255. Innovative methods in exercise testing

P2164

Influence of gas concentration and measurement interval on the reproducibility of non-invasive cardiac output determination by inert gas rebreathing in pulmonary healthy patients

Frederik Trinkmann, Matthias Sampels, Ursula Hoffmann, Martin Borggrefe, Jens J. Kaden, Joachim Saur. *1st Department of Medicine, Universitätsmedizin Mannheim, Mannheim, Germany*

Background: Cardiac output (CO) is an important physiological parameter. In recent comparative studies non-invasive inert gas rebreathing (IGR) showed promising results. The aim of the prospective study was to evaluate the influence of gas concentration and measurement interval on the reproducibility.
Methods: We performed four series with two measurements for a gas bolus of 7.5%, 10%, 15% and 20% in supine position, respectively, and at intervals of 2 or 5 minutes. To rule out ventilation and diffusion disorders a bodyplethysmography was performed.
Results: A total of 384 measurements could be performed in 48 subjects, in 34 with an interprocedural interval of 5 minutes and in 14 of 2 minutes. For a fraction of 7.5% and an interval of 2 minutes we found a reproducibility of -0.8±1.1 l/min compared to 5 minutes with +0.1±0.6 l/min ($p < 0.001$). Rising gas concentration improved the reproducibility, for an interval of 5 minutes and a 20% gas bolus fraction no statistically significant difference was detected ($p = 0.88$).
Conclusions: With an interval of 5 minutes a good reproducibility of the IGR measurements could be shown for all gas bolus fractions. For an interval of 2 minutes and low gas concentration we found a statistically significant reduced reproducibility. Using a 20% gas bolus the reproducibility reached the results of those of the 5 minute interval. This is particularly interesting for the determination of CO with a given small time frame, e.g. during spiroergometry. For the final assessment, however, additional studies with patients suffering from lung diseases are needed.

P2165

Pulse oximetry during saline challenge in vocal cord dysfunction and airway hyper-responsiveness

Allyson Upward[1], Jeffrey Pretto[1,2], Michael Hensley[1,2]. *[1]Department of Respiratory & Sleep Medicine, John Hunter Hospital, Newcastle, New South Wales, Australia; [2]School of Medicine and Public Health, University of Newcastle, Newcastle, New South Wales, Australia*

The hypertonic saline challenge (HSC) is a commonly used diagnostic tool to assess airway hyper-responsiveness (AHR) and vocal cord dysfunction (VCD). Dyspnoea during testing is not uncommon and we postulated that oxygen desaturation may be a causative factor.

Aim: To document the degree of arterial desaturation during saline challenge and compare SpO2 changes in AHR, VCD and negative responses.

Method: SpO2 (Nellcor N595) was continuously recorded during 78 consecutive HSCs. SpO2 data was averaged over 32 seconds and minimum values used for analysis. Change in dyspnoea score (Borg) during the challenge was also recorded. Results were classified as AHR (change in FEV1 $\geq$15%), as VCD (change in MIF $\geq$20%) or negative otherwise.

Results: Mean (SD) FEV1 was 86 (15)% predicted for AHR (n=20), 92 (18)% for VCD (n=18) and 94 (18)% for negative results (n=40). There was a consistent trend in SpO2 for all subject groups with significant desaturation during the final doses of saline and during bronchodilatation (ANOVA $p<0.001$), and consistent resaturation during spirometric efforts. Mean (SD) maximum falls in SpO2 of 4.3% (2.7) were observed for AHR, 4.1% (2.0) for VCD and 4.4% (2.7) for negative results. There was no relationship between change in dyspnoea and degree of desaturation (p=0.43).

Conclusion: Hypertonic saline challenge causes a significant and reproducible pattern of arterial desaturation irrespective of the test response. These data would be consistent with progressive hypoventilation during HSC rather than indicating desaturation due to worsening ventilation-perfusion mismatching. Hypoxaemia does not appear to be the primary cause of dyspnoea during HSC.

P2166

A randomised cross-over clinical testing of portable oxygen concentrators in patients with COPD

Annabelle Couillard, Dan Veale, Didier Foret, Boris Melloni, Philippe Sauder, Jean-François Muir. *Maison du Poumon, Fédération ANTADIR, Paris, France*

Portable oxygen concentrators (POC) deliver oxygen via intermittent demand valves (IDV). these merit comparison with standard continuous flow oxygen (CFO). We have performed a multicenter comparison of 4 POC in a cross over study in 74 patients with COPD (age = 67±10; FEV1 = 41±20% predicted). Each patient tested one of 4 POC at rest and during a six minute walk test (6MW), with oxygen saturation recording (SpO2). Noise and discomfort were evaluated by visual analogue scales (VAS).

Results: Mean 6MW distance was 308m ±114 with POC and 315 m ±111 with CFO (p>0,06). However the distance walked with POC was clinically significantly less (by >10%) than CFO in 23% of patients and significantly better than CFO (by >10%) in 13,5% of patients. Dyspnoea during 6MW by VAS was identical for both types of device. 55,5% of patients had SpO2 fall with both devices and 27% no fall in SpO2. 13,5% had SpO2 fall with POC alone and 4% with CFO alone. Overall patients appreciate the POC because of security of oxygen supply. However, they judged POC oxygen delivery significantly less amenable and noisier than CFO.

