

Smarż K, Jaxa-Chamiec T, Chwyczo T, et al. Cardiopulmonary exercise testing in adult cardiology: expert opinion of the Working Group of Cardiac Rehabilitation and Exercise Physiology of the Polish Cardiac Society. *Kardiol Pol.* 2019; 77: 730-756. doi:10.33963/KP.14889

REFERENCES

- 1 Weisman IM, Beck KC, Casaburi R, et al. ATS/ACCP Statement on cardiopulmonary exercise testing. *Am J Respir Crit Care Med.* 2003; 167: 211-277.
- 2 Mezzani A, Agostoni P, Cohen-Solal A, et al. Standards for the use of cardiopulmonary exercise testing for the functional evaluation of cardiac patients: a report from the Exercise Physiology Section of the European Association for Cardiovascular Prevention and Rehabilitation. *Eur J Cardiovasc Prev Rehabil.* 2009; 16: 249-267.
- 3 Fletcher GF, Ades PA, Kligfield P, et al. Exercise standards for testing and training: a scientific statement from the American Heart Association. *Circulation.* 2013; 128: 873-934.
- 4 Gibbons RJ, Balady GJ, Bricker JT, et al. ACC/AHA 2002 guideline update for exercise testing: summary article: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee to Update the 1997 Exercise Testing Guidelines). *Circulation.* 2002; 106: 1883-1892.
- 5 Guazzi M, Adams V, Conraads V, et al. EACPR/AHA Scientific Statement. Clinical recommendations for cardiopulmonary exercise testing data assessment in specific patient populations. *Circulation.* 2012; 126: 2261-2274.
- 6 Hollmann W, Prinz JP. Ergospirometry and its history. *Sports Med.* 1997; 23: 93-105.
- 7 Weber KT, Kinasewitz GT, Janicki JS, Fishman AP. Oxygen utilization and ventilation during exercise in patients with chronic cardiac failure. *Circulation.* 1982; 65: 1213-1223.
- 8 Mancini DM, Eisen H, Kusmaul W, et al. Value of peak exercise oxygen consumption for optimal timing of cardiac transplantation in ambulatory patients with heart failure. *Circulation.* 199; 83: 778-786.
- 9 Caspersen CJ, Powell KE, Christenson GM. Physical activity, exercise, and physical fitness: definitions and distinctions for health-related research. *Public Health Rep.* 1985; 100: 126-131.
- 10 Nazar K. Wysiłek fizyczny i adaptacja do środowiska naturalnego. In: Traczyk WZ, Trzebaski A, eds. *Fizjologia człowieka z elementami fizjologii stosowanej i klinicznej [Human physiology with elements of applied and clinical physiology].* Warszawa: PZWL; 2004: 890-914.
- 11 Wasserman K, Hansen JE, Sue DY, et al. Physiology of exercise. In: Wasserman K, Hansen J, Sietsema K, et al, eds. *Principles of exercise testing and interpretations: including pathophysiology and clinical applications.* Philadelphia: Lippincott Williams & Wilkins; 2012: 9-61.
- 12 Bergström J, Hermansen L, Hultman E, et al. Diet, muscle glycogen and physical performance. *Acta Physiol Scand.* 1967; 71: 140-150.
- 13 Bochenek A, Reicher M. *Anatomia człowieka. Tom I. Anatomia ogólna. Kości. Stawy i więzadła. Mięśnie [Human anatomy. Vol I. General anatomy. Bones. Joints and ligaments. Muscles].* Warszawa: PZWL; 1990: 618-649.
- 14 Kennelly PJ, Murray RK. Muscle and the cytoskeleton. In: Rodwell VW, Bender DA, Botham KM, Kennelly PJ, Weil P, eds. *Harper's illustrated biochemistry.* 31st ed. New York, NY: McGraw-Hill; 2018.
- 15 Lewartowski B. Fizjologia serca. In: Traczyk WZ, Trzebaski A, eds. *Fizjologia człowieka z elementami fizjologii stosowanej i klinicznej [Human physiology with elements of applied and clinical physiology].* Warszawa: PZWL; 2004: 445-507.
- 16 Lewartowski B. Fizjologia mięśni szkieletowych. In: Traczyk WZ, Trzebaski A, eds. *Fizjologia człowieka z elementami fizjologii stosowanej i klinicznej [Human physiology with elements of applied and clinical physiology].* Warszawa: PZWL; 2004: 71-92.
- 17 Goldstein RE. Exercise capacity. In: Walker HK, Hall WD, Hurst JW, eds. *Clinical methods: the history, physical, and laboratory examinations.* Boston: Butterworths; 1990: 69-71.
- 18 Arena R, Myers J, Williams MA, et al. Assessment of functional capacity in clinical and research settings. A scientific statement from the American Heart Association Committee on Exercise, Rehabilitation, and Prevention of the Council on Clinical Cardiology and the Council on Cardiovascular Nursing. *Circulation.* 2007; 116: 329-343.
- 19 Kozłowski S, Nazar K. *Wprowadzenie do fizjologii klinicznej [Introduction to clinical physiology].* Warszawa: PZWL; 1999.
- 20 Franklin BA, Whaley, MH, Howley ET, eds. *American College of Sports Medicine. ACSM's Guidelines for exercise testing and prescription.* 6th ed. Baltimore: Lippincott, William & Wilkins; 2000.
- 21 Ades P, Savage P, Brawner C, et al. Aerobic capacity in patients entering cardiac rehabilitation. *Circulation.* 2006; 113: 2706-2712.
- 22 Fleg JL, Morrell CH, Bos AG, et al. Accelerated longitudinal decline of aerobic capacity in healthy older adults. *Circulation.* 2005; 112: 674-682.
- 23 Dehn MM, Bruce RA. Longitudinal variations in maximal oxygen intake with age and activity. *J Appl Physiol.* 1972; 33: 805-807.
- 24 Wasserman K, Hansen JE, Sue DY, et al. Clinical applications of cardiopulmonary exercise testings. In: Wasserman K, Hansen J, Sietsema K, et al, eds. *Principles of exercise testing and interpretations: including pathophysiology and clinical applications.* Philadelphia: Lippincott Williams & Wilkins; 2012: 194-234.
- 25 Balady GJ, Arena R, Sietsema K, et al. Clinician's guide to cardiopulmonary exercise testing in adults: a scientific statement from the American Heart Association. *Circulation.* 2010; 122: 191-225.
