

Barriers to Treatment Adherence for Children with Cystic Fibrosis and Asthma: What Gets in the Way?

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Objectives The purpose of this study was to systematically identify barriers to treatment adherence for children with cystic fibrosis (CF) and asthma, as well as to examine the relationship between the number of barriers and adherence. **Methods** Participants included 73 children with CF or asthma and their parents. The mean age of the sample was 9.9 years, and 58% were males. **Results** Results indicated that barriers were quite similar by illness and informant (e.g., parent and child) for the same treatments, but unique barriers were identified for disease-specific treatments. Frequently mentioned barriers across diseases included forgetting, oppositional behaviors, and difficulties with time management. Trends were identified between adherence and barriers, suggesting that a greater number of barriers were related to poorer adherence. **Conclusion** Overall, this study provided evidence that patients and their parents experience specific barriers within the context of their own illness and highlights the need for disease-specific measures and interventions.

Key words barriers; knowledge; patient–provider communication; pulmonary; treatment.

It is assumed that patients will follow the treatment recommendations prescribed by their physicians; however, growing evidence indicates that average rates of adherence are 50% or less in young, chronically ill populations (Rapoff, 1999). Poor adherence can have serious consequences, including increased morbidity and mortality, reduced quality of life, and greater health care costs. More than 10 years ago, the costs associated with nonadherence were estimated to be over \$100 billion per year (Berg, Dischler, Wagner, Raia, & Palmer-Shevlin, 1993) and they continue to increase.

Adherence is particularly poor in pediatric pulmonary diseases, such as cystic fibrosis (CF) and asthma, because of the intensity and complexity of the treatment regimen. Rates of adherence for children with CF are estimated to be 40–47% for chest physical therapy, a form of airway clearance (Passero, Remor, & Solomon, 1981; Quittner et al, 2000), whereas adherence to dietary recommendations is even lower, ranging from 16 to 20% (Anthony, Paxon, Bines, & Phelan, 1999; Stark,

Jelalian, & Miller, 1995). Estimates of adherence for children with asthma vary widely for inhaled medications, ranging from 46 to 58% (Bender et al, 2000; Walders, Kopel, Koinis-Mitchell, & McQuaid, 2005). For both of these populations, poor adherence may lead to increased emergency room visits, more frequent hospitalizations, declines in pulmonary functioning, and shorter life span (Bauman et al, 2002; Warwick & Hansen, 1991; Weiss, Gergen, & Hodgson, 1992). To effectively address this problem, it is crucial to identify the barriers associated with poor adherence.

Patients with chronic conditions encounter numerous challenges in adhering to their treatment regimens which include forgetting, side effects, and lack of resources (Mansour, Lanphear, & DeWitt, 2000; Naspitz & Tinkelman, 2001). However, these studies present mainly anecdotal evidence provided by parents, with few systematic efforts to identify barriers for children. One exception to date is a study by Logan, Zelikovsky, Labay, & Spergel (2003) that developed the illness

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management survey (IMS), which examined adolescents' perceptions of barriers to adherence for asthma. The authors found that self-reported adherence was negatively correlated with scores on the IMS, suggesting that a greater number of barriers were associated with worse adherence. This was an important first step in systematically measuring barriers to adherence for adolescents with asthma; however, the perspective of younger children and parents also needs to be assessed. This study identified specific barriers for school-age children with CF or asthma and their parents.

Potential Barriers to Adherence

Several factors influence patterns of adherence for children with CF and asthma, including knowledge of the disease and regimen, patient-provider communication, and regimen characteristics. For children and their parents to effectively manage treatments associated with a chronic illness, they must understand the disease and its treatment regimen (LaGreca & Bearman, 2003). Evidence indicates that patients who are less knowledgeable about their disease may be less adherent to their medical regimens (Gudas, Koocher, & Wypig, 1991). For example, Henley & Hill (1990) found that 14% of parents of children with CF believed that chest physical therapy is necessary only when the child is feeling sick. Similarly, 20% of parents of African-American children with asthma felt they lacked knowledge about the disease, triggers, and use of different medications (Mansour et al., 2000). However, other studies have shown little relationship between knowledge and adherence in asthma (Farber et al, 2003; McQuaid, Kopel, Klein, & Fritz, 2003). This may partly be because of the use of different measures of knowledge and adherence that have not yet been validated. The current study assessed relations between adherence and knowledge for children with CF or asthma and their parents.

Gaps in knowledge and misconceptions about medication usage may be the result, in part, of inadequate or poor communication between the patient and healthcare provider. Patient-provider communication involves providing information in a culturally sensitive manner, developing a partnership regarding the treatment plan, responding to patient concerns, and making sure patients understand treatment recommendations (Brown, 1999). However, a majority of evidence suggests that such optimal communication is not occurring, and furthermore parents often do not recall what the physician has told them (Heffer et al, 1997). For example, Ievers et al (1999) reported that 12–33% of mothers

of school-age children with CF had incorrect information about the types of treatment being prescribed. In addition, physicians rarely provide a written treatment plan to families, which may lead to misunderstanding about the regimen. This is one of the first studies to examine rates of adherence in a pediatric sample using physician-reported prescriptions.

Research also suggests that complex regimens, negative side effects, and inconsistent efficacy can contribute to lower rates of adherence in these populations (Rapoff, 1999). Treatment characteristics such as the number of medications, the frequency of dosing, and routes of administration have all been shown to affect levels of adherence (Becker, Drachman, & Kirscht, 1972; Kelloway, Wyatt, & Adlis, 1994). For example, in the asthma population, 71% of mothers reported changing medication schedules for reasons of convenience, whereas 60% reported occasionally forgetting to dispense medications (Donnelly, Donnelly, & Thong, 1987). This study is the first to systematically examine parent- and child-reported barriers to adherence in two pediatric populations.

The central purpose of this study was to identify the most frequent barriers to adherence for children with CF or asthma and their parents. Similar types of barriers were expected to be reported by both disease groups for treatments that were similar; however, their frequency was expected to differ. Parents of children with CF were expected to identify a greater number of barriers than parents of children with asthma, because of the complexity of the treatment regimen. It was also hypothesized that the number of barriers would be significantly related to rates of adherence, with a greater number of barriers associated with lower adherence. Finally, it was hypothesized that disease and treatment knowledge would be strongly associated with adherence.

