



Airways clearance techniques

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Background

Cystic fibrosis (CF) is an inherited fatal disease characterised by pulmonary infection and thick airways secretions. CF is inherited as an autosomal recessive trait. The gene product, Cystic fibrosis Transmembrane Regulator (CFTR) is a membrane-based protein. In most cells the gene for CFTR is dormant but in epithelial cells it is switched on. Defective epithelial cell membrane transport impairs ion and water movement across the cell membrane causing dehydration of secretions and obstruction of the various body lumens (Yankaskas et al 2004).

Thick secretions within the respiratory tract may overwhelm the normal muco-ciliary escalator clearance mechanisms. Retained secretions create an ideal breeding ground for bacterial growth leading to repeated respiratory infections. Frequent infective exacerbations will promote inflammation and scarring within the respiratory tract eventually causing obstruction leading to hyperinflation and restriction in the lungs respectively. Chronically inflamed airways and repeated infections contribute to the progressive nature of a declining lung function, with obstruction and restriction causing an imbalance of supply and demand within the respiratory system. Davies (1999) reported respiratory failure as the cause of death in over 90% of this patient group.

Chest physiotherapy for sputum clearance has long been regarded as an integral part of treatment for CF. Methods of sputum clearance have over time developed from standard physiotherapy to include; percussion, vibration and cough in varying postural drainage positions to Active cycle of breathing techniques (ACBT), Autogenic drainage (AD), positive expiratory pressure devices (PEP) and oscillating positive expiratory pressure devices; the Flutter and Acapella. These more recent techniques rely on the principles of getting air behind the secretions to move them from distal to proximal along the muco-ciliary escalator. This theory is based on a necessity for shearing forces on the mucus within those airways to move the sputum in a proximal direction to aid expectoration (Lapin, 2002).

Opinion varies significantly on the most effective and appropriate method of physiotherapy; a meta-analysis by van der Schans et al (2000) concluded that although chest physiotherapy does appear to improve mucus transport in the CF population in the short term this could not be supported in the longer-term nor could it be claimed that it is harmful. Main et al (2005) in a later Cochrane review of the literature concluded that conventional chest physiotherapy including percussion and postural drainage could not be considered advantageous over any other airways clearance technique in the treatment of cystic fibrosis. However, both Cochrane reviews commented on the paucity of well designed, large, randomly controlled trials. This may in part be due to the withholding of chest physiotherapy being considered unethical in this group. The review by Main et al (2005) did however report a tendency for patients to prefer self-administered airways clearance techniques and

recommended an individually tailored regime that promoted independence. However, there appears to be a dearth in the literature concerning which airways clearance techniques have best effect on long term pulmonary function decline in adult CF patients.

The aim of this study was to retrospectively analyse airways clearance technique (ACT) (including those patients with poor compliance) in terms of lung function decline over one year in a population of adult cystic fibrosis patients.

Methods

A retrospective analysis of 124 CF patients (Male=68, Female=56, mean age=27.8 years) was conducted. Patients were grouped according to ACT performed with greater than 40% compliance this was self-reported by patients. Data were also collected in those patients with poor compliance (less than 40% compliance with treatment i.e. less than 4 out of 10 treatment sessions performed per week as prescribed by the physiotherapist). Forced expiratory volume in one second (FEV1) decline over one year was the primary outcome measure. FEV1 decline was measured during annual review when the patient was deemed as not having an infective exacerbation. Baseline demographics were also analysed including; diabetic and infection colonisation status, age, gender, baseline FEV1 (Percentage of predicted values were calculated from the equations of Knudson et al.), mucolytic and antibiotic therapy and Body Mass Index (BMI). FEV1 decline versus ACT data were assessed for normality and then analysed using a one-way ANOVA, post hoc analysis was conducted with a gabriels' test. Differences in baseline demographics were also analysed in this way. A kendall tau b and c was used to see if there were any differences between groups and for mucolytic and antibiotic usage.

