AP01 ADIPOSITY, ASTHMA AND AIRWAY INFLAMMATION

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Background: There have been a number of studies showing a relationship between obesity and asthma. Many have shown a stronger association in women, with only weak or non-significant associations in men. Most studies have relied on body mass index to determine overweight & obesity, which may be a less reliable measure of body fat in men than women.
Methods: A population based cohort of approximately 1000 individuals aged 32 years underwent measurements of body fat percent by bioelectrical impedance analysis, spirometry, bronchodilator response and exhaled nitric oxide and answered detailed respiratory questionnaires.
Results: In women there was a significant association between body fat percent and asthma (p=0. 043), airflow obstruction (p=0. 046) but not bronchodilator response (p=0.86). There was no association between body fat percent and asthma in men (p=0. 75) but they did have a significant association between lower percent body fat with airflow obstruction (p=0. 010) and bronchodilator response (p=0. 004). No association was found between airway inflammation as measured by exhaled nitric oxide and body fat in either women (p=0. 17) or men (p=0. 25).
Conclusion: Adiposity is associated with asthma and airflow obstruction in women but not men. This does not appear to be mediated by airway inflammation as measured by exhaled nitric oxide. Previously reported differences in the association between obesity and asthma in men and women are not due to less accurate characterisation of adiposity in men.

Keywords: Asthma, obesity, exhaled nitric oxide, body mass index, airway inflammation

AP02 LUNG VOLUMES AND GAS TRANSFER ARE NORMAL IN A HEALTHY COHORT WITH SEVERE OBESITY

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In recent years obesity has been identified as a significant public healthcare problem and it has been suggested that reduced lung volumes in obese individuals is associated with increased bronchial hyperresponsiveness. We describe the lung function of a cohort of obese subjects presenting for surgical gastric banding as treatment for morbid obesity.

The Aim of this study was to describe the lung function, in particular lung volumes, in otherwise well individuals with severe obesity.

Methods: 2053 patients with no history of lung disease, presenting for surgical treatment for morbid obesity were studied. Each patient received a preoperative assessment which included a number of anthropmetric measures and a range of respiratory function tests. Spirometry, DLCO and lung volumes (Nitrogen washout) were measured.

Results: 79.2% of the population was female. The average age of the group was 43.8 +/- 10.55 years, with a mean BMI of 44.4+/-7.9kg/m^2. Mean values for static lung volumes, gas transfer and spirometry were all within the normal range for the group. (Mean, 95%CI) TLC% predicted (89%, 60-117%), DLCO (83%, 54-112%), FEV1/FVC% (80%, 68-93%).

Conclusion: Despite severe obesity, this group presenting for gastric banding had normal lung volumes, gas transfer and spirometry. We intend to follow this group longitudinally following surgery and weight loss.

Key Words: Obesity, lung function.

AP03 ESTIMATION OF STATIC LUNG VOLUMES BY LINKED AND UNLINKED SPIROMETRY

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Williams & Bencowitz[1] have suggested it is feasible to determine static lung volumes using either linked or unlinked spirometry measurements. However, further investigations have been limited and it has not been fully addressed by the updated ATS-ERS statement 'Standardization of the measurement of lung volumes'.

Aim: To provide evidence that unlinked spirometry measurements may be used in the estimation of static lung volumes.

Methods: Retrospective analysis of lung volume data of 136 patients from 2 laboratories. Unlinked and linked spirometry data, including Inspiratory Capacity (IC) and Slow Vital Capacity (SVC) was used to calculate patient's lung volume measurements (TLC=FRC+IC). Patients from Canberra Hospital had both spirometry and lung volumes measured on a Medgraphics Elite constant volume Plethysmograph. Patients from the Southern Respiratory Services had spirometry measured on either a Jaeger MS IOS or Jaeger MS PFT system, and lung volumes measured on a Jaeger MS PFT system. All data used in the study meets ATS-ERS acceptability and repeatability criteria. Differences between paired samples were analysed statistically with Student's t-tests; p-values < 0.05 were taken as significant.

