Validation of an Instrument Measuring Patient Satisfaction With Chest Physiotherapy Techniques in Cystic Fibrosis*

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**Objectives:** Chest physiotherapy (CPT) has been an important part of cystic fibrosis (CF) treatment regimens for > 40 years. Techniques with different perceived costs, benefits, and patient satisfaction exist. An instrument measuring patient satisfaction with CPT has not been reported. Our goal was to develop and validate such an instrument.

**Design:** A cross-sectional survey sent to 349 patients seen at a large, urban, academic CF care center. The two-page survey asked 17 questions related to CPT satisfaction (efficacy, convenience, comfort, overall satisfaction), followed by 4 general CF-care questions (disease severity, importance of therapies, prescribed vs missed therapies). A 5-point Likert-type scale was used for responses. Psychometric analysis included itemetric performance, confirmatory factor analysis, test-retest reliability, and evaluation of subject’s responses to the general CF-care questions.

**Results:** One hundred twenty-nine individuals returned completed surveys (39%; 66 males and 63 females; age range, 2 months to 47 years). FEV\(_1\) values were 21 to 155% predicted (mean, 76%; n = 82). Disease severity was as follows: 60 mild, 47 moderate, and 14 severe. Seventy-nine subjects used postural drainage, percussion, and vibration (PDPV), 21 used a flutter device, and 14 used high-frequency chest wall oscillation (HFCWO). Five subjects used more than one technique. Internal consistency analysis found an overall coefficient \(\alpha\) of 0.87 (range, 0.74 to 0.89 for four domains). Factor analysis demonstrated domains for efficacy, convenience, comfort, and overall satisfaction. Mean total satisfaction scores differed significantly among therapies \((R^2 = 0.118; F[2,111] = 7.56; p = 0.0008)\): PDPV, 3.8 (SD = 0.6); Flutter, 4.3 (SD = 0.5); and HFCWO, 4.1 (SD = 0.5). Therapies also differed significantly on all subscores. Perceived importance of CPT and compliance with CPT increased linearly with disease severity. Overall satisfaction was positively correlated with CPT compliance.

**Conclusions:** The CPT satisfaction survey has good reliability and content validity. Significant differences in patient satisfaction exist among therapies. Sicker patients recognize the importance of, and demonstrate better compliance with prescribed CPT. Increased satisfaction is associated with better compliance with therapy.

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**Key words:** chest physiotherapy; compliance; cystic fibrosis; patient satisfaction

**Abbreviations:** ACT = airway clearance technique; CF = cystic fibrosis; CPT = chest physiotherapy; HFCWO = high-frequency chest wall oscillation; PDPV = postural drainage, percussion, and vibration; PEP = positive expiratory pressure

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Chest physiotherapy (CPT) has been an important part of cystic fibrosis (CF) treatment regimens for > 40 years. Traditionally, this has meant the use of postural drainage, percussion, and vibration (PDPV) for airway clearance. Unfortunately, this technique is time consuming, requires a skilled care provider, and may be associated with discomfort, gastroesophageal reflux, and hypoxemia. Compliance with home-prescribed CPT regimens is often poor because of these issues. Alternative airway techniques...
clearance techniques (ACTs) have been developed in an attempt to overcome some of the limitations of PDPV.

Newer ACT modalities include self-controlled breathing techniques and device-assisted therapy, and may offer certain advantages or disadvantages when compared to PDPV. The perceived advantages and disadvantages of differing therapies may relate to individual efficacy, convenience of care, comfort or tolerability of treatments, cost, and other factors. Together, these various components lead to an individual patient’s satisfaction with a specific ACT. Satisfaction, in turn, is thought to relate to compliance: the greater the satisfaction with a therapy, the greater the compliance with that therapy. No instrument measuring patient satisfaction with various ACTs has been reported.

This questionnaire was initially developed for use in a pilot study comparing three CPT techniques (PDPV, vibration, using Flutter [Scandipharm; Birmingham, AL], and high-frequency chest wall oscillation [HFCWO]) in 24 CF patients. We conducted a larger, cross-sectional survey among patients cared for at a single CF care center to more fully evaluate the instrument. Validation and assessment of its performance will make it a useful adjunct to fully evaluate the instrument. Validation and assessment of its performance will make it a useful adjunct to

**Analytical Techniques**

**Materials and Methods**

**Setting**

This study was performed at Baylor College of Medicine, a large, metropolitan, academic CF care center accredited by the United States Cystic Fibrosis Foundation. It was completed in compliance with institutional review board policies.

