Identifying Barriers to Treatment Adherence and Related Attitudinal Patterns in Adolescents With Cystic Fibrosis

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Summary. Introduction: The treatment of cystic fibrosis (CF) is directed toward correction of organ dysfunction and relief of symptoms resulting from the disease. Lack of adherence to daily treatment regimens may have substantial short-term and long-term effects on patients with CF. In this study, we attempted to identify barriers to treatment adherence which could be predicted by objective measures and explore ways to improve adherence in adolescents with CF. Methods: A questionnaire was given to patients 12.0–20.9 years of age, designed with focus on specific barriers to adhering to treatment plan and related attitudinal patterns. Observational and analytical results were collected. Results: We obtained questionnaires and objective health data for 60 respondents. The most commonly identified barriers to adherence were forgetting or losing medications (32/60) and being too busy (23/60). Attitudinal patterns that played a significant role for nonadherence included unintentional forgetting (40/60), feeling that following CF treatments resulted in less freedom in their lives (30/60), and believing it is acceptable to miss a treatment every few days (18/60) or to miss treatments when busy (18/60). Discussion: There were a few statistically significant differences of adherence patterns between demographic subgroups in our study. Males were more likely to agree that it is acceptable to miss doses if they are made up with extra doses later (24% vs. 3%, $P = 0.04$). Patients who perceived themselves to be less healthy agreed more to statements of limited freedom, nonsympathetic medical providers, and difficulty adhering during times of decreased symptoms. This highlights an unexpected risk: as CF progresses and patients perceive themselves to be less healthy, they may become less likely to be adherent during the periods they are feeling the best, while at the same time becoming less likely to perceive empathy from their physicians. Conclusions: Survey results describe a variety of beliefs and attitudinal patterns which contribute to nonadherence in CF treatment, especially relating to time management. While patients largely understood the importance of treatments to their health, predictors of risky behaviors could lead to targeted interventions by CF centers to address these challenges and improve adherence. **Pediatr Pulmonol. 2010; 45:450–458.** © 2010 Wiley-Liss, Inc.

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INTRODUCTION

The management of cystic fibrosis (CF) in patients of all ages is directed toward treatment of organ dysfunction and relieving symptoms resulting from the disease. Earlier diagnosis by newborn screening, advances in the treatment of the disease, and improved quality of care have all led to a steady increase in median predicted survival age, now standing at 37.4 years by 2007 data.[1,2] Pulmonary disease, however, remains the most common cause of

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morbidity and mortality, with patients suffering recurrent exacerbations and progressive deterioration of their lung function.[3,4] Daily CF treatment typically includes inhaled and oral respiratory medication, physiotherapy, exercise, and oral pancreatic enzyme and multivitamin supplements for treatment of pancreatic insufficiency and fat malabsorption.[5] The number of medications and therapies required to treat CF increases as disease severity progresses.[6,7] The lack of adherence to daily treatment regimens has been demonstrated to have substantial impact on the health of patients with CF.[8,9]

Due to the increasingly observed connection to morbidity and mortality, adherence to treatment recommendations has been an increasing focus for physicians and other CF healthcare providers.[10–13] Poor adherence to medication regimens in patients with life-threatening chronic disease is a common problem, and for decades there have been published studies reviewing and summarizing this issue.[10] The mean adherence rate for long-term preventative regimens has been calculated to be 57%, with a range of 33–94%, and for long-term treatment regimens the mean was 54%, with a range of 41–61%, with more recent work supporting these findings for CF.[11] One contributor to nonadherence is that physician treatment recommendations may be poorly understood by parents, children, or adolescents.[10,14] In addition, parents, children, and physicians all may have different understandings of severity of illness and necessity of certain treatments, which is likely to intensify adherence problems.[12,13]

