

Scompenso cardiaco ed esercizio fisico

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GUIDELINE

International Society for Heart and
Lung Transplantation Guidelines for
the Evaluation and Care of Cardiac
Transplant Candidates—2024



Table 4 Summary of CPET Parameters Supporting Transplant Listing in Different Populations	
Patient population	Parameter supporting transplant listing
On beta-blocker ^{63–67}	Lower peak VO ₂ cutoff is supportive of transplant listing, generally ≤12 ml/kg/min
Off beta-blocker ^{67,68}	Higher peak VO ₂ may be considered supportive of transplant listing, generally ≤14 ml/kg/min
Patients with obesity (BMI ≥ 30 kg/m ²) ⁶⁹	Peak VO ₂ adjusted for lean body mass ≤19 ml/kg/min
All, especially if submaximal CPET ^{70–75}	VE/VCO ₂ slope > 35
Women or patients ≤50 or ≥70 years ^{76–78}	Peak VO ₂ ≤ 50% predicted
Abbreviations: BMI, body mass index; CPET, cardiopulmonary exercise test; VE/VCO ₂ , the minute ventilation/carbon dioxide production. Maximal CPET: respiratory exchange ratio (RER) > 1.05 and reaching anaerobic threshold. ⁷⁹	

CPET parameters and Heart transplant

a) Peak VO_2

- BB yes or no

b) VE/VCO_2

c) Periodic breathing

Population of HF patients is changing over time

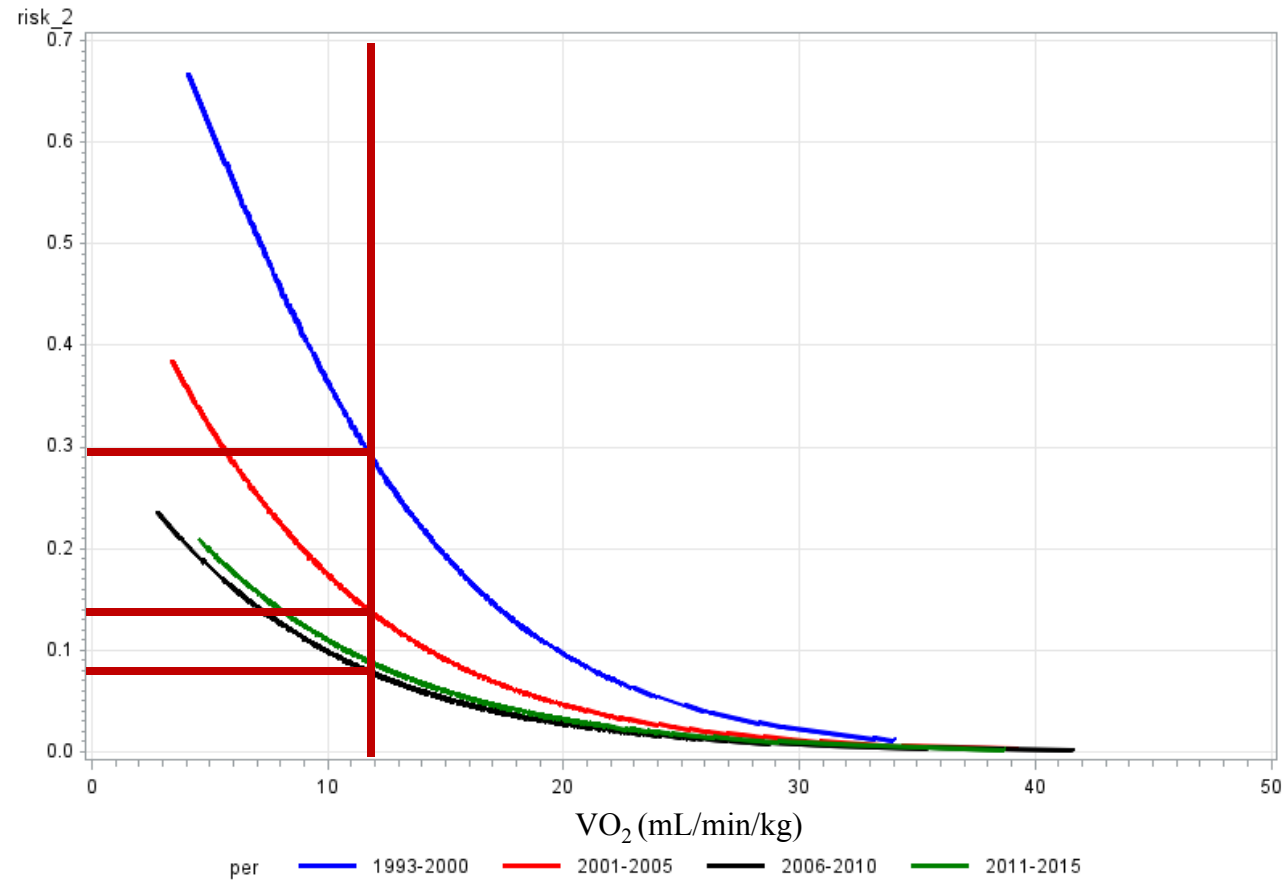
- group 1 1993-2000 (n=440)
- group 2 2001-2005
(n=1288)
- group 3 2006-2010
(n=2368)

Endpoint: CV death + transplant + LVAD
(n=1987)

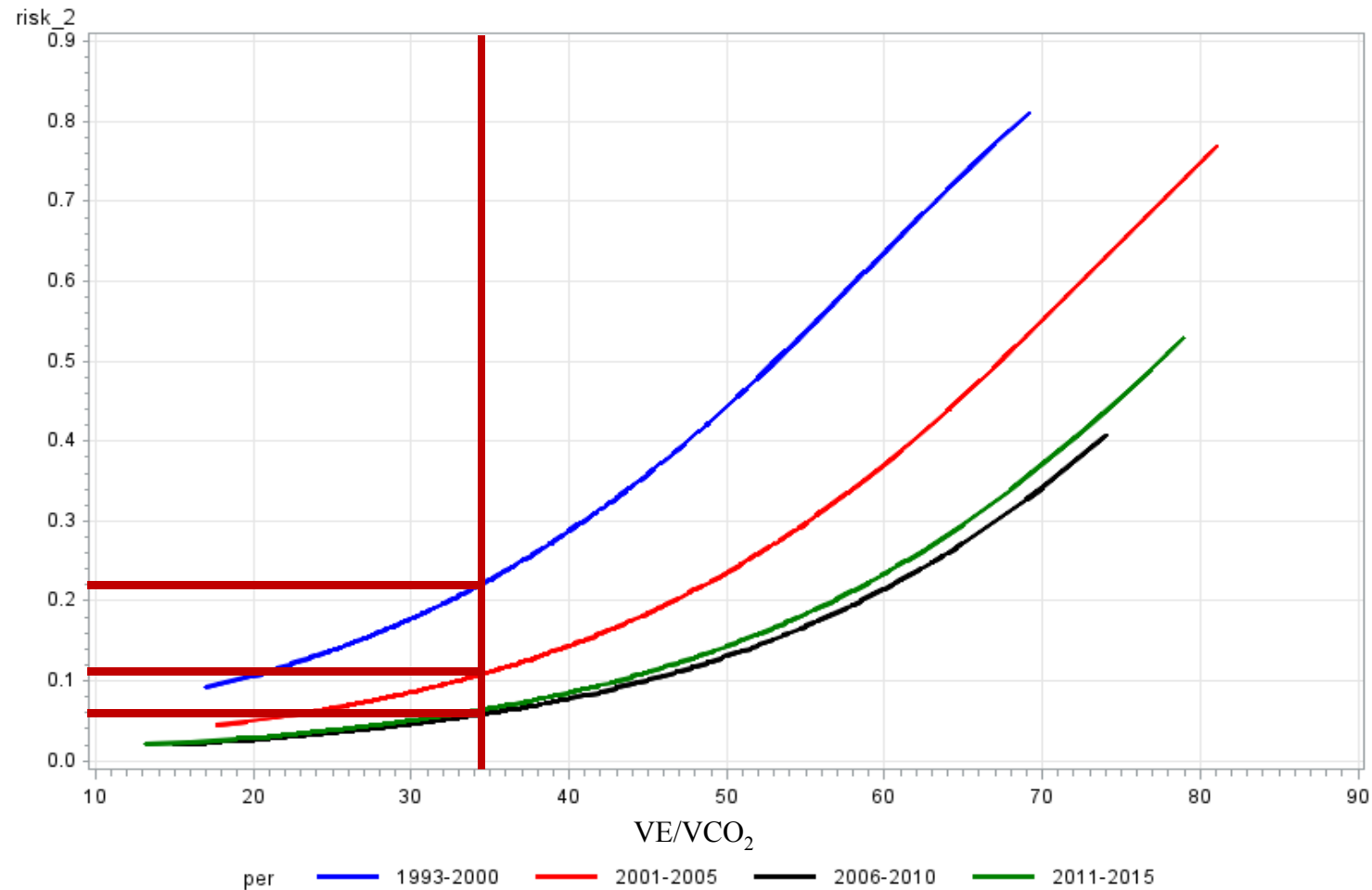


10 year survival

Rischio e VO_2



Rischio e VE/VCO_2



Prognostic value of VE/VCO₂ slope and y-Intercept in Heart Failure

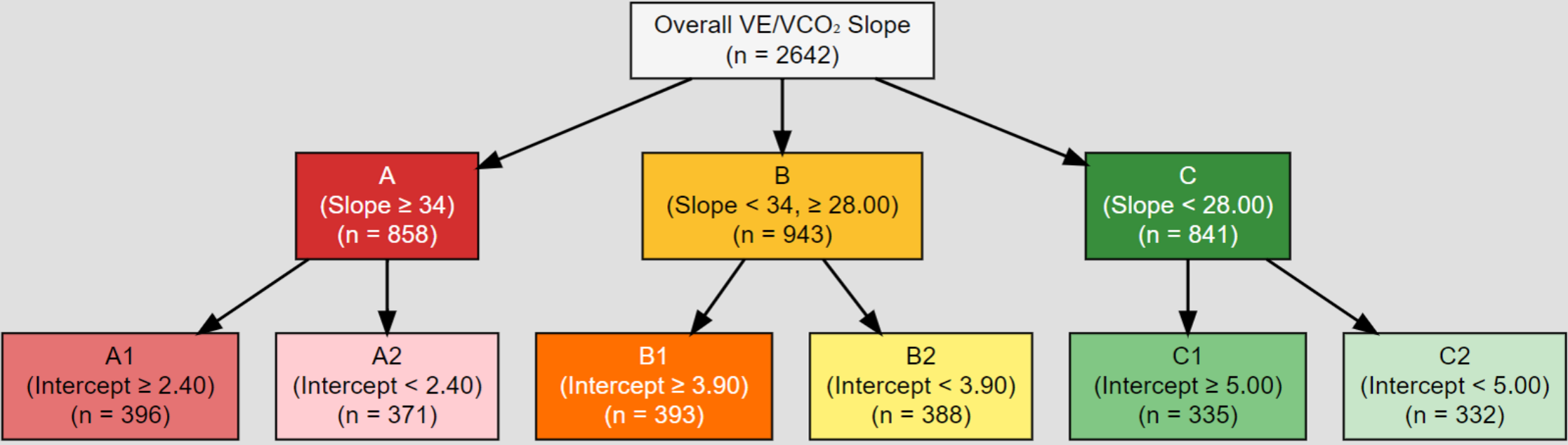
**2642 *p.* Heart
Failure**



**All cause mortality
LVAD
HTx**



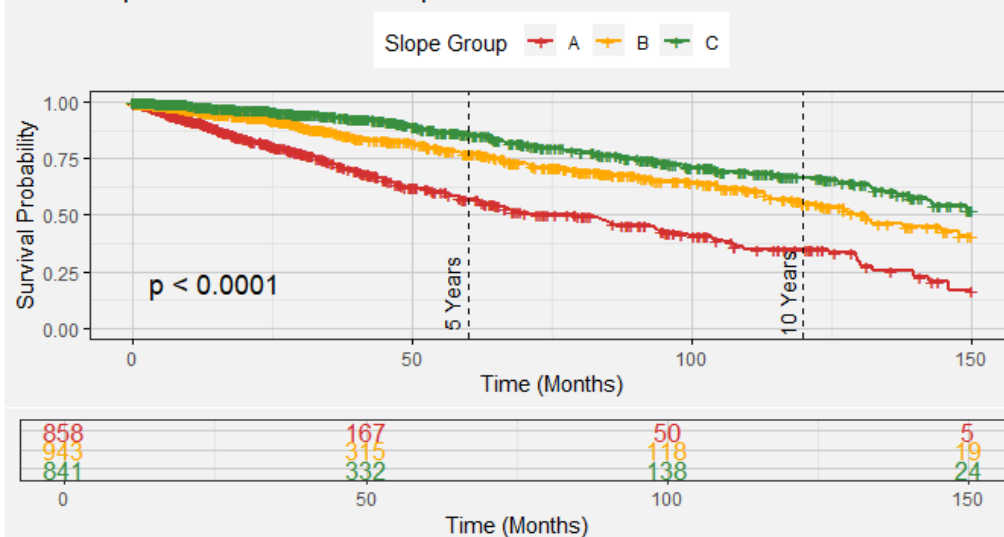
Group Classification by VE/VCO₂ Slope and Intercept