Results: Mean differences between linked and unlinked variables were: IC = 100ml ($p=0.692$), SVC = 100ml ($p=0.001$), TLC = 100ml ($p=0.692$), RV = 110 ml ($p=0.002$). TLC differences were as high as 700 ml but in only 4% of cases did use of unlinked spirometry data result in a change in interpretation from hyperinflated to non-hyperinflated. Gas trapping, measured by RV/TLC ratio, was changed in 14% of cases, mainly as a consequence of higher SVC.

Conclusion: In subjects who fail to perform satisfactory slow spirometry measurements in the body plethysmograph, there is justification for using unlinked spirometry data to calculate lung volumes, provided it is measured during the same testing session.

1. Williams JH & Bencowitz HZ. Differences in plethysmographic lung volumes: Effects of linked versus unlinked spirometry. Chest 1989; 95: 117-123.

Key Words: Total lung capacity, spirometry, linked, residual volume

AP04 ALVEOLAR VOLUME IS A POOR ESTIMATE OF TLC

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In normal subjects, alveolar volume (V_A) measured with single-breath DLCO, plus estimated dead space volume, is thought to closely match TLC determined by plethysmography. In patients with obstructive airways disease, V_A may be significantly less than TLC due to poor gas mixing. In addition, reducing the washout time between tests to below the recommended four minutes may cause V_A to be further underestimated. **Aims:** To compare the single-breath measurement of V_A with TLC in patients with and without obstructive airways disease. To determine if reducing the time between consecutive V_A measurements from > 4 minutes to < 2 minutes increases the difference between V_A and TLC. **Methods:** Using a random crossover design, we used paired *t*-tests to compare acceptable TLC and V_A data from 85 patients. Patients were classified as normal, obstructive or restrictive using their pulmonary function data. Intervals of either > 4 minutes or < 2 minutes were used during each set of 3 DLCO tests. A p-value < 0.05 was taken to indicate statistical significance. **Results:** The smallest difference between V_A and TLC was found in the normal group (n = 20) when the time between tests was > 4 minutes. The mean V_A was 0.55L less than TLC ($p<0.05$) and the difference increased to 0.63L when the time interval was reduced to < 2 minutes ($p<0.05$). The difference between V_A and TLC increased with severity of airway obstruction. When the time between tests was > 4 minutes, the largest difference between V_A and TLC was found in the patients with airway obstruction and significant gas trapping (n = 19). The mean VA was 2.28L less than TLC ($p<0.05$) and the difference increased to 2.50L when the time interval was reduced to < 2 minutes ($p<0.05$). **Conclusion:** V_A determined by single-breath washout is a poor estimate of TLC even in non-obstructive patients. The disparity between V_A and TLC is even more significant in patients with airway obstruction due to increased dead space and poor gas mixing. Reducing the washout time between tests below the recommended four minutes causes further underestimation in alveolar volume.
Key Words: DLCO, single-breath gas dilution, TLC, V_A

AP05 THE EFFECT OF DEAD SPACE ON DIFFUSING CAPACITY MEASUREMENT

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Instrument and anatomic dead space (V_D) are known to affect the measured single breath diffusing capacity ($DLCO_{SB}$) but assumed values are often used. The ATS/ERS task force guidelines for $DLCO_{SB}$ recommends that anatomic dead space is calculated as a function of body weight and height where body mass index is >30 kg/m^2.

Methods: Using the raw data from a Sensormedics Vmax Spectra lung function analyser, $DLCO_{SB}$ was recalculated using various combinations of anatomic and instrument dead space for 1556 consecutive measurements on subjects attending the lung function laboratory in 2006. Descriptive statistics were used to explore the effect of dead space over a range of measured height, weight, gender and $DLCO_{SB}$.

Results: When compared to an assumed anatomic dead space of 150mL, the calculated anatomic dead space resulted in less than 1% error in the sample as a whole (Female: +0.8% ± 1.2%; Male -0.3% ± 0.9%). However, when calculated V_D is less than 100 mL, $DLCO_{SB}$ was on average 3.5% higher. Adjusting instrument dead space for the presence of bacterial filters changed dead space from 30 mL to 80mL and resulted in a 2% decrease in $DLCO_{SB}$.