Research on adherence to the medical regimen in CF patients has often relied on subjective measures, including the use of interviews and/or questionnaires,[10–12] with some recent studies focusing more on objective measures. An assessment of the rates of adherence in children with CF aged 6–13 years using four different measurement methods was recently performed.[15] Adherence measures included parent and child self-reports, diary data, pharmacy refill history, and electronic monitors. Results suggested that rates of adherence varied by treatment component and across measurement methods. However, when examining more objective measures, rates of overall adherence were below 50% for children with CF, indicating generally poor adherence to treatment regimen. We previously studied adherence objectively in 44 patients with CF.[16] Children less than 12 years of age (Group 1) and adolescents 12 years of age and older (Group 2) were recruited. Adherence to ADEKs, an oral multivitamin, was monitored using the Medication Event Monitoring System (MEMS) Smart Caps (APREX, AARDx, Inc., Union City, CA). Dornase alfa, a nebulized mucolytic medication, was monitored by counting empty vials. The overall mean adherence rates for ADEKs and dornase alfa were ($\pm$SD) $63.6 \pm 24.0\%$ and $66.5 \pm 31.2\%$, respectively. The median ADEKs and dornase alfa

adherence rate for Group 1 was 84.6% and 79.1%, respectively ($P = 0.08$); and for Group 2 was 56.7% and 85.4%, respectively ($P = 0.07$). Due to these differences in adherence between the age groups in regard to each medication, we concluded that parental supervision and disease severity are likely to play a major role in adherence to medical management. Partnership with patients and families about the treatment plan could be important for improving adherence rates.[16]

Barriers to treatment adherence for children aged 6–13 years with CF and asthma were also studied.[17] Results indicated that barriers were quite similar by illness and by informant (e.g., parent or 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 having a greater number of barriers was related to poorer adherence.[17]

In this study, we are interested in identifying barriers to treatment adherence and attitudinal patterns in adolescents with CF, and thus exploring ways to improve adherence. As seen from our previous study, adolescents are likely to have different adherence rates than younger children to various medications.[16] As that study showed adherence rate differences across age categories, we hypothesize that the barriers to adherence could also vary by age. We have therefore tried to evaluate if adolescents present with unique barriers to adherence compared with other patients with CF. We also hypothesize that within adolescent and young adult patients, objective characteristics (sex, age, disease severity) could predict which barriers are most likely playing a role in individual nonadherence. Since health perceptions have been found to play a role in adherence for adolescents,[13] we additionally studied subjective self-categorization of health against barriers to adherence.

MATERIALS AND METHODS

Participants

Study participants included 60 adolescents and young adults recruited from the University of Michigan Cystic Fibrosis Center. Eligibility criteria included: (a) age between 12.0 and 20.9 years, and (b) CF diagnosed by sweat chloride ≥ 60 meq/L or two disease-causing mutations. The patient population meeting these criteria included 101 patients. Given the age range and the time frame of data collection (2007–2008), participants included both individuals born in the late 1980s and those born in the early to mid-1990s, when expectations of care and longevity were notably different. The study was approved by an Institutional Review Board at the University of Michigan.

Questionnaire

A questionnaire was designed by a post-graduate fellow in the Institute for Social Research at the University of Michigan. It was created to identify barriers for adolescents with CF in adhering to their treatment plans. There were four main sections to the questionnaire, and a total of 98 questions (including subquestions) were present. The first section addressed the patient's self-perception regarding physical health, disease severity, and level of daily functioning. The second section included multiple questions for several specific CF therapies to clearly identify which treatments an individual respondent was presently using. The third section listed 10 different attitudinal patterns of nonadherence; the respondent would select from a 5-point Likert scale of "Strongly agree" to "Strongly disagree" for each assertion. The final section allowed the participant to identify answers from lists of most prominent barriers, specific treatments likely to be missed, and family members influential to adherence. There was space for written feedback at the end of the questionnaire to elaborate further on the answers provided.

No scoring system or summary equations were used to interpret the data; individual questions were analyzed separately. The questionnaire developed for this study adapted several questions which have demonstrated reliability and validity in previous studies, including the Disease Management Interview-CF (DMI-CF),[12,17] the Barriers to Adherence Interview-CF,[17] the National Health Interview Survey (NHIS)[18] and the Adherence Attitude Inventory (AAI).[19] As each section was assessing different constructs, no factor analysis was performed specifically for our questionnaire. Instrument reliability and internal consistency were demonstrated through statistical agreement between subjective and objective health measures (see the Results Section), and psychometric properties of the source inventories are reasoned to be maintained in our questionnaire.

