Using Quality Improvement Science to Implement a Multidisciplinary Behavioral Intervention Targeting Pediatric Inpatient Airway Clearance

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Objective The objective of this study was to use quality improvement science methodology to develop a multidisciplinary intervention improving occurrence of best-practice airway clearance therapy (ACT) in inpatient adolescents with cystic fibrosis during routine clinical care. Methods The model for improvement was used to develop and implement interventions. Primary outcomes were quality of ACT (% ACT meeting criteria for best practice) and quantity of ACT (% of hospital days patients received ACT four times/day). Annotated control charts were used to document the impact of the interventions. Results Quality of ACT significantly improved from 21% best practice ACT at baseline to 73%. Quantity of ACT significantly improved from 41% days with ACT four times/day at baseline to 64%. Conclusions A multidisciplinary, evidence-based intervention was effective for improving occurrence of best-practice ACT. Pediatric psychology can make valuable contributions to improving the quality of care provided in the medical setting.

Key words adherence; cystic fibrosis; evidence-based practice; research design and methods.

For the past several years, there has been an intense focus within both the medical profession and public arena on the quality of health care. One area of particular concern has been the realization that patients do not always receive adequate or appropriate treatment within the current health care system, as highlighted in the 2001 Institute of Medicine (IOM) report ‘Crossing the Quality Chasm’ (Berwick, 2002; Institute of Medicine, 2001). This prominent report recommended major redesigns in health care teams in service of care that was more evidence-based, patient-centered and systems-minded. Since these reports were released, there has been a rapid expansion of reports of interventions focused on the care delivery processes critical to health. Even so, the discrepancy between recommended and actual care remains troubling. For example, a recent study of 2005–2006 data on inpatient provider compliance with evidence-based guidelines for asthma reported that compliance with quality of care measures was variable, reaching as low as 20% for some clinical interventions (Nkoy et al., 2008).

Quality improvement (QI) science is a flexible systems-based approach for improving the quality of health care delivery within daily clinical practice. One widely used QI framework for developing, implementing and testing changes in clinical practice is the Model for Improvement (Moen, Nolan, & Provost, 1999). A cornerstone of this model is the use of Plan-Do-Study-Act (PDSA) cycles. PDSAs are rapid, sequential, and cumulative learning cycles that provide valuable outcome data within the on-going work of care teams. A change idea is identified in the ‘Plan’ phase. The actual implementation and measurement of the idea occurs in the ‘Do’ phase. Review of the

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measurement data occurs in the ‘Study’ phase and next steps (whether to adopt, adapt, or abandon) are decided in the ‘Act’ phase, with subsequent PDSA cycles utilizing the data to improve the intervention. Thus, QI methodology is a means of increasing the delivery of evidence-based care to patients by developing interventions that are guided by on-going collection of relevant data. QI methodology has been utilized to improve care for a wide variety of medical situations, such as ventilator-associated pneumonia (Jain, Miller, Belt, King, & Berwick, 2006) and unplanned extubations (Sadowski et al., 2004).

Evidence-based care is essential for management of complex chronic illnesses such as cystic fibrosis (CF). Pulmonary compromise is one of the most serious life-limiting consequences of CF, and airway clearance therapy (ACT) is considered standard of care treatment for CF. ACT may be especially critical during periods of pulmonary exacerbation when pulmonary mucus clearance and infection control are paramount for limiting further disease progression. ACT delivered four times/day (i.e., ‘QID’) coupled with antibiotic treatment is considered evidence-based care for inpatient admissions for pulmonary exacerbation. However, even in the inpatient setting where ACT is a primary focus of treatment, done by professional respiratory therapists (RTs) and used during a period of acute health vulnerability, occurrence of optimal ACT can be low. In the one study to date that examined ACT in inpatients with CF, 35% of the 40 adolescents studied did not follow treatment recommendations (including ACT) during their stay (Czajkowski & Koocher, 1986).

