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Improving Patient–Provider Communication and Therapeutic Practice Through Better Integration of Electronic Health Records in the Exam Room: A Pilot Study

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Abstract

Background.—The rapid proliferation of electronic health records (EHRs) in clinics has had mixed impact on patient-centered communication, yet few evaluated interventions exist to train practicing providers in communication practices.

Aims.—We extended the evidence-based Physician Asthma Care Education (PACE) program with EHR-specific communication strategies, and tested whether training providers with the extended program (EHR-PACE) would improve provider and patient perceptions of provider communication skills and asthma outcomes of patients.

Method.—A pilot randomized design was used to compare EHR-PACE with usual care. Participants were providers ($n = 18$) and their adult patients with persistent asthma ($n = 126$). Outcomes were assessed at baseline and 3- and 6-month postintervention, including patient perception of their provider's communication skills and provider confidence in using EHRs during clinical encounters.

Results.—Compared with the control group, providers who completed the EHR-PACE program reported significant improvements at 3-month follow-up in their confidence with asthma counseling practices (estimate 0.90, standard error [*SE*] 0.4); $p < .05$) and EHR-specific communication practices (estimate 2.3, *SE* 0.8; $p < .01$), and at 6-month follow-up, a significant decrease in perception that the computer interferes with the patient–provider relationship (estimate −1.0, *SE* 0.3; $p < .01$). No significant changes were observed in patient asthma outcomes or their perception of their provider's communication skills.

Discussion.—Training providers with skills to accommodate EHR use in the exam room increases provider confidence and their perceived skills in maintaining patient-centered communications in the short term.

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Conclusion.—Evidence-supported training initiatives that can increase capacity of busy providers to manage increased computing demands shows promise. More research is needed to fully evaluate EHR-PACE on patients' health status and their perceptions of their provider's care through a large-scale trial.

Keywords

asthma management; electronic health records; patient–provider communication; provider education

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Most U.S. clinics and hospitals have now been equipped with electronic health records (EHRs) as a result of a federal mandate and incentive programs through Meaningful Use (Blumenthal, 2009). The impacts of this rapid integration has been shown to have both positive and negative consequences on care (Crampton, Reis, & Shachak, 2016; Pearce, Arnold, Phillips, Trumble, & Dwan, 2011). There are many potential benefits associated with EHR use for providers such as easier access to data, improved hospital financial performance, and better care coordination (Blumenthal, 2009). Recent reviews have also demonstrated positive impacts of the EHR on patient–provider communication, including improved patient understanding of conditions and treatment plans and increased sharing of medical information and decision making (M. A. Alkureishi et al., 2016; Asan & Montague, 2014; Crampton et al., 2016; Frankel, 2016; Kazmi, 2013; Pearce, Dwan, Arnold, Phillips, & Trumble, 2009).

However, recent health IT evaluation studies have also revealed numerous unintended adverse consequences due to the rapid EHR diffusion in complex health care settings (Zheng, Abraham, Novak, Reynolds, & Gettinger, 2016). These include increased screen gazing and keyboarding, which can interfere with patient-centeredness, and verbal and nonverbal communication between patients and providers during clinical encounters (Bassi, Lau, & Lesperance, 2012; Kazmi, 2013; O'Malley, Cohen, & Grossman, 2010; Swinglehurst, Roberts, & Greenhalgh, 2011). Interpersonal communication, especially face-to-face communication, is central to patient-centered care and has a direct impact on care processes and patient outcomes. Many health care providers now face challenges in meeting the high demand of computer use during clinical visits while focusing on their patients (Friedberg et al., 2014).

Much attention is now being devoted to helping providers adopt a long-term view and practice that the computer can be an important resource to support patient-centered care and communication. Initiatives aimed at providers early in their training have been increasingly integrated into professional school curricula and have shown positive results (M. L. Alkureishi, Lee, & Frankel, 2017). Less is known about training approaches and curricula for practicing providers since there is no formal mandate for such training or a straightforward forum to integrate training. There is a pressing need for evidence-based training on using EHRs effectively during clinical encounters for already practicing providers.

We modified and expand the evidence-based Physician Asthma Care Education (PACE) program to train practicing providers on effective use of EHRs at the point of care (EHR-

PACE). PACE is a theory-informed program that has proven effectiveness on enhancing communication, therapeutic practice, and the ability of practicing clinicians to foster effective self-management of asthma in their patients (Cabana et al., 2006; Clark et al., 1998). It utilizes asthma as the main target condition, a disease with exceedingly high societal burden and costs (Loftus & Wise, 2015). In several prior randomized controlled trial studies, the PACE program has produced significant improvements in communication, health care utilization, symptom control, and costs of care (Cabana et al., 2006; Clark et al., 1998).