Procedure

Patients were asked to complete the questionnaire either during a routine clinic visit, hospitalization, or via mail. After obtaining informed consent, the patients were allowed time to complete the questionnaire. Participants were reassured that their responses would be confidential and not shared with the healthcare team. If a patient could not complete the questionnaire during the clinic visit, they were permitted to take it home and mail it back when finished. The questionnaire was completed only once per patient. Four of these 60 responses could not be used in the analysis due to inadequate obtainment of consent or assent, or due to incomplete questionnaires.

Thirty patients who were not recruited during clinic visits or hospitalization were mailed the consent, assent,

questionnaire, and a letter explaining the study. Four of these patients mailed back the completed consent, assent, and questionnaire.

Other Measures

Patient age, sex, weight, height, body mass index (BMI), BMI percentile, and pulmonary function testing results were captured for all respondents to evaluate demographics and disease severity. These data were obtained from the clinic visit or hospitalization closest to the date that the patient completed the questionnaire. The same data were also collected for the 41 patients who did not participate in the study. The data for participating and nonparticipating patients were compared to assure that there were no significant differences between the two groups.

Analysis Methods

For the patients who did participate, the results of the questionnaire were combined with objective measures of disease severity. Subgroup analysis was performed based on sex, age categories, and health—both objective measures and self-perception. Initial data analysis, including the primary summary and analysis of survey responses, was performed using descriptive statistics. Confidence intervals for specific survey responses were calculated using the normal approximation method. Responses to questions employing a Likert-type scale of possible answers were evaluated as both categorical and continuous responses (i.e., 1–5 vs. Poor–Excellent). Comparisons of survey responses between specific subgroups of interest were performed using the chi-squared distribution or Fisher's exact test for categorical variables and Student's t-test for continuous variables. All statistical tests were performed using SAS for Windows 9.2 (Cary, NC). All summary data are presented as mean ($\pm$standard deviation), median (range), or number (%) as appropriate. P-values ≤ 0.05 were considered statistically significant.

RESULTS

Participant Characteristics

Study participants included 60 patients. Descriptive information for the study population and the male/female subgroups are summarized in Table 1. The mean age of participants was 16.3 years and 58% were females. Descriptive data for survey participants and the non-participants (41 patients) were compared. Statistical tests revealed no significant differences in sex distribution, age, BMI, $FEV_1\%$, $FEF_{25-75\%}$, and genotype results between respondents and nonrespondents (Table 1).

No significant difference was found between the male and female participant subgroups for average age, BMI,

TABLE 1—Descriptive Information of Respondents Versus Nonrespondents, and Male Versus Female Respondents[1]

	Respondents	Male	Female	P-value	Nonrespondents	P-value
N	60	25	35		41	
Age (years)	16.3 ± 2.1	16.4 ± 1.8	16.2 ± 2.2	0.688	16.7 ± 2.3	0.361
Age <16 years	27 (45.0%)	10 (40.0%)	17 (48.6%)	0.602	18 (43.9%)	0.973
BMI	20.9 ± 3.5	20.4 ± 3.3	21.3 ± 3.6	0.297	20.3 ± 3.0	0.323
BMI%	47.8 ± 32.0	40.8 ± 33.6	52.8 ± 30.2	0.160	41.5 ± 28.3	0.304
$FEV_1\%$	80.6 ± 24.5	79.9 ± 25.9	81.2 ± 23.9	0.845	78.4 ± 25.9	0.663
$FEF_{25-75\%}$	69.4 ± 36.9	63.8 ± 35.5	73.4 ± 37.8	0.323	50.7 ± 35.4	0.307
Known genetic mutations	41 (68.3%)	17 (68.0%)	24 (68.6%)	1.000	32 (78.0%)	0.538
ΔF508 homozygous[2]	20 (48.8%)	7 (41.2%)	13 (54.2%)	0.396[3]	16 (50.0%)	0.718[3]
ΔF508 heterozygous[2]	13 (31.7%)	5 (29.4%)	8 (33.3%)	—	11 (34.4%)	—
Other mutations[2]	8 (19.5%)	5 (29.4%)	3 (12.5%)	—	5 (15.6%)	—

[1]All data presented as mean ± standard deviation or as number (%), as appropriate.
[2]Percentage of those with known mutation status.
[3]Comparison of ΔF508 genotypes.