Conclusion: 4 POC devices with demand valve oxygen delivery had similar efficacy to CFO devices but were noisier and less comfortable. Prescription of such devices needs to be individualized as regards settings for O2 delivery and patient comfort and lifestyle.

P2167

The compensatory mechanisms of loaded and unloaded breathing in exercising men

Marina Segizbaeva. *Laboratory of Respiration Physiology, I.P. Pavlov Institute of Physiology RAS, S.-Petersburg, Russian Federation*

To characterize the ventilatory responses to the resistive loading or unloading, we studied the effect of breathing 79% helium – 21% oxygen (He-O2), 79% argon – 21% oxygen (Ar-O2) and 79% SF6 – 21% oxygen (SF6-O2) on the volume-time parameters, PETCO2, mouth pressure (PmI), work of breathing (WI), central inspiratory activity (dP/dtI) and electromyographic activity of parasternal muscles in 10 normal subjects at rest and during 3 min steady-state exercise. There were no significant changes in tidal volume (VT), breathing frequency (f), inspiratory (TI) and expiratory (TE) durations, minute ventilation (VE) and PETCO2 when air was replaced by He-O2 or SF6-O2 at rest. VE and PETCO2 were not significantly different after replacement of air by He-O2 or SF6-O2 during exercise. However inhalation of He-O2 decreased in VT and increased in f, whereas inhalation of SF6-O2 led to opposite effects compared with air during exercise. Both at rest and exercise, PmI, WI, dP/dtI and EMGps were significantly less during He-O2 breathing and higher during SF6-O2 breathing from the first respiratory cycle after room air was replaced by He-O2 or SF6-O2. Ar-O2 breathing did not affect on time-volume parameters both at rest and during exercise compared with air. The increase in PmI, WI, dP/dtI was observed at Ar-O2 inhalation during exercise relatively to air. We conclude that internal resistive loading or unloading breathing changes the neuromuscular output required to maintain constant ventilation. The mechanisms of load or unload compensation seem to be mediated by afferent impulsation from lung and respiratory muscle receptors as well as due to segmentary level reflexes and properties of the muscle fiber itself.

P2168

Oxygen kinetics during 6-minute walk tests using mobile telemetric cardiopulmonary monitoring

Lukas Kern[1], Sophie Condrau[2], Florent Baty[1], Wiegand Jan[3], Andrea Azzola[4], Michael Tamm[5], Martin Brutsche[1]. *[1]Department of Pulmonary Medicine, Cantonal Hospital St. Gallen, St. Gallen, Switzerland; [2]Department of Internal Medicine, Regional Hospital, Interlaken, Switzerland; [3]Department of Critical Care Medicine, University Hospital Bern, Bern, Switzerland; [4]Department of Pulmonary Medicine, Regional Hospital, Lugano, Switzerland; [5]Department of Pulmonary Medicine, University Hospital Basel, Basel, Switzerland*

Background & aim: Mean response time (MRT) is a prognostic factor for patients with congestive heart failure (CHF). With the current project we sought to validate the assessment of MRT using Mobile Telemetric Cardiopulmonary Monitoring (MOB) during a conventional 6-minute walk test (6MWT).

Material and methods: Oxygen uptake profiles of 203 patients and 16 healthy controls were obtained using MOB (Oxycon Mobile®) during a 6MWT. Curves were fitted using asymptotic regression models. The following parameters were assessed: O2-deficit, baseline and peak O2-uptake, MRT. MOB does not provide information on work load. Therefore, MRT was reparametrized (MRT*=MRT/dVO2) to correct for this variable. Differences in MRT* between disease categories were tested using ANOVA F-test. Associations between MRT* and patient outcome (hospitalisation and/or death) was tested using Cox proportional hazards regression.

Results: O2-deficit and MRT* were significantly increased in patients compared to healthy controls ($p<0.001$). There was no significant difference between other disease categories. MRT* significantly predicted the patient outcome only in patients with CHF (p=0.004, Figure 1).

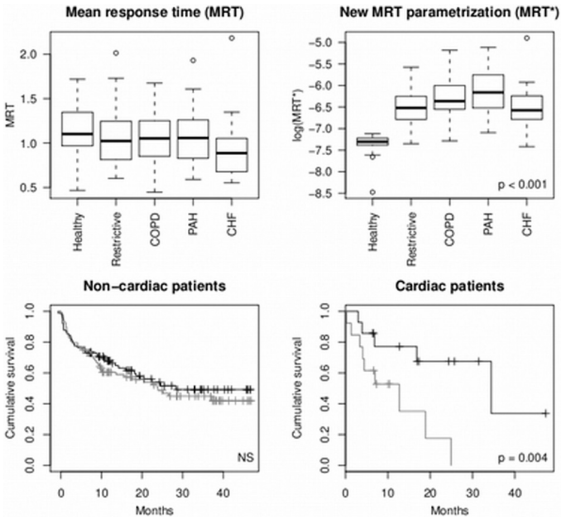

Figure 1

Conclusion: Compared to healthy controls MRT* was prolonged in all patient groups. MRT* was a significant prognostic factor for patients with CHF. We could therefore reproduce previous results obtained with cardiopulmonary exercise testing using MOB during a 6MWT.