EHR-PACE is based on concepts and skills for strengthening communication and patient–clinician relationships through behavior change principles specifically introduced for better integrating EHR use into clinical practice. This article describes the results of a pilot randomized controlled trial that aimed to obtain a preliminary understanding of how EHR-PACE compares with standard of care on patient perception of clinician communication and counseling with EHR, asthma control, and asthma-related quality of life of adults with asthma.

Method

Study Design

The trial utilized a two-arm randomized controlled design. Participants included providers and their adult patients with asthma across multiple ambulatory care practices throughout Southeast Michigan that are affiliated with a large nonacademic, independent multispecialty practice group in the region. All study procedures were approved by the University of Michigan Health Sciences and Behavioral Sciences Institutional Review Board.

Study Sample and Procedures

A convenience sample of providers affiliated with the multispecialty practice group were approached for participation in the study. Using a strategy of peer-to-peer recruitment from our prior studies (Cabana et al., 2006; Clark et al., 1998), a roster of potential providers was generated, each provider was approached by the physician on the study team (HL) via phone/e-mail, and provided basic study information using a recruitment script. The eligibility criteria included the following: (a) licensed and board certified practitioner in internal medicine practice or family medicine, (b) treated adults with asthma, (c) practiced at a clinic that had utilized an EHR system for at least 1 year, and (d) provided a roster of adult asthma patients for study eligibility assessment. On provider consent, patient lists of participating providers were obtained in order to recruit prospective participants and screen them for eligibility. Patients were eligible to participate if they met the following criteria: (a) treated by a participating provider, (b) 18 years of age or older, (c) diagnosed with asthma, (d) had at least one urgent medical care visit for asthma in the previous year, (e) did not have any other chronic disorders that present pulmonary complications, and (f) had access to a telephone.

Providers and patients who met the eligibility criteria and consented to participate in the study completed a baseline survey and were subsequently randomly assigned to either the

control group or the EHR-PACE intervention group. Patient participants followed their providers into the same randomized group. Given the pilot nature of this study, the control group comprised no intervention for providers, and therefore standard of care to patients.

Intervention

EHR-PACE resembles the existing PACE program to a great extent with a similar format and the same theoretical underpinnings to change provider behavior (see Table 1). PACE is informed by the Model for Managing Chronic Disease (Clark, 2013). The theoretical foundation for the Model for Managing Chronic Disease includes principles of self-regulated learning and constructs from social cognitive theory (Bandura, 1986). In the applications of the theory, the provider self-regulates his/her own behavior to better achieve desired responses from the patients: more effective at-home management of the patient's condition, greater adherence to provider's recommendations, and more positive perceptions of the provider's care.

EHR-PACE retains the fidelity of PACE based on our prior work (Patel et al., 2013) but was consolidated to better accommodate increasingly busy providers. EHR-specific communication and integration strategies, as an extension to PACE, were added to help providers develop skills and tactics to better incorporate EHR use in their day-to-day clinical practice. We conducted a systematic literature review to distill behavioral and communication techniques recommended for clinicians when interacting with patients in the presence of computerized systems during a clinical encounter (Patel, Vichich, Lang, Lin, & Zheng, 2017). This review included relevant literature to-date at the time of the study. The systematic literature review results were distilled into best practices of EHR-accommodating communication strategies with supporting evidence that showed changes in meaningful patient-centered outcomes or demonstrated high satisfaction among patients for further review. An expert panel composed of five individuals including physicians and behavioral scientists with expertise in patient–clinician communication practices convened to review, refine, and finalize the best practice communication techniques derived from the systematic literature review for relevance to already practicing providers. After further review, the recommended EHR-accommodating communication practices were operationalized into the intervention in the form of case studies, video clips, checklists of *do's and don'ts*, and interactive discussions between providers and leaders of the training.

In this study, the EHR-PACE program was delivered through an interactive, 1½ hour webinar facilitated by an asthma specialist in order to better accommodate busy providers. Intervention provider received 1.5 CME credits for completing the webinar.

Outcome Measures

Outcome measures were assessed based on a survey instrument developed and validated in our previous studies (Cabana et al., 2006; Clark et al., 1998). All participants, including both providers and patients, were invited to complete the survey three times during the study: once at baseline prior to randomization and then 3- and 6-month postintervention.

