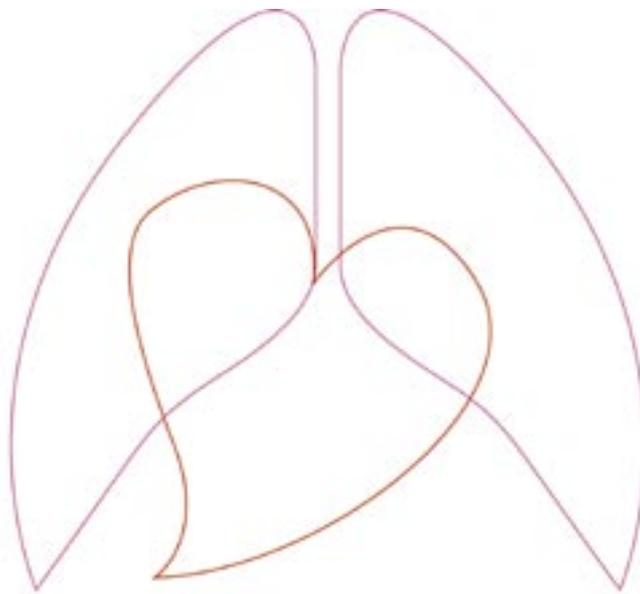


**Selected Abstracts**

**National Cardiothoracic Group  
9th Biennial Conference**



**Professional Issues**

**13–15 October 2005  
Melbourne, Australia**



**AUSTRALIAN PHYSIOTHERAPY ASSOCIATION**

## Introduction

The primary theme for the 9th National Cardiothoracic Group biennial conference was 'Professional Issues' where delegates were challenged to consider issues (such as specialising, advancing and extending practice, clinical education, burn-out, multidisciplinary liaison and communication) that shape both the specialty of cardiothoracic physiotherapy and the wider profession.

Fran Woodard and Sarah Keilty were invited from the UK to present the keynote addresses on Professional Issues. Fran's presentations inspired the audience as she described the development of physiotherapy consultant posts in the reform of the UK health system. Her conclusion that extended scope practice is here to stay challenged Australian physiotherapy to find a model for our health system that meets our needs. Sarah Keilty also put the issue of extended scope practice on the Australian agenda, describing the role of consultant physiotherapists in the NHS and identifying its advantages for patients, clinicians, and the health system.

In addition the conference showcased cutting edge cardiothoracic clinical practice and research. To that end, supplementing the plenary sessions there was a record number of over 100 peer reviewed oral and poster presentations. The conference program was organised around eleven major themes central to cardiothoracic physiotherapy practice:

- Professional issues
- COPD
- Education
- Airway clearance and progressive neuromuscular disease
- ICU
- Pulmonary rehabilitation/6MWT
- Cystic fibrosis
- Heart failure/Cardiac rehabilitation
- Asthma and physiology
- Surgery
- Exercise and muscle training

A record number of more than 220 physiotherapists participated in this conference — attendance has almost tripled since our inaugural conference in 1988. This gathering lived up to the reputation our conferences have earned of offering the opportunity to network with colleagues from around Australasia and beyond, being vibrant, fostering a celebration of diversity, innovation and strength within the specialty, and of being a vanguard for promoting debate, discussion and development amongst the cardiothoracic physiotherapy community.

### Shane Patman

Chairperson  
APA National Cardiothoracic Group

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## Understanding and learning to reason in cardiothoracic physiotherapy

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Effective clinical reasoning is fundamental to physiotherapy practice. Considerable research across the health disciplines has investigated the nature of clinical reasoning and its relationship with knowledge and expertise. However, physiotherapy research literature, to date, has not paid much attention to how cardiothoracic physiotherapists conceptualise reasoning in practice, neither has it explored modes nor patterns of learning that facilitate the acquisition of this complex skill. The purpose of this research was to investigate how experienced cardiothoracic physiotherapists reason in practice and how they learn to reason. This research was conducted in the interpretive paradigm, using mixed methods of data collection including observation, written reflective exercises and repeat, semi-structured interviews. Four physiotherapists with clinical and supervisory experience were recruited from the area of cardiothoracic physiotherapy. Data were organised using NVIVO software and analysed using hermeneutic methods including the hermeneutic circle. Participants' learning journeys were diverse although certain episodes of learning were common or similar. Various individual factors were found to actively direct learning of clinical reasoning, including level of responsibility, awareness and confidence in their ability. Role models, mentors and colleagues were found to be influential in the development of reasoning ability. The workplace setting also contributed to learning. The findings of this study have implications for cardiothoracic practice and teaching of clinical reasoning at university and in the workplace.

## Endurance arm exercise in patients with chronic obstructive pulmonary disease

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This study aimed to compare the end-exercise physiological responses of endurance arm exercise with incremental arm exercise in patients with chronic obstructive pulmonary disease (COPD). Subjects with diagnosed COPD were recruited. All subjects performed an incremental arm exercise test (IAT) to peak work capacity on an electrically braked arm crank ergometer (Seimens-Ellegaard, Sweden) and, on a separate day, an endurance arm exercise test (EAT) at 80% of the peak workload achieved on the incremental test. Throughout both exercise tests oxygen consumption ( $\text{VO}_2$ ), minute ventilation ( $V_E$ ), end-expiratory lung volume (EELV) ( $V_{\text{max}}$  29, SensorMedics, USA), dyspnoea and rate of perceived exertion (RPE) were measured each minute. Nine subjects with COPD of mean [SD] age 62 [6] years and  $\text{FEV}_{1\% \text{ pred}}$  54 [14]% completed the study. Peak work on IAT was 33 [7.5] watts and mean endurance time on EAT was 6.6 [1.5] minutes. There was no significant difference between end-exercise values for IAT and EAT for  $\text{VO}_2$  (0.842 [0.219] l/min and 0.851 [0.170] l/min respectively); HR (99 [19] b/min and 100 [32] b/min respectively); change in EELV (0.47 [0.25] l and 0.52 [0.36] l respectively).

However,  $V_E$ , dyspnoea and RPE were significantly higher at end EAT compared to IAT ( $p < 0.05$  for all). In patients with COPD, endurance arm exercise at 80% peak work elicited similar metabolic responses but higher ventilatory and psychophysical responses to those at peak work on the incremental arm test. These findings have implications for prescription of intensity of arm training at submaximal workloads.

## What factors influence adherence to pulmonary rehabilitation in patients with chronic obstructive pulmonary disease?

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The aim of this qualitative study was to explore the reasons patients with chronic obstructive pulmonary disease (COPD) gave for attending or not attending a program of pulmonary rehabilitation. Using a grounded theory methodology, 20 patients with COPD who had been invited to attend a pulmonary rehabilitation program in the previous two years were recruited and interviewed in their own homes. During a semi-structured interview, each patient was asked the same questions and the responses were audio-taped, then later transcribed. Of the 20 participants, two had refused to attend, two had dropped out completely, and five had not fully attended the program. The majority of participants who initially attended said they had done so because their doctor recommended it, even though none had received any information about pulmonary rehabilitation. Those who refused to attend said they felt the program was not a high priority for them. The two participants who had dropped out said they felt they could not motivate themselves or perceive any improvement. The five participants with sporadic attendance suggested that there were days when they felt attendance was too much for them, either due to transport issues or feeling unwell. Those who continued to attend felt the program had helped them to improve physically, and said they enjoyed being in a group with other patients with COPD. These findings are supported by findings in the adherence literature on other chronic diseases and provide some insight into patients' decision-making about treatment adherence.

## The prevalence of musculoskeletal dysfunction six and twelve weeks following open-heart surgery

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Research has shown between 30%–70% of patients suffer musculoskeletal (MS) complications following open-heart surgery (OHS) in Australia. The role of exercise in the resolution of this remains unclear. The aim was to ascertain the prevalence and area of MS pain and any contributing factors in such patients preoperatively and at six and twelve weeks postoperatively. The study design was a prospective cohort study. A survey scoring current pain in the upper limbs, thoracic cage and spine using visual analogues and a shoulder disability scale was completed preoperatively and at six and twelve weeks postoperatively. Usual care was provided to subjects including home exercise and walking program instruction. Data were collected on 76 subjects. Preoperative musculoskeletal pain was found in 65.79%

of subjects. At six weeks, total pain score significantly increased with 65.79% of patients reporting new/increased pain ( $p < 0.01$ ), shoulder pain score significantly increased ( $p < 0.05$ ), pain killer usage increased ( $p < 0.01$ ), mean disability score increased by 30% ( $p < 0.05$ ) and walking distance improved significantly ( $p < 0.01$ ). At 12 weeks postoperatively, total pain score and mean disability score were not significantly different to preoperative levels. Correlations ( $p < 0.05$ ) were found between preoperative risk score and pain/disability at six weeks; the number of grafts and pain/disability at six weeks; and the preoperative disability score and postoperative length of stay. Increased disability at six weeks was also correlated to female gender and subjects who underwent valve or left internal mammary artery graft (LIMA) OHS ( $p < 0.05$ ).

### Seven years of experience with nocturnal ventilatory support in motor neurone disease

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The effect of ventilatory assistance and tracheostomy on survival, sleep quality and oxygenation was assessed in a retrospective analysis of the 118 people with motor neurone disease (MND) who presented between July 1996 and January 2003 to the VRSS. Seventy-four received assisted ventilation, 44 were not ventilated, 51 used non-invasive ventilation and 23 used tracheostomy ventilation. Two patients received a tracheostomy but were not ventilated. Median survival of those ventilated was 35 months and of those not ventilated was 24 months; significantly different at two ( $p = 0.025$ ) and four years ( $p = 0.044$ ) after symptom onset. The median survival of those who received a tracheostomy was 41 months and of those who did not was 31 months; significantly different at three ( $p = 0.011$ ) and four years ( $p = 0.032$ ). Sleep quality was significantly worse during the initial sleep study in those who were ventilated (less rapid eye movement (REM) sleep ( $p = 0.049$ ), more arousals from sleep ( $p < 0.001$ ), more respiratory events ( $p = 0.022$ )) and more time was spent during sleep with an oxygen saturation (SpO<sub>2</sub>) less than 90% ( $p = 0.002$ ). Following treatment with ventilation, arousals from sleep decreased ( $p < 0.001$ ) and the percentage of REM sleep ( $p = 0.017$ ) increased. The patients slept for an average of 45 minutes longer ( $p = 0.021$ ), yet the time spent with a SpO<sub>2</sub> < 90% was reduced by 19 minutes ( $p < 0.001$ ). In our cohort, both tracheostomy and domiciliary ventilation independently increased survival in MND. Ventilatory assistance lengthened total sleep time, improved sleep quality and ameliorated sleep hypoxia.

### Inspiratory muscle training to enhance weaning from mechanical ventilation

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Prolonged mechanical ventilation of intensive care patients is associated with high health care costs and respiratory muscle weakness. Specific inspiratory muscle training (IMT) has been used in North America to enhance weaning from mechanical ventilation in selected patients. We describe the successful use of IMT to enhance weaning

from mechanical ventilation in an Australian intensive care unit (ICU). A 79-year-old previously fit and active man was admitted to ICU following laparotomy for small bowel obstruction. Following 17 days of mechanical ventilation, he had failed multiple weaning attempts. There was no identifiable contribution to weaning failure from nutritional, biochemical or metabolic factors. The subject was fully alert and cooperative. A program of daily inspiratory muscle training with a 'Threshold' inspiratory muscle trainer (Mayo Healthcare, Australia) was initiated in addition to his usual physiotherapy management. The subject's oxygen saturation as measured by pulse oximetry remained above 90% throughout each session. The subject's mean training threshold increased progressively during the program from 13 to 36 centimetres of water (cmH<sub>2</sub>O). Simultaneously with the improvement in training threshold, the periods of unassisted breathing tolerated by the subject gradually increased. By day 28 the subject no longer required mechanical ventilation, and was subsequently discharged to the ward. We conclude that IMT can be implemented effectively in the difficult to wean patient, and pending further investigation, should be considered for patients who have failed conventional weaning strategies.

### Quantitative measurement of mobility following upper abdominal surgery

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Mobilisation is frequently used by physiotherapists in the management of patients following upper abdominal surgery (UAS). Little evidence exists regarding the quantity and effect of mobilisation in the immediate postoperative period. This study aimed to quantify the amount of mobilisation performed in the first four days after UAS. Measurement of mobilisation in 50 subjects undergoing UAS was achieved using a positional activity logger (PAL1). The PAL1 recorded time spent in the upright position and frequency of standing performed by each subject. Demographic and surgery related data, incidence of postoperative pulmonary complications and hospital length of stay (LOS) were also recorded. Median daily uptime increased from 3.0 (IQR 8.2) minutes on the first postoperative day (day one) to 7.6 (IQR 11.5) on day two, 13.2 (IQR 26.6) on day three and 34.4 (IQR 65.6) on day four. Median daily standing frequency was 4 (IQR 4) on day one, 8 (IQR 9.5) on day two, 11 (IQR 11) on day three and 20 (IQR 26.5) on day four. Comparison of morning, afternoon and evening data using a Friedman's test demonstrated significantly higher levels of uptime in the morning on days two to four ( $p < 0.05$ ). Further analysis of the data was performed using simple linear regression models with logarithmic transformation. Uptime and anaesthetic duration were found to be predictive of LOS ( $p < 0.05$ ). This study provides physiotherapists with quantitative data on the amount of mobilisation performed following UAS and the relationship between mobilisation and LOS.

## Symptomatic and silent gastro-oesophageal reflux: a problem in patients with cystic fibrosis on waiting lists and after lung transplantation—implications for physiotherapy

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Recent reports suggest gastro-oesophageal reflux (GOR) and tracheal aspiration may be a problem in cystic fibrosis (CF). We hypothesized that GOR may contribute to declining lung function before and after lung transplantation (LTx). The aims were to establish whether GOR occurs pre- and/or post-LTx; and to determine whether patients have symptomatic or silent GOR. Following ethics approval, adults with CF who were on waiting lists and following lung transplant were recruited. Patients completed a structured symptom questionnaire followed by dual probe 24-hour oesophageal pH monitoring (proximal and distal oesophagus). Nine patients in the pre-LTx and 14 in the post-LTx groups were studied. Values for the pre-LTx and post-LTx groups will be reported respectively as medians with interquartile ranges (q1–q3) and includes proximal and distal oesophageal values. Median reflux index: pre-LTx: proximal = 1.5 (0.7, 4.4)% [normal value < 0.1%]; distal = 8.6 (4.9, 11.7)% [normal < 4.5%]. Post-LTx: proximal = 1.40 (0.6, 5.0)%; distal = 8.5 (3.5, 12.7)%. Median number reflux episodes: pre-LTx: proximal = 56 (38, 78) [normal value < 4]; distal = 180 (122, 239) [normal < 50]. Post-LTx: proximal = 43 (22, 126); distal = 213 (114, 293). DeMeester Score: pre-LTx: 38.7 (22.9, 53.0) [normal < 14.7]. Post LTx: 32.45 (9.9, 54.6). Symptom Score: pre-LTx: 6 (0, 9); post-LTx: 9 (3, 11) [normal < 4/18]. Three of nine subjects (33.3%) in pre-LTx and three of fourteen (21.4%) in post-LTx groups had silent GOR (< 4/18 symptom score). Symptomatic and silent GOR are significant problems which may contribute to lung function decline pre-LTx and obliterative bronchiolitis post-LTx. GOR should be aggressively treated with medication and head down tilted postural drainage positions should be avoided during airway clearance therapy.

## Effects of forced expirations on pelvic floor muscle activity in women with chronic lung disease versus controls

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Coughing and huffing trigger increased activity in pelvic floor muscles (PFM) related to increased intra-abdominal pressure. We postulated that women with chronic cough would have deficient PFM strength causing incontinence. The aim was to determine PFM activity during coughing and huffing in chronic lung disease (CLD) compared to controls. Electromyographic (EMG) activity of PFM was recorded using an intravaginal electrode concurrent with thoracic movement during coughing (over 1 and 20 seconds) and huffing with computer analysis of videotaped motion of a reference marker over the manubrium sternum. The 23 women with CLD were 44.2 ± 17.5 years compared to 22 controls aged 44.1 ± 12.4 years. The maximum voluntary EMG contraction during cough over 1 second

(represented as a multiple of resting value) was 4.81 ± 2.81 for CLD group; 6.83 ± 5.48 for control group, ( $p > 0.05$ ); while over 20 seconds: 3.48 ± 2.40 and 5.63 ± 4.77, ( $p = 0.06$ ) respectively. Both groups showed increased EMG during inspiration preceding the cough (CLD group 49.3% into inspiration, control 60.7%). Maximum PFM activity occurred 0.20 ± 0.47 ms after onset of the cough for CLD group versus 0.14 ± 0.21 ms in control group. The end of the EMG increased activity occurred 90% into the cough in both subject groups. Compared to coughs, huffs were of longer duration, with EMG activity sustained to end of the huff. There were no significant differences between the groups with respect to cough and huff measurements. The reasons why subjects with CLD experience incontinence appears not to be due to differences in PFM strength or timing of contractions but reduced endurance with prolonged/paroxysmal coughing.

## The effect of a physiotherapy pelvic floor muscle training program on women with chronic cough and self reported urinary incontinence

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The value of physiotherapeutic pelvic floor muscle (PFM) training has been established in a variety of contexts, however, it has not been investigated in chronic lung disease (CLD) associated with chronic cough and urinary incontinence (UI). The aim was to determine whether PFM training would benefit women with CLD and chronic cough and UI. Ten women (28–70 years) with CLD (four CF, six COPD) and UI were treated with exercise, electrical stimulation, biofeedback and bladder training by a qualified continence physiotherapist with up to five appointments over three months. Patients in this case series were assessed independently before (A x 1), at the end of treatment (A x 2) and three months later (A x 3). Outcome measures were EMG (maximum voluntary contraction at 1 second (MVC 1) and 20 seconds (MVC 20)), ultrasound (US) index and number of leakage episodes. The results for each measure recorded at A x 1, A x 2 and A x 3 together with percentage change from A x 1 to A x 3 respectively. Using EMG ( $\mu$ V) for MVC 1: A x 1 = 5.19; A x 2 = 4.59; A x 3 = 9.23; 63.5%. For MVC 20: 2.41; 3.86; 7.6; 153.5%. Using US (mm) for MVC 1: 2.15; 0.3; 5.95; 44.5%. To measure change in PFM function during cough and huff using US (mm): cough: –33; –16.6, –18.95; 44.5% and huff: –28; –15.5; –15.9; 48.5%. The number of leakage episodes before treatment averaged 18.5 ± 16.1, and 5.8 ± 7.0 following A x 2 ( $p = 0.01$ ). These results demonstrate an objective improvement in parameters related to urinary incontinence following state of the art treatment by continence physiotherapists in women with chronic cough including those with cystic fibrosis and COPD.

