163. Exercise assessment in different diseases

P1530

Metabolic and cardiopulmonary responses to the incremental shuttle walk test vs. six-minute walk test in healthy older adults

Victor Dourado[1], Ricardo Guerra[1], Suzana Tanni[2], Letícia Antunes[3], Irma Godoy[2]. *[1]Department of Health Sciences, Federal University of São Paulo (UNIFESP), Santos, Brazil; [2]Department of Internal Medicine, Botucatu Medical School (UNESP), Botucatu, Brazil; [3]Rehabilitation Section, Botucatu Medical School (UNESP), Botucatu, Brazil*

Whether the incremental shuttle walk test (ISWT) induces a higher physiological stress compared to six-minute walk test (6MWT) in patients remains controversial. However, previous studies did not include healthy subjects. We compared physiological responses to the ISWT and 6MWT in healthy adults (38 men, aged 60±10). Secondarily, peak oxygen uptake (VO_2) in these tests were compared to predict values of a maximal cycle-ergometer test. In a randomized order and alternate days, 80 participants completed three 6MWTs and three ISWTs. VO_2, CO_2 output (VCO_2), minute ventilation (VE), and heart rate (HR) were monitored by a portable telemetric system during each third test. Physiological responses were linear during ISWT and exponential during 6MWT. We could calculate deficit-O_2 (1072±622 mL) and VO_2 time constant –tauVO_2– (56±19 s) in all participants by exponential fittings (R^2=0.905±0.065). During the 6MWT, VO_2 (1627±441 mL/min), VCO_2 (1443±439 mL/min), VE (46±16 L/min), and HR (129±24 bpm) were not significantly different compared to ISWT (respectively 1714±544 mL/min; 1591±582mL/min; 51±19 L/min; and 132±21bpm). The distance covered correlated with peak VO_2 for ISWT (r=0.738; p<0.001) and 6MWT (r=0.652; p<0.001) with no difference between correlation coefficients (p=0.234). Estimated peak VO_2 (1541±422mL/min) was not significantly different from measured peak VO_2 obtained during ISWT and 6MWT. Although being considered to be closer to a maximal exercise test than 6MWT, ISWT does not induce a greater physiological responses in healthy adults. Larger studies should be performed in patients for better physiological comparisons between these walking tests.

P1531

Peculiarities of peripheral blood flow reaction during cold air bronchoprovocation

Juliy M. Perelman, Anna G. Prikhodko. *Laboratory of Functional Reseach of Respiratory System, Far Eastern Scientific Center of Physiology and Pathology of Respiration SB RAMS, Blagoveschensk, Russian Federation*

Background: Peripheral vessels reaction to different stimuli may be a sign of systemic vascular disturbances in chronic pulmonary diseases. It is unknown if cold airway hyperresponsiveness (CAHR) accompanied by any changes in systemic peripheral circulation.
Aim: To study peculiarities of peripheral vasomotor reaction during local airway cooling.
Methods: The reaction of peripheral vessels of finger (*àà. digitales palmares propriae*) during and after 3-min isocapnic cold (-20°C) air hyperventilation was studied in 11 healthy persons and 31 patients with chronic pulmonary diseases (bronchial asthma and chronic bronchitis) having CAHR. The amplitude of pulse wave (APW) was evaluated by photoplethysmography of finger.
Results: A phase reaction of finger artery to cold air inhalation was revealed in healthy persons. By the end of the 3rd min of hyperventilation there was a progressive drop of APW (-30.2±8.7%) as a result of vasoconstriction with further short-term vasodilation proved by the growth of APW higher than the initial level (8.7±6.5%) immediately after provocation cessation and its additional fall on the 5th min of recovery (-15.5±7.3%), which meant a repeated vessel spasm. In group of patients cold air inhalation led to sustained APW drop both during provocation (-21.4±8.9%) and recovery period (1st and 5th min) -26.2±7.6% (p<0.01); -10.5±7.8%, respectively. There was a correlation among airway reaction, changes in peripheral blood flow, skin temperature at the beginning and at the end of the bronchoprovocation in patients.
Conclusions: Revealed abnormalities in peripheral microcirculation in patients with the changed airway responsiveness can be an early sign of systemic vascular dysfunction.

P1532

Evaluation of two methods for measurement of cardiac output during exercise in patients with COPD

Ioannis Nasis[1], Dimitris Athanasopoulos[1], Evgenia Cherouveim[1], Zafiris Louvaris[1], Maroula Vasilopoulou[1], Helmut Habazettl[3,4], Harriet Wagner[5], Peter David Wagner[5], Spyros Zakynthinos[2], Ioannis Vogiatzis[1,2]. *[1]Department of Physical Education and Sport Sciences, National and Kapodistrian University of Athens, Athens, Greece; [2]Department of Critical Care Medicine and Pulmonary Services, Evangelismos Hospital, M. Simou, and G.P. Livanos Laboratories, National and Kapodistrian University of Athens, Athens, Greece; [3]Institute of Physiology, Charité Campus Benjamin Franklin, Berlin, Germany;[4]Institute of*

Anesthesiology, German Heart Institute, Berlin, Germany; [5]Department of Medicine, University of California San Diego, La Jolla, CA, United States