- 26 Guazzi M, Arena R, Halle M, et al. 2016 Focused update: clinical recommendations for cardiopulmonary exercise testing data assessment in specific patient populations. *Circulation.* 2016; 133: 694-711.
- 27 Straburzyńska-Migaj E. *Testy spirometryczne w praktyce klinicznej [Spirometry examinations in clinical practice].* Warszawa: Wydawnictwo Lekarskie PZWL; 2010.
- 28 Smarż K, Jaxa-Chamiec T, Bednarczyk T, et al. Electrocardiographic exercise testing in adults: performance and interpretation. An expert opinion of the Polish Cardiac Society Working Group on Cardiac Rehabilitation and Exercise Physiology. 2019; 77: 399-408.
- 29 Froelicher VF. Interpretacja reakcji hemodynamicznych na test wysiłkowy. In: Froelicher VF. *Podręcznik testów wysiłkowych [Manual of Exercise Testing].* Polish edition. Warszawa: Bel CORP Scientific Publ. Co; 1999: 35-61.
- 30 Stringer WW, Hansen JE, Wasserman K. Cardiac output estimated noninvasively from oxygen uptake during exercise. *J Appl Physiol.* 1997; 82: 908-912.
- 31 Wasserman K, Hansen JE, Sue DY, et al. Measurements during integrative cardiopulmonary exercise testing. In: Wasserman K, Hansen J, Sietsema K, et al, eds. *Principles of exercise testing and interpretations: including pathophysiology and clinical applications.* Philadelphia: Lippincott Williams & Wilkins; 2012: 71-106.
- 32 Wasserman K, Whipp BJ. Exercise physiology in health and disease. *Am Rev Respir Dis.* 1975; 112: 219-249.
- 33 Mezzani A, Hamm LF, Jones AM, et al. Aerobic exercise intensity assessment and prescription in cardiac rehabilitation: a joint position statement of the European Association for Cardiovascular Prevention and Rehabilitation, the American Association of Cardiovascular and Pulmonary Rehabilitation, and the Canadian Association of Cardiac Rehabilitation. *J Cardiopulm Rehabil Prev.* 2012; 32: 327-350.
- 34 Howley ET, Bassett DR Jr, Welch HG. Criteria for maximal oxygen uptake: review and commentary. *Med Sci Sports Exerc.* 1995; 27: 1292-1301.
- 35 Wasserman K, Hansen JE, Sue DY, et al. Normal values. In: Wasserman K, Hansen J, Sietsema K, et al, eds. *Principles of exercise testing and interpretations: including pathophysiology and clinical applications.* Philadelphia: Lippincott Williams & Wilkins; 2012: 154-180.

- 36 Arena R, Myers J, Abella J, et al. Determining the preferred percent-predicted equation for peak oxygen consumption in patients with heart failure. *Circ Heart Fail.* 2009; 2: 113-120.
- 37 Jones NL, Robertson DG, Kane JW. Difference between end-tidal and arterial PCO₂ in exercise. *J Appl Physiol Respir Environ Exerc Physiol.* 1979; 47: 954-960.
- 38 Sun XG, Hansen JE, Garatachea N, et al. Ventilatory efficiency during exercise in healthy subjects. *Am J Respir Crit Care Med.* 2002; 166: 1443-1448.
- 39 Dumitrescu D, Rosenkranz S. Graphical data display for clinical cardiopulmonary exercise testing. *Ann Am Thorac Soc.* 2017; 14 (Suppl 1): S12-S21.
- 40 Wasserman K, Hansen J, Sue DY, et al. Diagnostic specificity of exercise intolerance: a flowchart approach. In: Wasserman K, Hansen J, Sietsema K, et al, eds. *Principles of exercise testing and interpretations: including pathophysiology and clinical applications.* Philadelphia: Lippincott Williams & Wilkins; 2012: 181-193.
- 41 Ponikowski P, Voors AA, Anker SD, et al. 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). Developed with the special contribution of the Heart Failure Association (HFA) of the ESC. *Eur J Heart Fail.* 2016; 18: 891-975.
- 42 Mehra MR, Canter CE, Hannan MM, et al. International Society for Heart Lung Transplantation (ISHLT) Infectious Diseases Council; International Society for Heart Lung Transplantation (ISHLT) Pediatric Transplantation Council; International Society for Heart Lung Transplantation (ISHLT) Heart Failure and Transplantation Council. The 2016 International Society for Heart Lung Transplantation listing criteria for heart transplantation: a 10-year update. *J Heart Lung Transplant.* 2016; 35: 1-23.
- 43 Corrà U, Agostoni PG, Anker SD, et al. Role of cardiopulmonary exercise testing in clinical stratification in heart failure. A position paper from the Committee on Exercise Physiology and Training of the Heart Failure Association of the European Society of Cardiology. *Eur J Heart Fail.* 2018; 20: 3-15.
- 44 Corra U, Piepoli MF, Adamopoulos S, et al. Cardiopulmonary exercise testing in systolic heart failure in 2014: the evolving prognostic role: a position paper from the Committee on Exercise Physiology and Training of the Heart Failure Association of the ESC. *Eur J Heart Fail.* 2014; 16: 929-941.
- 45 Agostoni P, Paolillo S, Mapelli M, et al. Multiparametric prognostic scores in chronic heart failure with reduced ejection fraction: a long-term comparison. *Eur J Heart Fail.* 2018; 20: 700-710.
- 46 Piepoli MF, Corra U, Agostoni PG, et al. Task Force of the Italian Working Group on Cardiac Rehabilitation Prevention endorsed by the Working Group on Cardiac Rehabilitation and Exercise Physiology of the European Society of Cardiology. Statement on cardiopulmonary exercise testing in chronic heart failure due to left ventricular dysfunction recommendations for performance and interpretation. Part II: How to perform cardiopulmonary exercise testing in chronic heart failure. *Eur J Cardiovasc Prev Rehabil.* 2006; 13: 300-311.
- 47 Skalski J, Allison TG, Miller TD. The safety of cardiopulmonary exercise testing in a population with high-risk cardiovascular diseases. *Circulation.* 2012; 126: 2465-2472.
- 48 Keteyian SJ, Isaac D, Thadani U, et al. HF-ACTION Investigators. Safety of symptom-limited cardiopulmonary exercise testing in patients with chronic heart failure due to severe left ventricular systolic dysfunction. *Am Heart J.* 2009; 158 (Suppl 4): S72-S77.
