

AO 01 ENERGY EXPENDITURE MEASUREMENT AS AN ADJUNCT TO THE 6 MINUTE WALK TEST (6MWT)

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Introduction: 6MWTs are a self-limited exercise test that estimates the severity of disease effects on function and is related to morbidity and mortality. The SenseWear (BodyMedia, Pittsburgh, PA) physiologic armband measures movement, heat flux, skin temperature, near-body temperature and galvanic skin response to estimate total energy expenditure (TEE) and metabolic equivalents of task (METs). One MET is a metabolic rate consuming 3.5 mL O₂/kg/min. The SenseWear may provide additional useful information to the 6MWT, and therefore predicted values are required for this potential application.

Aims: To examine predictors of TEE and METs during the 6MWT.

Methods: 13 female and 13 male subjects, with no known lung, cardiac or muscle disease performed 6MWT following ATS guidelines wearing a SenseWear physiologic armband. Relationships between anthropometric parameters and TEE and METs were examined by multivariate analyses.

Results: Mean $\pm$ SD age was 45 $\pm$ 13yrs. 6MWD, TEE and METs were all unrelated. The 6 minute walk distance (6MWD) was 634 $\pm$ 34m and all subjects were within normal limits. 6MWD was predicted solely by height ($r^2=0.46$, $p=0.01$). There were no differences in 6MWD, TEE and METs between males and females. TEE was predicted solely by weight ($r^2=0.38$, $p=0.0005$) or by BMI ($r^2=0.38$, $p=0.0005$). METs were predicted by age and gender ($r^2=0.29$, $p=0.008$).

Conclusion: Energy expenditure during the 6MWT as measured by the SenseWear physiologic armband is unrelated to 6MWD in normals, and are predicted by different anthropometric parameters. They will therefore likely provide complementary information to the 6MWT.

Key Words: 6minute walk test, energy expenditure, METs.

Nomination for Young Investigator Award

AO 02 LACK OF TIME AND KNOWLEDGE ARE BARRIERS TO SPIROMETRY IN THE PRIMARY CARE SETTING

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Introduction: Current evidence has shown despite high spirometry ownership the use of spirometry in the primary care setting is low. This study was designed to investigate the perceived barriers to spirometry usage and the support required to overcome the barriers.

Methods: A survey assessing current ownership, usage and views towards spirometry was delivered to all primary care practitioners in the Western Cluster of Sydney West Area Health (St Marys to Portland) as well as regional areas that refer to Nepean Hospital.

Results: 63 (23.4%) responses were received from primary care practitioners, with the majority being non-general practitioners (62.5%). The majority of respondents indicated that their practice owned a spirometer (75%), however, 40% indicated they used spirometry 1-5 times per week. The most common barrier reported for the use of spirometry was a lack of time for the performance of spirometry (44%) with 38% believing the information obtained from spirometry was not useful. The majority of respondents indicated that more training on interpretation (64%), training on spirometry performance (51.8%) and more training on the clinical significance of the results (51.8%) would assist in the increased use of spirometry in their practice.

Conclusion: Lack of time and a lack of knowledge on spirometry were the perceived barriers by the primary care practitioners, with a large percentage of respondents indicating training on interpretation of spirometry results would increase the use of spirometry in the primary care setting.

Key Words: Spirometry, Primary Care, Barriers.

Nomination for Young Investigator Award.

AO 03 LUNG VOLUME MEASUREMENTS BY GAS DILUTION: TOWARDS EVIDENCE BASED WAIT TIME BETWEEN TESTS

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Background: Functional Residual Capacity (FRC) can be measured by Helium (He) dilution and Nitrogen (N₂) washout. Current recommendations on gas clearance time required between repeat FRC measurements vary for disease and age groups, with little or no supporting evidence.

Aim: To determine the appropriate wait period between consecutive FRC tests.

Method: Measurements of FRC were made using He dilution (adults) and N₂ washout (children).

He Dilution: FRC was measured in 10 healthy adults. Tests were performed in a randomised order, waiting 1x, 2x and 3x the initial equilibration time.

N₂ Washout: FRC was measured in 10 healthy and 10 obstructed children. The time interval between tests was 5 mins or 15 mins, in random order. Washout time was also recorded. Altman analysis was used to assess repeatability and repeated measures ANOVA or paired t-tests were used to assess differences in FRC by helium and nitrogen respectively.

