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Feasibility, acceptability, and preliminary effectiveness of patient advocates for improving adult asthma outcomes

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Abstract

Background—Asthmatic adults from low-income urban neighborhoods have inferior health outcomes which in part may be due to barriers accessing care and with patient-provider communication. We adapted a patient advocate (PA) intervention to overcome these barriers.

Objective—To conduct a pilot study to assess feasibility, acceptability, and preliminary evidence of effectiveness.

Methods—A prospective randomized design was employed with mixed methods evaluation. Adults with moderate or severe asthma were randomized to 16 weeks of PA or a minimal intervention (MI) comparison condition. The PA, a nonprofessional, modeled preparations for a medical visit, attended the visit, and confirmed understanding. The PA facilitated scheduling, obtaining insurance coverage, and overcoming barriers to implementing medical advice. Outcomes included electronically-monitored inhaled corticosteroid adherence, asthma control,

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quality of life, FEV1, ED visits, and hospitalizations. Mixed-effects models guided an intention-to-treat analysis.

Results—100 adults participated: age 47 ± 14 years, 75% female, 71% African American, 16% white, baseline FEV1 $69\% \pm 18\%$, 36% experiencing hospitalizations and 56% ED visits for asthma in the prior year. Ninety-three subjects completed all visits; 36 of 53 PA-assigned had a PA visit. Adherence declined significantly in the control ($p = 0.001$) but not significantly in the PA group ($p = .30$). Both PA and MI groups demonstrated improved asthma control ($p = 0.01$ in both) and quality of life ($p = 0.001$, $p = 0.004$). Hospitalizations and ED visits for asthma did not differ between groups. The observed changes over time tended to favor the PA group, but this study was underpowered to detect differences between groups.

Conclusion—The PA intervention was feasible and acceptable and demonstrated potential for improving asthma control and quality of life.

INTRODUCTION

Asthma, a chronic treatable disease, affects more than 18 million US adults.¹ Blacks have 3.3 times the emergency department (ED) visits, 2.2 times the hospitalizations, and 2 times the death rate for asthma compared to whites.² Other ethnic groups including Puerto Ricans also experience increased morbidity.^{2, 3} Few interventions have targeted low-income minority adults with moderate or severe asthma and even fewer have focused on the real-world clinical practices where care is provided. The need for such interventions is underscored by the Institute of Medicine assertion that access to health care and patient-provider communication may be particularly difficult to achieve for low-income and minority patients and may contribute to health disparities.^{4, 5} This is a report of the feasibility, acceptability, and preliminary effectiveness of such an intervention, called a Patient Advocate (PA) intervention.

We adapted the PA from the patient navigator model, first used to facilitate diagnosis and early treatment of cancer in low-income patients living in poverty in Harlem.^{6–8} Navigator tasks included arranging transportation, scheduling appointments, ensuring availability of medical records, and providing social and financial support.⁹ Efficacy has been shown but not uniformly; the most success in increased cancer screening and follow-up, but less in initiation of therapy and improving survivorship.^{10–14} Other navigator-like interventions have had mixed success.^{15–17} One, a tailored intervention involving a masters-level social worker working with inner-city children with asthma, resulted in reduced asthma symptoms and was most cost-saving in those with more severe asthma.^{18, 19} However, a review of programs involving 18,309 Medicare patients using nurses for patient education and monitoring found no differences in hospitalizations in 13 of 15 navigator-type programs, with none generating net financial direct cost savings for Medicare.²⁰ Thus, although patient navigators are thought to have great potential for assisting patients and reducing health care costs, there is no consensus on what training and characteristics they should have, what they should do, and in what settings.²¹

Informed by focus groups of patients with moderate or severe asthma living in low-income urban neighborhoods and their providers, we adapted a navigator model, called a Patient

Advocate (PA), to facilitate access to care and patient-provider communication in adults with moderate or severe asthma.²² We conducted a randomized controlled pilot study to test its feasibility and acceptability. Because we were interested in the impact of the PA intervention on electronically-monitored inhaled corticosteroid adherence, as a measurement of the adequacy of self-management, we also assessed whether the PA intervention is associated with improved asthma outcomes: asthma control, quality of life, FEV1, ED visits, and hospitalizations over the 16-week monitoring period.

METHODS

Focus groups informed the activities of the Patient Advocate

We held focus groups of asthmatic adults with moderate or severe asthma from low-income urban neighborhoods to determine what they would consider to be beneficial activities of a patient navigator. We then presented their ideas to a focus group of providers to determine if a navigator would be feasible and acceptable to both groups.²² The patients wanted an “advocate”, a term they preferred to “navigator”: “someone on your side.”²² They reported being anxious about medical visits and forgetting to ask questions, to obtain prescriptions, and the doctor’s recommendations. Providers thought navigators could help with tasks for which providers are limited by time, staff, or resources, such as helping obtain medications, transportation, insurance coverage, and medical information. Patients strongly recommended the advocate be like the research coordinators (RC) they had encountered in a previous study: recent college graduates who enjoyed working with patients.²³ The patients perceived these persons as willing to listen to them but also accepted by and comfortable with practice personnel.

Study Design and Summary

This was a mixed methods study. To test feasibility and acceptability we noted numbers of enrollees completing the study and used qualitative methodology to conduct open-ended interviews at the end of the last data collection visit in order to assess participants’ acceptance of the protocol.

Quantitative methods evaluated adherence to inhaled corticosteroids (ICS) and asthma outcomes. We selected a randomized controlled trial design because of its ability to control for both known and unknown potential confounders,^{24, 25} assigning adults with moderate or severe asthma 1:1 to either exposure to a PA or a minimal intervention (MI) for asthma. Adherence, the primary outcome, was electronically monitored for 16 weeks. Secondary outcomes were: FEV1, asthma control, asthma-related quality of life, and the number of ED visits or hospitalizations. In the PA intervention, the PA worked with patients by coaching them and modeling preparation for a visit with the asthma doctor, attending the visit with the permission of participant and provider, and confirming understanding of issues discussed. This study was approved by the institutional review boards of the University of Pennsylvania and registered as ClinicalTrials.gov no. NCT 01128348.

Subjects

Participants were English-speaking adults with moderate or severe persistent asthma according to National Heart Lung and Blood Institute Expert Panel Report 3 guidelines.²⁶ Inclusion criteria identified patients with sufficiently severe and reversible asthma to benefit from ICS therapy. Specific criteria were: 1) age ≥ 18 years; 2) physician's diagnosis of asthma; 3) prescription for an ICS-containing medication for asthma; 4) evidence of reversible airflow obstruction--- (i) an increase ≥ 15% and 200 ml in FEV1 with asthma treatment over the previous 3 years or (ii) an increase in FEV1 or FVC ≥ 12% and 200 ml in FEV1 within 30 minutes of 2–4 puffs of albuterol by metered dose inhaler or 2.5 mg by nebulizer. Smokers were included. Excluded were patients with severe psychiatric problems such as obvious mania or schizophrenia that would make it impossible for them to understand or carry out the protocol.

