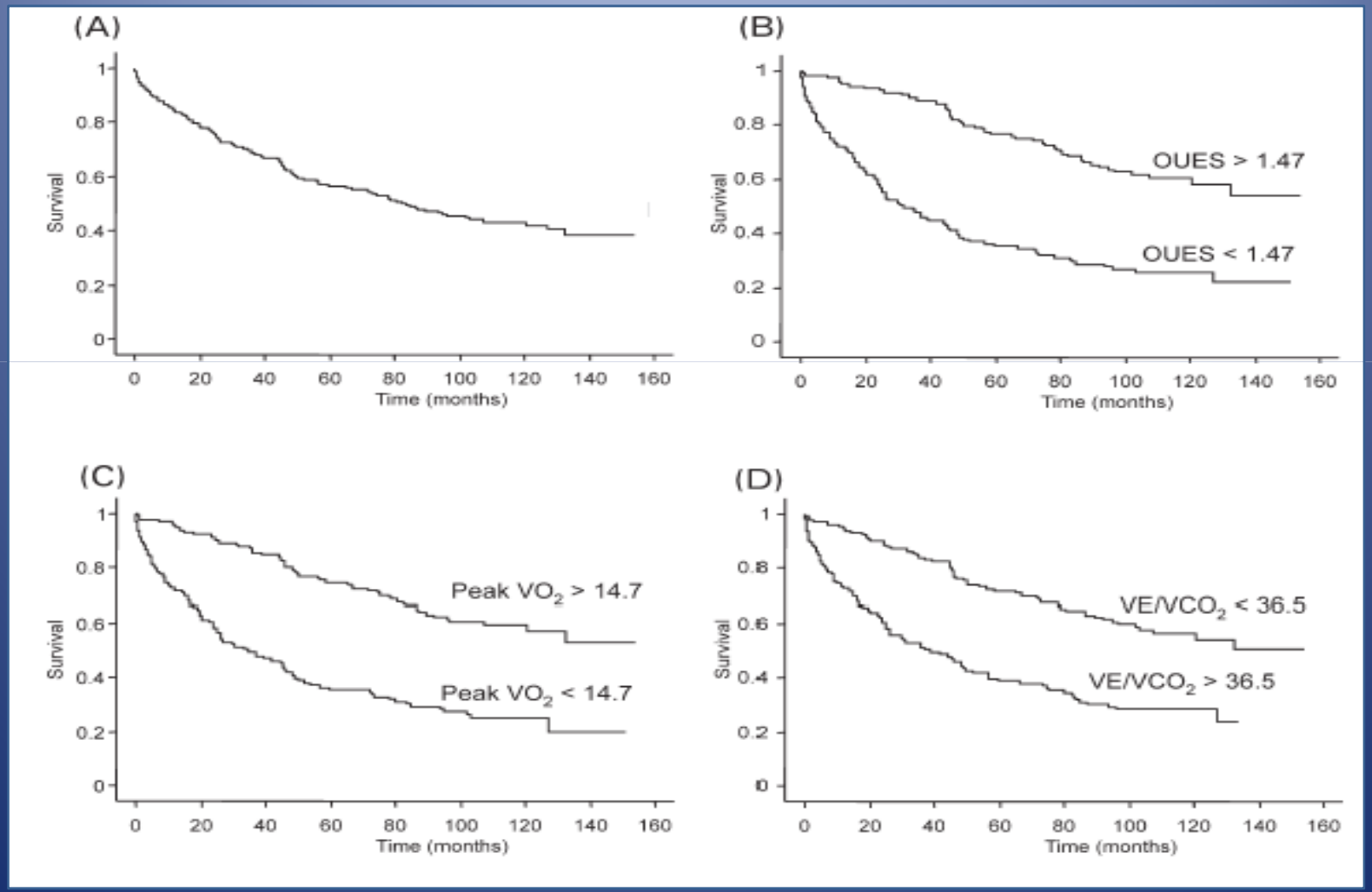


Corrà U et al. J. Chest 2002;121:1572-1580

OUES

OXYGEN UPTAKE EFFICIENCY SLOPE

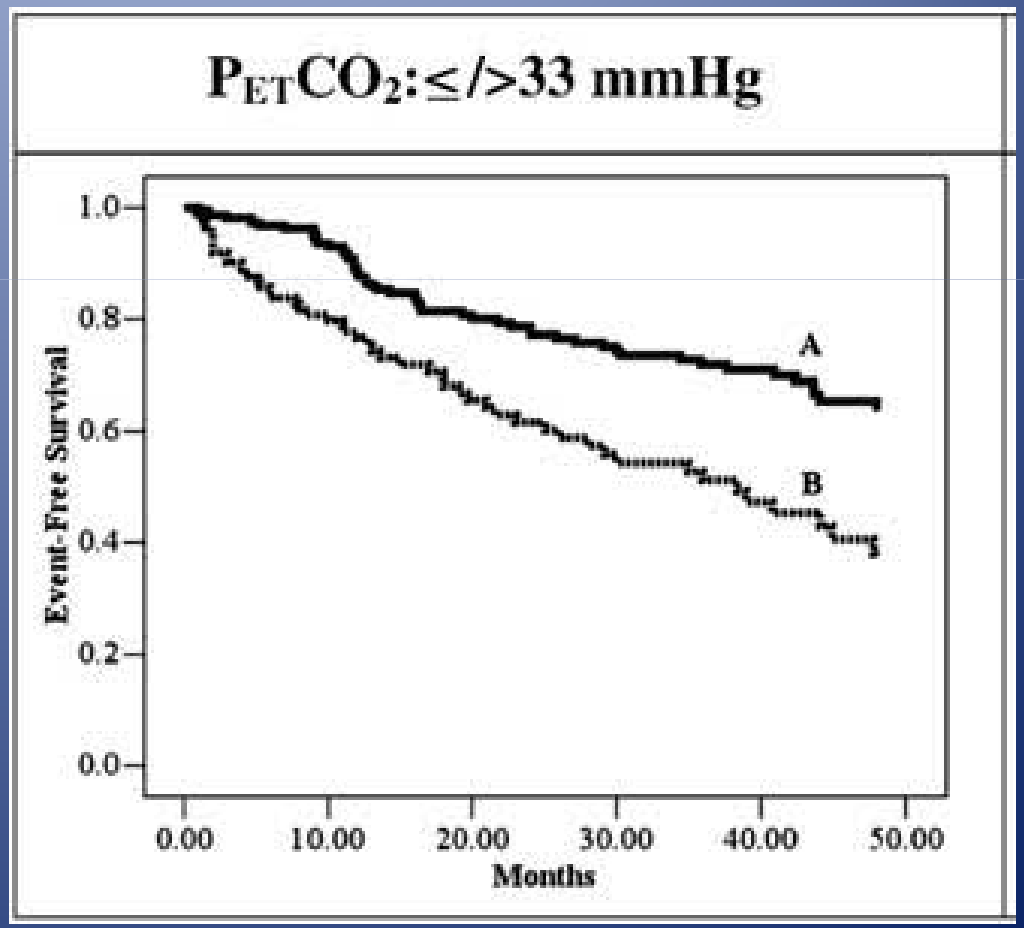
Enhanced prognostic value from cardiopulmonary exercise testing in chronic heart failure by non-linear analysis: oxygen uptake efficiency slope



Davies LC et al Eur Heart J 2006;27:684-90

OUTRAS VARIÁVEIS

- PEt CO2 repouso



Am Heart J 2008;156:982-88

Recuperação da FC e VE/VCO2 slope em area de VO2 intermediário (10-14 ml/kg/min)

