Spiroergometrie do Kardiocenter a kardiologických ambulancí- pokud ano, jaký přínos, co stojí proti rozšíření- platby od pojišťoven?

SOVOVÁ E, RADVANSKÝ J.

Circulation

American Heart Association

Importance of Assessing Cardiorespiratory Fitness in Clinical Practice: A Case for Fitness as a Clinical Vital Sign: A Scientific Statement From the American Heart Association

Robert Ross, Steven N. Blair, Ross Arena, Timothy S. Church, Jean-Pierre Després, Barry A. Franklin, William L. Haskell, Leonard A. Kaminsky, Benjamin D. Levine, Carl J. Lavie, Jonathan Myers, Josef Niebauer, Robert Sallis, Susumu S. Sawada, Xuemei Sui and Ulrik Wisløff
On behalf of the American Heart Association Physical Activity Committee of the Council on Lifestyle and Cardiometabolic Health; Council on Clinical Cardiology; Council on Epidemiology and Prevention; Council on Cardiovascular and Stroke Nursing; Council on Functional Genomics and Translational Biology; and Stroke Council

Circulation. 2016;134:e653-e699; originally published online November 21, 2016;
doi: 10.1161/CIR.0000000000000461
Circulation is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231

Print ISSN: 0009-7322. Online ISSN: 1524-4539

Table 4. Weber and Ventilatory Classification Schemes in HF Patients

Disease Severity	Weber Class		Ventilatory Class	
	Class	Peak $\dot{V}O_2$ (mL $O_2 \cdot kg^{-1} \cdot min^{-1}$)	Class	$\dot{V}E/\dot{V}CO_2$ Slope
Mild to none	A	>20	I	≤29.9
Mild to moderate	B	16–20	II	30.0–35.
Moderate to severe	C	10–16	III	36.0–44.
Severe	D	<10	IV	45.0

$\dot{V}E/\dot{V}CO_2$, indicates minute ventilation/carbon dioxide produc relationship; and $\dot{V}O_2$, oxygen consumption.

Reprinted from Arena et al.[151] Copyright © 2011, American H Association, Inc.

Table 10. Recommended Procedures for Measurement of CRF During Routine Clinical Visits

Patient Group	CRF Assessment Method	Recommended Equation/ Protocol
Healthy*	Option 1: Nonexercise estimate of CRF[294]	Nes et al,[38,190] others in Table 6
	Option 2: Submaximal exercise test or field/clinical test†	One-mile walk,[166] 6-min walk[167]
	Option 3: Maximal exercise test without CPX	Individualized[159] or standardized[157] ramp, others in Table 5
	Option 4: Maximal exercise test with CPX	Individualized[159] or standardized ramp[157]
Chronic disease	Maximal exercise test with CPX measures	Individualized ramp[159]

Box 1 Indications for performing cardiopulmonary exercise testing

Indications

- Investigation of unexplained dyspnoea.
- Evaluation of cardiovascular disease.
- Evaluation of respiratory disease.
- Preoperative assessment for major surgery.
- Exercise prescription.
- Evaluation of impairment/disability.
- Evaluation of exercise tolerance.

Adapted from the American Thoracic Society and American College of Chest Physicians.[8]

Tabulka č. 2

Funkční klasifikace na základě spotřeby kyslíku

NYHA	Třída	VO2 ml/kg/min	Omezení
I	A	> 20	žádné až mírné
II	B	6–20	lehké až střední
III	C	10–15	střední až těžké
IV	D	< 10	těžké

Poznámka k tab. 2

Weber a NYHA dle spotřeby kyslíku

Jestli průměrný mladý dospělý muž má VO2max 50 ml/kg/min

muž – osmdesátiletý senior má VO2max 19 ml/kg/min

Zdá se vám normální hodnotit stejným číslem spotřeby kyslíku

(třeba NYHA III 10-15 ml/kg/min) mladíka i seniora ?

Appendix 1: Universal CPX Reporting Form (Complete All Boxes That Apply for a Given ET Indication)

Exercise Modality: [ ] Treadmill [ ] Lower extremity ergometer

Exercise Protocol:

Peak $\dot{V}O_2$ ($mlO_2 \cdot kg^{-1} \cdot min^{-1}$): ☐☐.☐ $\dot{V}O_2$ at VT ($mlO_2 \cdot kg^{-1} \cdot min^{-1}$): ☐☐.☐ VT as % Peak $\dot{V}O_2$: ☐☐	Percent-Predicted Peak $\dot{V}O_2$ (%)*: ☐☐.☐ Peak RER: ☐.☐☐	$\dot{V}E/\dot{V}CO_2$ Slope†: ☐☐.☐ EOV‡ [ ] Yes [ ] No
$P_{ET}CO_2$ (mmHg): Resting: ☐☐.☐ Increase during ET: ☐.☐	$\dot{V}E/\dot{V}O_2$ at peak ET: ☐☐.☐	$\Delta Q/\Delta \dot{V}O_2$§ ☐☐.☐

$\dot{V}E$/MVV|| : ☐.☐☐ PEF (L/min): Pre ET - ☐☐.☐ Post ET: ☐☐.☐

FEV_1 (L/min): Pre ET - ☐☐.☐ Post ET: ☐☐.☐

Flow Volume Loops: Compare Maximal Flow Volume Loop to Exercise Tidal Volume Loop

Normal ☐ **or** Expiratory Flow Limitation ☐¶

O_2 pulse trajectory#:
[ ] Continual rise throughout ET [ ] Early and sustained plateau [ ] Decline

$\Delta \dot{V}O_2/\Delta W$ trajectory#:
[ ] Continual rise throughout ET [ ] Early and sustained plateau [ ] Decline

Resting HR(beats/min): ☐☐ Peak HR (beats/min): ☐☐☐ Percent of Age Predicted Maximal HR**: ☐☐☐ HRR at 1 minute (beats): ☐☐	Resting BP (mmHg): ☐☐☐/☐☐☐ Peak BP (mmHg): ☐☐☐/☐☐☐ Maximal Workload [ ] Treadmill speed/grade: ☐☐.☐/☐☐.☐ [ ] Cycle ergometer Watts: ☐☐☐	Resting Pulse Oximetry (%): ☐☐ Peak Pulse Oximetry (%): ☐☐

ECG Criteria [ ] No arrhythmias/Ectopy/ST segment changes [ ] Arrhythmias/Ectopy/ST segment changes: not exercise limiting [ ] Arrhythmias/Ectopy/ST segment changes: exercise limiting	ECG Description