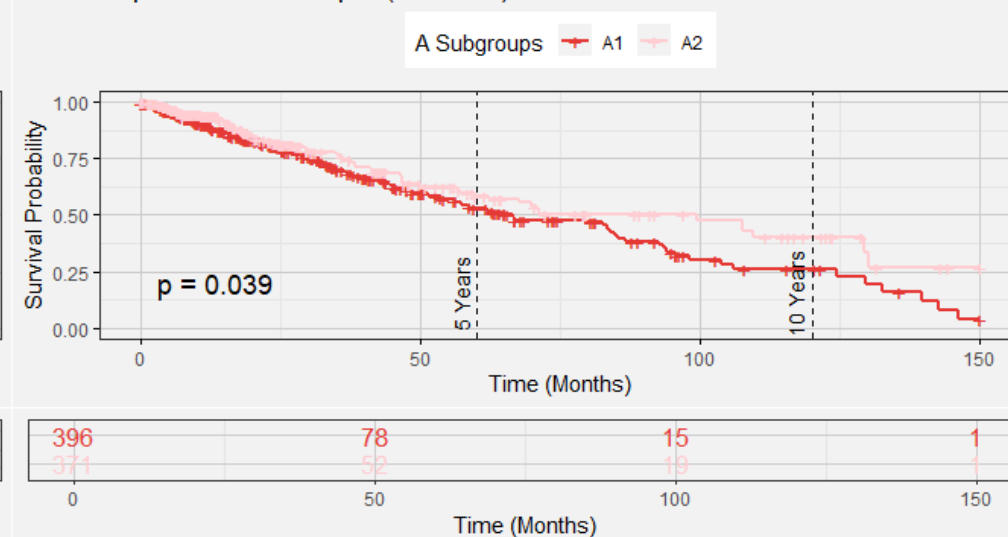
Time of follow-up	26 months (IQR 9-63)
Events	534



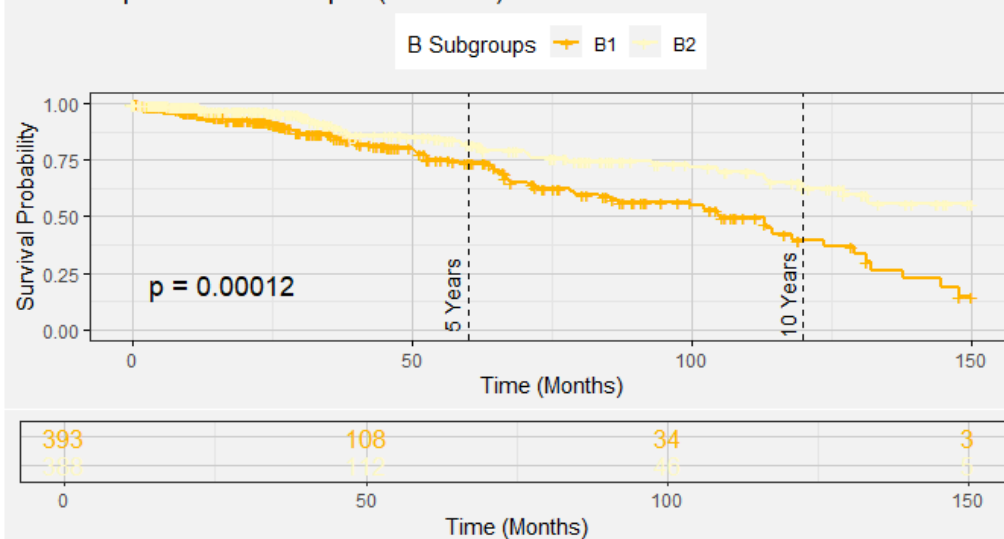
1 Kaplan-Meier: A, B, C Groups



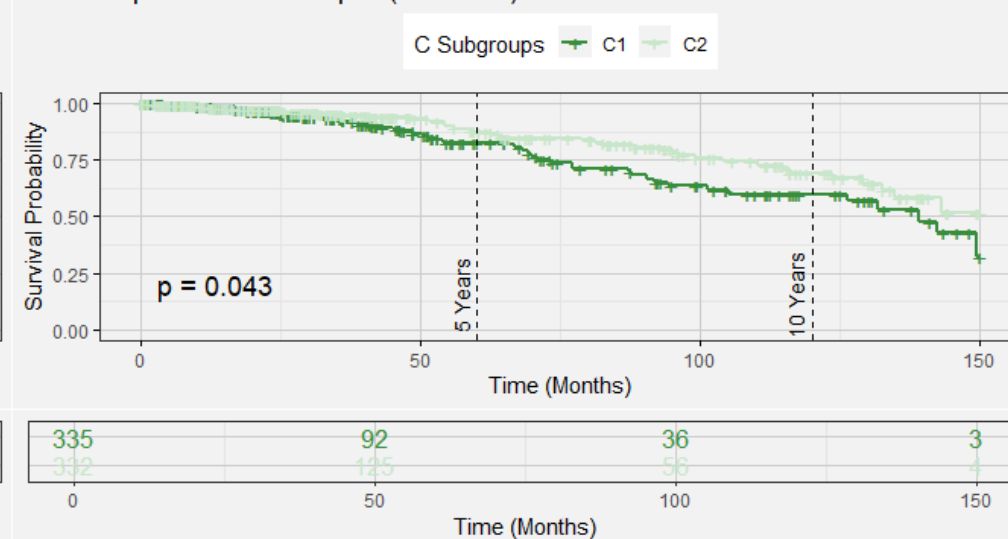
2 Kaplan-Meier: Group A (A1 vs A2)



3 Kaplan-Meier: Group B (B1 vs B2)

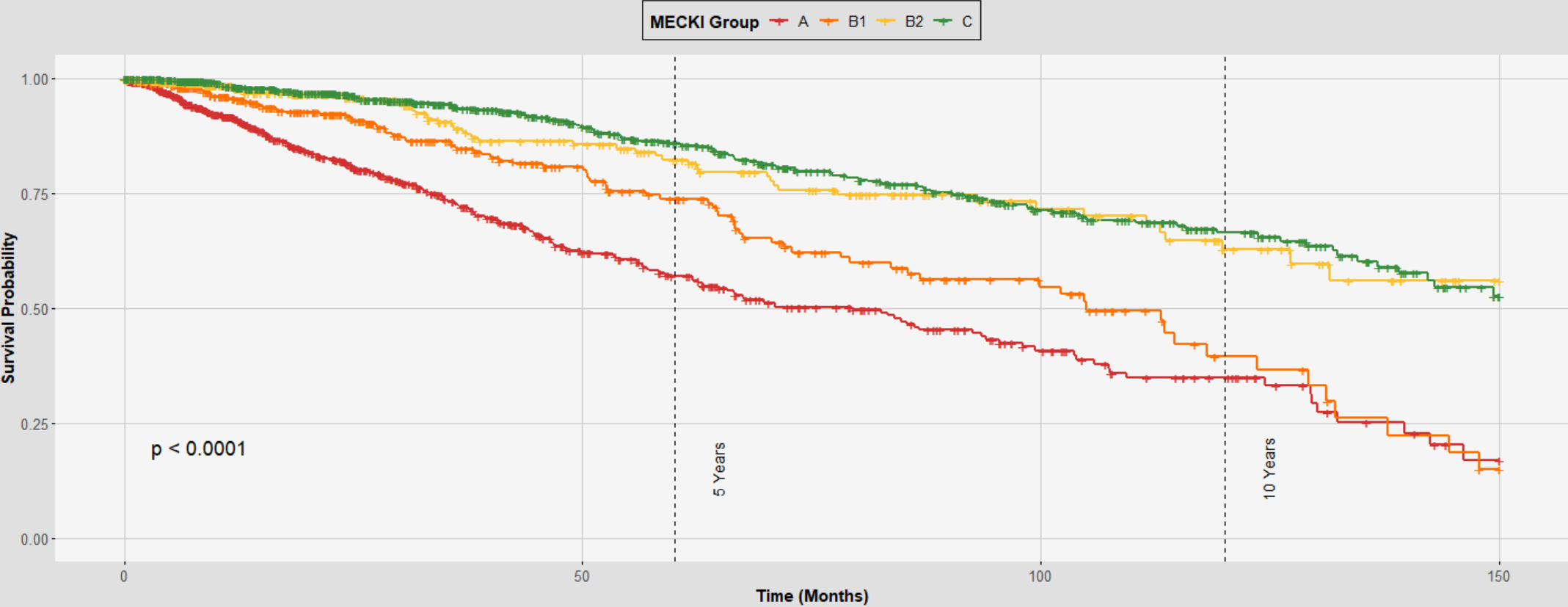


4 Kaplan-Meier: Group C (C1 vs C2)





Kaplan-Meier: A, B1, B2, C Groups



Number at risk

MECKI Group	0	50	100	150
A	858	167	50	5
B1	393	108	34	3
B2	388	112	46	5
C	841	332	138	24

Time (Months)

Prognostic role of β -blocker selectivity and dosage regimens in heart failure patients. Insights from the MECKI score database

Stefania Paolillo^{1,2}, Massimo Mapelli², Alice Bonomi², Ugo Corrà³, Massimo Piepoli⁴, Fabrizio Veglia¹, Elisabetta Salvioni², Piero Gentile⁵, Rocco Lagioia⁶, Marco Metra⁷, Giuseppe Limongelli⁸, Gianfranco Sinagra⁵, Gaia Cattadori⁹, Angela B. Scardovi¹⁰, Valentina Carubelli⁷, Domenico Scrutino⁶, Roberto Badagliacca¹¹, Rosa Raimondo¹², Michele Emdin^{13,14}, Damiano Magri¹⁵, Michele Correale¹⁶, Gianfranco Parati^{17,18}, Sergio Caravita¹⁷, Emanuele Spadafora², Federica Re¹⁹, Mariantonietta Cicoira²⁰, Maria Frigerio²¹, Maurizio Bussotti²², Chiara Minà²³, Fabrizio Oliva²¹, Elisa Battaia²⁴, Romualdo Belardinelli²⁵, Alessandro Mezzani³, Luigi Pastormerlo¹⁴, Andrea Di Lenarda²⁶, Claudio Passino^{13,14}, Susanna Sciomer¹¹, Annamaria Iorio²⁷, Elena Zambon⁵, Marco Guazzi²⁸, Giuseppe Pacileo⁸, Roberto Ricci¹⁰, Mauro Contini², Anna Apostolo², Pietro Palermo², Francesco Clemenza²³, Giovanni Marchese¹⁵, Simone Binno⁴, Carlo Lombardi⁷, Andrea Passantino⁶, Pasquale Perrone Filardi²⁹, and Piergiuseppe Agostoni^{2,30*}

Does beta blocker treatment influence VO₂ meaning?



Letter to the Editor

Severe heart failure prognosis evaluation for transplant selection in the era of beta-blockers: Role of peak oxygen consumption

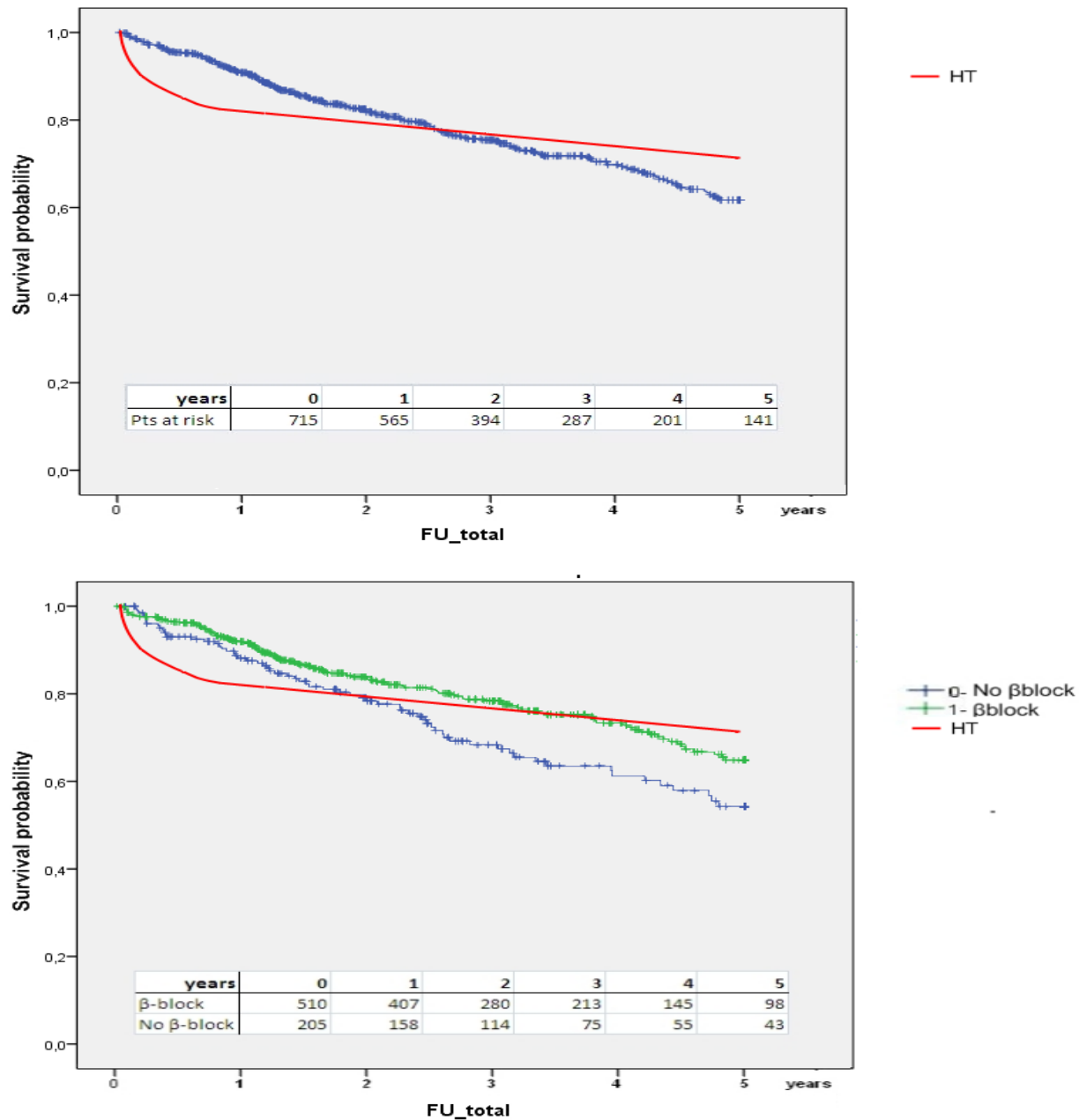
Gaia Cattadori ^{a,*}, Piergiuseppe Agostoni ^{a,b,c}, Ugo Corrà ^d, Andrea Di Lenarda ^e, Gianfranco Sinagra ^f, Fabrizio Veglia ^a, Elisabetta Salvioni ^a, Rocco La Gioia ^g, Angela B. Scardovi ^h, Michele Emdin ⁱ, Marco Metra ^j, Giuseppe Limongelli ^k, Rosa Raimondo ^l, Federica Re ^m, Marco Guazzi ⁿ, Romualdo Belardinelli ^o, Gianfranco Parati ^p, Damiano Magri ^q, Cesare Fiorentini ^{a,b}, Alessandro Mezzani ^d, Domenico Scrutinio ^g, Giuseppe Pacileo ^k, Anna Apostolo ^a, AnnaMaria Iorio ^f, Stefania Paolillo ^r, Pietro Palermo ^a, Mauro Contini ^a, Pantaleo Giannuzzi ^d, Elisa Battaia ^s, Mariantonietta Cicoira ^s, Claudio Passino ^{i,t}, Massimo F. Piepoli ^u, on behalf of the MECKI score research group (appendix)