Failure to consistently deliver optimal ACT was identified in our own institution. Our CF Care Center has undertaken a major initiative to improve the health care delivered to patients with CF. As part of this initiative, parents reported significant variation in the delivery of inpatient ACT, which prompted the development of empirically based protocols for each of the ACT modalities used with inpatients. The purpose of the current study was to systematically redesign care delivery processes using the model for improvement so that inpatients would consistently receive ACT based on these new evidence-based protocols. Our goal for this clinical effectiveness study was that patients would receive the accepted standard of care QID best practice ACT 80% of the time. We chose this goal based on our desire to set a stretch goal by which to measure ourselves while at the same time acknowledging that there will be occasional system- and patient-related limiters on 100% achievement (e.g., urgent procedures, patient too ill for ACT). By achieving this aim, we hoped to minimize the discrepancy between recommended care and actual care noted in the IOM ‘Crossing the Quality Chasm’ report. That is, we intended to close the gap between evidence-based standard of care ACT and the actual ACT occurrence on our unit. This report describes the results of this QI initiative, which we believe is the first to address the issue of enhancing ACT in an inpatient setting.

**Methods**

**Patient population**

Children’s Hospital Medical Center, affiliated with the University of Cincinnati Medical School, is a 475-bed pediatric hospital with an average yearly admission rate of 16,000 patients. The hospital serves a large catchment area. Approximately 200 pediatric patients with CF are followed at the CF Foundation accredited CF care center. Adolescent inpatients with CF are housed on a 24-bed medical-surgical unit. Admissions for pulmonary exacerbations typically include intensive QID ACT during which patients are offered their choice of ACT modalities (Percussion and postural drainage [P&PD], Vest, Acapella, Flutter, PEP, and IPV) in conjunction with a 14-day course of antibiotics. Regardless of modality, RTs are always present during ACT to educate and coach patients. During the time period of this study (January 2005 to January 2008), there were a total of 344 adolescent (≥12 years of age) admissions for pulmonary exacerbation, representing a total of 64 different patients. Of these patients, 44% were female. All patients were White except for one African American female. At the time of admission patients had an average forced expiratory volume in one second (FEV1) percent predicted of 53.5, indicating a moderate level of disease severity. Weight data were gathered on 211 of the admissions, for a median 27 BMI%tile.

**Interventions**

**First intervention: educational workshops**

Our initial change strategy to increase the occurrence of best-practice ACT on the inpatient unit was to educate RTs on the new ACT protocols with the stated expectation that their job performance evaluation would now be based on their ability to follow these protocols. Within the PDSA framework, our plan (P) was to address RT education by an 8h group-format workshop. This workshop was developed and conducted by a pediatric pulmonologist with full knowledge of the ACT protocols (JLW), as well as the RT educator for the unit (EC) who was also a senior clinical RT. By conducting these workshops, we hoped to enhance
RT knowledge of evidence-based ACT so that they would be able to implement optimal ACT consistently with inpatients. After we conducted this workshop (D), we assessed RT confidence about their ability to perform ACT according to protocol (S), and RTs expressed on-going confusion about delivery of the ACT protocols. In particular, they voiced strong concern that they had not been given the opportunity to practice these skills and solicit feedback within the privacy of one-on-one training. Based on these data, we decided that further intervention needed to occur (A). This education took place in December 2004, just prior to formal data collection for the current study.

**Second intervention: one-on-one training sessions**

Our second PDSA cycle targeted customization of training according to individual RT needs. A more intensive one-on-one training session was developed (P) and implemented (D) with RTs during January 2005. Present in these sessions were the pediatric pulmonologist (JLW), the RT educator (EC) acting as a ‘patient’, and the RT undergoing training. The purpose of this intervention was to provide RTs the opportunity for coaching during actual implementation of the protocol. Feedback was provided with RTs perfecting their ACT delivery until they were able to demonstrate best-practice ACT with the model ‘patient’. However, occurrence of best-practice ACT with actual patients remained low, with early data collection indicating that patients were receiving consistent protocol-based ACT less than 10% of the time. In addition, patients were receiving an average of three ACT per day, rather than the physician-ordered QID ACT (S). RTs expressed considerable frustration that, while they were knowledgeable of what best-practice protocols were, could model them on a ‘pretend’ patient and were trying to educate patients on these protocols and the importance of ACT, the patients were refusing to comply with the protocols or were delaying their scheduled ACT. This was impacting the ability of the RTs to meet their clinical demands and provide appropriate care to patients. RTs indicated that they were having particular challenges with adolescent patients. Further intervention was deemed necessary (A).