Method

Participants

Study participants included 73 children between the ages of 6 and 13 with a primary diagnosis of CF ($n = 37$) or asthma ($n = 36$) and their parents. Participants were recruited from two pediatric pulmonary clinics in Florida. Eligibility criteria included: (a) age between 6 and 13 years, (b) a proven diagnosis of CF or asthma for more than 1 year (e.g., sweat test, genetic test, and NHLBI guidelines), (c) no major comorbid medical diagnoses (e.g., cerebral palsy and cancer), and (d) use of routine or daily medications.

Ninety-four potential participants were mailed information letters and brochures explaining the study.

Participants were then contacted by phone or during routine clinic visits to review the informed consent. Twenty-one eligible participants were not included for the following reasons: (a) 16 parents declined to participate (quoting reasons as “too busy” and “moving”), (b) one participant was excluded from a set of twins, (c) one participant was no longer prescribed medications, (d) two participants did not return to the clinic for follow-up visits after they were recruited, and (e) one participant did not complete the initial assessment. Overall, data for barriers to adherence were collected for 37 children with CF and 36 children with asthma. In terms of adherence data, three children with CF and six children with asthma dropped out of the study because of busy schedules or family illness before completion of the 3-month assessment; however, self-reported adherence and barriers data were available for all of these participants.

The mean age of participants with CF and asthma was 10.1 and 9.7 years, respectively. Forty-nine percent of the CF sample and 36% of the asthma sample were girls. Eighty-nine percent of the CF sample were Caucasian, 3% African-American, 3% Hispanic, and 3% biracial. Forty-seven percent of the asthma sample were Caucasian, 42% African-American, and 11% Hispanic. For the CF sample, mean forced expiratory volume in 1 s predicated (FEV_1 % predicted) and forced expiratory flow₂₅₋₇₅ (FEF_{25-75}) were 79.6 and 91.4%, respectively. Sixty-six percent of the CF sample were mildly ill, 28% were moderately ill, and 6% were severely ill. In the asthma sample, mean FEV_1 % predicted and FEF_{25-75} were 72.2 and 74.0%, respectively. Thus, 70% were mildly ill, 26% were moderately ill, and 3% were severely ill. Seventy-four percent of primary caregivers of children with CF were married, and median family income was \$30,000–\$49,999. Fifty-three percent of primary caregivers of children with asthma were married, and median family income was \$20,000–\$29,999. Significant differences were found between the groups in terms of pulmonary functioning, race, and marital status of primary caregivers. As expected, children with CF had lower pulmonary functioning [$t(67) = -2.5, p < .05$], and a greater proportion of children in the asthma group were from minorities [$\chi^2(1, n = 73) = 14.9, p < .0001$]. Parents of children with CF were also more likely to be married than parents of children with asthma [$\chi^2(1, n = 73) = 3.9, p < .05$].

Procedure

Patients and their parents were recruited during a routine clinic visit and were asked to complete the following questionnaires: (a) background information form,

(b) self-report of adherence, (c) barriers to adherence, and (d) knowledge questionnaires. They were also scheduled to complete a daily phone diary (DPD) over 2 days before their next clinic visit and utilize electronic monitors for particular medications over a 3-month period (e.g., MEMS cap for enzymes and MDILog for inhaled corticosteroids). The institutional review board approved the protocol and consent forms, which included permission to contact pharmacies. To decrease social desirability responding, participants were told that information from the interviews would not be shared with the health care team. Pulmonary function tests (PFTs) were also conducted to assess the health status. Participants were given a \$5 gift certificate for participating in the study, \$10 for completing daily phone diaries, and \$10 gift certificates for returning electronic monitors.

Measures

Background Information Form

Parents completed a form assessing the child's date of birth, gender, parents' age, socioeconomic status, occupation, and composition of the family.

Prescribed Treatment Plan

The prescribed treatment plan (PTP) (Modi, 2002; Quittner, Espelage, Ievers-Landis, & Drotar, 2000) is a brief instrument completed by physicians in less than 2 min, which documents the current treatment regimen. Each component of the child's treatment (like medication, type, dosage, timing of dosage, and method of administration) is listed, and the current prescription is circled by the physician. A PTP was completed by a nurse, based on a chart review, for the initial clinic visit and later completed by the physician to document treatment changes.

Disease Management Interview

The disease management interview-CF (DMI-CF) is a 51-item self-report measure of adherence behaviors for patients with CF that was modified from the treatment adherence questionnaire-CF (TAQ-CF) (Quittner et al., 2000). Before administering the interview, the challenges of managing the child's regimen were normalized for the family to promote honest responding. For each component of the regimen, children (over 10 years of age) and parents were asked separately about the frequency and duration of each treatment performed (e.g., chest physical therapy for 30 min, twice a day). Children were given pictures of all possible medications to help them accurately report their treatment regimen. Ievers et al (1999) found satisfactory levels of agreement between children and mothers on an earlier version of this

instrument ($r = .69$ for aerosol frequency and $r = .99$ for chest physical therapy).

The DMI-Asthma was modified from the DMI-CF for parents and children with asthma. The DMI-Asthma is a 28-item questionnaire which asks when, how often, and how much of each medication they took [e.g., metered-dose inhalers (MDI), two puffs twice a day]. The same administration procedures were followed. In conjunction with the PTP, the DMI was utilized to calculate rates of self-reported adherence for each component of the child's treatment regimen.

Prescription Refill Data

Consent to obtain prescription refill data from all of the patients' pharmacies was obtained at the initial clinic visit. Each pharmacy was asked for comprehensive refill histories over the 3-month period of the study, and these data were combined for each patient. However, because of the implementation of new HIPPA guidelines, pharmacy refill history could not be obtained for 49% of patients with CF and 53% of patients with asthma.