- 49 Malhotra R, Bakken K, D'Elia E, Lewis GD. Cardiopulmonary exercise testing in heart failure. *JACC: Heart Fail.* 2016; 4: 607-616.
- 50 Arena R, Myers J, Abella J, et al. Development of a ventilatory classification system in patients with heart failure. *Circulation.* 2007; 115: 2410-2417.
- 51 Diller GP, Dimopoulos K, Okonko D, et al. Exercise intolerance in adult congenital heart disease: comparative severity, correlates, and prognostic implication. *Circulation.* 2005; 112: 828-835.
- 52 Rodahl K, Dahl HA, Astrand PO. *Textbook of work physiology, physiological bases of exercise.* New York: McGraw-Hill Book Company; 2003.
- 53 Hermansen L, Saltin B. Oxygen uptake during maximal treadmill and bicycle exercise. *J Appl Physiol.* 1969; 26: 31-37.
- 54 Takken T, Blank AC, Hulzebos EH, et al. Cardiopulmonary exercise testing in congenital heart disease: (contra)indications and interpretation. *Neth Heart J.* 2009; 17: 385-392.
- 55 Myers J, Bellin D. Ramp exercise protocols for clinical and cardiopulmonary exercise testing. *Sports Med.* 2000; 30: 23-29.
- 56 Myers J, Buchanan N, Walsh D, et al. Comparison of the ramp versus standard exercise protocols. *J Am Coll Cardiol.* 1991; 17: 1334-1342.
- 57 Buchfuhrer MJ, Hansen JE, Robinson TE, et al. Optimizing the exercise protocol for cardiopulmonary assessment. *J Appl Physiol Respir Environ Exerc Physiol.* 1983; 55: 1558-1564.
- 58 Karila C, de Blic J, Waernessyckle S, et al. Cardiopulmonary exercise testing in children: an individualized protocol for workload increase. *Chest.* 2001; 120: 81-87.
- 59 Rybicki J. Kompendium: Testy wysiłkowe w rehabilitacji kardiologicznej. Programowanie treningów sterowanych komputerowo [Compendium: Exercise testing in cardiac rehabilitation. Programming computer-controlled trainings]. Zbiórów: Wydawnictwo ASPEL; 2018.
- 60 Baumgartner H, Bonhoeffer P, De Groot NM, et al. Task Force on the Management of Grown-up Congenital Heart Disease of the European Society of Cardiology (ESC); Association for European Paediatric Cardiology (AEPC). ESC Committee for Practice Guidelines (CPG). ESC Guidelines for the management of grown-up congenital heart disease (new version 2010). *Eur Heart J.* 2010; 31: 2915-2957.
- 61 Astrand PO. Experimental studies of physical work capacity in relation to sex and age. Copenhagen: Munksgaard; 1952.
- 62 Kempny A, Dimopoulos K, Uebing A, et al. Reference values for exercise limitations among adults with congenital heart disease. Relation to activities of daily life-single centre experience and review of published data. *Eur Heart J.* 2012; 33: 1386-1396.
- 63 Dimopoulos K, Okonko DO, Diller GP, et al. Abnormal ventilatory response to exercise in adults with congenital heart disease relates to cyanosis and predicts survival. *Circulation.* 2006; 113: 2796-2802.
- 64 Inuzuka R, Diller GP, Borgia F, et al. Comprehensive use of cardiopulmonary exercise testing identifies adults with congenital heart disease at increased mortality risk in the medium term. *Circulation.* 2012; 125: 250-259.
- 65 Biernacka EK, Piotrowicz E, Fronczak A, et al. Influence of percutaneous pulmonary valve implantation on exercise capacity: which group of patients benefits most from the intervention? *Cardiol J.* 2015; 22: 343-350.
- 66 MacLellan-Tobert SG, Driscoll DJ, Mottram CD, et al. Exercise tolerance in patients with Ebstein's anomaly. *J Am Coll Cardiol.* 1997; 29: 1615-1622.
- 67 Masri A, Pierson LM, Smedira NG, et al. Predictors of long-term outcomes in patients with hypertrophic cardiomyopathy undergoing cardiopulmonary stress testing and echocardiography. *Am Heart J.* 2015; 169: 684-692.e1.
- 68 Magri D, Re F, Limongelli G, et al. Heart failure progression in hypertrophic cardiomyopathy possible insights from cardiopulmonary exercise testing. *Circ J.* 2016; 80: 2204-2211.
- 69 Elliott PM, Anastakis A, Borger MA, et al. 2014 ESC guidelines on diagnosis and management of hypertrophic cardiomyopathy: the Task Force for the Diagnosis and Management of Hypertrophic Cardiomyopathy of the European Society of Cardiology (ESC). *Eur Heart J.* 2014; 35: 2733-2779.
- 70 Tower-Rader A, Betancor J, Lever HM, Desai MY. A comprehensive review of stress testing in hypertrophic cardiomyopathy: assessment of functional capacity, identification of prognostic indicators, and detection of coronary artery disease. *J Am Soc Echocardiogr.* 2017; 30: 829-844.
- 71 Savage DD, Seides SF, Clark CE, et al. Electrocardiographic findings in patients with obstructive and nonobstructive hypertrophic cardiomyopathy. *Circulation.* 1978; 58: 402-408.
- 72 Bunch TJ, Chandrasekaran K, Ehsam JE, et al. Prognostic significance of exercise induced arrhythmias and echocardiographic variables in hypertrophic cardiomyopathy. *Am J Cardiol.* 2007; 99: 835-838.
- 73 Nagata M, Shimizu M, Ino H, et al. Hemodynamic changes and prognosis in patients with hypertrophic cardiomyopathy and abnormal blood pressure response during exercise. *Clin Cardiol.* 2003; 26: 71-76.
- 74 Olivetto I, Maron BJ, Monteregegi A, et al. Prognostic value of systemic blood pressure response during exercise in a community-based patient population with hypertrophic cardiomyopathy. *J Am Coll Cardiol.* 1999; 33: 2044-2051.
- 75 Sadoul N, Prasad K, Elliott PM, et al. Prospective prognostic assessment of blood pressure response during exercise in patients with hypertrophic cardiomyopathy. *Circulation.* 1997; 96: 2987-2991.
- 76 Maki S, Ikeda H, Muro A, et al. Predictors of sudden cardiac death in hypertrophic cardiomyopathy. *Am J Cardiol.* 1998; 82: 774-778.