Once the team identified that education alone was insufficient to ensure that best practice ACT would occur consistently for patients, a larger multidisciplinary team involved in direct patient care was formed, spear-headed by the pulmonologist (JLW), a pediatric psychologist (MME), the RT educator (EC) and the unit nursing leader (KD). Other team members included unit nurses, child life staff, unit RTs, and adolescent patients with CF and their parents. The purpose of the group was to identify barriers and re-design systems (according to evidence-based, patient-centered and system-minded principles) to facilitate best-practice ACT four times per day. At the initial meeting, 30 barriers to effective ACT were identified and categorized into seven key drivers as indicated in the fishbone diagram in Figure 1. Team consensus was that targeting the main drivers of patient behaviors and scheduling would have the most impact for improving quality and quantity of best practice ACT.

**Third intervention: multidisciplinary behavioral intervention targeting key drivers of patient behavior and scheduling**

Considering how patient behaviors appeared to be one prominent barrier to occurrence of best practice ACT, a behavioral intervention was identified as the next change strategy. Behavioral interventions have been successfully used in the CF population for improving outpatient ACT adherence (Hagopian & Thompson, 1999; Stark, Miller, Plienes, & Drabman, 1987) and nutrition (Stark, 2000). Our intervention strategy was to develop and implement the common behavioral tools of goal contracting, behavior monitoring and a reward system to promote patient behavior that would facilitate the occurrence of optimal ACT on the unit. A behavioral program was planned which began with implementation of a behavioral contract and schedule. Upon admission, the RT would meet with a patient to review ACT protocols. The RT and the patient were then to sign a behavioral contract reflecting that the patient had been educated on the importance of ACT and the various protocols from which they could choose, as well as the availability of the reward system tied to protocol achievement. It also indicated the specific protocol that they had chosen and their ACT scheduled times. At this point, the RT would also initiate a pre-printed daily schedule for the patients that listed the 24 h of the day in half an hour increments. The RTs wrote ACT in the slots where it was scheduled. Once this schedule was posted in the patient chart, nursing and staff from the other disciplines added the activities that they were responsible for. In this way, ACT was given priority for the schedule so that it was appropriately spaced throughout the day and interference by other disciplines or activities was minimized.

The next component of the behavioral program involved behavior monitoring and contingent positive reinforcement. Once ACT was initiated, the RT posted a weekly behavior log in the room which had the capacity to capture 28 ACT sessions (7 days, four ACT/day). Each box of the table reflected one ACT session, and listed the three target behaviors (‘awake’, ‘protocol’, and ‘huff cough’,
After each ACT the RT would indicate in that session’s box which of the target behaviors the patient had performed to best practice criteria. If the patient had adequately met all three targets, they were given a prize chip (also noted on the log) which they could trade in at anytime for a reward. Prizes ranged from candy (three prize chips) up to a $20 gift card (50 prize chips requiring that 95% of all ACT sessions were to best practice criteria).

RTs were responsible for distributing and collecting the prize chips as well as for ensuring that the patients received their prizes in a timely fashion. In addition to monitoring target behaviors and prompting tangible reinforcers (prizes), the weekly behavior log also facilitated social reinforcement by other staff and family who were instructed by the RTs and the CF team to praise successful ACT behaviors documented on the log. This was particularly helpful once RTs were given time to participate in CF family centered daily rounds because RTs used the log to facilitate productive multidisciplinary communication about ACT.

Although behavioral interventions had been used on a case-by-case basis with some adolescent inpatients, a population-wide behavioral program had never been implemented on the medical units in our institution.

Given the difficulties in consistent implementation of behavioral programs even when the same provider is working with just one patient, we were keenly aware of the need to thoughtfully trial the usability of all components of this intervention within the daily work processes of the unit. We deemed this especially important because the RTs would be managing these behavioral components in addition to their high patient census. Therefore, before testing the effectiveness of our overall behavioral intervention, we conducted PDSA cycles on each of the behavioral components to refine the process of integrating the intervention into the system. For example, the goal of our April 2005 PDSA on the contract was to develop the contract such that RTs felt comfortable with the content, were successful at reviewing it with patients, and would be able to consistently manage the paperwork. These PDSAs were also used to evaluate the responses of the recipients of the contract to determine if the contract language was understood by and acceptable to patients and their families. The purpose of these early PDSAs were communicated to families so that they would understand why we were presenting interdependent parts of a system in isolation (i.e., why we would practice reviewing the content of the contract with the patient even though we did not yet have the

Figure 1. Fishbone diagram reflecting the team-identified 30 barriers to best practice ACT organized into key drivers.