$FEV_1\%$, and $FEF_{25-75\%}$. In addition, there were no statistically significant differences in the number of CF respiratory therapies between males and females. Subgroups were created to compare younger (12.0–15.9 years, n = 27) and older (16.0–20.9 years, n = 33) participants. There was a similar sex distribution in the age categories (younger group is 63% female; older group is 55% female, P = 0.511).

As would be expected, there were notable differences in health status based on age category. While the younger patients had an average $FEV_1\%$ of 92 with 67% of them self-reporting better health (see next paragraph), the older patients' average $FEV_1\%$ was 71 ($P \leq 0.001$) with only 45% reporting to have better health (P = 0.100).

Self-reported health was based on a survey question: "In general, would you say your health is excellent, very good, good, fair, or poor?" Those who were considered to be self-reporting comparatively better health answered "excellent" or "very good" (n = 33). These patients tended to be younger and objectively more healthy (i.e.,

greater $FEV_1\%$) than patients who rated their health as only "good," "fair," or "poor" (Table 2).

Objective health categories were compared using a cutoff of $FEV_1\%$ of 70. Those above this threshold (n = 43) also had significantly lower age (15.8 years vs. 17.6 years, P = 0.001) and higher BMI (21.6 vs. 19.2, P = 0.008) than patients at or below $FEV_1\%$ of 70 (Table 2). These results were comparable to the subjective self-perception of health reported by the patients.

Specific Treatments

Participants self-reported their respiratory treatments. In addition, they were asked which treatments were acceptable to occasionally miss, with no limit to the number of treatments that could be chosen (Fig. 1). Results are reported only for actual current users of the treatment type, thus creating a different denominator for each treatment. Airway clearance techniques were the most likely to be listed as acceptable to occasionally miss

TABLE 2—Descriptive Information for Health Subgroups Based on Subjective and Objective Measurements[1]

	Subjectively more healthy	Subjectively less healthy	P-value	Higher $FEV_1\%$	Lower $FEV_1\%$	P-value
N	33	27		43	17	
Age (years)	15.5 ± 1.9	17.2 ± 1.9	0.002	15.8 ± 2.0	17.6 ± 1.7	0.001
Age <16 years	18 (54.5%)	9 (33.3%)	0.123	24 (55.8%)	3 (17.7%)	0.010
BMI	20.9 ± 3.3	21.0 ± 3.8	0.927	21.6 ± 3.5	19.2 ± 2.9	0.008
BMI%	51.9 ± 31.8	42.7 ± 32.1	0.273	57.3 ± 28.0	23.8 ± 29.3	<0.001
$FEV_1\%$	89.7 ± 21.4	69.6 ± 23.9	0.001	93.9 ± 12.2	47.1 ± 12.3	<0.001
$FEF_{25-75\%}$	84.8 ± 34.0	50.6 ± 31.6	<0.001	88.7 ± 23.2	20.6 ± 8.4	<0.001
Known genetic mutations	26 (78.8%)	15 (55.6%)	0.093	32 (74.4%)	9 (52.9%)	0.131
ΔF508 homozygous[2]	13 (50.0%)	7 (46.7%)	0.186[3]	17 (53.1%)	3 (33.3%)	0.427[3]
ΔF508 heterozygous[2]	10 (38.5%)	3 (20.0%)	—	10 (31.3%)	3 (33.3%)	—
Other genotype[2]	3 (11.5%)	5 (33.3%)	—	5 (15.6%)	3 (33.3%)	—