Introduction: Indicator-Dilution (ID) is considered as the standard method for the measurement of cardiac output (CO), but is invasive and therefore difficult to use in clinical practice. A non-invasive device reported to work during exercise and based on impedance cardiography (Physioflow, PF) has become available.
Aim: To simultaneously measure CO during exercise with (PF) and (ID) in patients with COPD.
Methods: Ten patients with COPD, (aged 60±7 years, FEV_1= 50±6%predicted) were studied.Exercise consisted of four constant-load tests, for (5min at 25% and 50%, 3 min at 75% and 2 min at 100% of their WRpeak). VO_2 and CO_2 were recorded breath-by-breath, and CO was measured at each exercise level using PF and ID (using indocyanine green) over the last minute of exercise.
Results: CO by PF exceeded that by ID by 2.6±0.3 L/min (Mean±SE) averaged across all exercise levels (p=0.001).

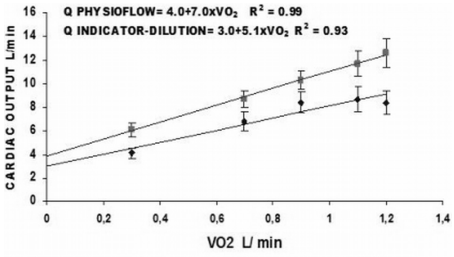

Fig.1 Correlation between cardiac output and VO_2 for (♦) Indicator-Dilution and for (■) Physioflow

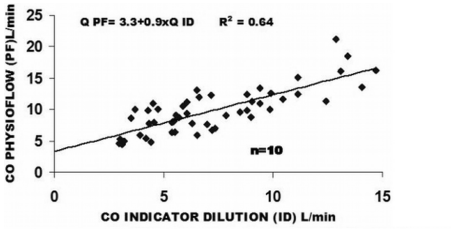

Fig.2 Correlation between Indicator-Dilution and Physioflow for measuring cardiac output (rest, 25%, 50%, 75%, 100%)

Conclusion: Compared to IT, PF overestimates CO across different levels of exercise but its slope of change relative to VO_2 is very similar. Hence PF can accurately estimate changes from resting CO during exercise in COPD.

P1533
Evaluation of heliox or oxygen breathing on improved quadriceps muscle oxygen delivery during exercise in COPD
Vasilis Andrianopoulos[1], Zafeiris Louvaris[2], Eleni Kortianou[1,2], Helmut Habazettl[3], Spyros Zakynthinos[1], Peter D. Wagner[4], Ioannis Vogiatzis[1,2]. *[1]Critical Care Medicine and Pulmonary Services, Evangelismos Hospital, National and Kapodistrian University of Athens, Athens, Greece; [2]Physical Education and Sport Sciences, National and Kapodistrian University of Athens, Athens, Greece; [3]Anesthesiology, Physiology Charite Campus Benjamin Franklin, Berlin, Germany; [4]Medicine, University of California, San Diego, United States*

Introduction: It is known that both normoxic heliox and pure oxygen breathing significantly increase locomotor O_2 delivery during exercise in COPD. However, it remains unknown which of the two gases is the most beneficial in terms of enhancing exercise tolerance and locomotor muscle O_2 availability.
Methods: 12 COPD patients [FEV_1=42±12%pred] performed 3 constant-load exercise tests at 75% of maximum work rate while breathing air, normoxic heliox or pure O_2. We measured cardiac output (Fick method), haemodynamic responses, quadriceps muscle blood flow by near infrared spectroscopy with ICG dye and changes in quadriceps muscle deoxygenation ([HHb], an index of fractional O_2extraction) at the transition from rest to exercise (on-kinetics).
Results: Exercise endurance time was not significantly different between heliox and O_2 *[(mean±SEM) He: 637±46 vs O_2: 670±43 vs Air: 394±35 s]*. Peak cardiac output was significantly greater on heliox *(He: 9.3±0.5 vs O_2: 8.2±0.6 vs air: 8.9 l/min)* but O_2 caused a significant greater elevation of arterial oxygen content *(He: 183±6 vs O_2: 213±7 vs air: 180±5 ml/min)*. However, neither quadriceps muscle blood flow *(He: 32±5 vs O_2: 31±6 vs Air: 22±5 ml/min/100gr)* nor quadriceps O_2 delivery *(He: 5.8±0.9 vs O_2: 6.3±1.1 vs Air: 3.9±0.8 ml O_2/min/100gr)* were significantly different between heliox and O_2. Mean response time of deoxygenated HHb on heliox *(MRT=18.1±1.7s)* and O_2 *(MRT=17.4±1.4s)* were not significantly different but were both greater compared to air *(MRT=13.8±1.3s) (P<0.05)*.
Conclusion: Supplementation of heliox or O_2 is equally beneficial in terms of enhancing exercise tolerance and locomotor muscle O_2 availability during exercise in COPD.