Subjects were recruited from practices serving low income urban neighborhoods with a high prevalence of asthma morbidity, that is, practices where there is a potential need for PAs to work with patients. These included outpatient primary care and asthma specialty practices of the University of Pennsylvania Health System and Woodland Avenue Health Center, a federally qualified health center. Charts or electronic medical records of participating practices were pre-screened for patients with a diagnosis of asthma who were prescribed an ICS. Potential subjects were then approached by telephone or at the time of a clinic visit and asked to sign consent for further screening, which included spirometry.²⁷ Those satisfying all enrollment criteria were then asked to sign a second informed consent to participate in the 16-week study.

Procedures

Meetings of researchers with participants generally occurred at a private location within the practice of the participant's asthma provider. All data were collected by researchers whose interaction with participants was restricted to data collection (DCs) and who did not perform PA functions. Upon enrollment, participants working with DCs completed questionnaires on socio-demographics, health literacy, present and past asthma status, knowledge of asthma management,²⁸ comorbidities, and baseline self-reported adherence assessed with the Inhaler Adherence Scale.^{29, 30} This 6-item questionnaire asks about adherence estimated over the past 3 months. Spirometry was obtained using American Thoracic Society procedures for FEV1 and FVC.²⁷ A compact disc of asthma education was given to all participants explaining the self-management of asthma based on Guidelines.³¹ An electronic monitor was attached to participants' ICS-containing inhaler.^{32, 33} Participants were informed that the monitor recorded time and date of inhaler actuation and that data would be downloaded at data collection visits. All subjects met with DCs monthly for 4 subsequent sessions (Visits 2–5) of data collection including spirometry, downloading monitor data, and reporting any ED visits or hospitalizations.

At the first visit, subjects were randomized according to a computer-generated algorithm in 1:1 ratio to either the PA intervention or the MI. Subjects randomized to the PA intervention met with the PA as described below before, during, and after a subject's visit with their asthma doctor. Subjects in the MI condition did not meet with the PA and met with

researchers only for data collection. All participants received a total of \$160: \$25 for completing Visit 1 (enrollment and randomization), \$15 for data collection Visits 2–4, \$20 for each of up to 2 medical visits during the study whether assigned to PA or MI, \$50–\$90 (the remainder of \$160) for completing data collection Visit 5. Tokens for public transportation were provided for all data collection visits.

Research Coordinators (RCs)

RCs were assigned either the role of DC or PA. DCs did not perform PA activities and PAs did not act as DCs. Both types of RC were college graduates interested in health-related or education careers, research experience, further schooling, working with patients, who collectively reflected the same race/ethnicity distribution as the subject population, as preferred by the focus groups.²² RCs trained for 3 weeks initially, using training manuals and then role-playing of recruitment, protocol, and data collection procedures. Training topics included asthma pathophysiology and education; spirometry; human subjects research; cultural competence; interpersonal skills; relating to practice personnel; administrative tasks required of patients; and procedures for reviewing medical records, screening, enrolling, obtaining consent, recognition of adverse and serious adverse events, and data collection. After satisfactory role-playing, initial encounters with participants were observed by the project manager then sporadically, and then unannounced. Procedures and problems were reviewed at weekly team meetings with the principal investigator. A social service resource book was prepared by the team to be used as needed.

Patient Advocate Intervention

Participants met their PA at the end of the first data collection visit. The PA introduced her/himself and gave some personal information about her/his background (e.g., where the PA grew up, went to school, career goals) to begin to establish the PA-patient relationship and to motivate the patient to volunteer similar information. The PA gave the participant a notebook containing pages to enter medications, a calendar for appointments, contact information of physicians and pharmacies, and insurance information. The notebook also contained a sample action plan that the PA encouraged the patient to discuss with their asthma doctor, and was used at subsequent meetings with the PA and as the patient otherwise desired. The PA also met briefly (5 minutes) with the patient following data collection at Visit 2 to ensure the PA-patient relationship was established. At this meeting they reviewed clinician recommendations or conversed about personal experiences/plans. It was important for the patient to get to know the PA as much as possible before the medical visits. Then the PA met the participant before, during, and after a visit to the asthma-treating clinician and modeled, facilitated, and empowered patients to complete tasks related to asthma management. Activities before, during, and after visits were recommended by our focus groups.²²

A few days before a visit with the asthma clinician—By phone or in person, the PA assisted the participant in making a medication list to provide to the MD, if not already made. Patient and PA discussed any problems with obtaining, refilling, or taking medications. The participant reviewed any questions she/he planned to address with the clinician, as this has been shown to improve communication and patient satisfaction with the

visit.²² The PA prompted the patient to prepare no more than 2 to 3 points to address at the medical visit. Preparing too many points was found to be frustrating to the clinician who may have had other issues to discuss and to the patient if they were not addressed. The PA inquired if forms, referrals, or other documents were needed for the visit and helped the patient obtain them if necessary.

The PA met the patient in the waiting room when the patient came for a visit—

The PA asked the participant if there was an emergency plan for an exacerbation and encouraged the participant to discuss this at the visit if it was not well described by the patient. The PA helped the participant organize any needed materials, e.g. study results, medication lists, insurance information in the notebook. The PA used the waiting time (which was sometimes considerable) to get to know more about the patient's life and priorities.

During the medical visit for management of asthma—If participant and clinician permitted, the PA accompanied the participant as an observer. In general the PA spoke only if invited by the participant. Patients and clinicians signed consent that allowed the PAs to take notes to assist with “teach back,” that is, to teach the instructions as if the patient were the clinician.

Immediately after the medical visit—If needed, the PA facilitated scheduling follow-up appointments with the clinician and/or others as recommended and completion of any paperwork, e.g., insurance forms or other documents. The PA reviewed instructions given to the participant at the appointment by asking the patient to “teach back.” If the participant had questions for the clinician after reviewing these instructions, the PA and participant completed a report of items needing clarification for the clinician or staff. Such reports have improved asthma outcomes and patient satisfaction.³⁴ The PA and participant, as necessary, organized medical and administrative information.

Between Visits—If there had been no contact with a participant for a month, the PA called and checked how the patient was feeling, general well-being, and whether the patient had sufficient medications. Together they reviewed upcoming appointments. The PA asked whether there were new problems surrounding obtaining care or filling or taking medications and whether there had been ED visits or hospitalizations. The participant, with help as needed from the PA, notified the clinician of problems judged significant by either PA or participant.

The PA used the social service resource book as needed; patients having unusual difficulty were discussed at team meetings and the asthma practice contacted if necessary.

Minimal Intervention (MI)

The MI intervention was minimal but more than usual care. These participants received the CD of asthma management, and their use of ICS was electronically monitored.. MI participants did not meet with PAs.

Outcomes

Participants were asked in open-ended questions about their satisfaction with the study and possible benefits, what they learned, and whether they would recommend participation to a friend.

Adherence to ICS Regimen Prescribed by Participant's Physician

Adherence, the primary outcome, was captured with electronic monitors that recorded the time and date of ICS actuation.^{23, 33} Such monitors can record multiple actuations over a short time-period and thus can detect medication “dumping.”³⁵ This is in contrast with inhalers with built-in counters, which display doses remaining; such counters cannot capture deliberate multiple actuations of an ICS unaccompanied by inhalation.³⁵

Only two electronic monitors that measured time and date of ICS use were available at the time of the study. No commercial monitor was available for a dry powder inhaler containing fluticasone-salmeterol, the most frequently prescribed ICS to subjects during the study period. We used the Diskus Adherence Logger or DAL, the research monitor developed by a team member (DKB).^{23, 33} A few patients used fluticasone or beclomethasone in metered dose inhalers; for these we used a commercial monitor, MDILog (Life Link Monitoring, Inc, Kingston, NY).

