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254. Clinical physiology for clinical problems

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Hyperinflation and health status contribute to 6-minute walk distance in COPD, contrary to airway inflammation

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Rationale: COPD is a chronic inflammatory airway disease that often limits functional exercise capacity in many patients. Airway inflammation has shown to be associated with bronchial hyperresponsiveness (BHR) and hyperinflation in COPD.

Aim: To assess if sputum inflammation and BHR contribute to functional exercise capacity (assessed by 6-Minute Walktest (6MWT)) next to lung function, health related quality of life (HRQL) and health status in COPD.

Methods: 108 COPD patients (GOLD stage II & III) participating in the GLUCOLD study [1] (87% male, median (range) FEV₁%pred 64% (41-78), mean (sd) 6MWT-distance (6MWD) 551 meter (74)). Measurements at baseline: PC₂₀methacholine, induced sputum, 6MWT, bodyplethysmography, RAND-36 and Clinical COPD Questionnaire (CCQ). Variables tending to be associated with 6MWD univariately (p<0.20) were analysed by multivariate regression analysis with adjustment for age, height, gender and FEV₁.

Results: Higher RV%pred (b= -0.440, p=0.037), lower RAND-36 "Physical functioning" domainscore (b=0.888, p=0.043) and higher CCQ total score (b= -20.79, p=0.031) were independent contributors of lower 6MWD. Furthermore, higher age (b= -3.56, p=0.000) was associated with lower 6MWD. Induced sputum and PC₂₀methacholine were not associated with 6MWD.

Conclusion: This study shows that increased sputum inflammation and BHR do not contribute to lower 6MWD in patients with moderate to severe COPD, yet markers of hyperinflation and health status are important determinants. A prospective analysis in this cohort will be performed to investigate if reduced inflammation causes less hyperinflation and improved exercise tolerance.

Reference:

[1] Lapperre ea. Ann Intern Med 2009;151:517-527.

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Variability in walking patterns during the 6MWT in COPD patients and healthy controls

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Measures of walking variability have shown to reflect physical fatigue and stability, which is particularly of interest in COPD patients prone to muscle atrophy and osteoporosis, and may contribute to 6 MWD. Therefore, the aim of this study was to characterize walking patterns during the 6MWT in COPD patients and healthy subjects.

79 COPD patients (60% men; age: 64±9yrs; height: 1.67±0.09 m; FEV₁: 53±19% pred) and 24 healthy controls (62% men; age: 64±6yrs; length: 1.73±0.08 m; FEV₁: 125±21% pred) performed 2 6MWTs with a tri-axial accelerometer attached to the trunk. The following parameters were derived: 1) Stride frequency (SF), 2) walking intensity (IMA), 3) interstride variability (VC) and 4) variability in medio-lateral (AC-ML) and vertical (AV-V) direction using an autocorrelation procedure (lower=higher variability). These parameters and subject characteristics were tested for their association with the 6MWD via regression models. Differences between COPD and healthy were found for 6MWD, SF, IMA and AC-ML (table 1).

Table 1. Walking parameters

	6MWD (m)	SF (sec)	IMA (counts)	VC (%)	AC-ML	AC-V
Healthy	672±85	1.10±0.07	8138±1856	2.05±0.68	0.74±0.12	0.87±0.07
COPD	494±96*	0.96±0.09*	5127±1770*	2.22±1.14	0.63±0.14*	0.84±0.10

*: p<0.05

The model explained 84% (healthy) and 87% (COPD) of the variance in 6MWD. IMA and height were the only predictors of the 6MWD for healthy subjects but for COPD patients also age, SF, VC, AC-ML and AC-V contributed significantly (10%) to the variance in 6MWD

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COPD patients use different walking strategies during the 6MWT than healthy control subjects that could be due to adaptations of both pulmonary and systemic impairments.

P2146**Exercise testing in the pre-flight evaluation of patients with cystic fibrosis**

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Background: Due to hypobaric hypoxia, air travel may imply a health hazard for cystic fibrosis (CF) patients. Studies of other lung patients have suggested that exercise testing might help predicting in-flight hypoxemia. The aim of the present study was to identify pre-flight factors that might predict severe hypoxemia during air travel in adult CF-patients.