P1534
Dynamic pathophysiology in stable COPD patients with severely reduced exercise capacity
Ryoji Maekura, Toru Hiraga, Keisuke Miki, Seigo Kitada, Kenji Yoshimura, Yoshitaka Tateishi. *Respiratory Medicine, National Hospital Organization Toneyama Hospital, Toyonaka, Osaka, Japan*

Introduction: The survival prognosis of COPD patients with severely reduced exercise capacity is extremely poor. However, the dynamic pathophysiology of these patients, including sympathetic activation and lactic acidosis, remains to be accurately established. Thus, we performed this study to clarify the differences in the dynamic pathophysiology of four COPD patient groups classified according to their exercise capacity.
Methods: Ninety-one COPD patients (82 males, 9 females; average age, 69.7±6.8 years) underwent incremental CPET using a cycle ergometer. During CPET, we measured the patient levels of arterial blood gases, lactate, and catecholamines.
Results: We found that the pathophysiology of the COPD patients was different among the groups. Patients with severely reduced exercise capacity (peak oxygen uptake < 654 ml/min) were characterized by the following: (i) exercise-induced rapid decrease of arterial oxygen pressure (PaO2-slope: -7.8±7.0 mmHg/100 ml); (ii) sympathetic activation at low-grade workload (plasma norepinephrine level, 1.4±0.94 ng/ml at 20 W); (iii) little change in lactic acidosis; (iv) a limitation in the increase of ventilation; and (v) impaired gas exchange. The norepinephrine increase exhibited during exercise was significantly correlated (r = 0.94±0.08) with the dyspnoea ratings.
Conclusions: The COPD pathophysiology significantly varied among patients with different exercise capacities. Patients with lower exercise capacity suffered from severe gas exchange disorder, sympathetic overactivation, and ventilatory disturbance during exercise. CPET should consistently be performed to assess the factors that contribute to exercise limitation in COPD patients.

P1535
Inspiratory muscle training (IMT) with normocapnic hyperventilation (NH) improves respiratory muscle strength, exercise performance and ventilatory pattern in COPD patients
Luca Pomidori, Eva Bernardi, Gianluca Grassi, Enzo Melloni, Gaia Mandolesi, Annalisa Cogo. *Biomedical Sport Studies Center, University of Ferrara, Ferrara, FE, Italy*

Introduction: IMT by means of NH is effective in improving exercise endurance in healthy subjects but few data are available for COPD.
Aim: To evaluate the effect of 4 weeks NH training (Spirotiger®) on respiratory function and exercise capacity in 21 moderate/severe COPD patients.
Materials and methods: 19 M, 2 F, aged 42-80. Respiratory function tests (FEV1, FVC, Pimax), QoL (St George's Questionnarie), 6MWT and endurance exercise performed at 75-80% of peak-work rate measured during an incremental test to the limit of tolerance (tLIM). 7 of 21 patients were instrumented with a portable inductive plethysmograflhy (Lifeshirt System) to evaluate breathing pattern during tLIM. After 1 month of weekly supervised training, the patients trained at home for 4 weeks: 10 min twice a day at a breathing rate 12-24/min with a tidal volume (TV) equal to 50% of CV.
Results: 6 patients dropped out (poor compliance). IMT significantly improved Pimax, QoL, exercise capacity. Ventilatory pattern after IMT is characterized by a significantly higher TV with no change in VE.

Table 1

	FEV1 (%)	FVC (%)	Pimax (kPa)	QoL (tot)	tLIM (min)	6MWt (m)
preIMT	55,2±16,9	82,3±22,8	8,9±3	22,7±16,6	6,4±3,4	436±74,5
postIMT	57,6±15,8	82,7±24,1	9,6±2,8*	17,5±12,2*	10,3±7,4*	466,2±79,7*

Table 2

	SpO2mean (%)	VE (L/min)	TV (L/min)	Br (b/min)
preIMT	91±2,2	28,6±16,1	0,8±0,4	33±4,2
postIMT	92,3±1,5*	29±16,4	0,9±0,4*	30,8±6,5

*p<0,05 (statistical analysis: T test and Wilcoxon signed rank test).

Conclusion: After a short IMT with NH, COPD patients show a higher exercise capacity and an intriguing change in ventilatory pattern which improves oxygen saturation.

P1536
Impact of anemia on dyspnea on exertion and exercise tolerance in patients with acute exacerbation of chronic obstructive pulmonary disease
Adam Nowinski, Daruisz Kaminski, Damian Korzybski, Michal Bednarek, Anna Stoklosa, Dorota Gorecka. *2nd Department of Respiratory Medicine, National Institute of Tuberculosis and Lung Diseases Research, Warsaw, Poland*

Introduction: Dyspnea and decreased exercise tolerance are symptoms of acute exacerbation of chronic obstructive pulmonary disease (AECOPD). Anemia is a risk factor for reduced functional capacity and dyspnea in stable COPD. There is limited information about the impact of anemia on functional capacity and dyspnea

Abstract P1536 – Table 1

Patients	Number of pts (N, % of total)	GOLD stage (mean)	6MWD (m)	Age (years)	SpO2 before 6MWD (%)	Dyspnea after 6MWT (Borg scale points)	Desaturation (ΔSpO2, %)
Anemic	N=105, 26%	3.4±0.7	258.1±125.1	74.5±8.2*	94.6±2.2	2.5±2.5	2.9±2.6
Non-anemic	N=297, 74%	3.5±0.6	271.3±136.0	70.2±8.7*	93.9±3.1	2.2±2.4	3.8±3.7
All	402	3.5±0.6	265.6±132.5	71.5±8.8	94.1±2.8	2.3±2.5	3.6±3.4

of patients during AECOPD. The aim of this study was to evaluate the impact of decreased blood hemoglobin level to results of six minute walking test in patients during after AECOPD.
Materials and methods: A retrospective analysis of data collected from long term study on AECOPD was performed. Haemoglobin level from the first obtainable hospital measurement was included in the assessment. 6MWD was performed after clinical improvement of the patient. Dyspnoea at baseline and after exercise was measured. Oxygen saturation (SpO2) during exercise was measured.
Results: 404 patients with AE COPD were analyzed. GOLD stages, hemoglobin level and results of 6MWD are shown in Table 1. Results are means ±SD. *p<0.05. The hemoglobin level did not correlate with 6MWD, dyspnea after 6MWT, exercise oxygenation and blood desaturation after exercise.
Conclusion: Decreased blood hemoglobin level didn't influence the results of 6MWT in patients after AECOPD.