Improving Inpatient Airway Clearance
For ease of testing, we utilized the subset of unit RTs involved in the initiative to conduct the PDSA cycles. That way, contingent components of the behavioral program could be systematically evaluated, such as having an RT already comfortable with utilization of the weekly log involved in testing the usability of the reward system based on that weekly log. Therefore, these initial PDSA were also conducted on just a subset of the patients currently hospitalized (i.e., those patients assigned to the involved RTs).

Additional examples of the way we used PDSA cycles to test components of the behavioral program are illustrated in Figure 2. As our initial PDSA cycle on the weekly log, the pediatric psychologist (MME) developed the first draft of the log based on her clinical expertise in behavior management (P), presented it to the RTs (D), collected their feedback about their predication of the usability of the weekly log during routine ACT (S), and then amended the log based on these data (A). Subsequent PDSA cycles were used to resolve issues related to the utility of the weekly log to monitor actual patient behaviors during clinical care, the placement of the weekly log in a prominent and user-friendly spot in the patient room for utmost effectiveness, and a system for tracking missing data on the weekly log during early implementation of the program. This same QI methodology was used to develop a user-friendly and effective reward system. As depicted in Figure 2, our initial PDSA cycle consisted of the development of a potential prize list by the multidisciplinary team (P), RTs reviewing the list of prizes with a subset of patients and parents (D), then assessing patient and parental perspectives on the reward system in terms of interest and acceptability (S), followed by the finalization of the prize list based on this data (A). The next PDSA cycle tested a process by which RTs would successfully manage the prize chips. Subsequently, the pediatric psychologist taught the RTs communication and behavioral strategies to use with patients to maximize the impact of the reinforcers. Our final reward system PDSA examined the effect of RT implementation of the reward system on RT work flow and clinical productivity. Based on RTs reports that the implementation of the reward system did not negatively affect their work flow, and, in fact, made their clinical time spent with patients more productive, the reward system was approved to move forward to full-spread.

These preliminary small tests of change testing the usability of the behavioral components within the busy clinical practice on the unit occurred during the first 11 months of 2005. Because only a subset of the inpatients was involved in these tests, we did not expect to demonstrate marked improvement in ACT outcomes for the inpatient CF population as a whole during this period. All components had been sufficiently tested by
were reviewed on all patients with CF. Per communication with our institution’s Institutional Review Board (IRB), formal IRB approval and patient consent was not deemed necessary due to the focus of our intervention on improving care delivery processes. However, all patients were informed of the initiative and were given the opportunity to opt out of the reward system with assurance that doing so would not affect their care. All patients’ ACT-related behaviors were monitored on the weekly log regardless of participation in the reward system.

**Measures and data collection**

As routine practice on the unit, RTs recorded clinical information about each patient’s ACT in the on-line electronic medical record ‘Integrated Clinical Information System’ (ICIS; 2002 Siemens Medical Solutions Health Services Corporation). Beginning January 2005, charts were reviewed on all patients with CF ≥12 years of age and admitted with the diagnosis of pulmonary exacerbation. Due to the volume of data, one day per each week during the data collection time period was randomly selected (Excel random number generator, Microsoft, Inc) and data collected on that day. Days in which an individual patient was being admitted or discharged were not included in the data collection but all other recorded sessions were reviewed. During the chart reviews, the data were collected, entered into a database (Access, Microsoft), percentages calculated on a monthly bases and graphed over time (Figure 3).

The primary outcomes for this project were the percent of ACT that was successfully completed according to best practice protocols (ACT quality) and the percent of days that patients received QID ACT (ACT quantity). Best practice ACT was defined as the patients completing all of the following: being awake for the session (deemed necessary for other components, particularly huff coughing), following the protocol of the selected airway clearance modality (per previously developed protocols), and performing huff coughs (identified as essential treatment during protocol development).

To determine ACT quality, the number of best practice ACT sessions was divided by the total number of ACT sessions to give a percentage for the reviewed day. For example, if on a data-pull day three patients each completed four ACT sessions, there was a total of 12 potential best practice ACT sessions for that day. The ACT quality outcome data would therefore reflect the number of best practice ACT sessions that actually occurred divided by 12. So, if six of the sessions reviewed met best practice criteria, there would be 50% best practice ACT for that day. A total number of 2072 ACT sessions were reviewed for the purposes of tracking ACT quality.