[1]All data presented as mean ± standard deviation or as number (%), as appropriate.
[2]Percentage of those with known mutation status.
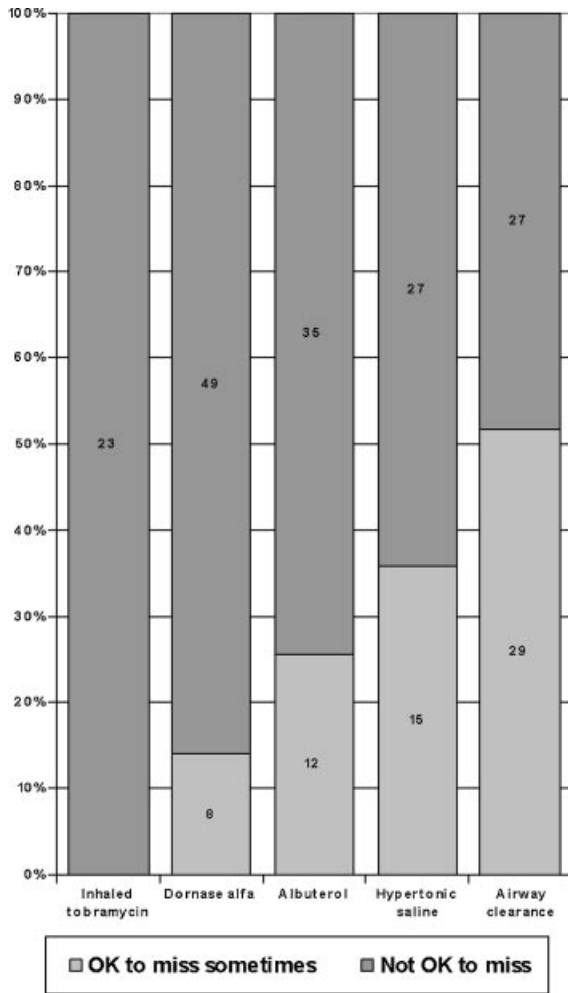[3]Comparison of ΔF508 genotypes.

Fig. 1. Perceived acceptability of missing specific treatments (as a percent of respondents who are currently using each therapy; numbers on the columns represent actual number of patients).

(52% of users), while other treatments were listed by 14–36% of their users. The exception was inhaled tobramycin, which was not listed by any of the 23 users as acceptable to miss. Questionnaire results also demonstrated that 32/60 respondents (53%) were current users of inhaled corticosteroids; however, information could not be accurately gathered about nonadherence acceptability for this treatment due to details of survey design.

Specific Barriers

A list of 14 barriers to treatment adherence was presented to participants. They were asked to choose two answers that represented their greatest personal barriers. While a single patient chose more than two answers (which were excluded from analysis) and a minority of participants chose no answers or only one answer, the majority chose two responses, resulting in 100 total answers (Fig. 2). By far, the most selected responses were

issues of time management: forgetting treatments, being too busy, and having too many treatments to manage. When responses were compared between subgroups (by sex, age, subjective health, or $FEV_1\%$ values), no significant differences were seen. There was some non-significant age stratification; for instance, while the older subgroup (which also had less optimal health) was more likely to identify busyness as a barrier to adherence (45% vs. 26%), the younger subgroup was more likely to identify a desire to be normal as a barrier (19% vs. 6%).

Attitudinal Patterns

Our questionnaire included 10 statements of attitudinal patterns, each of which could be associated with poor adherence, and asked participants to rate their agreement with the statements on a 5-point Likert scale (Table 3). The statements covered a variety of attitudes about CF treatments, but all can be generally considered to be less desirable attitudes than their converse statements. Analysis centered on total numbers of respondents who expressed agreement with the statement (choosing "Strongly Agree" or "Somewhat Agree"), as well as comparison of agreement levels between subgroups.