Discussion: In this representative sample of patients attending an adult respiratory function service, the effect of calculating dead space and adjusting for instrument dead space introduced an error of less than 2% for 93% of measurements and less than 5% for 99% of measurements.

Conclusion: Instrument dead space should be adjusted for the presence of a bacterial filter to reduce the systematic error of the measurement. Anatomic dead space should also be adjusted according to formulae such as those proposed by ATS/ERS. This is more important for individuals who have a low anatomic dead space and low $DLCO_{SB}$, *viz* females, low height and low weight.

Key Words: $DLCO_{SB}$, diffusing capacity, dead space

AP06 MULTI-RULE QUALITY CONTROL METHODOLOGY IN RESPIRATORY LABORATROY BIOLOGICAL DATA

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Rationale: Biological Quality Control (BioQC) methodology is recommended by the ATS/ERS taskforce. This study investigates the appropriateness of the recommended multi-rule analysis to monitor respiratory BioQC data. Control rules have a predefined probability of producing false positive results when instruments are in stable operation and we used this rationale to evaluate our BioQC data.
Methods: Four experienced healthy scientists performed spirometry, lung volumes and DL,CO tests on multiple days for 14 weeks on three instruments following ATS/ERS testing criteria. Five multi-rules were investigated. 1) Warning rule, 1 result +/- 2 SD from mean. 2) Random error detection rule, 1 result +/- 3 SD from mean. Systematic error detection rules: 3) 2 consecutive measures outside 2 SD from mean in the same direction; 4) 4 consecutive measures outside 1 SD from mean in the same direction; 5) 10 consecutive measures on one side of the mean. We measured the frequency of results outside defined limits and the effect of introducing a 3% volume error.
Results: The frequency of false positive results was below the expected range for the BioQC measurements. A significant increase in the frequency of rule violations was noted when a deliberate systematic error was introduced.

QC Rules	1	2	3	4	5
Expected false positive rate (%)	5	<1	<1	<1	<1
	Frequency of rule violations (%)				
BioQC data (n=2886)	4.1	0.17	0.21	0.03	0.28
Introduced error (n=150)	49	21	31	39	18

Conclusions: This multi-rule QC approach provides the expected number of false positive results for our BioQC data and the deliberate systematic shift was adequately detected. Multi-rule QC methodology is appropriate for monitoring BioQC data for the respiratory laboratory and sensitive for error detection.
Key Words: Biological Control, Quality Control, Multi-rule

AP07 THE REPEATABILITY OF COMPREHENSIVE LUNG FUNCTION TESTING WITHIN AND BETWEEN LABORATORIES

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Current national guidelines for performing Respiratory Function Tests recommend performance assurance testing is performed on at least two healthy normal subjects on a regular basis. They also recommend inter-laboratory comparisons are performed whenever possible, and at least annually. We report on the results of 10 years of performance assurance testing performed according to recommended guidelines.

Results: Comprehensive lung function measurements were performed periodically on two adult males (S) in two laboratories (L) over a 10-year period.

		FEV_1	FVC	FER	TLC	RV	DL_{CO}	VA
S1 L1	Mean	3.19	4.16	76.8	6.12	1.81	23.92	5.61
	SD	0.26	0.38	1.52	0.36	0.19	2.86	0.44
S1 L2	Mean	3.27	4.26	76.9	6.24	1.70	24.51	5.73
	SD	0.28	0.34	1.85	0.39	0.32	2.16	0.26
S2 L1	Mean	4.70	6.13	76.7	8.71	2.53	39.85	7.94
	SD	0.27	0.26	2.16	0.37	0.30	3.51	0.46
S2 L2	Mean	4.87	6.44	75.7	9.09	2.47	36.68	8.02
	SD	0.17	0.14	2.33	0.41	0.44	2.21	0.39

The coefficient of variation for measurements ranged from 1.98% for the forced expiratory ratio (FER) to 18.6% for the residual volume. L2 generally produced higher measurements than L1, but were within 8% of each other.

Conclusion: The performance of two lung function laboratories in Hobart has been well maintained over a period of 10 years, based on regular measurements of normal healthy subjects.

Keywords: Performance assurance, Lung function.

