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Contents

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Introduction

Welcome to the 2009 journal of the ACPRC. The ACPRC mission is focused on promoting best practice in respiratory physiotherapy for the benefit of patients. The ACPRC Journal does this by promoting the exchange of ideas in respiratory care and providing a forum for discussion of findings of research and development in respiratory physiotherapy.

2009 has been an exciting year for respiratory physiotherapy. We have received a range of submissions for publication in this year's Journal. Two papers focus on acute care: rehabilitation interventions in ICU and screening for postoperative complications; the other two papers focus on chronic care: exercise capacity in bronchiectasis and IMT and upper limb exercise in COPD. These papers reflect the diversity of the role of physiotherapy in respiratory care.

Three reviews are also included in this journal: The Guidelines for the Physiotherapy Management of the Adult, Medical, Spontaneously Breathing Patient (2009) will have a significant impact on patient care and represent a huge and commendable undertaking by our colleagues in the BTS/ACPRC guideline development group; other reviews of recent books highlight the availability of up-to-date texts which we can access to advance our practice.

The continued publication of this Journal is dependant on your support so we would like to encourage all of you to consider submitting your work for the next edition. The ACPRC website provides the authors guidelines for submissions and the deadline for submission to the next journal is Jan 31st 2010.

Best regards

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The incidence of physiotherapy and rehabilitation activities within a general Intensive Care Unit

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Summary

Rehabilitation is recognised as a fundamental component of Physiotherapy practice within the ICU. There remains a paucity of evidence underlying the efficacy, frequency, incidence and definition of rehabilitation interventions for critical care populations. This investigation seeks to determine the incidence of Physiotherapy related rehabilitation activity, including muscle strengthening interventions within an ICU population. This data may contribute to our appreciation of the use of exercise interventions in patients with critical illness and the characteristics of populations to which these interventions can be applied.

Keywords
Rehabilitation, Activity, Mobilisation, Critical care

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Introduction

Respiratory techniques and rehabilitation interventions are employed by Physiotherapists within critical care, and several reports describe the variety of rehabilitation practices within critical care units in Canada, the United Kingdom and Australia (King and Crowe 1998, Lewis 2003, Chang et al 2004 and Skinner et al 2008). These papers provide an indication of the variety of techniques used within critical care environments, but do not indicate their frequency of use, the proportion of all physiotherapy activity that is rehabilitation related or the characteristics of the populations in which they are targeted.

Stiller and colleagues (2004) examined the physiotherapy management of patients admitted to an Australian intensive care unit (ICU) over two 3-week periods. During these intervals, 19.3% of the population received mobilisation (moving from lying to sitting on the bed edge, sitting to standing, standing transfer from bed to chair, or walking) as a component of their global physiotherapy management. These activities accounted for 16% of the total Physiotherapy intervention during the study period. The

Table 1: Incidence of all physiotherapy interventions in relation to airway, ventilation mode and inotrope use

	Endotracheal Airway (n=185)	Tracheostomy (n=308)	Self Ventilating (n=194)	NIV (n=35)	CPAP via Ventilator (n=53)	Controlled Ventilation (n=131)	Inotropes (n=101)
Body positioning	89	80	53	57	83	94	88
Limb care	67	35	7	9	60	70	58
Suction events	72	75	21	9	81	75	78
MHI/VHI	12	4	0	0	11	16	17
Breathing exercises	1	2	0	0	2	<1	1
Manual techniques	18	11	4	23	25	17	25
Passive rehabilitation	2	34	17	20	4	3	7
Active assisted exercise	9	35	26	29	19	7	9
Free active exercise	6	26	63	40	15	3	9
Sitting on the bed edge	2	12	48	34	2	<1	1
Sitting to standing	0.5	12	49	31	2	0	1
Standing transfer	0.5	8	35	26	2	0	1
Walking	0	2	16	3	0	0	0

Values denote the incidence of each intervention as a percentage (%) of the number of episodes per category of airway type, mode of ventilation or inotrope use.
Abbreviations: CPAP = Continuous Positive Airway Pressure, NIV = Non-invasive ventilation, MHI/VHI = Manual or Ventilator Hyperinflation.

sample who participated in these interventions were selected on the basis of a comprehensive screening process (Stiller and Phillips 2003) but it is unknown what other physiotherapy intervention was provided.

Benchmarking standards do not currently exist for Physiotherapy interventions within ICU and the populations to which rehabilitation interventions are applied remain poorly understood. The aim of this project was to establish the frequency of all physiotherapy interventions within a general ICU, and determine the characteristics of the populations in which active rehabilitation interventions were included. Analysis of this nature may allow clinical standards to be established whereby physiotherapy performance can be evaluated.

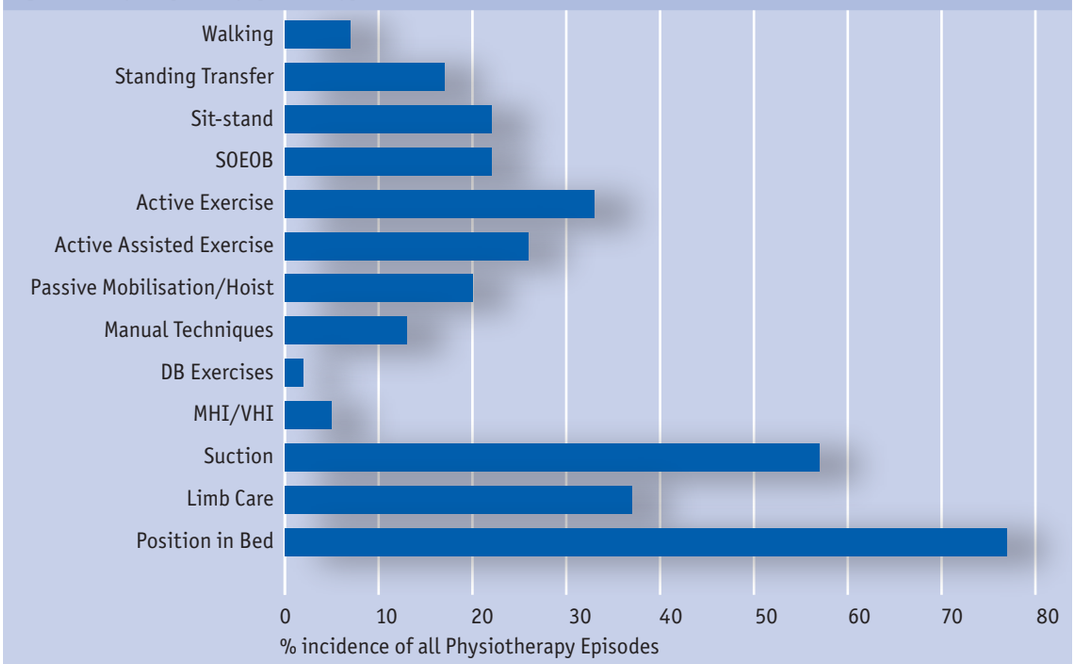
Methods

A convenience sample of patients admitted consecutively to an 8-bed district general ICU over a 3-month period were included. Demographic information (age and sex); admission diagnosis (surgical, sepsis, respiratory failure, neurological, renal failure, orthopaedic and cardiac); airway type; mechanical or non-invasive ventilation mode; oxygenation (PaO2 and FiO2) and physiotherapy interventions were recorded immediately following each episode of physiotherapy using a pre-designed tool. Data collection was completed by all physiotherapists' providing a service to the ICU (five day and on call service) during the study period. Patients in the ICU received a Physiotherapy service on weekends including the commencement and progression of rehabilitation interventions as required. The PaO2/FiO2 ratio was subsequently derived in mmHg.

For ease of data analysis, Physiotherapy interventions were categorised post hoc as follows:-

- "Standard care activities":- including body positioning in the bed; limb positioning and care (which included assessment

Figure 1: Frequency of all physiotherapy interventions observed



Abbreviations: SOEOB = Sitting on the edge of the bed; DBExercises = Deep breathing exercises; MHI/VHI = manual hyperinflation/ventilator hyperinflation.

of passive range of motion, muscle stretching and limb positioning); suction events (open or closed); manual or ventilator hyperinflation; breathing exercises; and manual techniques to facilitate secretion removal.

- "Passive rehabilitation":- including hoist and pat-slide transfers to a chair. Although patient participation was minimal, these activities are important in the rehabilitation of critically ill patients.
- "Active rehabilitation":- included active assisted and active muscle strengthening exercises, sitting on the bed edge, sitting to standing, standing transfers and walking. The term active rehabilitation was chosen to incorporate active assisted/ free active exercise and not just mobilisation.

Data was analysed descriptively for the total sample, for Physiotherapy episodes that included active rehabilitation and those that did not; and for individual active rehabilitation interventions. Ethical approval was not sought as this investigation constituted service evaluation and not the implementation of a new service. Local approval for this activity was granted by the Trust Audit committee.

Results

82 patients (mean age 59 ± 19yrs) received 681 episodes of physiotherapy over the study period. 43% of the sample had a surgical diagnosis while 23% had a diagnosis of sepsis and respiratory failure respectively. Neurological diagnoses accounted for 8% of the sample, while renal failure, orthopaedic and cardiac diagnoses combined accounted for 2.5%. Following assessment, Physiotherapy intervention was not provided on 12 occasions (1.8%) during the study period because of cardiovascular and respiratory instability, sedation, agitation and nursing care issues.

Of the remaining 669 Physiotherapy episodes, body positioning occurred with the greatest frequency (76%), followed by suctioning (56%) and limb care (36%). Interventions with the lowest frequency across all episodes included manual techniques (12%), MHI/VHI (5%), and breathing exercises (1.3%). Figure 1 shows the frequency of interventions across the 669 Physiotherapy episodes.

Table 1 illustrates the incidence of interventions in relation to airway, ventilation and cardiovascular support. For example, during episodes in which the patient was self ventilating (N = 194), a high incidence of active exercise, sitting and standing interventions occurred. Controlled ventilation was associated with high frequencies of body positioning, limb care and suction.

