Association of Observed Family Relationship Quality and Problem-Solving Skills with Treatment Adherence in Older Children and Adolescents with Cystic Fibrosis

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Objective  To examine associations between observations of the quality of family relationships and problem-solving skills and reported adherence to medical treatments for older children and adolescents with cystic fibrosis (CF).  Methods  Reports of adherence were obtained from 96 youth with CF and their parents recruited from six CF centers in the Midwest and southeastern United States. Videotaped observations of family discussions of high conflict issues were used to assess quality of relationships and problem-solving skills.

Results  Hierarchical regression analyses indicated that observed family relationship quality (RQ) was related to parent and child reports of adherence to airway clearance and aerosolized medications after controlling for demographic variables and illness severity. Observed family problem solving was not a significant predictor after controlling for RQ.

Conclusions  Older children and adolescents who come from families experiencing unhappy and conflicted relationships may be at greater risk for poor adherence to treatments; thus, family relationships are appropriate targets for interventions aimed at improving adherence.

Key words  cystic fibrosis; treatment adherence; family relationship quality; problem-solving skills.

The symptoms of cystic fibrosis (CF) and its treatment regimen lead to marked distress for children or adolescents with CF and their families, as parents assist their child in coping with the demands of the illness and the terminal nature of the disease while they manage normative and illness-specific caretaking responsibilities (Ievers & Drotar, 1996). In addition, the medical regimen affects family routines and priorities, making management of normative family tasks quite challenging (Patterson, Budd, Goetz, & Warwick, 1993; Quittner, et al., 1996; Quittner, Drotar, & Ievers, 1998). These psychological stressors may strain the capabilities of the family to comply with the prescribed regimen (Patterson et al., 1993; Quittner et al., 1996). Preliminary evidence suggests that family functioning may influence the pulmonary health of the child with CF (Patterson et al., 1993). Consequently, exploring the relationship between family functioning and adherence to medical treatments in families who have a child with CF is critically important.

CF is the most common terminal genetic disease among white populations and occurs in approximately 1 in 3,400 live white births and 1 in 17,000 African American births in the United States (Beers & Berkow, 1999; Orenstein, Winnie, & Altman, 2002). CF affects several major organ systems, including the respiratory, digestive, and reproductive systems (Beers & Berkow, 1999). The course of the disease varies greatly but
inevitably leads to death, with chronic lung infections accounting for the majority of morbidity and mortality (Morgan et al., 1999). With aggressive treatments, the prognosis for patients with CF has steadily improved, with a current median survival age of greater than 30 years (Beers & Berkow, 1999). The core treatment regimen includes airway clearance therapies to move mucus out of the airways, antibiotics for bacterial infections, and a modified diet that includes replacement enzymes with each meal and snack as well as increased calorie intake (Stark, Jelalian, & Miller, 1995).

Rates of adherence to the treatment regimen for CF vary greatly, depending upon which components are measured and which methods of measurement are used. In a survey of 58 patients with CF, Passero and colleagues (1981) reported high rates of adherence to medications (90%), moderate adherence to airway clearance (40%), and lower adherence to dietary alterations (20%). Similarly, Gudas, Koocher, and Wypij (1991) documented relatively high rates of adherence to medications (85%) and somewhat lower rates to airway clearance treatments and diet (65%). Most recently (Ievers et al., 1999), elementary school–age children with CF and their mothers reported high rates of adherence to airway clearance treatments (90% and 85%, respectively) and moderate levels to aerosolized medications (63% and 64%) and pancreatic enzymes (70% and 68%). Based on structured interviews and daily phone diaries (DiGirolamo, Quittner, Ackerman, & Stevens, 1997), more than 50% of adolescents with CF reported doing less than their prescribed airway clearance regimen and 30% indicated that they were not doing any of their prescribed treatments. As in other chronic illnesses, adolescents with CF have been found to be less adherent to treatments than younger children (Gudas, Koocher, & Wypij, 1991; Ricker, Delamater, & Hsu, 1998).

While family functioning has been considered an important factor in adherence to treatments, the relationship has received less attention. No studies of children or adolescents with CF could be located that examined the relationship between observed family functioning and treatment adherence.