**Study Design**

A two-page written survey containing two separate questionnaires was mailed to 349 CF patients cared for at the center. A $5 gift certificate was sent to individuals returning a completed survey. Responses were provided by either the patient or, in the case of infants or young children, their care provider. The first questionnaire consisted of 17 questions related to CPT. It was divided into three domains (perceived efficacy, convenience, and comfort) and had three general questions regarding overall patient/caregiver satisfaction. If more than one therapy type was used, subjects were asked to complete a questionnaire for each. Responses were scored on a 5-point Likert-type scale, where 1 indicated strong disagreement with the statement, and 5 indicated strong agreement. The second questionnaire asked about self-perceived disease severity (1 = very mild disease, to 5 = very severe disease), the importance of prescribed therapies (1 = not at all important, to 5 = very important), and the frequency of missed treatments (1 = always miss, to 5 = never miss). Twenty subjects were selected at random and asked to complete the surveys a second time to perform test-retest analysis.

**Statistical Analysis**

Analyses were performed to examine the reliability and validity of the measure. Reliability is concerned with the degree to which scores on a scale can be replicated. Internal consistency reliability measures the interrelatedness of an item set. A unidimensional scale or a single dimension of a multidimensional scale should consist of a set of items that correlate well with each other. Items included in a measure of patient satisfaction should all be closely related to patient satisfaction and to each other. Test-retest reliability examines the temporal stability of a measure or how constant scores remain from one occasion to another. Both internal consistency and test-retest reliability were examined using generalizability analysis. For test-retest reliability, two facets were considered: items and time. The resulting coefficient α reflects the degree of reliability of the measure.

Validity is generally assessed by comparing a new tool or measure to an accepted “gold standard.” There is no validated, “gold standard” measure of patient satisfaction with CPT. Therefore, more indirect methods must be used to determine the validity of the CF Chest PT Satisfaction Survey. Evidence for construct validity is examined using analyses of convergent relationships between the patient satisfaction factors and another theoretically related construct: disease severity. Hypotheses about severity and therapy type were tested using general linear models. When the independent variable was severity, polynomial contrasts were used, since we expected that differences would be linear by severity.

Content validity addresses the adequacy of item sampling to reflect a content domain. For measures of a multidimensional construct such as patient satisfaction, factor analysis provides an empirical way of establishing content validity. Factor analysis is used to examine the internal structure of a measure and confirm the grouping of items by construct or domain. A confirmatory factor analysis was done on the CF Chest PT Satisfaction Survey using Mplus (Muthen and Muthen; Los Angeles, CA). It was expected that four factors would be extracted, consisting of items 1 through 5 (effectiveness), 6 through 10 (convenience), items 11 through 15, with items 11 through 14 reverse coded (lack of discomfort), and items 16 and 17 (overall satisfaction). In addition, a “mean total satisfaction score” was derived from the numeric mean of the 17 responses for the entire measure.

**Results**

Seventeen survey packets (5%) were returned by the postal service as undeliverable. Of the remainder, 129 survey packets (39% of those delivered) were completed and returned. A repeat survey was sent to 20 responders to perform test-retest analysis. Sixteen of these surveys (80%) were completed and returned.

Survey responders included 66 male (51%) and 63 female (49%) subjects, ranging in age from 2 months to 47 years. FEV1 data were available on 82 subjects, with a mean of 76% of predicted (range, 21 to 155% of predicted). Distribution of disease severity (self-rated) was very mild (n = 25), mild (n = 35), moderate (n = 47), severe (n = 4), and very severe (n = 5). Eight subjects did not provide a response. Seventy-nine subjects (61%) used PDPV, 21 subjects (16%) used Flutter, and 14 subjects (11%) used
HFCWO. Twenty-one subjects did not specify or used an alternate technique.

As anticipated, a confirmatory factor analysis demonstrated domains for efficacy, convenience, comfort, and overall satisfaction. One item related to comfort performed better when included with overall satisfaction, and it was included in this domain for further analysis. Internal consistency analysis found an overall coefficient α of 0.87. Individual domains had coefficient α scores as follows: efficacy, 0.87; convenience, 0.89; comfort, 0.74; and overall satisfaction, 0.82. The α coefficients for the survey as a whole and the individual domains are in a generally acceptable range for this type of measure, and indicate good reliability.