AP08 BEST PRE-SCHOOL AND ADULT EQUATIONS TO USE WITH HIBBERT PAEDIATRIC REFERENCE EQUATIONS

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Without extrapolation no predicted value equations for spirometry include all ages. The use of different equations at transition ages results in a step change. The current Australian standard reference equations for spirometry in children aged 8-19y are those by Hibbert *et al* (1989) (H). The aim of this study was to determine which reference equations, when used in conjunction with H, either side of 8-19y minimises the step change in the predicted values of FEV_1, FVC and FEF_{25-75}. Predicted values were calculated for children 8y over a range of heights (3, 30, 50, 70, 97 centiles) using H equations and 2 pre-school reference equations (Zapletal *et al*, 2003 (Z) & Eigen *et al*, 2001(E)). Differences in predicted values of each parameter derived from the different equations were compared. Similarly H values at 19y with 3 sets of adult reference equations (Gore *et al*, 1995 (G); Morris *et al*, 1971 (M); Quanjer *et al*, 1993 (Q)), over the range of centile heights were obtained. **Results:** At 8y, the **smallest** mean difference (litres) was given by Z for male FEV_1 and FVC and by E for female FEV_1 and FVC. Only E had FEF_{25-75} equations. At 19y, the **smallest** mean difference was given by G for female FEV_1 & FEF_{25-75}, by M for male FEF_{25-75} and by Q for male FEV_1, FVC and female FVC.

Mean (SD), L	**H-Z 8y**	**H-E 8y**	**H-G 19y**	**H-M 19y**	**H-Q 19y**
Male: FEV_1	0.13 (.09)	**0.12 (.08)**	0.34(.21)	0.26 (.21)	**0.20 (.20)**
FVC	0.19 (.07)	**0.10 (.09)**	0.51(.14)	0.51 (.23)	**0.22 (.11)**
FEF_{25-75}	NA	**0.32 (.15)**	0.34 (.22)	**0.28 (.16)**	0.30 (.17)
Female: FEV_1	**0.06 (.05)**	0.09 (.07)	**0.10 (.06)**	0.12 (.11)	0.21 (.08)
FVC	**0.09 (.06)**	0.20 (.15)	0.19 (.07)	0.32 (.08)	**0.12 (.06)**
FEF_{25-75}	NA	**0.25 (.02)**	**0.17 (.11)**	0.46 (.20)	0.27 (.21)

Comparison of values at specific height centiles show that the smallest difference was achieved by Q in most parameters. **Conclusion:** Z or E give similar discrepancy for predicted values at transition (8y) to H, but only E has FEF_{25-75} equations. At transition to adult equations (19y) Q are the equations of choice.

Key Words: paediatric, spirometry, predicted, equations, transition

AP09 TECHNICAL ACCEPTABLILITY AND COMPLIANCE IN THE USE OF DAILY ELECTRONIC PEF/FEV_1 METERS IN CHILDREN WITH ASTHMA

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Background: Daily PEF monitoring does not contribute to the management of childhood asthma. Factors influencing a daily PEF program are ability to perform tests accurately, compliance with twice daily testing and truthful PEF diary entry. Electronic PEF/FEV_1 meters allow monitoring of technical quality and remove the need for diary entry. The aim of the current study was to assess the use of an electronic PEF/FEV_1 meter in asthmatic children.
Design: Asthmatic children (n=50; 7-12 years) were supplied with an electronic PEF/FEV_1 meter (PIKO-1, Ferraris) and given instructions and demonstrations of the required FVC technique. Subjects were required to perform forced manoeuvres morning and night during the study. We examined technical acceptability, compliance with twice daily testing (≥3 days/week) and PEF/FEV_1 diurnal variation agreement, (PEF/FEV_1 diurnal variation to be either <20% or >20%) over a 2 week period.
Results: 12 (24%) children withdrew from the study. 24% (9 of 38) of the remaining children had poor technique resulting in no useable data. In those children with technically acceptable data, compliance was poor with 69% (20 of 29) of children not performing at least 3 twice daily tests per week. In week 1 and 2 twice daily testing occurred with a mean of 4.9 and 4.1 days, respectively in 9 of 29 (31%) children. Agreement in PEF/FEV_1 diurnal variation occurred in 83% of compliant days (67 of 81).
Conclusion: Electronic PEF/FEV_1 meters do not improve the technical acceptability of tests nor the compliance with testing programs in children. Innovative ways to assess variability in lung function are required to improve compliance in this patient group.
Key words: paediatric asthma**,** portable electronic PEF/FEV_1 meter.
Funded by: Aus Bio Health Pty Ltd. PIKO-1 supplied by MayoHealthcare.