Thus, while existing evidence indicates that family functioning is related to treatment adherence in some pediatric chronic conditions (La Greca & Schuman, 1995), this relationship has received less attention in CF. The current investigation extends previous research by employing observational methods of family functioning found that relationship factors (e.g., communication, problem-solving skills, conflict resolution) significantly predicted adherence behaviors for children and adolescents with diabetes (Bobrow, AvRuskin, and Siller, 1985; Hauser et al., 1990; Wysocki et al., 1999). No studies of children or adolescents with CF could be located that examined the relationship between observed family functioning and treatment adherence.

The current investigation also further extends this previous work by examining the question of whether a more global index of how families get along may supersede more specific family-based skills in the prediction of adherence behaviors. Specifically, our purpose was to explore whether a more specific skill such as family problem-solving ability remains a significant predictor of adherence when controlling for the more global quality of family relationships (i.e., the extent to which family members experience happy, open, and emotionally satisfying relationships vs. unhappy, conflicted, and brittle relationships). Past
research, as reviewed above, has rarely compared the various dimensions of family functioning or made predictions regarding which dimension(s) may be more strongly associated with adherence. This strategy is important for discovering ways to streamline family-based interventions to offer child patients with a chronic illness and their families the most targeted and efficacious assistance possible.

Our first hypothesis was that after controlling for demographic variables (age, gender, socioeconomic status [SES]) and illness severity, observations of the quality of family relationships would significantly predict treatment adherence in all domains. The higher the quality of family relationships, the more adherent the child was expected to be to treatments. Our second hypothesis was that after controlling for demographics and relationship quality (RQ), observed family problem solving would still positively predict treatment adherence. Finally, our third hypothesis was that observed illness-specific family problem-solving skills would relate more closely to reported adherence than would general problem-solving skills. The development of study hypotheses was based on behavioral-systems models which posit that greater family reciprocity and deficient problem-solving skills are related to non-adherence (Robin & Foster, 1989) and on the literature recommending that the assessment of problem solving around health-related issues is much needed (Cox & Davis, 1999).

Method  
Design of Overall Study

This investigation focused on baseline data from children and adolescents with CF and their parents in a randomized, controlled trial with repeated measurements over a 2-year period to compare the effects of standard care with two manualized, structured interventions: (1) a family learning program and (2) behavioral family systems therapy (Quittner et al., 2000). The major outcomes included adherence behaviors; family conflict, communication, and coping skills; long-term health outcomes; and cost-effectiveness. The interventions consisted of 11 family sessions with a registered nurse or licensed clinical psychologist. The assessments included self-report questionnaires, audiotaped responses, videotaped family interactions, and daily phone diaries. Measures analyzed for the present manuscript included baseline assessment data for all participants from selected self-report questionnaires and coded videotaped family discussions.

Participants

Participants were 96 children and adolescents with CF, aged 9 to 16 years, and their parents who were recruited from six CF centers in the Midwest and southeastern United States. Inclusion criteria were: (1) age, 9.5 to 16.5 years, (2) diagnosis of CF for a minimum of 1 year, (3) illness severity as measured by a forced expiratory volume in 1 second (FEV₁) of greater than 35% predicted, (4) no other chronic disease (other than CF-specific diabetes), (5) no history of psychiatric treatment within the past year, and (6) no evidence of intellectual impairment, i.e., mild mental retardation as documented by school reports. In addition, both biological caregivers were required to participate in the intervention and assessments if the child was being raised in a two-parent home. Although some siblings (particularly younger children) living in the home were present during the intervention sessions, this was not a requirement of the study. Siblings did not participate in any of the assessments.

From the 231 families approached for participation, 18 were eventually excluded for not meeting study criteria, and 96 who met criteria declined to participate. The reasons for declining included travel distance (n = 22; 23%), time constraints (n = 21; 22%), and no interest (n = 4; 4%), as well as a variety of other, unique reasons (e.g., unwillingness to talk about the illness, biological father declined participation; n = 15; 16%). Some of those approached did not state a reason for declining (n = 26; 27%), and others (n = 8; 7%) agreed to participate but could not be reached after several attempts. Participants included in the present study resembled eligible nonparticipants in children’s age, gender, and the frequency of one- versus two-parent families. However, nonparticipants had lower FEV₁ scores, indicating greater illness severity. Unfortunately, 19 videotapes for coding of family variables at baseline were inaudible, damaged, or missing. In addition, demographic information from 2 families was incomplete. Therefore, data from 96 families were available for the present study.