P1537
Association between physical activity and asthma exacerbations
Silvia Pascual[1], Isabel Urrutia[1], Cristobal Esteban[1], Aitor Ballaz[1], Javier Moraza[1], Urko Aguirre[2], Iñaki Larrea[3], Itziar Arrizubieta[1], Maribel Cascon[3]. *[1]Pneumology, Galdakao Hospital, Galdakao, Vizcaya, Spain; [2]Research and Epidemiology Unit. CIBERESP, Galdakao Hospital, Galdakao, Vizcaya, Spain; [3]Pneumology, San Eloy Hospital, San Eloy, Vizcaya, Spain*

Introduction: There are some evidences that suggest that regular physical activity reduces the risk of exacerbations in asthma, regardless of the asthma severity and other factors. The aim of this paper is to measure the association between physical activity levels in asthma exacerbations, adjusted by FEV1, age and body mass index (BMI).
Methodology: This is a multicenter transversal study where has been included a population of asthmatics of Pneumology consultations of two hospitals in Vizcaya. It has been included patients with previous diagnosis of asthma and monitored by the pneumologist at least for a year, aged between 18 and 70. We used the International Physical Activity Questionnaire (IPAQ). We performed a multivariate logistic regression analysis to determine predictors of exacerbations.
Results: We studied 354 patients (54% men). 115 of these (32%) were younger than 32, 123 (35%) between 32 and 55 and 116 (33%) over 55 years. 250 patients (75%) had a BMI below 30. 63 patients (18%) had had asthma exacerbations during the past 6 months. 15 patients (4%) had a FEV1 value below 60%, 39 (11%) between 60 and 80%, and 300 (85%) greater than 80%. Physical activity was divided into quartiles, including 88 (24.8%) in the first quartile, 92 (25.7%) in the second, 54 (23.7%) in the third and 89 (25.1%) in the fourth.

Association between asthma exacerbations and physical activity and other factors		
	OR (95% CI)	p value
FEV1		
< 60%	3.92 (1.20-12.82)	0.02
60-80%	0.40 (0.11-1.39)	0.15
Age		
<32	1.23 (0.57-2.65)	0.60
32-55	1.52 (0.74-3.10)	0.25
BMI		
≥30	1.94 (1.04-3.63)	0.04
Met-min/week		
924-2250	0.78 (0.37-1.68)	0.53
2250-4752	0.82 (0.37-1.82)	0.62
≥4752	0.44 (0.19-0.99)	0.05
Reference: patients with FEV1> 80%, age > 55 years and BMI <30 with physical activity <924 met-min/week.		

Conclusions: Patients with asthma with increased physical activity had a reduced number of exacerbations.

P1538
The usefulness of ventilatory gas analysis during low intensity exercise to define pulmonary hypertension
Paul Woods, Robert Frantz, Bryan Taylor, Thomas Olson, Bruce Johnson. *Division of Cardiovascular Disease, Mayo Clinic, Rochester, MN, United States*

The 6-minute walk test is widely utilized to characterize activity tolerance and response to therapy in pulmonary arterial hypertension (PAH), but provides little information about cardiopulmonary pathophysiology. Previous studies employing maximal exercise testing suggest that ventilatory gas analysis may be a useful tool to help determine the presence and severity of PAH. The aim of the present study was to determine whether measures of pulmonary gas exchange during a simplified low intensity step test can be used to differentiate between PAH patients and healthy individuals, and also stratify disease severity. Forty PAH patients and 25 matched controls completed a novel submaximal exercise test that consisted of 2-min rest, 3-min step exercise and 1-min recovery. Ventilation, pulmonary gas exchange, arterial oxygen saturation (SaO_2) and heart rate were measured throughout using a simplified gas analysis system. A number of gas exchange variables separated PAH patients from controls. End-tidal CO_2 ($P_{ET}CO_2$) and SaO_2 were lower in PAH vs. controls (31±7 vs 39±3 mmHg and 89±5 vs 95±2%, respectively, $p<0.05$) while breathing efficiency (V_E/VCO_2 ratio) was higher in PAH vs. controls (42±10 vs 33±5, $p<0.05$). $P_{ET}CO_2$ and V_E/VCO_2 also discriminated between different severities of PAH. Gas exchange variables obtained during light exercise clearly discriminated PAH patients from healthy controls and also between different severities of PAH. A simplified submaximal step test incorporating non invasive gas exchange may be a useful measure to help quantify and track disease severity in PAH. This study was supported by Gilead and NIH HL71478.