### 6-minute walk distance in healthy Western Australians aged 55–75 years

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The 6-minute walk test (6MWT) is the most commonly used exercise test in pulmonary rehabilitation yet the paucity of 6-minute walk distance (6MWD) reference values from population based samples limits data interpretation. This study determined 6MWD in a population based sample of healthy Western Australians and identified predictors of 6MWD. Seventy healthy subjects (33 males), aged 64.5 ± 5.2 yr (mean ± SD) performed three 6MWTs, separated by 20 min rest, using a standard protocol. Heart rate (HR) was measured each minute during the test. 6MWD was defined as the maximum distance walked over the three tests. Mean 6MWD ± SD was 659 ± 62m (range 484–820m) and was higher in males than females (690 ± 53m vs 631 ± 57m,  $p < 0.001$ ). A small but significant learning effect was demonstrated with 6MWD increasing by 18 ± 30m ( $p < 0.001$ ) and 10 ± 17m ( $p < 0.001$ ) between test 1 and 2 and test 2 and 3 respectively. Maximum HR achieved on the 6MWT was 87 ± 13% predicted maximum HR (%<sub>pred</sub> HR<sub>max</sub>). 6MWD was significantly correlated with height ( $r = 0.54$ ,  $p < 0.01$ ) and forced expiratory volume in one second (FEV<sub>1</sub>) ( $r = 0.48$ ,  $p < 0.001$ ). Height and FEV<sub>1</sub> were independent contributors ( $p < 0.05$ ) to 6MWD and explained 34% of the variance. The addition of %<sub>pred</sub> HR<sub>max</sub> increased the amount of variance explained to 48%. Measured 6MWD was significantly higher than predicted values obtained from 3 previous studies ( $p < 0.05$ ). This is the first study to report 6MWD in a population based sample of healthy Western Australians. 6MWD in this population significantly exceeds predicted 6MWD obtained from published equations.

### Reduction in hospital admissions following pulmonary rehabilitation in chronic obstructive pulmonary disease

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Patients with chronic obstructive pulmonary disease (COPD) are high users of health care resources with hospital admission representing the largest component of direct costs. Pulmonary rehabilitation (PR) has been reported to decrease health care utilisation in this population. High levels of usual physical activity have been shown to reduce the risk of readmission to hospital, whereas poor quality of life (QOL) increases the risk. We report hospital admissions and length of stay (LOS) for COPD exacerbations in patients who completed an outpatient PR program. Two hundred and eighty-one patients (176 male), aged 67.4 ± 8.6 years (mean ± SD) and forced expiratory volume in one second (FEV<sub>1</sub>) 0.98 ± 0.48 l, 39.4 ± 18.4%<sub>pred</sub> entered PR. Number of hospital admissions and LOS<sub>pred</sub> data were collected for the 12-month period prior to and following PR. Two hundred and eight (74%) patients completed

PR and 73 failed to complete mainly due to illness and transport problems. FEV<sub>1</sub> and 6-minute walk distance were significantly lower in the non-completers (0.8 ± 0.4 l vs 1.0 ± 0.5 l,  $p = 0.003$ ; 324 ± 112 m vs 397 ± 121 m,  $p = 0.003$ , respectively), however there was no difference in QOL (Chronic Respiratory Disease Questionnaire). In patients who completed the program there was a reduction in the number admitted to hospital (74 to 40), in total number of admissions (124 to 65) and in total LOS (1116 to 494 days) following PR. Patients who completed PR were admitted to hospital less in the following 12 months, thus contributing to a reduction in the cost associated with hospitalisation.

### Medical inpatient long stay project: North Metropolitan Health Service (NMHS) in Western Australia

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Patients with chronic lung disease were identified as generating high volumes of medical activity in the NMHS. The aim of this project was to develop strategies to reduce length of stay (LOS) and frequent admissions in this population on the respiratory medicine ward at Sir Charles Gairdner Hospital. The project had three components: an audit of the adherence to clinical practice guidelines (COPDX) for the management of an exacerbation of chronic obstructive pulmonary disease (COPD); identification of barriers to earlier discharge for long stay patients (> 14 days) and the implementation of process change to reduce LOS using Plan-Do-Study-Act cycles; and identification of patients who were frequent admitters (≥ 2 admissions in 6-month period) and establish reasons for their presentations. Eighty-six patients admitted with COPD were audited over a 3-month period. Management was in line with the guidelines with the exception of nebuliser use for inhaled bronchodilators (median use 6 days) and intravenous versus oral antibiotic use (41 patients [50%] intravenous). During the 6-month study period there was an increase in separations (423 vs 432) and a decrease in total bed days (4457 vs 4159 days) compared with the previous year resulting in a reduction in the average LOS (9.6 vs 10.5 days). Twenty-two patients were identified as being 'frequent admitters' and 58% felt they could have coped at home with additional services during their acute illness. This project identified strategies to reduce hospitalisation in patients with chronic lung disease.

### The effects of breathing retraining techniques on end-tidal CO<sub>2</sub> measures in patients with asthma and healthy volunteers during a single treatment session

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Physiotherapists and others routinely use breathing retraining to treat patients with symptoms of dysfunctional breathing (e.g. asthma). One of the hypotheses underpinning this practice is that patients with dysfunctional breathing have lower CO<sub>2</sub> levels and are more sensitive to CO<sub>2</sub> than

healthy controls. It is suggested that altering the breathing pattern will raise individuals' CO<sub>2</sub> levels and that this 'desensitises' patients to CO<sub>2</sub> and hence reduces the sensation of breathlessness. In this pilot crossover study 11 patients with asthma and five volunteers with no lung pathology were taught two breathing techniques to assess the effect on end-tidal CO<sub>2</sub> (ETCO<sub>2</sub>) levels. Baseline data consisted of demographic and anthropometric data, lung function data, Nijmegen questionnaire, Hospital Anxiety and Depression Scale (HAD), ETCO<sub>2</sub> and O<sub>2</sub> saturations (SpO<sub>2</sub>). The intervention consisted of two routine breathing techniques ('slow breathing' and 'breath-holds') taught in random order by a senior clinical physiotherapist. Measures of ETCO<sub>2</sub>, SpO<sub>2</sub>, pulse and respiratory rate were recorded non-invasively before, during and after each intervention using a capnograph (BCI Sleep Capnocheck). Slow breathing resulted in a significant rise (mean 0.58 kPa, SD 0.28) in ETCO<sub>2</sub> levels during the intervention ( $p < 0.001$ ). In participants with asthma, statistically significant changes in ETCO<sub>2</sub> were also detected during five minutes quiet breathing after breath holds. This study lends support to the theory that ETCO<sub>2</sub> can be raised by manipulating breathing pattern.

### Inspiratory muscle fatigue persists following successful weaning from mechanical ventilation

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Respiratory muscle weakness and fatigability has been demonstrated in ventilated patients. However, its relationship to the duration of mechanical ventilation is not known. The aim of this study was to assess respiratory muscle endurance and its relationship to duration of mechanical ventilation following discharge from the intensive care unit (ICU). Twenty subjects who were ventilated  $\geq 48$  hrs and successfully discharged from ICU were recruited. FEV<sub>1</sub>, FVC and maximal inspiratory pressure (MIP) at functional residual capacity (FRC) were recorded. The MIP attained following resisted inspiration at 30% of initial MIP for 2 minutes was recorded and fatigue resistance index (FRI = MIP final/MIP initial) calculated. The durations of ICU stay (ICULOS), mechanical ventilation (MVD) and weaning (WD) and Charlson Co-morbidities Score (CCS) were also recorded. Relationships between fatigue and other parameters were analysed using Spearman's rho correlations. Subjects were admitted to ICU for a mean (SD) of 7.7 (3.7) days and required mechanical ventilation for a mean (SD) of 4.6 (2.5) days. FRI (SD) was 0.88 (0.13), indicating a 12% fall in MIP, and was negatively correlated with MVD ( $r = -0.65, p = 0.007$ ). No correlations were found between FRI and FEV<sub>1</sub>, FVC, ICULOS, WD or CCS. Patients mechanically ventilated for more than 48 hours have reduced inspiratory muscle endurance that worsens with the duration of mechanical ventilation and is present following successful weaning. These data suggest that patients needing prolonged mechanical ventilation are at risk of respiratory muscle fatigue and may benefit from respiratory muscle training.

### Ventilatory changes following head-up tilt and standing in healthy subjects

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Passive tilting increases ventilation in healthy subjects, however controversy surrounds the proposed mechanism. This study aimed to evaluate the possible mechanism for changes to ventilation following passive head-up tilt (HUT) and active standing by comparison of a range of ventilatory, metabolic and mechanical parameters. Ventilatory parameters (tidal volume (V<sub>T</sub>), minute ventilation (V<sub>E</sub>), ventilatory equivalent for O<sub>2</sub> (V<sub>E</sub>/VO<sub>2</sub>), ventilatory equivalent for CO<sub>2</sub> (V<sub>E</sub>/VCO<sub>2</sub>), respiratory rate (f) and end-tidal carbon dioxide (PetCO<sub>2</sub>), functional residual capacity (FRC), respiratory mechanics with impulse oscillometry, oxygen consumption (VO<sub>2</sub>) and carbon dioxide production (VCO<sub>2</sub>) were measured in 20 healthy male subjects whilst supine, following HUT to 70° and unsupported standing. Data were analysed using a linear mixed model. HUT to 70° from supine increased V<sub>E</sub> ( $p < 0.001$ ), V<sub>T</sub> ( $p = 0.001$ ), V<sub>E</sub>/VO<sub>2</sub> ( $p = 0.020$ ) and V<sub>E</sub>/VCO<sub>2</sub> ( $p < 0.001$ ) with no change in f ( $p = 0.488$ ). HUT also increased FRC ( $p < 0.001$ ) and respiratory system reactance (X5Hz) ( $p < 0.001$ ) with reduced respiratory system resistance (R5Hz) ( $p = 0.004$ ) and PetCO<sub>2</sub> ( $p < 0.001$ ) compared to supine. Standing increased V<sub>E</sub> ( $p < 0.001$ ), V<sub>T</sub> ( $p < 0.001$ ) and V<sub>E</sub>/VCO<sub>2</sub> ( $p = 0.020$ ) with no change in f ( $p = 0.065$ ), V<sub>E</sub>/VO<sub>2</sub> ( $p = 0.543$ ). Similar changes in FRC ( $p < 0.001$ ), R5Hz ( $p = 0.013$ ), X5Hz ( $p < 0.001$ ) and PetCO<sub>2</sub> ( $p < 0.001$ ) were found when compared to HUT. In contrast to HUT, standing increased VO<sub>2</sub> ( $p = 0.002$ ) and VCO<sub>2</sub> ( $p = 0.048$ ). The greater increase in V<sub>E</sub> in standing compared to HUT may be related to increased VO<sub>2</sub> and VCO<sub>2</sub> associated with increased muscle activity in unsupported standing. This has implications for exercise prescription and rehabilitation of critically ill patients who have reduced cardiovascular and respiratory reserve.

### A pain in the neck — musculoskeletal complications following cardiac surgery

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Although cardiothoracic physiotherapists may be aware of musculoskeletal complications following cardiac surgery, little investigation has been made in this area. The aim of this analytical cross-sectional study was to describe the percentage of patients affected by musculoskeletal pain after open-heart surgery, identify factors associated with its development, and current treatment options employed. Over a 6-month period, 53 cardiac surgery attendees at the cardiac rehabilitation phase 2 program at Princess Alexandra Hospital were surveyed. The survey was given to 11 women and 42 men (mean age = 61.0 years) two weeks following commencement of their cardiac rehabilitation program, and included questions on preoperative pain, postoperative pain (immediate and post discharge), and

any treatment received. Musculoskeletal pain was a considerable problem amongst patients surveyed. The incidence of pain during hospitalisation was 55%, and post discharge was 64%. Of those who reported postoperative pain during hospitalisation, the pain experienced was not pre-existing in 76%. The relative risk for developing pain only after discharge from hospital was significantly greater for patients who did not have coronary artery bypass surgery (relative risk [95% CI]: 3.4 [1.18, 9.86]). For 45% of all respondents, pain was reported both during hospitalisation and in the period following discharge, while for 19% pain was experienced only during the period following discharge. The current management for this problem is inconsistent. Further research is required to determine the severity of this condition and the impact it has on recovery.

### **Effect of acu-TENS on recovery heart rate after treadmill running exercise in normal healthy subjects**

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This study aims to investigate the effect of acu-TENS, applied at bilateral PC 6, on recovery heart rate (HR) in healthy male subjects after treadmill running exercise. A single blinded, randomised controlled trial was undertaken in 28 subjects (mean age  $\pm$  SD 26.96  $\pm$  4.36 yrs). Each subject participated in three protocols, in random order. During Protocol A the subjects ran on a treadmill adopting the Bruce protocol until their HR reached 70% of their maximum (220-age). At the 'target' HR, the subject immediately adopted the supine position and acu-TENS to bilateral PC 6 was commenced. HR was recorded at 2-minute intervals until it returned to the pre-exercise baseline. Protocol B was identical to protocol A except that acu-TENS was applied in supine position for 45 minutes prior to exercise rather than post exercise. Protocol C was identical to protocol A except that placebo acu-TENS was applied. The time for HR to return to baseline was compared for each protocol. acu-TENS applied to bilateral PC 6 resulted in a faster return to pre-exercise HR compared to placebo. Time ( $\pm$  SD) required for HR to return to pre-exercise level in protocols A, B and C was 5.5  $\pm$  3.0; 4.8  $\pm$  3.3; 9.4  $\pm$  3.7 minutes respectively ( $p < 0.001$ ). There was no statistical difference in HR recovery time between protocols A and B. Subjects expressed the lowest rate of perceived exertion (RPE) score at 70% maximum HR during protocol B. This study suggests that pre-exercise acu-TENS over PC6 may facilitate HR recovery after high intensity treadmill exercise.

### **Does weekly phase 3 cardiac rehabilitation program help increase exercise tolerance in patients following bypass graft surgery? Is more necessary?**

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This pilot study examined the effects of a combined (hospital and home based) approach to cardiac rehabilitation (CR). Nineteen consecutive patients referred for CR at

the Cardiothoracic Centre and Broadgreen Hospital were enrolled following coronary artery bypass graft surgery. Appropriate individualised exercise prescription was done based on submaximal incremental exercise testing performed on a cycle ergometer before and after the ten week CR program. The Specific Activity Scale (SAS), a quality of life questionnaire determining functional activity, was also completed before and after CR. The ten-week intervention phase 3 CR program included once a week supervised circuit training in the hospital followed by a relaxation session. Patients were encouraged to exercise at home and fill out an activity log on the remaining days. The patients also attended an education program. There was a significant increase in exercise tolerance post CR as measured by total time in minutes ( $p = 0.0003$ ), calculated oxygen consumption ( $\text{VO}_2$ ) ( $p = 0.048$ ) and MET level ( $p = 0.008$ ) at the termination of exercise. Further analysis at a submaximal workload of 50 watts showed a significant decrease in the rate-pressure product ( $p = 0.024$ ) and the diastolic blood pressure ( $p = 0.007$ ) at that level. The SAS showed that all except 2 subjects showed an improvement in their functional capacity. We conclude that this model is a clinically effective model to deliver optimal rehabilitation to low risk patients. It could be a good pilot for further randomised control trial and long term follow up.

### **Rehabilitation in the intensive care unit — a survey of current practice within the Trust**

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The aim was to determine the percentage of patients receiving rehabilitation and type of rehabilitation techniques used at different modes of ventilation and stages of weaning in four intensive care units (ICU) within the University Hospital Birmingham, UK. Fifty-eight (54.2 %) patients received rehabilitation out of the 107 patients seen by physiotherapists. The length of ICU stay was 7.7  $\pm$  9.3 days (range 1–38) of which 4.7  $\pm$  8.1 days (range 0–35) were spent on the ventilator. The mean number of days the patients received rehabilitation was 3.6  $\pm$  4.6 days (range 1–26). Eighty-one percent of patients received rehabilitation when self-ventilating ( $n = 47$ ), 27.5% patients ( $n = 16$ ) on spontaneous mode of ventilation, 18.9% patients ( $n = 11$ ) on synchronised intermittent mandatory ventilation (SIMV) and 13.7% patients ( $n = 8$ ) on continuous positive airway pressure (CPAP) mode of ventilation. Commonly used rehabilitation techniques whilst on the ventilator were passive, active-assisted and active exercises respectively. Furthermore, in spontaneous mode of ventilation, patients underwent spot march (8.6%), ambulation or tilt-table (5.1%), active or hoist transfer bed to chair (3.4%) and sitting edge of bed (1.7%). When self-ventilating, the preferred rehabilitation techniques were transfer bed to chair or active exercises (23.8%), spot march (18.3%), passive exercises (17.4%), ambulation (13.7%), hoist bed to chair or active-assisted exercises (10%), standing hoist or sitting edge of bed (4.5%) and tilt table (1.8%). This is very useful data representing the current practice of a team of cardiothoracic physiotherapists. It can be used for the preparation of evidenced-based guidelines and to identify research questions like the effects of rehabilitation on weaning.

### **Effects of upper limb movements in patients**

## with sternal instability — implications for physiotherapy

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Seven patients who had an unstable sternum as a complication after cardiac surgery carried out routine upper limb movements. A clinical ultrasound unit was adapted using a microphone stand and an adjustable pole positioned so that the ultrasound head could be brought into contact with the chest of a seated patient. During a selected regime of upper limb positions, the amount of bony separation at different vertical points on the sternum, which could be observed in the projected image, was measured. Proprietary software supplied with the unit enabled calculation of the gap between the two sides of the sternum from cursor points on the monitor screen. Test-retest reliability for sternal separation measurement at the varying upper limb positions was high and ranged between 0.77 and 0.93. Both unilateral and unilateral loaded positions were found to be significantly associated with sternal pain ( $p = 0.009$ ). The amount of sternal separation over 51 positions was significantly associated with pain for only one case. This was the patient with the largest resting sternal separation, who reported pain when any upper limb movement caused his sternum to separate by more than 3.4cm. In this group of patients with sternal instability, bilateral upper limb movements were significantly less associated with sternal pain than unilateral movements. Accordingly, bilateral upper limb movements can be recommended for the postoperative management as well as the cardiac rehabilitation of all cardiac surgery patients, who as a group have an essentially unstable sternum in the acute postoperative period.

## Effect of airway clearance techniques on the efficacy of the sputum induction procedure

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Sputum induction is used in the early identification of tuberculosis and pneumocystis infections of the lung. Although 75% of Australian hospitals incorporate physiotherapy techniques to clear the airways in the sputum induction procedure, their efficacy in this setting is unknown. This randomised, crossover trial enrolled adults referred for sputum induction for suspected tuberculosis and pneumocystis infections of the lung. All participants underwent two sputum induction procedures, inhaling 3% saline via ultrasonic nebuliser, on two different days within a five-day period. During one randomly allocated procedure, airway clearance techniques (chest wall percussion, vibration, huffing) were incorporated. Fifty-nine participants completed the trial. The airway clearance techniques had no significant effect on how the test was tolerated, the volume of the expectorate and the quality of the sample obtained (assessed by the presence of alveolar macrophages). The techniques did not significantly affect how often the test identified a suspected organism, nor the sensitivity and specificity of sputum induction. We were

unable to demonstrate any effect of the airway clearance techniques on the procedure. Our results provide some justification for not including airway clearance techniques as part of the sputum induction procedure.