The final sample included 50 males (52.1%) and 46 females (47.9%). A majority of these children (69.3%) were being raised in two-parent households. Ethnic background was 91 (94.8%) white, 4 (4.2%) African American, and 1 (1.0%) other. The educational level of the parents ranged from less than seventh grade to
graduate school, with the average between high school graduate and some college. Parental average occupational status as coded from the Hollingshead occupation index was midrange, including technicians, semiprofessionals, and clerical and sales workers. A pulmonary function test indicating disease severity was obtained from each patient's medical chart, with a higher score indicating better lung functioning (i.e., less severe disease). The FEV₁ scores at the baseline assessment ranged from 30% to 124%, with the mean falling into the “mild” category. Note that the pulmonary functioning of one subject who met the enrollment criteria when initially screened deteriorated prior to the baseline assessment. This subject's data were included in the present analyses.

**Procedures**

All patients meeting the basic study criteria were contacted, either during a clinic visit or by mail, and given an information letter describing the goals and procedures of the study. The letter indicated that the study's purpose was to compare the relative effectiveness of two family interventions for improving adherence to treatments for older children and adolescents with CF. A clinical nurse or trained research assistant approached the adolescent in the presence of a parent to discuss the requirements of the study and its potential benefits. Informed consent was obtained from parents and verbal assent from the child or adolescent. The baseline assessment was completed in the clinic or investigator's laboratory setting at a convenient time for the participants. A research assistant was present to answer any questions and to ensure that family members were not comparing answers.

**Measures**

**Treatment Adherence**

The Treatment Adherence Rating Scale (TARS) (Quittner et al., 1998) is a self-report measure of perceived treatment adherence, with parallel versions for child or adolescent patients with CF and their parents. The TARS is a new instrument designed by the investigators for the larger study. Ratings on the TARS indicate perceptions of how well the patient followed his/her prescribed regimen for CF care in the past 2 weeks (except where noted). The measure consists of 16 items rated on a Likert scale (1 = never followed recommendations, 2 = rarely followed recommendations, 3 = followed recommendations 50% of the time, 4 = usually followed recommendations, most of the time, 5 = always followed recommendations, and 6 = not applicable or not prescribed). The TARS was originally designed with five subscales representing the various domains of treatment for CF: (1) airway clearance, (2) aerosolized medications, (3) pancreatic enzymes, (4) nutrition, and (5) antibiotics. An example of an airway clearance item is “I did airway clearance treatments for as long as recommended.” For the antibiotic items, the respondent reports on adherence over the past 6 months. Scores are calculated by averaging ratings within each subscale. Any statement given a rating of 6 (not applicable) is omitted from further scoring.

Exploratory factor analyses based on principal-components factoring with varimax rotation was used to empirically determine the subscales for the mother, father, and child-patient reports on the TARS using the baseline sample of 117 participants. The number of factors extracted was based on eigenvalues of 1.0 or higher, and items were included if their loading was at least .40. Items with cross-loadings of more than half of the primary loading on another factor were dropped. For the mothers' reports, the factor analysis yielded a four-factor solution accounting for 60.4% of the variance. The empirically derived TARS subscales for mothers were: airway clearance/aerosolized medications, four items (coefficient α = .82–.84); enzymes, three items (coefficient α = .65); antibiotics, three items (coefficient α = .81); and nutrition, three items (coefficient α = .71–.76) (see Table 1 for items). For the children’s/adolescents’ and fathers’ reports on the TARS, the items for the airway clearance/aerosolized medication and nutrition factors corresponded to the mothers' reports. The other two factors were not interpretable, as high cross-loadings eliminated all but one or two items from the factor scores. Thus, the factors for enzymes and antibiotics will not be considered for further analyses with children or fathers.

**Family Relationship Quality and Problem-Solving Skills**

The Issues Checklist (IC) (Robin & Foster, 1989) and the CF Issues Checklist (CF-IC) (Quittner et al., 2000) determined which issues were discussed during the videotaped family discussions. The IC consists of 44 items reflecting issues that often cause conflict between parents and children or adolescents, with the parents and child independently rating the frequency and emotional intensity of recent discussions regarding these issues. The CF-IC is a modified version of the IC consisting of 17 issues. The CF-specific issues were
identified in recent studies by the principal investigator (A.Q.) from the larger study as being commonly experienced in older children and adolescents (Digirolamo et al., 1997). Example items on the CF-IC include “remembering to do airway clearance” and “telling your friends about CF.”