Subjective Symptoms (check box for primary termination criteria)
Fatigue [ ] Leg Fatigue [ ] Angina [ ] Dyspnea [ ] Other Peak RPE

Additional Notes

ESC European Society of Cardiology
European Heart Journal (2018) 39, 1144–1161
doi:10.1093/eurheartj/ehw180

SPECIAL ARTICLE
EACPR/AHA scientific statement

2016 focused update: clinical recommendations for cardiopulmonary exercise testing data assessment in specific patient populations

Marco Guazzi*, Ross Arena†, Martin Halle*, Massimo F. Piepoli*, Jonathan Myers, and Carl J. Lavie

Online publish-ahead-of-print 2 May 2016

Guidelines
BMJ Open Respiratory Research

ARTP statement on cardiopulmonary exercise testing 2021

Andrew Pritchard,[1] Paul Burns,[2] Joao Correia,[3] Patrick Jamieson,[4] Peter Moxon,[1] Joanna Purvis,[5] Maximillian Thomas,[6] Hannah Tighe,[7] Karl Peter Sylvester[8,9]

Box 2 Known risk of adverse events associated with performing cardiopulmonary exercise testing

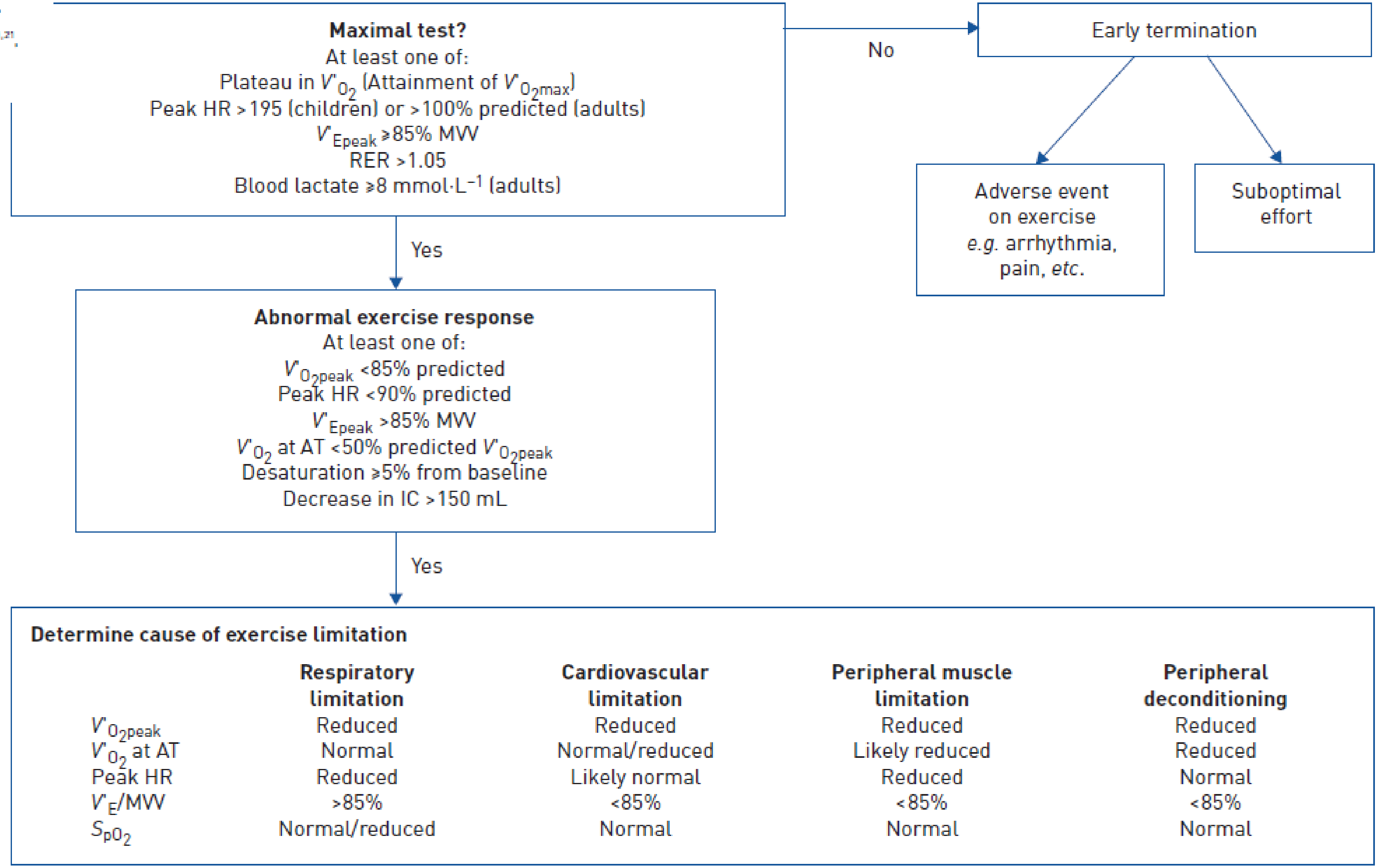
Risk of adverse events

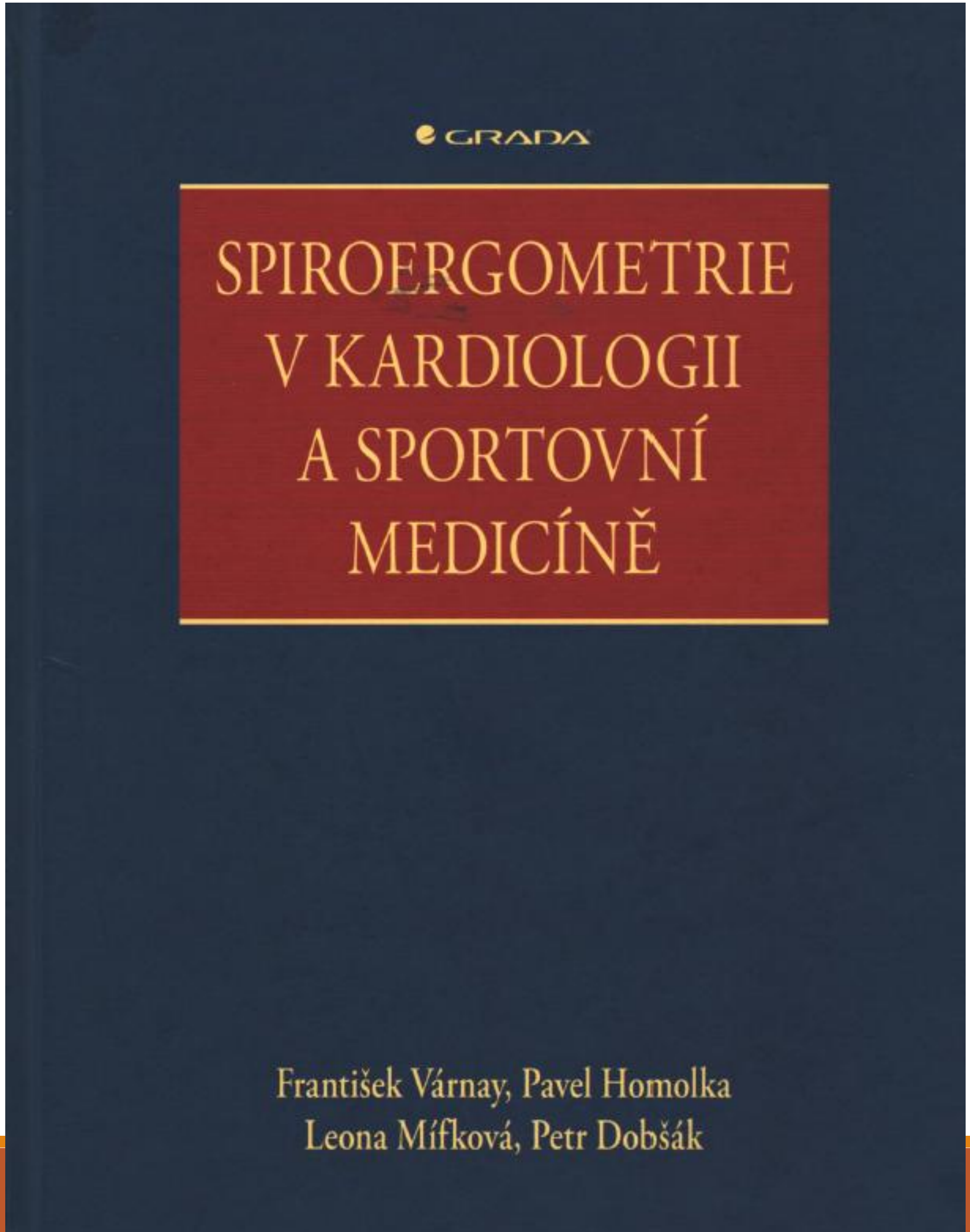
- Incidence of a complication requiring hospitalisation of ≤2 in 1000.
- Incidence of a major cardiac event of 1.2 per 10 000.
- Incidence of mortality of 2–5 per 100 000.

Adapted from Levett et al.[11]

ERS statement on standardisation of cardiopulmonary exercise testing in chronic lung diseases