Daily Phone Diary

The DPD uses a cued recall procedure to track parents through their activities over the past 24-hr (Quittner & Espelage, 1999; Quittner & Opiari, 1994). It is an unobtrusive measure of adherence that is likely to reduce social desirability responding because the full range of daily activities are elicited from parents, not just treatment behaviors. The DPD has yielded reliable stability coefficients over a 3-week period ($r_s = .61-.71$, $p < .01$) and high levels of interrater reliability ($>90\%$) in a CF population (Quittner, Opiari, Regoli, Jacobsen, & Eigen, 1992). Furthermore, strong convergent validity (77–80%; Quittner et al, 1992) was found for daily routines between the DPD and self-observation report technique (Stephens, Norris-Baker, & Willems, 1983). Moderate correlations have been found between the DPD and objective, electronic monitors, suggesting good convergence between these methods (Modi & Quittner, in press). The DPD procedure is computerized and yields both the number of treatments performed each day and their duration. A set of two DPDs (one weekday and one weekend day) were conducted with the primary caretaker by phone, and data were averaged to obtain rates of adherence for each treatment component. The 24-hr recall procedure has been adapted for use with parents of children with asthma.

Electronic Monitoring

Electronic monitoring provides an "objective" method of assessing adherence. However, owing to the high

costs of these devices, only the primary medications for CF and asthma were monitored. These included enzyme medications and MDIs (e.g., Flovent) for patients with CF and MDIs/diskus for patients with asthma. For patients with multiple inhalers in multiple locations (e.g., grandmother's house), separate MDILogs were given for each inhaler.

The Electronic Drug Exposure Monitor (eDEM®) made by AARDEX Corporation was used to monitor adherence to enzyme medications. It stores the dates and times for over 2000 doses, with data transferred to a Windows-based computer. The MDILog II®, developed by Westmed, records the date and time inhaled medications (e.g., bronchodilators and corticosteroids) were taken, whether the canister was shaken appropriately, and whether the medication was properly inhaled. Parents were instructed to bring current medications to their initial clinic visit. The MDILog was initialized and attached to their current MDI, and they were given instructions for attaching the MDILog for new prescriptions. These data were downloaded to a central docking station via computer. For MDILog data, only inhaled doses (not actuations without inhalation) were included in the calculation of adherence. The Advair discus is equipped with a counter that identifies the dosages left in the discus. This number was recorded at the initial visit and approximately 3 months later. These data were triangulated with pharmacy refill history to calculate rates of adherence.

Forty-six children were prescribed inhaled corticosteroids during the initial visit (29 Advair Diskus® and 17 traditional MDIs). Of those with MDIs, one patient utilized samples and thus did not use electronic monitors, and three patients were prescribed Pulmicort, for which no monitor exists. Of the remaining 13 patients, five monitors were faulty (because of improper downloading and no data), two did not fit the particular medication, three had missing data because of lost monitors, and three had complete adherence data. Twenty-nine patients were prescribed the Advair Diskus®, and counter data were available for nine patients. Missing counter data was because of patients utilizing multiple diskuses, lack of initial baseline counter readings, withdrawal from the study, or lost device.

Barriers to Adherence Interview

In conjunction with the disease-specific DMI, children and parents were interviewed separately about barriers to adherence. For each component of the treatment regimen, open-ended questions about the reasons why taking medications and doing treatments is difficult were asked. Participants were then given a list of 25 common

barriers [e.g., forgetting, oppositional behaviors, embarrassing, inconvenient, patient started feeling better and did not feel they needed medication, eating/feeding issues (feels full, rushes to eat)] and asked to choose any additional barriers that were relevant. Next, participants rated the frequency with which these barriers occurred on a 7-point Likert scale, ranging from (1) very rarely to (7) daily. The barriers to adherence interview for CF and asthma was also administered to children over 10 years of age.

Cystic Fibrosis Knowledge Questionnaire

The cystic fibrosis knowledge questionnaire (CFKQ) was specifically developed for studies conducted by Quittner et al (2000). This questionnaire assesses three broad domains of knowledge: respiratory/treatment, digestion, and nutrition. There are two versions of the CFKQ, one for school-age children (21 items) and one for parents (36 items). Because the responses were dichotomous, Kuder–Richardson 20 coefficients were calculated to assess reliability, with coefficients of .67 for an earlier version and .92 for a revised version reported for the parent versions and .77 for the child version.

Asthma Questionnaire

The asthma questionnaire (AQ) is a knowledge measure developed for children with asthma and their parents (Adams et al, 2001). Two versions were developed: the AQ-P for parents of children between 2 and 17 years and AQ-Y for children between 9 and 13 years of age. Alpha coefficients for the AQ-P and AQ-Y were .81 and .80, respectively, indicating good reliability (Adams et al, 2001). In this study, an adapted version of the AQ-Y was utilized so that younger children, aged 6 and older, could be tested. Questions were reworded with fewer answer options. Reliability of this younger version was .64 in this study.

Health Status

PFTs are the gold standard for measuring respiratory functioning and lung damage for patients with CF and asthma. For CF, FEV₁ % predicted is used as the primary indicator of health status, using the Knudson equations for age, sex, and weight (Knudson, Slatin, Lebowitz, & Burrows, 1976). Illness severity ratings are based on established cut-offs for mild (>70%), moderate (>40% and <69%), and severe (<39%) disease (Taussig, 1995) for CF. For asthma, severity is classified as mild intermittent, mild persistent, moderate persistent, and severe persistent. These classifications are not only based on lung function as measured by FEV₁ % predicted but also

on daytime and nighttime symptoms, as well as peak expiratory flow (PEF) variability. However, to compare children with asthma and CF, FEV₁ % predicted was utilized to calculate severity based on the following classification guidelines: mild intermittent or mild persistent (>80%), moderate (>60% and <80%), and severe (<60%) disease (National Institutes of Health: National Heart, Lung, and Blood Institute, 1997). PFTs were conducted at the clinic visit in the pulmonary function laboratory by a trained technician.

Statistical Analyses

Calculating Adherence Scores

For each adherence behavior, the number of treatments performed each day divided by the number of treatments prescribed was multiplied by 100 to determine percent adherence (e.g., % of prescribed inhaled medications taken each day). This procedure was used to calculate rates of adherence from the self-report, diary, and electronic measures. Rates of adherence were capped at 100% to decrease inflation for all medications, a method which has been used successfully in studies of children with asthma (Bender et al, 2000). It is important to note that rates of adherence could not be calculated for medications that were prescribed PRN (i.e., as needed).