The observed family discussion consisted of a 20-minute videotaped conversation between the patient with CF and his/her parent(s). For each family, 10 minutes were spent discussing up to three conflictual issues not related to CF, and 10 minutes were spent discussing up to three conflictual issues directly related to CF, with the order randomly selected. Family members were asked to attempt to solve at least one issue in each of the time periods and were encouraged to use the entire time. The research assistant left the room. After the first 10-minute period, the research assistant returned and instructed the family to discuss the other set of issues for the remaining 10 minutes. Family members were not asked to rate how typical the taped interactions were with regard to how the family got along and solved problems.

The Iowa Family Interaction Rating Scales (IFIRS) (Melby et al., 1998) were used as the observational coding system to measure family RQ and problem-solving skills. This rating system includes 60 scales, but single subscales and composite measures of different combinations of subscales have also been used (Melby & Conger, 2001). Raters in the present investigation studied the manual, did coding of practice tapes, and consulted with the IFIRS developers. Both coders had previous training in family assessment and coding. The primary coder had finished her graduate school courses for a degree in clinical psychology and had advanced training experience in the areas of family systems theories and family therapies. Interobserver reliability has been assessed extensively for the IFIRS, with correlations ranging from .55 to .85 for single scales (Melby & Conger, 2001). The correlations for composite scores are similar, ranging from .61 to .81 (Ge, Best, Conger, & Simons, 1996; Melby & Conger, 2001). The IFIRS problem-solving scales have been validated against self-report measures using correlational and confirmatory factor analysis (Rueter & Conger, 1992).

The subscales utilized were: (1) dyadic relationship scales and (2) group problem solving. The dyadic relationship scales required coding of RQ for each dyad in the family: mother/patient, father/patient, and mother/father. For single-parent families, there was only one RQ score. The RQ scores are single scores ranging from 1 to 9. A low score indicates an unhappy, conflicted, or brittle relationship. A family that received an RQ score in the middle range would present as somewhat involved with each other, but members may appear to avoid unhappiness or conflict. The relationships in such a family could be described as adequate but could benefit from improvements to increase their quality. A high score indicates a happy, open, and emotionally satisfying relationship. RQ scores have been positively associated with scores on the warmth/support, communication, listener responsiveness, and positive mood subscales of the IFIRS. Additionally, RQ scores have been negatively correlated with scores on the hostility, contempt, antisocial, and defiance IFIRS subscales (Melby et al., 1998).

The group problem-solving measure is a composite of four scales including family enjoyment (FE), agreement on problem description (AP), agreement on solution (AS), and implementation commitment. The FE scale measures the level of enjoyment the group appears to experience during the problem-solving process (Melby et al., 1998); the AP scale measures the extent to which members reach mutual consensus on the description of the problem; the AS scale measures the
extent to which family members reach agreement on a solution to a problem; and the implementation commitment scale measures the extent to which the group commits to implementing the solution. The four subscales are averaged to create an overall problem-solving score ranging from 1 to 9, with a low score indicating poor family problem-solving skills, and a high score good family problem-solving skills. Self-reported success in families’ abilities to solve problems and implement solutions has been associated with observed problem-solving interactions coded by the IFIRS (Rueter & Conger, 1992).

For the current study, a primary coder (K.D.) independently scored all videotapes, and a secondary coder scored 35% of the videotapes. The coders were blind to other data and did not meet the families in person. Interobserver reliability was estimated by calculating Spearman’s rho. Reliabilities were moderate to high, with correlations for the RQ scales of .77 for mother/child, .82 for father/child, and .76 for mother/father. The remaining single-score correlations ranged from .51 to .87, with an average of .72. Reliabilities for the problem-solving scales were .79 for the CF-specific issues and .86 for the non-CF-specific issues.