ICS adherence was calculated from the date-time record of the ICS data downloaded from the monitors. Daily adherence was defined as $(\# \text{ actuations} / \# \text{ prescribed}) \times 100$.^{28, 36} We truncated adherence at 100% for each monitoring period because it controls for multiple actuations over a very short period of time, and thus provides a better measure of adherence.^{28, 35–37} We calculated daily adherence from the day after a data collection visit through the day before return to the DC unless that number of days was more than 30 in which case we calculated 30 days from the day after the monitor was given.

Asthma outcomes

Asthma control was measured at each data collection visit using the 7-item version of the Asthma Control Questionnaire that inquires about symptoms over the past week.^{38–40} The score is the mean of all responses (0=total control, 6=extremely uncontrolled). The minimal important clinical difference is 0.5. A score ≥ 1.5 is considered inadequate control.⁴¹ Spirometry was obtained at each data collection visit using American Thoracic Society procedures for FEV1 and FVC.²⁷

Asthma-related quality of life (AQOL) was measured at Visits 1 and 5 with the Mini-Asthma Quality of Life Questionnaire (AQLQ).^{42–44} This 15-item questionnaire, reflecting well-being over the past two weeks, has a 7-point response scale that provides a mean summary score. A 0.5-unit change is considered clinically meaningful within individuals.⁴⁴ The AQLQ has been shown to be a useful indicator of AQOL in low-income adults.⁴⁵ Hospitalizations and ED visits for asthma or other causes, occurring over the previous month, were recorded at each visit.

Independent variables (baseline data)

Demographic characteristics—age, race, ethnicity, educational attainment, and household income—and asthma history were participant-reported. Baseline spirometry was obtained.

Statistical analysis

We aimed to enroll 100 participants to determine the feasibility of implementation and follow-up. Descriptive analyses were performed for all variables using STATA 11.0 (STATA Corporation, College Station, TX) and SAS V9.2 (SAS Corp, Cary, NC). We compared PA and MI groups for adequacy of randomization, examining whether covariates or baseline variables, were equally distributed among patient groups. The statistical tests were t-tests for continuous variables, and chi-square tests for categorical variables.

Open-ended questions posed to subjects at the end of the study to determine acceptability were reviewed by 3 investigators (RG, CP, AA) for investigators' consensus on whether subjects' comments on their study experience was positive, neutral or negative; whether subjects believed they learned about asthma health, and whether or not participants would recommend participation to a friend.

Regression models were fitted to compare the PA intervention with the MI group, using intention-to-treat principles. Linear mixed-effects regression models, with random intercepts and slopes to account for clustering by patient, were fitted for the following continuous outcomes: adherence, asthma control, FEV1, and asthma-related quality of life. A dummy variable was created for treatment, which was equal to 1 for the PA group and equal to 0 for the MI group. This dummy variable, visit number indicators, and interactions between the treatment dummy and the visit dummies were included in all models. For each outcome, we fitted two models. One model, which we call 'unadjusted,' included only treatment, time, and treatment by time interactions, as described above. We also fitted 'adjusted' models that further controlled for baseline variables.

We counted numbers of ED visits and hospitalizations for asthma or any cause for the time interval between Visits 4 and 5 when patients assigned to the PA group were most likely to have had exposure to the PA. We also compared overall numbers of ED visits and hospitalizations between groups.

As a sensitivity analysis we conducted an "as treated" analysis using ANOVA, comparing continuous outcomes of those assigned to PA intervention who never had a medical visit which included a PA, to those assigned to PA intervention who did have such a visit, to those assigned to the MI.

RESULTS

Recruitment

We prescreened more than 42,000 charts of patients scheduled to have a physician's appointment in participating general or specialty clinics within the subsequent two weeks. Charts were reviewed more than once if the patient had more than one appointment. This prescreening process identified approximately 2000 appointments for patients 18 years or

older with a physician's diagnosis of asthma for which an ICS was prescribed. After eliminating screening of patients with more than one appointment and screening for the other enrollment criteria, we identified 280 eligible patients. Of these, 60 simply declined, 50 stated they were too busy, 5 did not come for appointments scheduled with researchers, 30 thought the travel time for appointments too burdensome, and 25 did not consider the research likely to be beneficial to themselves or others. In addition, 10 eligible patients declined: 4 because of concerns about research, and 6 patients because they were unable to switch to an inhaled steroid for which we had a monitor.

Patient characteristics and adequacy of randomization

The 100 subjects were mostly female, Black/African-American, and from households earning less than \$30,000/year (Table 1). Twenty percent reported currently being employed full-time. Nineteen percent described themselves as working as a professional, executive, business owner, or a manager. Asthma morbidity was significant, with the cohort having a low mean FEV1 ($69\% \pm 18\%$). More than half had had an asthma-related ED visit in the year prior to enrollment and more than one-third reported being hospitalized for asthma in that time interval. Co-morbidities were common. More than half had hypertension and almost a quarter had diabetes. The mean BMI exceeded 33 and was higher in the MI group. Despite randomization, baseline FEV1 was lower in the PA group ($65\% \pm 15\%$ versus $75\% \pm 17\%$, $p=0.01$) (Table 1). The mean baseline Inhaler Adherence Scale score was 1.95, SD 1.57, with 2.0 ± 1.5 in PA group and 1.4 ± 1.3 in the MI group, $p=0.055$, suggesting a trend to poorer reported adherence at baseline in PA group. The adjusted models controlled for baseline FEV1, age, sex, race, educational attainment, and BMI. An analysis controlling for baseline Inhaler Adherence Scale score did not change the results (data not shown).

Outcomes: feasibility and acceptability

Of 100 participants enrolled, 93 completed the protocol; 7 withdrew (3 lost interest in participating, 4 were lost to follow-up). Of those that withdrew, 3 were assigned to PA intervention and 4 to MI.

There were 65 medical visits attended by a PA. Of 53 patients assigned to the PA intervention, 38 (72%) had at least one visit with the asthma provider attended by a PA, 20 had two visits, and 9 had 3 visits. For those who did not have such a visit, some did not make an appointment although encouraged to do so since current guidelines recommend an appointment in the time interval of the study;³¹ some patients had their appointments cancelled by the practice, some were scheduled for appointments but did not come for them. For one site, there was no electronic health record that the research team could scan for appointments and the team relied on phone contact with patients whose phone numbers sometimes changed. One physician refused to have a PA attend one visit, but consented to others; one patient refused a PA accompaniment for one visit.

Table 2 describes the acceptability of the protocol by participants completing the Study. Almost all (92%) found participation a positive and none found it to be a negative experience. The majority randomized to PA (79%) and MI (80%) reported learning from the study. Almost all (98%) would recommend participation in the study to a friend.