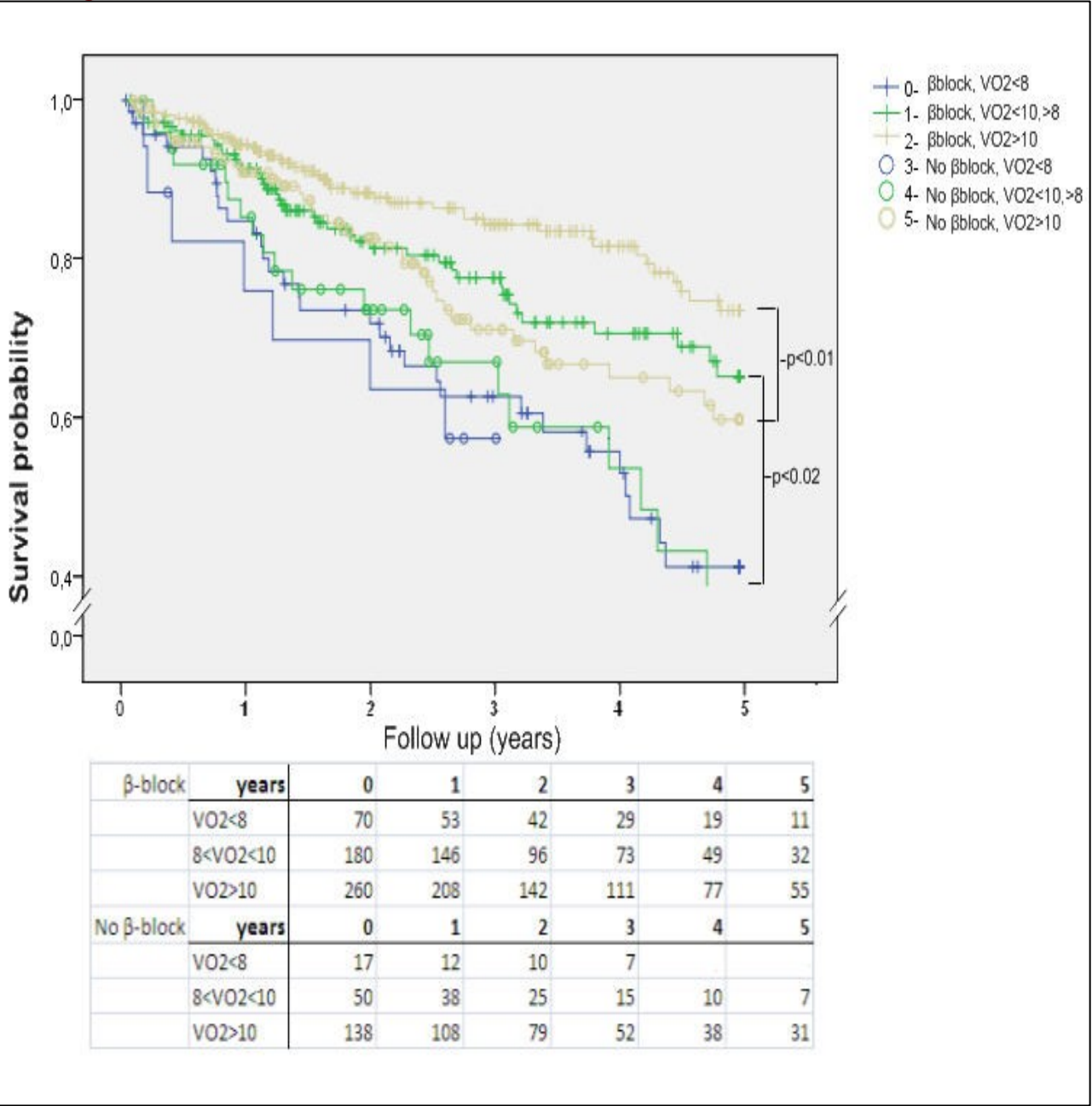
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I pazienti
β-bloccati hanno
una prognosi
diversa

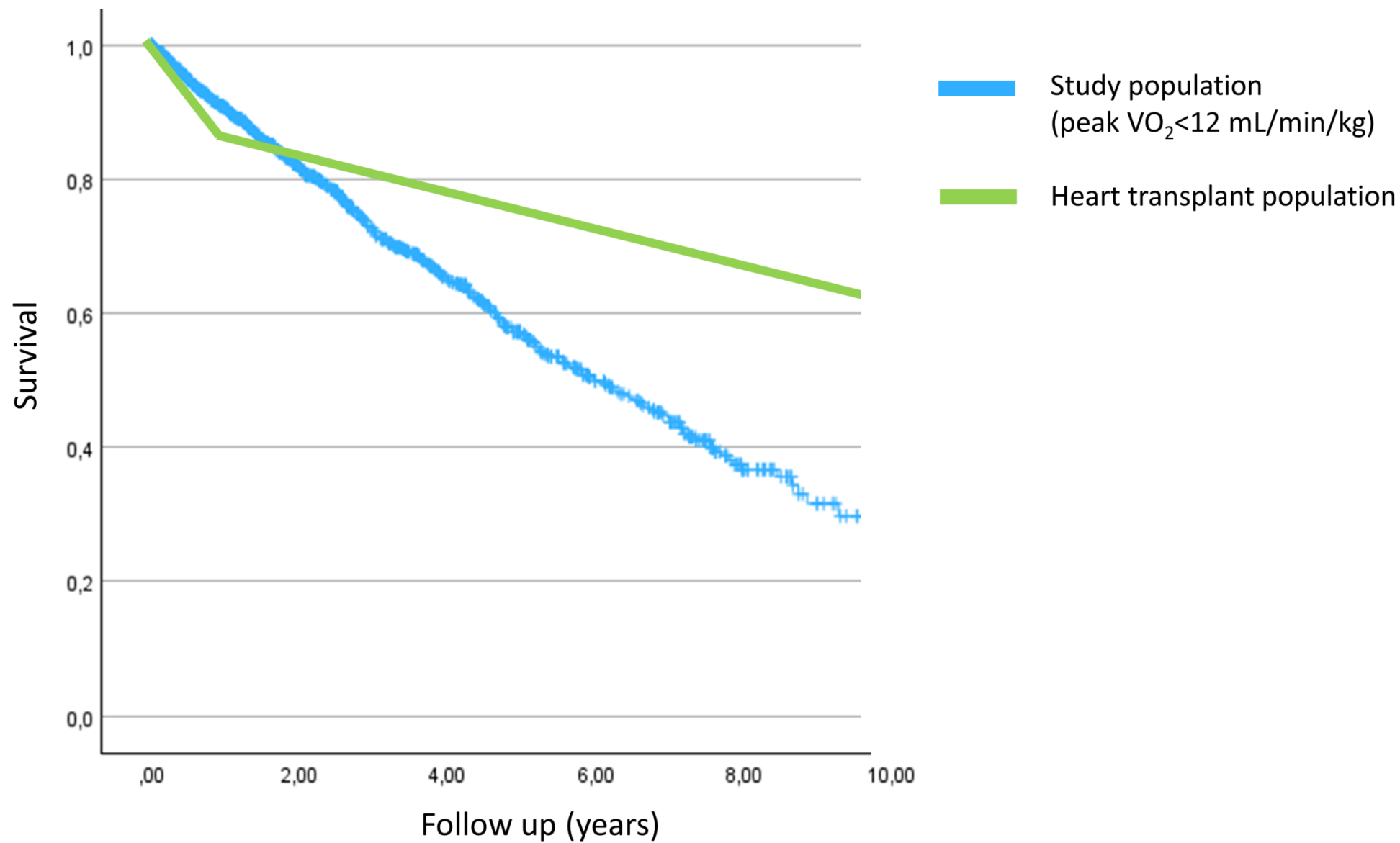


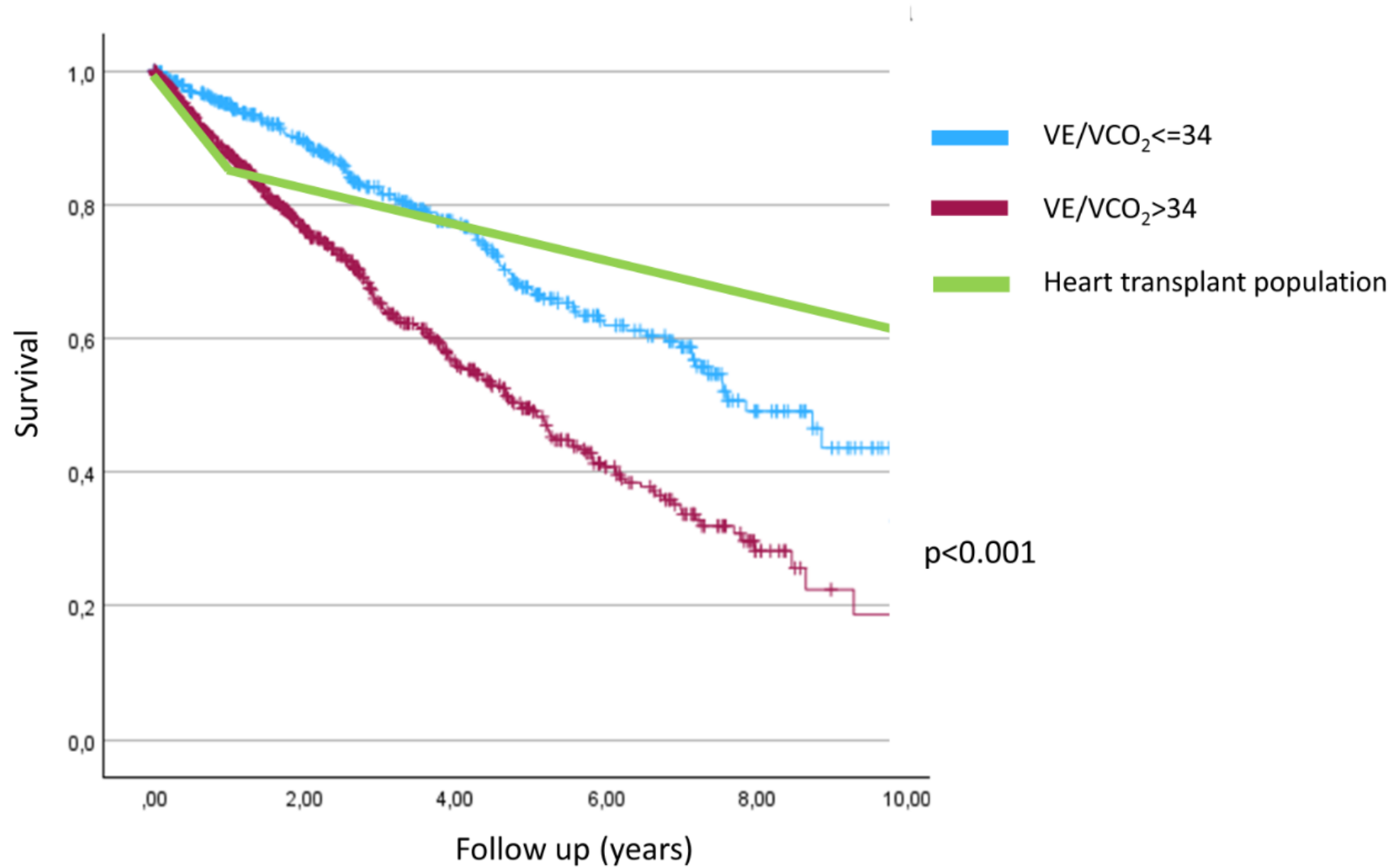
1218 patients with heart failure with reduced ejection fraction (HFrEF, n=1006) or improved ejection fraction (HFimpEF, n=212) **and peak VO₂**