### Table II. Means and Standard Deviations for Variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>M</th>
<th>SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Child patients’ age, y</td>
<td>13.12</td>
<td>1.69</td>
<td>9.78–16.93</td>
</tr>
<tr>
<td>SES</td>
<td>42.32</td>
<td>14.3</td>
<td>9.00–66.00</td>
</tr>
<tr>
<td>Severityb</td>
<td>83.15</td>
<td>19.59</td>
<td>30.00–124.00</td>
</tr>
<tr>
<td>Relationship quality</td>
<td>6.06</td>
<td>1.64</td>
<td>1.33–9.00</td>
</tr>
<tr>
<td>CF-specific problem solving</td>
<td>4.08</td>
<td>1.59</td>
<td>1.25–7.50</td>
</tr>
<tr>
<td>Non-CF-specific problem solving</td>
<td>3.79</td>
<td>1.42</td>
<td>1.50–7.75</td>
</tr>
<tr>
<td>Child/adolescent patient report</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Airway clearance/aerosol</td>
<td>4.14</td>
<td>0.90</td>
<td>1.00–5.00</td>
</tr>
<tr>
<td>Nutrition</td>
<td>2.82</td>
<td>1.41</td>
<td>1.00–5.00</td>
</tr>
<tr>
<td>Mother report</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Airway clearance/aerosol</td>
<td>3.84</td>
<td>0.98</td>
<td>1.00–5.00</td>
</tr>
<tr>
<td>Antibiotics</td>
<td>4.49</td>
<td>0.78</td>
<td>1.00–5.00</td>
</tr>
<tr>
<td>Enzymes</td>
<td>3.85</td>
<td>0.80</td>
<td>1.67–5.00</td>
</tr>
<tr>
<td>Nutrition</td>
<td>2.63</td>
<td>1.27</td>
<td>1.00–5.00</td>
</tr>
<tr>
<td>Father report</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Airway clearance/aerosol</td>
<td>4.12</td>
<td>0.81</td>
<td>1.00–5.00</td>
</tr>
<tr>
<td>Nutrition</td>
<td>2.59</td>
<td>1.27</td>
<td>1.00–5.00</td>
</tr>
</tbody>
</table>

SES = socioeconomic status; CF = cystic fibrosis.

*Based on Hollingshead index derived from parents’ education and occupation levels (Hollingshead 1975). Higher scores indicate higher SES.

*Severity is based on forced expiratory volume in 1 second, with ≥ 70 = mild illness, 40–69 = moderate illness, and < 40 = severe illness.

### Results

#### Descriptive Analyses

Means and standard deviations for all variables are presented in Table II. Regarding reported treatment adherence, the mean scores across domains and informants ranged from 2.6 to 4.5, corresponding to *followed recommendations to usually followed recommendations*. Reported adherence to airway clearance treatments, aerosolized medications, antibiotics, and enzymes was on average in the 4 range, or *usually followed recommendations*. Adherence to nutritional recommendations averaged 2 to 3, *rarely followed recommendations* to *followed recommendations 50% of the time*. Observed family RQ was on average 6, indicating somewhat positive relationships. Observed problem solving was on average in the 3–4 range, signifying that family members made statements describing the problem or were working toward a solution, but a consensus was not achieved.

#### Comparisons Across Informants

Spearman correlations were calculated to determine the relationship of scores among informants (child/adolescent, mother, father) on perceived treatment adherence. Correlations ranged from .42 to .57. Because of these relatively weak correlations, informant scores were not combined for further analyses.

#### Associations Among Independent Variables

Spearman correlations were also computed for the independent variables (family RQ, CF-specific problem solving, non-CF-specific problem solving). CF-specific problem solving and non-CF-specific problem solving were significantly related at .56. Although this correlation was statistically significant, it was not strong enough to warrant combining the scores for further analyses, particularly in light of our hypothesis that CF-specific problem solving would be more closely associated with adherence behaviors. Family RQ scores were strongly related between dyads (mother/child, father/child, mother/father), with correlations ranging from .80 to .93 (*p < .01*); and these dyad scores were therefore averaged for further analyses. Thus, the family RQ score for two-parent families was an average of three dyad scores. For single-parent families, the single dyad score (parent/child) was used. Observed family RQ and CF-specific problem solving were significantly correlated at .63 (*p < .01*). Observed family RQ was also significantly correlated with non-CF-specific problem solving (.68, *p < .01*).
Univariate Relationships Between Independent and Dependent Variables

Spearman correlations were computed between the independent and dependent variables (see Table III). Significant correlations were found between demographic factors, illness severity, observed family variables, and reported treatment adherence.