Interestingly, more than 60% of participants in both PA and MI groups reported that the study increased their awareness of adherence to medication.

Of the 4 patients expressing some reservations, two participants thought the PA did not help them but one of these thought a PA might help others. Two others were concerned about the confidential and private information being discussed at the doctor visit. One of these recommended getting to know the PA better first, and even thought home visits would be helpful.

Outcomes related to asthma

For the continuous outcomes, the means for each visit are displayed in Figure 1, stratified by treatment group. Table 3 presents the means at baseline and Visit 5, along with test results for differences over time within groups. The results from the regression models are presented in Table 4 for the continuous outcomes.

Substantial adherence data were missing. Of 400 possible downloads (4 for each of 100 patients), only 272 (68%) were recorded. Of the 128 that were missing, 48 (37%) were due to equipment failure. However, for 50 (39%) potential downloads the monitor was not returned and for 30 (23%) the patient never brought in a medication to attach the monitor. There was no difference in distribution of missing adherence data by treatment group. The mixed-effects model that we fitted to the observed data is valid if missing data are missing at random. The large degree of missing data may result in an overestimate of actual adherence, although the bias effect should be the same for both groups. Another study has demonstrated that such missing adherence tends to be associated with lower adherence when compared with subsequent data that is not missing.⁴⁶

The results for the adherence outcome are as follows. Both groups declined from baseline to Visit 5, but the decline was not significant in the PA group. (Table 3, Figure 1). As can be seen from row 1 of Tables 3 and 4, the PA group and MI group only differed by a mean of about 3% at baseline (slightly higher adherence for the MI group), which was not statistically significant. The second row of Table 4 shows the estimate change from baseline to Visit 5 in the MI group. This shows a decline in adherence of about 18% in both the unadjusted and adjusted models, which was statistically significant ($p=0.002$). Finally, we observed a lower rate of decline from baseline to Visit 5 in the PA group compared to the control group, although this difference was not statistically significant, $P=0.57$ (row 3, Table 4). Specifically, the change in adherence from baseline to Visit 5 was estimated to be 6.2 percent less in the PA group than the MI group, based on results from the unadjusted model. The p -value for the treatment-time interaction, the changes over time between groups, was 0.42 in the unadjusted model and 0.57 in the adjusted model (Table 4, bold line), and not significant. There was no difference in self-report of adherence between groups at Visit 5 ($p=.48$).

Asthma control improved in both groups (Figure 1, Table 3). Again, however, there was not a statistically significant difference in the change in asthma control between the PA and MI groups (Table 4). The point estimates (row 3, Table 4) for the interaction term were negative

(lower asthma control score indicates better control), showing slightly better (non-significant) results in the PA group.

FEV1 increased in PA, but not MI (increase 4.1% versus decrease in 1.3%). Again, the point estimate for the interaction term showed slightly better results in PA group. There was not, however, a statistically significant difference between the treatment groups ($p=.28$ and $.23$ from unadjusted and adjusted models).

Quality of life improved from baseline to Visit 5 by 0.59 in the PA group and 0.49 in the control group. Both were statistically significant (Table 3; $p<0.01$). These results are also clinically significant.⁴⁴ From the regression model, we estimated that the PA group improved more in quality of life, but the difference between groups was not statistically significant ($p=.78$ and $.52$ in the unadjusted and adjusted models, respectively, Table 4).

Between Visits 4 and 5, there were 7 asthma-related and 14 ED visits of any kind in the control group and respectively 10 and 15 in the PA group. In the control group there were 3 hospitalizations and 1 asthma-related compared with 4 and 2 in the PA group. Overall, hospitalizations and ED visits did not differ between groups.

We conducted the “as treated” sensitivity analysis, testing whether among patients assigned to the PA group, those who had a medical visit attended by a PA ($N=38$) had different continuous outcomes than those not having such a PA-attended medical visit ($N=15$) and whether these groups had different continuous outcomes from MI participants. There was no statistically significant difference among these 3 groups (data not shown).

DISCUSSION

This pilot study, while of relatively short duration with a relatively limited number of subjects (100), yields both intriguing results and questions for future investigation and clinical practice. The first significant result is that the use of PAs in our study population was feasible and acceptable for both patients and providers: 93% of patients completed the protocol, and only one PA visit was declined by a clinician. Such a high acceptance rate from both providers and patients was not expected at the outset. This group of patients is studied less often than younger patients, and has significant asthma morbidity along with prevalent co-morbidities and social barriers. High levels of medical nonadherence have been reported in this patient population, and skepticism about medical care providers including PAs was expected. Retention in research protocols in this population is often difficult; nevertheless, retention was high in this study.

Not only did participants complete the protocol, but 91% of those assigned to a PA rated their experience as positive and all would recommend a PA to others. Two expressed reservations about confidentiality, but one of these thought this could be solved by more contact with the PA prior to beginning visits, even proposing home visits. The flexibility of a PA and a subsequent study with a longer observation period could address these reservations allowing them to be tailored to individual patients.

The second finding was that PAs did not require advanced medical training to facilitate patient-provider communication and navigation of the health system. While PAs had knowledge and understanding of the concepts of patient education and expertise in health system navigation, they did not give medical advice which was given only by the patient's provider. This suggests that there could be flexibility in the choice of person or persons to fulfill the PA role. This will be important in controlling the cost of PA services. PA activities could, for instance, be distributed over multiple personnel in a clinical practice; or it could be carried out by someone who works in several practices, each with a different medical mission. PA functions also could potentially be performed by community members or patient peers. This study further evidences the intervention's feasibility by demonstrating that advanced medical training for the PA, which might make the cost of such an intervention prohibitive, is not necessary. Finally, that PAs were able to work with patients on comorbidities, not just asthma, improved acceptability and feasibility for both patients and providers. Given the high co-morbidity rate in the study cohort, this intervention is likely generalizable to low-income patients with chronic diseases of which asthma may be one and particularly useful for patients with several comorbidities or severe asthma for which the information given in a medical visit may be extensive and complicated.

A third finding involved the use of a college graduate as the PA. While in other studies, a variety of navigators have been used including peers, social workers, or nurses, the use of college graduates without advanced healthcare degrees or certifications was unique. Not only did patients like the interaction with a young person interested in their welfare, clinicians also found them acceptable and helpful in their crowded clinics. While it was not feasible to match patient and PA by race/ethnicity, PAs were diverse and were able in team meetings to contribute cultural education to the team. We found patients were equally accepting of their PA whether or not the race/ethnicity of the participant and PA matched.