Methods: 30 CF-patients (20 male), age 34±12 yrs, FEV₁ 59±25% pred (mean ± SD) participated in the study. Lung function tests, pulse oximetry (SpO₂ sea level), arterial blood gas (PaO₂ sea level), and a Hypoxia Altitude Simulation Test (HAST) breathing 15.1% oxygen were performed. In addition, 14 of the patients exercised until exhaustion on a treadmill measuring PaO₂ exercise, SpO₂ exercise, maximal oxygen uptake (VO_{2max}) and assessment of ventilation-perfusion mismatch defined as high V_E/VCO₂ at anaerobic threshold.

Results: Five patient fulfilled criteria for supplemental oxygen during air travel based on BTS recommendations (PaO₂ < 6.6 kPa or 50 mmHg). They all had FEV₁ < 50% of predicted. Ten patients with a FEV₁ < 50% of predicted had a negative HAST. The correlation between PaO₂HAST and the following pre-flight variables were: SpO₂ sea level: r=0.225 (p=0.231), SaO₂ sea level: r=0.515 (p=0.006), FEV₁, r=-0.544 (p=0.002), PaO₂ sea level: 0.582 (p=0.001). The correlation between PaO₂HAST and exercise variables was: VO_{2max}: r= 0.638 (p=0.014), V_E/VCO₂: r=0.76 (p=0.002), SpO₂ exercise: r=0.817 (p>0.0001) and PaO₂ exercise: r= 0.825 (p=0.001).

Conclusions: Exercise testing with measurement of oxygen desaturation and VE/VCO₂ may be useful tools in predicting the need for supplemental oxygen during air travel if HAST is not available.

P2147**Changes in operating lung volume and symptoms during daily activity in COPD**

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Patients with COPD perform low levels of daily physical activity and breathlessness and leg fatigue are symptoms limiting exercise. Less is known about symptoms and hyperinflation measured during laboratory exercise testing relate to daily activity.

We studied 20 stable COPD patients (15 male, mean (SD) age 67 (7) yrs, FEV₁ 0.96 (0.4) l, 36 (12)% predicted, IC 1.7 (0.4) l, 62 (14)% predicted during a time-limited endurance cycle exercise test at 70% VO₂ max. IC, dyspnoea and leg fatigue on a Borg scale were recorded every 2 minutes. We calculated the individual slope of the change in these variables expressed as IC absolute. We assessed daily physical activity using both Actiwatch (AW) and SenseWear (SW). There was a good relationship between AW mean activity score and AW mean activity moving (r²=0.7; p<0.01) and a close relationship between SW step count and AW mean activity score (r²=0.8; p<0.001). We found a good relationship between the AW mean activity score and the rate of increase of dyspnoea (r²=0.5; p<0.05) but no correlation between AW mean activity score and the rate of rise of leg discomfort (r²=0.2; p=NS). There was no relationship between the baseline IC and the AW mean activity score (r²=0.03; p=NS) and the SW number of steps (r²=0.1; p=NS).

Activity levels measured by these devices are similar and data registered with the same uniaxial leg accelerometer give similar level of daily activity. Baseline level of hyperinflation did not predict daily activity and the individual's perception of breathlessness as lung volume rises is the important factor limiting daily activity. Changes in symptoms related to peripheral muscle dysfunction did not limit the daily activity in our COPD patients.

P2148**The transfer coefficient predicts the endurance increment when oxygen is given in COPD and lung fibrosis**

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Background: Some but not all patients with COPD or interstitial lung disease (ILD) increase their endurance performance when supplemental oxygen is given.

Rationale: To find parameters that better predict oxygen response.

Method: We measured the effect of oxygen supplementation on the six-minute walking test performance (6MWD) in 59 COPD and 13 ILD patients. We compiled prediction models by means of multiple stepwise linear regression analysis.

Results: The percentage change in 6MWD was best predicted by the diffusion capacity, both in COPD (r= -0.43, p=0.0003) and ILD (r=0.75, p=0.001). The same applies for the absolute change in 6MWD in COPD (r= -0.44, p=0.0002) and ILD (r=0.71, p=0.002) patients.