Patient Perception of Provider Communication/Behavior.—Based on their personal experience in receiving care, patients were asked to report their perception on the general communication skills of their provider (3 items; scale: 1 = *strongly disagree* to 4 = *strongly agree*), asthma-specific counseling behaviors (16 items; scale: 1 = *never* to 6 = *often*), HER-specific communication practices (15 items; scale: 1 = *strongly disagree* to 5, = *strongly agree*), and their attitude toward their provider's use of EHRs in the exam room (6 items; scale: 1 = *strongly disagree* to 5 = *strongly agree*). Questions were adapted from our prior work with PACE and other studies examining perceptions of EHR use (Cabana et al., 2006; Clark et al., 1998; Rouf, Whittle, Lu, & Schwartz, 2007). Items were summed to create a score for each factor.

Provider Communication/Behavior.—The provider survey instrument contained seven items asking the providers to rate their use of EHR communication and integration strategies; response scale ranges from 1 = *never* to 6 = *often*. The instrument also contained six additional items that assessed the participating providers' perception of use of EHRs in the exam room (scale: 1 = *strongly disagree* to 5 = *strongly agree*). They were also asked to report the perception of their asthma counseling practices (6 items; scale: 1 = *never* to 5 = *always*), and of their general communication practices (6 items; scale: 1 = *strongly disagree* to 5 = *strongly agree*). Provider self-efficacy in communication practices with patients and in asthma counseling were measured by asking the providers to rate their confidence on a 6-point Likert-type scale (1 = *not at all confident* to 6 = *extremely confident*) in his or her ability to perform specific general communication (five items), asthma counseling behaviors (two items), and EHR-specific communication practices (seven items). Questions were adapted from our prior work with PACE and other studies examining perceptions of EHR use (Cabana et al., 2006; Clark et al., 1998; Rouf et al., 2007). Items were summed, with higher scores indicating higher level of skills or self-efficacy.

Patient-Reported Outcomes.—Additional patient-reported outcomes included asthma control, asthma-related quality of life, and patient satisfaction with the relationship with their providers and with the asthma care that they receive. Patient asthma control was measured using the sum of the five-item validated Asthma Control Test (ACT; Schatz et al., 2007), in which responses ranges from 5 (*poor control of asthma*) to 25 (*complete control*). A score of 20 or above indicates *satisfactory control*, and 19 or less indicates *not-well-controlled asthma* (National Asthma Education and Prevention Program, 2007). Asthma-related quality of life was measured using the mean of 15 items from the validated Mini Asthma Quality of Life Questionnaire (Juniper et al., 1992). Higher scores indicate better quality of life. Patient satisfaction with the relationship with their providers was measured by how much patients agreed or disagreed (scale: 1 = *strongly disagree* to 5 = *strongly agree*) with the following statement: "I am satisfied with the relationship I have with my provider." Patient satisfaction with their asthma care was measured by how much patients agreed or disagreed (scale: 1 = *strongly disagree* to 4 = *strongly agree*) with the following statement: "I am satisfied with the medical care I receive from my provider for my asthma."

Data Analysis

All statistical analyses were performed using SAS 9.4 (Cary, NC). Descriptive and bivariate analyses were conducted to examine the baseline sample of both providers and patients by randomization status. Then, we used mixed effect models to compare the intervention effects for patients (EHR-PACE vs. standard care) on longitudinal outcomes at baseline and at 3- and 6-month postintervention. Since the intervention was operationalized at the level of providers and patients followed their provider's randomization group, the adjusted mixed effect model with random intercept was utilized to account for the clustering effect. P values less than .05 were considered statistically significant.

Results

Recruitment and Retention

The study recruitment activities spanned a period of 7 months (April 2016 to October 2016). A total of 39 providers were contacted. Among them, 15 provided no response, 1 did not meet the eligibility criteria, 5 declined to participate prior to being screened, and 18 were screened and deemed eligible for the study. All 18 eligible providers consented and completed the baseline and both follow-up surveys, representing a 100% retention rate. Half of them were randomized into the control group and the other half into the intervention group.