Results: For He dilution there was no significant difference in FRC values at any time interval (mean 60ml [2%] $\pm$ 20ml, p=0.4). For N₂ washout the mean difference in FRC was not significant at either time intervals, and was not influenced by the presence of obstructive disease (mean 30 mL [2%] $\pm$ 13ml, p=0.6).

Conclusion: Current guidelines appear to be excessively conservative in their recommendations of wait time between consecutive measurements of FRC by gas dilution. These preliminary data suggest a time interval of 1 x equilibration or 5 mins between washouts ensures sufficient gas clearance in healthy adults, and in healthy and obstructive children.

Key Words: FRC, Nitrogen washout, Helium dilution

Nomination for Young Investigator Award

AO 04 VENTILATION HETEROGENEITY MEASURED BY SINGLE PHOTON EMISSION COMPUTED TOMOGRAPHY/COMPUTED TOMOGRAPHY (SPECT/CT) AND MULTIPLE BREATH NITROGEN WASHOUT (MBNW) IN ASTHMA

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Introduction: Baseline ventilation heterogeneity (patchy ventilation) measured by MBNW is strongly associated with airway hyperresponsiveness in asthmatics. The aim of this study was to determine if the extent of heterogeneity measured by MBNW is related to the spatial heterogeneity in ventilation images obtained using SPECT/CT.

Methods: Asthmatic subjects had SPECT/CT ventilation scans, using [^{99m}Tc]-Technegas, and MBNW before and after methacholine challenge (Mch). Ventilation heterogeneity was determined by the coefficient of variation (CV) of regional ventilation from SPECT images, and by *Scond*, an index of conductive airway heterogeneity, from MBNW.

Results: Ten patients, 6 male, (mean±SD) age = 39.8±21yrs were recruited. Baseline measurements were: FEV1 %Pred = 89 ±13, *Scond* = 0.068 ± 0.038 L⁻¹, logCV = -0.629 ±0.09. After Mch there was a significant worsening in both *Scond* (0.364 ±0.240 L⁻¹, p = 0.002) and logCV (-0.371 ±0.270, p = 0.02). Pooled analysis of baseline and Mch data showed a correlation between *Scond* and logCV (r= 0.47, p=0.04). However, changes in *Scond* were unrelated to changes in logCV after Mch.

Conclusions: Ventilation heterogeneity measured by MBNW appears to reflect quantitative topographic imaging by ventilation SPECT/CT. These data will contribute to our understanding of the underlying basis of *Scond* in asthma.

Key Words: Ventilation heterogeneity, methacholine, MBNW, SPECT.

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AO 05 EXHALED BREATH TEMPERATURE IN HEALTHY CHILDREN IS INFLUENCED BY ROOM TEMPERATURE AND LUNG VOLUME

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Exhaled breath temperature (EBT) has been proposed for the non-invasive assessment of airway inflammation. Previous studies have not examined the influence of room temperature or lung size on the EBT. This study aimed to address these issues in healthy children.

Methods: We assessed the effects of room and body temperature in 35 healthy 10 year-old children (22 male). Static lung volumes were assessed using multiple breath nitrogen washout. Questionnaire and skin prick tests were also used to establish respiratory health in the children. We obtained the EBT of slope, end plateau temperature (PLET) and normalised plateau temperature (= plateau temperature – inspired air temperature) and ascertained the methodological and physiological factors influencing exhaled breath temperature.

Results: PLET was shown to be proportionally affected by room temperature ($r=0.532$, $p<0.001$) whereas slope and normalised plateau temperature decreased with increasing room temperature ($p<0.02$ and $p = 0.002$). After adjusting for room temperature, height and age, the TLC ($r^2=0.435$, $p=0.006$) and SVC ($r^2=0.44$, $p=0.005$) were found to be the strongest predictors of PLET in healthy children. When all factors were included in a multiple regression model, SVC and room temperature were the only predictors of plateau and normalised plateau temperatures. Slope was only influenced by room temperature.

Conclusion: EBT measurements are highly feasible in children with a 90% success rate. Room temperature and VC significantly influence EBT variables in healthy children. Further studies are required to investigate the ability of EBT to assess airway inflammation in children with respiratory disease.

Key Words: children, exhaled breath temperature, lung volume.

Nomination for Young Investigator Award

AO 06 MOLECULAR MASS USING AN ULTRASONIC FLOW METER TRACKS PHASE III FROM VOLUME CAPNOGRAPHY IN INFANTS

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Background: Phase III slope (S_{III}) of the volume capnograph is influenced by ventilatory inhomogeneity. However, volume capnography is difficult to apply in infants due to slow sampling of CO₂ analysers. The molecular mass (MM) signal from an ultrasonic flow sensor is strongly influenced by CO₂ and has sampling rates sufficient for use in infants. We aimed to validate S_{III} MM measurements in infants and examine the effect of respiratory disease on these measurements.