A different procedure was utilized to calculate rates of adherence for the Advair discus. Because the Advair discus counter did not account for the number of devices utilized by families over the 3-month period, the technique described above was used in conjunction with pharmacy refill history data to determine how much medication was available. For example, if the counter indicated that 40 doses were available on the discus at the initial visit and 30 doses were available at the end of the study period, 90 days later, pharmacy refill data were checked to determine whether the family had acquired more Advair discuses during the 90-day time period.

Prescription refill data were calculated for each medication. Rates of adherence for a single medication taken continuously were calculated by dividing the supply obtained during a 3-month interval by the total number of days in that interval (90 days). For example, if 30 days of medication were obtained over a period of 90 days, the prescription refill rate was 33%. All medications obtained through pharmacies were recorded and included in the analyses.

Descriptive analyses, including the types of barriers endorsed and a rank ordering of the top three barriers, were examined. First, McNemar tests were conducted to examine differences in the endorsement of barriers across treatment components within each disease group.

Next, Fisher's exact tests were conducted to examine differences between the two disease groups regarding the presence of barriers (i.e., % endorsement of a barrier) for similar treatment components (e.g., MDIs, allergy medications, nebulizer treatment, and oral antibiotics). Student's *t* tests were conducted to examine group differences between the numbers of barriers identified. Pearson correlation coefficients were calculated between the different measures of adherence and number of barriers identified. Finally, Pearson correlation coefficients were calculated between disease-related knowledge and adherence. No significant relationships were found between disease severity and adherence and barriers ($p > .05$); thus, disease severity was not controlled in the analyses. Significance was identified as $p < .05$, and corrections for Type I error rates were not made owing to the exploratory nature of the study.

Results

Endorsement and Types of Barriers

Parents of children with CF and asthma were divided into two groups—those who endorsed one or more barriers and those who did not report any barriers. McNemar tests were conducted to examine differences in the endorsement of barriers by parents within each disease group. (Owing to small sample size, child comparisons were not conducted.) Only treatments that were prescribed for most children were utilized in these analyses (CF: enzymes, airway clearance, nutrition, and nebulized medications; asthma: inhaled corticosteroids, rescue inhalers, nebulized medications, and allergy medications). Seventy-seven percent of parents of children with CF endorsed barriers for enzymes, 92% for airway clearance, 69% for nutrition, and 73% for nebulized medications (e.g., dornase alpha, inhaled tobramycin, and albuterol). Fifty percent of children with CF endorsed barriers for enzymes, 75% for airway clearance, 44% for nutrition, and 75% for nebulized medications. Seventy-one percent of parents of children with asthma endorsed barriers for inhaled corticosteroids, 52% for bronchodilators, 46% for nebulized medications, and 41% for allergy medications. Sixty-seven percent of children with asthma endorsed barriers for inhaled corticosteroids, 50% for bronchodilators, 29% for nebulized medications, and 40% for allergy medications (e.g., nasal sprays, antihistamines, and decongestants).

For parents of children with CF, no significant differences were found in the endorsement of barriers for different treatment components. In contrast, parents of children with asthma endorsed a higher number of

barriers for inhaled corticosteroids compared to rescue inhalers ($p < .05$) and allergy medications ($p > .01$).

Next, a comparison of four treatments—inhaled corticosteroids, allergy medications, nebulizers to open airways, and rescue inhalers—common across the two disease conditions was made. First, Fisher's exact tests evaluated differences in the frequency of identified barriers per treatment component reported by parents for each group. Results indicated a significant difference between the frequencies of identified barriers for inhaled corticosteroids ($p < .01$). Parents of children with asthma were more likely to identify barriers to this treatment compared to parents of children with CF. Second, Student's *t* tests were conducted to examine differences in the number of barriers identified, with a significant difference being found only for inhaled corticosteroids [$t(42) = -2.9$; $p < .01$]. Parents of children with asthma reported three times as many barriers to inhaled corticosteroids as parents of children with CF. Additional analyses were conducted to examine whether marital status contributed to disease group differences in the number of barriers. The interaction term (marital status \times disease group status) was not significant for the four treatments examined, suggesting that single marital status does not account for the higher number of barriers that parents of children with asthma reported.

It was hypothesized that similar types of barriers would be identified across the two chronic conditions for similar treatments (e.g., inhaled corticosteroids, rescue inhalers, albuterol nebulizers, and oral antibiotics). The top three barriers across these two pulmonary conditions were rank ordered by frequency of parent and child endorsement. Although the rank ordering varied slightly, this hypothesis received considerable support, with similar barriers endorsed by parents and children in both groups (Table I). For example, "forgetting" was identified as the primary barrier by both groups for inhaled corticosteroid use. Children and parents also endorsed similar barriers, although the sample sizes were small. Finally, parents and children tended to agree with each other about these barriers. For example, parents and children with asthma reported oppositional behaviors as one of the most common types of barriers for inhaled corticosteroids.

In terms of disease-specific barriers, parents of children with CF identified oppositional behaviors, forgetting, and difficulties with time management as the most significant barriers to treatments such as airway clearance and enzymes (Table II). Although children endorsed similar barriers, they also identified several that were unique, such as difficulty swallowing pills and

Table I. Most Frequently Endorsed Barriers by Parents and Children for Similar Treatment Components

	Cystic fibrosis		Asthma	
	Parent	Child	Parent	Child
Inhaled corticosteroids	<i>n</i> = 13 Forgetting (15%) Dislikes taste (15%)	<i>n</i> = 7 All single responses	<i>n</i> = 31 Forgetting (55%) Taste (19%) Oppositional behaviors (19%)	<i>n</i> = 9 Forgetting (68%) Time management (22%) Oppositional behaviors (22%)
Nebulizer	<i>n</i> = 18 Oppositional behaviors (50%) Time management (17%)	<i>n</i> = 5 Oppositional behaviors (40%)	<i>n</i> = 24 Time management (25%) Oppositional behaviors (21%) Started feeling better (13%)	<i>n</i> = 7 All single responses
Oral antibiotics	<i>n</i> = 19 Forgetting (26%) Taste (16%) Oppositional behaviors (11%)	<i>n</i> = 8 Forgetting (25%) Swallowing (25%) Time management (25%)	<i>n</i> = 17 Forgetting (24%) Taste (24%) Side effects (12%)	<i>n</i> = 4 All single responses
Short term MDI	<i>n</i> = 19 Forgetting (21%) Side effects (21%) Oppositional behaviors (16%)	<i>n</i> = 11 Forgetting (27%) Taste (18%)	<i>n</i> = 29 Forgetting (25%) Time management (21%) Side effects (13%)	<i>n</i> = 12 Forgetting (42%) Taste (17%)