P1539
Cardiac bioimpedance during exercise testing in patients with idiopathic pulmonary arterial hypertension
Ralf Kaiser, Christian Frantz, Kerstin Hadasch, Christian Lensch, Robert Bals, Heinrike Wilkens. *Innere Medizin V, University Hospital Saarland, Homburg/Saar, Germany*

Purpose: In idiopathic pulmonary arterial hypertension (IPAH) right ventricular insufficiency develops due to pressure overload. Furthermore left ventricular function is reduced by chronic underfilling.
Hemodynamics are monitored by echocardiography and cardiac catheterisation. This may describe cardiac function only insufficient, as hemodynamics may change during exercise and balance between right and left ventricular function might change due to development of a septal shift.
Methods: Spiroergometry testing was performed in 20 healthy volunteers and 21 patients with IPAH. Cardiac performance was determined using a cardiac bioimpedance instrument.
Results: Patients with IPAH tolerated less workload (54.3±37 vs. 177.4±90W). Ejection fraction (EF) at baseline was comparable to control. During exercise the increase of EF was diminished in IPAH (62.1±8 vs. 67.4±5%) and maximal cardiac index (CI) was significantly lower (5.2±2 vs. 9.0±3,7l/min/qm). Enddiastolic volume (EDI) showed a trend to decreased values (102.9±41 vs. 128.8±53ml/qm), while stroke index was markedly reduced (53.5±17 vs. 72.0±21ml/qm). Peakflow during ejection was decreased (387.7±126 vs. 559.0±180ml/min/qm) as well as flow acceleration (ACI, 153.5±61 vs. 217.1±71/sec2).
Conclusions: In patients with IPAH, stroke volume and CI were reduced. The diminished filling is represented by reduced EDI, resulting in less increase of contractility as shown by reduced peak flow and ACI. Patients with IPAH were not able to compensate the lack of contractility by heart rate, resulting in lower CI. Left ventricular underfilling affects cardiac performance during exercise, and inotropic response is reduced in patients with IPAH.

P1540
Effects of continuous vs. interval aerobic training on PetCO2 response during graded exercise test in patients with coronary artery disease
Eneas Rocco[1], Danilo Marcelo Prado[12], Alexandre Silva[3], Jaqueline Lazzari[1], Pedro Bortz[1], Debora Rocco[3], Amanda Campolin[3], Carla Rosa[1], Valter Furlan[1]. *[1]Cardiorespiratory Rehabilitation, Amil- International Medical Assistence, São Paulo, Brazil; [2]Rheumathology Department, University of São Paulo- Medical School, São Paulo, Brazil; [3]Exercise Physiology, Santa Cecília University, Santos, São Paulo, Brazil*

Background: Previous studies have demonstrated in patients with coronary artery disease (CAD) that lower values in end-tidal CO2 pressure (PetCO2) during graded exercise test (GET) have been associated with ventilation perfusion (V/Q) mismatch.
Purpose: 1) to evaluate the effects of the continuos (CT) and interval aerobic training (IT) on PetCO2 responses during GET in CAD patients; and 2) examine the relationships between PetCO2 at ventilatory anaerobic threshold (PetCO2VAT) and cardiorespiratory parameters after interventions.
Methods: 37 patients with CAD (59.7±1.7 years) were divided into 2 groups: CT (n=20; 28.1±1 kg/m^2) and IT (n=17; 28.5±1 kg/m^2). All patients performed a GET on treadmill to determine VAT and peak oxygen consumption (VO2 peak).
Results: CT and IT groups showed increased in relative aerobic fitness (ΔVO2peak = 4.1± 0.4 and 4.4±0.3 ml/kg/min CT and IT, respectively; $p<0.05$).

PeTCO2 response during graded exercise test

	VAT		PEAK	
	pre	post	pre	post
CT	37.5±0.6	41.0±0.4*	35.1±0.8	38.0±0.7*
IT	38.0±0.6	40.2±0.3*	35.8±0.6	38.5±0.9*

Values are mean ± SE. *P<0,05 vs. preintervention (Two-way ANOVA).

Significant relationships were observed to: 1) CT (PetCO2VAT and VO2peak r=0.49; PetCO2VAT and VEVCO2VAT r= -0.80; P=0.01); and 2) IT (PetCO2VAT and VO2peak r=0.39; PetCO2VAT and VEVCO2VAT r= -0.45; P=0.01).
Conclusion: CT and IT demonstrated the same responsiveness in increase PetCO2 values during GET in CAD patients. These results suggest that the factors related to both an increased cardiorespiratory fitness and ventilatory efficiency after interventions may be responsible to increased PetCO2 during GET.