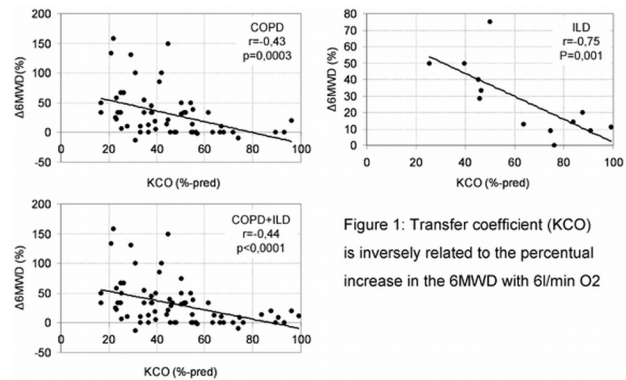


Figure 1: Transfer coefficient (KCO) is inversely related to the percentage increase in the 6MWD with 6l/min O₂

Conclusion: The diffusion capacity appears to be the single best parameter to predict endurance response to oxygen in COPD and ILD and therefore might be used as a screening tool to select appropriate patients.

P2149**Impact of hemodialysis on dyspnoea in chronic renal failure patients**

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Scarce reports exist on the symptom of dyspnoea in chronic renal failure patients. The aim of our study was to investigate the prevalence and severity of chronic dyspnoea in these patients and whether the severity of dyspnoea is different before and after hemodialysis. We recruited 25 patients with stage 5 (GFR<15ml/min) renal failure with (mean±SD) age = 52±11 years, hemodialysis duration = 5±4 years, urea = 141±26 mg/dl, creatinine = 10±2 mg/dl. None of the patients suffered from any concomitant pulmonary disease. We used the modified (m) MRC scale to assess chronic dyspnoea. Routine lung function tests in seated and supine positions position, closing volume (CV) with the single breath oxygen test, blood gases, Pimax, Pemax, P0.1, pattern of breathing were also measured. All of our patients (100%) complaint of some degree of dyspnoea before dialysis, which was significantly reduced after dialysis. The parameters that changed before and after dialysis were: Δ(m)MRC (-1±0.5, p<0.001), ΔWt% pred, (-3±1, p<0.001), ΔpH (0.1±0.05, p<0.001), ΔPimax%pred (33±8, p<0.001), ΔCC% predicted (-0.2±0.4, p= 0.032), and ΔP0.1 (-2±0.4, p<0.001) cm H₂O. Backwards regression analysis showed that the only single factor changed significantly after dialysis and correlates with Δ(m)MRC is ΔP0.1 (r = 0.527, p=0.01). We conclude that hemodialysis improves dyspnoea by reducing central respiratory drive in patients with renal failure.

P2150**Effects of oxygen on exertional dyspnea and exercise performance in patients with COPD**

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Background: Accumulation of studying the oxygen (O₂) response in chronic obstructive pulmonary disease (COPD) should provide important clues to the pathophysiology of exertional dyspnea.

We investigated the exercise responses of hyperoxia on the dyspnea profile, as well as cardio-pulmonary, acidotic and sympathetic parameters in 35 patients with stable COPD.

Methods: The patients breathed 24% O₂ or compressed air (CA) in random order during two incremental cycle exercise tests.

Results: The PaO₂ and PaCO₂ values were higher (P < 0.0001 and <0.05, respectively) at each exercise point while breathing 24% O₂ compared with CA. At a standardized point in time near peak exercise, O₂ reduced plasma lactate (P < 0.01). A similar peak minute ventilation/indirect maximum voluntary ventilation was observed between inhalations. At peak exercise, the dyspnea score, pH, and plasma norepinephrine were similar between inhalations. At each inhalation during exercise, the dyspnea - ratio (%) of the Δ oxygen uptake (peak minus resting oxygen uptake) curve reached a break point that occurred at a similar exercise point between inhalations.

Conclusion: Regardless of breathing CA or hyperoxia, COPD patients did not develop ventilatory compensation for the exertional acidosis to stop exercise, re-

sulting in reaching a similar pH. During a standardized exercise phase, hyperoxia did not change the pattern of exertional dyspnea while breathing CA in these patients, although hyperoxia exerted miscellaneous effects.

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The importance of completing the hypoxic challenge test in assessing the risk of altitude in air travel: Experience of flight fitness evaluation

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The atmospheric pressure in cabin of the pressurized commercial aircraft is not equivalent to the pressure at sea level. If this hypobaric environment doesn't trigger symptoms in most of people, the same is not true for patients with respiratory disease. Since the increase of air travel and the need to advice the patients to this particular setting, British Thoracic Society (BTS) have published recommendations to evaluate and prescribe supplemental oxygen in these conditions.

The present study describes 2 years' experience in advice respiratory patients on flight fitness in Hospital Santa Maria.