Improvements in asthma control and asthma-related quality of life were seen in both PA and MI groups. Although there was no significant difference between groups, a trend suggests that the PA group might have shown comparatively better outcomes in a longer adequately powered study or if a usual care control group receiving no additional contact had been employed. Five reasons support this statement. First, adherence, which usually decreases over the observation period,^{47, 48} did not decrease in the PA group, suggesting that with a longer observation period a difference between groups in asthma outcomes might be observable. Second, while the changes in adherence, asthma control, quality of life, and FEV1 did not attain statistical significance between the groups, the results were consistently in the direction of benefit with a PA intervention. Third, in this pilot study, some patients did not meet with a PA until several weeks into the study. Thus the benefit of the PA would not be seen during the initial data collection periods. Fourth, because of the scheduling of patients for appointments by their asthma doctors, only 38/53 (72%) assigned a PA actually had at least one PA visit during the short observation period. A larger effect likely would have been seen with a longer trial that ensured all participants had at least one or more PA visits. Finally, the numbers of ED visits and hospitalizations in each group was small and did not differ, but it is noteworthy that the baseline FEV1 in the PA group was lower than that of the MI group, raising the possibility that PA group participants had more severe asthma. It is also noteworthy that the PA group had a trend toward lower reported baseline

adherence which disappeared by Visit 5, although self-reported adherence is notoriously unreliable.^{49–51}

Limitations of this study include its relatively small size and short observation period, as is typical with pilot studies. There is a need for a future study with a larger sample and longer duration to ensure exposure to a PA in all randomized to this intervention. While our population has very high morbidity that requires intervention, the generalizability to other populations requires further study. It is possible the PA is applicable to patient groups where improved access to and improved communication with providers would improve outcomes and where the issues of poverty, education, culture, and barriers to care are important factors that influence health outcomes, but further study is required. It is possible data collectors could be unblinded if patients divulged their assignment, but data was either downloaded electronic adherence data or data collected by standardized questionnaires and script. Another limitation is that those that declined enrollment most commonly did so because they were too busy or the protocol too time-consuming. While the actual intervention may not be as time-demanding without the data collection necessary for this study, the intervention still may not be generalizable to those who were too busy to participate or those who work long hours. Nevertheless, the PA intervention may be particularly useful with populations experiencing health disparities. The tailored protocol while taking place within the practice allows PAs not only to consider narrow barriers to medication-taking but also to take into account the culture of the practice and patients' larger social context.⁵²

An additional limitation is the possibility of a Hawthorne effect, that observation, including medication monitoring, influenced adherence and other outcomes. Both PA and MI groups were monitored, possibly reducing the differences in outcomes between groups. DCs provided all participants with a CD of asthma education. As can be seen in Table 2, MI participants thought they learned from the intervention and were made more aware of the importance of adherence. Finally, adherence monitoring is not possible in patients who do not have medication, and many patients in real-life do not fill their prescriptions.⁵³ Monitoring required that both groups had ICS (The medication was supplied in a few cases where patients had no insurance coverage and copays were refunded for others.). Thus, patients in the MI group who received assistance in obtaining ICS actually received one of the services that might be provided by a PA. The net result may have been an inducement for both groups to take medication and seek medical attention when needed. Additionally, it is noteworthy that monitoring and ensuring participants had ICS and providing some asthma education as part of data collection distinguished the MI group from true usual care.

We noted that the 15 participants in the PAI group who did not have a medical visit with a PA received a notebook and instructions. Thus, having a notebook was an intervention that distinguished them from the MI participants. However, the numbers in this group were too small and our "as treated" sensitivity analysis did not show a difference between outcomes in the MI groups versus PA participants without a visit versus PA participants with at least one PA-attended medical visit.

Ultimately, PA activities make us mindful of how attention to communication can improve patient understanding of medical recommendations and promote adherence.⁵⁴ We also see

the importance of the choice of the comparison group. Usual care, an important comparison, cannot be used when monitoring adherence is an outcome; monitoring in the control group is an intervention.

This PA intervention shows promise as an intervention targeted at patients at high risk for morbidity from asthma, including those with significant co-morbidities, or adults at risks of poor outcomes from several comorbidities and barriers to accessing care.

Conclusions/Key findings

A patient advocate intervention is feasible and acceptable to patients and clinicians and has potential for improving asthma control and quality of life. This pilot study warrants a larger study of longer duration.

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ABBREVIATIONS

ANQ	Asthma Numeracy Questionnaire
BMI	Body mass index
ED	emergency department
ICS	inhaled corticosteroid
MI	Minimal intervention
PA	Patient Advocate
RC	research coordinator
RCT	randomized controlled trial

References

1. Akinbami LJ, Moorman JE, Bailey C, Zahran HS, King M, Johnson CA, et al. Trends in asthma prevalence, health care use, and mortality in the United States, 2001–2010. NCHS Data Brief. 2012;1–8. [PubMed: 22617340]
2. Akinbami LJ, Moorman JE, Liu X. Asthma prevalence, health care use, and mortality: United States, 2005–2009. Natl Health Stat Report. 2011;1–14. [PubMed: 21355352]
3. Hunninghake GM, Weiss ST, Celedon JC. Asthma in hispanics. Am J Respir Crit Care Med. 2006; 173:143–63. [PubMed: 16210666]

4. Smedley, BD.; Stith, AY.; Nelson, AR. Unequal Treatment: Confronting Racial and Ethnic Disparities in Health Care. Washington, D.C: Institute of Medicine. The National Academies Press; 2003.
5. Patient Centered Oriented Research Institute Funding Opportunities. Patient-Centered Outcomes Research Institute; 2012. Available from <http://www.pcori.org/funding-opportunities/funding-announcements/>
6. Freeman HP. Patient navigation: a community centered approach to reducing cancer mortality. J Cancer Educ. 2006; 21:S11–4. [PubMed: 17020496]
7. Freeman HP, Chu KC. Determinants of cancer disparities: barriers to cancer screening, diagnosis, and treatment. Surg Oncol Clin N Am. 2005; 14:655–69. v. [PubMed: 16226685]
8. Freeman HP. A model patient navigator program. Oncol Issues. 2004; 19:44–6.
9. Center to Reduce Cancer Health Disparities Patient Navigator Program. National Cancer Institute; <http://crchd.cancer.gov/> Available from <http://crchd.cancer.gov/> [accessed 9/27/2010]
10. Wells KJ, Battaglia TA, Dudley DJ, Garcia R, Greene A, Calhoun E, et al. Patient navigation: state of the art or is it science? Cancer. 2008; 113:1999–2010. [PubMed: 18780320]
11. Fang CY, Ma GX, Tan Y, Chi N. A multifaceted intervention to increase cervical cancer screening among underserved Korean women. Cancer Epidemiol Biomarkers Prev. 2007; 16:1298–302. [PubMed: 17548702]
12. Nash D, Azeez S, Vlahov D, Schori M. Evaluation of an intervention to increase screening colonoscopy in an urban public hospital setting. J Urban Health. 2006; 83:231–43. [PubMed: 16736372]
13. Vourlekis B, Eli K. Best practice case management for improved medical adherence. Soc Work Health Care. 2007; 44:161–77. [PubMed: 17548273]
14. Rahm AK, Sukhanova A, Ellis J, Mouchawar J. Increasing utilization of cancer genetic counseling services using a patient navigator model. J Genet Couns. 2007; 16:171–7. [PubMed: 17277995]
15. Van Wallegghem N, Macdonald CA, Dean HJ. Evaluation of a systems navigator model for transition from pediatric to adult care for young adults with type 1 diabetes. Diabetes Care. 2008; 31:1529–30. [PubMed: 18458141]
16. Jack BW, Chetty VK, Anthony D, Greenwald JL, Sanchez GM, Johnson AE, et al. A reengineered hospital discharge program to decrease rehospitalization: a randomized trial. Ann Intern Med. 2009; 150:178–87. [PubMed: 19189907]
17. Wolff JL, Roter DL. Hidden in plain sight: medical visit companions as a resource for vulnerable older adults. Arch Intern Med. 2008; 168:1409–15. [PubMed: 18625921]
18. Evans R 3rd, Gergen PJ, Mitchell H, Kattan M, Kercsmar C, Crain E, et al. A randomized clinical trial to reduce asthma morbidity among inner-city children: results of the National Cooperative Inner-City Asthma Study. J Pediatr. 1999; 135:332–8. [PubMed: 10484799]
19. Sullivan SD, Weiss KB, Lynn H, Mitchell H, Kattan M, Gergen PJ, et al. The cost-effectiveness of an inner-city asthma intervention for children. J Allergy Clin Immunol. 2002; 110:576–81. [PubMed: 12373264]
20. Peikes D, Chen A, Schore J, Brown R. Effects of care coordination on hospitalization, quality of care, and health care expenditures among Medicare beneficiaries: 15 randomized trials. Jama. 2009; 301:603–18. [PubMed: 19211468]
21. Dohan D, Schrag D. Using navigators to improve care of underserved patients: current practices and approaches. Cancer. 2005; 104:848–55. [PubMed: 16010658]
22. Black HL, Priolo C, Akinyemi D, Gonzalez R, Jackson DS, Garcia L, et al. Clearing clinical barriers: enhancing social support using a patient navigator for asthma care. J Asthma. 2010; 47:913–9. [PubMed: 20846085]
23. Apter AJ, Wang X, Bogen DK, Rand CS, McElligott S, Polsky D, et al. Problem solving to improve adherence and asthma outcomes in urban adults with moderate or severe asthma: A randomized controlled trial. J Allergy Clin Immunol. 2011; 128:516–23. [PubMed: 21704360]
24. TenHave, TR.; Coyne, JC.; Salzer, M.; Katz, I. Alternatives to Simple Randomized Trial. 2004.
25. Nagelkerke N, Fidler V, Bernsen R, Borgdorff M. Estimating treatment effects in randomized clinical trials in the presence of non-compliance. Stat Med. 2000; 19:1849–64. [PubMed: 10867675]