Thomas Radtke[1,2], Sarah Crook[1], Georgios Kaltsakas[3,4], Zafeiris Louvaris[5], Danilo Berton[6], Don S. Urquhart[7], Asterios Kampouras[8], Roberto A. Rabinovich[9,10], Samuel Verges[11], Dimitris Kontopidis[12], Jeanette Boyd[13], Thomy Tonia[14], Daniel Langer[5,15], Jana De Brandt[16], Yvonne M.J. Goërtz[17], Chris Burtin[16], Martijn A. Spruit[16,17,18], Dionne C.W. Braeken[17], Sauwaluk Dacha[5,15,19], Frits M.E. Franssen[17,18], Pierantonio Laveneziana[20,21], Ernst Eber[22], Thierry Troosters[23,24], J. Alberto Neder[25], Milo A. Puhan[1], Richard Casaburi[26], Ioannis Vogiatzis[4,27,28] and Helge Hebestreit[28,29]




GRADA
SPIROERGOMETRIE
V KARDIOLOGII
A SPORTOVNÍ
MEDICÍNĚ
František Várnay, Pavel Homolka
Leona Mífková, Petr Dobšák

Spiroergometrie PRO a PROTI

Je pacient v maximu?

Stanovení VO2 max (peak) jako jednoho z nejpřesnějších parametrů pro prognózu pacienta

Jednotlivé parametry

Diferenciální dg

Předpis pohybové aktivity

Nutná zkušenost s metodou

Cena přístroje

Úhrady pojišťovny

Dosažení maxima výkonu (metabolické maximum)

Když je RER(RQ), tedy poměr vydaného CO_2 a přijatého O_2 nad 1,09 **+ zároveň**

TFmax se blíží predikovanému maximu, (pokud není chronotropní inkompetence) **+ zároveň**

Plateau v křivce VO2 (maximum) **+ zároveň**

Pokud pacient i zkušený vyšetřující potvrdí, že to maximum bylo. (jinak řečeno vyšetřující potvrdí věrohodnost predikce u konkrétního pacienta)

(cave: někteří špičkoví sportovci žádné plateau nemají)

Stanovení VO2 max (peak)

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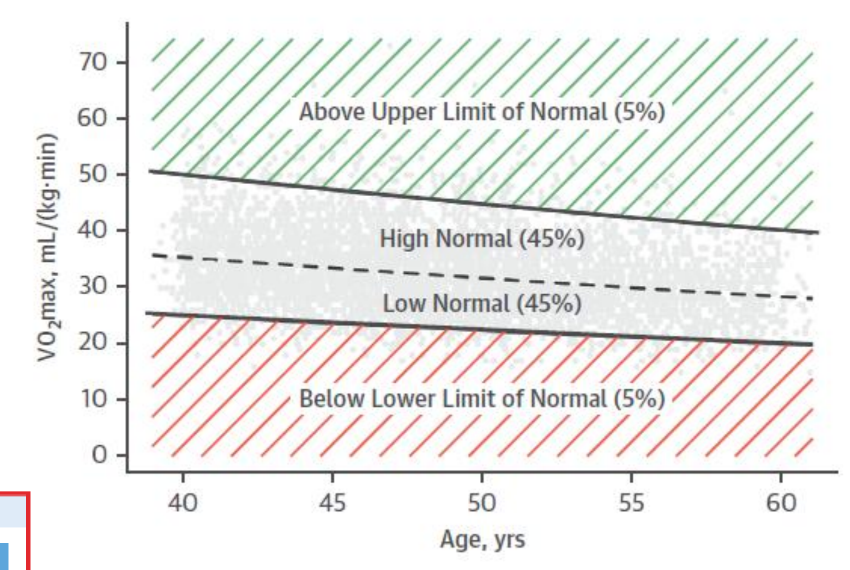
VOL. 72, NO. 9, 2018