- 77 Sharma S, Elliott PM, Whyte G, et al. Utility of metabolic exercise testing in distinguishing hypertrophic cardiomyopathy from physiologic left ventricular hypertrophy in athletes. *J Am Coll Cardiol.* 2000; 36: 864-870.
- 78 Lele SS, Thomson HL, Seo H, et al. Exercise capacity in hypertrophic cardiomyopathy. Role of stroke volume limitation, heart rate, and diastolic filling characteristics. *Circulation.* 1995; 92: 2886-2894.
- 79 Huff CM, Turer AT, Wang A. Correlations between physician-perceived functional status, patient-perceived health status, and cardiopulmonary exercise results in hypertrophic cardiomyopathy. *Qual Life Res.* 2013; 22: 647-652.
- 80 Cannon RO 3rd, McIntosh CL, Schenke WH, et al. Effect of surgical reduction of left ventricular outflow obstruction on hemodynamics, coronary flow, and myocardial metabolism in hypertrophic cardiomyopathy. *Circulation.* 1989; 79: 766-775.
- 81 Firoozi S, Elliott PM, Sharma S, et al. Septal myotomy-myectomy and transcatheter septal alcohol ablation in hypertrophic obstructive cardiomyopathy. A comparison of clinical, haemodynamic and exercise outcomes. *Eur Heart J.* 2002; 23: 1617-1624.
- 82 Sorajja P, Allison T, Hayes C, et al. Prognostic utility of metabolic exercise testing in minimally symptomatic patients with obstructive hypertrophic cardiomyopathy. *Am J Cardiol.* 2012; 109: 1494-1498.
- 83 Coats CJ, Rantell K, Bartnik A, et al. Cardiopulmonary exercise testing and prognosis in hypertrophic cardiomyopathy. *Circ Heart Fail.* 2015; 8: 1022-1031.
- 84 Mehra MR, Kobashigawa J, Starling R, et al. Listing criteria for heart transplantation: International Society for Heart and Lung Transplantation guidelines for the care of cardiac transplant candidates. *J Heart Lung Transplant.* 2006; 25: 1024-1042.
- 85 Rowin EJ, Maron BJ, Olivetto J, Maron MS. Role of exercise testing in hypertrophic cardiomyopathy. *J Am Coll Cardiol Img.* 2017; 10: 1374-1386.
- 86 Finocchiaro G, Haddad F, Knowles JW, et al. Cardiopulmonary responses and prognosis in hypertrophic cardiomyopathy: a potential role for comprehensive noninvasive hemodynamic assessment. *JACC Heart Fail.* 2015; 3: 408-418.

- 87 Arena R, Lavie CJ, Milani RV, et al. Cardiopulmonary exercise testing in patients with pulmonary arterial hypertension: an evidence-based review. *J Heart Lung Transplant*. 2010; 29: 159-173.
- 88 Galiè N, Humbert M, Vachiery JL, et al. 2015 ESC/ERS Guidelines for the diagnosis and treatment of pulmonary hypertension: The Joint Task Force for the Diagnosis and Treatment of Pulmonary Hypertension of the European Society of Cardiology (ESC) and the European Respiratory Society (ERS): Endorsed by: Association for European Paediatric and Congenital Cardiology (AEPCC), International Society for Heart and Lung Transplantation (ISHLT). *Eur Heart J*. 2016; 37: 67-119.
- 89 Guazzi M, Cahalin LP, Arena R. Cardiopulmonary exercise testing as a diagnostic tool for the detection of left-sided pulmonary hypertension in heart failure. *J Card Fail*. 2013; 19: 461-467.
- 90 Pinkstaff SO, Burger CD, Daugherty J, et al. Cardiopulmonary exercise testing in patients with pulmonary hypertension: clinical recommendations based on a review of the evidence. *Expert Rev Respir Med*. 2016; 10: 279-295.
- 91 Sun XG, Hansen JE, Oudiz RJ, Wasserman K. Exercise pathophysiology in patients with primary pulmonary hypertension. *Circulation*. 2001; 104: 429-435.
- 92 Belardinelli R, Lacialprice F, Tian L, et al. Cardiopulmonary exercise testing is more accurate than ECG-stress testing in diagnosing myocardial ischemia in subjects with chest pain. *Int J Cardiol*. 2014; 174: 337-342.
- 93 Chaudhry S, Arena RA, Hansen JE, et al. The utility of cardiopulmonary exercise testing to detect and track early-stage ischemic heart disease. *Mayo Clin Proc*. 2010; 85: 928-932.
- 94 Chaudhry S, Arena R, Wasserman K, et al. Exercise-induced myocardial ischemia detected by cardiopulmonary exercise testing. *Am J Cardiol*. 2009; 103: 615-619.
- 95 Chaudhry S, Arena R, Bhatt DL, et al. A practical clinical approach to utilize cardiopulmonary exercise testing in the evaluation and management of coronary artery disease: a primer for cardiologists. *Curr Opin Cardiol*. 2018; 33: 168-177.
- 96 Chaudhry S, Kumar N, Behbahani H, et al. Abnormal heart-rate response during cardiopulmonary exercise testing identifies cardiac dysfunction in symptomatic patients with non-obstructive coronary artery disease. *Int J Cardiol*. 2017; 228: 114-121.
- 97 Maddox TM, Stanislawski MA, Grunwald GK, et al. Nonobstructive coronary artery disease and risk of myocardial infarction. *JAMA*. 2014; 312: 1754-1763.
- 98 Whipp BJ, Higgenbotham MB, Cobb FC. Estimating exercise stroke volume from asymptotic oxygen pulse in humans. *J Appl Physiol*. 1996; 81: 2674-2679.
- 99 Goldraich L, Ross H, Foroutan F. Reevaluating modality of cardiopulmonary exercise testing in patients with heart failure and resynchronization therapy: relevance of heart rate-adaptive pacing. *J Card Fail*. 2017; 23: 422-426.
- 100 Mathony U, Schmidt H, Gröger C. Optimal maximum tracking rate of dual-chamber pacemakers required by children and young adults for a maximal cardiorespiratory performance. *Pacing Clin Electrophysiol*. 2005; 28: 378-383.