During this period, 64 patients were evaluated (54% men, mean age 46 ± 21 years) and underwent Hypoxic Challenge Test (HCT) with a protocol in agreement with BTS guidelines.

Relatively to diagnosis, 46% had cystic fibrosis, 18% chronic obstructive pulmonary disease, 12% interstitial lung disease, 7% thoracic neoplasm, 7% bronchiectasis and 3% had obstructive sleep apnoea. Six of these patients had respiratory failure and were on long-term oxygen therapy (LTOT).

At baseline, 60% of patients had $SpO_2 > 95\%$, 31% between 92-95% and 9% $< 92\%$. During HCT, only 52% of patients with a sea level $SpO_2 > 95\%$ maintained their $PaO_2 > 55$ mmHg. Twelve patients with a sea level SpO_2 between 92-95% desaturated to $PaO_2 < 55$ mmHg.

Supplemental oxygen therapy was prescribed to 31 patients and in the 6 patients on LTOT the debit was measured and increased in all of them.

In conclusion, despite the recommendations indicate only the HCT for patients with $SpO_2 < 95\%$, our experience showed that this limit not allow to predict those who need supplemental oxygen in air travel.

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Physiological responses to the six-minute walk test in older adults

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Physiological responses to the six-minute walk test (6MWT) have been increasingly evaluated in patients with cardiopulmonary diseases. However, previous studies did not include healthy persons. The aim of this study was to evaluate age- and gender-related changes in physiological responses to the 6MWT and to establish a set of predictive equations for such variables. We evaluated 102 non-trained healthy older adults (48 men, aged 62 ± 8) stratified in four age groups (40-49; 50-59; 60-69; ≥ 70). After familiarization, a third 6MWT was performed using a telemetric gas analyzer (k4b2) for assessing metabolic and cardiopulmonary responses as well as oxygen uptake (VO_2) time constant (τ) using an exponential fitting. Lean body mass (LBM) (impedance) and handgrip strength (HGS) were measured in 81 subjects. A set of linear equations was provided for prediction of the main physiological variables. The rate of gas exchange (R), VO_2 /heart rate (HR), deficit- O_2 and τVO_2 were not affected by sex as well as tidal volume (VT), R and VO_2 /HR were not affected by age. Deficit- O_2 and τVO_2 presented a tendency to age-related changes ($p = 0.06$). Several prediction equations adjusted by sex, age, height, weight, LBM, HGS, and 6MWT showed R^2 values ranging 0.114 to 0.574 (e.g. deficit- O_2 and VT respectively). The best model for predicting VO_2 peak was adjusted by LBM and age ($R^2 = 0.435$). None of the variables studied was selected as predictive factors for τVO_2 . Therefore the prediction equations might provide a more appropriate frame of reference for normal physiological responses to the 6MWT in healthy older adults. Our results may be useful for better interpretation of walking performance in patients with cardiopulmonary disease.

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Functional and neurophysiological aspects in patients with chronic obstructive pulmonary disease

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The neurophysiological alterations found in patients with chronic obstructive pulmonary disease (COPD) in combination with impairment of peripheral muscle, may further compromise functional activity of these patients. The purpose was to assess functional (balance and sit-to-stand test) and neurophysiological aspects (latency time the patellar and achilles reflexes) relating these responses to the BODE Index. A cross-sectional study design was used to assess 22 patients with

moderate to very severe COPD (> 60 years) and 16 healthy volunteers as the control group (CG), performed measures of static and dynamic balance (pressure plate and Tinetti scale), monosynaptic reflexes (surface EMG), peripheral muscle strength (load cell) and SST. The individuals with COPD had a reduced reflex response to patellar 36.77 ± 3.23 and Achilles reflex 43.54 ± 6.60 . Achieved a lower number repetitions on the SST 19.27 ± 3.88 , lesser peripheral muscle strength on the femoral quadriceps muscle, 24.98 ± 6.88 and exhibit deficits in functional balance on the Tinetti scale 26.86 ± 1.69 , compared to the CG, all with $p < 0.05$. The BODE Index demonstrated correlations with Tinetti scale, $r = 0.59$ ($p < 0.05$) and the SST, $r = 0.78$ ($p < 0.05$). The individuals with COPD had functional and neurophysiological alterations in comparison with control group. The Bode Index was correlated with the Tinetti scale and SST. Both are functional tests, easy to administer, low cost and feasible, especially the SST. The results suggest a worse prognosis; however, more studies are needed to identify the causes of these changes and the repercussions that could result in their activities of daily living.