Methods: We obtained paired tidal MM and volume capnography data in 22 infants. Thirty consecutive tidal breaths during quiet sleep in each subject were recorded. Linear regression was used and the corresponding slopes for each breath averaged to provide a mean S_{III} for CO₂ and MM. These slopes were compared for correlation and mean difference. The effect of respiratory disease was examined in a 24 infants with CF (13 un-infected and 11 infected with respiratory pathogens) and 12 age matched controls in which MM data only was obtained. Variables measured included dead space (V_d), phase II slope (S_{II}), S_{III} and KPlv (S_{III}/S_{II}).

Results: The averaged S_{III} MM was found to be highly correlated to S_{III} CO₂ with a strong positive Pearson's correlation ($R^2 = 0.959$, $p < 0.001$) and a mean (SD) difference of 1.4% (0.6) equating to $< 1SD$ of the S_{III} CO₂. In infants with CF S_{III} MM showed a worsening trend, while KPlv was significantly different ($p < 0.05$) in infected CF infants when compared to healthy infants and uninfected CF infants.

Conclusions: An ultrasonic flow meter MM signal is easily obtained in infants and meets equipment guidelines for use in infants. The S_{III} of the MM curve obtained from an ultrasonic flow meter may be useful as a surrogate for volume capnography. KPlv MM can discriminate between infants with CF that are un-infected and those that are infected with respiratory pathogens.

Key Words: Infant lung function, Phase III slope

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AO 07 AMBULATORY OXYGEN ASSESSMENT SHOULD BE PLACEBO CONTROLLED

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Queensland guidelines for ambulatory oxygen (AO) recommend a placebo controlled study using both medical air and oxygen. However the TSANZ Position Statement on oxygen therapy suggests the placebo arm may be unnecessary.

Aim: Determine placebo/learning effects in the exercise assessment for AO.

Method: Past AO studies were reviewed. Patients performed 3 incremental exercise tests on a treadmill breathing room air (baseline), medical air (placebo) and supplemental oxygen. The baseline test was performed first with 30 minutes separating each exercise. Distance walked, SpO₂, heart rate and dyspnoea scores were recorded.

Results: 57 studies were included. Mean age of patients was 70.4 years (range 46 – 86). COPD was the primary diagnosis in 34 patients, and pulmonary fibrosis in 15. Results displaying mean (SD) values:

	Baseline	Placebo	Oxygen
Distance (m)	119.7 (76.2)	143.1 (82.6)*	167.9 (95.7)#
End Ex SpO ₂ (%)	84.1 (6.5)	83.5 (6.6)*	88.9 (5.9)#
Dyspnoea (end ex)	8.6 (1.7)	8.6 (1.7)	8.1 (1.7)#

(* p<0.05 Placebo Vs Baseline. # p<0.05 Oxygen Vs Placebo)

Mean walking distance increased 23.4 metres (20%) in Placebo over Baseline. This additional exercise was reflected by greater fall in SpO₂ in the Placebo arm. Five (9%) patients who met the requirements for AO (SpO₂ ≤88%) using results from the Placebo arm, failed to meet this criteria on the baseline test. The Placebo walking distance improved considerably (44m or 70%) in these patients. The improvement in distance walked from Baseline to Placebo was greater in patients with pulmonary fibrosis (35m or 22%) than in those with COPD (15m or 16%). In all subjects, a further 24.8 metre improvement in distance over Placebo was observed with Oxygen.

Conclusion: Significant placebo/learning effects were evident in walking distance. Omission of the Placebo arm resulted in false negative studies in 9% of patients.

We believe the inclusion of a placebo or control study is warranted in the assessment for ambulatory oxygen.

Key Words: Oxygen assessment

AO 08 AIR TRAVEL HYPOXEMIA VERSUS THE HYPOXIA INHALATION TEST IN PASSENGERS WITH RESTRICTIVE LUNG DISEASE

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Introduction: To our knowledge, there are no published studies comparing the oxygenation response to air travel with the hypoxia inhalation test (HIT) in passengers with restrictive lung disease (RLD). The aim of this study was to assess the predictive capability of the HIT and respiratory function parameters to in-flight hypoxemia in passengers with RLD.