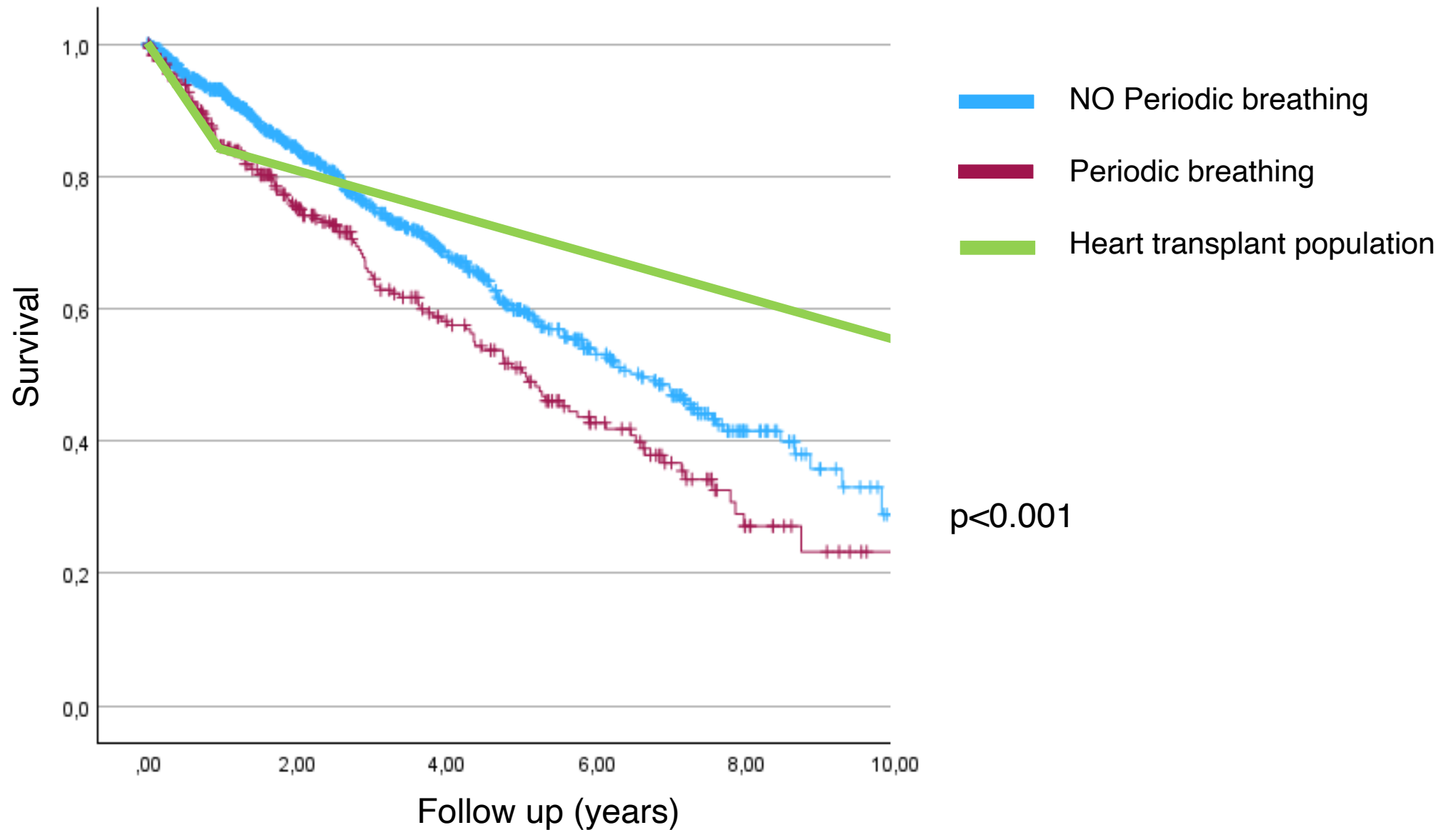
<12 ml/min/kg

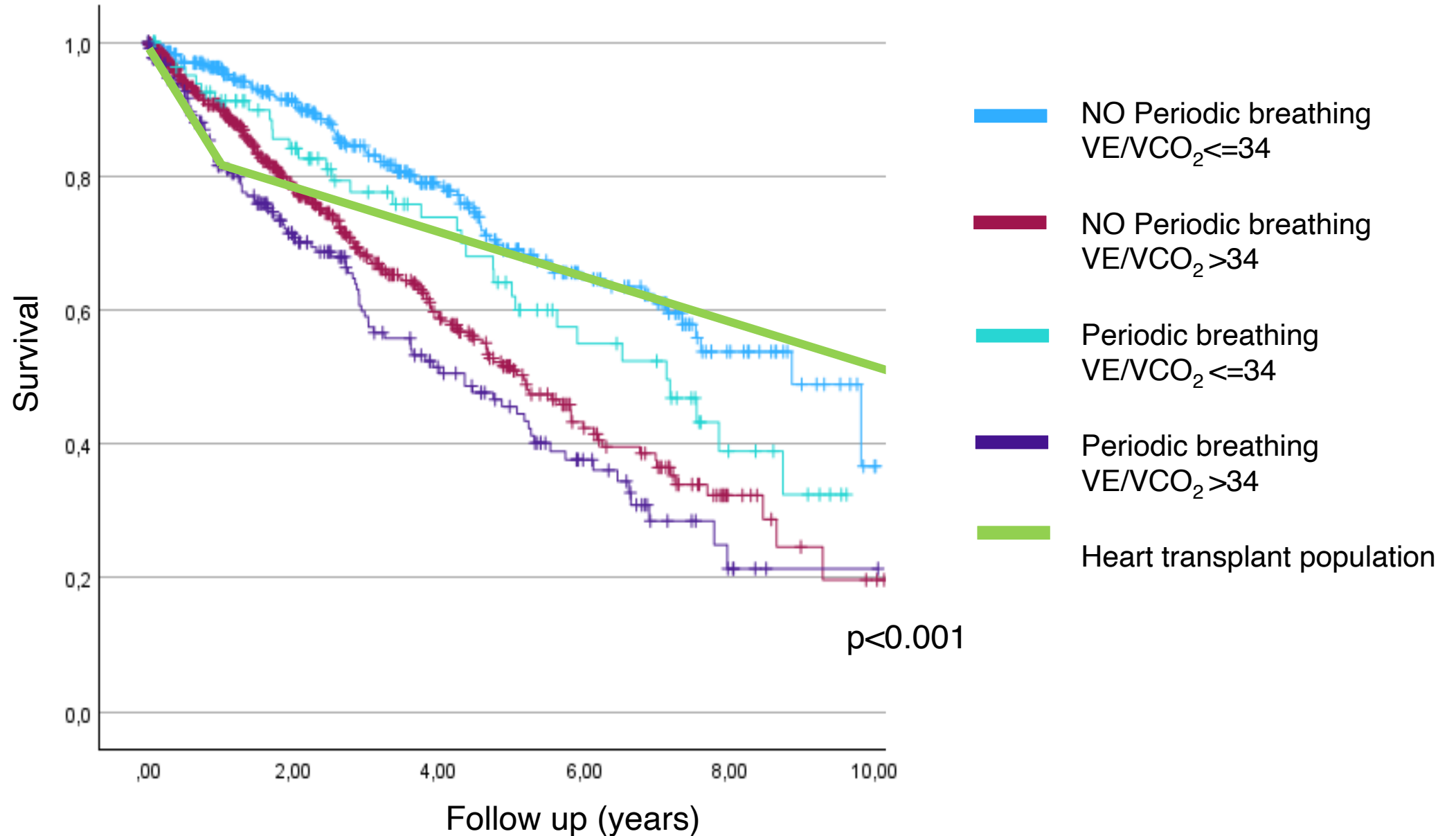
Enrollment after

	Mean ± SD
Age	66.9± 11.6
Weight (kg)	78.9±16.3
Height (cm)	169±9
LVEF	32.1±10.7
Sex, Male (%)	75.4%
NYHA 1(%)	6.9%
NYHA 2(%)	46.3%
NYHA 3(%)	42.9%
NYHA 4(%)	2.7%
IHD (%)	46.9%
AF (%)	28.1%
LVEF	32.1±10.7
EDV*	185±78
ESV**	130.6±69
Creatinine	1.37±0.82









ON TOP OF CPET

- **CPET IN THE PROGNOSTIC SCORES**
- **WHICH VALUE FOR HEART TRANSPLANT LISTING ?**

GUIDELINE

International Society for Heart and Lung Transplantation Guidelines for the Evaluation and Care of Cardiac Transplant Candidates—2024



Yael Peled, MD,^{1,2,a,*} Anique Ducharme, MD, MSc,^{3,a,**} Michelle Kittleson, MD, PhD,⁴ Neha Bansal, MD,⁵ Josef Stehlik, MD, MPH,⁶ Shah Nawaz Amdani, MD,⁷ Diyar Saeed, MD, PhD,⁸ Richard Cheng, MD, MS,⁹ Brian Clarke, MD,¹⁰ Fabienne Dobbels, PhD,¹¹ Mary Jane Farr, MD, MSc,¹² JoAnn Lindenfeld, MD,¹³ Lazaros Nikolaidis, MD,¹⁴ Jignesh Patel, MD, PhD,¹⁵ Deepak Acharya, MD,¹⁶ Dimpna Albert, MD, PhD,¹⁷ Saima Aslam, MD,¹⁸ Alejandro Bertolotti, MD,¹⁹ Michael Chan, MD,²⁰ Sharon Chih, MD,²¹ Monica Colvin, MD,²² Maria Crespo-Leiro, MD,²³ David D'Alessandro, MD,²⁴ Kevin Daly, MD,²⁵ Carlos Diez-Lopez, MD, PhD,²⁶ Anne Dipchand, MD,²⁷ Stephan Ensinger, MD,²⁸ Melanie Everitt, MD,²⁹ Alexander Fardman, MD,³⁰ Marta Farrero, MD, PhD,³¹ David Feldman, MD, PhD,³² Christiana Gjela, DNP,³³ Matthew Goodwin, MD, MS,³⁴ Kimberly Harrison, PharmD, BCTXP,³⁵ Eileen Hsieh, MD,³⁶ Emer Joyce, MB, BCH, PhD,³⁷ Tomoko Kato, MD,³⁸ Daniel Kim, MD,³⁹ Me-Linh Luong, MD,⁴⁰ Haifa Lyster, FRPharmS,⁴¹ Marco Masetti, MD,⁴² Ligia Neres Matos, RN,⁴³ Johan Nilsson, MD, PhD,⁴⁴ Pierre-Emmanuel Noly, MD, PhD,⁴⁵ Vivek Rao, MD, PhD,⁴⁶ Katrine Rold, MSc, PhD,⁴⁷ Kelly Schendorf, MD,⁴⁸ Martin Schweiger, MD,⁴⁹ Joseph Spinner, MD,⁵⁰ Madeleine Townsend, MD,⁵¹ Maxime Tremblay-Gravel, MD, MSc,⁵² Simon Urschel, MD,⁵³ Jean-Luc Vachery, MD,⁵⁴ Angela Velleca, MHDS, RN,⁵⁵ Georgina Waldman, PharmD, BCTXP,⁵⁶ and James Walsh, BPhy, PhD⁵⁷



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- Multiple prognosis scores have been developed to risk stratify patients with HF.^{51,52} The Heart Failure Survival Score (HFSS), Seattle Heart Failure Model (SHFM), Meta-Analysis Global Group in Chronic Heart Failure (MAGGIC) score, and Metabolic Exercise Test Data combined with Cardiac and Kidney Indexes (MECKI) score were developed for patients with chronic HF,^{53–55} while other scores such as the Organized Program to Initiate Lifesaving Treatment in Hospitalized Patients with Heart Failure (OPTIMIZE-HF), Get With The Guidelines-Heart Failure (GWTG-HF), and Evaluation Study of Congestive Heart Failure and Pulmonary Artery Catheterization Effectiveness (ESCAPE) score were developed for patients with acute HF.^{56–60} In circumstances where there is ambiguity regarding appropriateness for listing based on other data, scores that suggest an estimated 1-year survival < 85% may help guide decision-making. Importantly, because all scores have inherent limitations, few have been developed or validated in a contemporary cohort, and most perform poorly when applied to individuals (as opposed to populations). Thus, their values should not be used as the sole criteria for listing.^{61,62}



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

10. Advanced heart failure

Supplementary Table I3 Suggested clinical, laboratory, and echocardiographic criteria to trigger referral to a specialized heart failure or advanced heart failure unit

Clinical	Laboratory	Imaging	Risk score data
• >1 HF hospitalization in last year • NYHA class III–IV • Intolerant of optimal dose of any GDMT HF drug • Increasing diuretic requirement • SBP ≤ 90 mmHg • Inability to perform CPET • 6MWT <300 m • CRT non responder clinically • Cachexia, unintentional weight loss • KCCQ decrease >5 units	• eGFR <45 mL/min • SCr ≥ 160 micromoles/L • K^+ >5.2 or <3.5 mmol/L • Hyponatraemia • Hb ≤ 120 g/L • Persistently elevated high BNP/NT-proBNP, e.g. NT-proBNP ≥ 1000 pg/mL • Abnormal liver function test • Low albumin	• LVEF $\leq 30\%$ • Large area of akinesis/dyskinesis or aneurysm • Moderate^a-severe mitral regurgitation • RV dysfunction • Systolic PA pressure ≥ 50 mmHg • Moderate-severe tricuspid regurgitation • Difficult to grade aortic stenosis • IVC dilated or without respiratory variation	• MAGGIC predicted survival $\leq 80\%$ at 1 year • SHFM predicted survival <80% at 1 year • MECKI predicted survival $\leq 80\%$ at 1 year