Note. Nebulizer refers to nebulized bronchodilators. All single responses indicate endorsement by only one individual for a barrier.

disliking the taste of inhaled tobramycin. For the asthma group, barriers were examined for allergy medications and leukotriene modifiers (Table II). In general, parents in the asthma group identified barriers that were similar to their children, with “forgetting” endorsed most frequently by both across treatments.

Barriers and Adherence

The relationship between number of barriers and rates of adherence was also examined. Although no statistically significant relationships were found, several trends were identified, defined as two separate methods of measurement supporting the hypothesized relationship. Moderate correlations suggested that a greater number of barriers for inhaled corticosteroids were associated with lower adherence across several measures (e.g., child self-report, pharmacy refill history, and electronic monitoring) (Table III). Similarly, moderate negative correlations were observed between barriers for pulmozyme and adherence (e.g., parent self-report, pharmacy refill history, and DPDs). In contrast, child self-reported adherence was positively

correlated with the number of barriers for airway clearance and enzymes.

Disease-Related Knowledge and Adherence

The relationship between disease-related knowledge and adherence was examined for both samples utilizing all methods of adherence measurement. Substantial gaps in knowledge were identified for children with CF and their parents. Children with CF answered 55% of items correctly, evidencing substantial gaps in knowledge. They understood that CF primarily affects the lungs (82%); however, they lacked knowledge about nutrition, including the importance of adding snacks and boosting calories, and approximately one-quarter (26%) were unaware that enzymes should be taken before a meal or snack. Parents of children with CF correctly answered 68% of items. They had a good understanding of the symptoms of CF (like coughing and stomach cramps); however, their knowledge of nutrition was incomplete. For example, a large percentage (92%) were unaware that fat has more calories than carbohydrates and proteins, and 19% of parents were unaware that children

Table II. Most Frequently Endorsed Barriers by Parents and Children for Disease-Specific Treatments

	Parent	Child
Cystic fibrosis		
Airway clearance	<i>n</i> = 37 Oppositional behaviors (60%) Time management (57%) Embarrassment (22%)	<i>n</i> = 16 Time management (50%) Oppositional behaviors (38%) Forgetting (25%)
Enzymes	<i>n</i> = 35 Forgetting (46%) Embarrassment (17%) Oppositional behaviors (11%)	<i>n</i> = 16 Forgetting (44%) Swallowing (13%)
Nutrition	<i>n</i> = 35 Eating/feeding issues (22%) Oppositional behaviors (23%) Taste (17%)	<i>n</i> = 18 Eating/feeding issues (22%) Forgetting (11%)
Pulmozyme	<i>n</i> = 18 Oppositional behaviors (39%) Time management (22%) Forgetting (11%)	<i>n</i> = 9 Forgetting (22%) Oppositional behaviors (22%)
Inhaled tobramycin	<i>n</i> = 16 Time management (31%) Oppositional behaviors (25%) Taste (19%)	<i>n</i> = 9 Taste (44%) Time management (33%) Forgetting (22%)
Asthma		
Allergy	<i>n</i> = 22 Forgetting (18%) Swallowing (14%)	<i>n</i> = 10 Forgetting (18%)
Leukotriene modifiers	<i>n</i> = 14 Forgetting (29%) Time management (14%)	<i>n</i> = 4 All single responses

Table III. Correlations Between Adherence and Number of Barriers

	Number of barriers reported by parents			
	Inhaled corticosteroids	Airway clearance	Enzymes	Pulmozyme
Adherence measures				
Parent self-report	0.28 (<i>n</i> = 41)	-0.09 (<i>n</i> = 36)	0.05 (<i>n</i> = 35)	-0.41 (<i>n</i> = 15)
Child self-report	-0.46 (<i>n</i> = 18)	0.32 (<i>n</i> = 18)	0.32 (<i>n</i> = 17)	-0.17 (<i>n</i> = 8)
Pharmacy refill history	-0.39 (<i>n</i> = 18)	—	0.09 (<i>n</i> =16)	-0.65 (<i>n</i> =9)
Diary data	0.13 (<i>n</i> = 34)	0.27 (<i>n</i> = 31)	-0.02 (<i>n</i> = 30)	-0.42 (<i>n</i> = 13)
Electronic monitoring	-0.45 (<i>n</i> = 12)	—	0.10 (<i>n</i> = 26)	—

Note. Owing to the small sample size for allergy medications and inhaled tobramycin, they were not included in analyses. Although no statistically significant relationships were found between adherence and barriers, several trends were identified, defined as two separate methods of measurement supporting a particular relationship.

with CF need 125–150% of the recommended daily allowance of calories.

Children with asthma answered 50% of the items correctly, suggesting significant gaps in their understanding

of asthma and its treatments. They appeared to understand why they should avoid cigarette smoke, dust, and strong perfumes (94%); however, approximately half did not know that asthma results in airway tightening or

that a bronchodilator should be carried at all times. Parents answered an average of 80.6% of the items correctly. Parents had a thorough understanding of asthma triggers; however, only 72% understood the need to carry a bronchodilator at all times. Interestingly, no significant relationships were found between child or parent knowledge and rates of adherence (CF: $r_s = -.34$ to $.43$; asthma: $r_s = -.34$ to $.21$). However, the sample sizes for these analyses were relatively small (max $n = 30$).

Patient–Provider Miscommunication

Discrepancies between the physician's PTP and parents' understanding of the prescription were also found across all medications for both patient groups. Note that these data do not address confusion regarding frequency or dosage of medications, but simply awareness that a particular treatment was prescribed. Physicians and parents of children with CF disagreed on 17% of the medications prescribed, with even less agreement, only 31%, reported by parents of children with asthma. These data indicated significant problems with patient–provider communication.