The reliability for the total score (summed across items) was 0.63, indicating reasonable reliability as a research tool. The largest source of error was inconsistency over time independent of the items; the estimated error for the test was 0.1334, compared to variance of 0.2474 due to individuals being measured. This suggests a valid construct that is documenting changes in attitude over time. Examination of the individual domain coefficients demonstrated that the convenience factor had particularly low test-retest reliability (0.29), with comfort being somewhat higher (0.55), and efficacy being most reliable over time (0.81). This is not unexpected, as convenience is more likely to be dependent on other life-schedule demands that can vary over time, whereas efficacy is likely to remain constant.

Analysis of satisfaction scores by type of therapy was done for PDPV, Flutter, and HFCWO. A higher score indicates greater satisfaction (1 through 5). Mean total satisfaction scores were significantly different among therapies: PDPV, 3.8 (SD = 0.6); Flutter, 4.3 (SD = 0.5); and HFCWO, 4.1 (SD = 0.5). Significant differences among therapy types were also observed for subscores in the efficacy, convenience, and comfort domains. Overall satisfaction subscores also differed significantly: PDPV, 3.6 (SD = 1.0); Flutter, 4.4 (SD = 0.7); and HFCWO, 4.5 (SD = 0.6). Posttest comparisons using Tukey's HSD indicated that HFCWO was seen as significantly more efficacious than Flutter, Flutter was seen as more convenient than PDPV and more comfortable than HFCWO, and both Flutter and HFCWO produced more overall satisfaction than did PDPV. Neither the total satisfaction score nor domain subscores differed significantly by disease severity. These data, including statistical analysis, are summarized in Table 1.

The patient-perceived importance of CPT differed by self-perceived disease severity ($R^2 = 0.085$; $F[4,105] = 2.45$; $p = 0.05$) but only the linear contrast was significant ($F[1,105] = 6.08$; $p = 0.015$), so that individuals with more severe disease considered CPT more important. The importance of breathing treatments also differed by disease severity ($R^2 = 0.213$; $F[4,107] = 7.22$; $p = 0.0001$), and only the linear contrast was significant ($F[1,107] = 9.68$; $p = 0.0024$). The importance of enzymes, vitamins, dornase alfa, and inhaled antibiotics differed by disease severity, but the relations were not linear. The linear relations are shown in Figure 1.

The frequency of missed CPT differed significantly by severity ($R^2 = 0.108$; $F[4,103] = 3.11$; $p = 0.0185$), and was generally linear ($F[1,103] = 5.05$; $p = 0.0268$). Subjects with more severe disease missed fewer therapies. Enzyme use also differed significantly by severity level ($R^2 = 0.092$; $F[4,117] = 2.97$; $p = 0.0224$), but there were significant deviations from linearity. There was no relation of severity to missed therapies for vitamins, breathing treatments, dornase alfa, or inhaled antibiotics. Figure 2 shows the relation of compliance with CPT to disease severity.

The relations of therapy type and satisfaction with therapy vs self-reported degree of compliance were also examined. When a continuous scale (1 = always miss, to 5 = never miss) was used for analysis, no significant differences among therapy types were detected. However, when dichotomized into ever miss vs never miss, significant differences among therapy types were demonstrated. Thirty percent of subjects using PDPV and 21% of subjects using

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<th>Table 1—Scores for PDPV, Flutter, and HFCWO in the Domains of Therapy Efficacy, Convenience, Comfort, and General Satisfaction*</th>
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*A value of 1 indicates a very unfavorable score, and value of 5 indicates a very favorable score.

†Indicates statistical significance when compared to the lowest scoring therapy type.
Flutter reported never missing therapy, compared to 64% of subjects for HFCWO. There was also a significant difference in the degree of subject satisfaction with CPT vs the frequency of missed therapy (F \( [4,109] = 6.55; p < 0.01 \)). In general, those who reported missing therapy less often tended to also report greater satisfaction with their therapy (Fig 3).