These 18 providers saw a total 1,872 patients during the study period; 569 of them did not meet initial eligibility criteria (e.g., not an asthma patient). The rest were contacted. Among them, 844 did not respond, 332 declined to participate, and one did not complete the baseline survey. Thus, the study enrolled a total of 126 patients who were screened eligible, consented to participate in the study, and completed the baseline survey. One hundred and twenty-three patients completed the 3-month follow-up survey. At the 6-month follow-up, 116 patient participants completed the survey (9 were unreachable after multiple contact attempts and 1 participant withdrew from the study). The retention rate among the patient participants was therefore 92%. Figure 1 shows the trial flow charts that exhibit each of these processes.

Sample Characteristics

Characteristics of the patient participants are shown in the upper portion of Table 2. Patients' mean age was 46.8 ($SD = 14.1$) years; 81% of them were male, 69% were White, and 25% were African American (Table 2). Forty-four percent of the sample reported an annual household income >$60,000; 51% reported educational attainment of college or higher; and 56% reported being married. Thirty-five percent had moderate-severe asthma; their mean ACT score was 17.1 ($SD = 4.8$), mean asthma-related quality of life score was 4.7 ($SD = 1.2$), and average time under the provider's care was 57.1 ($SD = 42.6$) months. Eighty-eight percent of these patient participants were satisfied with the care that they receive; 83% were satisfied with their relationship with the provider. No significant differences were found at baseline between patient participants randomized into the treatment or the control group.

Eighty-three percent of the provider participants were female (see lower portion of Table 2). On average, their mean years in practice was 14.4 ($SD = 6.1$) years; 83% were part of a large group practice; and the mean number of asthma patients seen in their practice (reported by each clinic at the aggregated level) was 181.2 ($SD = 124.8$). Ninety-three percent of provider participants reported a flexible exam room structure (e.g., computer and/or computer screen can be readily repositioned to face the provider or the patient); and 7% did not have a flexible exam room. Twenty-eight percent of these providers reported participating in a prior EHR training effort. No significant differences were found at baseline between providers randomized into the treatment or the control group.

Patient-Reported Results

Patient-reported results are summarized in Table 3. Analysis of patient-reported data revealed no significant differences at either 3- or 6-month follow-up, across all study measures including asthma control, asthma-related quality of life, patient satisfaction, or perception of their provider's general communication practices, EHR-specific communication practices, or asthma counseling practices.

Provider-Reported Results

Provider-reported results are summarized in Table 4. At baseline, providers reported low perception of HER-communication with their patients ($M = 12.9$, $SD = 5.1$), moderate use of evidence-supported communication practices ($M = 5.0$, $SD = 1.6$), and low confidence in implementing EHR-communication practices with their patients ($M = 3.9$, $SD = 1.8$).

EHR-Related Outcomes.—Providers who completed the HER-PACE program also showed significant improvements at 3-month follow-up in their confidence with EHR-specific communication practices (Estimate 2.3, standard error [SE] 0.8; $p < .01$). However, these improvements were not sustained at 6-month follow-up.

In examining specific behaviors, EHR-PACE providers reported significant increased confidence at 3-month follow-up in their abilities to (a) ask patient to elaborate on answers to questions prompted by the EHR (Estimate 0.7, SE 0.3; $p < .03$); (b) reposition the computer screen to allow the patient to see (Estimate 1.1, SE 0.4; $p < .01$); (c) describe information that was interesting or helpful while sharing the screen (Estimate 0.8, SE 0.3; $p < .02$); (d) use computer as a resource to facilitate making shared decisions with patients (Estimate 1.3, SE 0.4; $p < .003$); (e) apply nonverbal communication skills while using the computer when the patient is talking (Estimate 1.2, SE 0.3; $p < .01$); and (f) tell patient what they were doing when turning to the computer (Estimate 1.1, SE (0.4); $p < .02$). However, these improvements were not sustained at 6-month follow-up.

At 6-month follow-up, EHR-PACE providers reported a significant decrease in perception that the computer interferes with the patient–provider relationship (Estimate −1.0, SE 0.3; $p < .01$) and increased confidence in keeping the conversation going while using the computer (Estimate 0.8, SE 0.3; $p < .03$). They also reported increased eye contact with patient while using the computer (Estimate 0.8, SE 0.2; $p < .003$) and increased confidence in this behavior (Estimate 0.8, SE 0.4; $p < .05$).

Asthma-Related Outcomes.—Compared with providers in the control group, providers who completed the EHR-PACE program reported significant improvements in their confidence in asthma counseling practices at 6-month follow-up (Estimate 0.90, *SE* 0.4; *p* < .05).