303 episodes of physiotherapy (45%) did not include an active rehabilitation intervention. These episodes where characterised by high frequencies of body positioning

Table 2: Characteristics of physiotherapy episodes that did and did not include active rehabilitation interventions

	No active Rehabilitation (N = 303, 45% of total episodes)	**Active Rehabilitation Intervention ≥1 (N = 368, 55% of total episodes)**
Self ventilating	4.5	49
Endotracheal airway	50	8
Tracheostomy	44.3	45
Controlled ventilation	45	4
CPAP via ventilator	47.5	40
NIV	2	8
Inotrope use	28	4
Body positioning	89	64
Limb care	61	15
Suction event	74	41
MHI/VHI	10	1
Breathing exercises	2	<1
Manual techniques	19	7
Passive rehabilitation	14	22
Active assisted exercise	-	43
Free active exercise	-	59
Sitting on bed edge	-	36
Sitting to standing	-	36
Standing transfer	-	27
Walking	-	9

Values denote the incidence of each characteristic as a percentage (%) of the number of interventions per category.
Abbreviations: CPAP = Continuous Positive Airway Pressure, NIV = Non-invasive ventilation, MHI/VHI = Manual or Ventilator Hyperinflation.

(89%), suction (74%) and limb care (61%). 55% of all episodes (N = 368) included at least one active rehabilitation intervention. Of these episodes, active assisted/active exercise occurred with the greatest frequency (43% and 59%), followed by sitting on the bed edge (36%), sitting to standing (36%) and standing transfers (27%). Walking occurred with the lowest frequency (9%).

Physiotherapy episodes that included active rehabilitation demonstrated a low incidence of controlled ventilation (4%), endotracheal airway (8%) and hyperinflation techniques (1%). 49% of these episodes occurred when patients were self-ventilating. Table 2 illustrates the characteristics of episodes where active rehabilitation did and did not occur. A progressive increase in the PaO2/FiO2 ratio was observed with increasing complexity of active rehabilitation interventions. Active assisted exercise was associated with the lowest mean ratio (234 ± 101mmHg) followed by sitting on the bed edge (260 ± 99mmHg) and standing transfers (263 ±101mmHg). Episodes with the highest mean ratio (310 ± 103mmHg) completed walking interventions.

Discussion

Other than the 16% and 32% incidence of mobilisation in a general ICU reported by Stiller et al (2004) and Stiller and Wiles (2006), little is known regarding the frequency of active rehabilitation within critical care. In the current analysis, active rehabilitation occurred in 55% of all physiotherapy episodes. The definition of active rehabilitation in the present analysis included active strengthening exercises, which were not included by Stiller et al (2004, 2006) in their definition of mobilisation. Skinner et al (2008) recently reported active assisted and free active exercise as the most commonly prescribed exercise in all patients in intensive care units in Australia. Nevertheless, removing episodes where active/active assisted exercise was the only active rehabilitation intervention in the current analysis (109 episodes), decreased the active rehabilitation incidence to 39% of all Physiotherapy episodes. Disparity between this study and Stiller et al (2004) may be a reflection of population differences, although the age, diagnoses and pre-treatment PaO2/FiO2 ratios are similar between the two reports.

The inclusion guideline used to select patients suitable for mobilisation by Stiller et al (2003) involved a complex

analysis including medical background, cardiovascular and respiratory reserve. This guideline has been recognised in the ESICM statement (Gosselink et al 2008) as a screening tool for the safe mobilisation of critically ill patients. Rigorous pre-activity screening was not a feature of the current study. The decision to commence rehabilitation was based on assessment, response to previous intervention and patient co-operation, as is typical of clinical practice. It is possible that the frequency of active rehabilitation interventions observed in the current study was due to a less restrictive inclusion process than that used by Stiller et al (2004).

It is also important to recognise that the guideline developed by Stiller and colleagues (2003, 2004 and 2007) remains the only published overview of safety considerations for the mobilisation of the acutely ill, although excellent reviews of the issue exist (Morris 2007). Exploration of the issues underlying clinical decision making are required to ensure our screening criteria are sensitive to the rehabilitation needs of this unique population. Investigations of potential differences in the "number of days to mobilise" using rigorous inclusion screening versus other clinically relevant methods are required. For example, Bailey et al (2007) selected few criteria for initiation of activity (response to verbal stimulation, $FiO2 < 0.6$, $PEEP < 10cmH2O$, absence of orthostatic hypotension or inotropes) and reported time to activity from initial ITU admission of 6.6 ± 5.5 days.

The frequency with which active rehabilitation interventions occurred in the current study is not surprising given the generally accepted hierarchy of mobilisation for patients with critical illness (Baker and Mansfield 2008) which emphasises an increase in function with patient tolerance. Bailey et al (2007) reported the incidence of activity events in their study of respiratory failure patients over a 6 month period. Of the 1449 activity events recorded, 16% involved sitting on the bed edge, 31% involved sitting in a chair and 53% involved ambulation. In the current investigation standing transfers to a chair occurred with a similar frequency (27%) to Bailey et al (2007), but mobilisation occurred with much less frequency (9% vs 53%). Stiller and Wiles (2006) report similarly low frequencies of walking (4%). It is difficult to extrapolate from the current data reasons for the low incidence of walking. It is interesting to observe the higher trend of $PaO2/FiO2$ ratio of those episodes that included walking, suggesting that appropriate clinical reasoning was informing practice associated with exercise interventions. Further analysis of the limited frequency of walking interventions in critically ill populations is required.

Other than the study by Bailey et al (2007) little is known with respect to the characteristics of patients able to participate in rehabilitation. These authors reported that 48% of activity events occurred in non-intubated patients, 11% in patients with a tracheostomy and 41% in patients with an endotracheal tube. In the current study only 8% of episodes including active rehabilitation occurred in patients with an endotracheal airway.

Bahadur et al (2008) noted that national or international standards detailing airway type and mobilisation practice do not exist. In their study sitting activities were initiated once tracheostomy formation had occurred. The decision to commence active rehabilitation in patients with an endotracheal airway involves analysis of the likelihood of airway compromise versus the benefits of the intended exercise. The low incidence of rehabilitation in patients with endotracheal airways in our study may have been due to the units participation in a national audit of early tracheostomy at the time of data collection. Further investigation of rehabilitation practice in relation to airway status is required, although local consensus and policy may ultimately guide this issue.

Norrenberg and Vincent (2000) have pointed out that the role of physiotherapy within European ICU's varies widely depending on staffing and expertise. The variety of physiotherapy practice throughout Europe and Australia make intercontinental comparisons difficult. However, recognition of the incidence of physiotherapy intervention within individual critical care units may facilitate comparisons with published research and the identification of service development priorities. Since indicators of clinical performance require a temporal component, the present study is limited by its inability to determine the number of days from ITU admission to the first active rehabilitation activity. Consequently temporally oriented standards are unable to be derived from this data.

Rehabilitation of the patient with critical illness has been identified as a priority within the National Health Service since these patients experience extreme functional loss (Sciaky 1994) and consume a significant proportion of the acute care budget. Establishing the baseline characteristics and incidence of active rehabilitation interventions in a population with critical illness may play an important role in the justification of further funding and research. In addition, analysis of this nature allows priorities to be established with

regard to multi-disciplinary in-service training and development.

Conclusion

There are few examples in the literature examining the prevalence of rehabilitation in critical care. In this study over half of all physiotherapy episodes documented in a general ICU over a 3 month period involved one or more active rehabilitation interventions. The most frequent intervention was active/active assisted exercise, followed by sitting and weight bearing. Walking occurred with the lowest frequency. Further investigation of the criteria used to determine readiness to exercise; the number of days between critical care admission and starting rehabilitation; and the factors preventing rehabilitation are required to enhance our appreciation of current clinical practice in this area.

Key Points

- Rigorous inclusion criteria for commencing rehabilitation may decrease the incidence of rehabilitation activity in critically ill patients.
- Appreciation of the incidence of physiotherapy and active rehabilitation interventions in critical care practice allows determination of priorities for multidisciplinary in-service training and development.
- Further research identifying the characteristics associated with rehabilitation activities including walking interventions is required.

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The Southampton Physiotherapy Post-Operative Screening Tool

A preliminary evaluation of the validity and reliability

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Summary

Physiotherapists in Southampton have developed a post–operative screening tool (SPPOST) for predicting patients at risk of developing post-operative pulmonary complications. This study tested a methodology to assess validity and reliability of the SPPOST. In the small samples used, the SPPOST was found to be both valid and reliable.

Keywords
Postoperative complications, Screening tool, Reliability, Validity

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Introduction

Post-operative pulmonary complications (PPCs), including atelectasis and chest infections, peak at 48 hours post-abdominal surgery in approximately 30% of patients (Ferguson 1999, Kroenke et al 1992). PPCs detrimentally increase recovery time, length of hospital stay and mortality, which in turn increases the strain on the National Health Service (NHS) (Lawrence 2001, Collins et al 1999, Brooks-Brunn 1997).

To reduce the impact of PPCs on NHS time and resources, it would be useful to be able to identify those individuals likely to develop a PPC, so that such individuals could receive interventions aimed at reducing the development of complications (Mackay et al 2005, Doyle 1999). Several risk factors (e.g. age, body mass index, smoking history and length / type of anaesthetic) have previously been identified and incorporated into different models (Collins et al 1999, Mitchell et al 1998, Wong et al 1995). However, many of these models attempt to predict PPCs pre-operatively, which is not always feasible for elective surgery and is impossible for emergency surgery. The existence of a valid and reliable mechanism to predict PPCs immediately post-surgery prior to the risk period of 48 hours would be beneficial (Rudra et al 2006,

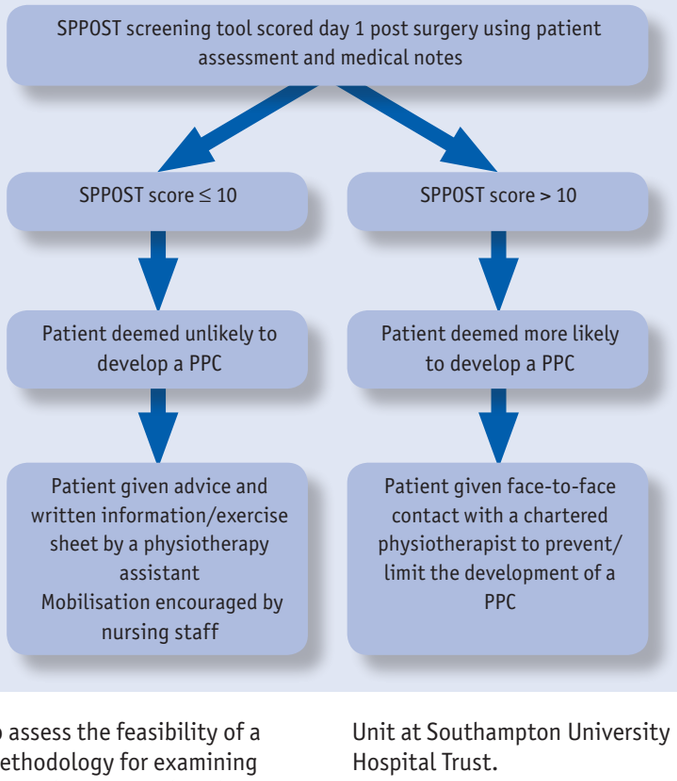
Hulzebos et al 2003, Ferguson et al 2002, Arozullah et al 2001, Collins et al 1999, Mitchell et al 1998, Brooks-Brunn 1997, Wong et al 1995).