**DISCUSSION**

Although the use of CPT for airway clearance in CF has been a cornerstone in CF therapy for \( >40 \) years, it is only within the past 5 years that studies have clearly shown PDPV to be effective in slowing the deterioration of lung function in CF.\(^{12-14}\) Studies by Reisman and colleagues\(^ {13}\) and Desmond and colleagues\(^ {14}\) have established PDPV as an effective therapy in CF, and the “gold standard” against which other CPT techniques are measured. Despite the proven efficacy of PDPV, compliance is often poor.\(^ {5-8}\) This is due, at least in part, to patient dissatisfaction with the shortcomings of PDPV, which include lengthy treatment sessions, the need for a skilled care provider, and adverse side effects of therapy. Alternative ACTs have been developed in an attempt to overcome the problems associated with PDPV and improve compliance with prescribed home therapy.

Newer ACTs include positive airway pressure (PEP) devices, Flutter, HFCWO, and others. With the exception of PEP, none of these modalities have been adequately studied, and convincing long-term efficacy data have not been reported. McIlwaine and colleagues\(^ {15}\) in a comparative trial evaluating PEP and PDPV, reported improved pulmonary function (FEV\(_1\), FVC, and forced mid-expiratory flow) in subjects treated with PEP, compared to a decline in pulmonary function in subjects treated with PDPV. Controlled studies evaluating Flutter and HFCWO have been short term or looked only at sputum production.\(^ {16-19}\) Patient satisfaction with therapy has not been addressed in trials of either PDPV or alternate ACTs; this questionnaire represents the first reported instrument measuring patient satisfaction with CPT in CF.

Our data demonstrate that patient satisfaction differs significantly among CPT techniques. This is true for overall satisfaction, in which HFCWO and Flutter outscored PDPV. Significant differences also existed in the convenience domain, where Flutter scored higher than PDPV; the efficacy domain, where HFCWO was perceived as most efficacious; and comfort domain, where Flutter was better tolerated than HFCWO. The reasons for these differences are undoubtedly multifactorial and suggest a need to individualize when prescribing home airway clearance therapy.

Studies in other disease processes have demonstrated the close relation between patient satisfaction and compliance with prescribed therapies.\(^ {20,21}\) The data that we have presented are the first indicating that this relation is also present in regard to CPT in CF. Additionally, we demonstrated that compliance
among ACTs can differ significantly. Assuming that compliance is a key component in efficacy, it becomes crucial to consider patient satisfaction issues when prescribing home CPT treatments. No therapy is effective unless it is used, and it will not be used if patients find it unacceptable. The decision to use one ACT vs another must be a mutual decision between care providers and patients, and must take into account a number of factors leading to overall patient satisfaction.

Patients’ perceptions of both the importance of CPT and compliance with prescribed airway clearance increase with disease severity. Patients’ perceptions of the importance of bronchodilators also increased with disease severity, although compliance with this therapy did not. This is in marked contrast with the use of enzyme replacement therapy, vitamin supplementation, dornase alfa, and inhaled antibiotics for which significant differences did not exist or were not linearly related. This may be due to patients’ feelings about the relative importance of pulmonary vs GI pathology in CF. At present, respiratory failure is the cause of death in 90% of CF patients. This is in contrast to malnutrition as the primary cause of death of CF patients in the 1940s and 1950s. Other factors influencing this may be the immediately apparent effects of CPT and bronchodilators vs the preventative nature of dornase alfa and prophylactic antibiotics, or the need for enzyme replacement and vitamin supplements throughout life, regardless of disease severity.

Although adequate variance was observed in all satisfaction domains, the voluntary nature of the survey with a relatively low response rate is a potential limitation of the study. Subjects responding may represent a cohort of individuals who are more motivated and generally more compliant with therapy than nonresponders. If this is the case, correlations between disease severity and compliance may be even more pronounced as those between satisfaction and compliance. Additionally, the numbers of subjects using ACTs other than PDPV were fairly small, although adequate to demonstrate statistically significant differences. No other measures of patient satisfaction are available, so comparisons with existing literature are not possible. It is anticipated that the items included in each of the four domains may be generalized to other CPT modalities not in use in this study population.

CONCLUSION

Despite its role as a cornerstone therapy for airway clearance in CF, PDPV continues to be plagued with compliance and satisfaction concerns that limit its effectiveness in home self-care. Studies have demonstrated the benefit of PDPV and, to a limited extent, some of the newer ACTs, but there is a continued need for research in this area, with expanded attention to secondary outcomes such as patient satisfaction and quality of life. This satisfaction measure can provide useful information in clinical trials evaluating airway clearance in CF. The CPT Patient Satisfaction Survey is currently in use as an outcome measure in a multicenter trial of ACTs in CF. It is available for use in other clinical trials evaluating new or existing ACTs.

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