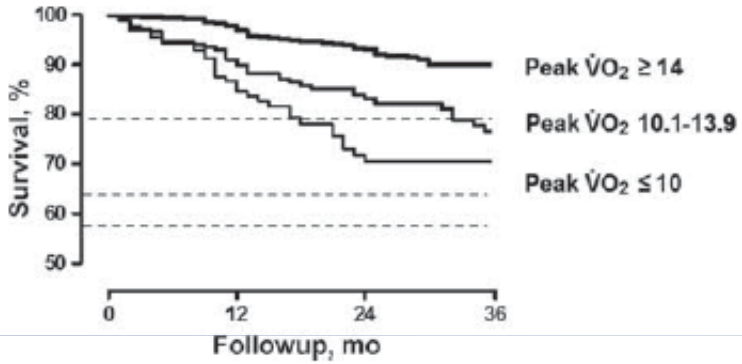


Figure 1. Kaplan-Meier survival curves for peak oxygen uptake ($\dot{V}o_2$) subgroups.

Groups	Hazard Ratio	95% CI	*P* Value
Peak $\dot{V}o_2$ ≥14 mL·kg^{-1}·min^{-1}	1 (Ref)	…	…
Peak $\dot{V}o_2$ 10.1-13.9 with			
$\dot{V}E/\dot{V}co_2$ ≥ 34 or HRR_1 <16	1.81	1.07-3.05	.02
Peak $\dot{V}o_2$ 10.1-13.9 mL·kg^{-1}·min^{-1} with			
$\dot{V}E/\dot{V}co_2$ ≥ 34 and HRR_1 < 16	3.51	2.33-5.29	<.001
Peak $\dot{V}o_2$ ≤ 10 mL·kg^{-1}·min^{-1}	3.11	2.07-4.68	<.001

Abbreviations: $\dot{V}o_2$, oxygen uptake; $\dot{V}E/\dot{V}co_2$ slope, minute ventilation/carbon dioxide production ($\dot{V}co_2$) slope; HRR_1, heart rate recovery at the first minute.

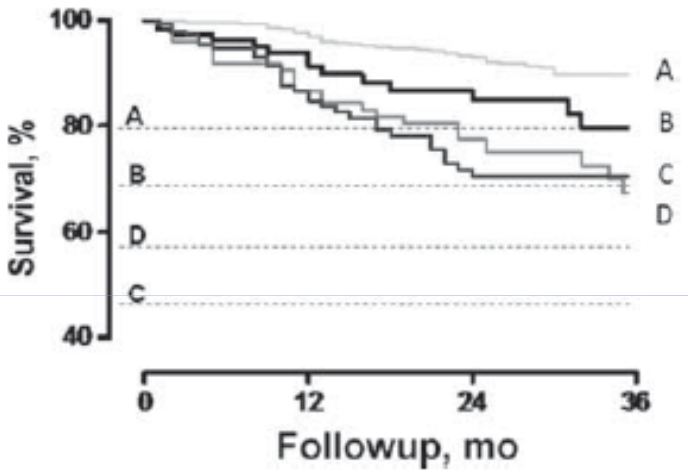


Figure 2. Kaplan-Meier survival curves for peak oxygen uptake ($\dot{V}o_2$) subgroups adding the minute ventilation–carbon dioxide production ($\dot{V}E/\dot{V}co_2$) slope and heart rate recovery at first minute (HRR_1) for subjects in the intermediate range.
(A) Peak $\dot{V}o_2$ 14 mL·kg^{-1}·min^{-1}.
(B) Peak $\dot{V}o_2$ 10.1-13.9 mL·kg^{-1}·min^{-1} and abnormal $\dot{V}E/\dot{V}co_2$ slope or HRR_1.
(C) Peak $\dot{V}o_2$ 410 mL·kg^{-1}·min^{-1}.
(D) Peak $\dot{V}o_2$ 10.1-13.9 mL·kg^{-1}·min^{-1} and abnormal $\dot{V}E/\dot{V}co_2$ slope and HRR_1.