- 101 Auricchio A, Stellbrink C, Butter C, et al. on behalf of the Pacing Therapies in Congestive Heart Failure (PATH-CHF) II Study Group, Kramer A, Huvelle E, on behalf of the Guidant Heart Failure Research Group. Clinical efficacy of cardiac resynchronization therapy using left ventricular pacing in heart failure patients stratified by severity of ventricular conduction delay. *J Am Coll Cardiol*. 2003; 42: 2109-2116.
- 102 Young JB, Abraham WT, Smith AL, et al. Combined cardiac resynchronization and implantable cardioversion defibrillation in advanced chronic heart failure - the MIRACLE ICD trial. *JAMA*. 2003; 289: 2685-2694.
- 103 Cazeau S, Leclercq C, Lavergne T, et al. Effects of multisite biventricular pacing in patients with heart failure and intraventricular conduction delay. Multisite Stimulation in Cardiomyopathies (MUSTIC) Study Investigators. *N Engl J Med*. 2001; 344: 873-880.
- 104 Thibault B, Harel F, Ducharme A, et al. LESSER-EARTH Investigators. Cardiac resynchronization therapy in patients with heart failure and a QRS complex <120 milliseconds: The Evaluation of Resynchronization Therapy for Heart Failure (LESSER-EARTH) trial. *Circulation*. 2013; 127: 873-881.
- 105 Lecoq G, Leclercq C, Leray E, et al. Clinical and electrocardiographic predictors of a positive response to cardiac resynchronization therapy in advanced heart failure. *Eur Heart J*. 2005; 26: 1094-1100.
- 106 Piepoli MF, Villani GQ, Corra U, et al. Time course of effects of cardiac resynchronization therapy in chronic heart failure: benefits in patients with preserved exercise capacity. *PACE*. 2008; 31: 701-708.
- 107 Arora S, Aarones M, Aakhus S, et al. Peak oxygen uptake during cardiopulmonary exercise testing determines response to cardiac resynchronization therapy. *J Cardiol*. 2012; 60: 228-235.
- 108 Berger T, Zwick RH, Stuehlinger M, et al. Impact of oxygen uptake efficiency slope as a marker of cardiorespiratory reserve on response to cardiac resynchronization therapy. *Clin Res Cardiol*. 2011; 100: 159-166.
- 109 Mastenbroek MH, Sant JV, Versteeg H, et al. Relationship between reverse remodeling and cardiopulmonary exercise capacity in heart failure patients undergoing cardiac resynchronization therapy. *J Card Fail*. 2016; 22: 385-394.
- 110 Chwyczo T, Dąbrowski R, Maciąg A, et al. Potential prevention of pacing-induced heart failure using simple pacemaker programming algorithm. *Ann Non-invasive Electrocardiol*. 2013; 18: 369-378.
- 111 Tse HF, Siu CW, Lee KL, et al. The incremental benefit of rate-adaptive pacing on exercise performance during cardiac resynchronization therapy. *J Am Coll Cardiol*. 2005; 46: 2292-2297.
- 112 Ujeyl A, Stevenson LW, West EK, et al. Impaired heart rate responses and exercise capacity in heart failure patients with paced baseline rhythms. *J Card Fail*. 2011; 17: 188-195.
- 113 Sims DB, Mignatti A, Colombo PC, et al. Rate responsive pacing using cardiac resynchronization therapy in patients with chronotropic incompetence and chronic heart failure. *Europace*. 2011; 13: 1459-1463.
- 114 Gierula J, Paton MF, Lowry JE, et al. Rate-response programming tailored to the force-frequency relationship improves exercise tolerance in chronic heart failure. *JACC Heart Fail*. 2018; 6: 105-113.
- 115 Global Initiative for Asthma. Global strategy for asthma management and prevention, 2018. Available from: www.ginaasthma.org.
- 116 Global Initiative for Chronic Obstructive Pulmonary Disease. Global strategy for the diagnosis, management and prevention of chronic obstructive pulmonary disease, 2018. Available from: www.goldcopd.org.
- 117 Lefcoe NM, Carter RP, Ahmad D. Postexercise bronchoconstriction in normal subjects and asthmatics. *Am Rev Respir Dis*. 1971; 104: 562-567.
- 118 Parsons JP, Hallstrand TS, Mastrorarde JG, et al. An official American Thoracic Society clinical practice guideline: exercise-induced bronchoconstriction in asthma. *Am J Respir Crit Care Med*. 2013; 187: 1016-1027.
- 119 Weatherald J, Lougheed MD, Taillé C, Garcia G. Mechanisms, measurement and management of exertional dyspnea. *Eur Respir Rev*. 2017; 26: pii: 170 015.
- 120 O'Donnell DE, Elbehairy AF, Faisal A, et al. Exertional dyspnea in COPD: the clinical utility of cardiopulmonary exercise testing. *Eur Respir Rev*. 2016; 25: 333-347.
- 121 Colice GL, Shafazand S, Griffin JP, et al.; American College of Chest Physicians. Physiologic evaluation of the patient with lung cancer being considered for resectional surgery: ACCP evidenced-based clinical practice guidelines (2nd edition). *Chest*. 2007; 132: 1615-1775.
- 122 DeCamp MM Jr, Lipson D, Krasna M, et al. The evaluation and preparation of the patient for lung volume reduction surgery. *Proc Am Thorac Soc*. 2008; 5: 427-431.
- 123 Opolski G, Krzakowski M, Szmít S, et al. Task Force of National Consultants in Cardiology and Clinical Oncology. Recommendations of National Team of Cardiology and Oncologic Supervision on cardiologic safety of patients with breast cancer. The prevention and treatment of cardiovascular complications in breast cancer. The Task Force of National Consultants in Cardiology and Clinical Oncology for the elaboration of recommendations of cardiologic proceeding with patients with breast cancer [in Polish]. *Kardiologia*. 2011; 69: 520-530.
- 124 Szmít S, Filipiak KJ, Litwiniuk M, et al. Liposomal doxorubicin in patients with breast cancer and concomitant cardiovascular diseases - interdisciplinary expert opinion. *Kardiologia*. 2016; 74: 1031-1036.
- 125 Lopez-Fernandez T, Martin Garcia A, Santaballa Beltran A, et al. Cardio-onco-hematology in clinical practice. Position paper and recommendations. *Rev Esp Cardiol (Engl Ed)*. 2017; 70: 474-486.
- 126 Jones LW, Eves ND, Haykowsky M, et al. Cardiorespiratory exercise testing in clinical oncology research: systematic review and practice recommendations. *Lancet Oncol*. 2008; 9: 757-765.