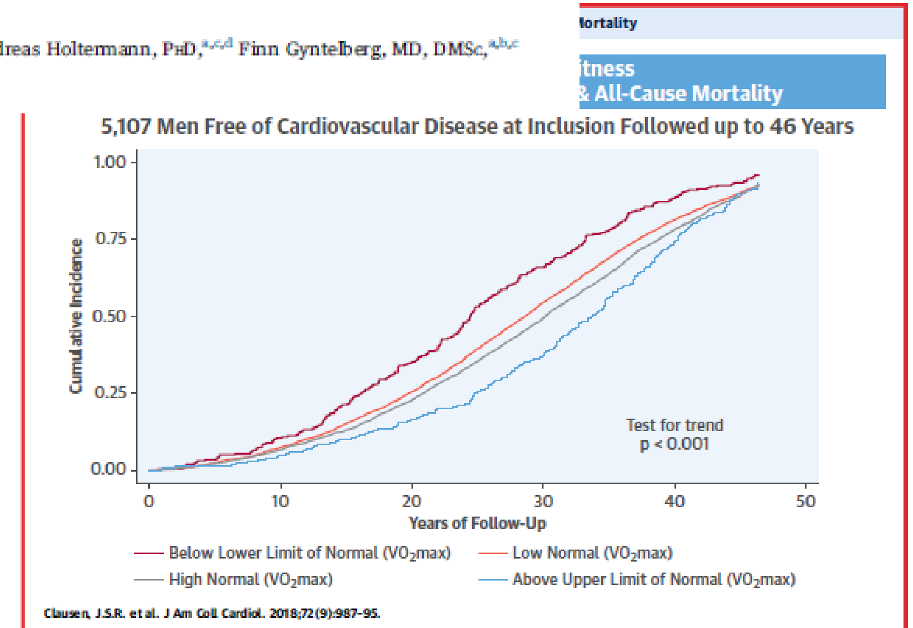
Midlife Cardiorespiratory Fitness and the Long-Term Risk of Mortality

46 Years of Follow-Up

Johan S.R. Clausen, MD,[a] Jacob L. Marott, MSc,[a,b] Andreas Holtermann, PhD,[a,c,d] Finn Gyntelberg, MD, DMSc,[a,b,c] Magnus T. Jensen, MD, PhD[a,e,f]

FIGURE 2 Distribution of CRF (Vo_2max) According to Age in 5,107 Middle-Aged, Employed Men Without CVD





Cumulative incidence of all-cause mortality according to categories of age-adjusted cardiorespiratory fitness level in 5,107 middle-aged, employed men without cardiovascular disease (CVD) followed up for up to 46 years. Cardiorespiratory fitness was related to longevity in a dose-response-dependent manner. Vo_2max = maximal oxygen consumption.

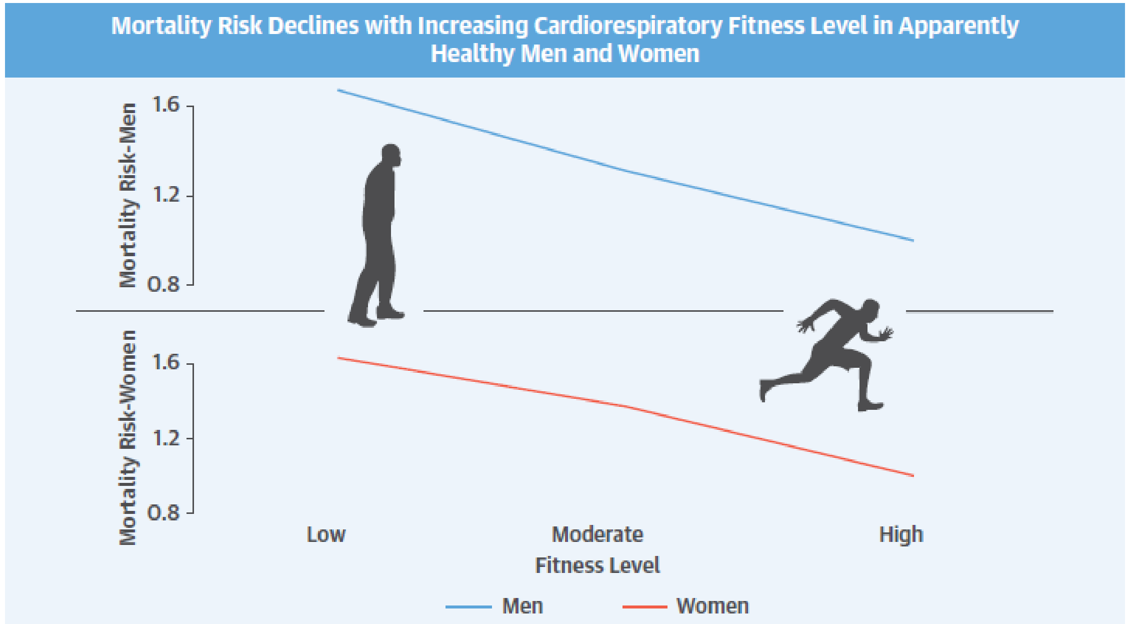
JOURNAL OF THE AMERICAN COLLEGE OF CARDIOLOGY VOL. 72, NO. 19, 2018

PUBLISHED BY ELSEVIER

ORIGINAL INVESTIGATIONS

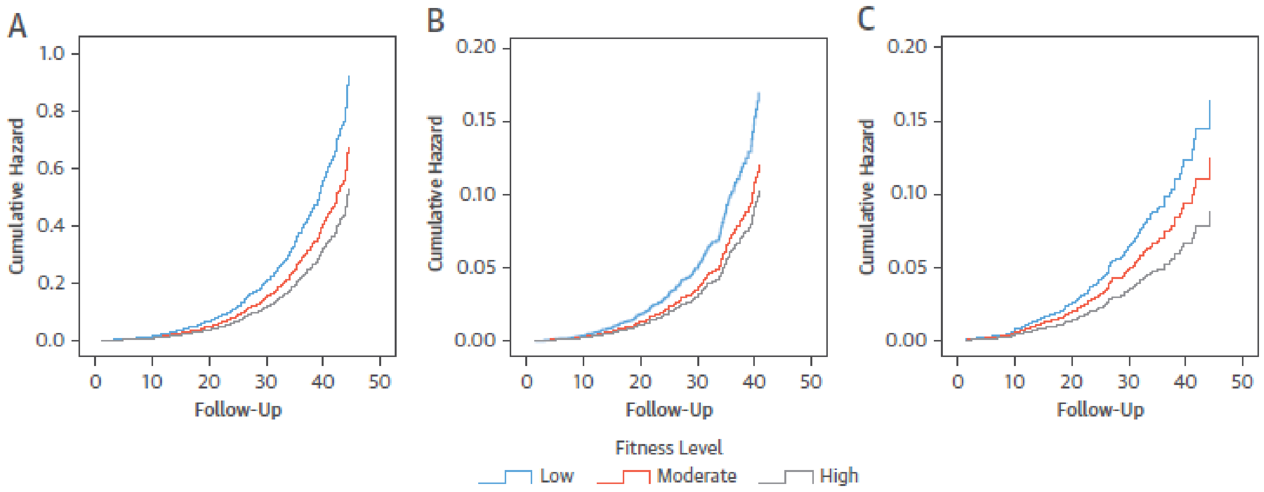
Cardiorespiratory Fitness and Mortality in Healthy Men and Women