Increasing demands on physiotherapists' time and resources led to the development of the Southampton Physiotherapy Post-operative Screening Tool (SPPOST) by Ostler et al (2008). This tool has been used by physiotherapists on day one post surgery to predict patients' PPC risk, after which high risk individuals were given preventative physiotherapy, whereas those at low risk were given self-management advice. However, although the SPPOST has been incorporated into clinical practice in Southampton, there is still uncertainty surrounding the validity and reliability of the tool. The research questions which need answered in relation to SPPOST validity and reliability are:

1. Is the SPPOST able to predict who will develop a PPC after abdominal surgery? (criterion-related validity)
2. Do different raters using the SPPOST for the same individual produce the same score? (Inter-rater reliability)
3. Does the same rater using the SPPOST on more than one occasion produce the same score? (Intra-rater reliability)

This pilot study primarily aimed to assess the feasibility of a methodology for examining these elements and explore potential subgroup analyses.

Figure 1: Diagram to illustrate the clinical use of the SPPOST within Southampton University Hospitals Trust



Methods

Ethics

External ethics approval for both validity and reliability pilot studies was obtained through the Southampton & South West Hampshire Research Ethics Committee (07/Q1704/58 and 07/Q1704/57 respectively). Approval was also obtained from the Research & Development Unit at Southampton University Hospital Trust.

SPPOST

The SPPOST incorporates eight weighted risk factors to generate an overall score that aims to predict a patient's risk of developing PPCs. It is used clinically in the way described within Figure 1.

Validity

To assess the usefulness of the SPPOST it was decided to examine criterion validity i.e.

Table 1: Criteria determining the presence of a PPC according to Brooks-Brunn (1997)
For a PPC to be deemed to have occurred, a minimum of two criteria had to have been present on two or more days within the first six post-operative days.

new cough/sputum production;
abnormal breath sounds as compared with baseline. Baseline measures are established pre-operatively via a chest assessment;
temperature 38°C;
chest radiograph documentation of atelectasis or new infiltrate;
physician documentation of atelectasis or pneumonia

the extent to which scores are in agreement with (concurrent validity) or predict (predictive validity) an external criterion. As no 'gold standard' exists for determining the presence of a PPC, Brooks-Brunn scores (Brooks-Brunn 1997) were used as a surrogate marker (see Table 1). The SPPOST was introduced to Southampton in 2006. It was therefore decided to examine medical records from surgical patients from 2005 (pre-introduction of SPPOST) and 2006 (post-introduction of SPPOST) to gather information about any predictive risk factors and any subsequent PPCs.

Inclusion & Exclusion Criteria for medical records accessed

Inclusion Criteria:

1. Medical records relating to individuals undergoing elective or emergency, upper or lower abdominal surgery between January 2005 and December 2006.

For 2006 data only:

2. Medical records relating to individuals who had been scored using the SPPOST on day one post-surgery (by a physiotherapist not involved in the tool's design).

Exclusion Criterion:

Medical records fulfilling the above criteria but relating to individuals already in hospital or awaiting further admission, as their medical records could not be requested for research.

Validity Sample

A total of 720 abdominal operations were performed within this time period which fulfilled the criteria. Sixteen complete sets of medical records (eight from 2005 and eight from 2006) were available for access from a purposive sample of 20 selected to provide a range of SPPOST scores. These were anonymised and allocated an identification number.

Validity Data Collection

Each of the 16 record sets was examined by one of the authors (EL) and the criteria applied to determine if a PPC had developed. For 2005 records, the SPPOST was then applied retrospectively by a senior physiotherapist regularly using the tool, to generate a score. She was blinded as to the PPC findings. For 2006 records the original SPPOST score was retrieved.

Reliability

Intra- and inter-rater reliability of the SPPOST were evaluated in two groups of physiotherapists i.e. Frequent users and Infrequent users of the SPPOST.

Inclusion & Exclusion Criteria for participating physiotherapists

Inclusion Criterion for the 'Frequent Users' Group

- All grades/bands of physiotherapists and Physiotherapy Assistants (PTAs) working on post-surgical wards who were using the SPPOST on a daily basis.

Table 2: SPPOST and Brooks-Brunn scores derived from 16 sets of notes from 2005 and 2006

Notes	2005		Notes	2006	
	Brooks Brunn scores**	SPPOST scores*		Brooks Brunn scores**	SPPOST scores***
1	0	5	9	0	4
2	3	5	10	0	5
3	0	7	11	0	7
4	5	7	12	0	7
5	1	8	13	0	8
6	1	12	14	0	12
7	0	12	15	4	12
8	3	16	16	9	16

** scores calculated retrospectively from medical notes by a senior physiotherapist*
*** scores calculated from medical notes by author (EL)*
**** scores recorded in medical notes at the time*
A Brooks-Brunn score ≧ 2 indicates a PPC, a SPPOST score ≥ 10 indicates high risk of developing a PPC

Table 3: Results of calculations to produce figures for the important features of a diagnostic screening test (Greenhalgh 1997)

Feature	2005 data	2006 data
True positives	1	2
False positives	2	1
True negatives	3	5
False negatives	2	0
Sensitivity	33.3%	100%
Specificity	60%	83.3%
Positive predictive value	33.3%	66.7%
Negative predictive value	60%	100%
Accuracy	50%	87.5%
Likelihood ratio:		
Positive test	0.83	5.99
Negative test	1.11	0

Inclusion Criterion for the 'Infrequent Users' Group

- All grades/bands of physiotherapists and PTAs whose main role was not on post-surgical wards and who were not using the SPPOST on a daily basis.

Exclusion Criterion for both groups

- Any physiotherapist or PTA involved in developing the SPPOST.

Reliability Sample

Sample size calculations were not deemed appropriate for this pilot study. The size of the physiotherapy surgical respiratory team (Total = 10) meant recruitment of frequent users was necessarily limited (n=6). Infrequent users (n=5) were recruited from another physiotherapy team within the hospital (Total = 14). Written informed consent was obtained from all participants. The banding of participants was matched across groups, which provided an approximate measure of years experience of the physiotherapy staff.

Reliability Data Collection

The medical records already accessed to assess validity were purposively sampled to obtain five sets of notes with a range of total SPPOST scores, using 2006 data only. Medical records of the surgical procedure and day one post surgery were photocopied, anonymised and coded as paper case studies A-E. Physiotherapy participants were invited to two meetings on a one-to-one basis with a researcher. During Meeting 1 (M1) participants completed the SPPOST for the five anonymous paper case studies using guidelines established by the tool's authors (Ostler et al 2008). They were asked not to confer with other participants to avoid influencing results. Meeting 2 occurred approximately two weeks after M1 to minimise any learning effect and followed an identical format. The cases were provided in a random order, to ensure participants did not recognise a familiar succession.

Data Analysis

Data collected from the SPPOST and PPC criteria were entered into SPSS 15.0 data package for further analysis. To assess predictive validity, data were entered into a two by two table to calculate sensitivity, specificity and other parameters associated with a valid diagnostic test (Greenhalgh 1997). To calculate the intra- and inter-rater reliability, the SPPOST scores from each rater on each occasion were analysed using Cohen's Kappa coefficients and interpreted by Landis & Koch classification (Landis and Koch, 1977, p.159-174).

Results

Validity

The raw data scores derived from the 2005 and 2006 notes are displayed in Table 2.

Table 3 gives the true/false positives and negatives, and the calculated sensitivity and specificity. For the 2006 data taken in isolation, the SPPOST showed high sensitivity and specificity. The probability of a patient not developing a PPC if they had scored low on the SPPOST was 100% i.e. perfect accuracy. The probability of a patient developing a PPC if they had scored high on the SPPOST was 83%, acceptable accuracy. The 2005 data show considerably lower figures for both sensitivity and specificity, making the SPPOST less accurate in predictive power for these data.

Reliability

All 11 consenting participants completed both data collection meetings. Within the frequent user group (n=6), all were female and used the SPPOST at least once a day. The infrequent user group (n=5) included two males, all specialised in the musculoskeletal field and only one had used the SPPOST before (on just one occasion).

Table 4: Average Kappa Coefficients for frequent & infrequent user inter-rater reliability

Group	Average Kappa Coefficient	Range of Kappas	Average Level of Agreement	Range of Standard Error	Landis & Koch (1977) Classification of Agreement
Frequent Users	0.6507	0.286 – 1.00	0.80	0.00 – 0.362	Substantial Agreement
Infrequent Users	0.6857	0.167 – 1.00	0.84	0.00 – 0.446	Substantial Agreement

Table 5: Average Kappa Coefficients for frequent & infrequent user intra-rater reliability

Group	Average Kappa Coefficient	Range of Kappas	Average Level of Agreement	Range of Standard Error	Landis & Koch Classification of Agreement
Frequent Users	0.832	0.545 – 1.00	0.92	0.00 – 0.362	Almost Perfect Agreement
Infrequent Users	0.7802	0.286 – 1.00	0.88	0.00 – 0.318	Substantial Agreement

Inter-rater Reliability

After M1 the total scores given by each participant for each case study were compared within the two groups and the individual Kappa coefficients were calculated. Table 4 summarises the Kappa coefficients for inter-rater reliability within each group.

Intra-rater Reliability

After M2 the total scores given by each participant for each case were compared with the corresponding scores from that participant in M1. Table 5 summarises the Kappa coefficients for intra-rater reliability within each group.

No trends could be seen in relation to age or experience of participants.

Discussion

The primary aim of this pilot study was to assess the feasibility of a method that could be used to examine the validity and reliability of the SPPOST. It has also provided some preliminary data on these aspects, the results from which have been presented and will be discussed first.