P2169

Cardiac bioimpedance as a non-invasive tool in patients with pulmonary hypertension

Christian Lensch[1], Ralf Kaiser[2], Christian Frantz[1], Robert Bals[1], Heinrike Wilkens[1]. *[1]Pneumology, Allergology and Respiratory Intensiv Care, University of Saarland, Homburg/Saar, Saarland, Germany; [2]Cardiology and Intensiv Care, University of Saarland, Homburg/Saar, Saarland, Germany*

Background: Pulmonary hypertension (PH) is a serious disease diagnosed by echocardiography and right heart catheterization. Left ventricular dysfunction and decreased cardiac output is a common feature in pulmonary hypertension. The aim of this study was to evaluate cardiac bioimpedance (CBI) as a possible non-invasive tool in hemodynamic monitoring.

Methods: 19 patients (19-76 years) with IPAH or CTEPH (PAPm 48±14,4 mmHg; PVR 799±497 dyn s cm^{-5}) and 6 healthy volunteers were measured simultaneously by thoracic echocardiography and non-invasive cardiac bioimpedance (CBI) using a BoMed NCCOM3. Parameters were standardized by body surface area. Linear regression analysis and F-Test were performed.

Results: Left ventricular end diastolic volume index in CBI correlated with echocardiography measurements in both M-Mode (r=0,6181; p=0,002) and B-Mode (Simpson, r=0,8431, p<0,001). Also the Stroke index in CBI correlated with the estimated stroke index in M-Mode (r=0,7077; p<0,001) and B-Mode (Simpson, r=0,7946; p<0,001).
Conclusions: In patients with IPAH or CTEPH, cardiac bioimpedance might be a useful non-invasive tool in monitoring left ventricular hemodynamics including left ventricular preload and cardiac output.

P2170
Relationship between pulse transit time and blood pressure during cardiopulmonary exercise tests
Thomas Wibmer, Cornelia Kropf, Kathrin Stoiber, Stefan Ruediger, Martin Lanzinger, Wolfgang Rottbauer, Christian Schumann. *Department of Internal Medicine II, University of Ulm Medical Center, Ulm, Baden-Wuerttemberg, Germany*

Introduction: Pulse transit time (PTT), the interval between ventricular electrical activity and peripheral pulse wave, is generally assumed to be a surrogate marker for blood pressure changes. Although recent studies have affirmed the potential use of PTT in the diagnostic of sleep disorders and the monitoring of psychophysiological stress, little work has been published on the effect of physical exercise on PTT and results have been inconsistant.
Aims: To analyse PTT and its relation to blood pressure during cardiopulmonary exercise tests.
Methods: In 20 patients (mean age 51, range 14-82) in a cardiopulmonary unit, ECG and finger-photoplethysmography were continuously recorded during routine cardiopulmonary cycle exercise tests. PTT was calculated for each R-wave in the ECG and the corresponding steepest upstroke in the plethysmogram. For each subject the resulting PTT-curve was averaged in order to compensate sample rate- and movement-associated variation, and values were compared to systolic (sBP) and diastolic blood pressure (dBP) in 9 predefined measuring points including measurements at rest, during increasing and maximum exercise as well as during the recovery period.
Results: Mean sBP and PTT at rest were 127 mmHg and 372 ms respectively, 197 mmHg and 287 ms under maximum exercise, and 132 mmHg and 365 ms during recovery. All subjects showed a significant, strong negative correlation between PTT and sBP (mean r=-0.97, range -0.99 to -0.93, p= <0.0001 to 0.015). The correlation between PTT and dBP with mean r=-0.41 (range -0.87 to 0.76, p=0.035 to 0.83) was rather weak.
Conclusions: These results indicate that PTT is a good potential surrogate measure for sBP during exercise.

P2171
Estimation of the ventilatory compensation point by the minute ventilation and heart rate relationship during exercise at high altitude
Gabriele Valli[1], Paolo Onorati[1], Dario Martolini[1], Alessandro Ferrazza[1], Giuseppe Morici[3], Claudio Passino[4], Luciano Bernardi[5], Daniela Bonardi[6], Annalisa Cogo[2], Paolo Palange[1]. *[1]Respiratory Pathophysiology, Department of Public Health and Infectious Diseases, University of Rome "La Sapienza", Rome, Italy; [2]Clinical and Experimental Medicine, Section of Respiratory Disease, University of Ferrara, Ferrara, Italy; [3]Experimenal Medicine, University of Palermo, Palermo, Italy; [4]Clinical Physiology, CNR, Pisa, Italy; [5]Internal Medicine, Universisty of Pavia, Pavia, Italy; [6]Insititute of Respiratory Disease, IRCCS, Univesity of Milan, Milan, Italy*