Most statements had a low percentage of total respondents who expressed agreement. Only three statements received higher than 30% agreement: "Even though I want to follow my treatments, sometimes I just forget" (67%); "Having to follow the treatments for cystic fibrosis means I have less freedom in my life" (50%); and "I have trouble sticking to my treatments when I have no physical symptoms" (42%). Comparing the younger patients (age 12.0–15.9 years) to the older patients (age 16.0–20.9 years), there were no significant differences in agreement level for any of these questions using this binomial approach. In comparing males and females, only one statement showed a significant difference in agreement: "It is OK to miss a treatment as long as I make up for it with an extra dose the next time" had agreement from 24% of males and only 3% of females ($P = 0.017$).

Comparison of attitudinal patterns was made between subgroups based on health status, using two separate measures. First, our objective measure showed no significant difference in agreement to any of the statements between those with $FEV_1\%$ greater than 70 versus those with lower values. However, the subjectively healthier group had significant differences on level of agreement with three of the statements compared to the self-described less healthy group: "My primary team does not fully understand how difficult it is for me to follow the treatments when I am supposed to" (6% vs. 33%; $P = 0.009$); "Having to follow the treatments for cystic fibrosis means I have less freedom in my life" (30% vs. 74%; $P = 0.002$); and "I have trouble sticking to my treatments when I have no physical symptoms" (24% vs.
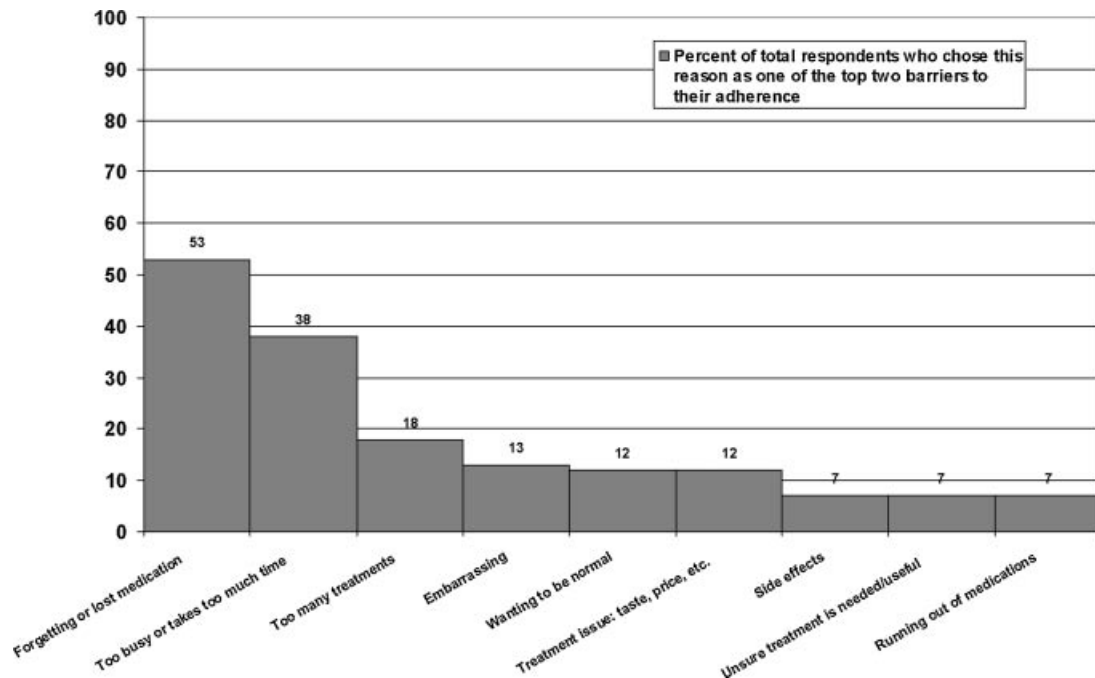
Fig. 2. Self-reported barriers to adherence. None of the respondents chose the following barriers: difficult to understand physician's instructions; no longer a need for medication; family emergencies; technique problems; financial problems.

63%; $P = 0.004$). In each of these statements, the group which self-describes as less healthy was significantly more likely to agree with the statement.