SPPOST Validity

In this small sample the SPPOST screening tool had high sensitivity and specificity when the results from 2006 were taken in isolation, but considerably less high for the 2005 data. Reasons for this apparent contradiction may be related to sample size and the application of the SPPOST retrospectively. There are always problems with the use of historical data, and the SPPOST was not designed to assess patients retrospectively using only medical records. There was also a slight imbalance in the purposive sample selected, as there were 10 data sets with SPPOST scores above the cut-off value and six below. Although Brooks-Brunn scores have been used in previous published articles (Mackay et al 2005, Ferguson et al 2002, Brooks-Brunn 1998, Brooks-Brunn 1997) they are not an ideal way to define a PPC because they have not been formally validated for this purpose. The validity data are encouraging, but further larger studies using only prospective data are required.

SPPOST Reliability

It was expected by the researchers that frequent users might be more consistent when using the tool through familiarity. It was also expected that more experienced clinicians would be more consistent, due to their clinical expertise. However, in this study no clear trend was observable, but samples were too small to make a judgement. Intra-rater reliability was interpreted as being 'almost perfect' agreement for frequent users and 'substantial' for infrequent users. This suggests that frequent use provides greater consistency in terms of screening a patient on two different occasions. However the SPPOST was designed to be a 'one-off' tool and therefore would rarely be applied by the same physiotherapist on the same patient more than once. Nevertheless, the level of reliability demonstrated is encouraging when considering the range of physiotherapy staff who took part, with varying levels of expertise.

Feasibility of Methodology

The methodology for assessing validity was feasible, but had limitations associated with the use of historical data for comparisons, and the use of the Brooks-Brunn score to determine development of PPCs. Although feasible, the reliability methodology used had some limitations associated with using paper case studies. Physiotherapists were unable to clarify factors with the patient as they would in routine clinical practice. Also contradictions could be detected in some medical records. For example, 'limited exercise tolerance' was documented in one set of pre-operative records, but 'fit and active' in anaesthetic records for the same person. Previous reliability studies (Thomas and Lane 2005, Ness et al 2003, Lennon and Johnson 2000) assessed tools within a clinical setting and used a comparison of a gold standard or expert rater. However, the benefits of using paper case studies are that they are inexpensive, quick to assess, and need only one data collector.

Limitations of the SPPOST

There may be limitations to the SPPOST which do not become evident until a larger trial is conducted. It only takes into account eight risk factors and the weighting of the risk factors was determined somewhat arbitrarily during its development, as was the overall cut-off value for determining high/low risk. Both of these require formal validation to ensure optimal sensitivity and specificity of the screening tool.

Implications for Practice

The SPPOST is reported to have been successfully implemented in one specific hospital for patients undergoing abdominal surgery (Ostler et al 2008). If it is to be used more widely, the tool needs to be formally validated at a range of different sites and following different operations where patients are at risk of developing PPCs. This could have a positive benefit for patient outcomes, including decreasing length of hospital stay and reducing the severity of complications. Physiotherapy workload could decrease or physiotherapy time and resources could be better allocated to those at high risk of developing PPCs. The screening tool may also have potential to be used by other health professionals within the multi-disciplinary team to enable workloads to decrease or become better managed.

Key points

- This study has successfully piloted a methodology for assessing the validity and reliability of the SPPOST.
- The SPPOST has potential to enable physiotherapists to target their contact time to those patients most likely to derive benefit.
- Further prospective evaluation is required before recommending the use of the SPPOST in routine clinical practice

Conclusion

This pilot study has tested a methodology for assessing the validity and reliability of a post operative screening tool (the SPPOST). To date there have been difficulties in creating a validated tool to predict PPCs post-surgery, due to ongoing debate over which risk factors are most important and the lack of a cut-off value for determining which patients are at high and low risk. The SPPOST is unique in comprising eight known risk factors and providing a specified (although unvalidated) cut-off value. Unlike the majority of previous models which assess patients prior to elective surgery, this screening tool is applied post-operatively and can therefore be used following both emergency and elective surgery.

The data from this pilot study suggest that the SPPOST has encouraging potential for both good predictive validity and good reliability when used prospectively i.e. that it can be used to predict which patients will not develop PPCs after abdominal surgery and can be used consistently by non-specialist physiotherapy staff with a range of expertise. If these findings are confirmed in larger studies the SPPOST has the potential to provide more cost effective service provision within post-surgical care.

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The 6-minute walk test for patients with bronchiectasis: comparison with normal predictive data

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Key Words
Bronchiectasis, 6 Minute Walk Test, St Georges Respiratory Questionnaire

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Summary

Reduced exercise tolerance has been demonstrated in several chronic respiratory diseases, but there has been little research involving bronchiectasis patients. In this study, six individuals with stable bronchiectasis completed two 6MWT's and results were compared with predictive data. Data were also compared to health related quality of life and lung function. In this small sample of participants, 4/6 had a substantially lower 6MWT distances than was predicted by normative equations.

Introduction

Bronchiectasis is characterised by abnormal dilatation of the airways as a result of airway remodelling and injury due to recurrent or chronic inflammation and infection (Morrissey and Evans 2003). Symptoms that patients describe may include dyspnoea and reduced exercise tolerance due to altered pulmonary mechanics, reduced muscle mass and ineffective gas exchange (Bradley et al 2005). Patients' response to exercise varies and this can be difficult to predict from lung function tests, therefore exercise testing may be required.

The gold standard exercise test is laboratory Cardiopulmonary Exercise Testing (CPET). The expense needed for a dedicated facility and equipment (Gross 2005) and the possible reduced applicability to function of a CPET, has led to the development of simple field tests that can be performed more easily (Singh et al 1992). The most commonly used of these is the six-minute walk test (6MWT) (Butland et al 1982). It involves individuals walking as far as they can in six minutes. The 6MWT has a number of advantages over other tests as it has been frequently used in research, is an easy test to administer, and may be the most reflective of activities of daily living (Solway 2001). It has been shown to correlate with oxygen uptake (Troosters et al 2002), self reported limitations in activities of daily living (Enright et al 2003) and is repeatable (American Thoracic Society (ATS) 2002). The criticisms include it being a sub-maximal test, the learning effect and that it is effort dependant (Solway 2001). This can be reduced by the use of a standardised testing procedure (ATS 2002). Redelmeir et al (1997) (n= 112) found that the 6MWT was significantly correlated to Chronic Obstructive Pulmonary Disease (COPD) patient's own ratings of their walking ability with a 70m difference required for them to rate themselves as worse relative to others (r = 0.59, 95% CI: 0.54 to 0.63). This may allow for an estimation of clinically

significant differences in walking distance for patients.

Reference equations for walking tests have been developed to allow interpretation of results and compare patient-generated data with those from healthy individuals. One study has examined 6MWT distances in a wide range of healthy subjects over 20 years old (n=79) (Gibbons et al 2001). They found that 6MWT was inversely related to age ($p<0.001$), directly to height ($p<0.001$) and was greater in men that women ($p<0.0002$).

The relationship between bronchiectasis and exercise capacity has not been explored fully. Much of the literature in this area has examined the effect of exercise training on this group, rather than if exercise capacity is reduced. A study of 17 children with bronchiectasis who completed an incremental treadmill test (Swaminathan et al 2003) showed that oxygen uptake and maximum ventilation was significantly lower in bronchiectasis patients than in healthy controls ($p<0.001$). A slightly larger study looked at a mixed group of patients with chronic lung disease (Foster and Thomas 1990) completing pulmonary rehabilitation. The 7 with bronchiectasis improved their exercise tolerance as measured by the 6MWT from 284 +/- 204m to 583 +/- 330m. The authors noted that the subjects with bronchiectasis had reduced mean walking distances in comparison to patients with COPD at the start of the programme. Newell et al (2005) in a study of 32 participants with bronchiectasis found significant increases in walking distance ($p<0.01$) after 8 weeks exercise training. The few studies examining exercise tolerance in patients with bronchiectasis suggest these patients may have a reduction in exercise capacity, as is seen in other respiratory diseases. However, they have used laboratory tests to measure exercise capacity and involved small numbers of subjects. It would therefore be of interest to establish if any reduction in exercise capacity can be detected in bronchiectasis patients using simple field tests.

Table 1: Inclusion and Exclusion criteria for study

Inclusion Criteria	Computer tomography diagnosis of bronchiectasis Over 20 years of age Not involved in any formalised exercise programme
Exclusion Criteria	Exacerbation of bronchiectasis within four weeks of the study Cystic Fibrosis (CF) as a primary diagnosis Diagnosed with any other lung pathology which may lead to a reduced exercise tolerance e.g. COPD (NICE guidelines for COPD 2004) Other medical problems which could contraindicate taking part in a sub-maximal exercise test e.g. myocardial infarction within four weeks of the study, unstable angina Any other pathology which may reduce mobility and therefore ability to take part in an exercise test e.g. osteoarthritis Participants who require the use of a walking aid to mobilise Participants who require ambulatory oxygen therapy

Bronchiectasis has been shown to lead to a reduction in Health Related Quality of Life (HRQOL) and this may be related to exercise capacity (O'Leary et al 2002). The St Georges Respiratory Questionnaire (SGRQ) has been found to be valid and repeatable in bronchiectasis and comparable to other tools such as 6MWT distance. (Jones et al 1992)

The aim of the study was to examine if patients with bronchiectasis would have a reduction in exercise tolerance as measured by the 6MWT in comparison with published normative data, and secondarily if there was any relationship between walking distance and lung function and quality of life.

Methodology

A single group experimental design was used to test the hypothesis. Permission to perform the study was approved by the Bath Research Ethics Committee (Ethics number 06/Q2001/112).

A power calculation showed that to detect a clinically significant difference in walking distance of more than 70m (Redelmeir et al 1997) using a two-sided significance level at 5% with 80% power, 17 participants would be required.

Eligible participants were identified by the medical team at the Bristol Royal Infirmary and were sent a letter inviting them to take part in the study, asking them to complete a reply slip if they were interested. Inclusion and exclusion criteria are shown in table 1.

Written consent was completed at the data collection session.