Discussion

Increased computing demands as a result of adoption of EHRs continue to rapidly change how provider and patients interact during clinical visits. To our best knowledge, this is the first study that has used a randomized controlled trial design to evaluate the impact of training practicing providers on how to work with an EHR system while simultaneously providing patient-centered care. We found that the EHR-PACE intervention, which equips providers with patient-centered communication techniques designed to enhance asthma management and EHR use, can significantly increase provider confidence, adoption of proper communication and interaction behaviors to better accommodate computer presence in the exam room, provision of guideline recommended care, as well as decreased perception that the computer interferes with their interactions with patients. Our findings align with outcomes of training initiatives for trainees in effective EHR use (M. L. Alkureishi et al., 2017; Lee, Alkureishi, Wroblewski, Farnan, & Arora, 2017; Reis et al., 2013; Shachak et al., 2015; Wald, George, Reis, & Taylor, 2014).

This preliminary study did not show any significant differences in patient perception of their provider's communication and counseling practices, especially specific to EHR. Our findings align with a recent systematic review that show that majority of studies examining patient perceptions reported no change in overall patient satisfaction, communication, or the patient–provider relationship (M. A. Alkureishi et al., 2016). The patient participants' baseline ratings of their provider's communication and counseling practices were very high, and in many cases, opposite of how providers rated themselves. Nonetheless, patient perspective is important to measure in order to inform nuanced ways that training interventions can improve care delivery. New validated instruments to measure patient perception of providers' communication practices have been developed since the time of our study that should be incorporated into future work (M. A. Alkureishi et al., 2018; Assis-Hassid, Reychav, Heart, Pliskin, & Reis, 2015). Furthermore, qualitative inquiry from patients regarding their perspective of communication and counseling behaviors during the clinical encounter may provide more robust insight into how the EHR-PACE intervention translates to improved patient-centeredness compared with close-ended survey items.

Our data also did not show any changes in asthma control and asthma-related quality of life, even though incremental positive changes were observed in asthma-specific outcomes over time. Given that this was a pilot study, more follow-up time is needed for improved asthma counseling practices to transpire to show a significant, clinically meaningful impact on patient health status.

We found that providers who completed the EHR-PACE program showed significant improvements in their confidence with EHR-specific communication and integration practices at 3-month follow-up. Behavioral theory posits that when individuals have high

confidence in performing particular behaviors, they are more likely to change their behavior and put forth greater and more persistent effort (Bandura, 1986). However, improvements were not sustained at 6-month follow-up, suggesting that future work should consider check-ins or mechanisms for positive reinforcement for implementing evidence-supported EHR-specific communication/integration practices with patients, thereby prompting their continued use.

We also found that EHR-PACE providers reported a significant decrease in perception that the computer interferes with the patient–provider relationship—a change that sustained through 6-month follow-up. This finding directly addresses an issue reported in the health IT literature regarding provider concern for the disruption of EHR on their ability to focus on the patient, maintain eye contact, and establish trust and rapport (Friedberg et al., 2014; O'Malley et al., 2010).

There are several limitations to this study that should be noted. Providers did not have an opportunity to practice the skills they were taught in EHR-PACE during the training, which may have resulted in improved confidence but may not have translated to actions in practice. Future iterations of the intervention should build in time for practicing behaviors. Our study relied on self-report measures available at the time of the study. New validated measures have been developed since the launch of our study that should be incorporated into future work to better assess both provider and patient perception of EHR-communication behaviors (M. A. Alkureishi et al., 2018; Assis-Hassid et al., 2015). Providers also completed self-evaluation reflective of all patient encounters. This global evaluation may not account for variation in the enactment of skills learned in PACE between patients. We also did not collect qualitative information. This was a missed opportunity to better understand for whom the intervention was beneficial and for whom it was not, as well as specific aspects of EHR-PACE that contributed to improved confidence in providers. This pilot study aimed to preliminarily establish the feasibility of using a specifically developed training program to improve practicing providers' EHR communication/integration skills, and thus had a small sample size and a short follow-up period that might not be adequate enough to allow the program's full impact to be observed. There may also have been self-selection of some providers in the study who already had good EHR communication skills. Furthermore, patient participants of this study were recruited from one large, integrated practice group in one geographic region and were predominately white. Other work has shown that diverse patients seen in safety net settings may have differing perceptions of their provider's EHR use (Ratanawongsa et al., 2017). A larger scale trial with a more diverse sample is necessary to assess the impact of EHR-PACE on patient health status and patient-centered outcomes. The findings may not be generalizable to all settings, and a future larger scale trial may consider a heterogeneous sample of practice settings.