DISCUSSION

As nonadherence can profoundly affect long-term treatment plans and outcomes of patients with CF, this study was designed to identify specific barriers to adherence which adolescent patients are facing. Since this is questionnaire-based research, we have primarily collected subjective data of the patients' perceived experiences and challenges. This has been combined with objective patient measures and analyzed for relevant information.

Importantly, we found that the respondents generally recognized the value of adhering to their treatment plans. The treatment most likely to be perceived as acceptable to miss, airway clearance therapy (with a large majority using a vest), is time-consuming and can be uncomfortable. In addition, because it is not pharmacologic, there may be a perception that it is less essential to maintaining health. This correlates well with a recent study in Spain which observed less adherence for airway clearance than for other respiratory treatments, with more patients claiming the chest therapy did not improve their quality of life.[20] In our results, the one therapy which no respondents answered to be acceptable to miss, inhaled tobramycin, might be perceived as especially important

because of its antibiotic activity. As it is typically prescribed in cycles (28 days on treatment followed by 28 days off), we would also speculate that having a specific short-term end date to treatment course may improve adherence by making the regimen feel more tolerable and finite. Additionally, patients may feel improvement in their symptoms while on treatment cycle, which could enhance adherence.

Respondents predominantly reported issues of time management to be the specific barriers that inhibited adherence; these findings are also reflected in other research with a younger patient population.[17] This would suggest that interventions to improve adherence may be best targeted at this concern. Some of these interventions may include technologic advances: for example, therapies may be developed which can be completed in less time and in combination with each other. Beyond this, however, there may be more basic approaches in time management counseling not unlike what would be ascribed for any person managing a complex daily schedule of tasks. Some of these barriers and their potential interventions may be age-specific as well. For instance, younger adolescents reported more concern about embarrassment and wanting to be normal and they may need more targeted guidance about the benefits and possible drawbacks of disclosure to peers. At the same time, it is important to consider that while respondents offered these specific issues as their greatest barriers to adherence, these may only be the most

TABLE 3— Agreement to Statements Which May Indicate Attitudinal Patterns of Nonadherence[1]

Statements on adherence attitudes (slight paraphrasing used for fit)	Total (n = 60)	Sex subgroups (%)		Age subgroups (%)		Health subgroups[2] (%)		$FEV_1\%$ subgroups (%)	
		Male (n = 25)	Female (n = 35)	12.0–15.9 years (n = 27)	16.0–20.9 years (n = 33)	More healthy (n = 33)	Less healthy (n = 27)	$FEV_1\%$ >70 (n = 43)	$FEV_1\%$ ≤70 (n = 17)
My primary team doesn't understand how tough it is to follow my treatments	18% [8.5–28.1%][3]	28	11	22	15	**<u>6</u>**	**<u>33</u>**	19	18
When I have a busy or changing schedule, it is OK to miss treatments	30% [18.4–41.6%]	36	26	30	30	27	33	33	24
Even though I want to follow my treatments, sometimes I just forget	67% [54.8–78.6%]	72	63	56	76	64	70	70	59
It is OK to miss one of the treatments every few days	30% [18.4–41.6%]	28	31	26	33	30	30	28	35
It is OK to miss a treatment as long as I take an extra dose the next time	12% [3.6–19.8%]	**<u>24</u>**	**<u>3</u>**	11	12	9	15	9	18
My health will be OK, even if I don't do my treatments when I'm supposed to	8% [1.3–15.3%]	12	6	7	9	9	7	12	0
I have trouble sticking to my treatments because they make me feel worse	13% [4.7–21.9%]	12	14	4	21	12	15	9	24
Having to follow the treatments for cystic fibrosis is embarrassing to me	15% [6.0–24.0%]	20	11	19	12	12	19	16	12
Having to follow the treatments for CF means less freedom in my life	50% [37.3–62.7%]	48	51	44	55	**<u>30</u>**	**<u>74</u>**	42	71
I have trouble sticking to my treatments when I have no physical symptoms	42% [29.2–54.2%]	36	46	41	42	**<u>24</u>**	**<u>63</u>**	42	41

[1]Bold font with underline indicates statistical significance.
[2]Respondents reporting excellent or very good health are categorized as "More healthy" while those reporting good, fair, or poor health are categorized as "Less healthy."
[3]Numbers in brackets represent 95% confidence intervals.

superficial barriers to acknowledge. Other obstacles to treatment adherence may lie deeper in the psychosocial framework, to the awareness of the patient or not.