P2154

Functional and psychological correlates to exercise dyspnea in patients with abnormal ventilatory impedance due to COPD or interstitial lung disease or obesity

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The ATS consensus stated that spirometry and lung volume measurements may be useful in the assessment of dyspnea, together with the evaluation of psychologic status. Our objectives were to assess these statements in non overlapping groups of patients with an abnormal impedance (obesity, COPD and interstitial lung disease [ILD]), and to provide cut-off values for defects that explain moderate/severe dyspnea.

Patients with severe obesity ($BMI \geq 35$) or COPD (GOLD definition) or ILD underwent spirometry, lung volume and psychologic status (Hospital Anxiety-Depression [HAD], Fatigue Impact Scale [FIS], SGRQ and SF-36 scores) assessments. Patients with mild dyspnea (MRC score 1-2) were compared with those with moderate/severe dyspnea (MRC score ≥ 3).

Three hundred and twenty-eight patients were prospectively enrolled, of whom 107 (33%) exhibited moderate/severe dyspnea (45/128 COPD, 28/78 ILD, 34/122 obese). Severe dyspnea was related to airflow limitation and lung hyperinflation in COPD, to the restrictive defect in ILD and to the only increase in resistance in obese patients. Principal component analysis demonstrated that anxiety and depression fatigue exhibited no effect on dyspnea because they were related to the mental component of SF-36, while dyspnea was related to its physical component only. In non obese patients, a $FEV_1 < 31\%$ predicted exhibited a 92% positive predictive value for severe dyspnea (99% specificity).

In conclusion, only very severe impairment of FEV1 can predict moderate to severe dyspnea in patients with either COPD or ILD. Exertional dyspnea is not affected by psychologic status in these patients.

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VO2 kinetics in asthmatic adolescents: A pilot study

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In normal subjects, ventilatory rate and oxygen ventilation (VO_2) increases during exercise from a resting state until maximal levels are attained, whereas it seems that in asthmatic patients this increase is higher. The aim of the study was to evaluate the kinetics of VO_2 during a constant-load exercise in a group of 11-16 y.o. asthmatic patients. 17 adolescents with mild stable asthma were studied. On the first day a progressive workload was applied to calculate the presumable aerobic threshold, which was assumed to be 80% of the maximum load tolerated. On the next day the subjects were asked to pedal at this constant load and the VO_2 kinetics were studied with a K4B2 and a Cosmed[®] cycloergometer. In 9 patients (53%) there was an increasing trend of VO_2 consumption, whereas in 5 (29%) this trend was not highlighted. In 3 patients (18%) data was unobtainable because of incompleteness of test or non-cooperation. In conclusion, it was not possible to outline a common pattern of VO_2 consumption, but in more than a half of our patients the behaviour of VO_2 consumption during constant load was similar to that of the normal population.

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Echocardiographic findings in severe chronic obstructive pulmonary disease (COPD) patients who desaturate during 6-minute walking test (6MWT)

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Objective: To study the relationship between clinical, functional and echocardiographic findings in severe COPD patients who desaturate during 6MWT.

Methods: 18 GOLD 3-4 patients who desaturated during 6MWT (SpO₂<90%) were studied with pulmonary function tests and Doppler echocardiography, measuring tricuspid insufficiency peak speed and estimating systolic pulmonary arterial pressure (PAP), taking 35 mmHg as cut off to define pulmonary hypertension. Fisher's exact test and t test of Mann-Whitney were used to compare numeric variables. Spearman correlation coefficients were calculated, p<0.05 was considered significant.

Results: Eight female and 10 male were studied, mean age 61.8±8 yrs, mean BMI was 24.75 (5) kg/m², mean FVC was 2.85±0.8, mean DLCO 45.5% (range=31-94), mean walked distance 315 m (range=120-480), the mean systolic PAP was 32.25±8.68 mmHg and 16/18 presented systolic PAP hypertension.

Mean systolic PAP was 26.12 mmHg in 8 patients with BODE 2-4 and 37.37 mmHg in 10 patients with BODE 5 (p=0.0312).

No significant association between systolic PAP and GOLD, FVC, MEP, MIP, DLCO, Tei Index, or basal SpO₂ were observed.

There was no significant association between 6MW distance and systolic PAP (r=-0.41; p=0.08) or between DLCO and O₂ saturation in the first minute walk (r=0.39; p=0.08).