Multiple Regression Analyses/Tests of Hypotheses

Hierarchical multiple regression analyses were conducted with each empirically derived treatment adherence subscale of the TARS (i.e., airway clearance/aerosolized medications, antibiotics, enzymes, nutrition) to identify the observed family variables that made a significant contribution to predicting adherence. For each TARS subscale, predictor variables were entered in blocks designed to test the stated hypotheses. Demographic variables (patients’ age and gender and household SES) were entered into the first block to control for demographic effects on reported adherence. (For all of the multiple regressions, SES was measured using the Hollingshead index of combined education and occupation scores, with the highest index among the caregivers selected to represent the household’s status (Hollinghead, 1975).) Severity level was entered as a second block to control for illness severity’s effects on reported adherence. Observed family RQ scores were entered as the third block to assess the effects of RQ on reported adherence. Finally, families’ observed CF- and non-CF-specific problem-solving scores were entered simultaneously as the fourth block to determine whether problem-solving skills accounted for any unique variance in adherence outcomes after accounting for RQ. On each block, the forward selection procedure was selected.

Regression analyses were conducted separately by informant within each TARS subscale. As described above, four subscales were used for the mothers’ reports. For child-patients’ and fathers’ reports, only the subscales of airway clearance/aerosolized medications and nutrition were included because the other factors (enzymes and antibiotics) for these informants were not clear (see clarification in the Measures section under Treatment Adherence). Thus, a total of eight regression analyses were conducted. To control for type I error, the modified Bonferroni test for planned comparisons was used, requiring an α level of .025 for significance (Keppel, 1982). Results are displayed in Table IV.

Child-Reported Treatment Adherence

Based on childrens’ reports of treatment adherence, observed family RQ predicted reported adherence to airway clearance/aerosolized medications (p = .018), with child/adolescent patients from families with more positive relationships reporting better adherence. No other variables significantly predicted adherence.

Mother-Reported Treatment Adherence

Based on mothers’ reports of their child’s treatment adherence, significant predictors of adherence were illness severity, gender, and observed family RQ. For airway clearance/aerosolized medications, illness severity predicted 9.6% of the variance in mothers’ reports on the TARS (p = .004), with more severely ill child patients being more likely to adhere. Observed family RQ predicted an additional 9.6% (p < .001), with more positive family relationships associated with better adherence to airway clearance/aerosolized medications. For the nutrition subscale, a trend emerged in which gender predicted 6.1% of the variance, with mothers of sons with CF reporting better adherence to nutritional recommendations than mothers of daughters (p = .026).

Table III. Correlations Between the Independent and Dependent Variables

<table>
<thead>
<tr>
<th>Dependent Variables</th>
<th>Independent Variables</th>
<th>SES</th>
<th>Age</th>
<th>Severity</th>
<th>RQ</th>
<th>CF PS</th>
<th>Non-CF PS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Child/adolescent patient</td>
<td>Airway clearance/aerosol</td>
<td>.120</td>
<td>−.060</td>
<td>−.203</td>
<td>232*</td>
<td>107</td>
<td>.195</td>
</tr>
<tr>
<td></td>
<td>Nutrition</td>
<td>−.024</td>
<td>−.033</td>
<td>−.129</td>
<td>.049</td>
<td>103</td>
<td>.095</td>
</tr>
<tr>
<td>Mother</td>
<td>Airway clearance/aerosol</td>
<td>.180</td>
<td>−.096</td>
<td>−.265*</td>
<td>362**</td>
<td>243*</td>
<td>.305**</td>
</tr>
<tr>
<td></td>
<td>Antibiotics</td>
<td>.094</td>
<td>−.299**</td>
<td>.077</td>
<td>.090</td>
<td>−145</td>
<td>−103</td>
</tr>
<tr>
<td></td>
<td>Enzymes</td>
<td>.119</td>
<td>−.103</td>
<td>.122</td>
<td>125</td>
<td>148</td>
<td>.082</td>
</tr>
<tr>
<td></td>
<td>Nutrition</td>
<td>−.032</td>
<td>−.053</td>
<td>−.141</td>
<td>.084</td>
<td>178</td>
<td>.058</td>
</tr>
<tr>
<td>Father</td>
<td>Airway clearance/aerosol</td>
<td>.006</td>
<td>.165</td>
<td>−.206</td>
<td>281*</td>
<td>294*</td>
<td>192</td>
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<tr>
<td></td>
<td>Nutrition</td>
<td>.023</td>
<td>.163</td>
<td>−.248</td>
<td>103</td>
<td>284*</td>
<td>177</td>
</tr>
</tbody>
</table>

SES = socioeconomic status; RQ = family relationship quality; CF = cystic fibrosis; CF PS = CF-specific problem solving; Non-CF PS = non-CF-specific problem solving.