AP10 THE RELATIONSHIP BETWEEN FOT & SPIROMETRY IN COPD, ASTHMA AND BRONCHIECTASIS

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Background: Forced oscillation measurements of respiratory conductance (Grs) and reactance (Xrs) differ physiologically from spirometry by being measured during tidal breathing. We hypothesised that this may lead to different relationships with spirometry in different obstructive airways diseases.
Methods: Grs, Xrs and spirometry were measured in 22 COPD, 26 asthmatic and 16 bronchiectatic subjects before (Pre-BD) and after salbutamol (Post-BD).
Results: In COPD, asthmatics and bronchiectatics, pre-bronchodilator mean ±SEM FEV_1's were 65±5, 71±3 & 65±5 % of predicted ($p>0.05$), respectively. Mean Grs were 0.21±0.01, 0.21±0.01 & 0.20±0.01 L/s/cmH_2O ($p>0.05$). Mean Xrs were -3.03±0.38, -2.67±0.49 & -3.02±0.35 L/s/cmH_2O ($p>0.05$). FEV1, Grs or Xrs were unrelated to age, height and BMI. In COPD Pre-BD, Grs was unrelated to spirometry, while Xrs was predicted independently by FEV1, FVC and FEV1/FVC ($R^2=0.69$, $p<0.0001$). Post-BD, Xrs was predicted by FVC and FEV1/FVC ($R^2=0.57$, $p=0.0001$). In asthmatics, Grs correlated with FVC alone both Pre-BD ($R=0.43$, $p=0.02$) & Post-BD ($R=0.48$, $p=0.008$), while Xrs was predicted independently by FEV_1, FVC & FEV_1/FVC Pre-BD ($R^2=0.68$, $p<0.0001$) but solely by FVC Post-BD ($R=0.72$, $p<0.0001$). In bronchiectatics, Xrs correlated with FEV_1 alone, both Pre-BD ($R=0.55$, $p=0.02$) and Post-BD ($R=0.51$, $p=0.02$). There were no relationships between the magnitudes of changes in FEV_1, FVC, Grs or Xrs associated with bronchodilator.
Conclusions: In COPD and asthma, Xrs related consistently and strongly to FVC whereas in bronchiectasis, it related to the FEV_1. The relationship was independent of bronchodilator administration. However, Grs related poorly to spirometry. Grs, Xrs and spirometry are complementary but their relationships may be affected by disease.
Keywords: forced oscillation technique, spirometry, asthma, COPD, bronchiectasis.

AP11 RASH AND REACTION - BILATERAL PHRENIC NEUROPATHY FOLLOWING VARICELLA INFECTION

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Presentation: A 31 year old man presented four months after a severe chickenpox infection. Bilateral brachial neuritis had previously been diagnosed after presentation with shoulder/arm pain and weakness. One month after the onset of arm weakness he developed exertional dyspnea, discomfort when recumbent, fragmented sleep and marked daytime somnolence. His wife also reported cessation of previously loud snoring and the new development of observed 'apneas'. Fluoroscopic screening of the diaphragm was reported as normal.

Investigations: Physical examination was unremarkable other than pharyngeal injection. CXR revealed bibasal atelectasis and raised hemidiaphragms. Lung function tests indicated a significant positional restrictive ventilatory defect.

	FEV_1 upright	FVC upright	FVC supine	FVC Left side	FVC Right	TLC	FRC	RV
Litres	2.3	2.85	0.94	1.72	1.64	4.11	1.79	1.25
%pred	56	58	19	35	33	59	64	72

Maximum inspiratory pressure was 72 cm H_2O (57% predicted) and maximum expiratory pressure was 245 cm H_2O (104% predicted). Polysomnography showed severe sleep disordered breathing (respiratory disturbance index 91, minimum SpO2 85%).