- 127 Jones LW, Eves ND, Mackey JR, et al. Safety and feasibility of cardiopulmonary exercise testing in patients with advanced cancer. *Lung Cancer*. 2007; 55: 225-232.
- 128 Knols R, Aaronson NK, Uebelhart D, et al. Physical exercise in cancer patients during and after medical treatment: a systematic review of randomized and controlled clinical trials. *J Clin Oncol*. 2005; 23: 830-842.
- 129 Schmitz KH, Holtzman J, Courneya KS, et al. Controlled physical activity trials in cancer survivors: a systematic review and meta-analysis. *Cancer Epidemiol Biomarkers Prev*. 2005; 14: 1588-1595.
- 130 Szmít S, Jurczak W, Zaucha JM, et al. Pre-existing arterial hypertension as a risk factor for early left ventricular systolic dysfunction following (R)-CHOP chemotherapy in patients with lymphoma. *J Am Soc Hypertens*. 2014; 8: 791-799.
- 131 Szmít S, Streb J, Starzec W, et al. Left ventricular systolic dysfunction in metastatic breast cancer patients: a Polish multicenter registry. *Anticancer Res*. 2015; 35: 989-995.
- 132 Bohlius J, Weingart O, Trelle S, Engert A. Cancer-related anemia and recombinant human erythropoietin - an updated overview. *Nat Clin Pract Oncol*. 2006; 3: 152-164.
- 133 Ekholm E, Rantanen V, Bergman M, et al. Docetaxel and autonomic cardiovascular control in anthracycline treated breast cancer patients. *Anticancer Res*. 2000; 20 (3B): 2045-2048.
- 134 Mao J, Kocak Z, Zhou S, et al. The impact of induction chemotherapy and the associated tumor response on subsequent radiation-related changes in lung function and tumor response. *Int J Radiat Oncol Biol Phys*. 2007; 67: 1360-1369.
- 135 Miller KL, Zhou SM, Barrier RC Jr, et al. Long-term changes in pulmonary function tests after definitive radiotherapy for lung cancer. *Int J Radiat Oncol Biol Phys*. 2003; 56: 611-615.
- 136 Esteban E, Villanueva N, Muniz I, et al. Pulmonary toxicity in patients treated with gemcitabine plus vinorelbine or docetaxel for advanced non-small cell lung cancer: outcome data on a randomized phase II study. *Invest New Drugs*. 2008; 26: 67-74.
- 137 Beckman JA, Thakore A, Kalinowski BH, et al. Radiation therapy impairs endothelium-dependent vasodilation in humans. *J Am Coll Cardiol*. 2001; 37: 761-765.
- 138 Jones LW, Haykowsky M, Peddle CJ, et al. Cardiovascular risk profile of patients with HER2/neu-positive breast cancer treated with

- anthracycline-taxane-containing adjuvant chemotherapy and/or trastuzumab. *Cancer Epidemiol Biomarkers Prev.* 2007; 16: 1026-1031.
- 139** Batchelor TT, Taylor LP, Thaler HT, et al. Steroid myopathy in cancer patients. *Neurology.* 1997; 48: 1234-1238.
- 140** Lucia A, Earnest C, Perez M. Cancer-related fatigue: can exercise physiology assist oncologists? *Lancet Oncol.* 2003; 4: 616-625.
- 141** Velthuis MJ, Agasi-Idenburg SC, Aufdemkampe G, Wittink HM. The effect of physical exercise on cancer-related fatigue during cancer treatment: a meta-analysis of randomised controlled trials. *Clin Oncol (R Coll Radiol).* 2010; 22: 208-221.
- 142** Speck RM, Courneya KS, Mäse LC, et al. An update of controlled physical activity trials in cancer survivors: a systematic review and meta-analysis. *J Cancer Surviv.* 2010; 4: 87-100.
- 143** Irwin ML, Crumley D, McTiernan A, et al. Physical activity levels before and after a diagnosis of breast carcinoma: the Health, Eating, Activity and Lifestyle (HEAL) study. *Cancer.* 2003; 97: 1746-1757.
- 144** Schumacher YO, Muser K, Hirschberger B, et al. Hodgkin's lymphoma in an elite endurance athlete. *Med Sci Sports Exerc.* 2008; 40: 401-404.
- 145** Doyle C, Kushi LH, Byers T, et al. Nutrition and physical activity during and after cancer treatment: an American Cancer Society guide for informed choices. *CA Cancer J Clin.* 2006; 56: 323-353.
- 146** Miller AM, Lopez-Mitnik G, Somarriba G, et al. Exercise capacity in long-term survivors of pediatric cancer: an analysis from the Cardiac Risk Factors in Childhood Cancer Survivors Study. *Pediatr Blood Cancer.* 2013; 60: 663-668.
- 147** Christiansen JR, Kanellopoulos A, Lund MB, et al. Impaired exercise capacity and left ventricular function in long-term adult survivors of childhood acute lymphoblastic leukemia. *Pediatr Blood Cancer.* 2015; 62: 1437-1443.
- 148** Zamorano JL, Lancellotti P, Muñoz DR, et al. 2016 ESC Position Paper on cancer treatments and cardiovascular toxicity developed under the auspices of the ESC Committee for Practice Guidelines [in Polish]. *Kardiol Pol.* 2016; 74: 1193-1233.
- 149** De Backer IC, Schep G, Hoogeveen A, et al. Exercise testing and training in a cancer rehabilitation program: the advantage of the steep ramp test. *Arch Phys Med Rehabil.* 2007; 88: 610-616.
- 150** Elbl L, Vasova I, Tomaskova I, et al. Cardiopulmonary exercise testing in the evaluation of functional capacity after treatment of lymphomas in adults. *Leuk Lymphoma.* 2006; 47: 843-851.
- 151** Adamsen L, Quist M, Andersen C, et al. Effect of a multimodal high intensity exercise intervention in cancer patients undergoing chemotherapy: randomised controlled trial. *BMJ.* 2009; 339: 895-899.
- 152** Jones LW, Eves ND, Haykowsky M, et al. Exercise intolerance in cancer and the role of exercise therapy to reverse dysfunction. *Lancet Oncol.* 2009; 10: 598-605.
- 153** McNeely ML, Campbell KL, Rowe BH, et al. Effects of exercise on breast cancer patients and survivors: a systematic review and meta-analysis. *Can Medical Assoc J.* 2006; 175: 34-41.