After giving informed consent, participants completed basic spirometry and a validated quality of life questionnaire (SGRQ) (Jones et al 1992) followed by two 6MWT's following the ATS guideline (2002) over a 30m course with a 45-minute rest period in between the two tests. The maximum distance walked was used for the analysis. This was compared to the normative distance walked as calculated from the normative

Table 2: Baseline characteristics of participants

				ID				
Characteristics	A	B	C	D	E	F	Median	Range
Gender	F	F	M	F	F	F	N/A	N/A
Age (years)	60	55	61	59	59	53	59	53-61
Spirometry								
FEV_1 (Litres)	0.75	1.59	1.35	1.87	1.31	0.9	1.33	0.75-1.87
FEV_1 (%Predicted)	41	68	39	81	60	36	50.5	36-81
FVC (Litres)	1.29	2.27	2.96	2.54	1.76	1.5	2.02	1.29-2.96
FVC (%Predicted)	59	82	67	92	67	52	67	52-92
FEV_1 / FVC	58	70	45	74	74	60	65	45-74

Abbreviations: FEV1 = Forced expiratory volume in one second; FVC = Forced vital capacity; FEV1/FVC = Ratio of forced expiratory volume in one second to forced vital capacity; N/A = not applicable, M= Male, F = Female

Table 3: Comparison of participants' walk distance and predicted normative data

I.D	Maximum 6MWT distance (m)	Predicted 6MWT distance (m)	Difference (m)	Distance walked (% predicted)
A	517	482	35	107
B	284	497	-213	57
C	342	496	-154	69
D	514	485	29	106
E	247	485	-238	51
F	224	503	-279	45
Median	313	490.5	-183.5	63
Range	224-517	482-503	35 to - 279	45-107

Abbreviations: 6MWT: 6 Minute Walk Test

equation (Gibbons et al 2001) below:

678.8- (Age x 2.99) - (Gender x 17.47) where gender is male=0 and female=1

Secondary outcome measures were SGRQ, FEV1 and FVC as a percentage of predicted and their ratio.

Data analysis

Data were entered into Excel (office version 2000) and SPSS (version 14.0) for analysis. Descriptive statistics have been used to describe data and assess normality of distribution. As the data were found not to be normally distributed the Wilcoxon rank test was chosen to compare 6MWT data for subjects and normative data. Pearson's r was used for correlation analysis.

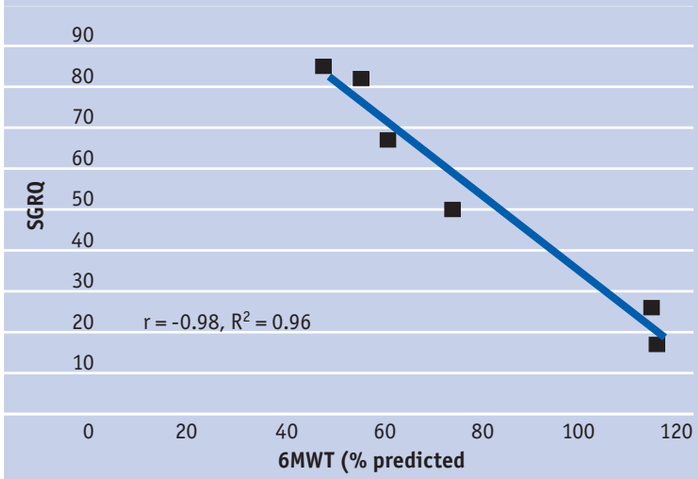
Results

Baseline data for participants are shown in table 2.

All participants were of a similar age with a median of 59 (range 53-61) years; however severity of disease as measured by lung function showed a large range (median predicted FEV1 50.5%, range 36-81%).

Table 3 shows that two participants walked distances roughly equivalent to their predicted 6MWT. The other four participants walked less than their predicted distance. There was a large range within this sample (Range 35m to -279m). When the distances walked were compared to the predictive data no statistically significant difference in median was found (Wilcoxon signed rank Z= -1.572, p= 0.116), but the median 6MWT distance (-183.5m) was more than the 70m predicted median reduction in walking distance (Redelmeir et al 1997). A strong negative relationship between the total score on the SGRQ and the 6MWT distance walked was found (figure 1) , i.e. the higher the SGRQ, the lower the 6MWT

Figure 1: Correlation between 6MWT distance and SGRQ total score



Abbreviations: 6MWT: 6 Minute Walk Test; SGRQ: St George's Respiratory Questionnaire

distance (Pearson's r = -0.98). A very weak relationship between both percentage predicted FEV1 and walking distance (r=0.26) and between FEV1/FVC ratio and walking distance (r=-0.02) was found.

Discussion

The group showed a lower than predicted median 6MWT distance which would be clinically significant (Redelmeir et al 1997), with 4 of the 6 participants having a walking distance less than expected for their age and gender. Due to the very small sample, it is difficult to support the hypothesis that patients with bronchiectasis would have reduced exercise tolerance. There is minimal previous literature to support or contraindicate this finding. Two studies have examined exercise tolerance in bronchiectasis (Swaminathan et al 2003, Koularis et al 2003) and both of these showed a reduction in walking distance in comparison to predicted values. However, both studies used CPET within a laboratory setting, which is not always practical in a clinical setting and is not a measure of endurance. All other studies have examined the effect of training on exercise capacity.

The small numbers in the study may have led to a type II statistical error. The weak correlation between 6MWT distance and FEV1 (% predicted) is similar to results involving other respiratory diseases such as COPD. In two studies a weak correlation was found between the 12MWT and FEV1 in seventeen patients with severe COPD (r=0.13) (Swinburn et al 1985) and in elderly men with COPD (r=0.24) (Bernstein et al 1994). There are no studies specifically examining the relationship between FEV1 and 6MWT distance in bronchiectasis. This may not be of relevance as within lung diseases FEV1 can poorly reflect exercise capacity (Patel and Sciurba 2005) showing the requirement for exercise testing in the clinical setting as a measure of function.

The strong negative correlation between scores in all domains of the SGRQ and the 6MWT distance has been reported by others. Lee et al (2009) showed that the SGRQ had a strong relationship with the 6MWT distance in 27 patients with bronchiectasis. Wilson et al (1997) showed in 111 patients with bronchiectasis of wide ranging disease severity (when measured by their spirometry results) that SGRQ total score was significantly correlated to shuttle walk distance (r= -0.558, p<0.0001). This may suggest that measures of HRQOL are more closely related to walking distance than physiological measures such as FEV1.

The main limitation of this study is the very small sample size due to recruitment difficulties. Participants were from a very narrow age range, which is also a limitation of this study as bronchiectasis is a disease that can be diagnosed at any age, thus the group may not be reflective of those of younger age groups. The small numbers of participants meant that statistical analysis required the use of non-parametric statistics, which makes comparisons with previous literature more difficult, as all other published research has documented means and standard deviations, which may not be appropriately compared to the median values reported in this study.

A further criticism of this study is in the use of reference equations to determine predicted walk distances rather than age / sex matched controls. The equations themselves only account for 41% of the between subject variation of the best 6MWT distance seen in the healthy adults (Gibbons et al 2001). This may make the value determined during this study as the "normal" value less accurate and therefore may also have contributed to the lack of statistical significance seen. In future studies it may be useful to use age /sex controls to try and reduce this. In the future improved reference equations may also become available.

Conclusion

It is not possible to support or reject the hypothesis that patients with bronchiectasis would have reduced exercise

tolerance when assessed using the 6MWT compared to normative data. Those participants (4/6) who did have a reduction in walking distance had a reduction of more than 70m (Redelmeir et al 1997) although this was not statistically significant, may suggest some clinical relevance. There was a relationship between HRQOL measured by the SGRQ and distance walked. There was no such link between the physiological variables such as lung function and exercise tolerance. Further research with a larger sample size is needed to examine this further.

Key Points:

- Bronchiectasis may lead to a reduction in exercise tolerance as measured by the 6MWT.
- In this study, the relationship between the 6MWT and lung function was poor.
- In this study, there was a relationship between 6MWT and the SGRQ.

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Combining inspiratory muscle training and upper limb exercises. Does it improve outcomes in COPD patients?

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Summary

This study aimed to determine if a combination of upper limb exercises with IMT have added effects in dyspnoea management, ADL's, respiratory strength and upper limb endurance, when compared to IMT only and a control group. Outcome measures pre and post treatment included lung function tests, 6-minute walk distance, dyspnoea score and Activities of Daily Living Scale. Statistically significant changes resulted in both exercise groups but this change was more pronounced in the combination group. In this study combining upper limb and inspiratory muscle training shows trends towards positive effects.

Keywords
Pulmonary Rehabilitation, COPD, Inspiratory Muscle Training, Upper limb Exercises

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Introduction

Dyspnoea and decreased ability to performing activities of daily living (ADLs) and exercise is common in Chronic Obstructive Pulmonary Disease (COPD) (Hill et al 2004). To limit dyspnoea some patients avoid activities leading to a sedentary lifestyle and muscle deconditioning (Maltais et al 2000). Respiratory muscle dysfunction is an important determinant for the increased use of health resources and the survival of hospitalised COPD patients (Decramer et al 1998).

Webber and Pryor (1998) state that dysfunction of the upper limbs due to weak musculature also distresses COPD patients for a given workload since upper limbs require more energy and are accompanied by higher ventilatory demands than lower limbs. In many COPD patients, activities performed in unsupported positions precipitate dyspnoea to a far greater extent than would be expected by that degree of metabolic work.

Inspiratory muscle training (IMT) has been researched in depth to find its optimum effective use with COPD patients (Sturdy et al 2003). Studies investigating IMT alone (Hill et al 2004, Sturdy et al 2003, Weiner et al 2003) or in conjunction with whole body or

lower limb exercises (Lotters et al 2002, Smith et al 1992) show improvements in respiratory muscle strength and exercise tolerance. These studies (Sturdy et al 2003, Weiner et al 2003) use loads varying from high (80%) to low percentages (30%) of their participants' maximal inspiratory pressure (PImax). Breathing control throughout the training process also needs to be considered as it may influence the end results (Smith et al 1992).

In the last 20 years there has been interest in upper limb training as part of exercise programmes for COPD patients with much of the available evidence dating back to the early 1990s. The various methodological differences in existing studies, further limits interpretation of results from these studies. Reductions in exercise capacity have been attributed to ventilatory constraints (Criner and Celli 1988, Celli et al 1986); however, during unsupported arm exercise additional mechanical constraints to ventilation occur (Criner and Celli 1988, Celli et al 1986). Previous studies investigated either the effects of arm position on ventilation or else the combination of IMT and lower limb exercises but no studies were retrieved which looked into the combination of upper limb and IMT.

Study aim

To determine if a combination of upper limb exercises with IMT have added effects in dyspnoea management, ADL's, respiratory strength and upper limb endurance, when compared to IMT only and a control group,.