Mary T. Imboden, PhD,[a] Matthew P. Harber, PhD,[a] Mitchell H. Whaley, PhD,[b] W. Holmes Finch, PhD,[c] Derron L. Bishop, PhD,[d] Leonard A. Kaminsky, PhD[e]



Imboden, M.T. et al. J Am Coll Cardiol. 2018;72(19):2283-92.

FIGURE 1 Cumulative Hazard of All-Cause, Cardiovascular Disease, and Cancer Mortality by Cardiorespiratory Fitness Group



Hazard plots for **(A)** all-cause, **(B)** cardiovascular disease (CVD), and **(C)** cancer mortality according to cardiorespiratory fitness (CRF) level. Low, moderate, and high CRF corresponds to ≤33rd, 34th-66th, and ≥67th percentiles of Fitness Registry and the Importance of Exercise National Database normative values. Low-fitness was associated with increased risk of all-cause, CVD, and cancer mortality compared to both moderate-fitness and high-fitness groups over the follow-up period.

Stanovení VO2 max (peak)

NORMY???

Kterou použijeme??

Tepový kyslík

Množství kyslíku, které je srdce schopno přenést jedním tepovým objemem

V klidu cca 5 ml/tep

Maximální hodnoty muži 15-16, ženy 10-11, sportovci 30-35

Hodnota takto vyjádřená je ale velmi závislá na hmotnosti

(David – 50 kg a Goliáš – 100 kg oba štíhlí a zdatní mají obdobnou tepovou frekvenci, ale Goliáš má dvojnásobnou spotřebu kyslíku)

?? Použití u nemocných: normy tepového kyslíku na kilo.

ΔVO2/ΔW

Normální hodnota pro bicyklový ergometr je

10,3± 1 ml/kg/min na každý jeden W/kg zatížení

Nižší hodnoty např. při dysfunkci LK

Technická poznámka: je kulturní zatěžovat různě hmotné pacienty ve Wattech na kilogram a hodnotit jejich aerobní kapacitu v ml/kg/min, proto je lépe uvádět

VE/VCO2 slope

Minutová ventilace s výdejem CO2 mají do AT (ba i za ním stoupat lineárně)

Poměr (sklon regrese) u mladého má být pod 29, u chronického selhání srdečního je špatná prognóza někde nad 32,8

Příčiny zvýšení:

Nerovnoměrnost ventilace/perfúze

Srdeční selhání

Nemoci plic- embolie, plicní hypertenze, CHOPN

HKMP

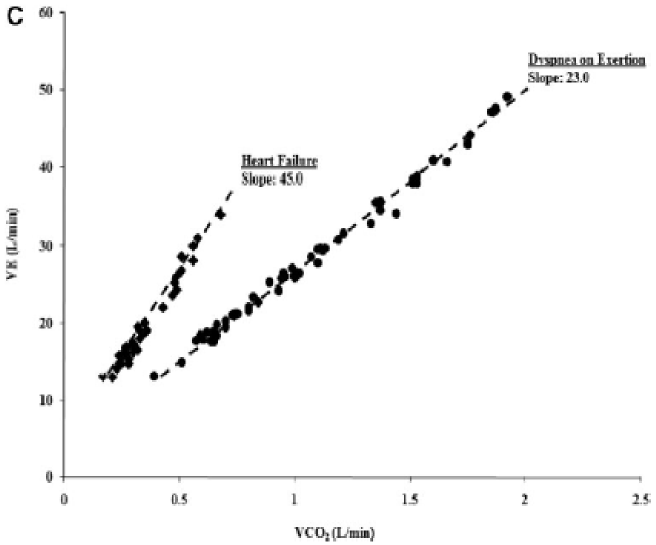


Figure 9 (Continued).

PET CO_2 (mm Hg)

Reprezentuje míru sladění ventilace a perfúze v plicích

Klidové hodnoty? 36-42…nad 38 mm Hg

Patologie pod 30 mm Hg

Během zátěže vzrůst nejméně o 3-8 mm hg

Ve VT2 setrvalý pokles

Vd/VT

Má klesat se stoupající zátěží

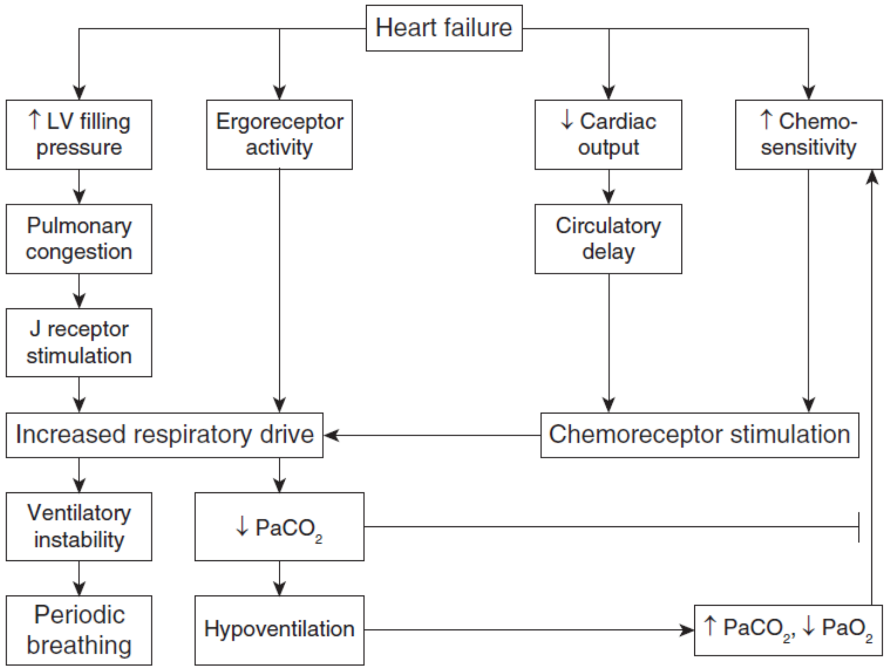
Když stoupá, je podezření na nepoměr ventilace/perfúze v zátěži