## The effect of bi-level non-invasive ventilation on mucociliary clearance in subjects with cystic fibrosis

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The effect of non-invasive ventilation (NIV) on mucociliary clearance in cystic fibrosis (CF) has not been evaluated. This study examined the effect of NIV on the clearance of secretions from the whole right lung, the central region and the peripheral region in subjects with CF. Ten adults with CF, mean (range) age of 27 (18–37) years and FEV<sub>1</sub> of 64 (31–98)%<sub>pred</sub> participated. Each subject underwent two mucociliary clearance studies, each involving the inhalation of <sup>99m</sup>Tc-labelled sulphur colloid aerosol while matching a target breathing pattern, followed by a 90 min dynamic SPECT scan with a triple head gamma camera. Subjects received NIV throughout one 90 min scan applied via full face mask (Inspiratory Positive Airway Pressure [IPAP] 15cmH<sub>2</sub>O, Expiratory Positive Airway Pressure [EPAP] 5cmH<sub>2</sub>O) and breathed spontaneously on room air during the other scan, in randomised order. The mean percentage of secretions cleared from each region of interest at 90 min (%C90) was calculated for each condition. No significant differences in %C90 were identified. The mean %C90 for the whole lung was 4% higher on the control day (95%CI 3–11,  $p = 0.23$ ). In the central region, mean %C90 was 9.6% higher on the control day (95%CI 8–27,  $p = 0.14$ ). In the peripheral region, mean %C90 was 1% higher on the NIV day (95%CI 8–10,  $p = 0.88$ ). NIV alone does not have a significant effect on whole lung or regional mucociliary clearance in CF.

## The effect of manual chest physiotherapy, positive expiratory pressure (PEP) and oscillating PEP on mucociliary clearance in subjects with cystic fibrosis

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The aim was to measure the effect of postural drainage with percussion and vibration (PDPV); positive expiratory pressure (PEP); and oscillating PEP on mucociliary clearance in subjects with cystic fibrosis (CF). Twelve adults with CF, mean (range) age of 25 (17–34) years and FEV<sub>1</sub> of 53 (16–88)%<sub>pred</sub> participated. Subjects underwent five mucociliary clearance studies, each involving the inhalation of <sup>99m</sup>Tc-labelled sulphur colloid aerosol while matching a target breathing pattern, followed by a 10-min baseline dynamic SPECT scan with a triple head gamma camera, a 30-min intervention period, and a subsequent 90-min scan. During the intervention period on the first four studies, subjects performed 20-min of PDPV, PEP, oscillating PEP, or rest in sitting (control) in randomised order. During the intervention period on the fifth study, subjects voluntarily coughed the maximum number of times they had coughed during any of the previous

intervention periods (matched cough). The mean percentage of radioactivity cleared from each region of interest during the intervention period (%C30) was the primary outcome. The mean %C30 for the whole lung with PDPV was 8.4% greater than on the control day (95%CI 2.4–14.5,  $p = 0.017$ ). Although %C30 was also greater with the other interventions and matched cough than with control, none reached statistical significance. No intervention produced a significant increase in the rate of clearance during the 90-min post intervention scan. A 20-min treatment of PDPV significantly accelerates mucociliary clearance in adults with CF.

### **Self efficacy and quality of life status of people with HIV are improved with participation in a supervised exercise program**

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With combination antiretroviral therapy, HIV has become a chronic, manageable medical condition. Medication adherence is now a critical determinant of patient outcomes. Quality of life (QOL) rather than just survival has also become an important consideration in HIV management strategies. The role of non-pharmacological interventions such as exercise to enhance QOL and self-efficacy, which correlate with medication adherence among people with HIV, requires formal investigation. We evaluated the impact of a supervised exercise program (SEP) on self-efficacy among people with HIV in a 24-week, randomised controlled trial of participation in a SEP of combined aerobic and resisted exercise (intervention) versus an individual walking program with monthly group forum (control). Quality of life and cardiovascular fitness were also evaluated as secondary endpoints. Twenty subjects were enrolled in each arm, and assessments were performed at baseline, two month and six months, including a Generic Self-Efficacy Scale, 1-minute heart rate response post 3-minute step test, and a validated HIV-specific QOL survey. Self-efficacy and cardiovascular fitness improved in the intervention but not the control subjects over the study period ( $p < 0.0001$  for both). Quality of life also improved (8 out of 10 dimensions) in the intervention group but not in controls (0 out of 10 dimensions). These data support the use of SEP as an important therapeutic intervention for people with HIV with significant benefits to self-efficacy, cardiovascular fitness and QOL over six months. Importantly, these benefits were not achieved through unsupervised exercise over the same period.

### **A comparison of expiratory pressures on volumes and peak cough expiratory flows using mechanical insufflation/exsufflation in subjects with neuromuscular disease**

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Mechanical insufflation/exsufflation (MI-E) has been demonstrated to be a useful adjunct to clearing secretions in people with neuromuscular disease (NMD). The aim of this study was to compare the peak inspiratory and expiratory volumes and flows produced using MI-E with a set insufflation pressure and a variety of exsufflation pressures in subjects with NMD. An experimental, same subject, randomised, repeated measures design was prospectively planned with a sample of convenience obtained. In a seated position, subjects were asked to take three deep breaths and on the fourth to take a large inspiration to full inspiratory capacity and perform a cough which was unassisted (0cm H<sub>2</sub>O insufflation and exsufflation: Condition 1) or assisted (+20 insufflation and either 0, -20 or -40 cm H<sub>2</sub>O exsufflation: Conditions 2, 3 or 4) depending on randomisation. Measurements were recorded using a pneumotachograph inserted within the framework of the machine. Six subjects (2 male) completed the study protocol. A repeated measures analysis of variance (ANOVA significance  $p < 0.05$ ) calculated differences between settings for flow and volume. Positive inspiratory pressure had a significant effect on flow ( $p = 0.01$ ). Negative pressure had a significant effect on expiratory flow ( $p = 0.031$ ). A significant increase was also found for inspiratory volume ( $p = 0.001$ ) and expiratory volume ( $p = 0.028$ ). A significant effect of MI-E on inspiratory and expiratory flows and volumes was found in this study. Whilst the sample size was small, all subjects appear to generate the greatest increases in flow and volume with MI-E set at +20, -20 cm H<sub>2</sub>O.

### **Acupuncture and breathing retraining for the treatment of hyperventilation syndrome: a preliminary crossover trial**

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Sustained and subtle hyperventilation can result in a wide variety of symptoms, leading to a chronic condition which has been termed hyperventilation syndrome (HVS). Anxiety is recognised as being a major component of this condition. Current treatment options include physiotherapy in the form of breathing retraining techniques. The aim of this study was to evaluate whether acupuncture is an appropriate treatment for HVS to reduce anxiety, and whether a crossover trial is an appropriate study design. A single-blind crossover trial was carried out comparing the effects of acupuncture and breathing retraining on patients with HVS. Ten patients diagnosed with HVS were recruited to the trial and randomised into two groups. Both groups received acupuncture and breathing retraining with a washout period of one week. The primary outcome measure used was the Hospital Anxiety and Depression Scale (HAD). Other outcome measures used were the Nijmegen questionnaire, Medical Research Council Dyspnoea scale and the Short Form 36 (UK version). The results showed

statistically significant treatment differences between acupuncture and breathing retraining. These improvements were found in the HAD A (anxiety) ( $p = 0.02$ ), Nijmegen (symptoms) ( $p = 0.02$ ) and emotional role (SF36) ( $p = 0.01$ ) scores. There was no evidence of any carryover effects. This preliminary study suggests that acupuncture may be beneficial in the management of HVS and that a crossover trial is an appropriate study design to assess its effects.

### Number of re-intubations: a possible outcome measure to evaluate the physiotherapy service provided in the intensive care unit?

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The object of this prospective cohort observational study was to describe the baseline data of a 10 bed closed surgical intensive care unit (ICU) in a university affiliated tertiary hospital in South Africa. Demographic information, admission diagnosis, co-morbidities and APACHE II score of all patients admitted to the ICU from June to September 2003 were recorded on admission. Physiotherapy techniques, frequency and duration of treatment sessions, and diagnosis of pulmonary complications were recorded daily. Total time of mechanical ventilation and the number and reasons for re-intubations were recorded. One hundred and sixty patients (mean age 49 years (SD 19.95)) with mean APACHE II score 12.3 (SD 7.19) were admitted. Despite routine daily physiotherapy for all patients, 39% ( $n = 62$ ) developed excessive secretions, 30% ( $n = 48$ ) were diagnosed with pneumonia and 27% ( $n = 43$ ) with basal atelectasis. Sixty-three percent ( $n = 100$ ) of patients were intubated and ventilated for a mean of 3.16 days (SD 5.98). Fifty-seven re-intubations were recorded with excessive secretions the reason documented most often ( $n = 30$ ). Every re-intubation resulted in a further mean time of 3.8 days (SD 6.30) on the ventilator. The development of excessive secretions and pneumonia ( $p < 0.001$ ) and basal atelectasis ( $p = 0.003$ ) significantly increased the ventilator time, while neither age nor APACHE II score nor co-morbidities significantly influenced this time. In this cohort, excessive secretions had the most significant impact on ventilator time and number of re-intubations. The potential value of these two outcomes to measure the efficacy of an evidence-based physiotherapy service in ICU should be explored.

### The use of transdiaphragmatic pressure as an indicator of voluntary relaxation of the diaphragm in a normal subject

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Previous studies of regional ventilation which used swallowed balloon catheters to provide feedback of transdiaphragmatic (Pdi) pressure, assumed that a Pdi of 0cmH<sub>2</sub>O during inspiration indicated that the subject had 'voluntarily' relaxed the diaphragm. We questioned whether it was possible to voluntarily relax the diaphragm using Pdi as feedback. Using a single subject design, diaphragmatic movement was recorded with ultrasound. Inspiratory volume and flow rate were controlled and the position of the diaphragm at functional residual capacity (FRC) was

marked using the ultrasound software. The ultrasound screen was not visible to the subject, who was asked to breathe using only the upper chest, keeping the diaphragm relaxed. Without the balloon catheters in place, the diaphragm descended in a caudal direction during inspiration (mean 18.75mm), returning to within 7 mm of the position at FRC at end expiration. With the balloon catheters in place and the subject attempting to keep Pdi = 0cm H<sub>2</sub>O, the diaphragm again descended in a caudal direction during inspiration (mean 17.9 mm). However, at the start of each inspiration the diaphragm was upwardly displaced in a cephalad direction from FRC (mean 16.4 mm). Inspiration therefore commenced at a lower lung volume during upper chest breathing when Pdi feedback was used. At no time did the diaphragm move in a cephalad direction during inspiration. We conclude that Pdi of 0cmH<sub>2</sub>O may have indicated passive recoil of the lengthened diaphragm due to abdominal contraction and relaxation, rather than voluntary relaxation of the diaphragm.

### High intensity exercise training reduces ventilation and carbon dioxide output in subjects with type 1 diabetes during maximal constant load exercise

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Pulmonary function and performance may be reduced during exercise in diabetes, however failure to match fitness levels in subjects with type 1 diabetes (T1D) and non-diabetic controls (CON) may contribute to this finding. We previously demonstrated that intense exercise training improved performance and reduced ventilation during maximal exercise in CON. Effects of intense training on respiratory variables are unknown in T1D. This study investigated the effects of high intensity exercise training on ventilatory responses to maximal constant-load exercise in eight subjects with T1D and 7 CON matched for fitness, age and body mass index. Subjects exercised to fatigue at 130% pre-training peak oxygen consumption ( $VO_{2peak}$ ) before and after seven weeks of cycle training. Additionally, after training, subjects performed another test in which pre and post training work was identical (PostM). Minute ventilation ( $V_E$ ) and mixed expired fractions of O<sub>2</sub> and CO<sub>2</sub> were determined and oxygen consumption ( $VO_2$ ), carbon dioxide output ( $VCO_2$ ), and ventilatory equivalents for O<sub>2</sub> ( $V_E \cdot VO_2^{-1}$ ) and CO<sub>2</sub> ( $V_E \cdot VCO_2^{-1}$ ) were calculated. After training, in PostF, performance was improved in both groups ( $p < 0.001$ ). In PostM, mean  $V_E$  ( $p = 0.05$ ),  $VCO_2$  ( $p = 0.02$ ), and  $V_E \cdot VO_2^{-1}$  ( $p = 0.03$ ) were lower, and  $V_E \cdot VCO_2^{-1}$  was unchanged compared with Pre. Interestingly, mean  $V_E \cdot VCO_2^{-1}$  was lower across all three tests in T1D ( $p = 0.04$ ). High intensity exercise training improved performance, reduced the ventilatory demand, and reduced  $VCO_2$  during maximal exercise in subjects with and without diabetes. Despite this, lower  $V_E \cdot VCO_2^{-1}$  may indicate reduced CO<sub>2</sub> sensitivity in T1D.

## Reliability of physiological and motor measures in inpatient children with cystic fibrosis during four motor tasks

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This dual study aimed to investigate the test-retest reliability of the six-minute walk test (6MWT) and a set of three self-paced motor tasks in a group of children with cystic fibrosis (CF) hospitalised due to pulmonary exacerbation. Reliability of these measures was investigated using physiological measures of heart rate and oxygen saturation (via pulse oximetry), motor measures (distance walked and number of cycles performed before fatigue) and measures of breathlessness (modified Borg scale, visual analogue scale of perceived breathlessness and fifteen-count breathlessness score). Sixteen children with CF aged 7–17 years (mean = 13.10 ± 2.65) with a range of disease severity performed the 6MWT, Astride Jumps, Forwards-Backwards Jumps and the Face-Stand Manoeuvre. Reliability of all outcome measures was determined using a Cronbach's alpha Two-Way Mixed Intra-Class Correlation (ICC). The effects of gender, age and forced expiratory volume in one-second (FEV<sub>1</sub>) status on reliability of measures were examined using the Mann-Whitney U Test. The effect of task order was examined using the Kruskal-Wallis test. Moderate to high test-retest reliability (ICC = 0.54–0.94) was found for all measures regardless of gender, age, FEV<sub>1</sub> status or task order ( $p < 0.05$ ), except for recovery time of heart rate and oxygen saturation following activities. This study contributes to the evidence base for practice, confirming the clinical usefulness of these performance measures in children with CF within the acute inpatient setting.

## High-intensity inspiratory muscle training improves dyspnoea and health related quality of life in chronic obstructive pulmonary disease

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Interval-based high-intensity inspiratory muscle training (HIMT) is well tolerated in patients with chronic obstructive pulmonary disease (COPD). The effects of HIMT on quality of life (QOL), dyspnoea and exercise tolerance are unknown. We performed a double-blind randomised controlled trial comparing HIMT with sham IMT (SIMT) in 33 COPD subjects (22 males; mean forced expiratory volume in one second [FEV<sub>1</sub>] of 42%<sub>pred</sub>). Subjects trained three times a week for eight weeks, using a threshold-loading device. The HIMT group (n = 16) trained at the maximum load tolerable (progressing to 101% of baseline maximum inspiratory pressure (P<sub>imax</sub>)) and the SIMT group (n = 17) 'trained' at 10% of P<sub>imax</sub>. Outcome measures included P<sub>imax</sub>, inspiratory muscle endurance (highest pressure sustained during incremental threshold loading [P<sub>thmax</sub>]), exercise tolerance (six-minute walk distance [6MWD]), QOL and dyspnoea (Chronic Respiratory Disease Questionnaire).

Following HIMT, P<sub>imax</sub> and P<sub>thmax</sub> increased by 28% ( $p < 0.001$ ) and 55% ( $p < 0.001$ ), respectively. Greater gains were seen in dyspnoea and 6MWD following HIMT compared with SIMT (1.4 vs 0.8 points per item;  $p = 0.048$  and 27.1 vs 1.6 m;  $p = 0.01$ ). Additionally, in subjects with inspiratory muscle weakness (P<sub>imax</sub> < 70 cmH<sub>2</sub>O) QOL improved following HIMT, compared with SIMT (0.9 vs 0.4 points per item;  $p = 0.02$ ). We conclude HIMT in subjects with COPD improves inspiratory muscle function, yields clinically meaningful reductions in dyspnoea and modest gains in exercise tolerance. In subjects with inspiratory muscle weakness HIMT also confers clinically meaningful improvements in QOL.

## A comparison of two manual resuscitation bags on the early effects of manual lung hyperinflation in critically ill patients

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Manual hyperinflation (MHI) is frequently used by Australian physiotherapists in the treatment of ventilated patients in intensive care, however recent surveys have demonstrated a wide variation in the type of manual resuscitation bag (MRB) used by physiotherapists to perform MHI. Therefore this prospective, randomised, crossover study compared the safety and short term effectiveness of manual lung hyperinflation (MHI) in mechanically ventilated patients using two different manual resuscitation bags (MRB), the Mapleson-C and the Laerdal MRB. Twenty patients from a tertiary level intensive care unit were included. Treatment involved MHI with either the Laerdal or Mapleson-C MRB, patient positioning (side lying) and suctioning. Patients received treatment with two different MRB on the day of data collection. Results demonstrated a significantly greater amount of secretions cleared using the Mapleson-C MRB compared to the Laerdal MRB measured as sputum wet weight ( $p < 0.02$ ). However there was no significant difference for static respiratory system compliance ( $p = 0.81$ ), gas exchange including PaO<sub>2</sub>/F<sub>I</sub>O<sub>2</sub> ( $p = 0.28$ ) and PaCO<sub>2</sub> ( $p = 0.17$ ) between MRB, although there was a trend for static lung compliance to improve with both MRB ( $p = 0.07$ ). There was no effect for order of intervention. In conclusion, total static respiratory system compliance and gas exchange were not significantly different when using either type of MRB for MHI during a physiotherapy treatment of positioning and suctioning in mechanically ventilated patients. However a greater amount of sputum was cleared with the Mapleson-C MRB. The results of this study support previous work in the laboratory setting.

## Expiratory flow limitation is associated with dynamic hyperinflation and chronic dyspnoea in adult cystic fibrosis

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Tidal expiratory flow limitation (EFL) may promote dynamic hyperinflation and play a role in the pathogenesis

of chronic dyspnoea. The aim of this study was to evaluate the prevalence of EFL in adult cystic fibrosis (CF). The presence of EFL was evaluated in 102 adults with stable CF (FEV<sub>1</sub> range 17.3–91.5%<sub>pred</sub>) and 20 control subjects with the Negative Expiratory Pressure (NEP) technique. Subjects were classified as not flow-limited (non-FL), flow-limited in supine (FLSupine) or flow-limited in sitting and supine (FLSeated). Inspiratory capacity (IC) was measured in sitting and supine, and chronic dyspnoea evaluated using the modified Medical Research Council (MRC) scale. Expiratory flow limitation was present in 34 subjects with CF (33.3 %). Sixteen subjects (15.7%) were FLSupine and 18 subjects (17.6%) were FLSeated. FEV<sub>1</sub> was lower in FLSeated subjects (mean FEV<sub>1</sub> 28.5%<sub>pred</sub>, 95%CI 24.9–32.0%<sub>pred</sub>) compared to FLSupine subjects (40.5, 34.8–46.1%<sub>pred</sub>) and non-FL CF subjects (57.3, 53.6–61.0%<sub>pred</sub>). Inspiratory capacity in sitting was reduced in FLSeated subjects ( $p = 0.03$ ) whilst IC in supine was reduced in both FLSeated ( $p = 0.001$ ) and FLSupine subjects ( $p = 0.03$ ) compared to non-FL CF subjects. IC was also reduced in non-FL CF subjects compared to the control group. FLSeated subjects reported higher MRC scores (2.2, 1.8–2.7) than either FLSupine (1.4, 1.1–1.7) or non-FL CF subjects (1.0, 0.9–1.2). Tidal EFL in CF is associated with severe lung disease and dynamic hyperinflation. Flow limitation in sitting is associated with increased levels of chronic dyspnoea.