Conclusions: We found a significant association between systolic PAP and BODE. Trends without significant association among systolic PAP and 6MW walked distance and DLCO with SpO₂ in the first minute were observed. Further studies are needed

P2157

Activity monitor outcomes in COPD – Assessment of variability of 6 monitors as part of the IMI PROactive project

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Background: Limited data exist on the validity of activity monitors to capture day-to-day variability in physical activity (PA). As part of the Proactive project we aimed at assessing the coefficient of variation (CV), the correlation between different activity monitors and their outcomes and their capability to detect less activity during Sundays, known to be less active days.

Methods: PA was measured in 64 COPD patients (Age 68±6 yr FEV₁ 57±19% pred. 6MWD 429±112 m) for 14 consecutive days. Three of the following monitors were worn simultaneously: SenseWear armband (SW n=57); RT3 (n=27); Actiwatch (AW n=30); Actigraph (AG n=30); Minimod (MM n=37) or Kenz (KZ n=27).

Results: Patients were generally inactive with 5495±3528 (MM); 4508±3528 (SW); 3847±2641 (AG) steps per day. CV was similar for step count assessed by MM (46%), SW (44%), AG (45%) and for walking time (MM 43%). CV was significantly less (20-30%) for energy expenditure, EE (SW), average METS (SW), sedentary time (SW) activity counts (AW), for average EE (MM; 17%) and activity level (KZ; 10%) compared to all other outcomes. All monitors identified Sundays as less active days. Differences were larger for motion related outcomes (SW 27%, MM 26%, AG 25%, AW 14%, RT3 13% lower), than for total EE (KZ 5%, average METS SW 8%, total EE MM 3%).

Conclusion: Walking related outcomes from activity monitors reflect daily variation in physical activity to the same extent. The outcomes from activity monitors assessing the same construct correlate moderately well whilst all monitors seem to be able to pick up less and more active days.

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Subjective impairments in COPD are associated with dynamic hyperinflation during daily life activities

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Goal: Dynamic hyperinflation (DH) is related to exertional dyspnea in patients with COPD and might explain subjective impairments (SUBIMP) in activities of daily life (ADL). We hypothesized that SUBIMP are associated with DH during ADL.

Methods: In 30 stable COPD patients lung function, SUBIMP (Nijmegen Clinical Screening Instrument) and activity level (accelerometry) were measured. DH during ADL was analysed using a portable breath-by-breath system (Oxycon Mobile) and defined as decrease in inspiratory capacity >10%. Patients with low (score ≤11) and severe (score >11) SUBIMP were compared.

Results: Groups were similar in age, BMI, sex. Patients with severe SUBIMP had worse lung function, lower activity levels and more DH during ADL compared to patients with low SUBIMP (Table 1). Five of 15 patients with low SUBIMP showed DH during ADL, in contrast to 13 of 14 patients with severe SUBIMP (p=0.002). SUBIMP correlated with amount of DH during ADL (r=0.52, p=0.004) and physical activity level (r=-0.41, p=0.028).

Table 1. Patient characteristics and response to ADL

	Low SUBIMP	Severe SUBIMP
FEV ₁ , % pred	67±19	50±20*
FEV ₁ /FVC, %	48±11	37±12*
Activity level, VMU	62±14	45±20*
DH, % decrease in IC	9±15	23±11*

Mean ± sd. *p<0.05 compared to Low SUBIMP. ADL: activity of daily life; DH: dynamic hyperinflation; FEV₁: forced expiratory volume in 1sec; FVC: forced vital capacity; IC: inspiratory capacity; SUBIMP: subjective impairments; VMU: vector magnitude units.

Conclusion: Patients with severe SUBIMP show more DH during ADL. DH during ADL might increase breathing effort, which could play a role in the decrease in activity level observed in patients with COPD.

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Daily physical activity is associated with muscle function, health status and fatigue in COPD

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Background: Daily physical activity (DPA) level is an increasingly important clinical outcome in COPD research and management. In contrast to exercise capacity, the association of DPA with muscle function, health status and fatigue, has not been investigated extensively.

Aim: To investigate if DPA is associated with muscle function, health status and fatigue in mild to very severe COPD patients.