Methods

COPD patients, aged 45 to 75 were recruited from the Chest Clinic, St. Luke's Hospital, Malta by Consultant Respiratory Physicians. A total of 45 patients were recruited. Ethical approval was gained and informed consent obtained from all participants. COPD was defined by the American Thoracic Society (ATS 1995).

Inclusion criteria: Moderate to severe airflow obstruction (FEV_1<65% predicted, FEV_1/FVC<70%), dyspnoea on exertion measured with the Borg scale, medically stable, willing to participate.

Exclusion criteria: History of asthma, COPD exacerbation within the previous 2 months as defined by the ATS, requirement of home oxygen therapy, oxyhaemoglobin desaturation below 85% with exercise, cardiovascular, musculoskeletal or neuromuscular disease that might interfere with exercise.

Sampling: Participants were assigned in equal numbers to one of the two exercise groups, or the control group.

Study protocol: Group 1 (combination group). This exercise group consisted of both an eight week training programme of once weekly supervised sessions of inspiratory muscle training (IMT) and an upper limb exercise programme. The latter included arm exercises for 15 minutes, which included throwing a ball against a wall, arms above horizontal, passing bean bags over the head and shoulder flexion using a dowel. Each exercise was performed for 40 seconds followed by 20 second rest periods, four times in four minutes.

Group 2 (IMT group). This exercise group underwent an eight week training programme of once weekly supervised sessions of IMT only. Both groups 1 and 2 continued the IMT treatment twice daily for five days per week at home.

All participants had a two week practical learning period prior to the assessment phase, to become familiar with the Threshold Trainer (Health Scan Products Inc., NJ, USA: Figure 1), a device which offers a constant load with a controlled breathing pattern. The load applied by the Threshold trainer was adjusted after four weeks to 30% of their new PImax reading. Participants were also encouraged to keep a diary to record their training and monitor progress which was reviewed by the researcher every 10 days by telephone.

Group 3 (control group). This group underwent no formal exercise but was offered an active exercise programme at the end.

Outcome measures: The following outcome measures were recorded at the beginning and end of the 8-week training period in all groups: PImax; respiratory muscle endurance; 6 minute walk test (6MWT); upper limb endurance; dyspnoea; lung function and ADL performance.

Maximal Peak Inspiratory Pressure (PImax) was measured as the maximum negative pressure maintained during a one second inspiratory effort against a closed valve from functional residual capacity repeated four times with the best effort recorded.

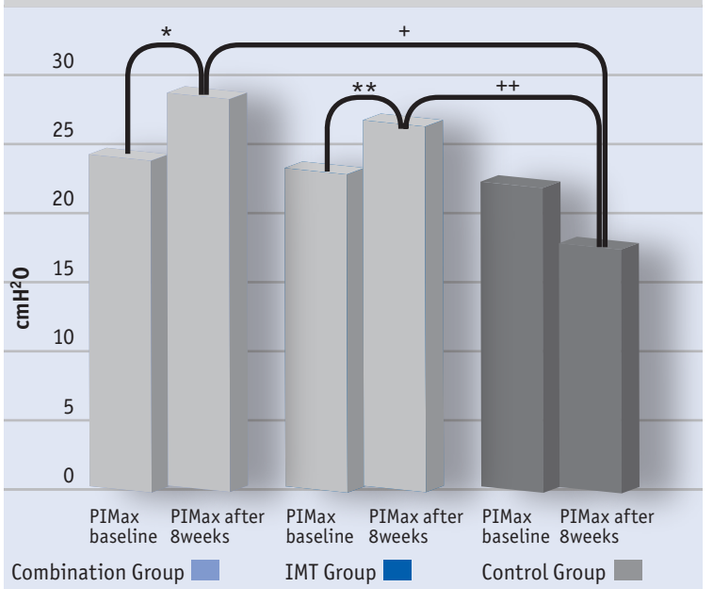
Respiratory muscle endurance was measured using the Discontinuous Incremental Threshold Loading test as described by Larson et al (1999).

The 6MWT distance was measured on three occasions with the furthest distance used for the results. Their oxygen saturation was measured before, during and after the test.

Upper limb endurance was measured by asking the patients to lift their arms above shoulder level for 10 or more repetitions, at a speed starting from 80 beats on the metronome until no more that 10 repetitions could be performed with an increase in speed markings.

Dyspnoea was scored using the Borg Category Ratio Scale (Mahler 1992) to measure patients' perceptions of

Figure 1: Changes in inspiratory muscle strength at baseline and after 8 week intervention.



*Abbreviations: IMT: Inspiratory muscle training; PImax:- peak inspiratory pressure There was a significant difference in PImax between the exercise groups and the control group. (+ combination versus control group p=0.0002; ++ IMT versus control group p=0.0006). PImax in the combination group increased significantly after training (*p< 0.0406). The change for the IMT group was less (**p=0.0950).*

breathlessness during exercise, respiratory and upper limb endurance tests. During the latter, perceived breathlessness was measured after 2 minute work periods. Breathlessness was also rated before and after the 6MWT.

Lung function analysis consisted of spirometry and plethysmography (ATS 1995). Whole body plethysmography (Jaeger, Germany) was carried out by the constant volume method.

The London Chest Activity of Daily Living (LCADL) scale (Garrod et al 2000) was completed by each participant before and after the exercise programmes to assess the level of ADL performance.

Data analysis: Analysis of variance was carried out to compare between group differences in key outcome measures. The paired student's t-tests were used to compare post treatment with respect to pre treatment values.

Results

Forty participants (30 male, 10 female) completed the study (Table 1). There were no significant differences in baseline measurements between groups at the start of the study. Enquiry concerning adherence suggested that most patients conducted their training sessions regularly. The p value p<0.05 was considered significant.

Inspiratory Muscle Strength (PImax)

When looking at the PImax values post treatment between the three groups, no significant difference in the end results was found when comparing both exercise groups (Figure 1). There was a significant difference in PImax between the exercise groups and the control group. This difference was more pronounced when comparing the combination group to the control group with a 61% difference (p=0.0002), as opposed to a change 44% change when comparing the IMT group with the control group (p=0.0006).

PImax in the combination group increased significantly after training from 24.7cmH_20 $\pm$0.7 to 29.1cmH_20 $\pm$2.2 (p< 0.0406). The change for the IMT group was less (p=0.0950). The control group showed a decrease in PImax by 16% (p=0.0892).

Respiratory Muscle Endurance

Respiratory muscle endurance for both exercise groups was significantly greater compared to the control group for post treatment values (p<0.05) (combination group versus control 22%; IMT group versus control 15%). Compared to baseline post treatment scores for endurance increased significantly in the combination group (p< 0.0039) and in the IMT group (p< 0.0719) but not in the control group.

Dyspnoea scores

There was no significant difference between the groups post treatment in the Borg Category Ratio Scale (Figure 2a and 2b). There were significant improvements in dyspnoea scores from baseline to post treatment in the exercise groups but not the control group.

Exercise test

Comparing the three groups together results in no significant change in the distance covered. Changes in the 6MWT distance though were significant when looking at the pre and post values for the combination group with an increase of 64% (p< 0.0010) (Figure 3).

LCADL

There were no significant

Table 1: Physical characteristics and resting lung function data of the participants of the three groups.

Test Measure	Combination group n = 11	IMT group n = 14	Control group n = 15
FEV_1 % Predicted	63.45 ±3.53	60.08 ±3	59.3 ±1.52
FEV_1/FVC %	72.91 ±1.45	76.64 ±1.7	76.60 ±2.33
PImax @ FRC cmH_20	24.73 ±0.7	24.28 ±0.8	22.33 ±1.3
PEmax cmH_20	20.10 ±1.9	17.14 ±1.6	22.87 ±1.9
Respiratory muscle endurance cm H_20	15.18 ±0.8	17.86 ±1	17.27 +1
6MWT (metres)	223 ± 23.4	274 ±37.4	255 ±28.7
SaO_2 before 6MWT %	94.5 ±0.6	94.6 ±0.36	93.9 ±0.4
SaO_2 during 6MWT %	93.5 ±0.9	94.1 ±0.6	93.6 ±0.6
SaO_2 after 6MWT %	94.9 ±0.5	94.7 ±0.5	93.9 ±0.6
Dyspnoea score before 6MWT	1.91 ±0.5	1.5 ±0.3	1.87 ±0.2
Dypnoea score after 6MWT	5.36 ±0.5	4.43 ±0.4	4.87 ±0.3
Dyspnoea score after UL test	5.5 ±0.3	5.1 ± 0.2	3.5 ±0.3
Dyspnoea score after respiratory endurance test	5.3 ±0.3	3.9 ±0.2	4.2 ±0.3
PEFR (L/min)	257.7 ±23.3	233.6 ±21.2	257.3 ±23.9
Gender (Male / Female)	6M/ 5F	11M/ 3F	13M / 2 F
Height cm	153.8 ±1.8	164.2 ±1.55	162.1 ±2.3
Weight Kg	62.9 ±3.2	75.3 ±4.7	82.1 ±6.4
TLC % predicted	115.6 ±5.8	101.4 ±3.9	101.7 ±4
RV % predicted	172.7 ±14.6	144.6 ±10.7	160.1 ±10
VC % predicted	82.1 ±6	72 ±5	67.5 ±3
LCADL (total score)	18.4 ±3.3	16.9 ±1.2	16.1 ±0.9
UL endurance test (beats)	85.1 ±0.8	90.2 ±3.4	102.7 ±4.3