### Determination of the effects of prone, supine and quarter prone positioning on lung function in preterm infants on CPAP

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The aim of this study was to determine the effects of three commonly used positions on lung function in preterm infants receiving continuous positive airways pressure (CPAP) to assist ventilation. Infant positioning, an integral component of respiratory physiotherapy, is of vital importance in maintaining good lung ventilation. The proposed mechanism is that certain positions facilitate increased lung volumes and reduce the work of breathing thereby optimising oxygen transport and gas exchange. Twenty-four infants with a mean gestational age of 28.6 weeks and a mean birth weight of 1151g who were admitted to the Mater Mothers' Hospital Neonatal Intensive Care Unit and were receiving assisted ventilation via CPAP were measured. Infants were randomised via concealed random allocation to rotate through positions of prone, supine, and quarter-prone, such that all position combinations were completed by four infants. Lung volume was measured using electrical impedance tomography (EIT), a technique reported as valid in monitoring lung recruitment and changes in regional lung ventilation. EIT uses small, safe electrical currents to generate cross-sectional images of the lungs that can be interpreted similarly to a CT scan. Oxygenation was measured via pulse oximetry. Measures were collected 30 min before, and at 30 min and 2 hours after each repositioning. Preliminary results show that ventilation is distributed to the dependent lung. This is in contrast to traditional teaching of regional ventilation which states that ventilation in the neonate is distributed to the uppermost lung.

### Survival and health related quality of life 12 months following discharge from an adult surgical intensive care unit

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This study forms part of a baseline study conducted on patients admitted to the adult surgical intensive care unit (ICU) at Tygerberg Academic Hospital, South Africa between June and October 2003. The aim was to determine the survival rate and health related quality of life (HRQOL) of this cohort at 12 months following discharge. A further aim was to determine the relationship between the HRQOL scores and selected demographic and ICU variables. In this prospective observational cohort study a sample of 83 subjects was obtained from the initial baseline study. Of these the survival rate was 69.8%. The surviving 69 subjects formed the sample to determine the HRQOL. The Short Form-36 version 2 (SF-36v2) and a self-developed questionnaire were used to measure the HRQOL and to obtain the selected variables for comparison. Twenty-three subjects of the sample were lost to follow up therefore 46 completed the questionnaire telephonically. The mean HRQOL scores ranged between 43% and 53% for each of the eight domains and the two component summary scores of the SF-36v2 measure. At 12 months, the cumulative proportion of survivors was 83%. Although the cumulative proportion surviving is comparative to some studies, the actual quality of life scores for this cohort is lower at 12 months following ICU discharge. The relationship between the selected demographic variables and HRQOL is complex, however some results seem to indicate a need for further rehabilitation before and after ICU discharge in order to improve the quality of life of ICU survivors in South Africa.

### Effect of a structured exercise program implemented within 24 hours after extubation on selected outcomes after coronary artery bypass graft

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The aim of this study was to determine the effect of a structured exercise program implemented within 24 hours after extubation on the functional capacity and self-efficacy of patients after uncomplicated coronary artery bypass graft (CABG). A double-blinded, randomised controlled trial was performed over four months. Thirty-eight subjects were randomised into an experimental group ( $n = 17$ ) or a control group ( $n = 21$ ). Subjects in the experimental group performed a structured exercise program implemented within 24 hours after extubation, whereas subjects in the control group performed the routine unstructured mobilisation program. Functional capacity and self-efficacy was tested by means of the 6-minute walk test (6MWT) and Jenkins Self-Efficacy Expectation Scales respectively. Testing was done on discharge and on follow up 10–14 days later. Functional capacity of subjects in the experimental group was significantly higher than that of those in the control group on discharge ( $p = 0.01$ ), however no significant difference was found between the two groups' self-efficacy. On subjects' first follow up visit, there was no significant

difference between the groups in functional capacity or self-efficacy, as the experimental group increased to a lesser degree relative to the control group. While subjects in both groups benefited from doing exercises, subjects in the experimental group initially benefited to a greater extent. A structured exercise program leads to higher levels of functional capacity on discharge and should be encouraged in the inpatient phase of cardiac rehabilitation. Reasons for the insignificant difference found between groups' self-efficacy is being investigated in a follow up study.

### **Does severity of chronic obstructive pulmonary disease affect the benefit of pulmonary rehabilitation?**

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Pulmonary rehabilitation has been shown to be effective in the management of chronic obstructive pulmonary disease (COPD). This retrospective study investigated the influence of severity of lung disease in COPD on the benefit of pulmonary rehabilitation (PR). One hundred and twenty-two patients who completed an eight-week, twice weekly comprehensive outpatient PR program were included. Spirometry, exercise capacity (6-minute walk test) and quality of life (QOL) using the St. George Respiratory Questionnaire (SGRQ) were measured on entry and completion of the program. Data were analysed according to disease severity (forced expiratory volume in one second (FEV<sub>1</sub>): mild: 60% < FEV<sub>1</sub> ≤ 80% (n = 22), moderate: 40% ≤ FEV<sub>1</sub> < 59% (n = 5) and severe: FEV<sub>1</sub> < 40% (n = 45). All groups had a significant improvement in 6-minute walk distance (6MWD), (change (Δ) in 6MWD [SD] mild: 38m [30] (*p* < 0.001); moderate: Δ 41.3m [44.4] (*p* < 0.001) and severe: Δ 30.6m [37.9] (*p* = 0.014)). All groups also had a significant improvement in SGRQ score (Δ SGRQ [SD] mild: -5.7 [13] (*p* = 0.016); moderate: -5.6 [12.6] (*p* = 0.003); severe: -5.5 [13] (*p* = 0.009)). No significance was found in the improvement of both 6MWD and SGRQ between groups. Patients with different severities of COPD had significant improvements in both exercise capacity and QOL. The degree of improvement was not affected by the severity. A larger sample size is needed to further elucidate the effects of disease severity on response to PR.

### **Can field-walking tests be used to prescribe bicycle training in patients with chronic obstructive pulmonary disease?**

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The aim of this study was to investigate the relationship between the 6-minute walk test (6MWT), the incremental shuttle walk test (ISWT) and the incremental bicycle test (IBT) in patients with chronic obstructive pulmonary disease (COPD); and to determine whether bicycle training intensity could be calculated from either the 6-minute walk distance (6MWD) or incremental shuttle walk distance (ISWD). Subjects with COPD performed the 6MWT, ISWT and IBT in random order (repeated measures design). Measurements at one-minute intervals included rate of perceived exertion

(RPE), dyspnoea, distance walked (m), work on the cycle ergometer (watts), metabolic and cardiorespiratory responses (portable COSMED K4b<sup>2</sup>). Both the 6MWT and ISWT were performed twice with data from the best test used for analysis. Twenty-two subjects (11 males) with COPD, FEV<sub>1</sub> 52%<sub>pred</sub> (SD ± 20), FEV<sub>1</sub>/FVC 45% (SD ± 13) completed the study. There was no significant difference in peak work capacity between the 6MWT, ISWT and IBT, as shown by peak oxygen consumption (VO<sub>2</sub>). However, peak carbon dioxide production (VCO<sub>2</sub>), minute ventilation (V<sub>E</sub>), dyspnoea and rate of perceived exertion (RPE) were all significantly higher at end exercise on the IBT compared with the walking tests, which suggests that cycling used a smaller muscle mass to achieve the same VO<sub>2</sub>. The significant relationship between 6MWD and ISWD with the peak watts on the IBT may allow for the prescription of intensity of cycle exercise training from either walking test in patients with COPD.

### **Muscle endurance training and ergonomic workstation modification improves performance of a repetitive manual industrial task in healthy subjects**

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The aim of this study was to examine whether resistance training or workstation modification optimised psychophysical tolerance for a repetitive manual material-handling (MMH) task. A single-blind randomised controlled trial was carried out in a cardiopulmonary research laboratory. Fifty healthy volunteers were initially randomly allocated to perform two MMH tasks to exhaustion in sitting, one requiring repetitive lifting and lowering of a box between waist level and a shelf positioned above-shoulder height, and a modified task in which the shelf was lowered to below-shoulder height. The box weighed 60% of each subject's initial repetition maximum (1-RM) upper limb muscle strength. Subjects were then randomised into an exercise training (experimental) group (n = 25) or a non-training (control) group (n = 25). Training group subjects participated in a task-specific muscle endurance training protocol consisting of 2–3 sets of a 15-RM dynamic resistance exercise, for 18 sessions over a 6-week period. Workstation modification from above shoulder to below shoulder significantly increased endurance time for the MMH task (*p* < 0.001). Compared to the control group, resistance training resulted in significantly greater endurance time, and lower rate of perceived exertion in both the above-shoulder task (*p* = 0.003, < 0.001 respectively), and the modified below-shoulder task, (*p* = 0.04, < 0.001 respectively), but was not significantly different to workstation modification alone. Muscle strength and muscle endurance were significantly improved in the training group (*p* < 0.001, for both). Both task modification and exercise training are recommended to improve performance in repetitive manual industrial tasks.

## The effect of inspiratory time during manual hyperinflation on pattern of ventilation and sputum cleared in intubated patients

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This study investigated the effect of a three-second inspiratory time on pattern of ventilation and wet weight sputum cleared in intubated patients. Thirteen patients in one intensive care unit were recruited. Each patient was seen on two consecutive days by a therapist trained to perform inspiration over three seconds, and another not specifically trained for the purpose of the study. The order of the treating therapists was randomised for day one and reversed on day two. Pattern of ventilation was recorded using a pneumotachometer and pressure transducer. Sputum was collected in a sputum trap and weighed at the end of each treatment. The difference in pattern of ventilation between the trained and untrained therapists was compared using a paired t test. A 2x2 ANOVA (factors: therapist and time of day) was used to compare difference in sputum weight. The trained therapist used a longer inspiratory time (2.65 vs 1.52 s,  $p < 0.001$ ), delivered a larger volume (1.74 vs 1.24 l,  $p = 0.02$ ) and produced a higher peak expiratory flow rate (6.33 vs 3.29 l/s,  $p < 0.001$ ). There was no significant difference between therapists for peak airway pressure and peak inspiratory flow rate. The trained therapist cleared 1.5 times more sputum, however this was not statistically significant. The longer inspiratory time produced a clinically significant, larger volume breath, without a significant increase in airway pressure. This finding suggests that using airway pressure to minimise volutrauma may not be valid. A longer inspiratory time may assist secretion clearance.

## Pattern of ventilation in intubated patients during manual hyperinflation with a Mapleson-F circuit

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There are only a few papers describing pattern of ventilation during manual hyperinflation in intubated patients, and none using a Mapleson-F circuit. In addition, only one or two therapists participated in the studies, and the number of variables reported is limited. The aim of this study was to document pattern of ventilation during manual hyperinflation by physiotherapists with a Mapleson-F circuit. Nine rotating physiotherapists in one intensive care unit were recruited. Twenty-six data sets were collected from 15 patients. Manual hyperinflation was performed using a Mapleson-F circuit with a two-litre bag. The end point for inspiration was a peak inspiratory pressure of 40 cm H<sub>2</sub>O visualised on an inline manometer. An end inspiratory hold was not used. Pattern of ventilation was recorded using a pneumotachometer and pressure transducer. The mean (SE) for the measures of pattern of ventilation were: inspiratory time 1.54 (0.09) s; peak airway pressure (PAP) 35.76 (1.23) cm H<sub>2</sub>O; volume delivered 1.26 (0.07) l; peak inspiratory flow rate 1.42 (0.06) l/s; peak expiratory flow rate 3.14 (0.33) l/s and inspiratory to expiratory flow rate ratio 0.60 (0.05). Inspiratory time was less than the three seconds suggested in the literature. Volume delivered was greater than tidal volume and thus should assist volume

restoration. Peak expiratory flow rate was greater than that previously reported in the patient population for the Laerdal, Mapleson-B and C circuits. The inspiratory to expiratory flow rate ratio met the theoretical requirement to assist secretion movement.

## Flow profiles during huffing in normal subjects

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A huff can be performed from different inspired lung volumes and in various body positions. The effect of inspired lung volume on flow rates during huffing has not previously been reported. The aim of this study was to examine the effect of four starting inspired lung volumes, in sitting and side lying, on peak inspiratory (PIFR) and expiratory peak flow (PEFR) rates and the inspiratory to expiratory (I: E) flow rate ratio during huffing. Twelve normal subjects were recruited. Body position and inspired lung volume were randomised. Subjects were asked to inspire to the desired lung volume and then to huff out. A volumeter was used to control inspired lung volume, and flow rates were measured with a heated pneumotachometer. The effect of body position was analysed with a 2 x 2 ANOVA. Paired t tests were used to compare the effect of inspired lung volume on PIFR, PEFR and I: E flow rate ratio. The inspired lung volumes were full inspiration, and 82.28% (2.42), 68.51% (2.95) and 36.56% (1.32) of full inspiration (mean [SE]). Body position had no significant effect at any inspired lung volume, on the variables reported. Both PIFR and PEFR decreased as inspired lung volume decreased. PEFR for each inspired lung volume was within the range reported to promote secretion clearance. All I: E flow rate ratios were less than 0.9. These findings need to be reproduced in patient populations.

## Chronic obstructive pulmonary disease (COPD) disease severity classification systems — the variability of results when using different guidelines

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This analysis was undertaken to compare six disease severity classification systems commonly utilised to describe subjects with chronic obstructive pulmonary disease (COPD). Disease severity systems have been proposed by the American Thoracic Society (ATS), European Respiratory Society (ERS), British Thoracic Society (BTS), the Thoracic Society of Australia and New Zealand (TSANZ) and The Global Initiative for Chronic Obstructive Lung Disease (GOLD). The observed percentage of predicted forced expiratory volume in one second ( $_{FEV1}$ ) is used to define categories. The spirometry results of 194 subjects with a diagnosis of COPD were analysed. Subjects were divided into four categories of severity: normal, mild, moderate and severe. A comparison of the severity classification systems was undertaken. Analysis demonstrated a large variability in describing a population using the various scales. The percentage of individuals classified with mild COPD ranged between 4.0%–31.2%, moderate 16.1%–62.3% and severe

31.2%–65.8%. These results highlight the importance of acknowledging which classification system has been used in research involving subjects with COPD and draws attention to the need for consensus amongst researchers on which scale will be universally utilised.

### Is the force applied to the chest wall during vibration transmitted to the airways?

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It is unknown whether forces applied to the chest wall during vibration are transmitted to the airways. The aims of the study were to determine if forces of vibration were transmitted through the lung and the relationship between forces and expiratory flow rates. Seven physiotherapists (one male) applied vibration to the chest walls of three healthy subjects. Expiratory flow during vibration was compared to those of passive expiration from total lung capacity (TLC<sub>relax</sub>). The order of interventions was randomised. Measurements were; expiratory flow rates (heated Hans Rudolph pneumotachograph); oesophageal pressure (Jaeger oesophageal catheter (720199) and Validyne pressure transducer (DP 45)); and forces applied to chest wall (instrumented bed which had 7 load cells). The mean (weighted average of subjects' SD) peak intrapleural pressure of vibration and TLC<sub>relax</sub> was 0.73 (0.89) and -1.37 (0.48) respectively. Cross-correlation analysis showed that the relationship between the forces applied to the chest wall during vibration and expiratory flow had a median coherence of 1.0 where for every Newton of force applied there was an increase (mean phase 237 degrees) in flow of 0.01l/s. The forces applied during vibration by physiotherapists are transmitted to the airways. In addition, the oscillatory forces of vibration accounted for all of the variance of the expiratory flow.

### Comparison of vibration to other physiotherapy interventions in subjects with cystic fibrosis

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Vibration is widely used to aid secretion clearance, but the physiological effects of vibration on expiratory flow rates have not been evaluated or compared with other interventions. The main aim of the study was to compare the respiratory flow rates and frequency of airflow oscillation of vibration to those of Acapella, Flutter, positive expiratory pressure (PEP) and percussion. Stable cystic fibrosis subjects were recruited. Each intervention was performed in random order with the same physiotherapist applying all the interventions. The respiratory flow rates were measured with a heated Hans Rudolph pneumotachograph. The difference in flow data were analysed with a post-hoc Dunnett's test of repeated measures ANOVA. Oscillation frequency was determined with power spectral analysis. In the 18 (seven female) subjects, the mean peak expiratory flow rate (PEFR) during vibration was 1.4 times faster than Flutter ( $p = 0.002$ ), 1.9 times faster than percussion ( $p < 0.001$ ), 2.7 times faster than Acapella ( $p < 0.001$ ) and 3.6 times faster than PEP ( $p < 0.001$ ). The peak expiratory flow rate to peak inspiratory flow rate ratio (PEFR/PIFR) of vibration was 1.5 and Flutter was 1.2. The mean (SD) of the oscillation of the airflow of Acapella, Flutter, vibration and

percussion were 13.5 (1.7), 11.3 (1.5), 8.4 (0.4), 7.3 (0.3) Hz respectively. If secretion clearance is aided by increased expiratory flow rates, vibration and Flutter may be the physiotherapy intervention of choice. However if secretion clearance is aided by oscillation of airflow then Flutter and Acapella may be the physiotherapy intervention of choice.

### Bronchoscopic lung volume reduction surgery using the Emphasys endobronchial valve improves quality of life

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This study determined the effect of bronchoscopic lung volume reduction surgery (BLRS) on lung function, exercise capacity and quality of life (QOL) in subjects with chronic obstructive pulmonary disease. Fifteen subjects (mean age  $\pm$  SD = 64.4  $\pm$  1.7 years; FEV<sub>1</sub> [%<sub>pred</sub>]  $\pm$  SD = 32  $\pm$  10%) were recruited. At baseline, one and three months following valve placement each subject had tests of lung function and exercise capacity using both a 6-minute walk test and an incremental cycle test to peak work capacity. QOL was measured using the St George's Respiratory Questionnaire. All values were analysed using a repeated measures ANOVA. Two to eight valves were inserted per patient. QOL (mean total score  $\pm$  SD) at baseline was 54  $\pm$  13 and significantly improved at one month (50  $\pm$  15) and three months (46  $\pm$  18) following surgery ( $p < 0.05$ ). Five subjects had an increase in FEV<sub>1</sub> following surgery although for the group there was no significant change in lung function across the time interval ( $p > 0.1$ ). The 6-minute walk distance (6MWD  $\pm$  SD) increased in five subjects from 402  $\pm$  30m to 427  $\pm$  32m at three months following surgery. There was no significant change in 6MWD across time intervals for the group ( $p = 0.3$ ). Peak work capacity (watts (W)  $\pm$  SD) was 37  $\pm$  20W at baseline, 27  $\pm$  16W at one month following surgery ( $p = 0.01$  to baseline) and 32  $\pm$  20W at three months following surgery ( $p = 0.5$  to baseline). A significant improvement in QOL was shown following BLRS despite no significant change in lung function and exercise capacity.