Methods: In a cross-sectional analysis we included 84 COPD patients (49 male, GOLD I (n=5), II (n=25), III (n=32), IV (n=22), mean age 59±11 years, FEV₁ 46±18% pred) who were entering a pulmonary rehabilitation program. DPA was measured with a pedometer (DigiWalker SW-200), muscle force with a handheld dynamometer and muscle endurance with the chair-stand test and the arm-curl test. Health status was assessed with the Groningen Activity Restriction Scale (GARS), Saint George Respiratory Questionnaire (SGRQ) and RAND-36, and fatigue with the Dutch Exertion and Fatigue Scale (DEFS).

Results: Mean DPA was 3302±2098 steps/day. Significant Spearman's correlations (p<.05) were demonstrated with: quadriceps force (r=0.249) and endurance (r=0.311), biceps force (r=0.480) and endurance (r=0.355), GARS (r=-0.531), SGRQ activity scale (r=-0.258), RAND-36 physical functioning domain (r=0.504) and vitality domain (r=0.235), and DEFS (r=-0.356).

Conclusion: Low DPA associates with low muscle force and endurance, low physical functioning and high fatigue in mild to very severe COPD patients. Whether these variables contribute to the development of a low DPA level in COPD patients should be investigated in longitudinal studies.

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Cardiopulmonary stress test: Determinations of oxygen consumption, power and cardiac variables at ventilatory threshold. Correlation with values at maximal exercise in COPD

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Background: In normal individuals a direct correlation exists between Oxygen consumption (VO₂) and Power (W) measured at ventilatory threshold (AT) and maximal exercise (ME).

Purpose: To simplify cardiopulmonary stress test in COPD patients, demonstrating correlation of Oxygen, Power and Cardiac variables at AT and ME.

Methods: Prospective study of 44 COPD patients, mean age 63, mean FEV₁ 73.2%, mean FEV₁/FVC 63.6% and mean DCO 56% of predicted. Cardiopulmonary stress test was performed calculating W, VO₂, HR, VO₂/HR, ΔVO₂/ΔW and reduction in Inspiratory Capacity (IC). Lineal regression was calculated between values at AT and ME.

Results: Patients ended the test due to dyspnea (Borg 5), reduction of Breathing reserve and IC (17%, -0.33L respectively). Mean Wmax, VO₂max and AT of 74%, 85% and 50% of predicted respectively. Close correlation was demonstrated between VO₂ and Power measured at AT and ME (r: 0.7 and 0.7 respectively), and between maximal HR and VO₂/HR (r: 0.7 and 0.8 respectively).

Conclusions: A straight correlation was demonstrated in Oxygen, Power and Car-

Correlations between values measured at AT and ME

	VO2 (AT/ME)	W (AT/ME)	DVO2/DW (AT/ME)	HR (AT/ME)	HR/VO2 (AT/ME)
Mean	885 1361	60 105	8.6 10.2	109 134	8.3 10.2
SD	297 505	26.1 43.9	4.1 4.1	15.4 18.8	2.3 2.9
r	0.7	0.7	0.6	0.7	0.8
r ²	0.5	0.5	0.4	0.4	0.6
p	<0.005	<0.005	<0.005	<0.005	<0.005

diac variables measured at AT and ME in COPD patients. The duration, effort and risks of Cardiopulmonary stress test may be reduced by the approach to measure Oxygen, Power and Cardiac variables at AT.

P2161**Heterogeneous causes and degree of exercise limitation in COPD GOLD1 and 2: Predictive value of CCQ and MRC**

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In COPD severity of disease is assessed with spirometry and dyspnoea score such as CCQ (Clinical COPD Questionnaire) or MRC (Medical Research Council). Dyspnoea scores and spirometry are poorly correlated, dyspnoea may also be the result of other, not pulmonary aspects, especially in COPD GOLD 1 and 2.

Questions: 1. What is the predictive value of CCQ and MRC with respect to the degree and cause of exercise limitation in patients with COPD
2. Which factors predict a pulmonary limitation?

Methods: 60 symptomatic COPD patients in a stable phase without relevant comorbidity. At baseline they scored CCQ and MRC. A score of > 2 was considered abnormal dyspnoea (D +), others were D -. Exercise limitation in a cardiopulmonary exercise test was labelled pulmonary (pulm), cardiac (card) or nonspecific (nonspec).

Results:

Main exercise limiting factor

	D-			D+		
	pulm	card	nonspec	pulm	card	nonspec
GOLD 1	2	2	9	0	0	1
GOLD 2	8	0	3	9	3	7
GOLD 3 + 4	6	0	0	10	0	0

D + patients had a higher BMI (p<0.05), lower FEV1% (p <0.01), a lower Wattmax, VO2max and Inspiratory Capacity (p<0.005).