To determine ACT quantity, the number of daily ACT sessions delivered to a patient was collected and entered into the database (Access, Microsoft). Then, whether or not QID ACT occurred for that patient on that day was noted. The percentage of hospital days with QID ACT was calculated by dividing the number of days with QID sessions by the total number of hospital days. For example, if on a data-pull day four patients each should have received four ACT sessions, there were a total of four possible hospital days that QID should have occurred. The ACT quantity outcome data would reflect the number of days that patients actually received the treatment QID. So, if only two patients received QID ACT on that given day, there would be 50% QID ACT occurring for that hospital day. A total number of 521 hospital days were reviewed for the purposes of tracking occurrence of QID ACT sessions.

**Data analysis**

We used control charts, annotated to detail the timing of PDSA cycles, to document the impact of our interventions (Moen et al., 1999). A control chart is a run chart of data from a system with an average and upper and lower control limits superimposed. These points are derived from the distribution of the underlying data and are conventionally set at ±3 SDs. The area between the upper and lower control limits captures the range of scores that would be expected given a stable performance of a system. Control charts can also identify ‘special cause’ variation—variation that is not an inherent part of a process, but arises out of intermittent, unpredictable, and/or unstable factors. When a system begins to display multiple special causes (e.g., multiple points beyond the control limits), this reflects a change in the system such as that related to a purposeful intervention or to other more permanent factors. Because our measurement was based on analysis of proportional data (i.e., % ACT session at criteria, % hospital days which had QID ACT), the control chart we used was a p-chart, with the standard deviation based on the binomial distribution.

We used these charts to analyze our data for three purposes. First, control charts (and run charts) allow display of the system performance over time: We used the control charts to show changes in the system over the course of the intervention and follow-up periods. Second, control charts allow interpretation of ‘special cause’ variation: We calculated control limits based on
the January through November 2005 data (our ‘baseline’ period, because full-spread of the interventions to all patients began December 2005) and carried these limits forward through the second year, then used standard interpretation rules to determine whether and when special cause variation emerged that might be related to the interventions. Third, control charts can be used to show whether a system that has been subjected to change has stabilized at a different level of performance: We recalculated the control limits based on the last 12 months of data collection to determine whether the system was now performing at a different level (Figure 3).
Results

Changes in quality of ACT during intervention implementation are noted in the first annotated control chart in Figure 3. The data show a fairly stable system during our baseline of the first 11 months. During the baseline period, an average of 21% of ACT met criteria of ‘best practice’. Beginning in December 2005 and for every month thereafter, with the exception of January and April 2006, special cause variation was evident and demonstrated that the system performance had shifted significantly above the baseline period following full implementation of the intervention. As illustrated by the recalculated control limits, the system had stabilized at 73% of ACT sessions reaching best practice criteria for the last 12 months.

Changes in the quantity of ACT across time are noted in the second annotated control chart in Figure 3. Again, the system is stable during the baseline period, performing at 41% of hospital days with QID ACT. After full spread of the intervention, special cause variation demonstrated that the system was performing above baseline and recalculated control limits for the last 12 months showed a stable system with QID ACT occurring on 64% of hospital days.

Discussion

The research reported here is, to our knowledge, the first published account of a systemic intervention addressing inpatient ACT. Our QI behavioral program has resulted in significant improvements in the quality of ACT, with a three-fold increase in the occurrence of best practice ACT that has been maintained for over 1 year. Our QI intervention also had an effect on the quantity of ACT that patients were receiving in that the number of days in which patients received QID ACT increased by 50%. This higher rate of QID ACT also stabilized for the last 12 months of the study. Examination of the control charts in Figure 3 suggests that the change processes began with the introduction of the reward system with more substantial improvement occurring after full spread of the program. While our focus on clinical effectiveness limited to some extent our internal validity, we are not aware of any other changes in ACT delivery, hospital-wide systems or admitted population that occurred during this time period to otherwise explain the steady improvement and maintenance of gains illustrated. Thus, our QI initiative has moved us further towards closing the ‘chasm’ between what we know to be evidence-based ACT and the ACT that these adolescent inpatients with CF are participating in.