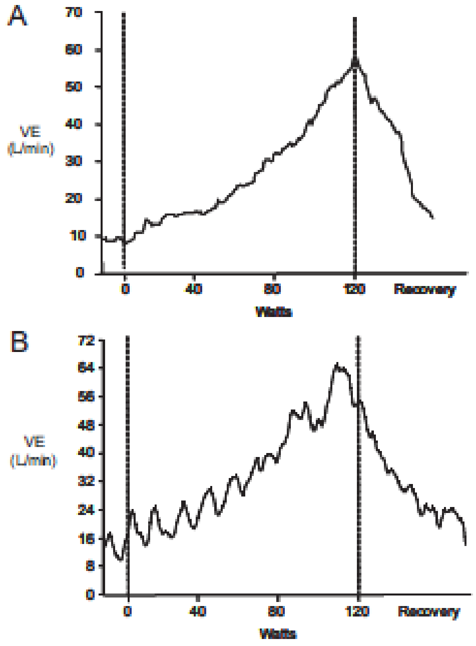
Technologie je velmi závislá na software i hardware analyzátoru

Pomocná metoda, bodově slušně hodnocená na to, že je automaticky měřitelná v rámci spiroergometrie…

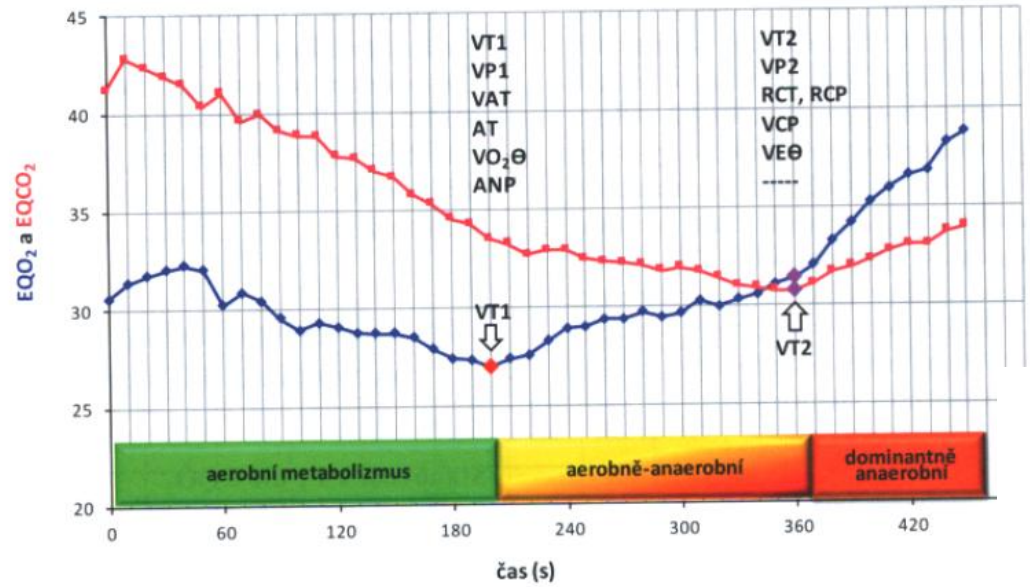
EOV- oscilující dýchání při zátěži

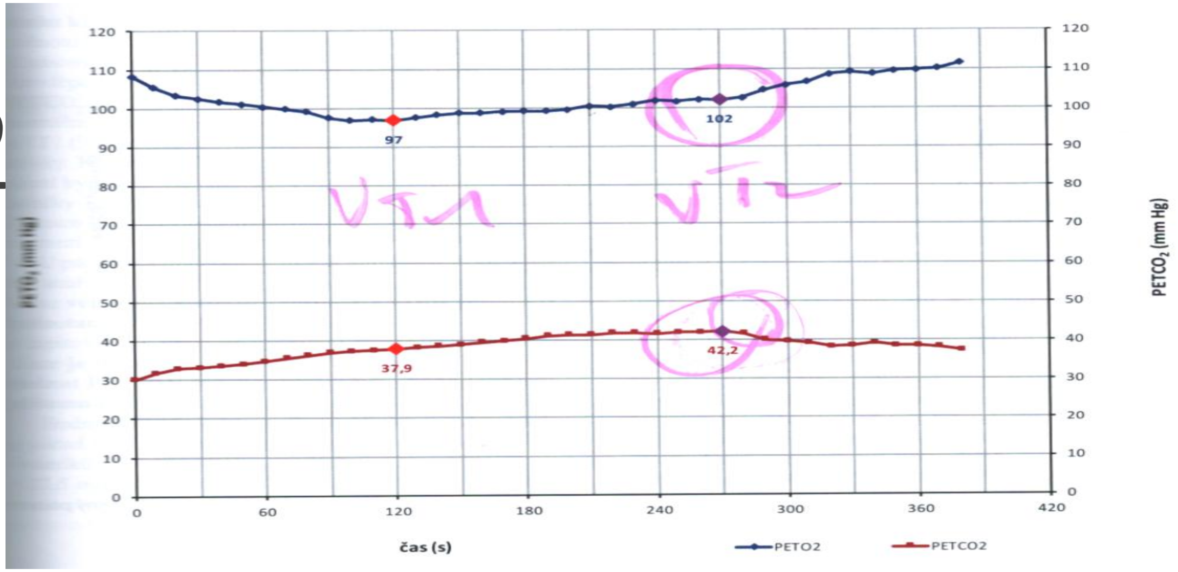
Oscilace ventilace nejméně 60% doby zátěže s amplitudou více než 15% normy