Ritt LE, Oliveira RB, Myers J et al. JCRP 2012

A cardiopulmonary exercise testing score for predicting outcomes in patients with heart failure

Jonathan Myers , PhD,[a,b] Ross Arena, PhD,[c] Frederick Dewey, BA,[b] Daniel Bensimhon, MD,[d]
Joshua Abella, MD,[a] Leon Hsu, BS,[a] Paul Chase, MEd,[d] Marco Guazzi, MD, PhD,[c] and Mary Ann Peberdy, MD[c]

Circulation
Heart Failure

American Heart Association®

Validation of a Cardiopulmonary Exercise Test Score in Heart Failure

Jonathan Myers, Ricardo Oliveira, Frederick Dewey, Ross Arena, Marco Guazzi, Paul Chase, Daniel Bensimhon, Mary Ann Peberdy, Euan Ashley, Erin West, Lawrence P. Cahalin and Daniel E. Forman

Circ Heart Fail. 2013;6:211-218; originally published online February 7, 2013;
doi: 10.1161/CIRCHEARTFAILURE.112.000073
Circulation: Heart Failure is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231

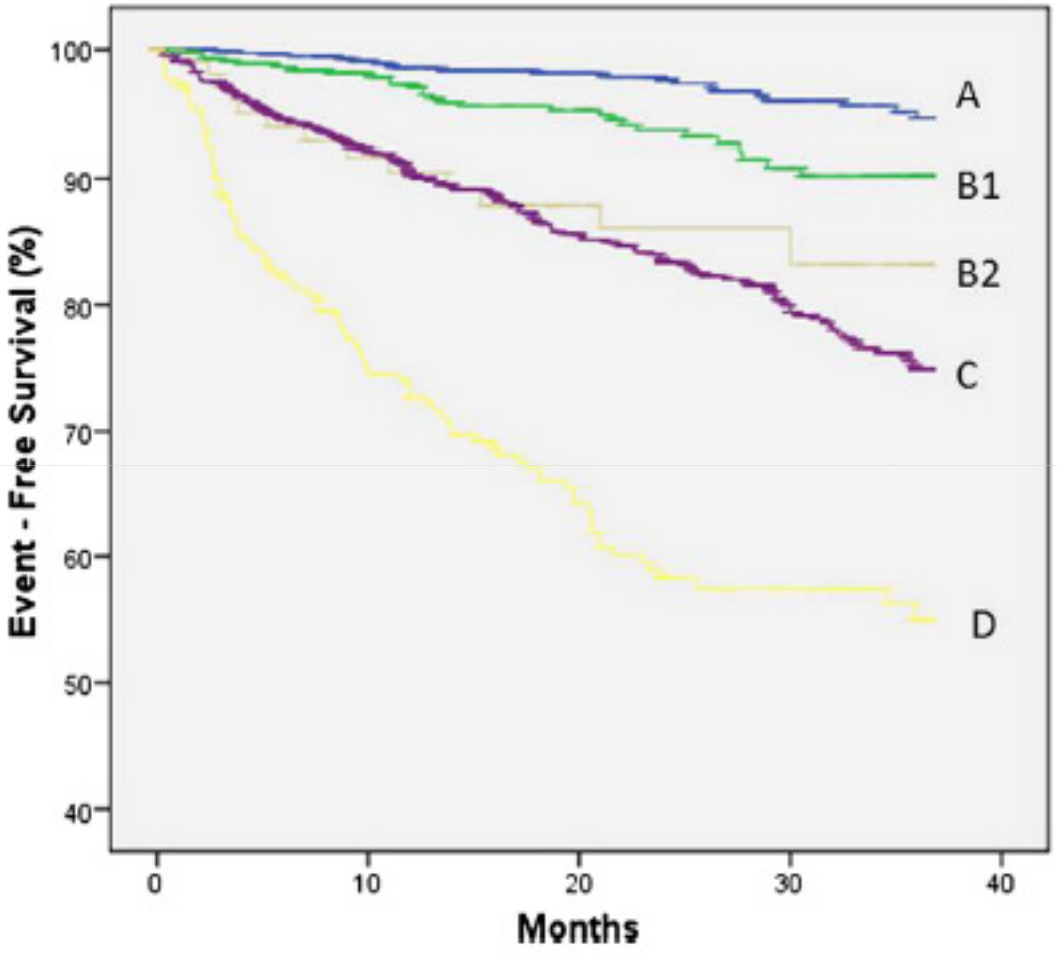
HHR1 – 5 pontos
OUES – 3 pontos
PETCO2 – 3 pontos
VO2 – 2 pontos
Total: 20 pontos