Implications for Research and Practice

Despite these limitations, EHR-PACE has important implications for practice. Training initiatives for practicing providers, with specific emphasis on skills training in therapeutic practice coupled with EHR communication/integration practices, increases provider confidence and their perceived ability in maintaining patient-centered communications in the

short term. Given the rapid proliferation of computerized systems in clinical settings, evidence-supported training initiatives that can increase the capacity of busy providers to manage increased computing demands while attending to patient needs shows promise but requires further investigation. More research is needed to fully evaluate EHR-PACE for practicing providers to assess its impact on long-term behavior change and patient health status.

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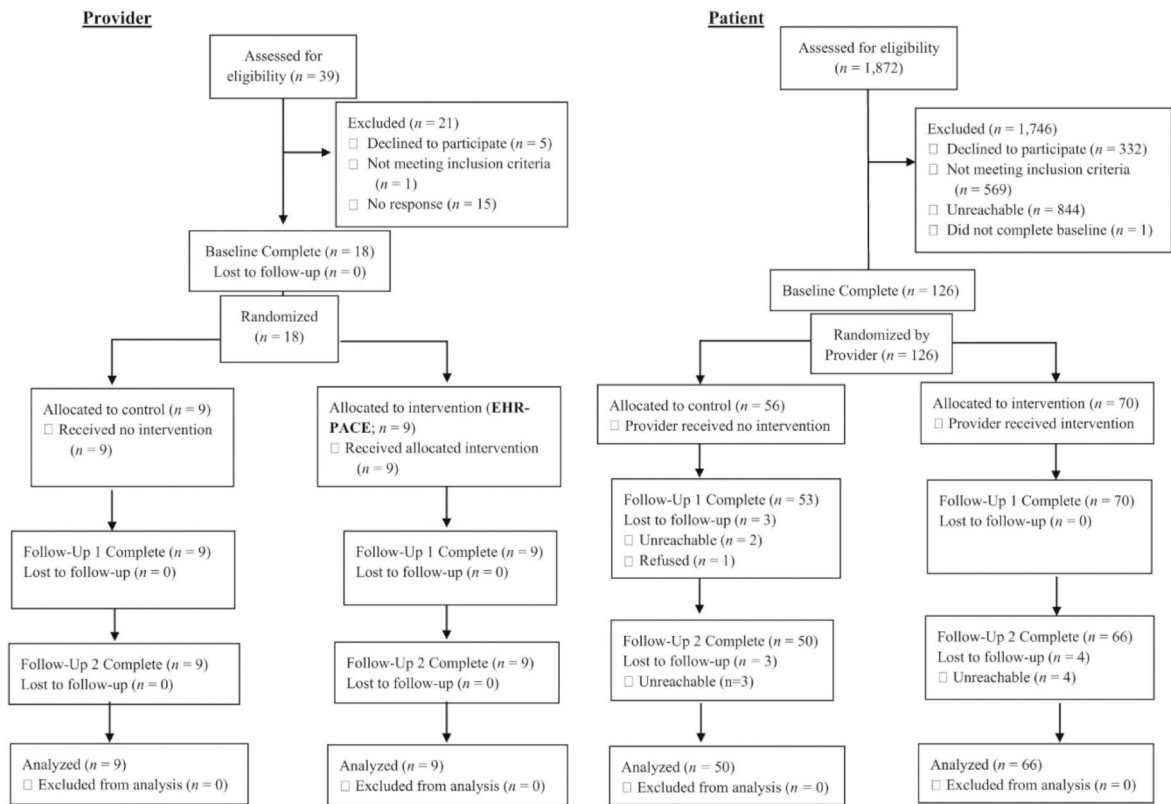
Figure 1.
Provider and patient flow charts.

Table 1.

Components of the Original PACE Program Adapted to EHR-PACE.

PACE	EHR-PACE
Two face-to-face group meetings lasting 2 hours each held over a 2-week period. Format is a combination of mini lecture, video, case studies, and discussion.	One and a half hour webinar of PACE curriculum integrated with EHR–communication skills and components. Format is a combination of mini lecture, video, case studies, and discussion.
Asthma specialist and/or primary care physician, or behavioral science expert	
Curriculum Components	
Session based on NAEPP Asthma Guidelines; trends of asthma in primary care practice; components of good asthma control; review of long-term treatment plan; asthma medications; cases of asthma diagnosis	
Theoretical background Evidence on adherence and efficacy of PACE Introduction of 10 communication strategies and discussion Use of self-rating scale and communication strategies with patients Patient education and presentation of core asthma messages and discussion	Same communication strategies as PACE (listed on the left) with HER modifications: Evidence of EHR-related communication strategies Introduction of recommended EHR-related communication strategies Video of EHR-related communication strategies and discussion Use of self-rating scale and communication strategies with patients Discussion focused on integrating patient education messages into patient–clinician interaction with EHR-related communication strategies
Asthma treatment cases + discussion	

Note. PACE = Physician Asthma Care Education; EHR = electronic health record.