P1541
Quantifying oscillatory ventilation during exercise in patients with heart failure
Thomas Olson, Kenneth Beck, Bruce Johnson. *Cardiovascular Diseases, Mayo Clinic, Rochester, MN, United States*

Background: This study tested the validity of a data analysis scheme to quantify measures of oscillatory ventilation at rest and during exercise in heart failure patients (HF).
Methods: Eleven patients (age=53±8yrs, LVEF=17±4%, NYHA Class=II (7)/IV (4)) were recruited. Ventilation (V_E) and gas exchange were measured. Amplitude and period of oscillations in V_E, tidal volume (V_T), end-tidal carbon dioxide ($P_{ET}CO_2$), and oxygen consumption (VO_2) were measured manually (MAN), using novel software which included a peak detection algorithm (PK), sine wave fitting algorithm (SINE), and Fourier analysis (FOUR).
Results: During PB, there were no differences between MAN and PK for amplitude of V_E, V_T, $P_{ET}CO_2$, or VO_2. Similarly, there were no differences between MAN and SINE for amplitude of V_E or V_T although $P_{ET}CO_2$ and VO_2 were lower with SINE ($p<0.05$). The PK demonstrated shorter periods for V_E, V_T, $P_{ET}CO_2$, and VO_2 compared to MAN ($p<0.05$) whereas there were no differences in periods of oscillations between MAN and SINE or FOUR. During exercise, there were no differences between MAN and PK for amplitude of V_E, V_T, $P_{ET}CO_2$, or VO_2. SINE demonstrated lower amplitudes for V_T, $P_{ET}CO_2$, and VO_2 ($p<0.05$) although V_E was not different. PK demonstrated shorter periods for all variables ($p<0.05$) whereas there were no differences between MAN and SINE or FOUR for all variables during exercise.
Conclusion: These data suggest 1) PK consistently captures amplitudes but underestimates period, 2) SINE and FOUR consistently capture period although SINE underestimates amplitude. Thus, an optimal algorithm for quantifying oscillatory ventilation in HF might combine multiple analysis methods. NIH grants HL71478/KL2-RR024151

P1542
The pattern and timing of breathing during graded exercise test in systemic lupus erythematosus
Danilo Marcelo Prado[1], Renata Miossi[1], Fernanda Lima[1], Bruno Gualano[2], Hamilton Roschel[2], Eduardo Borba[1], Eloisa Bonfa[1], Ana Lucia Sá Pinto[1].
[1]Reumatology Division, University of São Paulo Medical School, São Paulo, Brazil; [2]Exercise Physiology, University of São Paulo Physical Education School, São Paulo, Brazil

Background: Systemic lupus erythematosus (SLE) is an inflammatory autoimmune disease that affects all organs including the respiratory system. Abnormal control of breathing during maximal voluntary ventilation has been recently identified in this disease.
Purpose: To evaluate the pattern and timing of breathing at selected submaximal ventilatory stress in SLE.
Methods: Twenty consecutive women (age: 28.8±1.0 years) with SLE were selected and compared to an age and BMI matched group of 19 healthy women (CTRL) (age: 26.2±1.3 years). All of the subjects performed a progressive treadmill cardiopulmonary test until exhaustion. Data were analyzed at absolute isoventilation (40, 60 and 80 L/min).
Results: SLE presented lower relative aerobic fitness (VO2peak) (26.8±1.2 vs. 35.9±1.2 mL kg^{-1} min^{-1}, p=0.001) than their healthy peers.

Ventilatory parameters at different absolute isoventilation

Ventilation	40 L/min		60 L/min		80 L/min	
	SLE	Control	SLE	Control	SLE	Control
RF/VT (breaths/min-L1)	40.0±3.8*	23.4±2.5	38.7±3.9*	23.6±1.9	38.8±2.7*	25.0±1.5
TTOT (s)	1.58±0.1*	2.17±0.1	1.32±0.0*	1.78±0.1	1.13±0.0*	1.51±0.1
VT/TI (L s^{-1})	1.41±0.0	1.42±0.0	2.09±0.1	2.08±0.0	2.63±0.1	2.60±0.1
VE/VCO2	31.0±0.6*	27.8±0.7	31.9±0.6*	29.0±0.6	34.2±0.6*	30.5±0.6

Values are means ± SE. TOT, total respiratory time; VT/TI, mean inspiratory flow; VE/VCO2, ventilatory equivalent for carbon dioxide. *P<0.05 vs. Control.

Conclusion: These results demonstrated a thachypnoeic breathing pattern and shorter timing of ventilation in SLE woman during exercise. This suggests that the reduced aerobic capacity observed in SLE patients may be accompanied by ventilation-perfusion mismatches.

P1543
Utility of ergospirometry in the diagnosis of hyperventilation syndrome (HVS)
Angelica Tiotiu[1], André Noseda[2], Sophia Abdelkafi[2]. *[1]Department of Pneumology, CHU Nancy, Nancy, France; [2]Department of Pneumology, CHU Brugmann, Brussels, Belgium*

The hyperventilation syndrome (HVS) is characterized by several somatic and psychological symptoms due to hypocapnia not secondary to any underlying organic disease. The purpose of the present study was to evaluate the place of exercise-induced hyperventilation in the diagnosis of HVS.
Twenty-three patients with normal spirometry, referred for suspicion of HVS on the basis of a Nijmegen's questionnaire (score ≥23) were eligible. Asthma was documented in 15 patients. The mean score of anxiety by the Spielberberg's State-Trait Anxiety Inventory for Adults was 53.5 which are suggestive of moderate anxiety. During the hyperventilation provocation test (HVPT), at least two symptoms of Nijmegen's questionnaire were reproduced in 14 patients. The mean level of PetCO 2 at baseline was 27.6 mm Hg and decreased to 15.2 mm Hg for a maximal ventilation of 57 l/min. No patient recovered the baseline level of PetCO2 at 5 min after the end of the HVPT (mean ratio PetCO2 after/before = 75%). Exercise-induced maximal ventilation (VEmax) was 52 l/min and was accompanied by a PetCO 2 level of 35.8 mm Hg and an EqCO2 of 32 mm Hg. No significant difference in the ventilatory pattern (VEmax, PetCO2, EqCO2) was found between HVS group (n=8) and the asthma and HVS group (n=15).
In conclusion, in our group of patients with HVS, with or without asthma, the hyperventilation during exercise did not induce abnormal reduction in PetCO2 or abnormal increase in EqCO2. Our results suggest that, unexpectedly, the exercise could be a therapeutic tool in the HVS. It could be hypothesized that anxiety plays a role in the genesis of symptoms at rest but not during exercise where the patient has to be concentrated on his effort.