26. Expert Panel Report 3: Guidelines for the Diagnosis and Management of Asthma, Full Report 2007. U.S. Department of Health and Human Services, National Institutes of Health, National Heart, Lung and Blood Institute; 2007.
27. American Thoracic Society. Standardization of Spirometry, 1994 Update. *Am J Respir Crit Care Med.* 1995; 152:1107–36. [PubMed: 7663792]
28. Apter AJ, Boston R, George M, Norfleet A, Tenhave T, Coyne JC, et al. Modifiable barriers to adherence to inhaled steroids among adults with asthma: it's not just black and white. *J Allergy Clin Immunol.* 2003; 111:1219–26. [PubMed: 12789220]
29. Morisky DE, Green LW, Levine DM. Concurrent and predictive validity of a self-reported measure of medication adherence. *Med Care.* 1986; 24:67–74. [PubMed: 3945130]
30. Dolce JJ, Crisp C, Manzella B, Richards JM, Hardin JM, Bailey WC. Medication adherence patterns in chronic obstructive pulmonary disease. *Chest.* 1991; 99:837–41. [PubMed: 2009784]
31. Expert Panel Report 3: Guidelines for the diagnosis and management of asthma. Bethesda, MD: National Institutes of Health, National Heart, Lung, and Blood Institute; 2007. NIH Publication 08-5846:1–416
32. Apter AJ, Wang X, Bogen DK, Rand C, McElligott S, Polsky D, et al. Problem-solving to improve adherence and asthma outcomes in urban adults with moderate or severe asthma: a randomized controlled trial. *J Allergy Clin Immunol.* In press.
33. Bogen D, Apter AJ. An adherence logger for a dry-powder inhaler: an new device for medical adherence research. *J Allergy Clin Immunol.* 2004; 114:863–8. [PubMed: 15480328]
34. Lieu TA, Finkelstein JA, Lozano P, Capra AM, Chi FW, Jensvold N, et al. Cultural competence policies and other predictors of asthma care quality for Medicaid-insured children. *Pediatrics.* 2004; 114:e102–10. [PubMed: 15231981]
35. Rand CS, Wise RA, Nides M, Simmons MS, Bleecker ER, Kusek JW, et al. Metered-dose inhaler adherence in a clinical trial. *Am Rev Respir Dis.* 1992; 146:1559–64. [PubMed: 1456575]
36. Apter AJ, Reisine ST, Affleck G, Barrows E, ZuWallack RL. Adherence with twice-daily dosing of inhaled steroids. Socioeconomic and health-belief differences. *Am J Respir Crit Care Med.* 1998; 157:1810–7. [PubMed: 9620910]
37. Bender B, Wamboldt FS, O'Connor SL, Rand C, Szeffler S, Milgrom H, et al. Measurement of children's asthma medication adherence by self report, mother report, canister weight, and Doser CT. *Ann Allergy Asthma Immunol.* 2000; 85:416–21. [PubMed: 11101187]
38. Juniper EF, O'Byrne PM, Ferrie PJ, King DR, Roberts JN. Measuring asthma control. Clinic questionnaire or daily diary? *Am J Respir Crit Care Med.* 2000; 162:1330–4. [PubMed: 11029340]
39. Juniper EF, O'Byrne PM, Guyatt GH, Ferrie PJ, King DR. Development and validation of a questionnaire to measure asthma control. *Eur Respir J.* 1999; 14:902–7. [PubMed: 10573240]
40. Juniper EF, O'Byrne PM, Roberts JN. Measuring asthma control in group studies: do we need airway calibre and rescue beta2-agonist use? *Respir Med.* 2001; 95:319–23. [PubMed: 11392570]
41. Juniper EF, Bousquet J, Abetz L, Bateman ED. Identifying 'well-controlled' and 'not well-controlled' asthma using the Asthma Control Questionnaire. *Respir Med.* 2006; 100:616–21. [PubMed: 16226443]
42. Juniper EF, Buist AS, Cox FM, Ferrie PJ, King DR. Validation of a standardized version of the Asthma Quality of Life Questionnaire. *Chest.* 1999; 115:1265–70. [PubMed: 10334138]
43. Juniper EF, Guyatt GH, Cox FM, Ferrie PJ, King DR. Development and validation of the Mini Asthma Quality of Life Questionnaire. *Eur Respir J.* 1999; 14:32–8. [PubMed: 10489826]
44. Juniper EF, Guyatt GH, Willan A, Griffith LE. Determining a minimal important change in a disease-specific Quality of Life Questionnaire. *J Clin Epidemiol.* 1994; 47:81–7. [PubMed: 8283197]
45. Leidy NK, Chan KS, Coughlin C. Is the Asthma Quality of Life Questionnaire a Useful Measure for Low-Income Asthmatics? *American Journal of Respiratory and Critical Care Medicine.* 1998; 158:1082–90. [PubMed: 9769264]
46. Krishnan JA, Bender BG, Wamboldt FS, Szeffler SJ, Adkinson NF Jr, Zeiger RS, et al. Adherence to inhaled corticosteroids: an ancillary study of the Childhood Asthma Management Program clinical trial. *J Allergy Clin Immunol.* 2012; 129:112–8. [PubMed: 22104610]