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International Journal of Cardiology

journal homepage: www.elsevier.com/locate/ijcard



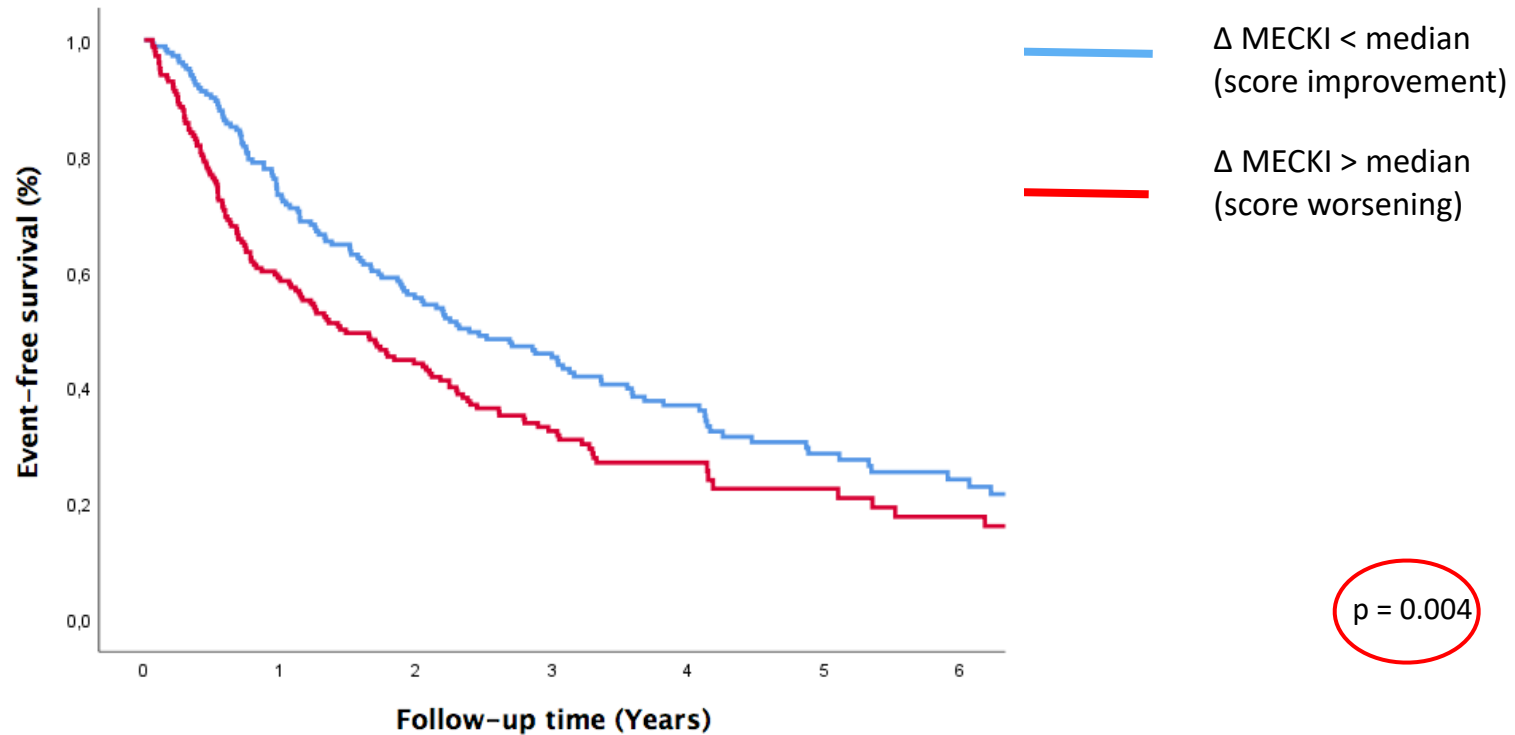
The importance of re-evaluating the risk score in heart failure patients: An analysis from the Metabolic Exercise Cardiac Kidney Indexes (MECKI) score database

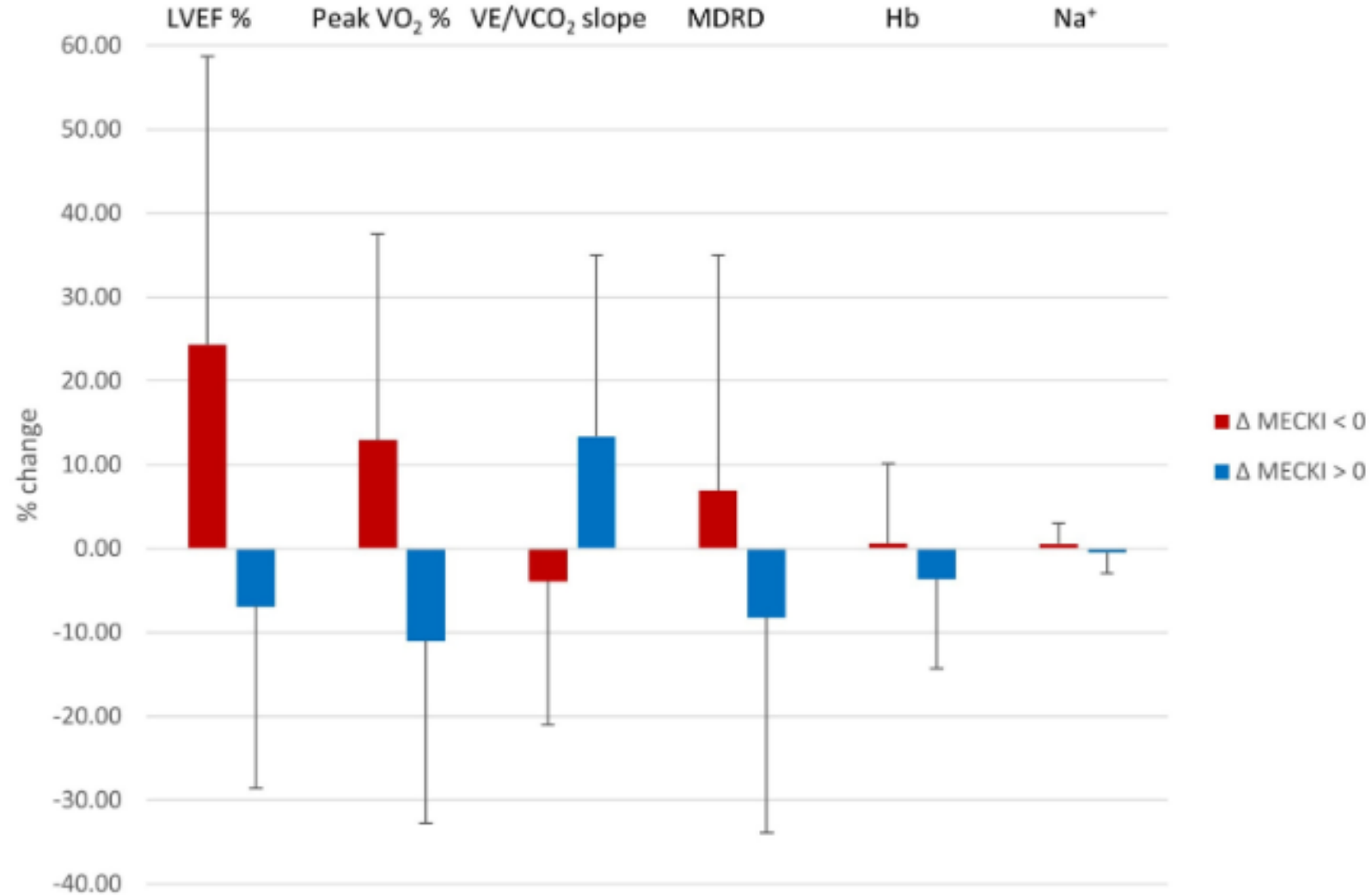
Beatrice Pezzuto^{a,1}, Massimo Piepoli^{b,c,1}, Arianna Galotta^{a,1}, Susanna Sciomer^{d,1}, Denise Zaffalon^{e,1}, Domenico Filomena^{d,1}, Carlo Vignati^{a,1}, Mauro Contini^{a,1}, Marina Alimento^{a,1}, Nikita Baracchini^{e,1}, Anna Apostolo^{a,1}, Pietro Palermo^{a,1}, Massimo Mapelli^{a,f,1}, Elisabetta Salvioni^{a,1}, Cosimo Carriere^{e,1}, Marco Merlo^{e,g,1}, Silvia Papa^{d,1}, Jeness Campodonico^{a,1}, Roberto Badagliacca^{d,1}, Gianfranco Sinagra^{e,g,1}, Piergiuseppe Agostoni^{a,f,*,1}

Aim of the study - To investigate whether modifications from baseline of the second evaluation of MECKI score, performed at least 1 year after baseline, present an added prognostic value for morbi-mortality prediction in heart failure patients

Event-free survival

Exitus for any cause + hospital admission for cardiovascular event



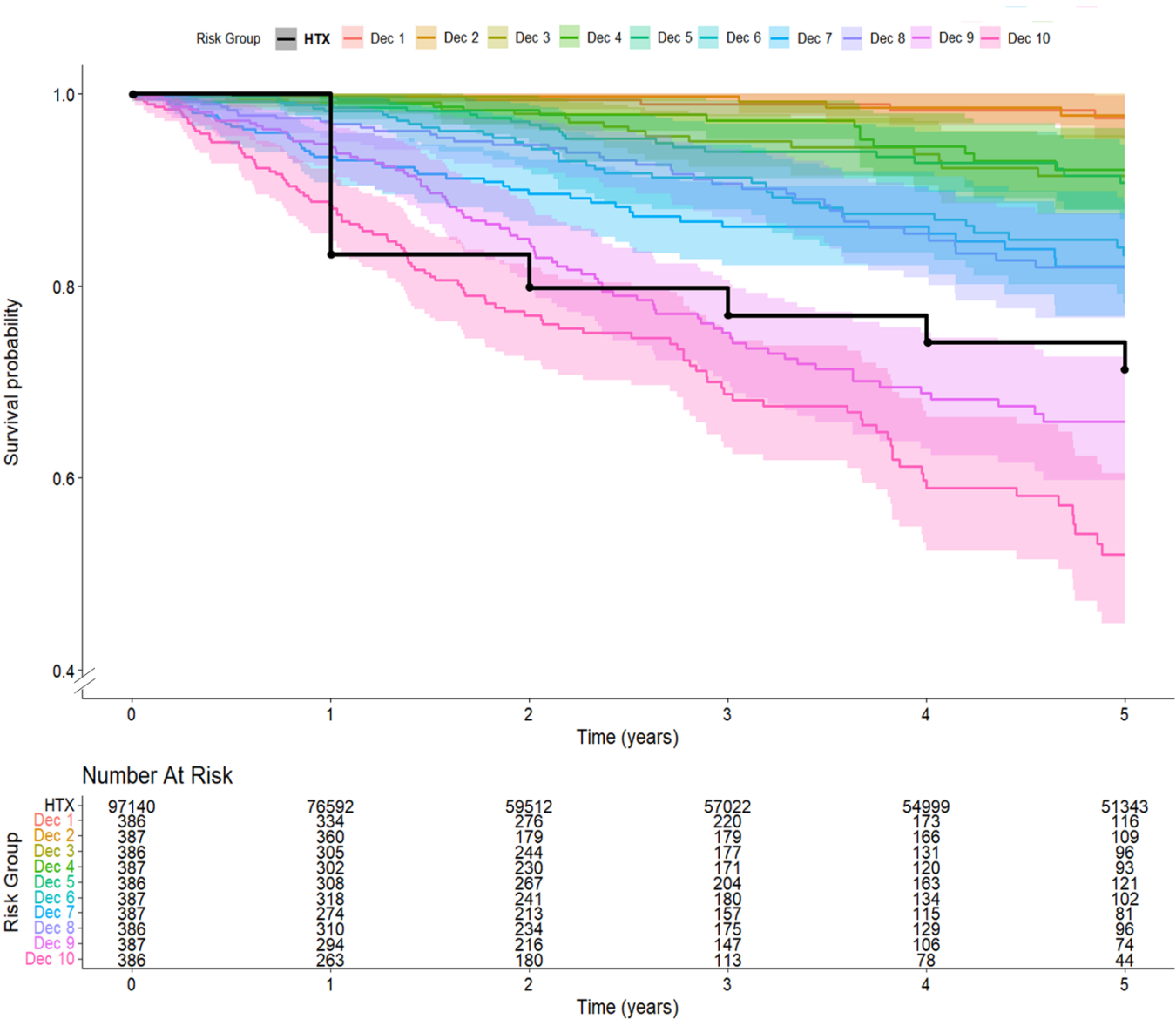


New cut-offs?

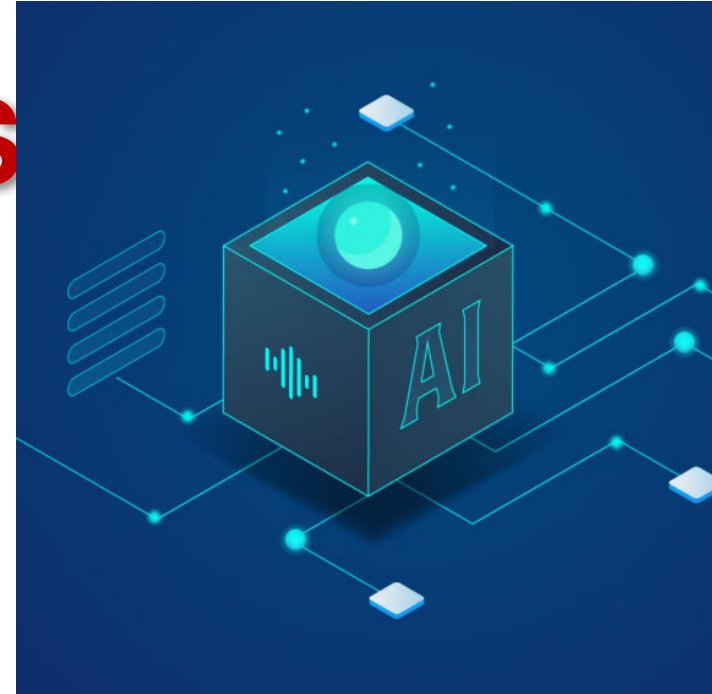
3865 patients with HFrEF 2010-today

	N = 3685
Age	62.41±12.65
BMI	26.96±4.53
Weight	78.56±15.49
Height	170.47±8.53
LVEF (%)	33.7±10.41
MDRD	73.25±25.89
VO ₂ _Kg	15.12±5.06
VE/VCO ₂ slope	33.17±8.08
VO ₂ _Peak	1185.37±453.19
VE Peak	48.52±16.13
VE/VCO ₂ slope %pred	125.99±29.88
MECKIscore	0.05(0.02;0.11)
Male	3134(81.09%)
AF	661(17.61%)
Etiology	
0	1433(40.08%)
1	1606(44.92%)
2	164(4.59%)
3	372(10.41%)
NYHA	
1	617(16.07%)
2	2179(56.74%)
3	993(25.86%)
4	51(1.33%)