Methods: Thirteen passengers (7 females) with RLD (mean $\pm$ SD TLC % predicted; $67 \pm 15\%$) volunteered for this study. Respiratory function tests were performed pre-flight. Pulse oximetry, cabin pressure and dyspnoea were recorded in-flight. A HIT was performed post-flight. In-flight oxygenation response was compared to the HIT and respiratory function.

Results: Subjects flew without oxygen and no adverse events were recorded in flight (mean cabin altitude 2070m; range 1770-2462m). Air travel caused significant desaturation (pre-flight: $95 \pm 2\%$; in-flight $87 \pm 4\%$) which was worsened by activity (nadir $80 \pm 7\%$). The HIT caused comparable desaturation to air travel ($87 \pm 4\%$). The pre-flight SpO₂ showed the strongest correlation with in-flight SpO₂ ($r=0.77$, $p<0.01$). HIT SpO₂ had a moderate correlation with in-flight SpO₂ ($r=0.58$, $p<0.05$). Respiratory function (spirometry, D_{L,CO}, TLC) showed no correlation with in-flight SpO₂. Dyspnoea scores increased in 4 participants in-flight.

Conclusion: Significant in-flight desaturation can be expected in passengers with RLD. Respiratory function parameters do not adequately predict in-flight desaturation. The HIT compares moderately with air-travel, however, pre-flight oximetry may be a more practical parameter to predict in-flight hypoxemia in passengers with RLD.

Key words: Air travel; restrictive lung disease; hypobaric hypoxemia.

AO 09 SERIAL CHANGE ON CHEST RADIOGRAPHY IN SARCOIDOSIS: OPTIMAL SCORING AS JUDGED BY CORRELATIONS WITH SERIAL PULMONARY FUNCTION TESTS

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In sarcoidosis, the chest radiographic (CXR) staging system is validated for prognostication but not for quantifying serial change. However, in the only large series to integrate serial CXR data, change in stage was used to define the evolution of pulmonary disease.

Aim: To quantify and compare the functional significance of change in stage and change in disease extent on CXR, as judged by correlations between CXR change and serial pulmonary function test (PFT) trends.

Methods: 354 patients with sarcoidosis had concurrent tests (CXRs and PFTs within three months at baseline, two years and/or four years). CXRs were assessed by two radiologists for change in stage (using a seven point scale) and change in extent (using a five point scale). Concordance between the scoring systems was examined using the weighted kappa coefficient of variation (Kw). Correlations between PFT trends (% change from baseline in FEV1, FVC and DLco) and CXR change were examined using Spearman's rank correlation coefficient.

Results: Change in disease extent was more frequent than change in stage at two years (66/343, 19% vs 234/343, 68%, $p<0.0001$) and four years (60/248, 24% vs 185/248, 74%, $p<0.0001$) [McNemar chi-squared test]. There was poor agreement between change in stage and change in extent at two years ($Kw = 0.22$), and four years ($Kw = 0.25$). Change in disease extent on CXR correlated with PFT trends ($p<0.0005$ for all PFT variables at two and four years), whereas change in stage did not.

Conclusion: In sarcoidosis, there is discordance between change in disease extent and change in stage on chest radiography. Change in disease extent, scored using a simple semi-quantitative scale, is more sensitive than change in stage, has much more functional significance, and is, therefore, the preferable means of assessing the evolution of pulmonary sarcoidosis in clinical series.

Key Words: Sarcoid, radiographic staging, pulmonary function

AO 10 EFFECT OF IDIOPATHIC PULMONARY ARTERIAL HYPERTENSION ON RESPIRATORY AND PERIPHERAL MUSCLES

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Idiopathic Pulmonary Arterial Hypertension (IPAH) has recently been shown to result in inspiratory muscle weakness; however the mechanism of dysfunction is unknown. This study aimed to compare inspiratory muscle strength and endurance, peripheral muscle strength, exercise tolerance and quality of life in IPAH versus healthy individuals.

Twenty-eight participants (6 male, 22 female) were recruited for this prospective case-controlled study; 14 individuals with IPAH, and 14 healthy matched controls. Measures of inspiratory muscle strength (MIP) and endurance, quality of life (QoL), quadriceps strength, and exercise tolerance were measured. Data were analysed using independent samples t-tests and spearman's rho correlations.