* p ≤ .05; ** p ≤ .01.
Father-Reported Treatment Adherence
Based on fathers’ reports of their child’s adherence to airway clearance/aerosolized medications, observed family RQ was a significant predictor of adherence, predicting 14.9% of the variance ($p = .001$). Fathers from families with more positive relationships reported better adherence to the treatment regimen.

**Post hoc Regression Analyses**
Post hoc analyses were conducted to further test the strength of our finding that observed family RQ rather than family problem-solving skills significantly predicted reported treatment adherence. The first series of modified regression analyses were conducted by entering RQ and problem solving together as one block, while still controlling for demographics/illness severity. Problem solving did not emerge as a significant predictor in any of these analyses. A second series of modified regression analyses were conducted while also controlling for demographics/illness severity. On the third block, problem solving was entered by itself, and RQ was entered as the last block. In one of these regression analyses (maternal reports of adherence to airway clearance/aerosolized medications), both non-CF-specific problem solving and RQ were significant predictors.

**Discussion**
The central hypothesis, that observed family RQ would be significantly related to reported adherence behaviors, was partially supported. This finding is congruent with the literature on other childhood chronic conditions, including diabetes, renal failure, and arthritis (e.g., Chaney & Peterson, 1989; Davis, Tucker, & Fennell, 1996; Hauser et al., 1990). In the present investigation, a more positive family relationship was associated with mother, father, and child-patient reports of better adherence to airway clearance treatments and aerosolized medications. This association was not found for the other domains of treatment. One possible reason that significant relationships were found for this domain of treatment rather than for the other domains (enzymes, nutrition, antibiotics) is that the burden of these treatment tasks may require greater family support and coordination. In addition, these daily treatments for the lungs may carry a particularly high emotional valence, since lung infections are responsible for the majority of morbidity and mortality.

The second hypothesis, that family problem-solving skills would explain additional variance in adherence outcomes after accounting for the more global family RQ was not supported. Family problem-solving skills did not significantly relate to adherence for any informant or treatment domain after controlling for demographics, illness severity, and RQ. One possible explanation is that in the absence of a positive family relationship, good problem-solving skills may not promote adherence. The lack of relationship between problem-solving skills and adherence may appear to contradict the literature on other childhood chronic conditions (e.g., Kurtz & Delamater, 1987; Bobrow, AvRuskin, & Siller, 1985), but these studies differ methodologically by not accounting for the effects of family RQ on adherence prior to examining the role of problem-solving skills. This is supported by our finding that both CF-specific and non-CF-specific problem-solving skills were significantly related to adherence at the univariate level and in a regression analysis in which RQ was entered in a subsequent block. Based on these findings, family problem-solving interventions to improve adherence among children with CF should take the overall quality of family relationships into consideration. More research is needed to determine whether this finding generalizes to other illness groups.

Finally, the third hypothesis—that illness-specific problem-solving skills would be more closely related to reported adherence than general problem-solving skills—was not supported. Although univariate analyses yielded three significant correlations between CF-specific problem solving and adherence and one significant correlation for non-CF-specific problem solving, none

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**Table IV. Summary of Hierarchical Multiple Regression Analyses**

<table>
<thead>
<tr>
<th>Dependent Variable and Block</th>
<th>$F$</th>
<th>Unique $R^2$ (%)</th>
<th>$\beta$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airway clearance/aerosol (child/adolescent patient)</td>
<td>Relationship quality 5.78*</td>
<td>6.2</td>
<td>14</td>
</tr>
<tr>
<td>Airway clearance/aerosol (mother)</td>
<td>Severity 8.77**</td>
<td>9.6</td>
<td>-0.00</td>
</tr>
<tr>
<td></td>
<td>Relationship quality 9.89**</td>
<td>9.6</td>
<td>19</td>
</tr>
<tr>
<td>Nutrition (mother)</td>
<td>Gender 5.15*</td>
<td>6.1</td>
<td>-63</td>
</tr>
<tr>
<td>Airway clearance/aerosol (father)</td>
<td>Relationship quality 11.05**</td>
<td>14.9</td>
<td>19</td>
</tr>
</tbody>
</table>