Regimen Complexity

Pearson correlation coefficients were calculated between the four adherence measures and the number of treatments prescribed. Results indicated a trend between the DPD and the number of prescribed treatments ($r = -0.24$, $p < .06$), with fewer treatments associated with better rates of adherence for both CF and asthma.

Discussion

A key objective of this study was to systematically assess barriers to adherence for children with CF or asthma and their parents. To date, no studies have examined parent- and child-reported barriers to adherence for individual components of the medical regimen. Across treatments, parents were most likely to identify barriers for the primary and most time-consuming treatments, in particular airway clearance for CF and inhaled corticosteroids for asthma. Parents in the CF group also identified significant barriers to taking enzymes, which are typically given five times a day. Parents of children with asthma were more likely to report barriers for inhaled corticosteroids than rescue inhalers and allergy medications, and they also identified significantly more barriers for this treatment than parents of children with CF. This may be attributable to the fact that inhaled corticosteroids are the primary daily treatment for children with asthma, highlighting the importance of examining barriers

within the context of each illness group. For example, the salience of inhaled corticosteroids is likely to be different for parents of children with CF and asthma. Children with CF are required to perform numerous treatments each day (e.g., airway clearance, boosting calories, taking enzymes, and nebulized medications), whereas inhaled corticosteroids are the major treatment component for children with asthma. This suggests that adherence interventions need to be both context (fitting medications into daily routines) and disease specific, with a focus on increasing the salience of treatments that are most important for long-term health.

Common barriers for parents in both groups included forgetting, oppositional behaviors, difficulties with time management, and side effects. Children with CF also identified difficulty swallowing pills as a key barrier to oral medications (like oral antibiotics and enzymes) and disliked the taste of particular medications. Although the frequency and types of barriers differed between parents of children with CF and asthma, this study clearly indicated that parents can identify barriers for the treatments they perceive to be important and potentially more stressful.

For other treatment components (e.g., nebulizers and rescue inhalers), approximately half of the parents were unable to identify any barriers. Given the poor adherence documented for these two populations, parents are surprisingly unaware of what is getting in the way. There are several possible reasons for this. First, physicians do not routinely ask patients about adherence behaviors, partly because of time constraints and partly because of their discomfort in dealing with these issues. Second, parents may be unaware of activities during the day that interfere with completing treatment regimens and thus may not anticipate the optimal ordering of tasks to accommodate treatments, especially when less typical events arise (like birthday party and soccer games). Third, parents need to be sensitized to the common barriers they face in fitting these treatments in, with practical suggestions for overcoming them. Intervention efforts should focus on helping families identify key barriers, followed by problem-solving strategies to reduce them; such intervention efforts are now being evaluated (Johnson & Quittner, 2001). Several of the commonly identified barriers in this study, including oppositional behaviors and difficulty swallowing pills, can easily be targeted with behaviorally based interventions (DeLambo, Ievers-Landis, Drotar, & Quittner, 2004; Stark et al, 2003).

In terms of the association between number of barriers and adherence, although no statistically significant

relationships were found, the strength of several of these relationships was notable. For example, a greater number of barriers were moderately related to poorer adherence recorded by electronic monitors. In contrast, positive relationships were found between barriers and child-reported adherence to enzymes and airway clearance, which may be because of differences in respondents (e.g., parent-reported barriers and child self-reported adherence). In addition, some of these analyses were constrained by a lack of power to detect significant relations. Future studies need to examine this important relationship with larger samples.

No significant relationship was found between disease-specific knowledge and adherence. These results are consistent with studies conducted by McQuaid and colleagues (2003), which indicated a weak relationship between knowledge and adherence for both children with asthma and their parents. To date, this is the first study to examine this important relationship for patients with CF. Despite these findings, most intervention studies for children with asthma have focused on providing education to children with asthma and their parents (da Costa, Rapoff, Lemanek, & Goldstein, 1997; LeBaron, Zeltzer, Ratner, & Kniker, 1985), and similar approaches have been used in CF (Goldbeck & Babka, 2001). These data suggest that intervention efforts should focus not only on education but also on individualized barriers identified by children and their parents. Empirically supported strategies that incorporate skills training (e.g., nebulizer or MDI use) as well as problem solving (DeLambo et al, 2004; Wysocki et al, 2000) might prove to be more effective than education alone.

Another barrier to adherence for patients with CF and asthma is patient-provider communication. A significant discrepancy was found between what physicians prescribed and what parents understood. Several reasons may account for this discrepancy: (a) confusion about current versus past prescriptions, (b) prescription of new treatments that have not been adequately described, and (c) parents' modification of long-term prescriptions. Despite the complexities of these medical regimens and frequent changes to prescriptions, no written PTPs were provided to parents or patients. This may be a central cause of patient-provider miscommunication and could be addressed fairly simply by providing patients with a simple, user-friendly written treatment plan (Quittner et al., 2000). In our current intervention trial, copies are provided to both parents and physicians to enhance their communication.

Although this study represents an innovative method for examining barriers to effective disease management for children with CF and asthma, several limitations

should be noted. Prescribed treatment regimens for these populations change frequently, making it difficult to measure both rates of adherence and barriers over time. We also encountered difficulties in determining what physicians had prescribed before enrollment in the study based on medical charts, which were often incomplete. Without a clear prescription, it is impossible to calculate accurate rates of adherence for these patients. The study was also limited by small sample sizes and missing data, which was compounded by different regimens for each child. This led to unequal samples for different medications and measurement methods.

The measures themselves also have limitations. For example, it was difficult to obtain pharmacy refill data because of the use of multiple pharmacies, dispensing of free samples, and an increasing use of online pharmacies. Although electronic monitors are often viewed as the "gold" standard, in this study, 77% of MDILogS failed, did not fit properly, or were lost. Furthermore, electronic monitors were not available for all components of the treatment regimen (e.g., airway clearance). As a result, there were limited objective data on rates of adherence for inhaled corticosteroids. These problems reduced our sample sizes and resulted in an emphasis on descriptive rather than inferential statistics.