Ventilační prahy VT1, VT2





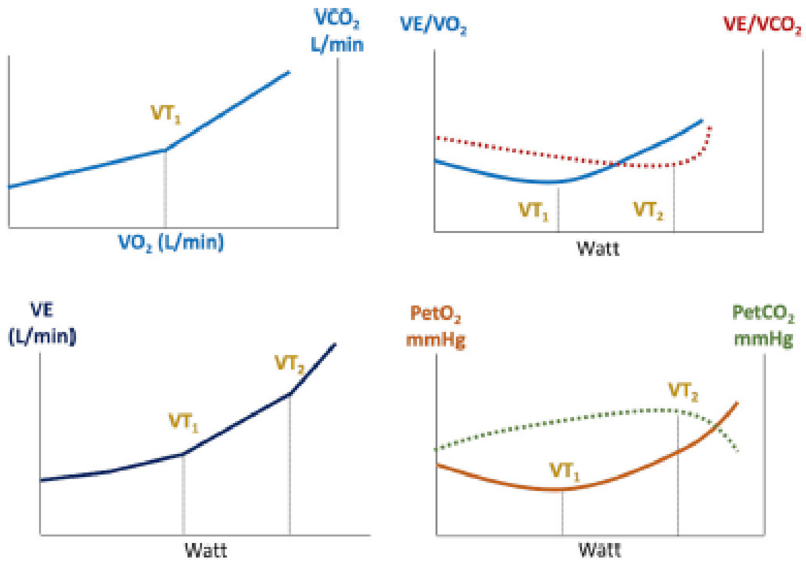


FIGURE 1 Determination of first and second ventilatory thresholds (VT_1 and VT_2) by cardiopulmonary exercise test (CPET) in a male: The VT_1 and VT_2 are usually obtained by analyzing all CPET panels, with particular attention to VO_2 vs. VCO_2, VE/VCO_2 and VE/VO_2, VE vs. power, and $PetO_2$ and $PetCO_2$ panels

Diferenciální diagnóza

Appendix 2 Diagnostic stratification for patients with unexplained exertional dyspnea

Primary CPX Variables			
$\dot{V}_E/\dot{V}_{CO_2}$ Slope	Percent Predicted Peak $\dot{V}_{O_2}$*	P_{ETCO_2}	$\dot{V}_E$/MVV†
Ventilatory class I $\dot{V}_E/\dot{V}_{CO_2}$ slope <30.0	≥100% predicted	Resting P_{ETCO_2} 36–42 mm Hg 3- to 8-mm Hg increase during ET	≤0.80
Ventilatory class II $\dot{V}_E/\dot{V}_{CO_2}$ slope 30.0–35.9	75%–99% predicted		
Ventilatory class III $\dot{V}_E/\dot{V}_{CO_2}$ slope 36.0–44.9	50%–74% predicted	Resting P_{ETCO_2} <36 mm Hg <3-mm Hg increase during ET	>0.80
Ventilatory class IV $\dot{V}_E/\dot{V}_{CO_2}$ slope ≥45.0	<50% predicted		

Primary PFT Variables: Flow-Volume Loop and FEV_1 and PEF‡	
exT_x loop: normal	exT_x loop: expiratory flow limitation
No change in FEV_1 and/or PEF from before to after CPX	≥15% reduction in FEV_1 or PEF from before to after CPX

Standard ET Variables		
Hemodynamics	ECG	Pulse Oximetry
Rise in systolic BP during ET: 10 mm Hg/3.5–mL $O_2\cdot kg^{-1}\cdot min^{-1}$ increase in $\dot{V}_{O_2}$	No sustained arrhythmias, ectopic foci, and/or ST-segment changes during ET and/or in recovery	No change in Sp_{O_2} from baseline
Flat response or drop in systolic BP during ET Or Excessive rise in systolic BP during exercise: ≥20 mm Hg/3.5-mL $O_2\cdot kg^{-1}\cdot min^{-1}$ increase in $\dot{V}_{O_2}$	Altered rhythm, ectopic foci, and/or ST-segment changes during ET and/or in recovery: did not lead to test termination	>5% decrease in Sp_{O_2} from baseline
	Altered rhythm, ectopic foci, and/or ST-segment changes during ET and/or in recovery: led to test termination	

Appendix 5 Valvular heart disease/dysfunction

Primary CPX Variables		
$\dot{V}_E/\dot{V}_{CO_2}$ Slope	Peak $\dot{V}_{O_2}$*	Percent Predicted Peak $\dot{V}_{O_2}$†‡
Ventilatory class I $\dot{V}_E/\dot{V}_{CO_2}$ slope <30.0	Weber class A Peak $\dot{V}_{O_2}$ >20.0 mL $O_2\cdot kg^{-1}\cdot min^{-1}$	≥100% predicted
Ventilatory class II $\dot{V}_E/\dot{V}_{CO_2}$ slope 30.0–35.9	Weber class B Peak $\dot{V}_{O_2}$=16.0–20.0 mL $O_2\cdot kg^{-1}\cdot min^{-1}$	75–99% predicted
Ventilatory class III $\dot{V}_E/\dot{V}_{CO_2}$ slope 36.0–44.9	Weber class C Peak $\dot{V}_{O_2}$=10.0–15.9 mL $O_2\cdot kg^{-1}\cdot min^{-1}$	50%–75% predicted
Ventilatory class IV $\dot{V}_E/\dot{V}_{CO_2}$ slope ≥45.0	Weber class D Peak $\dot{V}_{O_2}$ <10.0 mL $O_2\cdot kg^{-1}\cdot min^{-1}$	<50% predicted

Standard ET Variables	
Hemodynamics	ECG
Rise in systolic BP during ET	No sustained arrhythmias, ectopic foci, or ST-segment changes during ET or in recovery
Flat systolic BP response during exercise	Altered rhythm, ectopic foci, or ST-segment changes during ET or in recovery: did not lead to test termination
Drop in systolic BP during ET	Altered rhythm, ectopic foci, or ST-segment changes during ET or in recovery: led to test termination

Patient Reason for Test Termination	
Lower-extremity muscle fatigue	Angina or dyspnea

Appendix 6 Apparently healthy individuals

Primary CPX Variables		
Percent Predicted Peak $\dot{V}_{O_2}$*†	$\dot{V}_E/\dot{V}_{CO_2}$ Slope	EOV
≥100% predicted	Ventilatory class I $\dot{V}_E/\dot{V}_{CO_2}$ slope <30.0	Not present
75%–99% predicted	Ventilatory class II $\dot{V}_E/\dot{V}_{CO_2}$ slope 30.0–35.9	
50%–74% predicted	Ventilatory class III $\dot{V}_E/\dot{V}_{CO_2}$ slope 36.0–44.9	Present
<50% predicted	Ventilatory class IV $\dot{V}_E/\dot{V}_{CO_2}$ slope ≥45.0	