P1544
Exercise capacity as an index of progress of lung disease among children and adolescents with CF
Elpis Hatziagorou[1], Vassiliki Georgopoulou[2], Kalliopi Kontouli[1], Vasiliki Avramidou[1], Fotis Kirvassilis[1], John Tsanakas[1]. *[1]Paediatric Pulmonology Unit, 3rd Paediatric Dept, Hippokration Hospital, Aristotle University, Thessaloniki, Greece; [2]Radiology Dept, Hippokration Hospital, Thessaloniki, Greece*

Background: Spirometry, high resolution computed tomography (HRCT) and exercise testing provide addional information about lung disease among children with cystic fibrosis (CF). There is significant correlation between levels of aerobic fitness (VO_2 peak) and survival rate.
Aim: To compare decline of exercise capacity, HRCT scores and lung function among children with CF over a period of two years.
Method: Sixteen stable children and adolescents with CF, aged 8–19 years, performed spirometry and maximal incremental cardiopulmonary exercise testing using a cycle ergometer, as part of their annual review. At the same time the patients underwent low dose of radiation chest HRCT scans, with a Bhalla score assessment.
Results: Sixteen stable children and adolescents with CF were evaluated (mean age 15.64±3.2 years and FEV_1 38-94% predicted). There was evidence of mild exercise limitation during the cardiopulmonary exercise test, with mean Peak Aerobic Capacity (V'Opeak) 71.81±14.07% predicted. Evaluation of the study population two years later, showed that Bhalla total score, Peak Aerobic Capacity (V'Opeak) and Anaerobic Threshold (AT) deteriorated significantly (mean difference ±SD, p): 1.4±1.7, p: 0.029, -6.4±9.1, p: 0.022, -7.8±9.3, p: 0.006, respectively. Ventilatory equivalent for CO_2 ($V'E/V'CO_2$), Dead space/Tidal Volume Ratio (VD/VT) and FEV_1 didn't deteriorate significantly (p: 0.321, p: 0.165 and p: 0.135, respectively).
Conclusions: The maximal incremental cardiopulmonary exercise test correlates well with HRCT scans; it is a very sensitive method for measuring progression of lung disease in children with CF.

P1545
Children with bronchopulmonary dysplasia (BPD) have increased dynamic flow limitation and an altered ventilatory response to exercise
Christopher O'Dea[1,2], Karla Logie[3], Andrew Wilson[1,2], Andrew Maiorana[2,6], Jane Pillow[4], Graham Hall[1,2,5]. *[1]Respiratory Medicine, Princess Margaret Hospital, Perth, WA, Australia; [2]Faculty of Health Science, Curtin University, Perth, WA, Australia; [3]School of Paediatric and Child Health, University of Western Australia, Perth, WA, Australia; [4]School of Women's and Infants' Health, University of Western Australia, Perth, WA, Australia; [5]Paediatric Respiratory Physiology, Telethon Institute for Child Health Research, Perth, WA, Australia; [6]Cardiac Transplant Unit, Royal Perth Hospital, Perth, WA, Australia*

Introduction: Children born preterm are known to have altered lung structure and function. These changes may lead to dynamic flow limitation (DFL) during

exercise. This study aimed to determine the prevalence of DFL and the ventilatory response to exercise in preterm children aged 9-11yrs with and without BPD.
Methods: Preterm children (<32 w gestation) with and without BPD (>28 d supplemental O_2 at 36 w post menstrual age) and term born healthy controls performed an incremental treadmill exercise test to volitional exhaustion with breath by breath analysis and exercise tidal flow volume loops.
Results: To date 89 children (33 BPD, 25 nonBPD and 31 controls) performed acceptable exercise tests. Children with BPD were more likely to have DFL (n=15, 36%) compared to nonBPD (n=3, 11%) and term controls (n=2, 6.3%) $p<0.05$. The pre-term children had a significantly lower peak $V'O_2$ than the term born controls (43.8 *vs*. 49.8. mL/kg/min, $p<0.001$). Children with BPD had a reduced O_2 pulse ($p<0.001$), tidal volume and V'_E ($p<0.001$) compared to nonBPD and term controls. Preterm children with dynamic flow limitation had lower FEV_1 z-scores compared to those without ($p<0.02$) with other ventilatory responses to exercise not altered in the presence of DFL.
Conclusion: Children born preterm have a lower aerobic exercise capacity and those with BPD exhibit both cardiac and respiratory limitation to exercise. The presence of DFL in children born pre-term with BPD is a novel finding and further research on its potential impact is required.