We previously demonstrated that changes in the slope (S) of increment in minute ventilation over heart rate ($\Delta V'E/\Delta HR$) can be utilized for the detection of the ventilatory compensation point (VCP) during incremental exercise at sea level (SL) (Onorati P, *EurJApplPhysiol,* 2008). We hypothesized that the influence of hypoxic conditions, such as at high altitude (HA), on the V'E and HR responses do not compromises VCP detection using the $\Delta V'E/\Delta HR$ method.
Methods: Six healthy subjects (42±14SD,yrs) performed, on immediate ascent to HA (5050m) and at sea level (SL) a maximal-incremental exercise test on cycle ergometer; O_2 uptake ($V'O_2$), CO_2 output ($V'CO_2$), V'E and HR were measured breath-by-breath. The $\Delta V'E/\Delta HR$ method was compared to standard one ($\Delta V'E/\Delta V'CO_2$). The S of $\Delta V'E/\Delta HR$, before (S1) and after (S2) VCP were computed by linear regression.
Results: A significant difference in the slope of increase in $\Delta V'E/\Delta HR$, S1 vs S2, was observed both at SL and HA, as well as a good agreement (mean difference ± 2SD of the differences) between methods ($\Delta V'E/\Delta HR$ vs $\Delta V'E/\Delta V'CO_2$) in VCP detection was found in both environmental conditions (SL: -22±112 $V'O_2$ ml and HA: 39±81 $V'O_2$ ml). For both methods, $V'O_2$ value at VCP (VCP-$V'O_2$) was significantly lower at HA compared to SL while, whereas S1 and S2 were significantly higher at HA compared to SL.
Conclusions: The changes in the $\Delta V'E/\Delta HR$ slope during cycle ergometer incremental exercise can be used for VCP detection alternately to the ventilatory equivalents method despite the environmental conditions (hypoxic vs normoxic) which, however, significantly affect the S and VCP-$V'O_2$ values.

P2172
Lung diffusion at high altitude after endurance exercise in high- and lowlanders
Maria Overbeek[1], Jean-Benoit Martinot[2], Claire De Bisschop[3], Cristina Scoditti[4], Sofia Beloka[5], Herman Groepenhoff[1], Mart Van der Plas[6], Francisco Villafuerte[7], Jose Luis Macarlupu[7], Robert Naeije[5], Herve Guenard[8]. *[1]Pulmonary Diseases, VU University Medical Center, Amsterdam, Netherlands; [2]Department of Pneumology, St. Elisabeth Hospital Namur, Namur, Belgium; [3]Laboratory of Physiologic Adaptations to Physical Activities, Poitiers University, Poitiers, France; [4]Reparto di Fisiopatologia Respiratoria, Universitá degli Studi, Bari, Italy; [5]Department of Physiopathology and Cardiology, Erasme University Hospital-Free University of Brussels, Brussels, Belgium; [6]Pulmonalary Diseases, Onze Lieve Vrouwe Hospital, Amsterdam, Netherlands; [7]Laboratorio de Fisiologia Comparada, Facultad de Ciencias y Filosofia, Universidad Peruana Cayetano Heredia, Lima, Peru; [8]Laboratory of Physiologie, Medical Faculty, University of Bordeaux, Bordeaux, France*

Introduction: Both the membrane (Dm) and the capillary (Vc) component of lung diffusing capacity (DL) have been shown to be increased in high altitude residents and to remain essentially unchanged in high altitude sojourners. Maximal exercise has been reported to decrease Dm at sea level (Manier 1993). The effects of high altitude exercise on Dm and Vc as evaluated from the DL for carbon monoxide (DLCO) and nitric oxide (DLNO) respectively, are incompletely understood.
Methods: Lowlanders (n=10) and highlanders (n=14) were tested at 4380m above sea level (Cerro de Pasco, Peru); lowlanders also underwent tests at sea level. Spirometry, alveolar volume (VA), DLCO, DLNO, Dm and Vc were assessed (Hypercompact Medisoft, Belgium) using the NO/CO transfer technique. Values were corrected for $PcapO_2$, Hb and are presented as mean predicted value (Aguilaniu 2008) ±SEM. Measurements took place at rest and after an endurance test at 80% of VO_2max at heart rate returned to rest values.
Results: Spirometry was normal in all subjects. Hb nor SaO_2 at rest were significantly different between the groups.

	H pre-E	H post-E	L pre-E	L post-E
DLCO/VA %	150±4*	153±4*	125±4	120±3†
DLNO %	143±7*	154±7*†	117±4	110±4†
Vc/VA %	143±5*	145±6*	120±6	113±4†
Dm %	133±5*	140±5*†	110±2	106±3†

H: highlanders, L: Lowlanders; E = endurance. *p<0.05 H *vs.* L, †p<0.05 pre- *vs.* post-exercise.

At sea level, lowlanders did not demonstrate alterations in diffusion parameters pre- *vs.* post-endurance test.
Conclusion: Strenuous exercise in lowlanders resulted in a decrease of DLCO which was probably caused by interstitial lung edema thickening the alveolocapillary membrane, whereas highlanders were capable of maintaining DLCO-levels by an increase in Dm.

P2173
Early oxygen desaturation is related to AMS development during acute exposure to high altitude (HA)
Luca Pomidori, Gaia Mandolesi, Giovanni Avancini, Eva Bernardi, Annalisa Cogo. *Biomedical Sport Studies Center, University of Ferrara, Ferrara, FE, Italy*

Early desaturation during acute simulated HA exposure is significantly related to AMS development.
Aim: To study the hypoxic profile and the AMS development during the ascent from Alagna (A), 1200m, to Capanna Regina Margherita (M), 4559m, with an overnight stay in Rifugio Gnifetti (G), 3647m.
Methods: 44 (8F) subjects (age 18-67) were recruited in A, equipped with a 24-h data memory pulse oximeter (Pulsox-3Si, Minolta) and asked to fill the Lake Louise questionnaire (LL).
Results: 15 subjects (34%) showed a LL score ≥3 (AMS+). In A SpO2 data were similar but during HA exposure AMS+ group had a significantly lower SpO2: at Punta Indren (I), 3275m after a 45min cable car ascent; in G during 3h rest and the subsequent night. There was no significant difference during the 2h exercise (Ex1) to reach G.