Diagnosis and outcome: A diagnosis of bilateral phrenic neuropathy was made. We conclude that diaphragm weakness has converted previous upper airway obstruction (as evidenced by snoring) to respiratory muscle hypoventilation. Nocturnal bilevel ventilation was commenced and led to a marked symptomatic improvement.

Discussion: Bilateral post-viral phrenic neuropathy is rare, and can be missed on diaphragm screening, as this test is most useful in identifying the paradoxical movement associated with unilateral hemidiaphragm dysfunction. Simple positional respiratory function tests are pivotal in clarifying the bilateral dysfunction. The recovery of diaphragm function is slow, owing to the length of the phrenic nerves, and often incomplete.

Key words: varicella, phrenic neuropathy, diaphragm weakness

AP12 VIBRATORY CHARACTERISTICS OF THREE HANDHELD AIRWAY CLEARANCE DEVICES

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Handheld airway clearance devices generate mucus-loosening vibrations by providing a series of pressure pulses to the lungs. These pressure pulses can be characterised by their amplitude (i.e. how strong the vibratory pulses are). The purpose of this study was to compare the amplitudes of the pressure pulses generated by three commercially available handheld airway clearance devices: The Acapella (Green) (Smiths Medical); The Flutter (Axcan Scandipharm); and The Quake (Thayer Medical).

Method: Three of each device (n=3) were evaluated at three different settings (handle turning at 30, 60 and 120 RPM for the Quake; counterclockwise, midpoint, and clockwise dial settings for the Acapella; 0° (horizontal), 20° and 40° alignments for the Flutter). The devices were attached via 22 mm respirator tubing to a modified Harvard Apparatus ventilator simulating tidal breathing of 1500 mL and 1000 mL at 12 breaths/minute and 1:1 I:E. Resulting pressure waves were measured with Honeywell ASDX series voltage pressure sensors attached to the mouthpieces of the devices.

Results: At the 1500 mL tidal volume, the best setting of the Quake (30 RPM) yielded a significantly higher mean pressure pulse amplitude (14.1 cm H_2O (1.2 (SD))) than both the best Acapella setting (7.4 cm H_2O (0.7), midpoint setting, $p=0.001$ vs Quake), and the best Flutter setting (8.4 cm H_2O (0.3), horizontal, $p=0.001$ vs Quake). At the 1000 mL tidal volume, the best setting of the Quake (30 RPM) also yielded a significantly higher mean pressure pulse amplitude (7.8 cm H_2O (0.7)) than both the best Acapella setting (4.3 cm H_2O (0.2), midpoint, $p=0.001$ vs Quake), and the best Flutter setting (6.5 cm H_2O (0.3), horizontal, $p<0.05$ vs Quake).

Conclusions: At both 1500 mL and 1000 mL simulated tidal volumes, the Quake generated significantly larger pressure amplitudes than both the Flutter and Acapella. This should translate into stronger airway vibrations and better mucus loosening.