P1546
Consequences of obesity on gas exchange during exercise
Bohumil Matula, Stanislav Majerník, Plamen Kabaivanov, Daniel Magula, Ján Plutinsky. *Functional Diagnostics, Specialized Hospital of St. Zoerardus Zobor, Nitra, Slovakia (Slovak Republic)*

Obesity produces an increment in total blood volume and cardiac output and a decrease in lung compliance as a result of increased pulmonary blood volume and alveolar collapse in the lung bases.
Aim: To evaluate gas exchange parameters under incremental exercise in "healthy" obese patients (pts).
Methods: Analysis of symptom limited incremental cardiopulmonary exercise tests in supine position of 115 pts (36M, 79F) with FEV1,VC and TLCO $\geq$ 80% predicted (ECCS) and without history of cardiovascular disease. Punctions of arteria radialis were made to evaluate arterial oxygen and carbon dioxide pressure (PaO2, PaCO2) at peak exercise (PE) and to calculate dead-space to tidal volume ratio at PE (VD/VT) and alveolar-arterial oxygen pressure difference (PA-aO2). Slope of heart rate to oxygen uptake (DHR/DVO2 beat. l/min) was determined. Pts were divided into 2 groups: Ob (n=58): Body mass index (BMI) $\geq$ 30kg/m^2, N (n=57): BMI < 30kg/m^2.
Results: Significant differences were found between group Ob and N at PE in PaO2 (83.3 vs 89.1mmHg, $p<0.01$) and in PA-aO2 (26.4 vs 22.0mmHg, $p< 0.05$), but no in minute ventilation (mean 51.6 vs 52.0 l/min), VD/VT (mean 0.22 vs 0.22) and PaCO2 (mean 37.5 vs 36.7mmHg). Significant differences were found in DHR/DVO2 between groups in both sexes (M: mean 42.5 vs 31.4, $p<0.01$; F: mean 58.1 vs 48.7, $p<0.05$). These data indicate an increased extent of lung units with low ventilation/perfusion ratio (V'/Q'), but no differences in parameters of alveolar ventilation. Lowering of V'/Q' ratio seems to be produced mainly by increase in lung perfusion.
Conclusion: Hypervolemia and pulmonary over-perfusion may be an important factor of gas exchange impairment under exercise in obese patients.

P1547
Oxygen saturation response during the six-minute walk test in patients with chronic respiratory disease
Raúl Carrión-Sevilla[1], Elena Gimeno-Santos[1,2], Diego A. Rodriguez[3], Alba Ramirez-Sarmiento[4], Joaquim Gea[4], Josep Roca[3], Mauricio Orozco-Levi[4], Jordi Vilaró[3,5]. *[1]Respiratory Physiotherapy, Oydis, Physiotherapy Services, Barcelona, Spain; [2]Centre for Research in Environmental Epidemiology (CREAL), Hospital del Mar Research Institute (IMIM), CIBERESP, Barcelona, Spain; [3]Respiratory Medicine Service (ICT), Hospital Clinic de Barcelona, IDIBAPS, CIBERES, Barcelona, Spain; [4]Respiratory Medicine Service, Parc Salut Mar-IMIM, Barcelona, Spain; [5]FCS Blanquerna, GReF, Universitat Ramon Llull, Barcelona, Spain*

Some guidelines recommend stopping 6-minute walk test (6MWT) if arterial oxygen saturation (SaO_2) <85% as safety criteria. Our aim was to analyze the SaO_2 response <85% during 6MWT and its relation with clinical and symptomatic outcomes.

Methods: Retrospectively, we analyzed 6MWT from two respiratory medicine services from tertiary hospitals: Hospital del Mar and Hospital Clínic, Spain, from 2006 to 2010. They did not stop 6MWT using SaO_2<85% criteria. We analyzed the data in 4 groups according SaO_2.
Results: 796 patients (68±10 years) were analyzed. The results of ANOVA are: Only 2 (0.5%) patients showed complications (leg pain and leg paresthesias) within groups (p=0.43). Few patients stopped during 6MWT in all groups (p=0.15).
Conclusions: Patients with SaO_2<85% during 6MWT showed less distance walked and poor functional parameters. However, this group did not show differences neither in number of patients who stopped during the test nor presence of clinical complications during and after 6MWT. Our results confirm there are not critical effects in this kind of patients to stop the test using the SaO_2<85% criteria.

	SaO_2 <85% (n=192)	SaO_2 85–90% (n=241)	SaO_2 91–95% (n=272)	SaO_2 >95% (n=90)	p value
FEV_1 (%pred)	46±64	51±52	56±22	67±19	<0.01
PaO_2 (mmHg)	61±10	69±10	75±11	83±11	<0.01
Distance (m)	337±125	385±109	419±104	427±113	<0.01
SaO_2 at rest (%)	91±3	94±2	96±1	98±1	<0.01
SaO_2 min (%)	79±6	88±2	93±1	97±1	<0.01
HR at rest (bpm)	91±12	84±14	84±14	76±6	0.37
HR max (bpm)	117±16	111±17	110±15	104±19	<0.01
Dyspnea end (Borg scale)	6±3	5±3	3±3	3±3	<0.01
Fatigue end (Borg scale)	2±3	2±3	2±3	3±3	0.54

Results are presented as mean ± SD.