One of the key goals of clinical effectiveness research is to determine the external validity of empirically determined efficacious interventions in clinical practice (Green & Glasgow, 2006). Our work here provides practice-based evidence that it is possible and effective to integrate evidence-supported behavioral management strategies into standard care. Frequent impromptu spot-check of treatment fidelity suggested that the RTs were able to deliver the behavioral components as developed, and the program became well-integrated into standard daily care as evidenced by the ubiquitous presence of daily schedules, weekly logs, prize chips and prizes on the unit, not to mention the maintenance of outcome gains. Another goal of clinical effectiveness research is to evaluate the generalizability of clinical interventions to other settings. In comparing genetic mutations, and pulmonary and nutritional outcomes of our CF population to the National CF registry, our patients are similar to the national CF population (Cystic Fibrosis Foundation, 2006); thus, it is likely that our patients are representative of other clinical sites. The vast majority of patients participated in the reward system—one patient needed a more intensive behavioral approach and a couple of the patients in the 17–21-year-old range declined the reward program on repeat admissions because they did not believe it to be of value to them. Thus, the program appears to have utility for a wide age range of adolescents, although it may be somewhat less effective with some young adult patients.

The behavioral program was relatively straightforward with simple, defined behavior goals and a standardized behavioral protocol (i.e., schedule, behavioral contract, weekly log and reward system). Once staff were trained, the program did not require behavioral specialists for implementation. The program also seems to be well-accepted by important consumers (e.g., unit staff, hospital administration, families) due to its fit with expressed consumer needs (e.g., RTs expressing frustration with patient behaviors, parents concerned about the quality of the ACT delivered to their children). Thus, it would seem that this behavioral program could be generalized to other inpatient CF clinical settings, and, once tested within the particular characteristics of the new environment, could be reasonably expected to produce improvements in behavioral outcomes as well as consumer satisfaction.

While a comprehensive cost-benefit analysis was beyond the scope of our project, it is important to consider resource implications of a multidisciplinary project such as this one. Cost-wise, the maximum we spent on prizes per admission is $20. This was initially supported by a small institutionally funded clinical care grant and has subsequently been put in the yearly nursing budget for that unit. In retrospect, it is likely that a smaller gift card would be sufficiently motivating for patients given the...
other social reinforcement that is in place. Other fiscal costs include RTs’ time for implementing program which, per RT report, appears to be off-set by more efficient ACT delivery. Notably, there has been no decrease in RT expected clinical load. Additional resources were needed for real-time data collection which was initially managed by an internal QI consultant but is now managed by unit nursing staff. The key leaders of this initiative (the pediatric pulmonologist, the pediatric psychologist, the RT unit educator and nursing leadership) were supported by their divisional and institutional leadership to provide expertise and time. Future investigations establishing actual fiscal costs of an endeavor such as this compared with a reduction of fiscal costs due to potential benefits of this type of intervention (e.g., reduced hospital stay, reduced procedures due to pulmonary complications, etc.) will be invaluable for establishing the fiscal case for improving quality of health care.

The improvement in care system notwithstanding, our study has several limitations. Our outcomes measures, ACT quality and quantity as charted in the medical record, were not evaluated for their psychometric properties prior to initiating this study. The use of clinical data that is already being collected as part of routine practice (e.g., medical record information) is standard for QI initiatives, but can pose challenges from a reliability and validity perspective, particularly if there is evidence of unreliability in the documentation. This may have been especially problematic for our QID ACT data, which demonstrated great variability, especially in the first 12 months after full-spread. For example, we noted instances in which the medical record ACT data (charting at RTs at various points in the day) reflected that ACT had occurred less than QID for a given day whereas the patient’s weekly log for that day (completed after each ACT) indicated that the QID criteria had been met. While these charting issues may have affected our data, it is likely that the effect would have been one of underestimation of our outcome. Instances where ACT was documented in the medical record but not on the weekly log were not identified and patients typically prompted RTs to document ACT on the weekly log in order to achieve their prize chip. Other means for documenting reliability and validity, such as videotaping ACT sessions to be scored by independent observers, were beyond the scope and resources of this clinical QI intervention. Nonetheless, systematic steps to ensure accurate charting would have strengthened our study and should be addressed in the future.

