The "physician on call patient engagement trial" (POPET): measuring the impact of a mobile patient engagement application on health outcomes and quality of life in allergic rhinitis and asthma patients

Cemal Cingi, MD[1], Arzu Yorgancioglu, MD[2], Can Cemal Cingi, PhD[3], Kıvılcım Oguzulgen, MD[4], Nuray Bayar Muluk, MD[5], Seçkin Ulusoy, MD[6], Nezih Orhon, PhD[3], Cengiz Yumru, MD[7], Dursun Gokdag, PhD[3], Gul Karakaya, MD[8], Şaban Çelebi, MD[9], H. Bengü Çobanoglu, MD[10], Halis Unlu, MD[11] and Mehmet Akif Aksoy, MD[1]

Background: **In this prospective, multicenter, randomized, controlled, double-blind study, we investigated the impact of a mobile patient engagement application on health outcomes and quality of life in allergic rhinitis (AR) and asthma patients.**

Methods: **In total, 327 patients with diagnoses of persistent AR or mild-to-severe persistent asthma were randomized into 2 intervention groups and 2 control groups upon their admission at outpatient clinics. The intervention groups (POPET-AR and POPET-Asthma) received a mobile phone application ("physician on call patient engagement trial" [POPET]), enabling them to communicate with their physician, and record their health status and medication compliance. The AR groups completed the Rhinitis Quality of Life Questionnaire (RQLQ) at initiation and at the first month of the study. The asthma groups completed the Asthma Control Test (ACT) at initiation and at the third month of the study.**

Results: **The POPET-AR group showed better clinical improvement than the control group in terms of the overall RQLQ score as well in measures of general problems, activity, symptoms other than nose/eye, and emotion domains ($p < 0.05$). In the POPET-Asthma group, more patients (49%) achieved a well-controlled asthma score (ACT > 19) compared with the control group (27%); this was statistically significant ($p < 0.05$).**

Conclusion: **Use of a mobile engagement platform, such as POPET, can have a significant impact on health outcomes and quality of life in both AR and asthma, potentially decreasing the number of hospital admissions, repeat doctor visits, and losses in productivity. Improvements were seen in domains related to activity, productivity, perception of disease, and emotion.**

Key Words:
mobile health; mobile applications; patient engagement; medicine reminders; patient communication; Rhinitis Quality of Life Questionnaire (RQLQ); Asthma Control Test (ACT); physician on call patient engagement trial (POPET); allergic rhinitis (AR); asthma

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Studies have shown that collaborative communication and patient-centered chronic disease self-management programs can improve disease control and patient satisfaction through improved medication compliance and better general care.[1,2] However, patients with chronic conditions

[1]*ENT Department, Medical Faculty, Eskisehir Osmangazi University, Eskisehir, Turkey;* [2]*Department of Chest Diseases, Medical Faculty, Celal Bayar University, Manisa, Turkey;* [3]*Faculty of Communication Sciences, Anadolu University, Eskisehir, Turkey;* [4]*Department of Chest Diseases, Medical Faculty, Gazi University, Ankara, Turkey;* [5]*ENT Department, Medical Faculty, Kırıkkale University, Kırıkkale, Turkey;* [6]*ENT Clinic, GOP Taksim Ilkyardım Training and Research Hospital, Istanbul, Turkey;* [7]*Anaesthesiology Clinic, Taksim Ilkyardım Training and Research Hospital, Istanbul, Turkey;* [8]*Department of Chest Diseases, Medical Faculty, Hacettepe University, Ankara, Turkey;* [9]*ENT Clinic, Haseki Training and Research Hospital, Istanbul, Turkey;* [10]*ENT Clinic, Trabzon Training and Research Hospital, Trabzon, Turkey;* [11]*ENT Clinic, Ekol ENT Hospital, İzmir, Turkey*

Correspondence to: Nuray Bayar Muluk, MD, Birlik Mahallesi, Zirvekent 2. Etap Sitesi, C-3 blok, No: 62/43, 06610 Çankaya, Ankara, Turkey; e-mail: nbayarmuluk@yahoo.com, nurayb@hotmail.com

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need care that is delivered by a healthcare team that supports self-management.[3] As patients and physicians today have started to use online communications, the potential of mobile applications to support healthcare increases, and the amount of research in the use of the online channels to interact with patients is growing rapidly. However, there are few studies in which good clinical practice examples with mobile applications are available and that show the potential impact on health outcomes.

A Cochrane database analysis by de Jongh et al.[4] indicated a lack of quality evidence in this area. Results from 2 studies showed that patients receiving mobile phone messaging support reported perceived improvements in diabetes self-management, wanted to continue receiving the messages, and preferred mobile phone messaging to e-mail as a method to access a computerized reminder system. For asthma patients, the total number of office visits was higher in the text-messaging group, whereas the number of hospital admissions was higher in the control group. The author of the study above concluded that because of the small number of trials included, and the low overall number of participants for any of the reviewed outcomes, the quality of the evidence could at best be considered moderate.[4]

Considering the lack of clear results in this area, it is quite possible that these types of interventions may only be effective for some diseases, such as allergic rhinitis (AR) and asthma, and a certain subset of patients and/or clinical settings. Also, the results may be affected by the communication content, motivational factors, compliance, and the software itself.