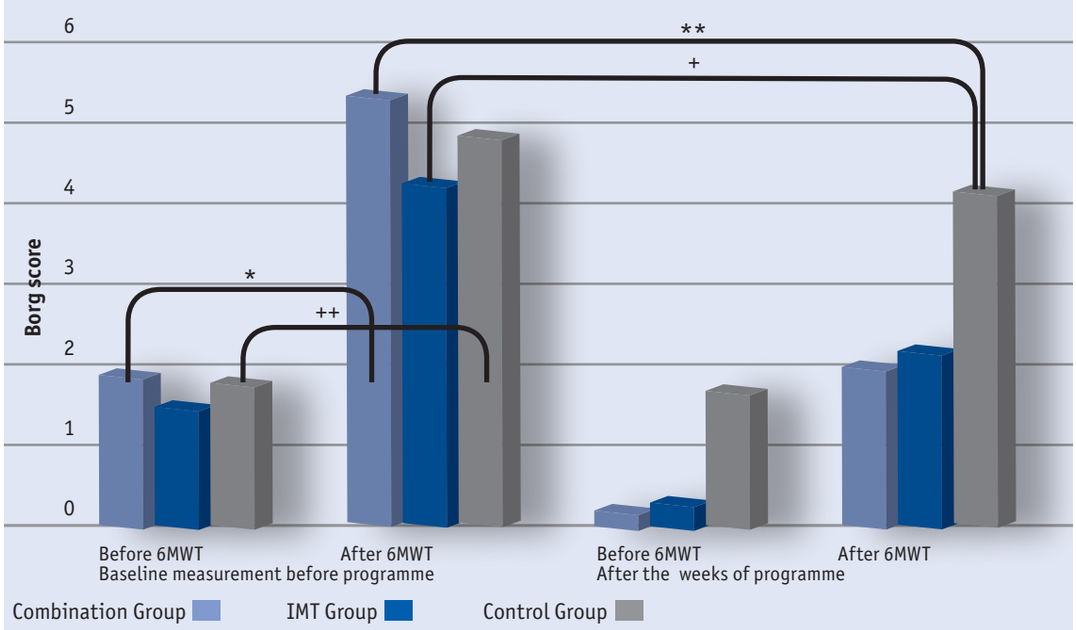
Data presented as mean + SEM.
Abbreviations: 6MWT: 6 Minute Walk Test; FEV1: Forced Expiratory Volume in one second; FRC: Functional Residual Capacity; FVC: Forced Vital Capacity; IMT: Inspiratory Muscle Training;
LCADL: London Chest Activity of Daily Living Scale; PEFR: Peak Expiratory Flow Rate; PEmax: Maximal Peak Expiratory Pressure; PImax: Maximal Peak Inspiratory Pressure; RV: Residual Volume; SaO2: Saturation of oxygen; TLC: Total Lung Capacity; UL: Upper Limb; VC: Vital Capacity.
of Daily Living Score, PEFR: Peak Expiratory Flow Rate; SaO2: Saturation of oxygen, PImax, PEmax,

differences in post treatment total scores between the three groups. There were some significant differences in specific sections, for example the self care (p=0.0351), physical (p=0.0029) and leisure (p=0.0000) sections were better for the combination group compared to the control group. The physical (p=0.0171) and leisure (p=0.0080) sections were significantly better for the combination group compared to the IMT group.

Upper limb endurance

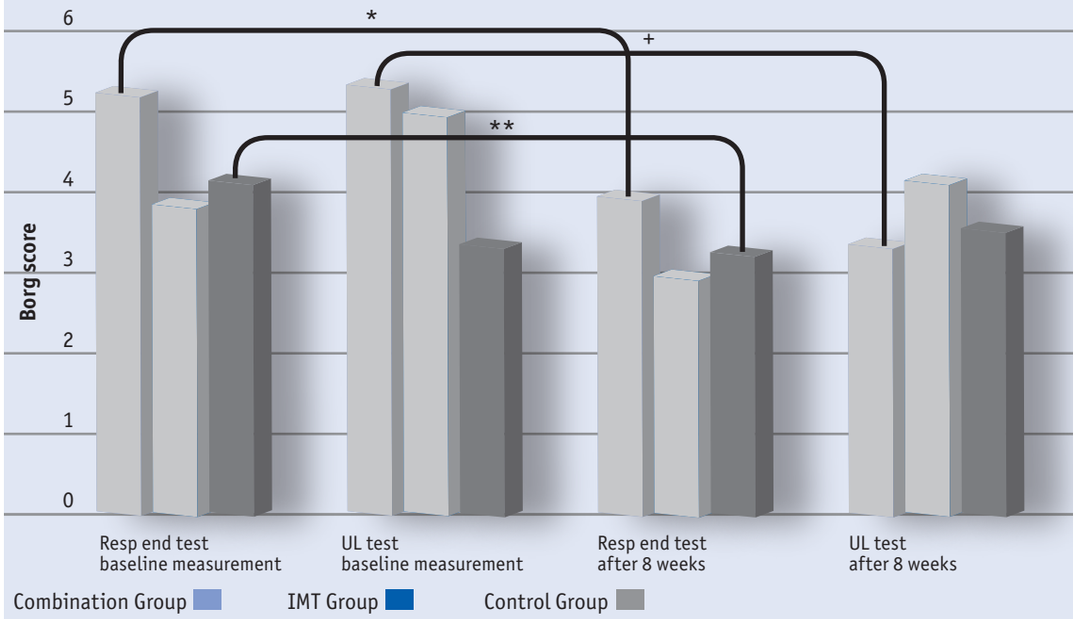
There was no significant difference in upper limb endurance between groups in post treatment scores. For the combination group, there was a significant increase in

Figure 2a: Changes in Borg scale scoring before and after the 6MWT before and after the 8 week programme.
* p < 0.0117, ** p < 0.0020, + p < 0.0002, ++ p < 0.007



Abbreviations: 6MWT: 6 Minute Walk Test; IMT: Inspiratory muscle training

Figure 2b: Changes in the Borg rating score for the respiratory endurance and upper limb endurance test before and after the eight week programme. * p < 0.0078, ** p < 0.0080, + p < 0.0020.



Abbreviations: IMT: Inspiratory muscle training; UL: upper limb; wks: weeks

endurance of 35% between pre and post treatment scores (p< 0.0010) which was not observed in the IMT and control groups.

Discussion

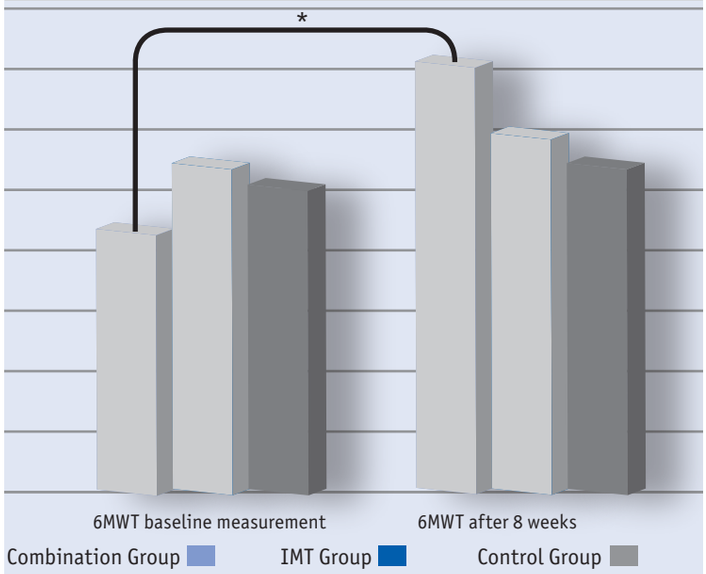
There may be added benefit for patients with COPD when combining IMT and upper limb exercises in relation to dyspnoea, respiratory muscle strength and endurance, 6MWT distance, and ADL performance. Improvements demonstrated in respiratory muscle strength compare to other studies using the same training (Larson et al 1999, Villafranca et al 1998, Lisboa et al 1994) or threshold loading (Weiner et al 2003, Larson et al 1999, Lisboa et al 1994). There was a greater improvement in the combination

group compared to the IMT group in relation to pre and post treatment data. Study results may have been affected by the participant drop out from the combination group.

Preusser et al (1994) found that participants with the highest degree of hyperinflation and chest wall dysfunction benefited the most from conditioning at high level intensity. However, they found that low intensity training also proved to be beneficial yielding significant results in severely affected patients. As is well known, in order to avoid an increase in resistive work whilst carrying out upper limb activities, patients with COPD become hyperinflated at the expense of greater elastic work (Dodd et al 1984). Criner & Celli (1988) studied the differences in breathing patterns between patients performing supported and unsupported upper limb exercises and noted that changes in breathing patterns were secondary to limitations of the inspiratory muscles' ventilatory capacity,

Inclusion of upper limb exercises in the combination group resulted in a more efficient performance of ADLs. Apart from superior results in PImax values, improvements in lung function and dyspnoea scores were noted in the combination group when compared to the IMT group. When COPD patients perform unsupported arm exercises, as with normal ADLs, there is shortening of the accessory muscles together with passive stretching of the thoracic cage. As Dolmage et al (1993) has indicated, this leads to the muscles becoming less effective, which increases ventilation resulting in rapid, shallow breathing patterns and dyspnoea. The increase in upper limb strength and endurance allows participants to adopt more effective breathing patterns. This may account for the decrease in dyspnoea score reported by the combination group.

Figure 3: Changes in the distance covered in 6 minutes before and after the training programme *p< 0.0010.



Abbreviations: 6MWT: 6 Minute Walk Test; IMT: Inspiratory muscle training

When training loads are controlled, the increment in inspiratory muscle strength and endurance is translated into a clinically meaningful improvement in functional status. The use of threshold loading devices also ensured in this study that each participant reached a constant load sufficient to obtain favourable results. Most previous studies have used external resistive loads which are dependent on breathing patterns, thus making a constant target load impossible (Lisboa et al 1994, Smith et al 1992).

There is very little evidence about the transfer effects of IMT to ADL and dyspnoea. The LCADL score showed significant improvements in the physical and leisure sections, especially for the combination group. This could be attributed to the fact that once dyspnoea decreased, patients felt more confident in increasing their mobility and resuming activities leading in turn to emotional improvement as well as better physiological control of the disease. This may also be applied to the high rate of increase in the 6MWT distance seen in the combination group. This group integrated well, giving each other continuous positive reinforcement throughout the programme.

Limitations of the study

While the sample size was small this study does give some insight into the problems inherent in such studies. The highest drop out rate was from the combination group and this might have influenced the end result, expressed as a mean, when compared with the other groups.

The location and appointment times may also have been a limitation. Since there was no group in this study performing upper limb exercises only, one was not able to compare the effects of this type of exercise on its own as opposed to upper limb exercises and IMT together.

The fact that the researcher was aware of all the patient's groupings and was present during all the tests may have

led to biased results especially between the exercise and control groups with the former having weekly appointments for 8 weeks.

Further research

Further study is required to establish the optimal training regime for patients with COPD.

Conclusion

This paper provides some evidence in support of IMT showing that inspiratory muscles can be trained leading to reduction in dyspnoea scores, improvements in lung function and exercise tolerance. It also shows an added trend for improvements when IMT is combined with upper limb training. These are important factors to consider when planning and implementing programmes to help in the management of COPD.

Key Points

- IMT using threshold devices and upper limb exercises may have a role in the management of COPD patients.