### NSW chronic care collaborative: Central Sydney Area Health Service (CSAHS) results for chronic obstructive pulmonary disease (COPD)

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The aim of the NSW Chronic Care Collaborative (CCC) was to improve the quality of life of people with COPD by the implementation of the Respiratory Clinical Services Framework. The collaborative is a quality improvement methodology developed in the USA. It focuses on the spread of evidence-based innovations over multiple sites in a 12-month period. It commenced in November 2003 and involved 22 Area Health Services across NSW. A baseline audit was conducted across CSAHS using the COPD monitoring tool and then in the following seven months, three implementation periods (Plan-Do-Study-Act cycles) were conducted to improve the diagnosis and management of COPD. The baseline audit identified the need to improve documentation about COPD management in the emergency department (ED), educate GPs about

the use of spirometry, smoking cessation interventions and pulmonary rehabilitation (PR) and improve referral to smoking cessation and pulmonary rehabilitation clinics. Improvements made included the creation of a COPD ED care plan, which resulted in improved documentation of COPD management, and the development of spirometry and smoking cessation training. This resulted in GPs using spirometry and nicotine replacement therapy (NRT) more frequently (baseline: 30% used spirometry and 14% used NRT daily/weekly, one month post training: 60% used spirometry and 67% used NRT daily/weekly). In addition, the development of a PR and smoking cessation referral form for GPs has increased referral from GPs to these clinics. The NSW CCC has improved the diagnosis and management of COPD in CSAHS.

### NSW clinical indicator project using the 6-minute walk test

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The 6-minute walk test (6MWT) is used as an outcome measure to assess the effectiveness of pulmonary rehabilitation programs in improving exercise capacity. The aim of this project was to collect data on change in 6-minute walk distance (6MWD) from pulmonary rehabilitation programs across NSW and the ACT, and to determine whether programs were successful in achieving the clinically significant important difference (CSID) of 54m increase in 6MWD. Surveys with questions related to patient diagnosis, smoking status, disease severity, 6MWD pre and post pulmonary rehabilitation; and program details including length, frequency and 6MWT protocols were sent to all pulmonary rehabilitation programs in NSW. Thirty-eight pulmonary rehabilitation programs voluntarily participated providing data from 983 patients. Patient diagnoses included chronic obstructive pulmonary disease (COPD), asthma, bronchiectasis, interstitial lung disease, and undiagnosed shortness of breath. Fourteen programs (39%) completed two 6MWT at initial assessment, whilst 22 programs (61%) conducted only one 6MWT (i.e. no control for learning effects). For the pulmonary rehabilitation programs that conducted two 6MWT at entry, the statewide average improvement in 6MWD for COPD patients was 49.2m ( $p < 0.001$ ), with 55.6% of these programs achieving a CSID of 54m. Of these programs, those with the highest frequency of exercise sessions reported the greatest improvement in 6MWD. In conclusion, the major finding from this project was that insufficient programs controlled for a learning effect, by conducting only one 6MWT at baseline. A CSID in 6MWD was achieved in over half these programs.

### Easy walkers walking group — maintaining pulmonary rehabilitation outcomes at twelve months

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Evidence has shown that improvements in exercise tolerance, quality of life and emotional wellbeing following pulmonary rehabilitation can be difficult to maintain. The aim was to determine the effects of the Easy Walkers

maintenance walking group on the above parameters. The 6-minute walk distance (6MWD), quality of life measured by the St George's Hospital Respiratory Questionnaire (SGRQ), and anxiety and depression measured by the Hospital Anxiety and Depression Scale (HAD) were completed at the conclusion of the 6-week Easy Breathing pulmonary rehabilitation program and at 12 months following commencement of the Easy Walkers walking group. Baseline data on nine patients (one male) at the completion of the Easy Breathing pulmonary rehabilitation program was: 6MWD (mean  $\pm$  SD) = 392  $\pm$  53 m, SGRQ (mean  $\pm$  SD) = 50  $\pm$  15% and HAD (anxiety/depression) = 7/6. Twelve months after the establishment of the maintenance walking group these patients had maintained, and slightly improved (though not significantly), their final pulmonary rehabilitation results: 6MWD (mean  $\pm$  SD) = 405  $\pm$  41 m, SGRQ (mean  $\pm$  SD) = 43  $\pm$  16% and HAD 7/4. The nine patients attended the walking group an average of 35 occasions over the 52-week period. The Easy Walkers maintenance walking group has maintained pulmonary rehabilitation improvements in exercise tolerance, quality of life, anxiety and depression at 12 months.

### Effect of transcutaneous electrical nerve stimulation (TENS) on expiratory flow rate during exercise in healthy subjects

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Transcutaneous Electrical Nerve Stimulation (TENS) is a common modality for pain management. The proposed pain gate control and endorphin release mechanisms were believed to exert effects on conditions other than pain. We are interested to find out the effect of TENS on changes of expiratory flow rates during exercise in healthy subjects. Eleven healthy male subjects, aged 18–34, with no current cardiopulmonary and musculoskeletal disease were recruited. On two separate days, prior to a treadmill exercise program (Bruce protocol), subjects received either placebo TENS or acu-TENS (believed to have positive effects in the relief of asthmatic symptoms) over acupuncture points, for 45-minutes. Spirometry lung function was measured before and after the exercise. The percentage drop of forced expiratory volume in one second ( $_{FEV1}$ ) after exercise for each subject and the duration of treadmill running during the test between subjects in the two TENS groups were compared using independent t-test. There was a significant reduction in the percentage drop of  $_{FEV1}$  after exercise in subjects who received acu-TENS ( $p < 0.05$ ). The duration of exercise time in this subject group was also significantly longer compared to the group who received placebo TENS ( $p < 0.05$ ). The result of this study suggested that TENS might be effective in attenuating the airway obstruction which accompanied intensive exercise, thereby enhancing the exercise training effect on the respiratory system.

### **Changes in triceps surae muscle length and stiffness during intensive care admission: an observational study**

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This prospective descriptive study aimed to determine if changes in triceps surae muscle length and stiffness occur in ICU following acquired brain injury (ABI). Adult patients admitted to ICU for invasive ventilation and sedation for greater than 48 hours were studied. Twelve subjects met inclusion criteria over the six-week audit, five with ABI and seven with other diagnoses. Muscle stiffness was quantified by measuring ankle joint angles achieved from the application of three standardised torques (5, 10 and 15 Nm) via a modified Lidcombe template. Maximum dorsiflexion was used to indicate muscle length changes. Measurements were performed in knee flexion and extension to selectively bias soleus and gastrocnemius. Serial measurements were undertaken three times per week from admission to ICU until subjects were able to actively achieve ankle dorsiflexion, or were discharged from ICU. Subject comparisons were made between first and final day measurements, with comparison also made between subjects with ABI and those with other diagnoses. No significant differences were found between groups and neither group showed a significant change between admission and pre discharge measures. Analyses of all subjects showed a significant decrease in one of the measures of muscle stiffness. One subject developed extensor tone as sedation was withdrawn, which was reflected in all measures as decreased ankle dorsiflexion. Changes associated with contracture were evident only in one subject, and were related to the presence of extensor muscle tone. Some subjects exhibited increased ankle extensibility. The trend towards increased extensibility may have been related to muscle atrophy.

### **A survey of pulmonary rehabilitation programs in Australia and their associated maintenance programs and support groups**

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Evidence has shown that long term follow up is needed to maintain the benefits achieved after attending a comprehensive pulmonary rehabilitation program. The aim of this survey was to evaluate the availability of maintenance programs and support groups associated with pulmonary rehabilitation programs in Australia and to ascertain the hurdles faced in providing these programs. A letter of invitation was sent to the co-ordinators of all known pulmonary rehabilitation programs in Australia, inviting them to complete a questionnaire. One hundred and twenty-seven letters were sent and 90 questionnaires were completed and returned. Fifty-three percent of respondents were from metropolitan centres and 47% were from rural areas. Maintenance programs were provided by 63% of rehabilitation programs, with 63% of these being in metropolitan centres. The mean program length was eight weeks and the median percentage of people attending these programs following pulmonary rehabilitation was 50%. The main constraints for providing these programs were funding

and staffing issues. Support groups were available for 58% of rehabilitation programs. Social support and education were cited as the main aim of these groups. The majority of respondents reported that only 10% of their rehabilitation participants attended a support group. The reasons for lack of attendance at both maintenance programs and support groups were cited as lack of interest, illness and transport issues. Further research is needed to ascertain the follow up needed after attendance at a pulmonary rehabilitation program, so that appropriate funding and support can be given to establish these programs.

### **Peripheral strength training for people with chronic obstructive pulmonary disease: a randomised controlled trial**

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Peripheral strength training (ST) can improve muscle strength for people with chronic obstructive pulmonary disease (COPD). However it is not known whether ST leads to changes in functional performance or is effectively performed using simple elasticised resistance. Fifty-four people with COPD were randomly allocated to ST (n = 27, mean age 67.0 yrs; mean FEV<sub>1</sub>%<sub>pred</sub> 49%, 11 males) or to a non-intervention control group (n = 27, mean age 68.4 yrs; mean FEV<sub>1</sub>%<sub>pred</sub> 52%, 10 males). ST participants completed three sessions per week (one supervised, two at home) for 12 weeks. Six exercises, targeting major arm and leg muscles, were performed at an intensity of three sets of 8–12 repetition maximum progressed against graduated elasticised resistance bands. Outcomes were muscle strength, 6-minute walk, grocery-shelving task, Chronic Respiratory Disease Questionnaire and Patient-specific Functional Scale. ST group participants completed 88% of scheduled training sessions, with only minor muscle soreness reported as adverse effects. The ST group showed a 34% increase in both lower and upper limb strength compared with 10% and 14% increases for the control group, respectively. However, strength changes were only statistically significant for the quadriceps (p = 0.003). Interestingly, ST participants showed a reduction in their Fev<sub>1</sub>/FVC ratio (p = 0.04), but a trend towards reduced breathlessness (p = 0.06). No change or trend was found for exercise capacity or physical function measures post ST. A simple, predominantly home-based ST program can improve quadriceps strength for people with COPD, but it remains unclear whether there is beneficial carry-over into functional performance.

### **Pulmonary rehabilitation — part of a comprehensive chronic disease management program for the COPD 'frequent flyer' population at Western Health**

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Western Health has developed an innovative program to assist in managing patients with chronic obstructive pulmonary disease (COPD). Funded through the Department of Human Services Hospital Admission Risk Management Program (HARP), the Chronic

Disease Management Program (CDMP) aims to reduce inappropriate and avoidable presentations to the emergency department (ED) and inpatient services. Criteria for entry to the program are based on patients with COPD who have three or more hospital presentations within 12 months or 'frequent flyers'. Patients who are recruited to CDMP are assigned a care facilitator and encouraged to become active participants in the management of their condition. In addition, all patients have access to a six-week outpatient pulmonary rehabilitation program followed by ongoing maintenance. The goal of pulmonary rehabilitation is to achieve and maintain the individual's maximum level of function and independence within the community, which further enhances the philosophy of CDMP. Between April 2003 and December 2004, 117 patients were recruited to CDMP at Western Health. Data collected from patients who had been involved in CDMP for more than three months consisted of utilisation of hospital services and the St Georges Respiratory Questionnaire. Results showed significant decreases in ED presentations by 20% ( $p < 0.005$ ), inpatient admissions by 33% ( $p < 0.001$ ) and bed days by 33% ( $p < 0.002$ ) compared to pre recruitment. Further comparison data will be presented.

### Physiotherapy for ventilator associated pneumonia in patients with acquired brain injury

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Respiratory physiotherapy is often provided to treat ventilator-associated pneumonia (VAP) in patients with acquired brain injury (ABI) due to the morbidity and mortality associated with VAP. However there are limited data on the efficacy of physiotherapy in ICU and no data on the effect of respiratory physiotherapy on outcomes in patients with ABI. This prospective randomised controlled trial investigated the effect of respiratory physiotherapy on the resolution of VAP, the duration of ventilatory support, and length of ICU stay in adults with ABI and VAP. Subjects admitted with a Glasgow Coma Scale  $\leq 9$ , requiring intracranial pressure monitoring, and invasive ventilatory support for  $>24$  hours, and who developed VAP, were randomised to a treatment group (six treatments in each 24-hour period whilst ventilated;  $n = 17$ ), or a control group (routine medical and nursing care only;  $n = 16$ ). Respiratory physiotherapy comprised positioning, manual hyperinflation and suctioning. Groups were comparable on baseline demographic variables. Four subjects (two from each group) were withdrawn as three became medically unstable and one was incorrectly randomised. Using multivariate analysis of variance with intention to treat philosophy and analysis by treatment principle, there were no significant differences for daily mean clinical pulmonary infection scores or measures of arterial to inspired oxygenation, duration of ventilatory support (mean hours  $\pm$  SD) [342.0  $\pm$  185.3 vs. 351.0  $\pm$  174.7;  $p = 0.89$ ], or ICU stay (mean hours  $\pm$  SD) [384.7  $\pm$  179.6 vs. 397.9  $\pm$  190.7;  $p = 0.84$ ]. In this sample, respiratory physiotherapy for ABI patients with VAP did not expedite recovery by reducing duration of ventilation or length of ICU stay.

### The financial costs associated with respiratory physiotherapy for ventilator associated pneumonia in patients with acquired brain injury

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This study provides the first description of the financial costs of respiratory physiotherapy for patients with acquired brain injury (ABI) in the intensive care unit (ICU) aimed at decreasing the incidence of ventilator-associated pneumonia (VAP), duration of mechanical ventilation (MV) and length of ICU stay. Consent was obtained for 144 adult ABI patients admitted with a Glasgow Coma Scale  $\leq 9$ , requiring intracranial pressure monitoring, and invasive MV for  $> 24$  hours, with randomisation to a treatment group (six respiratory physiotherapy treatments in each 24-hour period whilst ventilated,  $n = 72$ ), or a control group (routine medical and nursing care only,  $n = 72$ ). Respiratory physiotherapy comprised positioning, manual hyperinflation and suctioning. For subjects with ABI receiving prophylactic physiotherapy, the respiratory physiotherapy cost was \$487.00 per subject. In comparison, ICU bed-days cost for the period of MV was \$33 380.00 per subject. Thirty-three subjects (23%) developed VAP (14 from the prophylactic treatment group) and were re-randomised to a treatment group ( $n = 17$ ), or a control group ( $n = 16$ ). For subjects with VAP, the total respiratory physiotherapy cost was \$1029.00 per subject, compared to \$510.00 for subjects without VAP. The respective ICU bed-days cost for the period of MV per subject was \$61 092.00 and \$25 142.00, giving an incremental health cost of \$35 950.00 per episode of VAP. The cost of respiratory physiotherapy as a percent of their ICU bed-days cost for the period of MV was 1.4 % in those with VAP and 1.1 % in those without VAP.

### Realistic home exercise advice for the patient with chronic heart failure (CHF)

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This study assessed whether 60 minutes of low intensity exercise performed five days per week would maintain fitness in patients with CHF. Twenty-seven subjects (22 male, mean age 59.11 years, mean Left Ventricular Ejection Fraction 27%) entered the study and 18 completed the eight-week protocol. The subjects were randomised into two groups. Group 1 ( $n = 11$ ) performed two 30-minute walks per day, and Group 2 ( $n = 7$ ) performed six 10-minute walks per day. Repeated measures included three 6-minute walk tests (6MWT) and two quality of life measures. All subjects completed an exercise diary. The study was ceased due to poor protocol compliance. There was no significant change at exit either within or between the groups in the 6MWT results (Group 1 6MWT entry: exit, 607.27 m: 632.00 m,  $t = -0.84$ ,  $p = 0.42$ ; Group 2 6MWT entry: exit, 626.57 m: 634.14 m,  $t = -0.87$ ,  $p = 0.42$ ; Group 1: Group 2 exit 6MWT, 632.00 m: 634.14 m,  $t = -0.05$ ,  $p = 0.96$ ). To discover why

subjects had not complied with requested exercise patterns, semi structured interviews were conducted. These revealed that subjects were keen to participate but were reluctant to alter established exercise habits. Implications for clinical practice are that exercise prescription needs to be flexible and adapt to established lifestyles. It may not be important how the individual accrues their exercise but rather that the total daily amount is reached.

### **Medical record documentation as a professional issue: a retrospective audit of physiotherapists' inpatient documentation at the Royal Adelaide Hospital**

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Medical documentation must fulfil many legal requirements, but currently no national guidelines for physiotherapy medical record documentation exist. This study evaluated the standard of inpatient medical record documentation by physiotherapists at the Royal Adelaide Hospital (RAH) during 2003. The impact of patient characteristics (e.g. diagnosis and length of stay) and physiotherapist features (e.g. employment classification level and years of employment) on the standard of documentation were also explored. One hundred medical records were randomly selected for review and 224 physiotherapy entries were audited. The audit tool was based on the RAH Physiotherapy Department Guidelines for Documentation, and comprised five sections. Each section contained several items, which were scored as complete, incomplete, absent or not applicable. The total number of completed scores was calculated for each section of the audit form. A standard of 100% completed was expected for the two sections containing the mandatory requirements for documentation, whereas a lower completion rate was considered acceptable for the remaining sections. There were five items (4.3%) that achieved a 100% completion rate, namely 'date', 'heading physiotherapy', 'signature', 'page includes patient details' and 'after the first attendance', with 94 items (81.7%) at least 50% completed. The patient diagnosis was the only patient characteristic that significantly affected the standard of documentation ( $p = 0.03$ ). No physiotherapist characteristic was significantly related to the standard of documentation. While the overall standard of medical record documentation was considered to be acceptable, it was clear that there was considerable room for improvement.

### **The development of a clinical assessment tool to assess capacity for mobilisation of acutely ill inpatients**

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Evidence-based practice should be part of every physiotherapist's professional life. In the acute care setting, the deleterious effects of bed rest and immobility are well known. As movement specialists, physiotherapists are ideally placed to intervene. However, the difficulty in attributing aspects of improvement to physiotherapy intervention has made outcome measurement a complex process. A literature

search failed to identify an appropriate measure to guide therapists' reasoning or monitor patients in the acute care setting. Therefore, the aim of the study was to investigate the indicators that experienced acute care physiotherapists used when determining a patient's status prior to mobilisation. Physiotherapists' reasoning underlying clinical decisions was sought through in-depth, semi-structured interviews in a focused ethnography. Twelve Australian physiotherapists with substantial expertise in acute care were selected via chain sampling and took part in an individual audiotaped interview. Interviews were transcribed, validated by all participants, prior to a manual thematic analysis. The results of the thematic analysis indicated that mobilisation as an intervention was goal related and prioritised based on institutional variations, and a risk/benefit analysis. Integrated into subjects' risk/benefit reasoning were: safety considerations, physiological data, appearance, patient history, patient compliance, environmental, experiential and objective examination factors. Physical examination for mobilisation is an integrated, individualised, task specific process with importance on bed mobility and lower limb strength assessment. The results from this study may be used to form the foundation for an outcome assessment tool for clinical, teaching and research purposes.