Thus, we conducted a clinical trial that measured the impact of a mobile patient engagement application on health outcomes in AR and asthma patients, aiming to better understand the effect of the variables above and to determine best practices in mobile patient engagement.

Patients and methods

This multicentric prospective study was conducted from June 2013 to December 2013 in the Pulmonary Diseases Departments of Celal Bayar University, Gazi University, and Hacettepe University, Turkey; and the ENT Departments of Osmangazi University, GOP Taksim Training and Research Hospital, Haseki Training and Research Hospital, and Ekol ENT Hospital, Turkey. The Taksim Training and Research Hospital Clinical Research Evaluation Commission Ethics Committee approval this study.

Research design

The goal of this trial was to test our design in a variety of chronic diseases and treatment settings against a control group and measure its impact on health outcomes and quality of life. The study was controlled, randomized, and double-blinded, and involved 327 patients with middle-high socioeconomic status who were diagnosed with persistent AR or moderate-to-severe asthma upon presentation at outpatient clinics (Fig. 1). Randomization was performed by simple randomization using a random number generator.[5]

Patients were required to own a smartphone and to consent to participation in a study researching the impact of mobile communication on disease management. Exclusion criteria were pregnancy, breast-feeding, and failing to provide consent. Patients who did not complete the final survey were excluded from the analysis and reported as attrition.

Patients

AR patients

In total, 191 patients, all with a diagnosis of persistent AR for at least 2 years, were randomized to 96 patients in the intervention group and 95 patients in the control group. The diagnosis of AR was established in light of medical history (presence of nasal congestion, anterior and posterior rhinorrhea, sneezing, and nasal itching), physical examination findings consistent with the Allergic Rhinitis and its Impact on Asthma Guidelines (ARIA) classification. The diagnosis was then confirmed by a prick test. All patients received standard treatment during the study period according to the ARIA treatment guidelines.

Asthma patients

In total, 136 patients with a diagnosis of mild-to-severe persistent asthma according to the Global Initiative for Asthma (GINA) classification[6] were randomized evenly to 68 patients in the each group. Patients received standard treatment during the study period, according to treatment guidelines.[7]

Methods

The intervention group received a mobile phone application ("physician on call patient engagement trial" [POPET]), specifically designed for the trial by the collaborators of the principal investigators and the developer POPET LLC (Fig. 2). There were separate features in the physician and patient applications. Our research design provided the opportunity to track patient health status; and to share motivational and educational content while also reminding the patient to take prescribed medications. Our design imperative was to focus on the essential disease progression and treatment data and make them accessible to physicians with an automatically triaged list of patients.

The patient application enabled the patients to submit their overall health status on a 7-point scale (6 = very good, 0 = extremely bad) with an emoticon, share a 140-character status update, send and receive messages, and ask for immediate assistance with an urgent message option, track their medicine use with a diary that sent automated reminders according to their prescribed treatment plan (once or twice daily) and complete the Rhinitis Quality of Life Questionnaire (RQLQ)[8,9] or Asthma Control Test (ACT)[10,11] within 24 hours after enrollment and again at the end of the study (1 month later for the AR group and 3 months later for