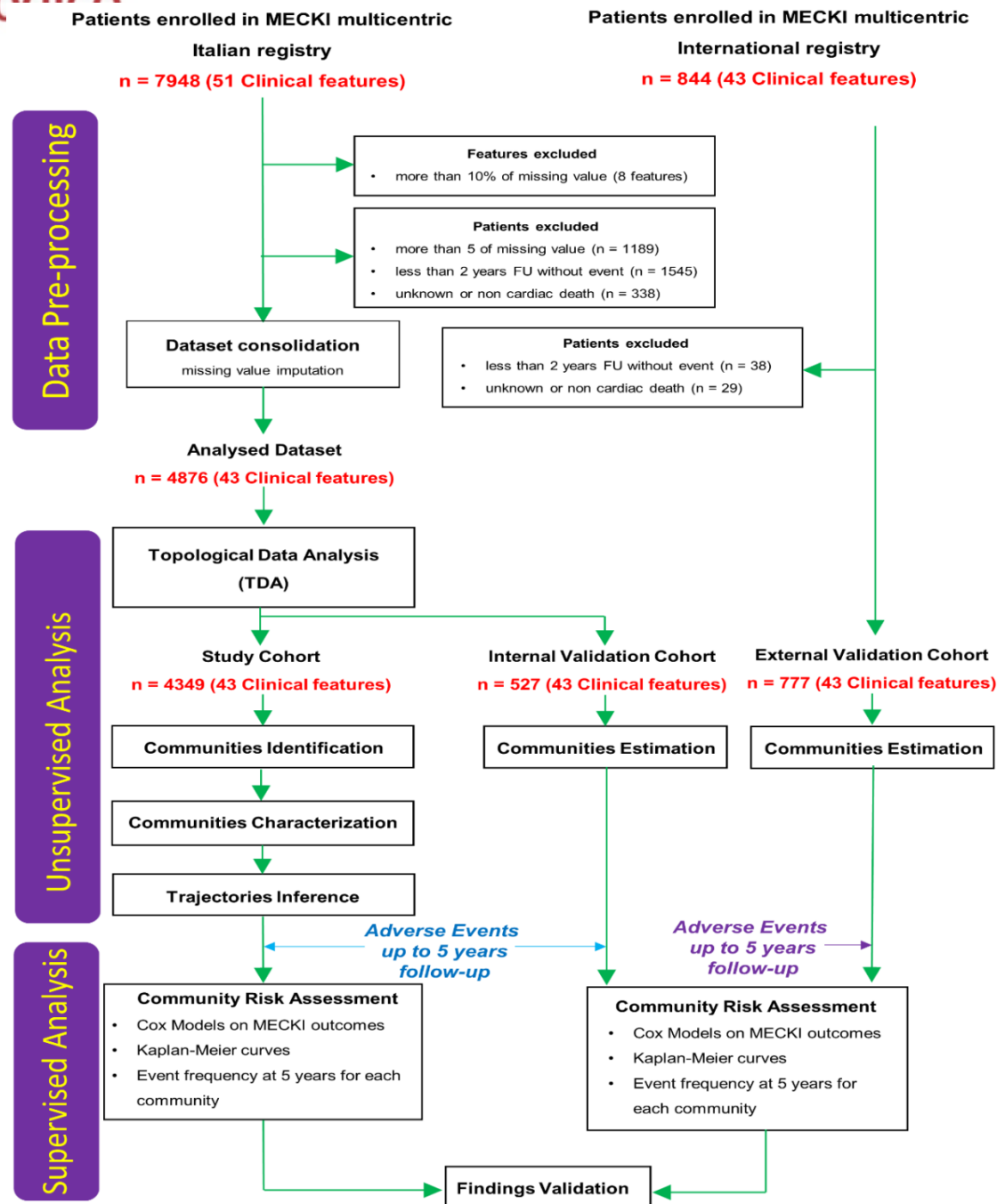
	N	Events at 2 years	% at 2 years	Events at 5 years	% at 5 years
ALL	3865	204	5.3%	372	9.6%
Deciles (min-max of MECKI Score)					
0.0005 - 0.0082	386	2	0.5%	5	1.3%
0.0083 - 0.0156	387	1	0.3%	4	1.0%
0.0156 - 0.0229	386	6	1.6%	17	4.4%
0.0230 - 0.0321	387	5	1.3%	14	3.6%
0.0321 - 0.0458	386	9	2.3%	22	5.7%
0.0458 - 0.0650	387	16	4.1%	37	9.6%
0.0651 - 0.0942	387	32	8.3%	44	11.4%
0.0944 - 0.1368	386	17	4.4%	40	10.4%
0.1368 - 0.2240	387	46	11.9%	83	21.4%
0.2240 - 0.8505	386	70	18.1%	106	27.5%

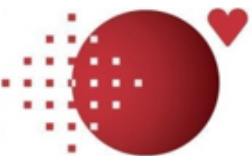


ON TOP OF SCORES

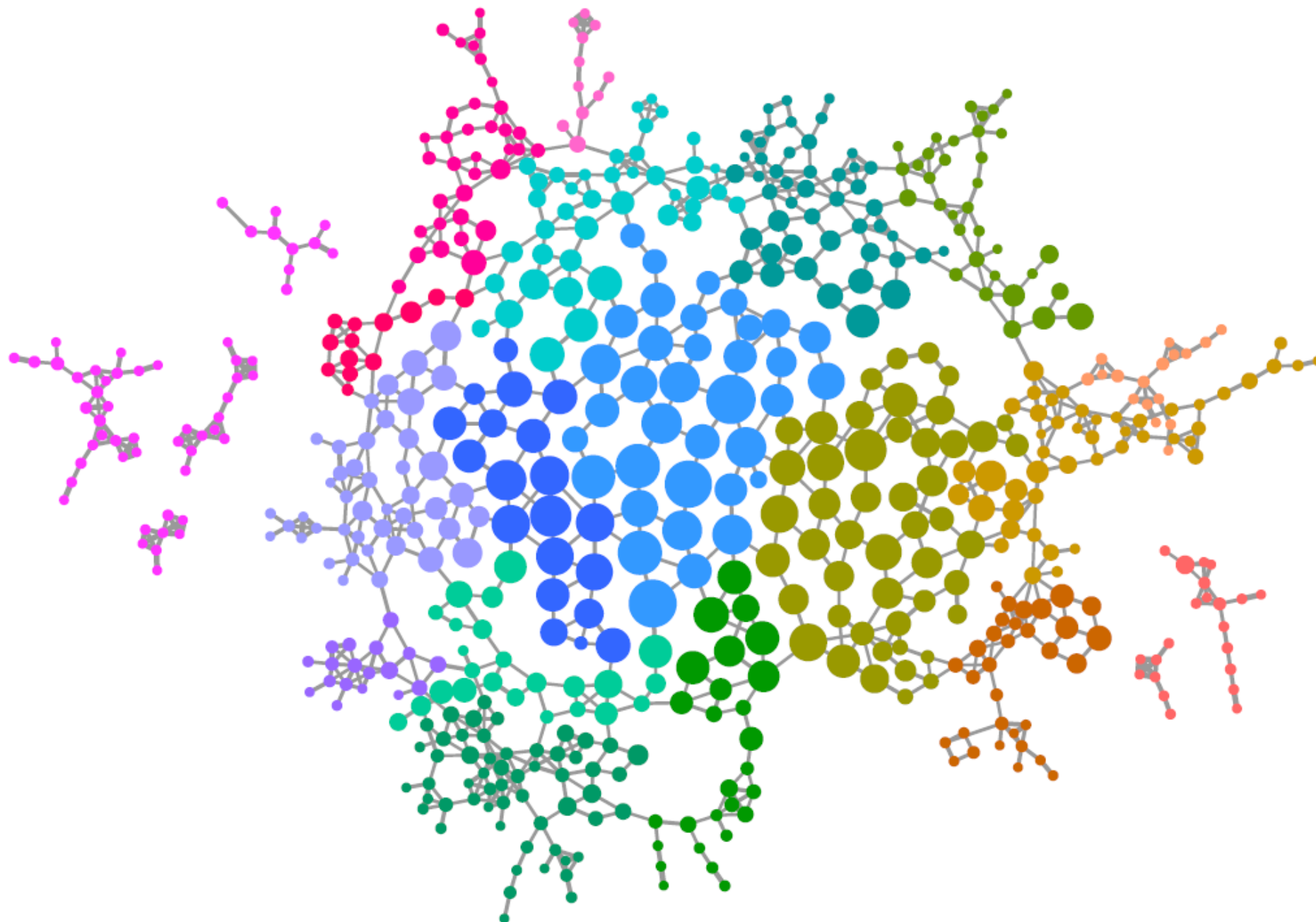


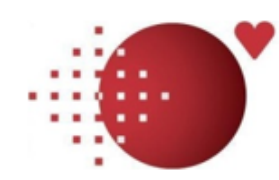
- **ARTIFICIAL INTELLIGENCE FOR PROPER DECISION MAKING**





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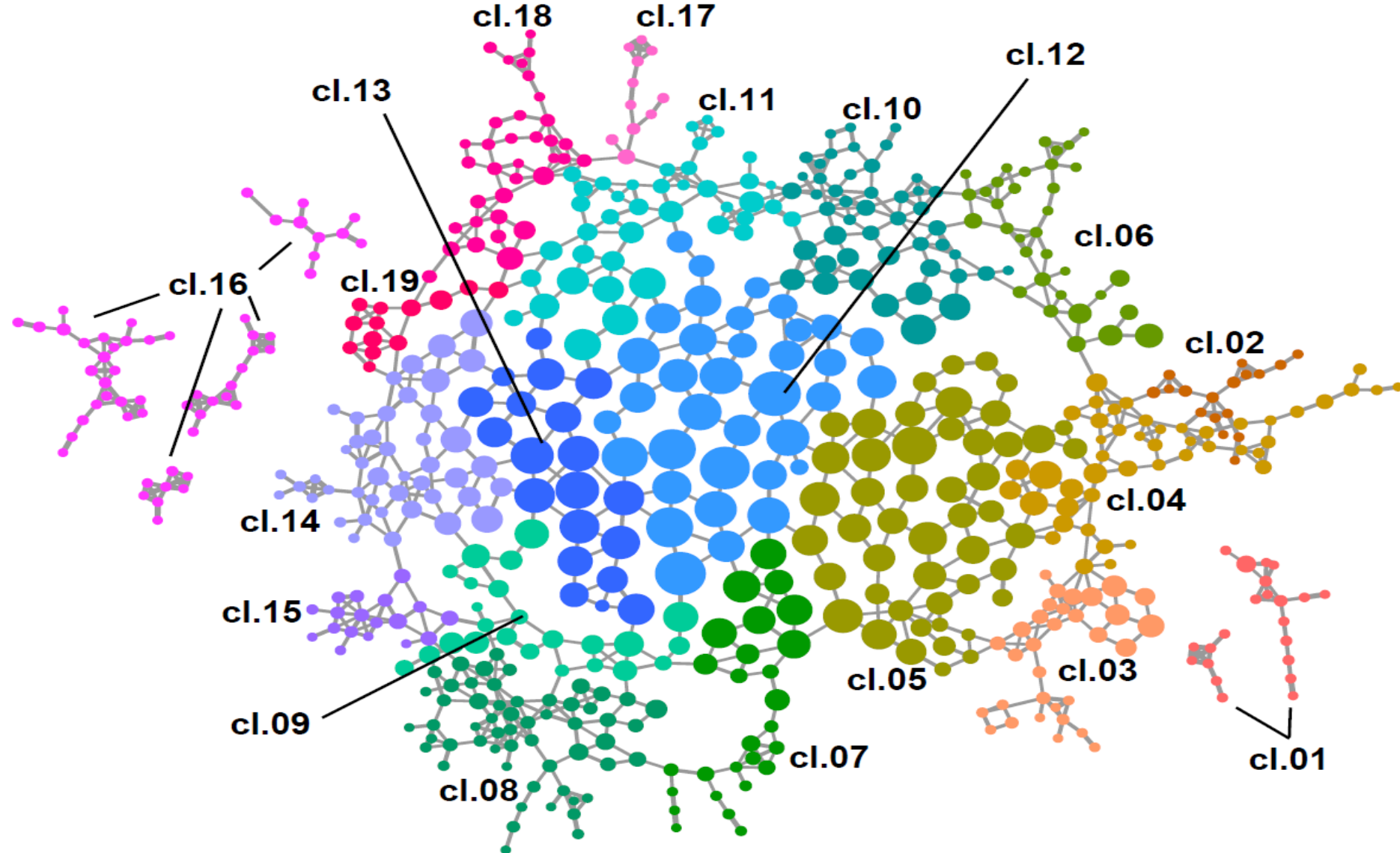