Table 1. Spo2% mean

	A (rest)	I (rest)	Ex1	G (rest)	G (night)	Ex2
AMS+	94.5±1.6	84±4,5	81.3±2.9	84±2.1	76.7±3.8	76.±3.1
AMS–	95±1.4	86.8±3.7*	82.1±2.5	86.1±1.9*	79.1±3.4*	71±4.5*

In G, AMS+ always spent more time with a lower SpO2.

Table 2. % of total time

	At rest SpO2 <85%	Overnight SpO2 <75%
AMS+	56±21	35±27
AMS–	34±18*	18±19*

As regard the ascent to M (Ex2), data of only 24 subjects are available, (5 AMS+;

19 AMS–). None of AMS- group developed AMS during the climb to M. AMS+ had a significantly lower SpO2 as compared to AMS- but the sample is too small to draw definitive conclusions.
Conclusion: AMS development is significantly related to a more severe O2 desaturation at rest and during the night; the more severe hypoxemia occurs very early at the beginning of HA exposure as already shown during hypoxia simulated test (Loeppky '08 and Burtscher '04) (*p<0,05).

P2174
Eucapnic voluntary hyperventilation tests in elite athletes at Centre Hospitalier Universitaire de Montreal
Marc Fortin[1], Claude Poirier[2]. [1]*Internal Medicine, Centre Hospitalier Universitaire de Montreal, Montreal, QC, Canada;* [2]*Pneumology, Centre Hospitalier Universitaire de Montreal, Montreal, QC, Canada*

Introduction: Since 2001, the International Olympic Committee requires athletes to demonstrate exercise induced bronchospasm (EIB) to be granted the permission to use beta-agonists. Eucapnic voluntary hyperventilation (EVH) has become the test of choice for the diagnosis of EIB but experience with this test is limited.
Objective: The aim of this retrospective study is to describe the population of elite athletes who underwent EVH at Centre Hospitalier Universitaire de Montreal and to identify factors related to a positive result.
Methods: 41 elite athletes underwent EVH in our institution from 1/1/2009 to 1/5/2010. Positive tests were compared to negative tests. From 1/1/2011 to 1/2/2011 each athlete was sent a questionnaire to gather further information.
Results: 22/41 (54%) tests were positive. 16/25 (64%) aquatic sport (AS) athletes vs 6/16 (38%) non-AS athletes had a positive test (p=0,10). There were no difference between positive and negative tests in mean respiratory rhythm (RR) (66,3breaths/min vs 67,7, p=0,68), tidal volume (TV) (1,43l vs 1,62, p=0,27) and pourcentage of target minute ventilation reached (%TMV) (78,9% vs 83,0%, p=0,22) but there were significant differences in mean minute ventilation per kilogram (MV/kg) (1,48l/kg/min vs 1,63, p=0,04) and age (19,6 vs 22,8, p=0,02). 7/13 (54%) athletes who reported EIB symptoms during sport had a positive test.
Conclusions: 54% of elite athletes had a positive EVH test. AS athletes tended to have more positive tests. Symptoms perceived by athletes had a poor positive predictive value. RR, TV and%TMV were not determinants of EVH test result but a younger age and lower MV/kg were related to a positive EVH test.

P2175
Non-invasive estimation of cardiac output by impedance cardiography during incremental exercise in patients with pulmonary arterial hypertension
Eloara Ferreira, Roberta Pulcheri Ramos, Priscila Figueiredo, Jaquelina Sonoe Ota Arakaki, L. Eduardo Nery, J. Alberto Neder. *Medicine, Respiratory Division, Federal University of Sao Paulo, Sao Paulo, SP, Brazil*

Non-invasive monitoring of haemodynamic responses during incremental cardiopulmonary exercise testing (CPET) could provide useful information on disease severity and prognosis in pulmonary arterial hypertension (PAH). Using an impedance cardiography (ICG) device that does not require basal impedance or blood resistivity estimations (*PhysioFlow PF-05®*, Manatec Biomedical, France), stroke volume (SV) and cardiac index (CI) were evaluated in 50 patients and 21 age- and gender-matched controls during a ramp-incremental CPET on a cycle ergometer. An ICG signal was not obtained in 5 patients and its quality was deemed as "poor" in another 7 patients, i.e., technical problems were found in 24% of the readings. Early decrease (N= 9) or a subsequent "plateau" in SV (N= 8) and Δ SV peak-unloaded exercise < 10 mL were found in more advanced PAH ($p<0.05$). A multiple logistic regression analysis revealed that ΔCI from rest ≤ 1.5-fold and oxygen uptake ($V O_2$) at the gas exchange threshold were the only predictors of a severely-reduced peak $V O_2$ ($R^2=0.71$, $p<0.001$). In fact, peak $V O_2$ < 50% predicted *plus* Δ CI < 1.5-fold were associated with other clinical and functional markers of disease severity and 1-year frequency of PAH-related adverse events (death and balloon atrial septostomy, N= 8; $p<0.05$). This study demonstrated that "qualitative" and "semi-quantitative" ICG might be useful to estimate disease severity and short-term prognosis in PAH patients in whom an acceptable impedance signal can be obtained.
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P2176
The effects of pressure-threshold inspiratory load on lactate clearance after maximal exercise
Michael Johnson[1], David Brown[2], Katie Bayfield[3], Javier Gonzalez[4], Dean Mills[1], Graham Sharpe[1]. [1]*School of Science and Technology, Nottingham Trent University, Nottingham, United Kingdom;* [2]*Division of Nutritional Sciences, University of Nottingham, Leicester, United Kingdom;* [3]*Department of Gene Therapy, Imperial College London, London, United Kingdom;* [4]*School of Life Sciences, Northumbria University, Newcastle, United Kingdom*