47. Onyirimba F, Apter AJ, Reisine ST, McCusker C, Connors ML, ZuWallack RL. Direct Clinician-to-Patient Feedback of Inhaled Steroid Use: Its Effect on Adherence and Asthma Outcome. *Annals of Allergy and Asthma Immunology*. 2003; 90:411–5.
48. Kim C, Feldman HI, Joffe M, Tenhave T, Boston R, Apter AJ. Influences of earlier adherence and symptoms on current symptoms: a marginal structural models analysis. *J Allergy Clin Immunol*. 2005; 115:810–4. [PubMed: 15806003]
49. Nides MA, Tashkin DP, Simmons MS, Wise RA, Li VC, Rand CS. Improving inhaler adherence in a clinical trial through the use of the nebulizer chronolog. *Chest*. 1993; 104:501–7. [PubMed: 8339641]
50. Milgrom H, Bender B, Ackerson L, Bowry P, Smith B, Rand C. Noncompliance and treatment failure in children with asthma. *J Allergy Clin Immunol*. 1996; 98:1051–7. [PubMed: 8977504]
51. Bosley CM, Fosbury JA, Cochrane GM. The psychological factors associated with poor compliance with treatment in asthma. *Eur Respir J*. 1995; 8:899–904. [PubMed: 7589375]
52. Canino G, McQuaid EL, Rand CS. Addressing asthma health disparities: a multilevel challenge. *J Allergy Clin Immunol*. 2009; 123:1209–17. quiz 18–9. [PubMed: 19447484]
53. Williams LK, Peterson EL, Wells K, Campbell J, Wang M, Chowdhry VK, et al. A cluster-randomized trial to provide clinicians inhaled corticosteroid adherence information for their patients with asthma. *J Allergy Clin Immunol*. 2010; 126:225–31. [PubMed: 20569973]
54. Zolnieriek KB, Dimatteo MR. Physician communication and patient adherence to treatment: a meta-analysis. *Med Care*. 2009; 47:826–34. [PubMed: 19584762]

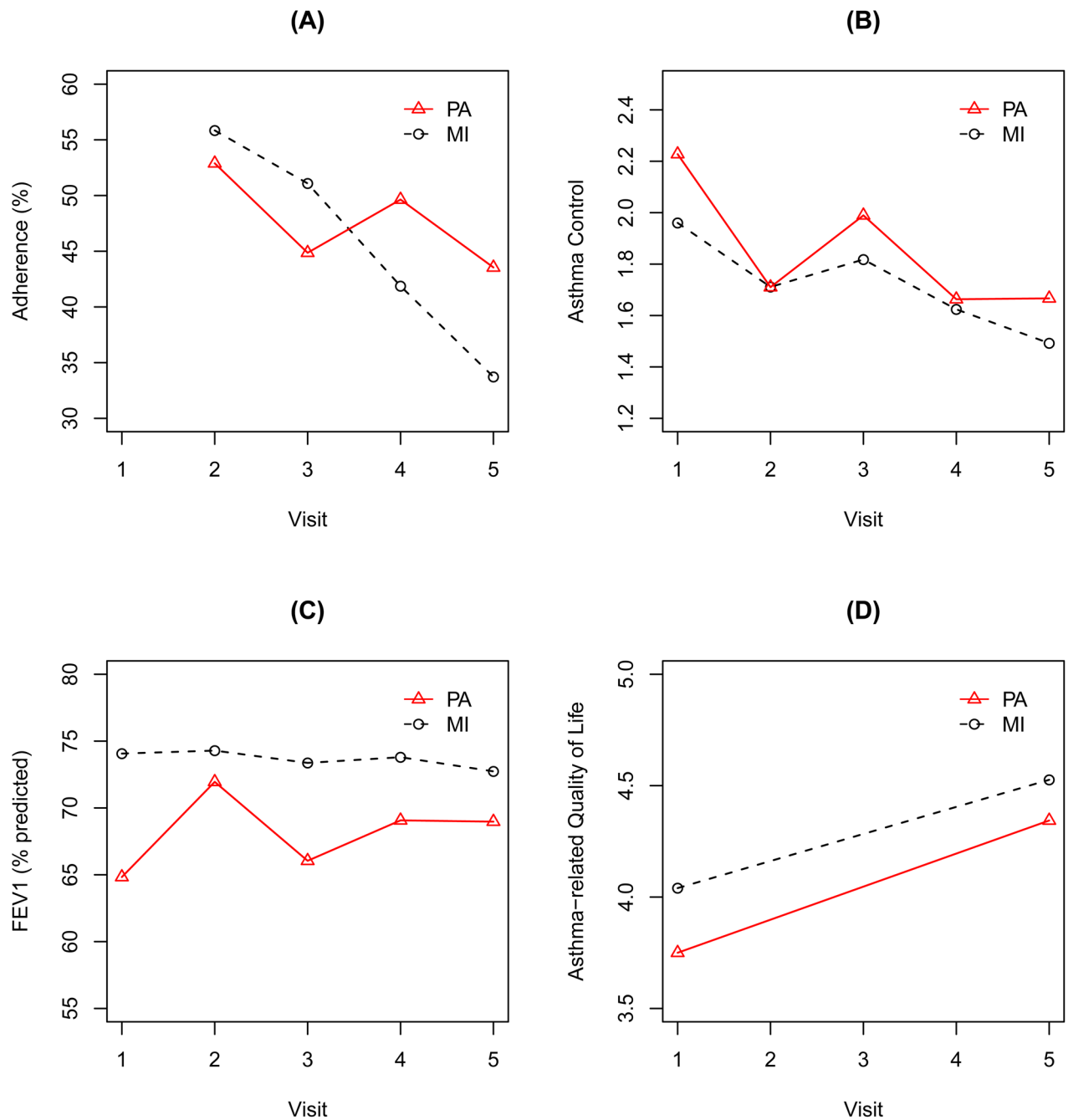


Figure 1. Adherence and asthma outcomes over the study period by PA or MI assignment

Figure 1A: Mean Adherence. Each point represents the mean monitored adherence over the time from the last visit. Thus, there is no value at Visit 1 when monitoring began.

Figure 1B: Mean Asthma control. A score ≥ 1.5 is considered inadequate control.

Figure 1C: Mean FEV1.

Figure 1D: Mean asthma-related quality of life. The score ranges from 1–7 with higher score associated with better quality of life. A 0.5-unit change is considered clinically meaningful within individuals.

Table 1

Baseline characteristics of 100 adults with moderate to severe asthma, 53 assigned to PA, 47 to MI, expressed as percent for discrete and mean (SD) for continuous variables.