- 154** Courneya KS, Segal RJ, Mackey JR, et al. Effects of aerobic and resistance exercise in breast cancer patients receiving adjuvant chemotherapy: a multicenter randomized controlled trial. *J Clin Oncology.* 2007; 25: 4396-4404.
- 155** Courneya KS, Segal RJ, Gelmon K, et al. Six months follow-up of patient-rated outcomes in a randomized controlled trial of exercise training during breast cancer chemotherapy. *Cancer Epidemiol Biomarkers Prev.* 2007; 16: 2572-2578.
- 156** Klika RJ, Callahan KE, Drum SN. Individualized 12-week exercise training programs enhance aerobic capacity of cancer survivors. *Physic Sportsmed.* 2009; 37: 68-77.
- 157** Klika RJ, Callahan KE, Golik KS. Exercise capacity of a breast cancer survivor: a case study. *Med Sci Sports Exerc.* 2008; 40: 1711-1716.
- 158** Carlson LE, Smith D, Russell J, et al. Individualized exercise program for the treatment of severe fatigue in patients after allogeneic hematopoietic stem-cell transplant: a pilot study. *Bone Marrow Transplant.* 2006; 37: 945-954.
- 159** Moran J, Wilson F, Guinan E, et al. Role of cardiopulmonary exercise testing as a risk-assessment method in patients undergoing intra-abdominal surgery: a systematic review. *Br J Anaesth.* 2016; 116: 177-191.
- 160** Snowden CP, Prentis JM, Anderson HL, et al. Submaximal cardiopulmonary exercise testing predicts complications and hospital length of stay in patients undergoing major elective surgery. *Ann Surg.* 2010; 251: 535-541.
- 161** Wilson R, Davies S, Yates D, et al. Impaired functional capacity is associated with all-cause mortality after major elective intra-abdominal surgery. *Br J Anaesth.* 2010; 105: 297-303.
- 162** Older P, Hall A, Hader R. Cardiopulmonary exercise testing as a screening test for perioperative management of major surgery in the elderly. *Chest.* 1999; 116: 355-362.
- 163** West MA, Lythgoe D, Barben CP, et al. Cardiopulmonary exercise variables are associated with postoperative morbidity after major colonic surgery: a prospective blinded observational study. *Br J Anaesth.* 2014; 112: 665-671.
- 164** Prentis JM, Trenell MI, Vasdev N, et al. Impaired cardiopulmonary reserve in an elderly population is related to postoperative morbidity and length of hospital stay after radical cystectomy. *BJU Int.* 2013; 112: E13-19.
- 165** Ausania F, Snowden CP, Prentis JM, et al. Effects of low cardiopulmonary reserve on pancreatic leak following pancreaticoduodenectomy. *Br J Surg.* 2012; 99: 1290-1294.
- 166** Prentis JM, Manas DM, Trenell MI, et al. Submaximal cardiopulmonary exercise testing predicts 90-day survival after liver transplantation. *Liver Transpl.* 2012; 18: 152-159.
- 167** Carlisle J, Swart M. Mid-term survival after abdominal aortic aneurysm surgery predicted by cardiopulmonary exercise testing. *Br J Surg.* 2007; 94: 966-969.
- 168** Brutsche MH, Spiliopoulos A, Bolliger CT, et al. Exercise capacity and extent of resection as predictors of surgical risk in lung cancer. *Eur Respir J.* 2000; 15: 828-832.
- 169** Benzo R, Kelley GA, Recchi L, et al. Complications of lung resection and exercise capacity: a meta-analysis. *Respir Med.* 2007; 101: 1790-1797.
- 170** West MA, Loughney L, Lythgoe D, et al. Effect of prehabilitation on objectively measured physical fitness after neoadjuvant treatment in preoperative rectal cancer patients: a blinded interventional pilot study. *Br J Anaesth.* 2015; 114: 244-251.
- 171** Barakat HM, Shahin Y, Khan JA, et al. Preoperative supervised exercise improves outcomes after elective abdominal aortic aneurysm repair: a randomized controlled trial. *Ann Surg.* 2016; 264: 47-53.
- 172** Levett DZH, Jack S, Swart M, et al. Perioperative cardiopulmonary exercise testing (CPET): consensus clinical guidelines on indications, organization, conduct, and physiological interpretation. *Br J Anaesth.* 2018; 120: 484-500.
- 173** Kristensen SD, Knutti J, Saraste A, et al. 2014 ESC/ESA Guidelines on non-cardiac surgery: cardiovascular assessment and management: The Joint Task Force on non-cardiac surgery: cardiovascular assessment and management of the European Society of Cardiology (ESC) and the European Society of Anaesthesiology (ESA). *Eur Heart J.* 2014; 35: 2383-2431.
- 174** WHO Committee. Rehabilitation after cardiovascular diseases, with special emphasis on developing countries. Report of a WHO Expert Committee. *World Health Organ Tech Rep Ser.* 1993; 831: 1-122.
- 175** Karvonen M, Kentala K, Mustala O. The effects of training on heart rate: A longitudinal study. *Ann Med. Exp Biol.* 1957; 35: 307-315.
- 176** Górski J, ed. Fizjologiczne podstawy wysiłku fizycznego [Physiological basis of exercise]. Warszawa: PZWL; 2006.
- 177** Gielen S, Brutsaert D, Saner H, Hambrecht R. Rehabilitacja kardiologiczna [Cardiac rehabilitation]. In: Camm AJ, Luescher TF, Serruys PW, eds. Choroby serca i naczyń. Tom II. Podręcznik Europejskiego Towarzystwa Kardiologicznego [The ESC Textbook of Cardiovascular Medicine]. Poznań: Termedia; 2006.
- 178** Hollmann W, Strüder H, Predel HG, Tagarakis CVM. Spiroergometrie Kardio-pulmonale Leistungsdiagnostik des Gesunden und Kranken [Spiroergometry. Diagnosis of circulatory and respiratory efficiency of healthy and sick people]. Stuttgart, Germany: Schattauer GmbH; 2006.
- 179** Kodama S, Saito K, Tanaka S, et al. Cardiorespiratory fitness as a quantitative predictor of all-cause mortality and cardiovascular events in healthy men and women: a meta-analysis. *JAMA.* 2009; 301: 2024-2035.