### **The physiotherapy management of patients undergoing thoracic surgery: a survey of current practice in Australia and New Zealand**

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Physiotherapy is considered an essential component of the management of patients following thoracotomy, yet the type of interventions utilised and evidence of their efficacy has not been clearly established. This study aimed to ascertain the current physiotherapy management of patients undergoing thoracotomy. A purpose-designed postal questionnaire was distributed to senior physiotherapists in all thoracic surgical units throughout Australia and New Zealand ( $n = 57$ ). A response rate of 81% was obtained ( $n = 46$ ). Preoperatively, 35% ( $n = 16$ ) of respondents assessed all patients presenting for thoracotomy, 41% ( $n = 19$ ) assessed only some patients (usually based on risk assessment) with 24% ( $n = 11$ ) undertaking no preoperative physiotherapy assessment or treatment. The majority of respondents (96%,  $n = 44$ ) attended all patients following surgery, with 63% ( $n = 29$ ) performing prophylactic physiotherapy interventions to prevent postoperative pulmonary complications. Others assessed all patients postoperatively but treated only when appropriate (33%,  $n = 15$ ). Physiotherapy usually commenced on day one postoperatively (80%,  $n = 37$ ) with the most commonly used treatment interventions being deep breathing exercises, active cycle of breathing techniques, cough, forced expiratory techniques and sustained maximal inspirations. Most respondents reported patients sat out of bed on day one postoperatively (89%,  $n = 41$ ) and commenced walking on day one (70%,  $n = 32$ ). Shoulder range of movement exercises also normally commenced on day one (50%,  $n = 23$ ). The majority of respondents offered no postoperative pulmonary rehabilitation (54%,  $n = 25$ ), outpatient follow up (94%,  $n = 43$ ) or post-thoracotomy pain management (87%,  $n = 40$ ). While most patients after thoracotomy receive physiotherapy assessment and/

or treatment postoperatively, relatively few are reviewed following discharge from hospital.

### **A program of inspiratory muscle training in a 15-year-old boy with Duchenne's muscular dystrophy**

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A small pilot trial was conducted to investigate whether an eight-week program of inspiratory muscle training (IMT) had positive effects on inspiratory muscle strength and endurance and quality of life (QOL) in a 15-year-old boy with Duchenne's muscular dystrophy (DMD). A positive expiratory pressure mask with a resistor placed in the inspiratory valve was used for training. The resistance was determined by 30% of the child's maximal inspiratory resistance obtained from a manometer. Weekly visits were made to physiotherapy to adjust resistance and to ensure the child was consistently working to 30% of his maximal inspiratory resistance. Both spirometric and force outcome measures were chosen to assess the effectiveness of this program in improving inspiratory muscle strength and endurance. Strength and endurance were measured by maximal inspiratory pressure (MIP) and 12-second maximum voluntary ventilation (MVV12). Spirometric measures of inspiratory muscle function included FEV<sub>1</sub>, FEV<sub>1</sub>/FVC, PEF<sub>R</sub>, FEF<sub>25-75%</sub>. QOL was measured using the PEDSQL questionnaire. The results of the program were encouraging. There were significant improvements in inspiratory muscle strength and endurance as measured by MIP and MVV12 (77% and 87% above baseline respectively). Spirometric and QOL measures remained unchanged. Interestingly this child's decline in FVC for the year was smaller than previous years. The child did not have any respiratory infections during the study. The results of this small pilot trial provide good rationale for a larger study of longer duration investigating the effects of inspiratory muscle training in DMD, particularly in its more advanced stages.

### **The involvement of APAC in early cardiac rehabilitation and improving attendance at cardiac rehabilitation programs post emergency stenting for acute myocardial infarction**

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Cardiac rehabilitation programs are strongly recommended by the World Health Organisation and Australian health care bodies. In Northern Sydney Area Health Service (NSAHS) those patients with suspected acute myocardial infarction (AMI) are diverted directly to Royal North Shore Hospital (RNSH) for emergency stenting. Post stenting, patients are discharged to district hospitals when medically stable and then home (within 24–72 hours). As a result in-hospital cardiac education is limited. The challenge for the NSAHS is to adapt and meet the changing needs for this group of patients. The provision of rehabilitation services and the appropriate follow up post early discharge has been provided by the collaboration of two multidisciplinary teams, the North Shore Cardiovascular Education Centre (NSCEC) and Acute Post Acute Care (APAC). The role of the APAC team is to commence early home based cardiac

rehabilitation, continue education and improve participation in hospital based cardiac rehabilitation. The APAC care plan for these patients begins as soon the patient is discharged from the hospital. Liaison with the cardiologist and general practitioner is sometimes necessary. From January 2004 to 2005, 156 patients were referred to APAC. Most of these patients started a gentle exercise program after being visited by the APAC physiotherapist. All patients were encouraged to continue their exercise program and progress gradually until they started hospital based cardiac rehabilitation (phase 2). To date, 71 % of the patients contacted post discharge from APAC had finished their cardiac rehabilitation program and their feedback from both services has been very positive.

### **Comparison of the effectiveness of manual and ventilator hyperinflation at different levels of positive end-expiratory pressure**

**Savian C**,<sup>1,2</sup> Paratz J<sup>1,2</sup> and Davies A<sup>1</sup>

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Manual (MHI) and ventilator hyperinflation (VHI) are commonly used in ventilated patients in order to improve lung compliance and increase secretion mobilisation. The aim of this single-blinded randomised crossover study was to compare the effectiveness of these two techniques on respiratory and haemodynamic variables at different levels of positive end-expiratory pressure (PEEP). Patients were given three minutes of either MHI (Laerdal circuit with PEEP valve in situ) or VHI (sigh mechanism) randomly applied, with a washout period of three hours. Outcome measures included sputum wet weight (SWW), peak expiratory flow rate (PEFR) static lung compliance (Cst) oxygenation ratio (PaO<sub>2</sub>/FiO<sub>2</sub>) mean arterial blood pressure (MAP), heart rate (HR) and carbon dioxide production (VCO<sub>2</sub>). Fourteen patients were enrolled and all completed the study. A between-within ANOVA and post hoc analyses found that there was no significant difference in technique or PEEP level between SWW, PaO<sub>2</sub>/FiO<sub>2</sub> or Cst. However, VHI increased Cst significantly at 30 minutes post treatment ( $p = 0.012$ ) and a significant difference was observed in Cst between PEEP levels 5 and 7.5 cmH<sub>2</sub>O ( $p = 0.02$ ) during MHI. Higher PEFR was generated during MHI compared to VHI ( $p < 0.05$ ) at all PEEP levels. There were no significant differences in HR or MAP between techniques; however VCO<sub>2</sub> was significantly higher during MHI compared to VHI ( $p = 0.045$ ). VHI appeared to promote greater improvements in respiratory mechanics with less metabolic disturbance compared to MHI. The level of PEEP did not appear to affect oxygenation or secretion mobilisation.

### **The effect of PEEP level on peak expiratory flow rate during manual hyperinflation**

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Including positive end expiratory pressure (PEEP) in the manual resuscitation bag (MRB) may render manual hyperinflation (MHI) ineffective as a secretion manoeuvre technique in ventilated patients. The aim of this study was to determine the effect of increased PEEP and/or decreased compliance on peak expiratory flow rate (PEFR) during

manual hyperinflation. A blinded, randomised study was carried out on a lung simulator in a cardiopulmonary research laboratory. Ten physiotherapists experienced in MHI and intensive care practice performed the technique of MHI on a lung simulator attached by a pneumotachometer to a respiratory mechanics monitor. PEEP levels of 0–15cmH<sub>2</sub>O, compliance levels of 0.05 and 0.02 L/cmH<sub>2</sub>O and MRB type were randomised. The Mapleson-C MRB generated significantly higher PEFR ( $p < 0.001$ , mean difference (md) = 11.02) when compared to the Laerdal MRB for all levels of PEEP. In normal compliance (0.05 l/cmH<sub>2</sub>O), there was a significant decrease in PEFR ( $p < 0.01$ , md = 10.85) for a PEEP greater than 10 cmH<sub>2</sub>O in the Mapleson-C circuit. In low compliance (0.02 l/cmH<sub>2</sub>O), there was no significant decrease in PEFR at any PEEP level in either MRB. At PEEP levels of greater than 10 cmH<sub>2</sub>O the Laerdal MRB produced a PEFR less than 0.41 l/sec. The Laerdal MRB at PEEP levels of greater than 10 cmH<sub>2</sub>O may not generate a PEFR that theoretically is capable of producing two-phase gas-liquid flow and, consequently, mobilising pulmonary secretions. If MHI is indicated due to mucous plugging, the Mapleson-C MRB may be the most effective method of secretion mobilisation.

### Comparison of the effectiveness of ventilator hyperinflation in intensive care patients ventilated on high levels of positive end-expiratory pressure

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In order to avoid disconnection from the ventilator during manual hyperinflation, physiotherapists frequently apply ventilator hyperinflation (VHI) in intensive care patients in order to deliver hyperinflation breaths with the aim of improving lung compliance, oxygenation and of facilitating secretion mobilisation. VHI avoids the problem of disconnection especially in patients on high positive end-expiratory pressure (PEEP) levels. The aim of this single-blinded randomised crossover study was to investigate the effectiveness of VHI on respiratory and haemodynamic variables in patients ventilated on PEEP of 10cmH<sub>2</sub>O and over (12.5 and 15cmH<sub>2</sub>O). Patients were randomly given three minutes of VHI (sigh mechanism) plus endotracheal suctioning or suctioning alone, with a washout period of three hours. Outcome measures included sputum wet weight (SWW), peak expiratory flow rate (PEFR), static lung compliance (Cst), oxygenation ratio (PaO<sub>2</sub>/FiO<sub>2</sub>), mean arterial blood pressure (MAP), heart rate (HR), and carbon dioxide production (VCO<sub>2</sub>). Fifteen patients were enrolled in the study. A one-way ANOVA found no significant increase in secretion clearance with the addition of VHI. A repeated-measures analysis including the covariate PEEP level found no significant difference in PaO<sub>2</sub>/FiO<sub>2</sub>, Cst, MAP, HR, and VCO<sub>2</sub> over time, between techniques or PEEP level. The PEFR was found to be significantly higher with the addition of VHI technique ( $p = 0.021$ ).

### Development of a risk assessment model to predict pulmonary risk following upper abdominal surgery

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This prospective, multicentre study identified risk factors associated with the development of postoperative pulmonary complications (PPC) and developed a risk prediction model to predict PPC in patients undergoing upper abdominal surgery. Two hundred and seventy-two consecutive patients having elective upper abdominal surgery were assessed across 17 preoperative and intraoperative risk factors. Patients received standardised preoperative education on deep breathing exercises and the importance of early mobilisation. In addition, patients received one standardised postoperative physiotherapy treatment on the first postoperative day. Patients were monitored daily until discharge for signs of PPC. Data were analysed using univariate analysis and forward stepwise logistic regression to determine the variables for inclusion in a risk prediction model for PPC. The incidence of PPC was 13% (n = 35). Five risk factors were identified by univariate analysis: duration of anaesthesia (odds ratio (OR) = 4.322); surgical category (OR = 2.272); current smoking (OR = 2.109); respiratory co-morbidity (OR = 2.057) and predicted VO<sub>2</sub> max (OR = 2.027). Logistic regression was used to develop a weighted PPC risk prediction model. The risk prediction model predicted 82% of patients who developed a PPC. High risk patients were 8.4 times more likely to develop a PPC than low risk patients. These results provide a model for predicting PPC in people having upper abdominal surgery. Further validation of the model could allow prioritised preoperative and postoperative respiratory care for high risk patients.

### A survey of Australian physiotherapy management of patients having abdominal surgery

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This questionnaire sought to establish the frequency of conduct of preoperative assessment, the content of the preoperative assessment, and the preoperative and intraoperative risk factors in people having upper abdominal surgery (UAS), considered important by Australian clinicians for the development of postoperative pulmonary complications (PPC). Members of the National Cardiothoracic Group (NCTG) were invited to participate in the questionnaire, which was administered via mail and consisted of 15 questions related to the preoperative physiotherapy management of patients having elective UAS. Sixty-five physiotherapists working in the area of UAS responded to the questionnaire, a response rate of 49%. The majority of respondents reported that less than 25% of the patients were able to be assessed preoperatively in their

hospital. Respondents ranked 16 risk factors in order of importance for the preoperative prediction of PPC. The six preoperative risk factors most highly ranked were: respiratory co-morbidity, type of surgery, recent chest infection, current smoker, poor pre-morbid mobility and age. The findings of this survey indicate that although preoperative assessment is widely conducted throughout Australia, only a small percentage of the people undergoing UAS are actually reviewed preoperatively. Respondents demonstrated good knowledge of preoperative and intraoperative risk factors which may contribute to the risk of PPC, however the results of this study suggest physiotherapists have not adopted the practice of using published preoperative risk assessment tools. Further research to develop a valid and sensitive tool with demonstrable clinical utility for preoperative risk assessment is necessary to promote increased utilisation by Australian physiotherapists.

### **Favourable outcome extending to five years following lung volume reduction surgery — a single centre experience**

**Seale H, Walsh J, Tam R, Bell S and Hopkins P**

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Lung volume reduction surgery (LVRS) improves quality of life and may be associated with survival benefit in emphysema. Evidence supports return to baseline in the majority of patients within 3–5 years. Our objective was to evaluate at three and five years, survival, respiratory function and 6-minute walk test (6MWT) data in LVRS cohort. The method used was prospective evaluation of a tertiary centre's experience in upper lobe stapled LVRS using video thoracoscopy. From June 1996 to April 2002, 53 patients (28 male) underwent surgery, with a mean age  $\pm$  SD of  $61 \pm 7$  years. Baseline parameters  $\pm$  SD include: FEV<sub>1</sub>  $0.79 \pm 0.2$  L,  $31 \pm 0\%$ <sub>pred</sub>; RV  $4.9 \pm 1.0$  L; TLC  $7.75 \pm 1.2$  L; DLCO  $39.2 \pm 12\%$ <sub>pred</sub> and 6MWT  $356 \pm 105$  m. Following LVRS, mortality at three and five years was 5% and 9% respectively. Forty patients were available for analysis three years after surgery, with improvements above or below baseline as follows: FEV<sub>1</sub>  $\geq 200$ ml increase 30% ( $n = 12$ ), TLC  $\geq 10\%$  below 33% ( $n = 13$ ), RV  $\geq 10\%$  below 55% ( $n = 20$ ) and DLCO  $\geq 15\%$  improvement 33% ( $n = 13$ ). Mean 6MWT  $\pm$  SD was  $457 \pm 96$  m in the FEV<sub>1</sub> improved patients versus  $404 \pm 100$  m in the non-improvers ( $p < 0.01$ ). At five years, 17 patients were available for analysis with improvements in the above parameters seen in 12%, 29%, 53% and 19% patients respectively. Mean 6MWT  $\pm$  SD was  $411 \pm 122$  m for the whole group ( $p < 0.05$ ). Improvements in respiratory function at five years are reflected in static lung volumes. Enhanced exercise capacity represents a measure of reduced hyperinflation and gas trapping rather than increases in FEV<sub>1</sub>.

### **Benchmarking physiotherapy practices for inpatient chronic obstructive pulmonary disease (COPD) management in 2002/2004: a pilot survey in south-east Queensland hospitals**

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Management of COPD is well documented however there is limited evidence of inpatient physiotherapy practice. Seven hospitals participated in a benchmarking project to determine current practice. The aim was to determine current intervention used in treatment of COPD. Following initial analysis it was anticipated that key elements had changed. Demographics, admission status, length of stay (LOS), COPD risk stratification, treatment type, occasions of service (OOS), discharge referral, destination data were collected. Data were collected over two intensive periods. There were 232 patients (126 male) mean age  $71 \pm 10$  years and FEV<sub>1</sub>  $38\% \pm 17\%$ . Demographics between the two data sets were similar. Median risk stratification (scale 0 – 15) was  $4.0 \pm 1.8$ , LOS  $8.0 \pm 5.6$  and OOS  $7.0 \pm 5.6$ . LOS and risk stratification ( $r = 0.19$ ) had no correlation. Change of physiotherapy practice included: in absolute figures, decreases in airway clearance 79% to 33% ( $p < 0.001$ ), breathing control 81% to 64% ( $p < 0.01$ ) and mobilisation 93% to 42% ( $p < 0.001$ ). Increases occurred in functional exercise testing 13% to 51% ( $p < 0.001$ ), community and pulmonary rehabilitation referrals 9% to 31% ( $p < 0.001$ ) and pelvic floor prescription 8% to 71% ( $p < 0.001$ ). Exercise prescription was unchanged at 40%. While exercise is a key element of COPD management, benchmarking of south-east Queensland does not reflect this practice. The results suggest a change in treatment approach away from airway clearance. While relevant, teaching of the pelvic floor appears a higher priority than pulmonary rehabilitation.

### **Correlation of 6-minute walk test to VO<sub>2</sub> max in cardiopulmonary exercise testing in usual interstitial pneumonitis**

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The 6-minute walk test (6MWT) is a simple and inexpensive tool relative to cardiopulmonary exercise testing to measure functional capacity. Correlation of the 6MWT and VO<sub>2</sub> max in exercise testing has been reported for chronic obstructive pulmonary disease (COPD) and patients awaiting lung transplantation. Usual interstitial pneumonitis (UIP) is the most common form of idiopathic pulmonary fibrosis with a poor prognosis and estimated five-year survival of 32%. There is a paucity of data on correlation of these tests of the functional capacity of patients with UIP. The aim was to determine if a correlation exists between 6MWT and VO<sub>2</sub> max. The method was prospective evaluation of UIP patients recruited from an existing randomised controlled trial with two data sets obtained six months apart. Twenty patients (14 male) of mean age  $\pm$  SD  $59.7 \pm 4.8$  years and baseline parameters  $\pm$  SD as follows: FEV<sub>1</sub>  $2.3 \pm 0.6$  L, TLC  $4.4 \pm 0.91$ , RV  $1.5 \pm 0.31$ , KCO  $3.0 \pm 0.8$ ml/min/

mmHg/l, PO<sub>2</sub> 76 ± 11mmHg, 6MWT 489 ± 100 metres and VO<sub>2</sub> max of 20.4 ± 6.5 were studied. Six-month analysis of the above parameters was 2.1 ± 0.5, 4.2 ± 0.7, 1.5 ± 0.3, 2.9 ± 0.8, 69 ± 14, 515 ± 123 and 20.2 ± 5.4 respectively. The correlation between 6MWT and VO<sub>2</sub> max was r = 0.75 and r = 0.79 at baseline and 6 months (t-test statistically significant at (p < 0.001). Our results demonstrate a strong correlation between 6MWT and cardiopulmonary exercise test of patients with UIP. Therefore, the 6MWT serves as a useful sole measure to monitor functional outcomes in such patients.