Am Heart J 2008;156:1177-83

CPX score em NYHA II

Additive prognostic value of a cardiopulmonary exercise test score in patients with hear

Luiz E. Ritt [a,*,1], Jonatha ... ul Chase [g,1], Daniel Bensimhon [g,1], E



		Weber C (n 990)	Weber D (n 262)
Age, y		± 13*	59 ± 13*
Male sex, %(n)		% (688)*	69% (180)*
BMI, kg/m²		± 6.0*	30 ± 7.5*
Medications %(n)			
Beta-blocker		% (678)*	73% (185)*
ACE inhibitor		% (598)*	63% (165)*
Diuretic		% (592)*	78% (174)*
Ejection fraction, %		± 14.2*ε	29 ± 14.3*
NYHA class		± 0.7*‡	3.0 ± 0.6*
Peak VO_2, ml^{-1} kg^{-1} min^{-1}		.1 ± 1.6*‡	8.0 ± 1.3*
Peak RER		0 ± 0.14	1.08 ± 0.17*
VE/VCO_2 slope		± 8.7*ε‡	44 ± 13*
OUES		0 ± 0.49*	1.07 ± 0.44*
HRR_1, beats		± 11*ε	13 ± 13*ε
Resting $PetCO_2$, mm Hg		± 4.7*‡	32 ± 5.0*
CPX summed score		± 4.6*‡	9.4 ± 3.8*
Combined Events, % (n)		5% (163)*ε‡	35.9% (94)*ε

§ $p < 0.05$ versus Weber D.
* $p < 0.05$ versus Weber A
† $p < 0.05$ versus Weber B1.
‡ $p < 0.05$ versus Weber C.

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RESUMO CASO

- Classe Weber B (VO2 15 – 20 ml/kg/min)
- Redução moderada capacidade funcional

- Classe ventilatória IV
- Recuperação VO2 = 200’ (VN < 90 seg)
- Comportamento hemodinâmico deprimido

- FC pico= 120; FC rec 1= 114 bpm
(≠ 6 bpm; VN > 16 bpm)
- Score TCP: 18

- FC limiar = 91 bpm e carga 2,4 Km/h

AHA Scientific Statement

Clinician's Guide to Cardiopulmonary Exercise Testing in Adults

A Scientific Statement From the American Heart Association

Gary J. Balady, MD, FAHA, Chair; Ross Arena, PhD, FAHA; Kathy Sietsema, MD; Jonathan Myers, PhD, FAHA; Lola Coke, RN, PhD; Gerald F. Fletcher, MD, FAHA; Daniel Forman, MD; Barry Franklin, PhD, FAHA; Marco Guazzi, MD, PhD; Martha Gulati, MD; Steven J. Keteyian, PhD; Carl J. Lavie, MD; Richard Macko, MD; Donna Mancini, MD; Richard V. Milani, MD, FAHA; on behalf of the American Heart Association Exercise, Cardiac Rehabilitation, and Prevention Committee of the Council on Clinical Cardiology; Council on Epidemiology and Prevention; Council on Peripheral Vascular Disease; and Interdisciplinary Council on Quality of Care and Outcomes Research

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POSITION STATEMENT

EACPR/AHA Joint Scientific Statement

Clinical recommendations for cardiopulmonary exercise testing data assessment in specific patient populations

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