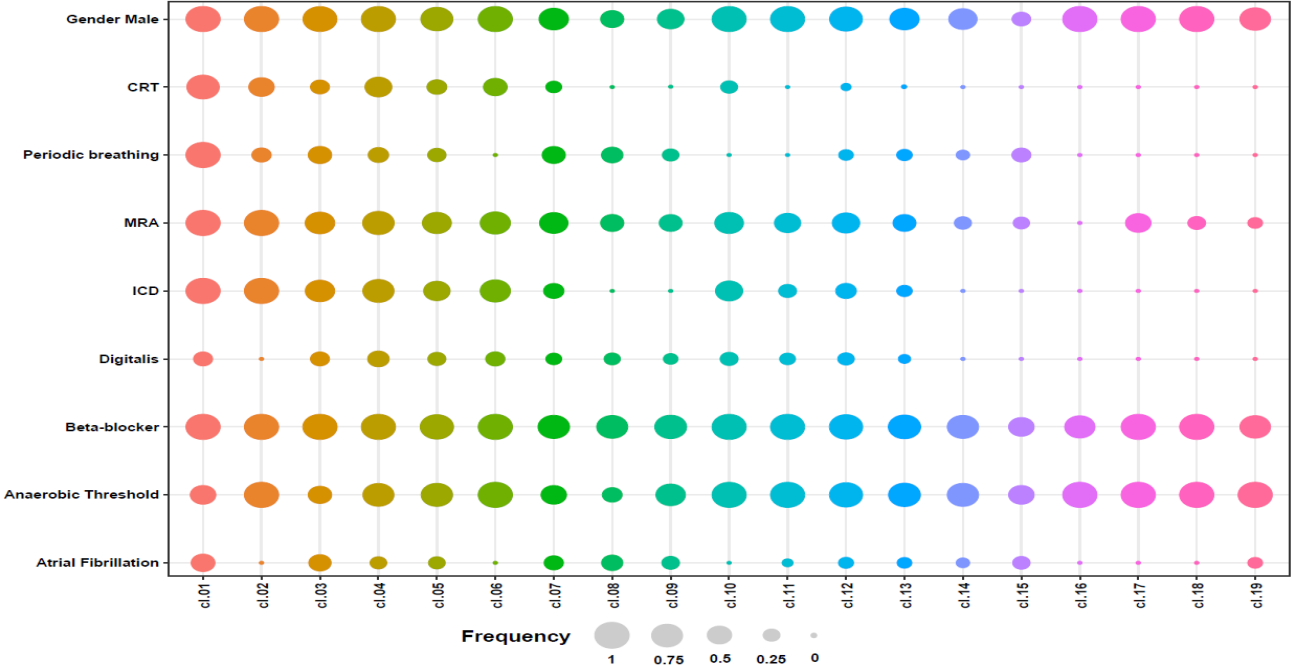


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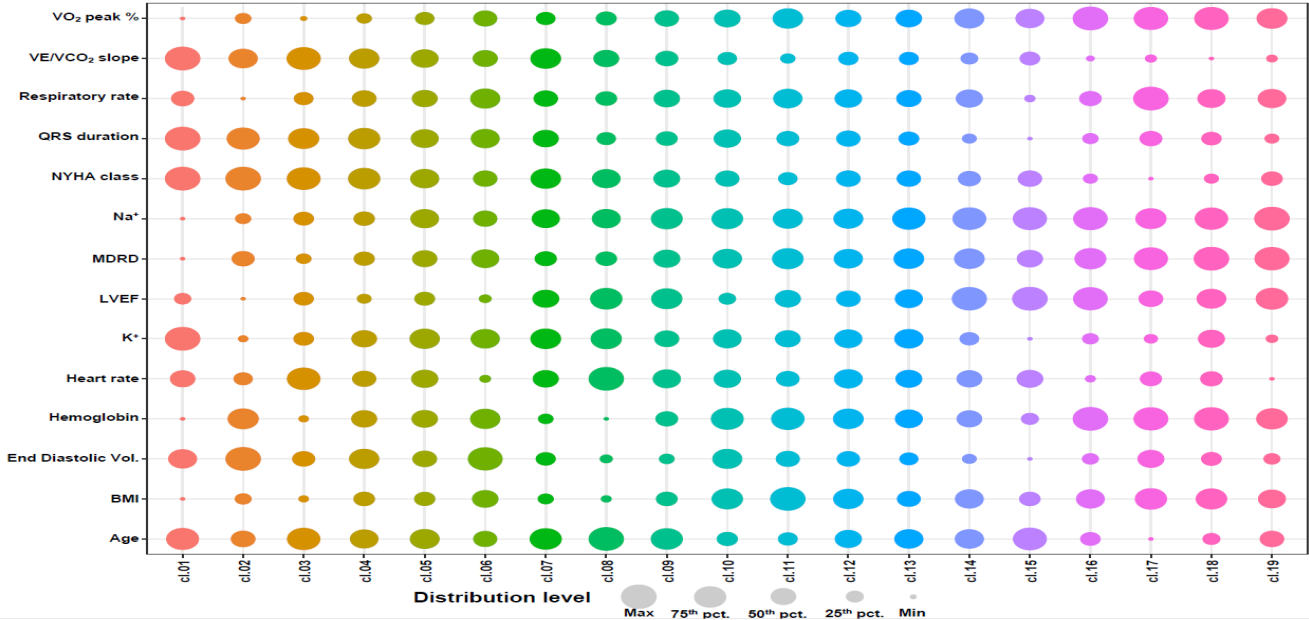


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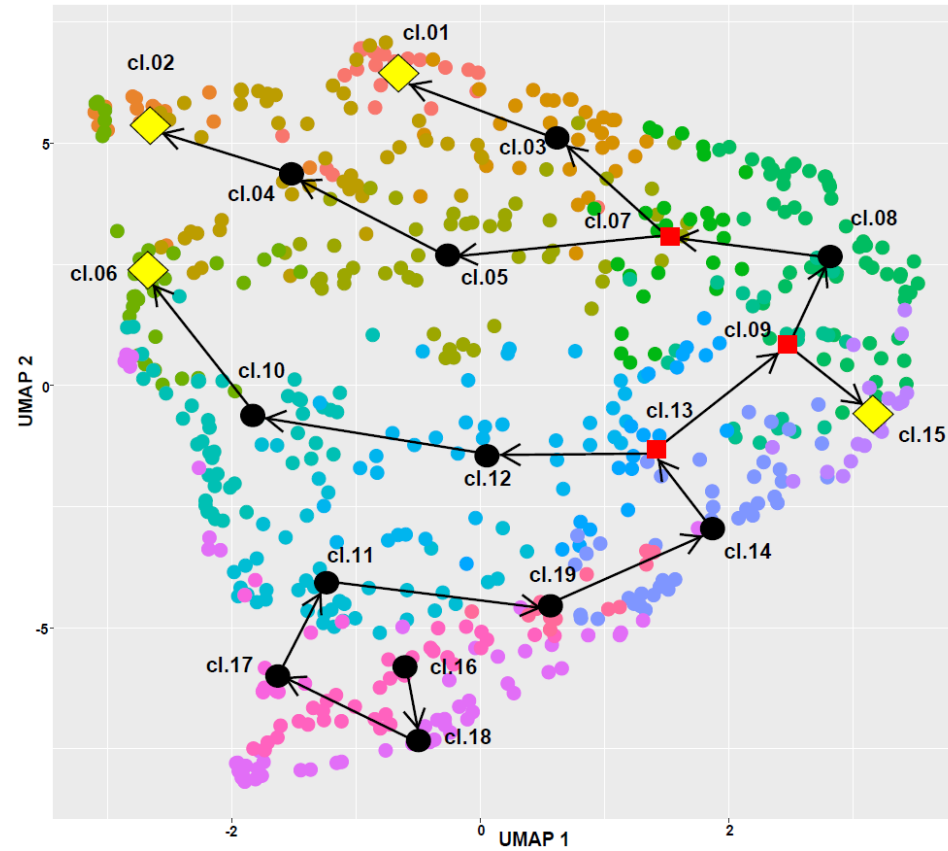


A

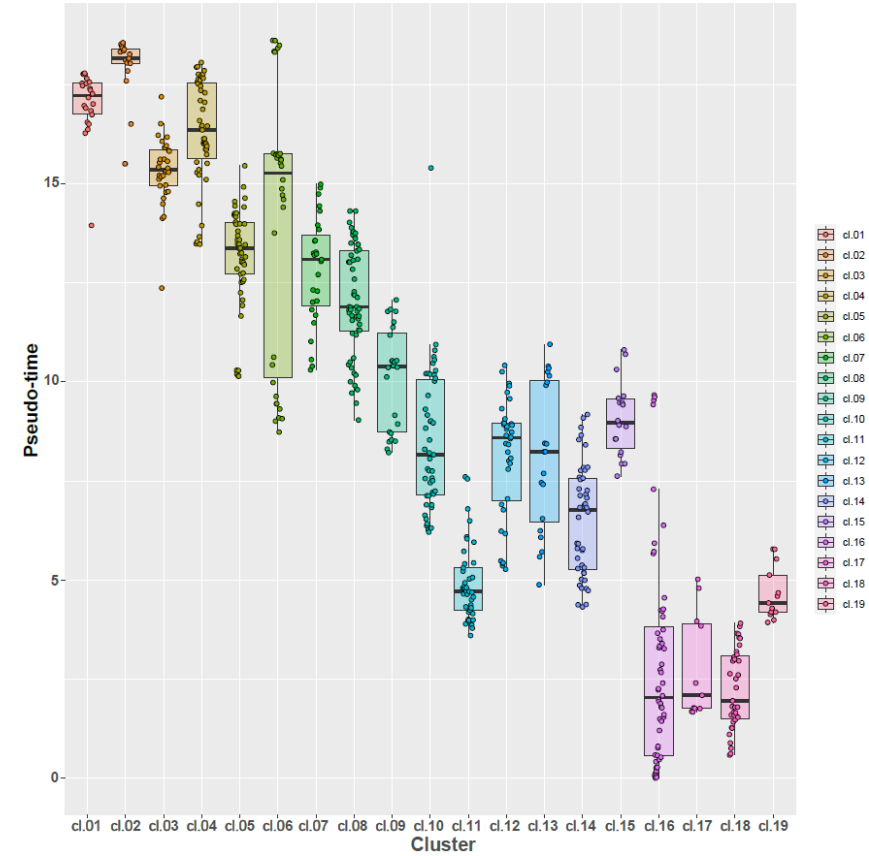


B

A



B



Variables means in bifurcation points

First Bifurcation (cl.13)

	cl.12 (N=36) (n=717)	cl.13 (N=20) (n=359)	cl.09 (N=24) (n=236)	p- value (cl.12 vs. cl.13)	p- value (cl.09 vs. cl.13)
BMI (kg/m ²)	27.8 ± 0.746	26.7 ± 0.892	26.3 ± 0.984	<0.001	0.156
Atrial Fibrillation (%)	0.141 ± 0.0746	0.128 ± 0.0575	0.239 ± 0.196	0.464	0.006
NYHA class	1.99 ± 0.173	2.03 ± 0.121	2.18 ± 0.123	0.34	<0.001
VO ₂ peak (% of predicted)	59.4 ± 5.02	60.9 ± 6.50	55.6 ± 5.56	0.389	0.002
VE/VCO ₂ slope	30.2 ± 1.59	30.1 ± 1.46	32.8 ± 2.07	0.85	<0.001
MDRD (mL/min/1.73 m ²)	71.6 ± 4.12	74.2 ± 5.29	67.0 ± 8.07	0.069	<0.001
Na ⁺ (mmol/L)	139 ± 0.501	140 ± 0.501	140 ± 1.29	0.002	0.328
QRS duration (ms)	116 ± 5.95	107 ± 6.58	107 ± 10.6	<0.001	0.974
MRA (%)	0.596 ± 0.114	0.403 ± 0.116	0.409 ± 0.178	<0.001	0.892

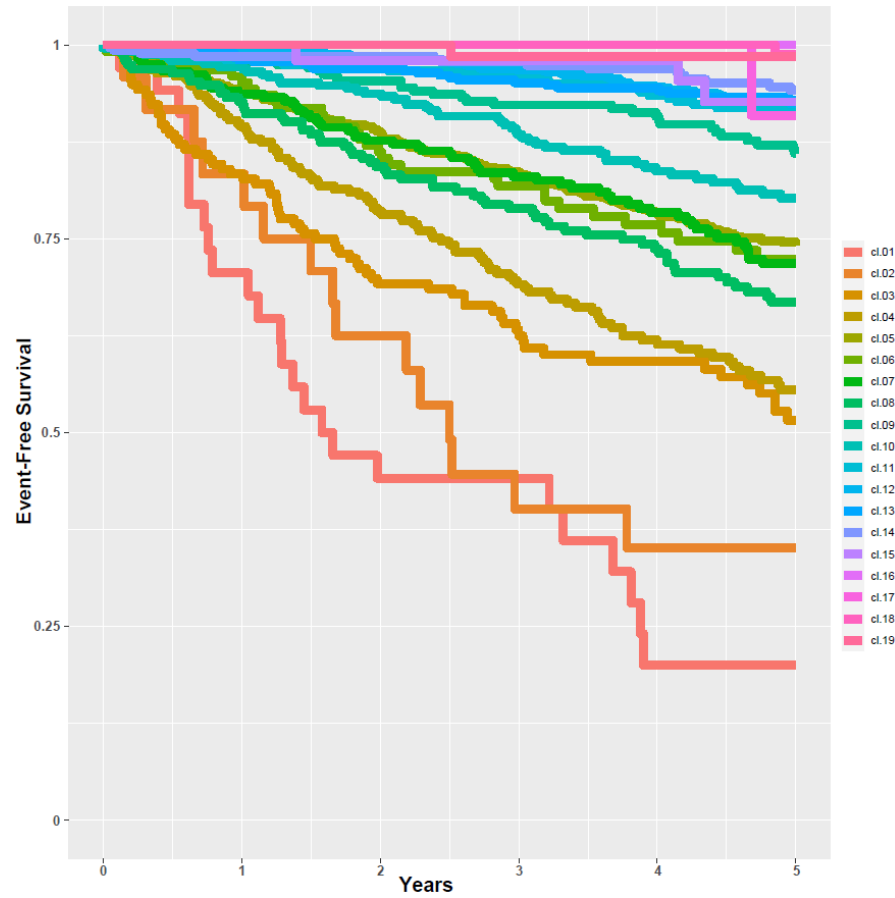
Second Bifurcation (cl.09)

	cl.15 (N=18) (n=49)	cl.09 (N=24) (n=236)	cl.08 (N=56) (n=191)	p- value (cl.15 vs. cl.09)	p- value (cl.08 vs. cl.09)
BMI (kg/m ²)	26.2 ± 2.48	26.3 ± 0.984	25.2 ± 2.30	0.585	0.005
LVEF (%)	50.3 ± 3.57	41.6 ± 5.63	44.2 ± 7.26	<0.001	0.085
QRS duration (ms)	86.4 ± 9.99	107 ± 10.6	101 ± 15.3	<0.001	0.052
Peak heart rate (bpm)	71.3 ± 7.76	71.0 ± 3.10	74.6 ± 6.97	0.78	0.011
Peak respiratory rate (bpm)	29.3 ± 3.06	31.4 ± 1.67	30.5 ± 3.78	0.0133	0.132
Exercise oscillatory ventilation (%)	0.258 ± 0.257	0.212 ± 0.142	0.355 ± 0.260	0.759	0.0107
Hemoglobin (g/dL)	12.5 ± 0.538	12.8 ± 0.495	11.9 ± 0.722	0.078	<0.001
MDRD (mL/min/1.73 m ²)	64.7 ± 11.2	67.0 ± 8.07	54.8 ± 11.7	0.465	<0.001
ICD (%)	0 ± 0	0.0519 ± 0.0945	0.0408 ± 0.0854	0.002	0.173
MRA (%)	0.197 ± 0.260	0.409 ± 0.178	0.392 ± 0.297	0.006	0.67
Digitalis (%)	0.0742 ± 0.104	0.151 ± 0.124	0.142 ± 0.131	0.030	0.835