* Variables were entered in blocks. First block: demographic variables; second block: illness severity; third block: observed family relationship quality; fourth block: CF (cystic fibrosis)- and non-CF-specific problem solving. Only the variables reaching significance at least at the .05 level are displayed.

* $p \leq .01$

** $p \leq .05$
of these associations was significant in the regression analyses that controlled for RQ. Additionally, in the post hoc regression analyses in which problem-solving skills were entered in a block prior to RQ, non-CF-specific problem solving was a significant predictor in mothers’ reports for adherence to one treatment domain.

Gender and illness severity were also associated with reported adherence. Males adhered better to dietary alterations than did females, possibly because there is greater societal stigma associated with small stature in males. Illness severity was related to adherence to airway clearance/aerosolized medications, with more severely ill adolescents being more likely to adhere. This makes intuitive sense, as older children and adolescents who are more severely ill may be more aware of the reasons for and potential benefits of doing their treatments than adolescents who are asymptomatic or experiencing less severe symptoms. More severely ill child patients may also be more likely to feel the immediate benefits of these treatments, which may increase their motivation to comply. Other studies have also shown that adherence is better for treatments that produce an immediate and noticeable effect (La Greca & Schuman, 1995). This finding lends some credence to the notion that perhaps for the child with more severe illness who may be more adherent to at least some domains of treatment, family RQ and problem-solving abilities are less important for promoting adherence. An investigation to study this possibility would be quite compelling.

A number of limitations should be noted when considering these findings. First, self-reports of adherence are subject to informant bias; therefore, our findings must be interpreted in the context of the perceptions of child patients, mothers, and fathers. Second, our measure of adherence was created for this investigation, and only two subscales were similar between all three informants in an empirically derived factor analysis. Improvement of this measure would allow for measurement of adherence in other treatment domains across informants. Third, our observational measure of RQ was fairly general in nature and may have included a number of factors such as communication skills, warmth, closeness, etc. Fourth, our observational assessment of family problem solving was limited because of the short amount of time allowed (10 minutes each for CF- and non-CF-related issues). Additionally, how typical the videotaped interaction was for each family was not ascertained, as family members were not asked to provide this type of rating. Despite these caveats, we observed the full range of problem-solving skills and found some significant univariate relationships with self-report measures of adherence completed by three different informants (mother, father, and child patients) when not controlling for RQ.

Finally, our investigation was cross-sectional and does not provide evidence for the direction of effects. Perhaps poor adherence to CF treatments erodes the quality of family relationships, leading to further deterioration in adherence, both occurring in a circular fashion. Conversely, higher-quality family relationships may promote better treatment adherence, which may improve the quality of the relationships. Intervention efforts aimed at improving either family functioning or treatment adherence could therefore be hypothesized to positively influence both.

While this investigation clearly supports the notion that the quality of family relationships is related to how well an older child or adolescent will adhere to the treatment regimen for CF, further elucidation of the specific aspects (i.e., use of praise and expression of feelings) that are most closely related to adherence will be an important next step. Developing and utilizing more comprehensive measures of observed family RQ could serve this purpose. An additional direction is in conducting randomized clinical intervention trials of behavior therapy for families of adolescents with CF to determine how this type of intervention improves RQ and subsequently whether family therapy will increase treatment adherence. Findings from postintervention assessments from this investigation will soon be available to help address this question. A trial of behavior therapy for families of adolescents with diabetes (Wysocki et al., 1999) found that increased observed positive communication by mothers and improved family problem resolution scores were associated with improved treatment adherence at 3-month follow-up. Additionally, the group receiving family therapy showed significantly improved treatment adherence at 6- and 12-month follow-ups compared with the education and support group or the current therapy group (Wysocki, Greco, Harris, Bubb, & White, 2001).

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References


Hollingshead, A. B. (1975). Four factor index of social status. Unpublished ms., Yale University, Department of Sociology.