Chiappa, G.R. *et al.* (*Med Sci Sports Exerc* 2008; 40:111-116) showed that a 15 cmH_2O pressure-threshold inspiratory load accelerated lactate clearance during recovery from intense exercise. However, we observed such an effect only when the relative intensity of the inspiratory load fell due to a training-induced increase in maximum inspiratory pressure (Brown, P.I. *et al. Med Sci Sports Exerc* 2010; 42:1103-1112). This study thus tested the hypothesis that lactate clearance is influenced by the magnitude of inspiratory load applied in recovery from maximal exercise.
Eight male participants (VO_2max 4.34±0.54 L/min) completed four maximal incremental cycling tests (20 W/min starting at 0W), of identical duration (16.20±1.22 min), followed by 20 min recovery comprising either passive recovery (PR) or breathing against an inspiratory pressure-threshold load of either 10 (IPTL10), 15 (IPTL15) or 20 (IPTL20) cmH_2O. Arterialised venous blood samples were taken during recovery and analysed for blood lactate concentration ($[La]_B$) every 2 min and blood pH every 4 min. During PR, IPTL10, IPTL15 and IPTL20 the $[La]_B$ after 2 min of recovery (11.2±1.9, 11.5±2.6, 11.2±2.0 and 11.2±1.8 mmol/L, respectively), the area under the $[La]_B$ curve during recovery (191±48, 192±55, 182±48 and 187±45 mmol, respectively), and mean blood pH (7.27±0.05, 7.28±0.05, 7.28±0.06 and 7.28±0.06, respectively) were not different between trials.
In conclusion, all inspiratory loads failed to influence lactate clearance after maximal exercise. Why inspiratory loading accelerates lactate clearance in some (Chiappa *et al.*), but not all (present study; Brown *et al.*), participants is thus unclear and warrants further exploration.

P2177
Heart rate recovery kinetics after exercise in the assessment of autonomic nervous system dysfunction in COPD patients
Anael Barberan[1], Alejandro Raimondi[2], Diego Agustin Rodriguez[1], Gimeno Elena[3], Arbillaga Ane[1], Vilaró Jordi[1], Roca Josep[1]. [1]*Pulmonary Medicine - Pulmonary Function Laboratory, Hospital Clinic i Provincial de Barcelona, Barcelona, Spain;* [2]*Internal Medicine, CEMIC, Buenos Aires, Argentina;* [3]*Epidemiology Department, Centre de Recerca en Epidemiologia Ambiental -CREAL-, Barcelona, Spain*

Chronic Obstructive Pulmonary Disease (COPD) patients can develop autonomic nervous system dysfunction (ANSd) during the curse of the disease. Although heart rate recovery (HRR) measured immediately after exercise is considered an ANS marker easy to evaluate, the cutoff point to establish dysfunction remains unclear. Our hypothesis is that the slope of the HRR kinetics after exercise (HRRk) is a simple and useful index to evaluate ANSd in COPD.
HRRk after a constant work-rate cycloergometer exercise was recorded before and after 8 weeks of endurance training in 10 COPD patients (FEV1: 47±8%pred; 71±3 yrs) and 10 healthy controls (66±10 yrs). To calculate HRRk, the heart rate during the recovery period was normalized to range from 1 at the end of the exercise to 0 at minute 6 of the recovery period.
At baseline, the slope of the HRRk was significantly higher in the control group than in the COPD group ($p<0.001$). Thus, the HRR at the first minute after exercise was lower in the COPD group (mean 11 beats) than in the control group (21 beats) ($p<0.001$). After training, the HRRk slope increased in the control group (from 0.009 to 0.012) ($p<0.05$) but no changes were seen in COPD patients (from 0.007 to 0.008).
We conclude that HRR kinetics after exercise enhances assessment of ANSd in COPD patients.
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P2178
Validation of a compact accelerometer for the measurement of physical activity in patients with COPD
Yoshiaki Minakata, Akihito Sugino, Manabu Nishigai, Masae Kanda, Keiichiro Akamatsu, Akira Koarai, Tsunahiko Hirano, Hisatoshi Sugiura, Kazuto Matsunaga, Masakazu Ichinose. *Third Department of Internal Medicine, Wakayama Medical University, Wakayama, Japan*