- 180** Kaminsky LA, Arena R, Beckie TM, et al. on behalf of the American Heart Association Advocacy Coordinating Committee, Council on Clinical Cardiology, and Council on Nutrition, Physical Activity and Metabolism. The importance of cardiorespiratory fitness in the United States: the need for a national registry: a policy statement from the American Heart Association. *Circulation.* 2013; 127: 652-662.
- 181** Guazzi M, Bandera F, Ozemek C, et al. Cardiopulmonary exercise testing: what is its value? *J Am Coll Cardiol.* 2017; 70: 1618-1636.
- 182** Bandera F, Generati G, Pellegrino M, et al. Role of right ventricle and dynamic pulmonary hypertension on determining $\Delta V_{O2}/\Delta$ Work Rate flattening: insights from cardiopulmonary exercise test combined with exercise echocardiography. *Circ Heart Fail.* 2014; 7: 782-790.
- 183** McIntosh RA, Silberbauer J, Veasey RA, et al. Tissue doppler-derived contractile reserve is a simple and strong predictor of cardiopulmonary exercise performance across a range of cardiac diseases. *Echocardiography.* 2013; 30: 527-533.
- 184** Shimaie J, Sherez J, Aviram G, et al. Determinants of effort Intolerance in patients with heart failure: combined echocardiography and cardiopulmonary stress protocol. *JACC Heart Fail.* 2015; 3: 803-814.
- 185** Rubis P, Podolec P, Kopec G, et al. The dynamic assessment of right-ventricular function and its relation to exercise capacity in heart failure. *Eur J Heart Fail.* 2010; 12: 260-267.
- 186** van Zalen J, Patel NR, J Podd S, et al. Prognostic importance of tissue velocity imaging during exercise echocardiography in patients with systolic heart failure. *Echo Res Pract.* 2015; 2: 19-27.
- 187** Guazzi M, Villani S, Generati G, et al. Right Ventricular contractile reserve and pulmonary circulation uncoupling during exercise challenge in heart failure: pathophysiology and clinical phenotypes. *JACC Heart Fail.* 2016; 4: 625-635.
- 188** Guazzi M, Naeije R, Arena R, et al. Echocardiography of right ventricular-arterial coupling combined with cardiopulmonary exercise testing to predict outcome in heart failure. *Chest.* 2015; 148: 226-234.
- 189** Thaden JJ, McCully RB, Kopecky SL, Allison TG. Echocardiographic determinants of peak aerobic capacity and breathing efficiency in patients with undifferentiated dyspnea. *Am J Cardiol.* 2014; 114: 473-478.
- 190** Nedeljkovic I, Banovic M, Stepanovic J, et al. The combined exercise stress echocardiography and cardiopulmonary exercise test for identification of masked heart failure with preserved ejection fraction in patients with hypertension. *Eur J Prev Cardiol.* 2016; 23: 71-77.
- 191** Guazzi M, Dixon D, Labate V, et al. RV contractile function and its coupling to pulmonary circulation in heart failure with preserved ejection fraction: stratification of clinical phenotypes and outcomes. *JACC Cardiovasc Imaging.* 2017; 10 (10 Pt B): 1211-1221.

- 192** Topilsky Y, Rozenbaum Z, Khoury S, et al. Mechanisms of effort intolerance in patients with heart failure and borderline ejection fraction. *Am J Cardiol.* 2017; 119: 416-422.
- 193** Rozenbaum Z, Khoury S, Aviram G, et al. Discriminating circulatory problems from deconditioning: echocardiographic and cardiopulmonary exercise test analysis. *Chest.* 2017; 151: 431-440.
- 194** Garbi M, Chambers J, Vannan MA, Lancellotti P. Valve stress echocardiography: a practical guide for referral, procedure, reporting, and clinical implementation of results from the HAVEC Group. *JACC Cardiovasc Imaging.* 2015; 8: 724-736.
- 195** Baumgartner H, Falk V, Bax JJ, et al. ESC Scientific Document Group. 2017 ESC/EACTS Guidelines for the management of valvular heart disease. *Eur Heart J.* 2017; 38: 2739-2791.
- 196** Gersh BJ, Maron BJ, Bonow RO, et al. American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines; American Association for Thoracic Surgery; American Society of Echocardiography; American Society of Nuclear Cardiology; Heart Failure Society of America; Heart Rhythm Society; Society for Cardiovascular Angiography and Interventions; Society of Thoracic Surgeons. 2011 ACCF/AHA guideline for the diagnosis and treatment of hypertrophic cardiomyopathy: executive summary: a report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines. *Circulation.* 2011; 124: 2761-2796.
- 197** Argulian E, Chaudhry FA. Stress testing in patients with hypertrophic cardiomyopathy. *Prog Cardiovasc Dis.* 2012; 54: 477-482.
- 198** Okeie K, Shimizu M, Yoshio H, et al. Left ventricular systolic dysfunction during exercise and dobutamine stress in patients with hypertrophic cardiomyopathy. *J Am Coll Cardiol.* 2000; 36: 856-863.
- 199** Lazzeroni E, Picano E, Dodi C, et al. Dipyridamole echocardiography for diagnosis of coexistent coronary artery disease in hypertrophic cardiomyopathy. Echo-Persantine International Cooperative (EPIC) Study Group - Subproject Hypertrophic Cardiomyopathy. *Am J Cardiol.* 1995; 75: 810-813.
- 200** Bandera F, Generati G, Pellegrino M, et al. Exercise gas exchange analysis in obstructive hypertrophic cardiomyopathy before and after myectomy (cardiopulmonary exercise test combined with exercise-echocardiography in HCM). *Int J Cardiol.* 2015; 178: 282-283.
- 201** Smarż K, Zaborska B, Jaxa-Chamiec T, Budaj A. Exercise left ventricular outflow tract obstruction as a cause of exercise intolerance: combined stress echocardiography and cardiopulmonary exercise testing. *Kardiol Pol.* 2018; 76: 1492.
- 202** Chia EM, Lau EM, Xuan W, et al. Exercise testing can unmask right ventricular dysfunction in systemic sclerosis patients with normal resting pulmonary artery pressure. *Int J Cardiol.* 2016; 204: 179-186.
- 203** Badagliacca R, Papa S, Valli G, et al. Echocardiography combined with cardiopulmonary exercise testing for the prediction of outcome in idiopathic pulmonary arterial hypertension. *Chest.* 2016; 150: 1313-1322.