Standard ET Variables		
Hemodynamics	ECG	HRR
Rise in systolic BP during ET: 10 mm Hg/3.5–mL $O_2\cdot kg^{-1}\cdot min^{-1}$ increase in $\dot{V}_{O_2}$ and no change/slight decrease in diastolic BP	No sustained arrhythmias, ectopic foci, or ST-segment changes during ET or in recovery	>12 beats at 1 min recovery
Hypertensive response: excessive rise in systolic BP during exercise: ≥20 mm Hg/3.5–mL $O_2\cdot kg^{-1}\cdot min^{-1}$ increase in $\dot{V}_{O_2}$ or increase in diastolic BP: did not lead to test termination	Altered rhythm, ectopic foci, or ST-segment changes during ET or in recovery: did not lead to test termination	≤12 beats at 1 min recovery
Hypertensive response: Excessive rise in systolic BP during exercise: ≥20 mm Hg/3.5–mL $O_2\cdot kg^{-1}\cdot min^{-1}$ increase in $\dot{V}_{O_2}$ or increase in diastolic BP: led to test termination Hypotensive response: flat response or decrease in systolic BP during exercise: led to test termination	Altered rhythm, ectopic foci, or ST-segment changes during ET or in recovery: led to test termination	

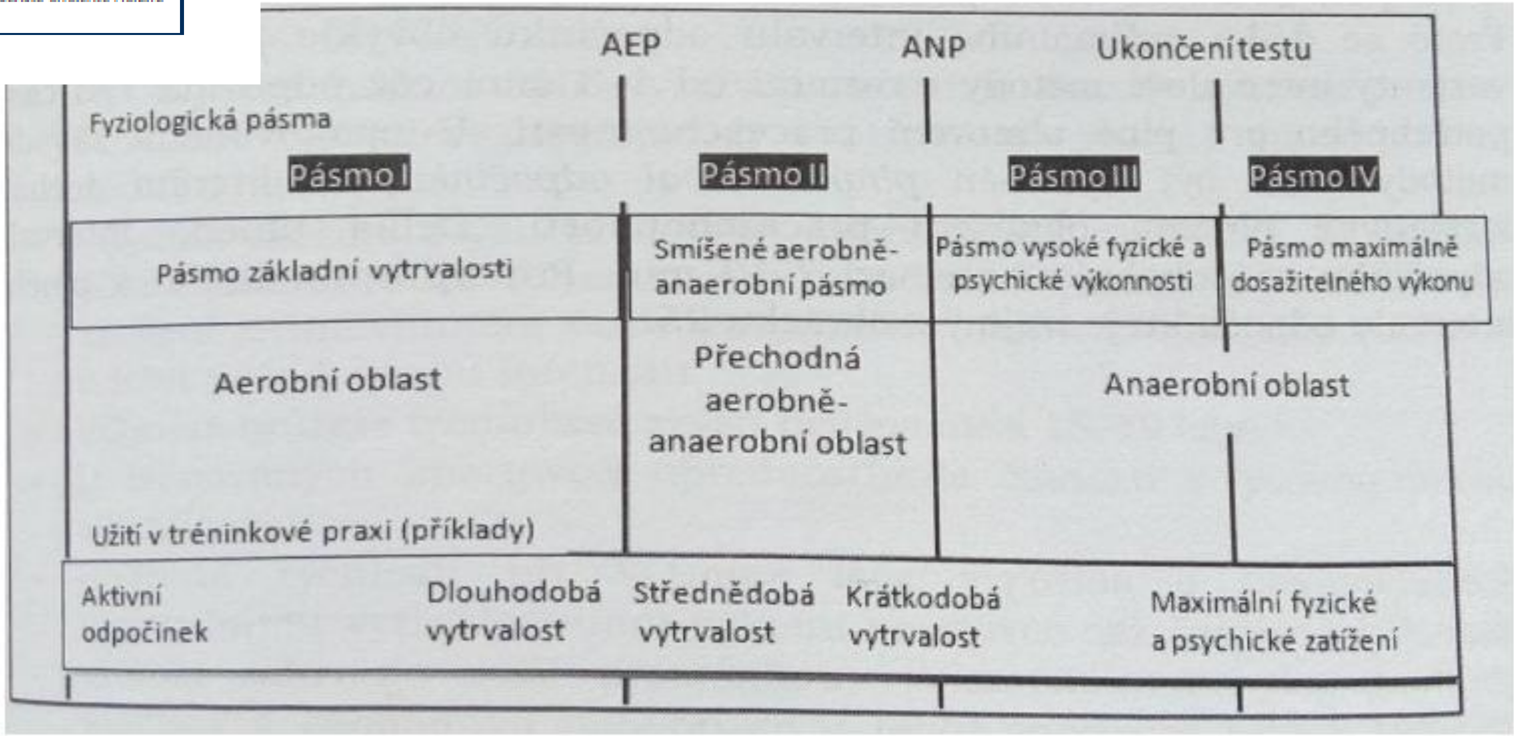
Patient Reason for Test Termination	
Lower-extremity muscle fatigue	Angina or dyspnea

Předpis pohybové aktivity

Tab. 1 Einordnung der Intensitätsbereiche für die Trainingssteuerung anhand der spiroergometrisch ermittelten ventilatorischen Schwellen VT1 und VT2. (Nach [8, 13, 14])

Intensität	Einstufung der Belastung	% peakVO$_2$	% HFpeak	% HFR	Borg-Skala	Mögliche Belastungsdauer (min)	Belastungsmodalität
Unterhalb der VT1	Sehr leicht	45–55	60–70	45–55	6–9	> 30	Dauermethode
Gering oberhalb der VT1	Leicht	55–75	70–80	55–70	10–12	> 30	Dauermethode
Unterhalb der VT2	Moderat	70–80	80–90	70–80	13–14	≤ 30	Dauermethode
Oberhalb der VT2	Intensiv	> 80	> 90	> 80	> 14	≤ 3	Intervallmethode

VT1 erste ventilatorische Schwelle, *VT2* zweite ventilatorische Schwelle, *peakVO$_2$* höchste erreichte Sauerstoffaufnahme, *HFpeak* höchste erreichte Herzfrequenz, *HFR* Herzfrequenzreserve



Zkušenost s metodou

Buď se tomu opravdu věnujte, nebo ji nechte jiným

Reproducibilita závislá na „kinderstube laboratoře“ … myslet si že stačí jednou naprogramovat počítač a vše půjde samo není realistické.

Cena přístroje

Cca 500-800 tisíc Kč pokud kupujete vše najednou: ergometr + EKG + analyzátor výměny dýchacích plynů

Samotný analyzátor dostanete pod 350 tisíc.

Úhrady (od pojišťoven)

Různé mechanismy úhrady- kombinovaná cena od 2000- 3000- 6000 bodů u pneumologů

Hlasování

Díky za pozornost

(pohled na maratónce na Karlově mostu)