Key Words: Airway clearance, Acapella, Flutter, Quake, COPD, cystic fibrosis

AP13 DRUG DELIVERY PERFORMANCE OF A DISPOSABLE PAPERBOARD HOLDING CHAMBER VERSUS TWO PLASTIC HOLDING CHAMBERS

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Purpose: The purpose of this study was to compare the metered-dose inhaler (MDI) drug output through three valved holding chambers (VHCs) of comparable size. The three VHCs evaluated included one disposable, non-static VHC made from paperboard (LiteAire™, Thayer Medical, 160 mL chamber volume) and two VHCs made from rigid polymer (AeroChamber Plus®, Trudell Medical Corp., 150 mL; and OptiChamber®, Respironics, 200 mL).
Method: Five of each of the three VHCs (n=5) were evaluated using a USP throat model attached via 22 mm tubing to a Harvard Apparatus ventilator simulating tidal breathing of 750 mL at 12 breaths/minute and 1:1 I:E. Three actuations of 250 µg/dose fluticasone propionate (Flixotide, GlaxoSmithKline) were delivered from a pre-primed MDI canister at 10 second intervals. Fluticasone propionate delivered through each VHC was captured on a filter connected just downstream of the throat model and eluted with 9 mL of dimethyl sulfoxide. Drug concentrations in these solutions were quantified via ultraviolet spectroscopy at 260 nm.
Results: The dose of fluticasone propionate delivered through the paperboard LiteAire (108 µg/actuation (9 (SD))) was significantly larger than the doses delivered through either the AeroChamber Plus (83 µg/actuation (18 (SD)), p = 0.03 vs. LiteAire), or the OptiChamber (65 µg/actuation (19 (SD)), p = 0.002 vs. LiteAire). When compared to the 250 µg/actuation delivered by the Flixotide canister alone, the LiteAire delivered 43% (4% (SD)) of the canister dose, which was a significantly higher percentage than the AeroChamber Plus (33% (7% (SD))), or the OptiChamber (26% (8% (SD))).
Conclusion: Under the conditions tested, the paperboard LiteAire valved holding chamber provided drug delivery performance that was superior to the two rigid plastic valved holding chambers.
Key Words: MDI, spacers, holding chambers, AeroChamber, LiteAire, OptiChamber

AP14 COMPUTATIONAL MODEL OF AIRWAY SURFACE LIQUID REGULATION

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Mucociliary clearance is the airways' primary innate mechanism against inspired noxious materials. For this system to work efficiently the periciliary liquid (PCL) must be maintained at a height 0.5µm less than the length of an outstretched cilium. A cellular electro-physiological model of pulmonary airway epithelia has been developed to investigate regulatory mechanisms for the control of the PCL height.

Methods: The mathematical model of the cell consists of expressions of apical Na^+ and Cl^- channels and basolateral K^+ channels, Na-K-ATPases, and Na-K-2Cl cotransporters. The concentration changes of purinergic molecules through variation of height and metabolic interconversion was described and coupled to mathematical descriptions purinergic receptors. $P2Y_2$ receptors were involved in regulating ion channel gating through intracellular calcium release via the Phospholipase C pathway. Modification of channel conductance results in the production of osmotic gradients and a corresponding movement of water. Local water movement was incorporated into an anatomically correct upper bronchial airway model to allow a description of regional water levels.

Results and Conclusions: A novel mathematical model has been constructed which couples dynamic cellular regulatory mechanisms to regional airway PCL height. Predicted cellular reactions of the model to various agonist concentrations in the lumen produce physiologically consistent oscillatory calcium responses. The model demonstrates the importance of extracellular nucleotides for the control of cytosolic calcium and water movement across the airway epithelia.

Key Words: Periciliary Liquid, Mucociliary clearance, Cellular Modeling, Multi-scale

University of Auckland Doctoral Scholarships, Fisher and Paykel Healthcare

AP15 COMPUTATIONAL MODELLING OF REGIONAL GAS EXCHANGE IN THE LUNG

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Rationale: Pulmonary disorders are generally characterised by regional abnormalities in the structure and function of the lung parenchyma, or the airways and vascular trees. In order to investigate regional gas exchange in the lung, we are incorporating mathematical descriptions of gas exchange into anatomically-detailed models of the pulmonary vascular and airway trees, which couple finite deformation elasticity to air and blood flow.
Methods: A model for gas exchange is coupled to a detailed model of alveolo-capillary blood transport. Boundary conditions are specified to control hematocrit, perfusion of extra-alveolar vessels, mixed venous blood partial pressures and saturation. Outputs of the model are the distributions of oxygen and carbon dioxide partial pressures in the capillary network, and the end-capillary values at the venules that drain the capillary network. The changes in end-capillary values of blood oxygen partial pressure are investigated in response to varying extra-alveolar vessel flow rates and mixed venous blood partial pressures.
Results and Conclusions: The alveolo-capillary gas exchange model gives predicted end-capillary partial pressure values that are physiologically consistent. For a normal flow rate, the partial pressures in the venules are equilibrated with the alveolar partial pressures. For a five-fold increase in blood flow rate, which simulates moderate exercise, the venule partial pressures are still in equilibration. The small-scale alveolo-capillary gas exchange model provides a base to build a hierarchy of multi-scale models up to the acinus and the whole lung.
Key words: Computational model, gas exchange, lung physiology.
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