In patients with a strict pulmonary limitation dyspnoea was not different from patients without pulmonary limitation. FEV1 and DLCO were significantly different, p<0.0001. Positive predictive value of dyspnoea score for pulmonary or cardiac limitation was 84% in all and 75% in patients with GOLD 1 and 2. Negative predictive value was 35% and 44% respectively.

Conclusions: In COPD patients GOLD 1 and 2 exercise limitation was not due to pulmonary factors in 86% and 43% of patients, respectively.

Pulmonary or cardiac limitation can be expected at high CCQ or MRC score, and can not be excluded in patients with a low score.

P2162**The impact of anemia of chronic disease on exercise capacity among patients with chronic obstructive pulmonary disease**

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Background: The presence of anemia has been associated with reduced performance in 6 minute walk test among patients with Chronic Obstructive Pulmonary Disease (COPD).

Aim: To investigate, for the first time, the impact of Anemia of Chronic Disease (ACD) on exercise capacity among COPD patients, utilising cardiopulmonary exercise testing (CPET).

Methods: It is a case-control study. Cases (27 stable COPD outpatients who were identified to fulfill clinical and laboratory criteria of ACD) and 27 matched by age, height, sex, FEV₁ and current smoking status non-anemic stable COPD controls underwent maximal CPET. Student's T-test for independent samples was used for statistical comparisons between the groups; level of p<0.05 was considered significant.

Results: Cases (92.6% males; 64.8±8 years old; FEV₁%predicted=42.3±10) compared to controls (92.6% males; 65.3±7.2 years old; FEV₁%predicted=42.8±12.8) achieved lower: a) peak%predicted oxygen uptake (59.5±17.2 vs 71.3±11.9; p<0.01), b) peak work rate (67±24.9 vs 86.1±29.4 watts; p<0.05), c) peak%predicted work rate (54.9±21.4 vs 68.7±20.8; p<0.05), d) peak oxygen pulse (8.8±2 vs 10.4±2.9 ml/beats; p<0.05) and e) peak%predicted oxygen pulse (69.1±17.3 vs 82±18.2; p=0.01). There was also a trend for a lower%predicted

anaerobic threshold (p=0.062) in the group of cases. Rest gas exchange values and exercise parameters indicative of respiratory limitation (such as peak minute ventilation, peak respiratory rate and tidal volume to inspiratory capacity ratio) did not differ between the groups.

Conclusions: The presence of ACD significantly impairs the exercise capacity of COPD patients.

P2163**Effects of an intra-dialytic aerobic training program on oxygen uptake kinetics in patients with end-stage renal disease**

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Background: End-stage renal disease (ESRD) is associated with several hemodynamic and peripheral muscle abnormalities that could slow the rate of change in oxygen uptake (VO₂) at the onset and at the end of dynamic exercise. We therefore investigated the effects of supervised aerobic training during hemodialysis on the VO₂ on- and off-kinetics in ESRD patients.

Methods: Twelve patients and 12 age- and gender-matched, non-trained patients underwent an incremental and constant work rate cardiopulmonary exercise tests on a cycle ergometer at baseline and after 12 wks of exercise training or a similar control period. Exercise training was performed during the first two hours of hemodialysis sessions by using a stationary cycle, three times a week.

Results: Training significantly accelerated VO₂ kinetics (τ decreased from 62.5±19.6 s to 45±12.6 s) and reduced O₂ deficit at the onset of a sub-anaerobic threshold (AT) exercise test (p<0.05). At a supra-AT test, τ decreased from 52.9±17.4 s to 40.4±13.8 s (p<0.05) and time to exercise intolerance increased significantly (311.9±223.4 s vs. 589.2±358.1 s). Similar positive effects of training were observed at the off-exercise transient in both sub- and supra-AT tests (τ=75.1±16.4 s vs. 66.2±20.8 s and 73.4±20.4 s vs. 59.9±12.8 s, p<0.05, respectively). In contrast, VO₂ on- and off-kinetics were significantly slower at the final evaluation in the non-trained patients (p<0.05).

Conclusions: A 12-week supervised aerobic training program was highly effective in accelerating on- and off-exercise VO₂ kinetics at both moderate and severe exercise intensity domains in ESRD patients undergoing hemodialysis.