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Book reviews

BTS/ACPRC Guidelines for the Physiotherapy Management of the Adult, Medical, Spontaneously Breathing Patient. Thorax 2009; 64 (Suppl1) i1-i51

Julia Bott, Sharron Blumenthal, Maria Buxton, Sheric Ellum, Caroline Falconer, Rachel Garrod, Alex Harvey, Tracey Hughes, Melanie Lincoln, Christine Mikelsons, Catherine Potter, Jennifer Pryor, Lesley Rimington, Frances Sinfield, Catherine Thompson, Pamela Vaughn, John White (On behalf of the BTS/ACPRC guideline development group)

Thorax 2009; 64 (Suppl1) i1-i51 contains the full document: recommendations, a summary of the evidence, references, a historical background and details of the development process, and 3 appendices. These are also available on-line at http://brit-thoracic.org.uk and http://thorax.bmj.com/content/vol64/issuesuppl1.

The guidelines arose because of the imperative need to inform all physiotherapists and respiratory physicians of the scope of physiotherapy practice and the evidence supporting physiotherapy techniques. These guidelines cover management of adult, medical patients only. They exclude the management of paediatrics and surgical and critically ill patients requiring invasive ventilatory support. It is hoped that these topics will be covered in further guidelines.

The development process was rigorous and to the BTS' exacting criteria. The literature was searched, all papers critically appraised and levels of evidence assigned to them by two people. This evidence was then summarized, with recommendations formulated where possible, graded to reflect the strength of the evidence supporting them.

There are 6 clinical sections (COPD, asthma and disordered breathing, cystic fibrosis, non-cystic fibrosis bronchiectasis, non-obstructive / restrictive lung diseases, and neuromuscular diseases and chest wall disorders). Many of the recommendations and good practice points will come as no surprise, but a few areas have highlighted strong evidence for physiotherapy interventions that may not reflect current common clinical practice. For example, the value of relaxed, reduced ventilation breathing exercises in patients with symptomatic asthma, the importance of postural drainage or hypertonic saline for some patients, the need to identify stress incontinence in our patients since it may impact on adherence, and the need to carefully monitor and intervene quite intensely in patients with weakness due to neuromuscular disease.

A seventh section addresses workforce considerations in delivering the guidance set out in the clinical sections, but since it is a large piece of work by itself, it has merely served to start the process of further work, with the support of the BTS. The first step is to survey practice around the UK and members will soon be receiving an on-line questionnaire which we are most anxious that you complete.

ACPRC are also now about to commence the development of patient information leaflets for every treatment modality recommended in the guidelines. Many of you have already registered interest in helping via iCSP, so thank you.

The ACPRC has been in existence for 25 years. These guidelines are a collaborative work between the BTS and ACPRC and the first set of comprehensive guidelines in respiratory care, setting a benchmark for the future. They will guide clinicians, including specialist practitioners, and be useful for students and on-call staff, those less familiar with management of respiratory patients and any other interested professionals who wish to examine the evidence base for physiotherapy interventions for respiratory populations.

This is a truly exciting time for respiratory physiotherapy and these guidelines provide us with an opportunity to be taken seriously as a profession with a solid grounding in evidence, a good deal to offer the patient and also an opportunity to improve our own practice and our services. We must not lose this opportunity.

Reviewed by Julia Bott, Consultant Physiotherapist, Surrey PCT NW Locality

Clinical Case Studies in Physiotherapy: A guide for students and graduates. (2008)

Lauren Jean Guthrie (Ed)
Price: £22.99

This book, aimed at undergraduate physiotherapy students and recently qualified staff offers a subject by subject approach to refreshing and updating knowledge and skills in physiotherapy. It would be of particular use to students on placement and recently qualified staff on rotation.

Chapter two (chapter one is an

brief overview and introduction to the book) begins with a review of the basic knowledge and skills required for working in each of the main clinical areas and has a suggested reading list of core texts for each speciality which could be helpful for students and newly qualified staff. Chapter three, entitled 'what to expect on placement', is mainly aimed at undergraduate students and gives some helpful pointers to help students get the most out of their clinical experience and opportunities. Recently qualified staff could also benefit by applying many of these principles to new rotations. The importance of good preparation is emphasised and the author highlights the importance of reflection and self appraisal. The concept of learning outcomes is not explored in this chapter and this would have been the ideal place to encourage students and newly qualified rotational staff to consider what their learning objectives for the placement or rotation might be prior to commencing work in that area.

The following chapters cover the core clinical areas of respiratory, neurology, orthopaedics, musculoskeletal outpatients and care of the elderly and also address mental health and women's health. Paediatrics is not covered in a discrete chapter of its own however key clinical aspects of paediatric physiotherapy are covered in most of the core clinical areas. Each chapter begins with a brief introduction and continues with a selection of case studies which address some of the most commonly encountered aspects of working in each clinical field. The case studies offer patient assessment findings followed by a list of pertinent questions for the reader to consider (answers are given at the end of each chapter).

Chapter five focuses on respiratory physiotherapy and has a good selection of case studies that cover respiratory medicine (in-patient and out-patient), surgical conditions, intensive care, cardiothoracics (including cardiothoracic ICU) and paediatrics. The case studies address many of the common problems encountered by respiratory physiotherapists and encourage the reader to think holistically about the patient and take a multi-systems approach to assessment. As cardiology isn't covered elsewhere in this book it may have been a helpful addition to have also included it in this chapter. Respiratory care is also considered in subsequent chapters with case studies in stroke and fractured neck of femur also highlighting the importance of holistic assessment including respiratory assessment and treatment.

Although aimed at less experienced staff, this book may be a useful tool for many physiotherapists to refresh their skills in clinical areas where they do not regularly practice. It may also be a useful book for a department to own, providing a starting point for case study discussion and clinical reasoning as part of an inservice training programme.

Reviewed by Catherine Thompson, Senior Physiotherapy Lecturer, York St.John University

Respiratory Physiotherapy: An on-call survival guide. (2009) Second Edition.

Beverly Harden, Jane Cross, Mary-Ann Broad, Matthew Quint, Paul Ritson, Sandy Thomas (Eds)
Price: £22.99

This is the second edition of the valuable on-call survival guide. Published five years after the original it has been enhanced with additional editors, updated references and useful case studies to encourage self assessment. The chapters are written and edited by expert clinicians giving very practical information in a format that is easy to follow. Flow charts and tables are well used and allow the reader to access relevant information quickly and easily.

The guide contains chapters on preparation for on-call duties as well as respiratory assessment of the adult and paediatric patient, and chest x-ray review. These chapters are particularly valuable for those who are less experienced or who do not normally work in the area of respiratory care.

As in the first edition, there are excellent chapters covering the physiotherapy management of specific respiratory problems such as sputum retention, volume loss and work of breathing, as well as an additional chapter on the management of respiratory failure.

To help those who are called to areas of the hospital they are unfamiliar with, there are also chapters on specific units such as intensive care, the cardiothoracic unit, surgical unit and oncology unit. These chapters would be useful to all on-call staff whether they are based in respiratory physiotherapy or simply participate in the on-call rota. Experienced respiratory physiotherapists would also find these chapters a useful reminder for those wards and units where they do not normally work.

This guide will be invaluable to those new to on-call or not working in respiratory physiotherapy and will be a handy addition to the library for the more experienced respiratory physiotherapist.

Reviewed by Sian Goddard, Clinical Specialist Physiotherapist in Respiratory Care, Royal Cornwall Hospital.

volume 41 2009

Journal of the Association of Chartered Physiotherapists in Respiratory Care

INSTRUCTIONS FOR AUTHORS

Submissions may take the form of review papers, research reports, audit reports, case studies, editorials, conference reports, equipment reports and reviews of books, CDs or DVDs. Student contributions are welcomed.

Please use double-spacing throughout, with a 4 cm margin on the left, with no headers and footers (other than page numbers), and without footnotes unless these are absolutely necessary, all pages must be numbered.

Articles should normally be no longer than 2000 words (editorials, case studies 1000 words and book reviews 250 words). They should be emailed to b.oneill@ulster.ac.uk with the files named as follows

- Main document: Author, date of submission, title of paper e.g. Smith011206Bronchiectasis
- Tables: Author, date of submission, title of Table e.g. Smith011206Table1
- Figures: Author, date of submission, title of figure e.g. Smith011206Figure1

Structure of respiratory paper/ article/ audit/ review:

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The title page should carry:
- Title of the article
- The names and initials of each author.
- Institutional affiliation of each author.
- Full details of each author's current appointment.
- Authors most recent qualification
- Name, e-mail address and telephone number of the author responsible for correspondence.
- Please provide up to 4 keywords
- Word count (excluding summary)

SUMMARY (Not for editorials or brief reports)

This is typeset in bold at the beginning of the article, and should be between 50 and 60 words in length. It should be designed to develop the readers' interest in the article.

INTRODUCTION
The introduction should have a clear rationale and purpose/aim or state the question that the paper sets out to answer.

METHODS
This should outline the methodology used to complete the respiratory project or literature review. A summary of the statistical process should be provided, for research projects a statement of ethical approval should be included.

RESULTS
Results should include a detailed summary of your findings.

DISCUSSION
Interpretation of the results obtained in the study should be offered here. The findings must be considered in relation to previous work and in terms of whether the aim specified in the INTRODUCTION has been achieved. Suggestions should also be included for the improvement of the study. Furthermore recommendations for future research should be offered.

CONCLUSION
Your conclusions should be succinct and logically ordered. Identify gaps in present knowledge and suggest future initiatives.

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Please supply 3-5 key phrases that summarise the major themes of your article.
These will appear at the end of the article.

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Please use headings and subheadings appropriately.

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Abbreviations should be defined at their first mention. SI units should always be used.
For numbers: all numbers under 10 should be written as words except when describing

a quantity e.g. PaO2 8.5Kpa. Numbers greater than 10 should be written as digits, except at the start of a sentence.

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Ensure that each table and figure are cited in the text e.g.

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In the text, use the name and year (Harvard system) e.g. As Black and White (1987) have shown..., As already reported (Black and White, 1987)...

For three or more authors print the first author's name followed by et al e.g. As Black, et al, (1987) have shown...

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In the reference list arrange references alphabetically by first author's surname. Print the names and initials of all authors for references with six or less authors; for seven or more authors print the first three and add 'et al'. The sequence for a journal article is: Author, Initials, Year, Title of article. Full title of Journal, Volume number (issue/part number), page numbers.

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The total number of references should not exceed 20.