Table 2.

Baseline Characteristics of Patients and Providers by Treatment Group.

Factor	Total sample ($n = 126$), % (n)	Control ($n = 56$), % (n)	EHR-PACE ($n = 70$), % (n)	p value [*]
Patients				
Age, M (SD)	46.8 (14.1)	47.8 (15.0)	46.0 (13.4)	.50
Sex (% identified as female)	81 (102)	82 (46)	80 (56)	.76
Education				.73
Less than high school	2 (3)	2 (1)	3 (2)	
High school	13 (16)	13 (7)	13 (9)	
Vocational/some college/associates	34 (43)	39 (22)	30 (21)	
College or above	51 (64)	46 (26)	54 (38)	
Annual income				.85
<$20,000	21 (25)	20 (11)	22 (14)	
$20,001–40,000	15 (17)	17 (9)	13 (8)	
$40,001–60,000	20 (24)	22 (12)	19 (12)	
>$60,000	44 (52)	41 (22)	47 (30)	
Marital status (% married)	56 (70)	50 (28)	60 (42)	.26
Race/ethnicity				.07
White	69 (86)	57 (32)	78 (54)	
African American	25 (31)	34 (19)	17 (12)	
Hispanic/Latino	1 (1)	2 (1)	0 (0)	
Multiracial	5 (7)	7 (4)	4 (3)	
Asthma severity				.23
Intermittent	55 (67)	61 (34)	50 (33)	
Mild	10 (12)	11 (6)	9 (6)	
Moderate	16 (20)	9 (5)	23 (15)	
Severe	19 (23)	20 (11)	18 (12)	
Years with asthma diagnosis, M (SD)	24.8 (15.5)	25.2 (15.7)	24.5 (15.4)	.79
Time under provider's care (months), M (SD)	57.1 (42.6)	53.8 (48.9)	59.7 (37.2)	.46
Asthma control, M (SD)	17.1 (4.8)	17.4 (4.9)	16.8 (4.7)	.50
Asthma-related QOL, M (SD)	4.7 (1.2)	4.7 (1.2)	4.8 (1.2)	.81

Factor	Total sample ($n = 18$), % (n)	Control ($n = 9$), % (n)	EHR-PACE ($n = 9$), % (n)	p value[a],[*]
Satisfaction with care (% agree)	88 (104)	91 (48)	86 (56)	.46
Satisfaction with provider relationship (% agree)	83 (104)	79 (44)	87 (60)	.21
Provider and practice characteristics				
Sex (% identified as female)	83 (15)	88.9 (8)	77.8 (7)	1.00
Years in practice, M (SD)	14.4 (6.1)	16.6 (7.1)	12.3 (4.4)	.15
# of adult asthma patients in panel, M (SD)	181.2 (124.8)	204.4 (146.0)	155.0 (98.9)	.43
Practice setting				.21
Small group practice (2–5)	17 (3)	33 (3)	0 (0)	
Large group practice (>6)	83 (15)	67 (6)	100 (9)	
Participated in other EHR training efforts in the past (% yes)	28 (5)	44 (4)	11 (1)	.29
Exam room structure				.56
Room flexible	93 (13)	100 (7)	85 (6)	
Room not flexible	7 (1)	0 (0)	14 (1)	

Note. EHR = electronic health records; PACE = Physician Asthma Care Education; QOL = quality of life.

[a] Due to small sample, Fisher's exact test was performed instead of chi-square test for categorical variables.

[*] $p < .05$.

P values are two-tailed.

Table 3.

Intervention Effects Based on Patient-Reported Data.