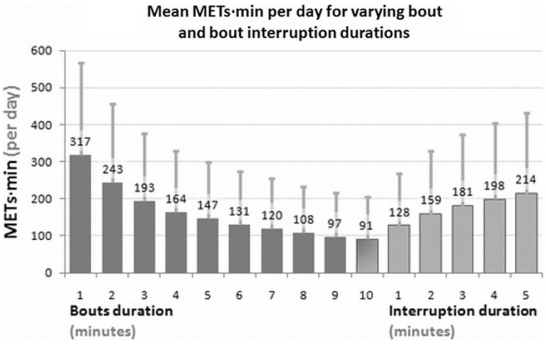
Background: The DynaPort Activity Monitor (DAM) has been reported to be useful to evaluate the activity in patients with COPD. However, its battery works for only several hrs and it should be worn at two parts of body. A newly developed compact, single-position triaxial accelerometer (Actimarker) can measure the activity for more than 1 month, but has not been validated for patients with COPD.
Objectives: The validation of the Actimarker in patients with COPD was evaluated and the conditions of day for analysis were determined.
Methods: In study 1, the reproducibility of the Actimarker was evaluated for 14 stable COPD patients by comparing it with DAM. In study 2, the influence of holiday and the weather on the activity was examined. In study 3, the number of measurement days to ensure repeatability was determined.
Results: The differences in the activity by Actimarker and the locomotion by DAM were all within the limit of agreement at the intensity of ≥2.0 METs, ≥2.5 METs and ≥3.0 METs with Bland-Altman Plots. The durations of activity on holidays in patients with jobs and on rainy days were significantly shorter than those on weekdays and on non-rainy days, respectively. The values of intra-class correlation coefficient were more than 0.8 in 3, 4 or 5 day-measurements, and the mean values of duration of activity from 3 or 4 days were all within the limit of agreement with Bland-Altman Plots.
Conclusions: The physical activity assessed by Actimarker was confirmed for its reproducibility and repeatability when the data from 3 non-rainy weekdays were analyzed. Actimarker seems to be useful as a simplified method to evaluate the physical activity in patients with COPD.

P2179

Use of accelerometers for measuring consecutive bouts in physical activity recommendations

Menno J. Zuidema[1], Jorine E. Hartman[2], Nick H.T. ten Hacken[2], Matthieu H.G. de Greef[3], Rob C. van Lummel[1]. *[1]Research and Development, McRoberts BV, The Hague, Netherlands; [2]Pulmonary Department, University Medical Center, University of Groningen, Groningen, Netherlands; [3]Institute of Human Movement Sciences, University of Groningen, Groningen, Netherlands*

Background: Most recommendations for physical activity (PA) are based on subjective self reported measures, although performance-based accelerometers are already available for many years. To meet PA recommendations, subjects need to be physically active in bouts varying from 5 to 20 minutes. However, the influence of bout length and bout interruptions in objectively measured PA status is not exactly known.
Aim: The aim of the present study is to investigate the effect of different consecutive bout lengths and bout interruptions on the PA status using accelerometers.
Methods: Twenty COPD patients were selected from a larger dataset, based on a large range in PA level. The DynaPort accelerometer (100Hz, ±2g, McRoberts BV, The Hague, the Netherlands) was used for measuring PA during a full week of daily living. Systematically varied bout lengths and interruptions are investigated to examine PA status.
Results: Bout length of 10 versus 1 minute shows a 71% difference in PA status (91 METs·min vs 317 METs·min) (figure 1a). Bout interruption duration of 0 vs 5 minutes shows a 57% difference in PA status (91 METs·min vs 214 METs·min) (figure 1b).



Conclusion: This study shows that varying bout length and interruption duration has large impact on PA status. When applying PA recommendations this should be taken into account, particularly in subjects with a sedentary life style.

P2180

Physiological responses to the incremental shuttle walk test in healthy 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*

Physiological responses to the incremental shuttle walk test (ISWT) have been increasingly evaluated in patients. However, previous studies did not include healthy individuals. The aim of this study was to evaluate age- and gender-related changes in physiological responses to the ISWT and to establish predictive equations for such variables. We evaluated 103 non-trained healthy adults (49 males, aged 60±10). After familiarization, ISWT was performed using a telemetric gas analyzer. Physiological responses including oxygen uptake at ventilatory threshold (VO_2VT) were obtained. Maximum walking velocity (Vmax), lean (LBM) and fat (FM) body masses (impedance), and handgrip strength (HGS) were also measured. Participants were stratified in four age groups (40-49 to ≥70). A set of linear equations was provided for predicting physiological variables. The VO_2VT was identified in all but one participant. Among peak variables, heart (HR) and respiratory (RR) rates, tidal volume (VT), and gas exchange ratio (R) were not affected by sex as well as VO_2/HR, R, RR, and VT were not influenced by age. There were no effect of age and gender in VO_2VT (% of peak VO_2). Prediction equations adjusted by sex, age, height, weight, LBM, FM, HGS, and ISWT showed R^2 values ranging 0.352 to 0.661 (VO_2VT and peak VO_2 respectively). The best predictors of peak VO_2 were HGS, weight, FM and age (R^2=0.661). Age, weight, height and gender explained 59.7% of Vmax variability. The results therefore might provide a more appropriate frame of reference for normalcy of physiologic responses to the ISWT in healthy older adults. Our results may be useful for better interpretation of walking performance in patients with cardiopulmonary disease.