Another factor that limits the interpretation of our findings is our lack of information on the number of participants from whom the QI data were obtained and lack of information about patient-related variables specific to those participants. This information may have fine-tuned our understanding of patient characteristics related to program outcomes. For example, patients who were more ill may have had greater difficulty reaching best practice criteria, became unduly discouraged, and therefore did not work as diligently toward ACT protocols. While standardizing care delivery processes based on empirical and clinical evidence is essential for improving health care for all, exploring individual differences related to performance on these delivery systems will be critical for understanding which are the cogent characteristics that may indicate the need for different evidence-based protocols. Similarly, collecting more systematic data about the interface between particular RT factors and ACT outcome may have given us data guiding further systemic intervention. For instance, RTs with greater experience working with patients might have been more successful in behavioral implementation.

There are several directions that the results of this research can take us. A study of the impact of this intervention on physiological outcomes (FEV1 status) is currently underway and will have important implications for the cost-benefit analysis of behavioral programs in the medical setting. We also are currently adapting the program to target younger inpatients with CF. In terms of future research, there is clearly work to be done to enhance the frequency of ACT. Considerable variability remains in the occurrence of QID ACT, with the documented outcomes notably below our established stretch goal of QID ACT on 80% of hospital days. It is possible that this goal may be unrealistic given the numerous procedures (expected and unplanned) that may interfere with scheduled ACT, as well as occasional patient-related factors (e.g., excessive fatigue post-procedures). However, it is important to investigate more fully what other system factors (e.g., staffing issues, scheduling errors) may be impacting RT ability to deliver the recommended frequency of ACT. Other research agendas could explore the generalizability of this multidisciplinary behavioral approach to other inpatient populations that also require active patient participation in intensive treatment regimes (e.g., increasing physical activity for inpatients hospitalized with chronic pain). Finally, this practice-based evidence could also be utilized as pilot data to determine the feasibility of taking a more traditional empirical design to test inpatient adherence interventions.

Our multidisciplinary behavioral intervention highlights the ways in which pediatric psychologists can take active roles in the national movement toward enhanced quality of care as mandated in the IOM report. Changing
care delivery systems requires behavior change on the part of both the providers and recipients of health care, and involving experts in behavioral processes can maximize the success of clinical effectiveness initiatives. While education about the required behavior change may be sufficient for simple health-related behaviors or processes, research suggests that more complex or aversive health behaviors require additional interventions providing supervision, reinforcement or skills training (Beale, Bradlyn, & Kato, 2003; La Greca, Bearman, & Roberts, 2003). This was true for our inpatient population who had been educated about the components of best practice ACT but were not participating to criteria.

This was also true for our RTs, who were keenly aware of the quality of ACT they were supposed to do with patients but had not been given the skills to increase patient motivation to participate. The pediatric psychologist was able to work closely with RTs to enhance their ability to effectively deliver the behavioral intervention that was developed within the context of their daily clinical practice. Pediatric psychology has typically focused on parent behaviors as related to child health behavior. However, our scope needs to extend to health care providers to increase their capacity to facilitate behavior change and work collaboratively, whether as part of a formal program such as described here, or in the routine, day-to-day interactions they have with patients and families. Thus, our theoretical, empirical and clinical experiences as related to behavior management and systems-theory make an especially valuable contribution to improving multidisciplinary care. For example, Kazak and colleagues have provided a pediatric psychology treatment framework highlighting the therapeutic triad of child, parents and health care team (Kazak, Simms, & Rourke, 2002). Similarly, Brown (2002) has described the reciprocity of behaviors between pediatric patients and the systems in which they function.

Partnering with medical colleagues and highlighting the viability of pediatric psychology for improving pediatric health outcomes and making value-added contributions to the health care system have been identified as critical issues facing the field of pediatric psychology (Brown & Roberts, 2000). As the health care climate increasingly focuses on transparency in clinical outcomes while tightly managing fiscal costs, multidisciplinary clinical collaborations that utilize the extensive pediatric psychology literature base and clinical expertise to invoke significant changes in health-related outcomes are essential for solidifying the role of pediatric psychology in the changing health care environment. By demonstrating the ability of pediatric psychology to contribute in responsive, meaningful ways to improving the standard of care that occurs on the medical unit, the study reported here illustrates the significant strengths that pediatric psychologists can bring to health care systems seeking to increase the provision of evidence-based care in the clinical setting.

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