### **The development of a client-based continuum of care for patients with chronic obstructive pulmonary disease**

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Following the allocation of Chronic and Complex Care funds, individual health areas were encouraged to use funds in the most effective and appropriate manner for their population. At Northern Sydney Health, after consultation with service providers and consumers, a model has been created for the care of patients with chronic obstructive pulmonary disease (COPD), aimed to provide a seamless continuum of care through all stages of the disease. The patients are supported and educated to gain a thorough understanding of the disease to empower them to self-manage their condition and to know when to seek early medical assistance. The service, recently named BREATHE, has built on pre-existing services and incorporates acute/postacute care in the home, chronic care and monitoring, and pulmonary rehabilitation. Members of staff from these three aspects of care meet monthly to maintain communication and identify ways to improve the provision of care to this population. It has been a challenge to find ways to measure the effectiveness of the model, particularly in the acute stages where patients generally improve regardless of intervention. One indicator has been a reduction in admissions of patients with COPD to area hospitals since the service commenced in 2002. Two case studies demonstrate the co-ordination of the service and describe the interventions which occur in both a patient with uncomplicated COPD, and one with complex needs.

### **Positive expiratory pressure to enhance cough effectiveness in tracheomalacia**

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Chronic suppurative lung disease is a common complication of repaired oesophageal atresia, particularly in children with significant tracheomalacia. Effective cough is essential for clearing secretions and, in those with tracheomalacia, cough flow may be impaired due to collapse of the trachea during cough. Positive expiratory pressure (PEP) is usually used as an airway clearance technique but may also be used to support intrathoracic airways, enhance expiratory flow and improve cough efficacy. The aim of this study was to determine the effectiveness of increasing levels of PEP to enhance expiratory flow during coughing. Twenty-one

controls and 40 children with tracheomalacia (aged 8–18 years) performed spirometry followed by cough spirometry with PEP of 5, 10, 15 and 20 cmH<sub>2</sub>O, using an adjustable PEP valve. Cough expiratory flow for each curve was calculated to represent the effectiveness of cough at mid-lung volume (CEF<sub>25-75</sub>), the region of the flow-volume curve most vulnerable in tracheomalacia. The results showed clinically significant increases in CEF<sub>25-75</sub> of children with tracheomalacia at PEP of 5 and 10 cmH<sub>2</sub>O. CEF<sub>25-75</sub> was unchanged or decreased at PEP of 15 and 20 cmH<sub>2</sub>O in this group. The control group demonstrated a decrease in flow at all levels of PEP. The results of this study demonstrate that the use of a simple adjustable PEP valve increases CEF<sub>25-75</sub> during cough spirometry and may provide a useful adjunct to airway clearance in children with tracheomalacia.

### **Frequency of sleep-related breathing disorders in patients presenting with acute cardiovascular events**

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The aim of this study was to identify the frequency of previously undiagnosed obstructive sleep apnoea (OSA) and other sleep disordered breathing (SDB) in patients presenting with acute cardiovascular illness. OSA is an independent risk factor for cardiovascular morbidity. Making the diagnosis of OSA in patients with cardiovascular disease is important particularly given that adequate management improves both morbidity and mortality associated with OSA. A repeat observational study was carried out in the coronary care unit (CCU) over a two-month period. Consecutive patients admitted with a diagnosis of unstable angina, acute myocardial infarction, left ventricular and/or cardiac failure were invited to participate. Each patient underwent Level III sleep monitoring within 72 hours of admission using the Embletta® digital recording device. The study was repeated after a mean interval ± SD of 74 ± 5 days (range 38–106 days) post discharge. Twenty-six patients were entered and 18 completed both studies: 13 of the 26 patients (50%) had SDB (Apnoea Hypopnoea Index (AHI) ≥ 15) at Study 1 with 46% fulfilling the criteria for a diagnosis of OSA. Only 5 of the 18 (28%) patients had SDB at Study 2. All those five had OSA. Our findings indicate that SDB occurs commonly in patients presenting with an acute cardiovascular event but the abnormalities may be transient. Sleep studies to investigate OSA as a potential risk factor for cardiovascular morbidity should be carried out when the patient is clinically stable. The findings also raise some important questions about history taking and management of co-morbidities during an acute cardiac illness.

### **Contextual influences on cardiopulmonary physiotherapy decision making**

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Quality decision making is an essential element of good clinical practice. The aim of this study was to explore the influence of context on decision making in cardiopulmonary

physiotherapy in acute care hospital settings. Context is defined as the human and environmental features of situations in which decision making takes place, at given points in time. A qualitative research study was conducted using a hermeneutic approach. Fourteen participants in three experience categories were recruited. Data were collected from each participant on two occasions by observing them undertaking their usual patient care activities, and interviewing them about their decision making. Data analysis involved an in-depth, iterative process of reading and interpretation to identify themes in the data. Findings indicate that context influenced the cardiopulmonary physiotherapists' decision making in two ways: specific reasoning about contextual factors, such as managing and using time, reasoning about the actions of other health professionals, and reasoning about the unique contexts of patients, occurred prior to, and during patient interactions; and contextually shaped, individual frames of reference were used by the participants, consciously and subconsciously to guide their decision making. These individual frames of reference were constructed from the interaction of context specific elements such as local system practices (for example criteria for sitting patients out of bed), practices of colleagues and supervisors, clinical experience (such as experiencing success and failure), academic teaching, personal life experiences and published research. The findings of this study illuminate the breadth of factors underpinning and shaping decision making.

### **Finding a balance: dimensions of the clinical reasoning process in acute care cardiopulmonary physiotherapy**

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Studies of clinical reasoning in physiotherapy have largely ignored cardiopulmonary physiotherapy (CP). The unique context of clinical reasoning in an acute care setting makes studies in other areas of physiotherapy limited in relevance. As part of a larger study of the effect of context on CP clinical decision making, dimensions of the clinical reasoning process in acute care CP were identified. This was a qualitative research study in which 14 participants from three experience categories were recruited. On two separate days the participants were observed undertaking their usual patient care activities and, were interviewed about their decision making. Data analysis involved an in-depth, iterative process of reading and interpretation to identify and describe the process of clinical reasoning in CP. Clinical reasoning in CP is a multidimensional, dynamic and complex process with different foci of reasoning. Clinical reasoning about treatment was characterised by tensions between perceptions of saliency (such as how important physiotherapy was judged to be), limitations to treatment choices (such as the perceived risk of adverse effects), feelings of self-efficacy (such as confidence or valuing their personal contribution) and contextual elements (such as local system rules, individual patient wishes or expectations of medical professionals). Making treatment choices involved reasoning, in which a balance was sought between these tensions, to arrive at treatments that were believed to be optimal given the circumstances. Understanding dimensions of CP clinical reasoning will assist in teaching, identifying areas of research to aid

decision making and facilitating reflection on practice in the clinical setting.

### **Acute effects of chest physiotherapy on gas exchange and wellbeing in patients with severe cystic fibrosis**

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Evidence-based conclusions on the acute efficacy of chest physiotherapy (CPT) historically focus on sputum quantification. The acute effects of CPT on the physiological variables of: spirometry, oximetry, arterial blood gases (ABG) and ventilation-perfusion ( $V_A/Q$ ) distribution as measured by the multiple inert gas elimination technique (MIGET) were studied in 24 stable adults with cystic fibrosis. Perception of wellbeing following CPT and any correlation between wellbeing and physiological changes were investigated. Spirometry, oximetry, ABG, detailed  $V_A/Q$  (in 11), and perception of wellbeing, were measured prior to and 90 mins following CPT. The effect of a CPT session on FEV<sub>1</sub>, FVC and oximetry was small. The effect on mean values of PaO<sub>2</sub>, PaCO<sub>2</sub>, Log SDQ and Log SDV was small. Individual perception of wellbeing ranged from much worse to much better. Large changes in PaO<sub>2</sub> were not correlated with subjective wellbeing, (Spearman's  $r = 0.33$ , 95% CI – 0.08 to 0.65). No correlation between wellbeing and changes in PaCO<sub>2</sub>, %FEV<sub>1</sub> or FVC was identified. The effect of CPT acutely on Log SDQ was highly variable ranging from a marked broadening (e.g. 0.29–1.03) in a subject who felt much worse to a marked narrowing (e.g. 1.07–0.73) where the subject felt much better. There was a strong correlation between the acute effects of CPT on subjective wellbeing and changes in  $V_A/Q$  inequality, as measured by Log SDQ, (Spearman's  $r = 0.97$ , 95% CI 0.89 to 0.99,  $p < 0.0001$ ). The acute effects of CPT on gas exchange were present for at least two hours after its completion and may have implications for treatment adherence.

### **Two 6-minute walk tests at the end of pulmonary rehabilitation: is it necessary?**

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It is recommended that at least two 6-minute walk tests (6MWT) be performed at the commencement of pulmonary rehabilitation (PR). This enables the subject to achieve the best result allowing for anxiety, unfamiliarity with the track and learning effect. Improvement between first and second walk tests is reported to be 7%. It is unknown if there is a learning effect when the 6MWT is used as an outcome measure at the end of a PR program. This study aims to determine if it is necessary to repeat the 6MWT at the end of PR program. Subjects completed two 6MWT before and at the end of an eight-week PR program. Twenty-eight subjects diagnosed with chronic obstructive pulmonary disease (COPD) (mean FEV<sub>1</sub> ± SD = 1.4 ± 0.4L; mean age ± SD = 67 ± 10yrs) were recruited. There was a significant increase in 6-minute walk distance (6MWD) from the first to the second 6MWT performed at baseline from 437 ±

80m to  $467 \pm 89\text{m}$  ( $p < 0.01$ ) (7% increase). There was no significant change in 6MWD from the first to the second 6MWT performed at the end of PR from  $513 \pm 95\text{m}$  to  $530 \pm 110\text{m}$  ( $p = 0.14$ ) (3% increase). In conclusion, the 6MWT should be performed twice at entry to PR to account for a learning effect. This study suggests that the 6MWT may not need to be performed twice at the end of PR.

### **Maintenance exercise programs following pulmonary rehabilitation: a randomised controlled trial**

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This study compared the effects of two types of program in maintaining exercise capacity and quality of life (QOL) in patients with chronic obstructive pulmonary disease (COPD), following the completion of an eight-week pulmonary rehabilitation (PR) program. Subjects with COPD were recruited after an eight-week PR program and randomised into either a maintenance exercise (ME) group (weekly, supervised, centre based exercise) or a home exercise (HE) group (unsupervised home exercise). Measurements at baseline (post PR), three and six months included 6-minute walk test (6MWT), incremental shuttle walk test (ISWT), endurance shuttle walk test (ESWT) and St George Respiratory Questionnaire (SGRQ). Results to date show that 12 subjects have completed six-month measures (six in ME group, six in HE group). At baseline there was no significant difference between the ME and HE groups for age [SD] (ME = 67 [10] yrs; HE = 67 [10] yrs) or FEV<sub>1</sub> [SD] (ME = 1.14 [0.6] l; HE = 1.40 [0.32] l). Baseline exercise capacity and QOL were not significantly different between groups. At 6 months there was no significant change (Δ) in either group from baseline in 6MWT (ME Δ -29m [41]; HE Δ 24m [69]), ISWT (ME Δ 30m [27]; HE Δ 7m [41], ESWT (ME Δ 113m [631]; HE Δ 4m [704]) or SGRQ (ME Δ -1.2% [8]; HE Δ -4% [15]). This preliminary data suggests that at six months following PR, an unsupervised home exercise program is equally as effective as a supervised weekly exercise program in maintaining exercise capacity and QOL.

### **Rehabilitation in NSW: a report following rural visits**

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The NSW Chronic Care Program (2001–2006) aims to improve the diagnosis and management of chronic conditions such as chronic obstructive pulmonary disease (COPD), asthma, heart failure and cancer. To achieve this, Clinical Service Framework Standards were developed. These standards encourage early referral to and completion of rehabilitation, where exercise, self-management education and psychosocial support can be given. Disease specific programs (pulmonary and cardiac) exist in many areas and now due to the work of the chronic care program others (both disease specific and general) have been established.

Two members of the NSW Department of Health, Chronic Care Unit visited rural programs to observe rehabilitation in progress, to meet with chronic care health professionals and identify rural features across the area. Seven rural programs were visited and some common features identified. There were five disease specific programs and two general programs. All programs offered exercise and education, prescribed low to moderate exercise intensity following the use of a 6-minute walk test as the main outcome measure, accepted GP referral and had good attendance. Five programs measured quality of life. Multidisciplinary staff were used in five programs. No program performed two six-minute walk tests at baseline. The rural programs visited, both general and disease specific, offered appropriate and accessible exercise and education. Areas identified for improvement include baseline assessment and exercise prescription.

### **The effect of inspiratory muscle training on dyspnoea, exercise tolerance and respiratory muscle strength in patients with asthma: a pilot study**

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Dyspnoea is one of the main symptoms of asthma. Patients with asthma avoid activity as a strategy to limit the experience of dyspnoea which in turn leads to a sedentary lifestyle. Dyspnoea, at least in part, results from inappropriate respiratory effort. Studies have shown that the inspiratory muscles can be trained for both strength and endurance in healthy subjects, and in those with chronic obstructive pulmonary disease and cystic fibrosis. However, few studies have investigated the effect of inspiratory muscle training (IMT) in patients with asthma. The main aim of this pilot study was to evaluate the effect of IMT on shuttle walk performance, respiratory muscle strength and dyspnoea in patients with asthma. The experimental design involved an uncontrolled pre and post test treatment comparison. Eight patients with a diagnosis of mild/moderate asthma have been recruited to date. Participants were instructed on the use of the Powerbreathe® respiratory muscle trainer and followed a training protocol of 30 breaths, against patient determined resistance, twice daily, for a total of six weeks. Before and after the intervention, patients completed outcome measures which included: the shuttle walk test (SWT), lung function tests, maximal inspiratory pressure (MIP), maximal expiratory pressure (MEP), Borg Perceived Rate of Exertion and Asthma Quality of Life Questionnaire. Preliminary results do not show any statistically significant differences, however trends suggest improvements in MIP, SWT and Asthma Quality of Life Questionnaire. No such trends have been detected in lung function tests, MEP and Borg scale.

### **Mobilisation of intensive care unit patients**

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Mobilisation is an integral part of the physiotherapy management of acute inpatients and aims to optimise respiratory function, minimise the effects of immobility and improve fitness. The aim of this quality activity was

to investigate the frequency and type of mobilisation treatments given to intensive care unit (ICU) patients. Data were collected regarding all physiotherapy visits to patients in the Royal Adelaide Hospital ICU over a two-month period and consisted of the number of weekday physiotherapy visits, the method of mobilisation and the factors preventing mobilisation. Of the total of 841 weekday physiotherapy visits, 272 (32.3%) included mobilisation. Thirty-five (13.0%) of the 272 mobilisation treatments involved sitting the patient upright in bed and 33 (12.1%) involved a patslide transfer to a Hausted chair. Of the more active mobilisation methods, 132 (48.5%) involved sitting the patient on the edge of the bed; 61 (22.4%) were standing transfers to sitting out of bed; and 11 (4.0%) treatments included walking. Of the 841 weekday physiotherapy visits 569 (67.7%) did not include mobilisation, with the main reasons being a patient's unstable medical condition (34.3%), patient sedation (17.8%) or mobilisation being contraindicated (16%). In summary, approximately one-third of physiotherapy interventions to ICU patients involved mobilisation, with mobilisation being prevented in the other patients by factors pertaining to their medical condition.

### Quality of life and musculoskeletal problems following thoracic organ transplantation

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Thoracic organ transplantation (TOTx) aims to improve the survival and/or quality of life (QOL) of patients with end-stage heart or lung disease. Considering the high prevalence of musculoskeletal morbidity related to immunosuppression, the aim of this study was to examine the relationship between musculoskeletal problems (MP) and quality of life (QOL) of TOTx recipients. A random sample of 200 TOTx recipients who received their transplant at The Alfred Hospital, Melbourne, and who were at least one year post transplant were surveyed. Demographic data were collected. The Sickness Impact Profile (SIP) was used to determine QOL. The Musculoskeletal Discomfort Survey (MDS) was used to measure MP. There was a 58.5% response rate, 78.6% of subjects were male. The mean age ( $\pm$  SD) was  $56 \pm 13$  yrs and time since transplant was  $6.78 \pm 4.2$  yrs. The sample consisted of heart transplant (79.5%) heart-lung (2.6%) double lung (6%) and single lung (10.3%) transplant recipients. Subjects reported a high QOL with SIP score  $7.88 \pm 8.59$  and a low level of MP with MDS score  $23 \pm 23.6$ . There was a moderate correlation between SIP and MDS score  $r = 0.47$   $p < 0.001$ . 22.5% of the variation in SIP score was attributed to MDS. The findings of this study support the hypothesis that TOTx recipients who experience musculoskeletal problems have poorer QOL than those who do not. This result is consistent with the limited research in the area and strengthens the need for further research to determine strategies to reduce the occurrence of MP.

### Influence of academic qualifications, place of employment and prior research experience on physiotherapy research practice

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Physiotherapists are responding to evidence-based practice through greater involvement in research activities. However, the awareness and understanding of ethical research practices by physiotherapists is unknown. The aim of this study was to describe physiotherapists' knowledge of good research practices. Content validity and test-retest validity for the survey were established. Physiotherapists who presented abstracts at Australian Physiotherapy Association conferences (including the National Cardiothoracic Group Conference) in 2003/2004 were surveyed ( $n = 167$ , response rate = 50%). The majority of abstracts involved humans (82%), with 85.4% of these having human research ethics committee (HREC) approval, 9.5% reported as quality improvement activities and 2.9% reported as human research without HREC approval. Despite the high level of HREC approval, only 47.9% of respondents had read or referred to the Declaration of Helsinki and/or NHMRC National Statement on ethical conduct in research involving humans. For guidance on ethical considerations in research, 28.9% of respondents would primarily rely on colleagues, 36.7% would utilise local HREC guidelines alone and 33.1% would use HREC guidelines and other ethical guidelines. There was an association between awareness of research guidelines and extent of prior research involvement ( $p < 0.001$ ), attainment of academic research qualifications ( $p < 0.001$ ) and place of employment ( $p = 0.004$ ). Only 58% of respondents identified the correct process for providing study information for consent. Information from this survey has implications for tertiary training programs, research supervisors, clinicians and physiotherapy managers.