Finally, our sample had a restricted range of disease severity, with approximately three-quarters of the sample in the mildly ill range. Comparisons of disease severity in the CF and asthma groups were also limited by the use of FEV₁ % predicted. Future studies should examine disease severity based on the complete National Heart, Lung, and Blood Institute (1997) guidelines for asthma, which include PEF variability and nighttime and daytime symptoms. It is also possible that patients with more severe disease have different adherence rates and barriers compared to patients with milder disease. Thus, examining these relationships in an older sample with a greater variability in disease severity will be important.

Future Directions

Adherence research is in its infancy and has focused to a large extent on measurement issues (see Quittner et al., 2000 and Riekert & Rand, 2002 for recent reviews). However, a more important question concerns the processes that contribute to poor adherence based on the patient's and parent's own perspective. Given the negative trend between the number of prescribed treatments and adherence reported on the daily diary, one suggestion is that physicians may want to prioritize the number of treatments prescribed each day in a negotiated contract with the family.

An important next step is to assess barriers and rates of adherence for individuals with CF and asthma across different developmental stages. This study focused on school-age children; however, few studies have examined these issues in younger children (ages 6 and younger) and adolescents. Assessing barriers to adherence for adolescents may be particularly beneficial because they typically have the poorest adherence across the life span (Rapoff, 1999). Adolescents may be better able to articulate barriers to disease management than the younger children in this study, who identified fewer barriers than their parents, and these barriers may be unique to this developmental period (e.g., wanting to be “normal,” adolescent rebellion and time management because of homework/school activities). Results of this study indicated that interventions to improve adherence should focus on barriers identified by individual patients, within the context of their own illness. This highlights the need for disease-specific tools that are developmentally appropriate for the patient. For example, if oppositional behaviors are identified as a primary barrier for a teen with CF, interventions should utilize behavioral and communication strategies, including positive reinforcement, contracting, and contingency management. Interventions will also have to be multifaceted, including education, skills training, provision of written treatment plans to improve patient–provider communication, and pragmatic solutions aimed at the barriers that are so commonly faced by children with these medical conditions and their families.

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References

- Adams, C. D., Brestan, E. V., Ruggiero, K. J., Hogan, M. B., Wilson, N. W., Shigaki, C. L., & Sherman, J. M. (2001). Asthma questionnaire: Psychometric

properties and clinical utility in pediatric asthma. *Children's Health Care, 30*, 253–270.

- Anthony, H., Paxon, S., Bines, J., & Phelan, P. (1999). Psychosocial predictors of adherence of nutritional recommendations and growth outcomes in children with cystic fibrosis. *Journal of Psychosomatic Research, 47*, 623–634.
- Bauman, L. J., Wright, E., Leickly, F. E., Crain, E., Kruszon-Moran, D., Wade, S. L., & Visness, C. M. (2002). Relationship of adherence to pediatric asthma morbidity among inner-city children. *Pediatrics, 110*, e6.
- Becker, M. H., Drachman, R. H., & Kirscht, J. P. (1972). Predicting mother's compliance with pediatric medical regimens. *Journal of Pediatrics, 81*, 843–854.
- Bender, B., Wamboldt, F. S., O'Conner, S. L., Rand, C., Szeffler, S., Milgrom, H., & Wamboldt, M. Z. (2000). Measurement of children's asthma medication adherence by self-report, mother report, canister weight, and Doser CT. *Annals of Allergy, Asthma & Immunology, 85*, 416–421.
- Berg, J. S., Dischler, J., Wagner, D. J., Raia, J., & Palmer-Shevlin, N. (1993). Medication compliance: a health care problem. *Annals of Pharmacotherapy, 27*(Suppl.), 2–21.
- Brown, S. J. (1999). Patient-centered communication. *Annual Review of Nursing Research, 17*, 85–104.
- da Costa, I. G., Rapoff, M. A., Lemanek, K., & Goldstein, G. L. (1997). Improving adherence to medication regimens for children with asthma and its effect on clinical outcome. *Journal of Applied Behavior Analysis, 30*, 687–691.
- DeLambo, K. E., Ievers-Landis, C. E., Drotar, D., & Quittner, A. L. (2004). Association of observed family relationship quality and problem-solving skills with treatment adherence in older children and adolescents with cystic fibrosis. *Journal of Pediatric Psychology, 29*, 343–353.
- Donnelly, J. E., Donnelly, W. J., & Thong, Y. H. (1987). Parental perceptions and attitudes toward asthma and its treatment: a controlled study. *Social Sciences and Medicine, 24*, 431–437.
- Farber, H. J., Capra, A. M., Finkelstein, J. A., Lozano, P., Quesenberry, C. P., Jensvold, N. G., Chi, F. W., & Lieu, T. A. (2003). Misunderstanding of asthma controller medications: Association with nonadherence. *Journal of Asthma, 40*, 17–25.
- Goldbeck, L., & Babka, C. (2001). Development and evaluation of a multi-family psychoeducational program for cystic fibrosis. *Patient Education and Counseling, 44*, 187–192.