The main outcomes of this study were 1) Decreased MIP in IPAH compared to controls (IPAH 53.35 ± 24.66 cmH₂O, Control 72.41 ± 23.11 cmH₂O, p-value 0.045), 2) Trend towards increased inspiratory muscle fatigue in IPAH (Fatigue resistance index - IPAH 0.938 ± 0.14 , Control 1.034 ± 0.108 , p=0.054), and 3) No difference in quadriceps muscle strength between groups (IPAH 42.24 ± 11.66 kg, Control 44.86 ± 12.96 kg, p-value 0.527).

This study confirms the presence of inspiratory muscle weakness and suggests the possibility of reduced inspiratory muscle endurance in IPAH compared to healthy individuals. These changes in inspiratory muscle function are not associated with reductions in quadriceps strength in individuals with IPAH.

Key Words: Inspiratory Endurance, Pulmonary Hypertension, Respiratory Strength.

AO 11 LARGE MEALS DO NOT AFFECT LUNG FUNCTION TEST RESULTS IN PATIENT GROUPS

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Background: The joint 2005 American Thoracic Society and European Respiratory Society guidelines recommend patients avoid consuming a large meal in the 2 hours prior to lung function testing, despite providing no clinical evidence to support this recommendation. In our laboratory, patients instructed to avoid a substantial meal prior to testing often fast inappropriately, risking an adverse event. We have previously shown that in healthy subjects there is no effect of a large meal on lung function test results. This study addresses the question of a meal effect in patients with respiratory disease.

Design: Randomised crossover trial

Methods: 20 patients with known lung disease, (10 with obstructive lung disease, 10 with restrictive lung disease) performed lung function tests (spirometry, lung volumes by helium dilution and single breath gas diffusion) on 2 days within a week of each other. Tests were performed at 0800, 0930 and 1130 after fasting from midnight the previous day. Participants fasted or had a large breakfast (0830) in random order. Data were analysed using a linear mixed model for the effect of time, meal and time*meal.

Results: No effect was seen in lung function test results, either immediately (<1hr) or 2 hours after consuming a substantial meal. In patients with obstructive lung disease (n=10), the analysis showed no effect of a meal: FEV₁ p=0.926, FVC p=0.945, TLC p=0.959, DL_{CO} p=0.972 K_{CO} p=0.709. In patients with restrictive lung disease (n=10), the analysis also showed no effect of a meal: FEV₁ p=0.928, FVC p=0.942, TLC p=0.943, DL_{CO} p=0.965 and for K_{CO} p=0.878.

Conclusion: We have demonstrated that consuming a large meal prior to testing does not affect lung function test results in these major patient groups. We believe that the recommendation to avoid large meals is inappropriate.

Key Words: Patient preparation, meal effect, lung function testing

AO 12 LABORATORY USAGE HABITS AND DELIVERED SALBUTAMOL DOSE IN COMMONLY USED SPACERS IN AUSTRALIA AND NEW ZEALAND

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Recent changes to regulations for processing semi-critical medical devices have impacted on the use of spacers in respiratory laboratories. Purchase and processing costs and medication delivery factors may influence the choice of medication delivery options. This study assessed laboratory medication delivery habits and quantified the delivered salbutamol dose of locally available spacers.

Methods: Using an online survey we obtained data on: choice of aerosol delivery devices and processing habits and costs. Delivered dose of 6 spacers were assessed (Volumatic, large and small Space Chambers, Breath-a-tech, Lite Aire and E-Chamber). Particle size distribution of salbutamol (Ventolin; 100µg/actuation) from 6 spacers of each type was measured with an Andersen cascade impactor. Particle size fraction drug content was determined by UV spectrophotometry. Clinical conditions were simulated using a flow-volume simulator (FVS) and delivery of salbutamol via pMDI-spacer to a low resistance filter was measured.

Results: Survey responses from 50 laboratories were obtained, with 37 (74%) using ≥1 type of spacer of which 92% re-processed single use spacers. The most common spacers were Volumatic (n=23), Breath-a-tech (n=8) and Space chamber (n=7). The average re-processing cost was \$4.50. Delivered salbutamol dose varied significantly between spacers and ranged from 16.98 to 38.28µg with the Cascade impactor and 22.56 to 58.82µg with the FVS. Under clinical conditions (FVS), small volume spacers delivered similar doses (22.56 to 28.46µg), while large volume spacers delivery was more varied (24.31 to 58.82µg).

Conclusions: The majority of respiratory laboratories have not yet updated their re-processing policies to comply with new regulations. The delivered salbutamol dose varied significantly and may impact of the choice of preferred spacer type.

Key Words: Spacers, aerosol delivery, respiratory laboratories.

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