Outcome	Baseline (n = 126)	3-Month follow-up (n = 123)	6-Month follow-up (n = 116)	Changes in outcomes between 6-month follow-up and baseline		EHR-PACE[a] vs. control at 3 months, estimate (SE)	p value	EHR-PACE[a] vs. control at 6 months, estimate (SE)	p value
				Control	EHR-PACE				
EHR-related outcomes, M (SD)									
Perception of EHR use in exam room	22.7 (5.1)	22.9 (5.0)	22.9 (5.0)	0.8 (4.0)	−0.5 (5.2)	−0.3 (1.1)	.79	−1.0 (1.1)	.38
Provider's communication while using EHR	53.3 (8.0)	54.6 (7.4)	55.1 (8.5)	2.9 (8.8)	0.8 (8.1)	−0.4 (1.4)	.79	−1.9 (1.4)	.19
Perception of provider use of general communication practices	10.1 (1.8)	10.3 (1.6)	10.4 (1.6)	0.3 (2.0)	0.2 (1.4)	0.1 (0.3)	.75	−0.1 (0.3)	.70
Satisfaction with relationship 9	4.2 (0.9)	4.3 (0.9)	4.3 (0.8)	0.3 (0.9)	0.02 (0.8)	−0.1 (0.2)	.64	−0.3 (0.2)	.07
Asthma-related outcomes, M (SD)									
Asthma control	17.1 (4.8)	17.6 (5.0)	17.8 (4.9)	0.8 (3.8)	0.8 (4.4)	−0.4 (0.9)	.63	−0.4 (0.9)	.63
Asthma-related QOL	4.7 (1.2)	4.8 (1.3)	5.0 (1.3)	0.2 (1.0)	0.3 (1.0)	0.1 (0.2)	.66	0.1 (0.2)	.77
Perception of provider use of asthma counseling practices	10.7 (4.3)	11.3 (3.9)	11.3 (4.3)	0.9 (3.7)	0.4 (2.8)	−0.7 (0.6)	.21[b]	−0.7 (0.6)	.25[b]
Satisfaction with care received	3.3 (0.7)	3.3 (0.7)	3.3 (0.7)	0.02 (0.6)	0.1 (0.7)	−0.1 (0.1)	.57	0.004 (0.1)	.97

Note. EHR = electronic health records; PACE = Physician Asthma Care Education; SE = standard error; QOL = quality of life.

[a] Models adjusted for fixed effects of baseline outcome, age, gender, baseline asthma severity, random effect of provider.

[b] Model did not converge.

Table 4.

Intervention Effects Based on Provider-Reported Data.

Outcome	Baseline (n = 126)	3-Month follow-up (n = 123)	6-Month follow-up (n = 116)	Changes in outcomes between 6-month follow-up and baseline		EHR-PACE[a] vs. control at 3 months, estimate (SE)	p value	EHR-PACE[a] vs. control at 6 months, estimate (SE)	p value
				Control	EHR-PACE				
EHR-related outcomes, M (SD)									
Perception of EHR communication	12.9 (5.1)	15.4 (4.4)	16.5 (5.2)	2.6 (2.7)	4.8 (5.8)	1.7 (1.3)	.23	2.2 (1.7)	.23
EHR communication	5.0 (1.6)	5.8 (1.2)	5.8 (1.4)	0.2 (0.8)	1.4 (1.7)	0.5 (0.4)	.21	0.4 (0.6)	.44
Confidence in EHR communication practices	3.9 (1.8)	5.3 (2.3)	5.5 (1.7)	0.3 (1.2)	2.9 (2.0)	2.3 (0.8)	.01	1.1 (0.6)	.10
Patient-centered communication practices	26.3 (3.0)	28.2 (3.1)	27.1 (2.8)	0.4 (2.7)	1.2 (1.8)	2.2 (1.1)	.08	0.2 (1.0)	.86
Confidence in patient-centered communication practices	24.6 (3.0)	25.3 (2.6)	25.4 (2.4)	0.6 (2.4)	1.2 (1.3)	1.3 (0.8)	.15	0.2 (0.6)	.79
Asthma-related outcomes, M (SD)									
Asthma counseling practices	19.8 (4.0)	21.6 (4.6)	21.0 (4.0)	0.6 (2.1)	1.8 (3.1)	0.4 (1.4)	.79	0.6 (1.2)	.62
Confidence in asthma counseling practices	8.3 (1.4)	9.1 (1.3)	9.0 (1.2)	−0.1 (1.6)	1.4 (1.4)	0.8 (0.6)	.19	0.9 (0.4)	.05

Note. EHR = electronic health records; PACE = Physician Asthma Care Education; *SE* = standard error; QOL = quality of life.

[a] Models adjusted for fixed effect of baseline outcome, provider's gender, examine room structure, years in practice.