- Gudas, L. J., Koocher, G. P., & Wypig, D. (1991). Perceptions of medical compliance in children and adolescents with cystic fibrosis. *Journal of Developmental and Behavioral Pediatrics, 12*, 236–242.
- Heffer, R. W., Worchel-Prevatt, F., Rae, W. A., Lopez, M. A., Young-Saleme, T., Orr, K., Aikman, G., Krause, M., & Wier, M. (1997). The effects of oral versus written instructions on parents' recall and satisfaction after pediatric appointments. *Journal of Developmental and Behavioral Pediatrics, 18*, 377–382.
- Henley, L. D., & Hill, I. D. (1990). Global and specific disease-related information needs of cystic fibrosis patients and their families. *Pediatrics, 85*, 1015–1021.
- Ievers, C. E., Brown, R. T., Drotar, D., Caplan, D., Pishavar, B., & Lambert, R. G. (1999). Knowledge of physician prescriptions and adherence to treatment among children with cystic fibrosis and their mothers. *Journal of Developmental and Behavioral Pediatrics, 2*, 335–343.
- Johnson, S. B., & Quittner, A. L. (2001). Clinic-based adherence intervention for diabetes and cystic fibrosis. HL69736.
- Kelloway, J. S., Wyatt, R. A., & Adlis, S. A. (1994). Comparison of patients' compliance with prescribed oral and inhaled asthma medications. *Archives of Internal Medicine, 154*, 1349–1352.
- Knudson, R. J., Slatin, R. C., Lebowitz, M. D., & Burrows, B. (1976). The maximal expiratory flow-volume curve. *American Review of Respiratory Disease, 113*, 587–600.
- LaGreca, A. M., & Bearman, K. J. (2003). Adherence to prescribed medical regimens. In M. C. Roberts (Ed.), *Handbook of pediatric psychology* (3rd ed., pp. 119–140). New York: Guilford.
- LeBaron, S., Zeltzer, L. K., Ratner, P., & Kniker, W. T. (1985). A controlled study of education for improving compliance with cromolyn sodium (Intal®): The importance of physician-patient communication. *Annals of Allergy, 55*, 811–818.
- Logan, D., Zelikovsky, N., Labay, L., & Spergel, J. (2003). The illness management survey. *Journal of Pediatric Psychology, 28*, 383–392.
- Mansour, M. E., Lanphear, B. P., & DeWitt, T. G. (2000). Barriers to asthma care in urban children: Parent perspectives. *Pediatrics, 106*, 512–519.
- McQuaid, E. L., Kopel, S. J., Klein, R. B., & Fritz, G. K. (2003). Medication adherence in pediatric asthma: Reasoning, responsibility, and behavior. *Journal of Pediatric Psychology, 28*, 3232–3333.
- Modi, A. C. (2002). Adherence in children with cystic fibrosis and asthma. F31-HS11768–01.
- Modi, A. C., & Quittner, A. L. (in press). Utilizing computerized phone diary procedures to assess health behaviors in family and social contexts. *Children's Health Care*.
- Naspitz, C. K., & Tinkelman, D. G. (2001). Barriers to measuring and achieving optimal outcomes in pediatric asthma. *Journal of Allergy and Clinical Immunology, 107*, S482–S484.
- National Institutes of Health: National Heart, Lung, and Blood Institute (1997). National Asthma Education and Prevention Program Expert Panel Report 2: Guidelines for the Diagnosis and Management of Asthma (NIH Publication No. 97-4051).
- Passero, M. A., Remor, B., & Solomon, J. (1981). Patient-reported compliance with cystic fibrosis therapy. *Clinical Pediatrics, 20*, 264–268.
- Quittner, A. L., Drotar, D., Ievers-Landis, C., Seidner, D., Slocum, N., & Jacobsen, J. (2000). Adherence to medical treatments in adolescents with cystic fibrosis: The development and evaluation of family-based interventions. In D. Drotar (Ed.), *Promoting adherence to medical treatment in childhood chronic illness: Interventions and methods*. Hillsdale, NJ: Erlbaum Associates.
- Quittner, A. L., & Espelage, D. L. (1999, August). Assessing complex family interactions using the daily phone diary. In A. L. Quittner (Chair), *Strengthening self-report: Diary methods for measuring child and family processes*. Symposium conducted at the Annual Meeting of the American Psychological Association, Boston, MA.
- Quittner, A. L., Espelage, D. L., Ievers-Landis, C., & Drotar, D. (2000). Measuring adherence to medical treatments in childhood chronic illness: Considering multiple methods and sources of information. *Journal of Clinical and Psychology in Medical Settings, 7*, 41–54.
- Quittner, A. L., & Opiari, L. C. (1994). Differential treatment of siblings: Interviews and diary analyses comparing two family contexts. *Child Development, 65*, 800–814.
- Quittner, A. L., Opiari, L. C., Regoli, M. J., Jacobsen, J., & Eigen, H. (1992). The impact of caregiving and role strain on family life: Comparisons between mothers of children with cystic fibrosis and matched controls. *Rehabilitation Psychology, 37*, 289–304.
- Rapoff, M. A. (1999). *Adherence to pediatric medical regimens*. New York, NY: Kluwer Academic/Plenum Publishers.
- Riekert, K. A., & Rand, C. S. (2002). Electronic monitoring of medication adherence: When is

- high-tech best? *Journal of Clinical Psychology in Medical Settings*, 9, 25–34.
- Stark, L. J., Jelalian, E., & Miller, D. L. (1995). Cystic fibrosis. In M. C. Roberts (Ed.), *Handbook of pediatric psychology* (2nd ed., pp. 241–262). New York, NY: The Guilford Press.
- Stark, L. J., Opiari, L. C., Spieth, L. E., Jelalian, E., Quittner, A. L., Higgins, L., Mackner, L., Byars, K., Lapey, A., Stallings, V., & Duggan, C. (2003). Contribution of behavior therapy to dietary treatment in cystic fibrosis: a randomized controlled study within 2-year follow-up. *Behavior Therapy*, 34, 237–258.
- Stephens, M. A., Norris-Baker, C., & Willems, E. P. (1983). Patient behavior monitoring through self-reports. *Archives of Physical Medicine and Rehabilitation*, 64, 167–171.
- Taussig, L. M. (1995). Advances in cystic fibrosis: Bring the bench to the bedside. *European Journal of Pediatrics*, 154(Suppl. 4), S9–S10.
- Walders, N., Kopel, S. J., Koinis-Mitchell, D., & McQuaid, E. (2005). Patterns of quick-relief and long-term controller medication use in pediatric asthma. *Journal of Pediatrics*, 146, 177–182.
- Warwick, W. J., & Hansen, L. G. (1991). The long-term effect of high-frequency chest compression therapy on pulmonary complications of cystic fibrosis. *Pediatric Pulmonology*, 11, 265–271.
- Weiss, K., Gergen, P., & Hodgson, T. (1992). An economic evaluation of asthma in the United States. *The New England Journal of Medicine*, 326, 862–868.
- Wysocki, T., Harris, M. A., Greco, P., Bubb, J., Danda, C. E., Harvey, L. M., McDonnell, K., Taylor, A., & White, N. H. (2000). Randomized, controlled trial of behavior therapy for families of adolescents with insulin-dependent diabetes mellitus. *Journal of Pediatric Psychology*, 25, 23–33.