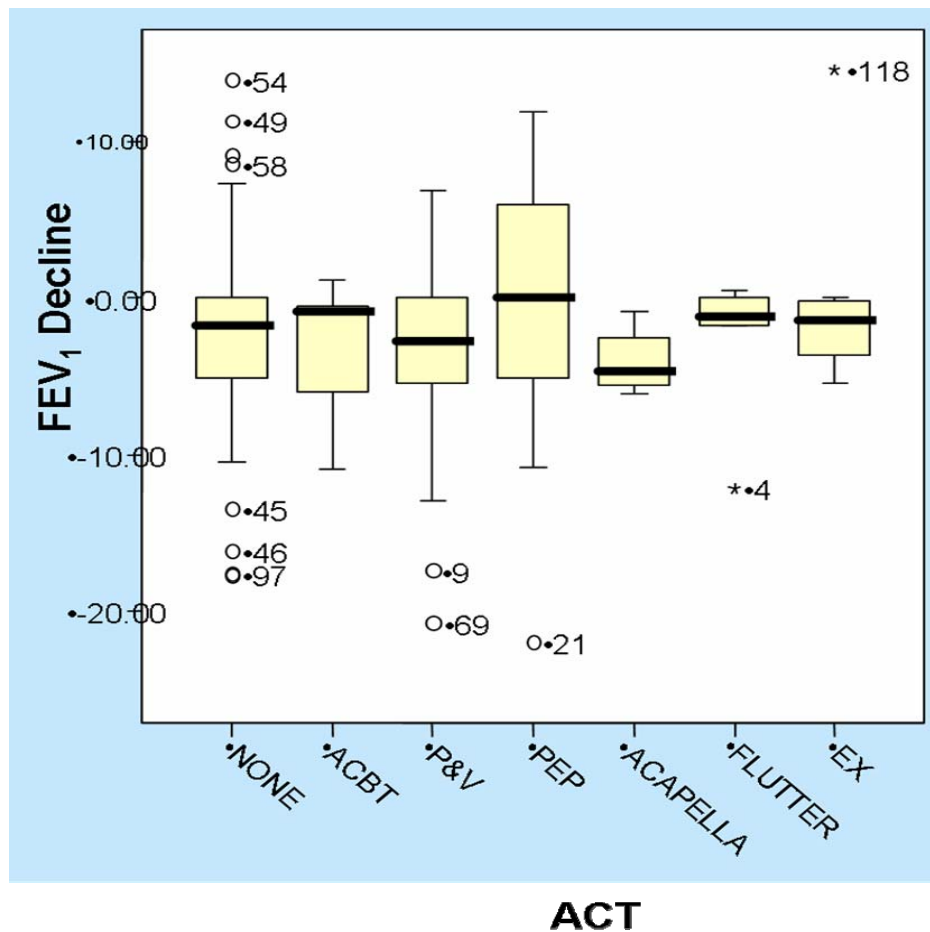
Results

RESULTS Annual FEV1 Decline v ACT		
ACT	FEV1 Decline Annually	FEV1 Baseline
None	-2.25 (n=38)	60.1
ACBT	-3.01 (n=6)	77.8
P&V	-3.33 (n=25)	49.8
PEP	-0.37 (n=28)	70.9
Oscillating PEP	-3.20 (n=10)	61.4



Exercise	-0.75 (n=12)	61.4
Total	-2 (n=119)	61.5

When patients were grouped according to airways clearance technique performed differences in baseline demographic data did not reach statistical significance in any group ($p>0.05$). No statistically significant differences in FEV1 decline were seen between any ACT including the non-compliant group after one year ($p>0.05$). However, a trend was suggestive of a lower decline in FEV1 in the Positive Expiratory Pressure (PEP) group (-0.37% n=45) compared with the non-compliant group (-2.25% n=38); the percussion and vibration group (-3.33% n=20); the ACBT group (-3.01% n=15), the oscillating PEP group (-3.20% n=10) and the exercise alone group (-0.75% n=6). However, post hoc analysis of FEV1 baseline versus ACT revealed a significantly lower baseline FEV1 in the percussion and vibration group compared to the PEP group ($p=0.042$). When groups were analysed for mucolytic and antibiotic therapy including Pulmozyme, hypertonic saline, colomycin, TOBI and gentamycin, no significance was found between antibiotic (0.677) or mucolytic (0.996) therapy between groups.





Limitations of the study

The retrospective nature of the study did not allow for monitoring of patient compliance which may have lead to inaccuracies in the reporting of compliance. Low numbers in some groups may have lead to an under powering of statistical analysis and a potential for type II error exists. Smoking history bacterial genotyping was not recorded in this group which may affect lung function decline over a one year period.

Discussion

The percussion and vibration group had a tendency for greater decline in FEV1 over one year than any other ACT and although this trend was not statistically significant when compared to the PEP group. Interestingly however, post hoc analysis revealed a significantly lower baseline FEV1 in the percussion and vibration group than the PEP group. It could be assumed that patients with poorer lung function have more exacerbations and therefore may show a greater decline in lung function than those with higher lung function. It may also be possible that patients with lower lung function require assistance to perform airways clearance techniques and so receive percussion with the assistance of a relative.

Low numbers in some groups for example the exercise group (6 patients) may contribute to a possible type II error and reduced clinical significance. Decline data were therefore analysed when acapella, flutter and PEP patients were grouped, this failed to reveal statistically significant differences.

Compliance was self-reported this may present inaccuracies in the data. Myers and Midence (1998) suggest that patients may over-report compliance to medical professionals with actual compliance being as low as 29.5% for CF patients who include chest physiotherapy as part of their daily routine. Myers and Horn (2006) reported 48.7% admitted that they were only sometimes or less adherent to chest physiotherapy. This was compared to this study of 30.6% patients admitting to less than 40% adherence to treatment. If compliance has been over-reported in this study results may be skewed in some or all treatment groups. It is also likely that those patients who reported poor compliance with chest physiotherapy were also poor at complying with other medication which may have an adverse effect on lung function. It appears unlikely that BMI status affected decline data as there were insignificant differences in numbers of low BMI patients between ACT groups.

The number of diabetic patients in each group did not differ significantly between treatment groups. Numbers of patients with differing bacterial colonisation did not vary significantly between groups. BMI, diabetic status and bacterial colonisation are all factors that are associated with increasing decline in lung function in Cystic fibrosis (Sharma 2000, Milla 2000, Ledson, 2000) but all of these factors in the study are unlikely to have affected the results. The number of patients taking nebulised antibiotics or mucolytics did not differ between groups however the statistical analysis was difficult with this data due to the large number of groups and the small number of subjects within those groups, increasing the possibility of error.

Conclusion

This study revealed that over a one year period no significant difference existed between various ACT and the no treatment group in terms of lung function decline.

These findings concur with those of the Cochrane review (van der Schans, 2000) that suggest there is no evidence supporting one ACT over another in the long-term treatment of CF patients. Decisions on physiotherapy treatments should be tailored according to individual effectiveness of treatment and patient preference. Further study with greater numbers may help to identify whether trends in the data for different airways clearance techniques reach statistical significance. Collection of more demographic data in these patients may elicit whether any other factors contributed to declining lung function such as smoking history and clinic or hospital attendance. Monitored compliance may also produce stronger results.

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