P2181

Cardiopulmonary exercise testing and hormonal status in winter sports elite athletes

Alexander Ulyanov, Samira Gasymova, Lydia Nikitina, Fedor Petrovskiy. *Allergy and Clinical Immunology, Khanty-Mansiysk State Medical Academy, Khanty-Mansiysk, Russian Federation*

Background: There are no data available yet regarding relationship between cardiopulmonary exercise testing and hormonal status in athletes.
Methods: A total of 86 elite athletes of winter sports (biathlon, ski, ice hockey, snowboard) aged 14-35 were included in the study. Total minute ventilation (V_E), oxygen uptake (VO_2), V-slope anaerobic threshold (AT) and oxygen pulse (O_2/HR) were analyzed (Oxycon Mobile, Viasys). Morning levels of thyroid-stimulating hormone (TSG), free T4 (FT4), cortisol and testosterone were determined using electrochemical immunoassay. Blood samples were taking 7.00 - 8.00 am before exercise.
Results: In contrast to females, males had higher values of V_E max, AT, VO_2 max, O_2/HR max and testosterone ($p < 0.01$ for all comparisons) and lower cortisol ($p = 0.03$). Males and females had comparable proportions of those who achieved AT during the exercise test (58% and 60% respectively). In athletes who achieved AT, testosterone level was two fold lower compared to those who did not achieved AT (16.2 nmol/l vs 31.8 nmol/l respectively, $p = 0.03$). We found the following correlations between (i) V_E max and testosterone (rs=0.59; $p<0.01$); (ii) VO_2 max and testosterone (rs=0.83; $p<0.01$); (iii) VO_2 max and FT4 (rs=0.71; $p<0.01$); (iv) O_2/HR max and FT4 (rs= 0.56; $p<0.03$). Multiple linear regression analysis (forward stepwise) with the inclusion of all studied hormones as independent variables showed that testosterone was the only factor to be significantly associated with V_E max, AT, VO_2 max, O_2/HR max in athletes.
Conclusion: The present data suggest a significant role of testosterone in cardiorespiratory fitness in elite athletes.

P2182

Comparison of two different O_2-delivery systems during exercise in patients with chronic hypoxia

János Juhász[1], Júlia Juhász[2]. *[1]Internal Medicine, Ilmtalklinik GmbH, Hospital Mainburg, Mainburg, Germany; [2]Faculty of Medicine, Christian Albrechts University, Kiel, Germany*

Results from case studies using a high-flow oxygen delivery system (TNI®) suggest advantage regarding the oxygenation compared to conventional O_2-therapy (LTOT). Aim of the study was to verify the feasibility, safety and clinical significance of TNI® compared to LTOT.
Method: 14 patients (pts) with chronic hypoxia underwent standardized treadmill six-minute walk test (6MWT) in a prospective, randomized study. All pts completed 6MWT on room air (basis). Then, they underwent consecutive 6MWTs applying TNI® and LTOT in a random order (40% O_2-admixture each). Between 6MWTs, pts had a rest of 30 minutes. We measured walking distance (m), workload performance (Watt), energy expenditure (kcal), and collected data from Borg-dyspnoea-scale (BDS) and blood gas analysis (BGA) before 6MWT and at maximum workload (WLm). Primary outcome measures were ΔPaO_2 and $\Delta PaCO_2$ from rest to WLm and their relation to walking distance ($m/\Delta PaO_2$), exercise performance ($Watt/\Delta PaO_2$) and energy expenditure ($kJ/\Delta PaO_2$).
Results: BDS scores increased from rest to WLm by 5,58±2,15 (basis), 2,67±1,78 (TNI®) and 3,38±2,04 (LTOT) scores. Waking distances during basis, TNI® and LTOT were 182,14 m, 235,86 m and 232,86 m respectively. ΔPaO_2 from rest to WLm was higher during LTOT compared to TNI® (-10,19 mmHg vs. -7,80 mmHg respectively) at identical workload performance (43,21 Watt). Workload economy, performance- and energy efficacy was better during TNI® vs. LTOT (30,22 vs. 22,85 m/mmHg; 5,53 vs. 4,24 Watt/mmHg and 2.02 vs. 1,51 kJ/mmHg respectively).
Conclusion: TNI® compared to LTOT was safe to deliver O_2 for pts with hypoxia during exercise and superior in regard to workload economy, performance- and energy efficiency.

P2183

The use of submaximal metabolic stress test derived end tidal CO2 may reflect pulmonary hypertension and need for further workup

Mary Lynn Zaremba, Kristin Elliott, Alicia Redford, Syed Ali, Nipurn Shah, Sridhar Reddy. *St.Clair Pulmonary & Critical Care, 1210 10th Avenue, Port Huron, MI, United States*

There is considerable interest in identifying patients with pulmonary hypertension. In a small pulmonary practice we looked at the use of end tidal CO2 (ETCO2) derived from a quick submaximal stress test and its relevance to pulmonary arterial pressures. Submaximal stress testing is much easier for patients to perform and is being increasingly used in a small office setting. We looked at patients with drops in ETCO2 on exercise and echocardiographic parameters of pulmonary hypertension.
During submaximal metabolic stress testing using Shape non-invasive medical devise, breath by breath analysis of air flow, O2 consumption and CO2 production were measured. Patients n=25 with a drop in ETCO2 (n=11) during exercise were compared to patients with a rise in ETCO2 (n=14). Echocardiographic parameters were extracted and used for analysis.

In the group of patients with a drop in ETCO2 there was a significantly higher peak right ventricular systolic pressure (p=0.013477) compared to patients with an increase in ETCO2 during exercise.
Submaximal stress testing can be easily performed in the outpatient setting. In patients being evaluated for pulmonary disease and dyspnea, submaximal stress testing may help detect patients that may benefit from further workup of pulmonary hypertension.

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