Presenting respondents with specific attitudinal patterns allowed us to identify thought processes and belief patterns which may be underlying their nonadherence. Relatively high levels of agreement that CF treatments lead to less freedom and that forgetfulness can affect treatment adherence were not surprising to us and concur with previous study.[6] Although other research has shown differences in adherence rates and in emotional impact of CF between male and female adolescents,[21] our study demonstrated almost no distinction in attitudinal patterns between the sexes. However, the most telling data from this set of answers may be the differences between the self-perceived healthier and less healthy subgroups. Other work has suggested that deterioration of physical health in

CF may be associated with impaired overall psychological and psychosocial functioning.[22,23] In our study, as patients perceived themselves to be less healthy, they were significantly more likely to agree that their healthcare providers did not understand adherence challenges, freedom was being restricted, and adherence was more challenging during times when they felt relatively better. This can provide some insight into a cycle of worsening symptoms. As the patients' baseline health diminishes and number of routine treatments increases, they can experience treatment fatigue and brief windows of improved symptoms may inspire self-prescribed "treatment holidays." Other recent research has demonstrated that physicians are more likely to discuss the importance of adherence with patients when they are experiencing worsening symptoms.[24] Our findings suggest that it may actually be their periods of best health when patients are

most tempted to skip their scheduled treatments, and that may be when anticipatory guidance about adherence and time management could be most valuable. It is also notable that the significant differences in attitudinal pattern responses were seen when comparing self-perceived health and not seen when comparing $FEV_1\%$ values; our interventions into nonadherence may need to take into account the patients' own health perceptions and not just their objective data to most accurately identify their concerns.

The goal of this study was to learn about treatment adherence among patients with CF by characterizing adherence determinants in our local CF population. To that end, the statistical analysis included primarily descriptive statistics, with some additional two-group comparisons (subgroup analyses) being made using straightforward statistical tests. No sample size calculations were performed since the study attempted to include the entire local population and then to make reasonable inferences regarding the broader CF population by comparing the local population to other populations of patients with CF. However, to provide some reference for how well the main responses regarding adherence attitudes reflect those of the broader CF population, 95% confidence intervals were calculated (Table 3).

Objective data from the nonrespondents suggest that the participants in this study are representative of the wider adolescent and young adult population in our CF center. However, we cannot exclude the possibility that those patients who opted not to complete a questionnaire would have different perceptions and adherence behaviors than respondents. Choice of study participation, as in nearly all clinical or behavioral research, may create a nonrepresentative sample. The different era of CF care that our younger patients were born into, in comparison to the older subset, could also confound any age-related differences that were observed in the study. Treatment options and expectations for survival were markedly more limited in the 1980s and this may have effects on the older patients' attitudes and disease progression that were not captured in our data. There were other limitations inherent to our study design as well: our objective health data ($FEV_1\%$, BMI, etc.) was not always collected on the same day as completion of the questionnaire if it was submitted via mail, and variability may have been introduced by the multiple settings in which questionnaires were completed.

There is growing literature that demonstrates the enormous impact of nonadherence on health outcomes for patients with CF. Our study was unique in how it was designed to incorporate the perceptions of adolescent patients into our understanding of specific barriers. Both internal barriers (attitudinal patterns) and external barriers (such as social and economic factors) were examined. Certain behaviors, especially relating to time manage-ment, are clearly identified by adolescents as barriers to adherence. Their attitudes and perceptions about CF can also affect adherence, and these patterns have potential to be predicted by sex, age, and disease progression. Interventions could be targeted to individual nonadherence risk factors once these aspects are better understood. We believe that programs that address these challenges would improve adherence and could be further studied for effectiveness.

ACKNOWLEDGMENTS

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