### A survey of positioning practices for ventilated intensive care patients: an Australian perspective

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Little is known about the practice of positioning ventilated intensive care patients. A survey was developed to explore the type, frequency, duration, rationales, aims and perceived risks of positioning for ventilated patients. A senior physiotherapist and nurse from within thirty-eight Australian intensive care units were approached to complete the survey. Seventy-one surveys were returned (response rate = 93%, 35 nurses, 36 physiotherapists). Fifty-nine respondents (83%) agreed that there is an accepted standard of care for the duration of a position change with ventilated patients. Of these respondents, 51 (86%) agreed that the standard is to turn patients every two hours. Compliance to the practice of repositioning patients every two hours was reported to occur 'more than 50% of the time' in 47% ( $n = 34$ ) of intensive care units. Educational and environmental issues may particularly impact on positioning practices. Semi-recumbent and full side-lie positions were frequently recommended in the management of a range of patient conditions. However, full side-lie was less commonly used than supine positioning techniques. Prone and head down tilt positioning are the least frequently utilised. Common

aims in the use of positioning include postural drainage and the prevention of ventilator associated pneumonia and pressure ulceration. A moderate to high level of agreement was displayed for precautions and contraindications to positioning into full side-lie and sitting. Positioning practices may improve with the development of evidence-based and/or consensus driven positioning guidelines that can be used to educate physiotherapy and nursing staff.

### **Sitting versus semi-recumbent positioning: effect on gas exchange, respiratory mechanics, and haemodynamics**

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This study investigated the effect of semi-recumbent and sitting positions in intensive care patients. Twenty-two intubated and ventilated subjects were studied. Subjects were passively mobilised from supine into a seated position (Oxford chair) or into a semi-recumbent position (> 45° backrest elevation) in bed. The order of positioning was randomised. Minute ventilation ( $V_E$ ), tidal volume ( $V_T$ ), respiratory rate (RR), dynamic lung compliance ( $C_{dyn}$ ),  $PaO_2/FiO_2$  ratio,  $PaCO_2$ , heart rate (HR), mean arterial blood pressure (MABP) and arousal were measured in supine and 30 minutes post repositioning. Comparison of supine values between groups found only the  $PaO_2/FiO_2$  ratio to be significantly different (semi-recumbent =  $216 \pm 63$ , sitting =  $229 \pm 60$ ,  $p = 0.02$ ). The angle of backrest inclination in sitting was greater than gained with the semi-recumbent position ( $69 \pm 4^\circ$  versus  $51 \pm 5^\circ$ ,  $p < 0.001$ ). There were no significant changes in  $PaO_2/FiO_2$  ratio,  $V_T$ , RR or  $C_{dyn}$  due to either position. In sitting,  $V_E$  increased by  $0.9 \pm 1.7$  L ( $p = 0.03$ ) and  $PaCO_2$  decreased by  $1.2 \pm 2.2$  mmHg ( $p = 0.02$ ). While HR increased in sitting ( $93 \pm 16$  to  $97 \pm 18$ ,  $p = 0.03$ ), there were no significant changes in MABP induced by either position. Over the 30-minute periods, subjects slid forward more in semi-recumbent than seated positions ( $5 \pm 4$  cm versus  $1 \pm 1$  cm,  $p < 0.001$ ). Neither position change affected a subject's level of arousal. Sitting patients out of bed is an effective method to increase ventilation and is more easily maintained than semi-recumbent positions.

### **The 6-minute walk distance as a predictor of survival on a lung transplant waiting list: a tertiary centre's experience**

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Predictors of survival pre and post lung transplant are complex. The 6-minute walk distance (6MWD) is a widely used clinical marker of functional exercise capacity and is measured during lung transplant assessments. The aim was to evaluate the association between 6MWD and mortality pre and post lung transplant. The method was retrospective review of patients listed or who received a single or double lung transplant from June 1996 to April 2005. Comparative analyses made of those patients alive post transplant (APT), deceased post transplant (DPT) and those who died while on the waiting list (DWL) was performed. Clinical

parameters at time of listing were respiratory function, 6MWD and percentage of predicted exercise capacity. One hundred and forty-four patients (75 male) of mean  $\pm$  SD: age  $44.6 \pm 13.2$  years, KCO  $55.0 \pm 36.4\%$ <sub>pred</sub> and FEV<sub>1</sub>  $29.2 \pm 16.0\%$ <sub>pred</sub> were analysed. At listing, the mean 6MWD (m)  $\pm$  SD for APT was  $343 \pm 17$  (n = 69) DPT  $276 \pm 20$  (n = 41) and DWL  $240 \pm 22$  (n = 28). The mean distance  $\pm$  SD as a percentage of predicted 6MWD for APT was  $55.7 \pm 2.7\%$ , DPT  $44.9 \pm 2.8\%$  and DWL  $33.3 \pm 3.6\%$ . Comparatively, APT had a higher 6MWD distance ( $p < 0.01$ ) and percentage of predicted 6MWD than either DPT or DWL ( $p < 0.01$ ). A 6MWD of less than 276 m or 44.9% of predicted 6MWD was associated with an increased risk of death post transplant. A 6MWD distance of less than 240 m or 33.3% of predicted 6MWD was associated with an increased risk of death while on the waiting list.

### **The medical inpatient long stay project: the development of a pulmonary rehabilitation network to improve management of chronic respiratory disease**

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Chronic respiratory disease was recognised as a major cost to the WA health system. Pulmonary rehabilitation (PR), being scientifically proven and recognised as an integral component for the management of chronic obstructive pulmonary disease, was identified as a target area for improving the quality of health care for these patients. The physiotherapy department at Royal Perth Hospital obtained funding in March 2004 for a six-month pilot project to develop a network of PR to improve patient accessibility and utilisation of PR programs within the North East Metropolitan Area Health Service. This enabled establishment of four maintenance programs within secondary and community settings in addition to existing services. Linking the PR programs has strengthened staff relationships, facilitated support systems for sharing of expertise and enables a seamless pathway of care to be provided to patients according to their changing individual needs. Success of this initial stage resulted in additional funding being granted until June 2005 allowing for further expansion of services within all tertiary, secondary and community programs across the health service. With minimal funding this project has achieved its aims of improving accessibility and utilisation of PR services. Numbers of weekly sessions have increased from 12 to 19 and total enrolment numbers have significantly increased from 62 at baseline to 134 in March 2005. Referral base has increased and waitlist times have been reduced when compared to baseline data, despite a 235% increase in demand. Health care utilisation data continues to be collected for participants enrolled during the project period.

### **The negative expiratory pressure technique for measuring expiratory flow limitation in chronic obstructive pulmonary disease — is it reliable?**

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Tidal expiratory flow limitation (EFL) contributes to chronic dyspnoea and exercise intolerance in chronic obstructive pulmonary disease (COPD). It can be assessed with the Negative Expiratory Pressure (NEP) technique using three scoring systems: %tidal volume over which EFL occurs ( $FL\%V_T$ ), a three-point score consisting of not flow limited, flow limited in supine, or flow limited in seated and supine; and a five-point score which combines these two indices. The aim of this study was to evaluate the reliability of the NEP technique in COPD. Tidal EFL was evaluated with NEP in 19 subjects with stable COPD ( $FEV_1$  range 18-61%<sub>pred</sub>) on two occasions (mean re-test interval 8.4 days) by the same rater. Agreement between testing occasions was assessed with the kappa statistic for the three-point and five-point EFL scores, and with intraclass correlation coefficients (ICCs) for  $FL\%V_T$ . On the first testing occasion, nine subjects had no EFL, four subjects had EFL in supine, and six subjects had EFL in sitting and supine. Using the three-point score, agreement was present in 14/19 subjects at time two (kappa = 0.61), indicating substantial agreement. Using the five-point score, agreement was seen in 13/19 subjects (kappa = 0.54), indicating moderate agreement. The reproducibility of  $FL\%V_T$  measurements was lower than that required to reliably detect clinical change in both sitting ( $ICC_{2,1} = 0.85$ ) and supine ( $ICC_{2,1} = 0.72$ ). The three-point score provides a reliable assessment of EFL in COPD. More complex scoring systems are less reliable, probably due to the variability inherent in tidal breathing.

### **Exercise following bone marrow transplant — preliminary results of a randomised controlled trial**

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Exercise has been promoted as a way to improve functional capacity and quality of life following bone marrow transplant (BMT) or peripheral blood stem cell transplant (PBSCT). However, existing studies have excluded patients with reduced cardiac and pulmonary function caused by preconditioning treatment. This single blinded study aimed to compare the effects of: control, aerobic exercise and aerobic plus resisted exercise over a six-week period. Patients were stratified for graft type and randomly allocated to groups at 30 days post BMT or PBSCT. Outcome measures included a disease-specific quality of life measure (FACT BMT), handgrip strength, skin fold measurements, adverse events during exercise and metabolic equivalents (METS) obtained on a modified Bruce protocol stress test. Thirteen subjects were recruited (mean age 42.3 years, [range 27–63 years] 7 male and 6 female, 4 allografts, 9 autografts). Four subjects did not complete the study due to intercurrent illness. No adverse events were observed in any subject during exercise. A preliminary analysis indicates no significant difference between groups for either physiological or quality of life measures. Further numbers are needed to complete this trial and recruitment is continuing. However, preliminary results indicate it is safe to exercise patients following bone marrow transplant and that those patients with cardiac and pulmonary function abnormalities need not be excluded.

### **Can the BODE index be useful in predicting outcomes in pulmonary rehabilitation?**

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BODE index is a simple ten-point multidimensional grading system used in predicting outcome among patients with COPD compiled from body mass index (B), American Thoracic Society airflow obstruction criteria (O), dyspnoea: Modified Medical Research Council (D) and exercise tolerance: 6-minute walk test (6MWT) (E). The aim was to assess if BODE index is sensitive to change from pulmonary rehabilitation and which patients benefit most. Patients were assessed at baseline and on program completion. Data collected included BODE index parameters, 6MWT and quality of life questionnaire (Taunton). Ninety-two patients (71 with COPD) were assessed: mean  $\pm$  SD age  $68 \pm 9$  years and  $FEV_1$   $50\% \pm 20\%$ . Overall BODE index improved from 2.8/10 to 2.5/10 ( $p < 0.02$ ) where a BODE index of 10 indicates the worst predicted outcome. Completion rate ([BODE index], patients completed/patients enrolled): Quartile I (0–2/10), 24/32, II (3–4/10), 19/32, III (5–6/10), 10/20 and IV (7–10/10), 0/4. Largest decrease was in Quartile III from 5.4 to 4.5/10 ( $p = 0.03$ ). Quartile II: 3.5 to 3.2/10 and Quartile I: 1.3/10 to 1.2/10 was not significant. BODE improvers had a higher baseline score: 3.6/10 vs 2.4/10 ( $p < 0.001$ ). In COPD this baseline score was 3.9/10 vs 2.5/10 ( $p = 0.01$ ). Non-completers baseline score was higher 4.2/10 vs completers 2.8/10 ( $p < 0.01$ ). Change in BODE index had no correlation with change in Taunton or 6MWT. The BODE index is sensitive to change in the more severe group (Quartile III). Despite a better completion rate, the milder disease group (I and II) had minimal change.

### **Adherence of adults who have cystic fibrosis with airway clearance and exercise regimens**

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Regular airway clearance and exercise form an important part of the physiotherapy management of patients with cystic fibrosis (CF). The adherence of these patients with physiotherapy regimens is variable, with factors such as gender and disease severity influencing adherence. To date, the adherence of Australian patients with CF has not been investigated. Thus, the aim of this study was to measure the adherence of a sample of Australian adult patients with CF and to ascertain factors that improved or decreased adherence with physiotherapy. A questionnaire was conducted via an interview with an independent physiotherapist and completed by 57 of the 84 patients attending the Royal Adelaide Hospital CF unit (67.9% response rate). Ninety-eight percent of patients reported performing some form of airway clearance treatment over the last six months, although only 28.1% had performed it as often as advised by their physiotherapist. Regular exercise was performed by 91.2% of patients when well, with 73.7% also exercising regularly when unwell. The most common reasons reported by patients for non-adherence with airway clearance regimens were being too busy and that they couldn't be bothered. Being too busy and too tired were the most frequent reasons for decreased adherence with exercise regimens. Adherence with airway clearance treatments improved when patients felt unwell,

and the positive feelings associated with exercise increased adherence with exercise regimens. Overall, the levels of adherence with physiotherapy regimens found in this study were considered to be satisfactory.

### **Satisfaction of adults who have cystic fibrosis with their physiotherapy management**

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Although physiotherapy forms a vital part of the management of patients with cystic fibrosis (CF), the satisfaction of these patients with their physiotherapy management has been poorly addressed in the literature. Thus, the aim of this study was to measure the level of satisfaction of patients with CF with their physiotherapy management. As part of a larger study, patients attending the Royal Adelaide Hospital (RAH) CF unit answered a questionnaire via an interview with a physiotherapist who was not involved in the CF unit. The questionnaire was completed by 57 of the 84 patients attending the RAH CF unit (67.9% response rate). All patients had seen a physiotherapist during the preceding 12 months, with the majority (91.2%) citing the number of times they saw a physiotherapist as being 'about right'. All patients reported receiving education and advice regarding the need for physiotherapy, with approximately 90% noting the education/advice was of a high standard. All 57 patients thought the amount of responsibility the physiotherapist gave them for doing their treatment was appropriate when they were well but, when unwell, 18 patients (31.6%) thought they were given too much responsibility. The majority of patients made favourable comments, finding the CF physiotherapist friendly, courteous, encouraging and caring. Overall, 45 patients (78.9%) rated the present physiotherapy service at the RAH as good or very good. Thus, a high level of satisfaction with the physiotherapy service provided at the RAH was found.

### **Cardiothoracic physiotherapists wanted — must be committed, motivated and competent in this speciality area**

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Eligibility to join the physiotherapy profession is achieved through successful completion of a recognised tertiary program and registration with an appropriate state or territory board. After this point, opportunities to formally demonstrate focused clinical expertise both within the physiotherapy profession and to the broader health, tertiary and government communities have been associated with the completion of postgraduate coursework or research degrees. While opportunities to pursue postgraduate education exist throughout Australia, advanced professional clinical competencies might also be demonstrated by behaviours and attributes other than holding a postgraduate qualification. The majority of physiotherapists are likely to be able to name cardiothoracic physiotherapists who demonstrate admirable assessment and treatment skills underpinned by a contemporary body of knowledge and

enviable communication, critical thinking and problem-solving skills. The Clinical Standards Committee of the National Cardiothoracic Group (NCG) is responsible for developing and assessing the competencies in order to be eligible for the title of 'cardiothoracic physiotherapist'. The development of advanced cardiothoracic skills may occur through a variety of formal and informal educational experiences which may not always include the completion of a postgraduate degree. Titled membership should be attainable by cardiothoracic physiotherapists committed to working in the area. This presentation will clarify the aim and role of the titling process, the application and assessment procedures and the breadth of evidence which could be used to support each of the clinical standards competencies. In short: cardiothoracic physiotherapists wanted — must be committed, motivated and competent in this speciality area.

### **What evidence is represented within undergraduate cardiothoracic physiotherapy curricula?**

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Simplistically, educational materials should reflect the underlying evidence base of a curriculum. The purpose of this study was to identify the levels of evidence represented within the cardiothoracic curricula in undergraduate (entry level) physiotherapy programs within Australia. Using a retrospective document review, all tertiary institutions providing undergraduate physiotherapy programs were invited to submit paper copies of course materials used during 2003 to the Centre for Allied Health Evidence (CAHE), University of South Australia. A single independent reviewer collated all references cited within the teaching materials and ranked each reference according to a hierarchy of evidence, where systematic reviews were regarded as the highest level of evidence and expert opinion/case studies at the lowest level. A total of 974 references were cited within educational materials from the five participating universities. The number of references per university ranged from 71–256. Each ranking category was calculated as a percentage of the total number of references submitted by each university. All five universities demonstrated the same pattern of reference hierarchy where the lower levels of evidence represented approximately 70% of all references. Less than 1% of all references were common to all five universities. While auditing references cited within education material does not reflect educational process, the results from this study provide a baseline to review and create strategies to strengthen the evidence base of cardiothoracic curricula. Issues concerning the decision making processes used to select curriculum sources need further consideration.

## Changes in motor performance, physiological measures and respiratory function from admission to discharge in hospitalised young people with cystic fibrosis

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This study aimed to compare admission and discharge outcomes utilising the 6-minute walk test (6MWT) and a validated set of three self-paced motor tasks in children with cystic fibrosis (CF) hospitalised due to pulmonary exacerbation. Selected motor tasks involved jumping and short bursts of activity, aiming to reflect paediatric participation levels as described in the International Classification of Function (ICF). Physiological measures (heart rate [HR], oxygen saturation [SpO<sub>2</sub>], breathlessness [modified Borg, visual analogue VAS] and 15-count breathlessness scales) monitored these activities. Thirty-three patients with CF aged 7–17 years (mean 12.56 yrs) were tested. Significant improvements in 6MWT occurred from admission to discharge ( $p = 0.04$ ). No significant change occurred in the ability to perform jump tasks from admission to discharge (Astride jump:  $p = 0.121$ , Face stand manoeuvre:  $p = 0.196$ , Forwards-backwards jump:  $p = 0.342$ ). Physiological measures (HR, SpO<sub>2</sub>, breathlessness) did not change from admission to discharge. Cough during walk tests was significantly greater at admission ( $p = 0.005$ ), demonstrating its usefulness as an additional measure during walk tests with respiratory patients. Significant improvements occurred in FEV<sub>1</sub> (%) during hospitalisation ( $p = 0.01$ ), but not in FVC and FEF<sub>25-75%</sub> ( $p = 0.06$ ,  $p = 0.27$ ). Intensive physiotherapy and other multidisciplinary interventions promote significant improvements in 'Body Structure and Function' and 'Activity' levels, but not the 'Participation' level of the ICF. Physiological variables (HR, SpO<sub>2</sub>) were not the limitation on high demand propulsive activities. Further studies may identify activities and measures sufficiently specific and sensitive to make functionally important changes.

## Incidence of adverse physiological changes in intensive care during physiotherapy — a multicentre audit

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There has been some concern in the literature as to whether physiotherapy causes adverse physiological changes (APC) that could be harmful to intensive care patients. A multicentre audit was performed to: investigate the incidence of APC during physiotherapy in critically ill patients over a three-month period; benchmark this against studies which have recorded spontaneous APC; and to investigate whether there were any trends in patient category, demographic characteristics, type of intervention, or seniority of physiotherapist. There were 12 800 physiotherapy treatments completed with 29 treatments resulting in adverse physiological changes (0.22%). This incidence was significantly lower than a previous study of

APC (663 events/247 patients over a 24-hour period), that is, the incidence during physiotherapy was lower than during general ICU care. Significant trends in the 29 patients who had an APC during physiotherapy were apparent, with a deterioration in cardiovascular status the major APC noted (i.e. decrease in blood pressure or arrhythmia) in patients on medium to high doses of inotropes/vasopressors, having unstable baseline hemodynamic values, previous cardiac co-morbidities, receiving intervention consisting of positive pressure, and/or with junior physiotherapists completing the intervention. Combinations of incidents in these 29 patients demonstrated that a decrease in blood pressure commonly occurred if a patient on inotropes with unstable baseline values was either turned to right side lying (2 sided Fishers exact test,  $p = 0.006$ ) or received positive pressure (2-sided Fishers exact test,  $p = 0.07$ ). This audit has demonstrated that the overwhelming majority of physiotherapy treatments in intensive care are safe.