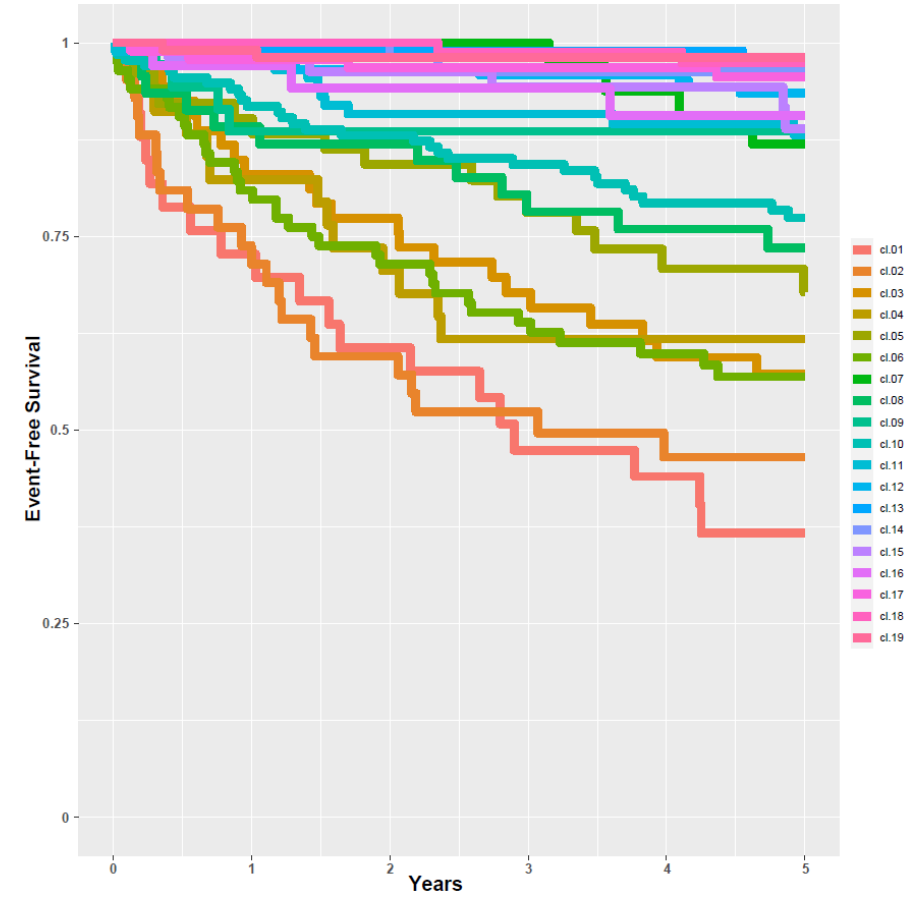
Third Bifurcation (cl.07)

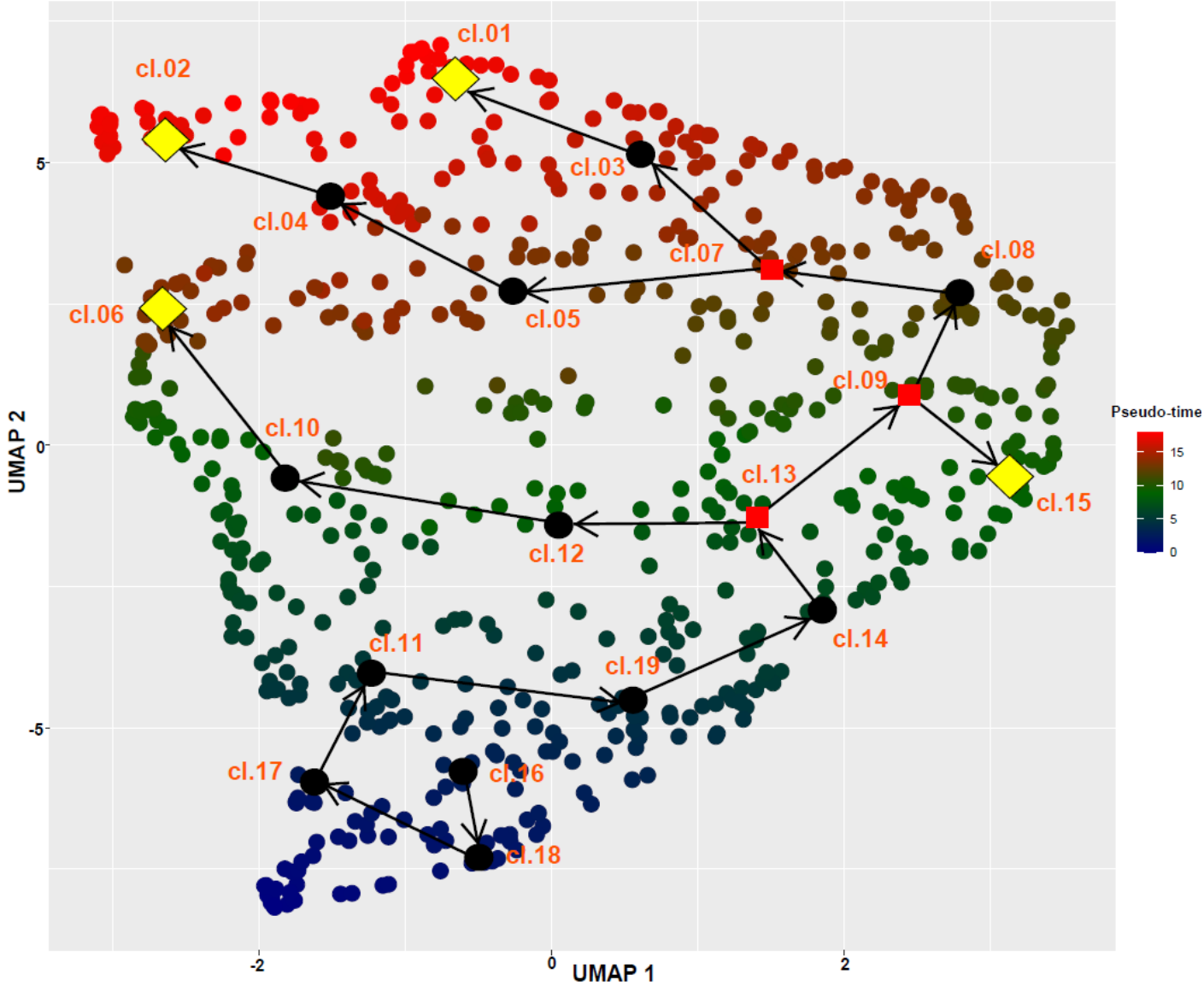
	cl.05 (N=49) (N=761)	cl.07 (N=27) (n=235)	cl.03 (N=32) (n=156)	p- value (cl.05 vs. cl.07)	p- value (cl.03 vs. cl.07)
Atrial Fibrillation (%)	0.168 ± 0.0722	0.332 ± 0.281	0.347 ± 0.245	0.003	0.437
NYHA class	2.39 ± 0.219	2.46 ± 0.259	2.79 ± 0.241	0.199	<0.001
VO ₂ peak (% of predicted)	45.6 ± 4.63	42.7 ± 8.53	32.9 ± 4.68	0.27	<0.001
Peak heart rate (bpm)	70.8 ± 2.41	69.3 ± 4.68	74.1 ± 7.51	0.17	0.003
Exercise oscillatory ventilation (%)	0.221 ± 0.096	0.398 ± 0.251	0.457 ± 0.270	0.002	0.391
Hemoglobin (g/dL)	13.3 ± 0.490	12.2 ± 0.762	11.9 ± 0.948	<0.001	0.259
Na ⁺ (mmol/L)	139 ± 0.649	139 ± 1.47	138 ± 1.36	0.786	0.009
K ⁺ (mmol/L)	4.32 ± 0.111	4.33 ± 0.151	4.20 ± 0.233	0.789	0.011

A



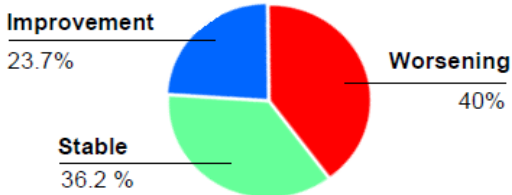
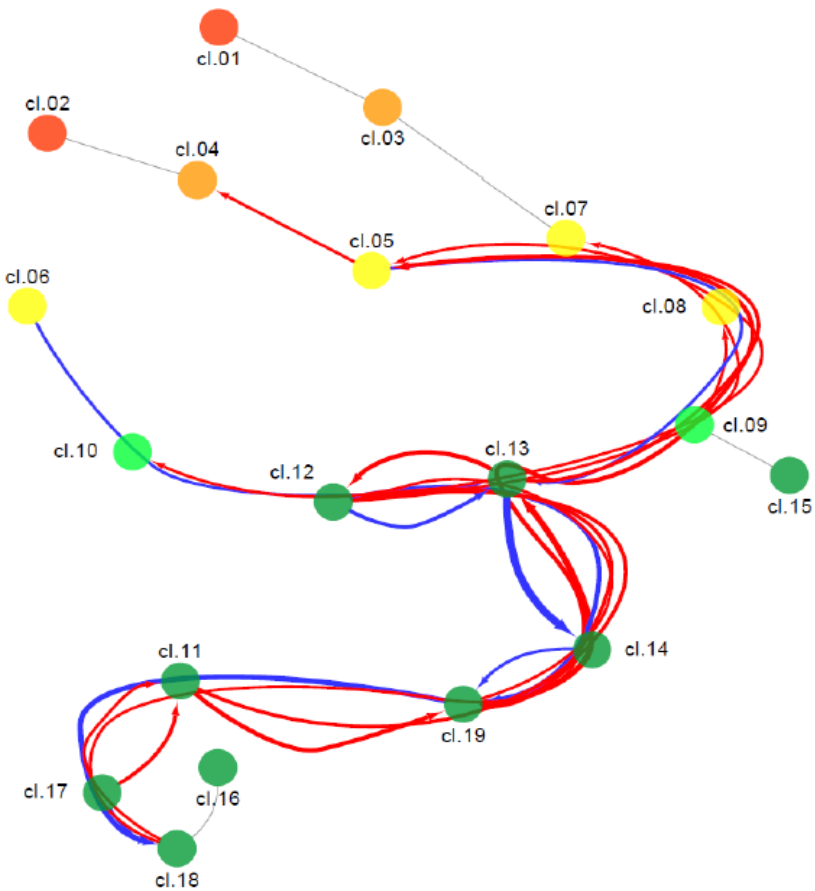
B



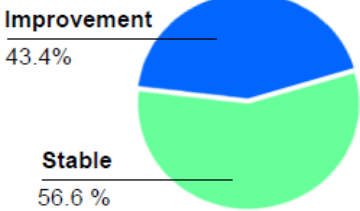
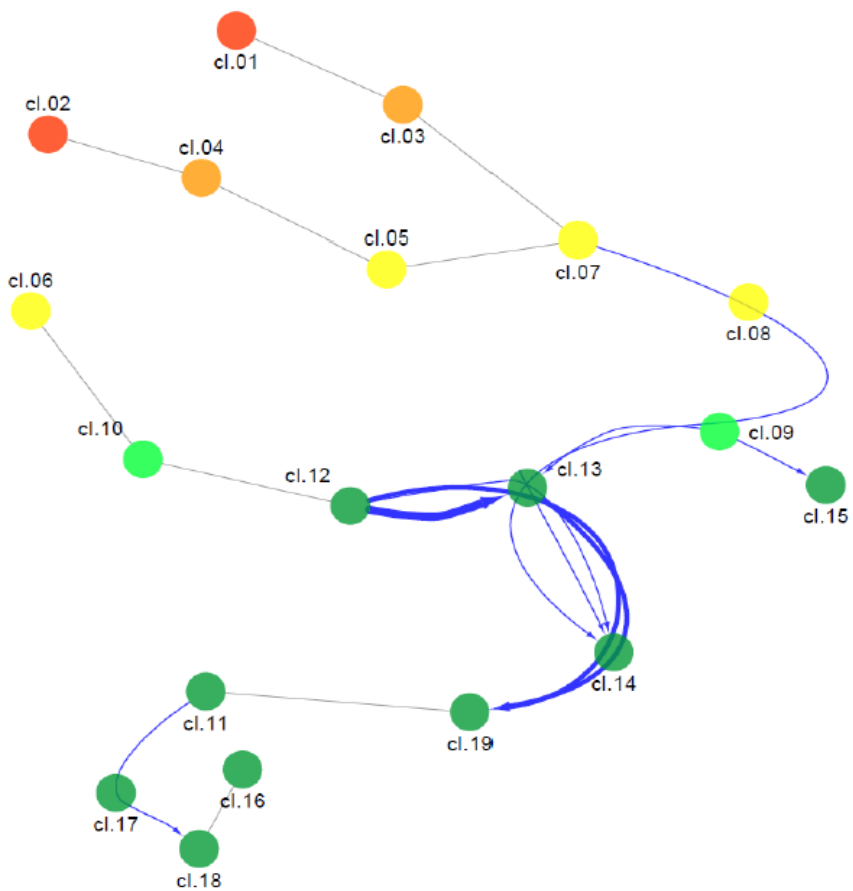




A



B



A light gray wavy background graphic that flows from the top left towards the bottom right, creating a sense of movement and depth.

Thank you