Characteristic	Total N=100	PA N=53	MI N=47	p-value **
Sociodemographics				
Age (years)	47 ± 14	46.2±15.3	47.6±12.3	.60
Sex				.08
Female	75	37 (70%)	38 (81%)	
Male	25	16 (30%)	9 (19%)	
Race				.87
Black/African American	71	38 (72 %)	33 (70%)	
White	16	8 (15 %)	8 (17%)	
Other ***	10	4 (8 %)	4 (9 %)	
No response or declined to answer	3	2(4 %)	2(4 %)	
Ethnicity: Hispanic/Latino	2	2 (4 %)	0 (0 %)	.28
Household income				.41
< \$30,000/year	64	36 (68 %)	28 (60%)	
\$30,000 – \$49,999/year	8	3 (6%)	5 (11%)	
\$50,000 to \$99,999	10	6 (11 %)	4(9%)	
\$100,000 or more	8	2 (4%)	6 (13%)	
No response or declined to answer	10	6 (11%)	4 (9 %)	
Educational attainment (highest level achieved)				.08
8 th grade or less	3	0 (0%)	3 (6 %)	
Some high school	17	7 (13 %)	10 (21%)	
High school graduate	36	23 (43 %)	13 (28%)	
Some college or trade school	22	14 (26%)	8 (17 %)	
College graduate	22	9 (17%)	13 (28 %)	
Asthma severity at baseline				
FEV1 (percent predicted) *	69 ± 18	65±16	74±17	.01
# with 1 ED visit for asthma in past yr	56	30 (57 %)	26 (55%)	.16
# with 1 hospitalization for asthma in past yr	36	19 (36 %)	17 (36%)	.17
Asthma-related quality of life *	3.9± 1.4	3.7±1.3	4.0±1.5	.31
Asthma control *	2.1 ± 1.23	2.2±1.2	2.0±1.2	.28
Co-morbidities (#)				
Hypertension	53	29 (55 %)	24 (51 %)	.71
Diabetes	23	14 (26%)	9 (19%)	.42
BMI *†	33.2 ± 8.9	31.6±8.5	35.6±9.4	.03
Ever smoked	63	36 (68 %)	27 (57%)	.11
Current smoker	20	12 (23%)	8 (17%)	.49

** Comparing PA and MI groups

*
mean \pm sd

Other = American Indian/Alaskan Native, Asian, Native Hawaiian/Pacific Islander

[†]
BMI 30 is classified as obese, 25–29 is considered overweight.

Table 2

Acceptability of study to patients completing the protocol*

	PA N= 47	MI N=40	All N=87
	N (% PA)	N (% MI)	N (% All)
Subjects' rating of experience (Q1)			
Positive	43 (91%)	37 (93%)	80 (92%)
Neutral	4 (9%)	3 (8%)	7 (8%)
Negative	0 (0%)	0 (0%)	0 (0%)
Subject believed s/he learned about health while participating (Q2)			
Positive	37 (79%)	32 (80%)	69 (79%)
Participant mentioned without prompting that the study increased awareness of adherence	29 (62%)	26 (65%)	55 (63%)
Participant would recommend study to a friend			
Positive	47 (100%)	38 (95%)	85 (98%)
Neutral	0 (0%)	2 (5%)	2 (2%)
Negative	0 (0%)	0 (0%)	0 (0%)

* RCs did not ask 5 participants to complete this questionnaire.

Q1: What did you think of the study? Probe: What was satisfying about the study? Did you benefit?

Q2: Did you learn anything new about asthma by being in the study? Probe: Tell me more.

Table 3
Adherence and asthma outcomes at baseline and the end of the observation period (Visit 5)

Outcome	PA			MI		
	Baseline	Visit 5	P-value ^I	Baseline	Visit 5	P-value ^I
Adherence (%) [*]	52.9(28.1)	43.6 (28.8)	0.30	55.8 (26.2)	33.7 (25.8)	0.0011
Asthma control [*]	2.23 (1.24)	1.67 (1.16)	0.01	1.96 (1.21)	1.49 (1.10)	0.01
FEV1% of predicted [*]	64.8 (16.5)	69 (17.9)	0.36	74.1 (17.5)	72.7 (21.1)	0.74
Quality of life [*]	3.75 (1.31)	4.34 (1.28)	0.001	4.04 (1.50)	4.53 (1.30)	0.004
ED for asthma ^{**}	5.66%	14%	0.16	12.77%	9.30%	0.41
Hospitalizations for asthma ^{**}	1.89%	4%	0.56	2.13%	2.33%	1
Prednisone bursts ^{**}	16.98%	22.45%	0.44	14.89%	18.60%	0.48
Urgent visits ^{**}	11.32%	8%	0.41	6.38%	11.63%	0.48
ED for any cause ^{**}	15.09%	20%	0.16	12.77%	14%	0.41
Hospitalizations for any cause ^{**}	5.66%	6%	1	2.13%	2.33%	1

^{*} Mean (standard deviation)

^{**} Percent of participants

^I P-value for within group difference between baseline and Visit 5

Table 4

Results from linear mixed-effects regression models for adherence, asthma control, FEV1 and asthma-related QOL. For each outcome, results from an unadjusted (only treatment, time, and treatment by time interactions are in the model) and an adjusted model are reported.¹ Of primary interest is the treatment-time interaction (bolded)

Variable	Adherence (%)				Asthma Control				FEV1				Asthma-related QOL			
	Unadjusted		Adjusted		Unadjusted		Adjusted		Unadjusted		Adjusted		Unadjusted		Adjusted	
	Estimate [*]	P-value	Estimate	P-value	Estimate	P-value	Estimate	P-value	Estimate	P-value	Estimate	P-value	Estimate	P-value	Estimate	P-value
Difference between PA and MI at baseline	-2.89	0.68	-6.02	0.44	0.27	0.28	0.14	0.57	-9.02	0.01	-8.01	0.03	-0.29	0.30	-0.19	0.50
Change from baseline to Visit 5 for MI group	-17.59	0.002	-18.07	0.002	-0.49	0.01	-0.53	0.004	-0.86	0.71	-0.97	0.61	0.49	0.003	0.52	0.002
Interaction: difference between PA and MI in the change from baseline to Visit 5	6.16	0.42	4.49	0.57	-0.06	0.83	-0.05	0.86	3.45	0.28	3.22	0.23	0.06	0.78	0.15	0.52
Age (years)			0.42	0.04			0.001	0.92			-0.30	0.02			0.006	0.53
Female			2.60	0.68			0.13	0.59			5.01	0.22			-0.06	0.84
Race ²																
Other			-19.04	0.06			0.70	0.09			-10.36	0.12			-0.49	0.33
no response			-37.95	0.03			0.31	0.62			-20.31	0.05			0.09	0.91
Black/African American			-26.30	0.001			0.59	0.06			-13.73	0.01			-0.37	0.33
Baseline FEV1			-0.20	0.24			-0.01	0.03							0.02	0.01
BMI			-0.34	.24			0.01	.50			0.066	0.73			-0.02	0.28
Education: ³																
High school or above			7.83	0.25			-0.36	0.18			-2.79	0.52			0.86	0.008

¹ Adjusted for age, sex, race, educational attainment, baseline FEV1, and BMI.

² Reference is white.

³ Reference is less than a high school education.

* "Estimate" indicates the parameter from the regression models and provides an estimate of the variable in the left hand column. For example, in the top and left-most estimate, -2.89% is the estimate of the difference in adherence at baseline between the PA and MI groups, with PA higher.