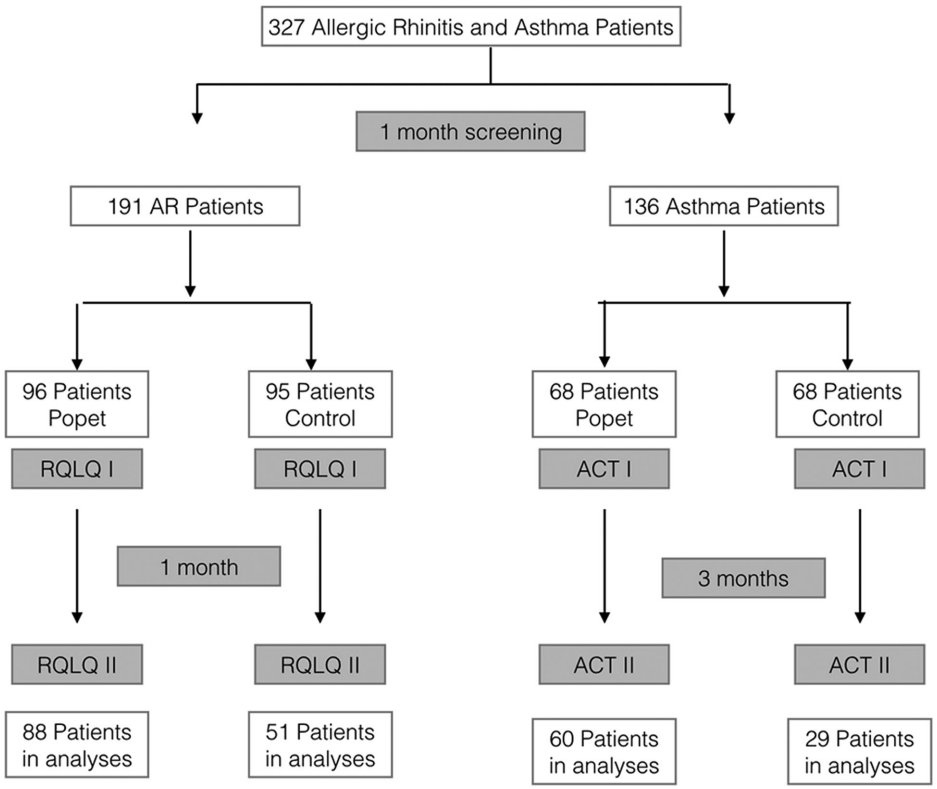

FIGURE 1. Flowchart of enrollment and patient status (n = 327) in the allergic rhinitis and asthma groups. ACT = Asthma Control Test; AR = allergic rhinitis; POPET = "physician on call patient engagement trial"; RQLQ = Rhinitis Quality of Life Questionnaire.

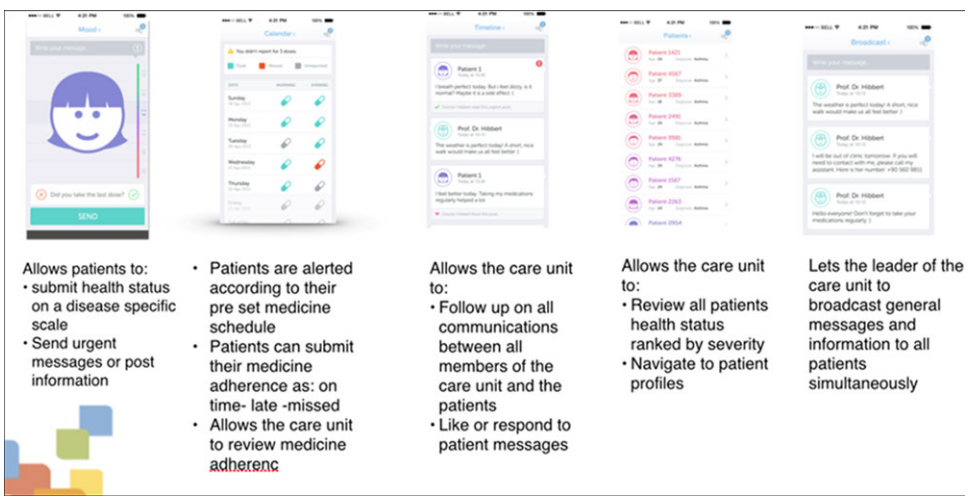

FIGURE 2. Application design.

asthma group). The control groups received an application that allowed completion of the RQLQ or ACT only at the beginning and end of the trial and did not include the communication, health status, or medication usage tracking. The physicians communicated with the control group patients only with conventional methods upon patient request, which were recorded as study findings.

Following the consent to participate, both groups were educated on the recommended use of their prescribed medications and were informed about the RQLQ or ACT in the clinic. Patients were blinded to the type of software (POPET or control) they would receive and were not trained in the use of the application in the clinic setting. The participating patient list was shared with POPET LLC (only the initials, age, gender, diagnosis, treatment plan of the patients), which randomized the patients daily to their respective groups. Patient were recruited within 1 month (Fig. 1). Following randomization, the patients received a code to download the software, which matched each patient with their physician. More information about the trial,

training of the application and technical support was available online https://www.startuphealth.com/c/8614/PoPET-LLC.

Patients in the POPET (or intervention) groups were instructed to complete the RQLQ or ACT within 24 hours of enrollment. Further instructions asked the patients to rate their health status and record their medicine usage (on time/missed/late) as convenient. They were also asked to share a short update about how they feel if they wanted to. Patients were also given the option to send physicians urgent messages, which triggered a voice notification in the physician application and was marked as urgent. Communications and educational content shared by the physician was available on a timeline (Fig. 2).

The control group received the same application but was allowed to complete the RQLQ or ACT only at the beginning and end of the trial. There was no other communication with the control group during the study period, unless prompted organically by the patients themselves.

All patient input was visible via the physician application to the assigned physician only. Both study and control group patients received a reminder to complete the tests and return for follow-up at the end of the trial period. Patients who did not complete the final survey were excluded from the trial.

Follow-up of the patients

Six ear, nose, and throat specialists and 6 chest specialist were matched with the patients they recruited. Physicians were allowed to view a list of their patients in order of severity of health status, respond to messages with text or likes, view all of their patients' input, and broadcast messages or multimedia to all patients simultaneously. Physicians were blinded to the patient's name but were able to access the diagnosis, gender, and age of the patients. To support their engagement with patients, all physicians were given the option to send predefined 140-character disease/treatment information and motivational nudges.

All users (physicians and patients) were free to engage the patients and physicians according to their personal preferences and needs with any online training content available. The number of interactions (login, status updates, sent/answered messages, response time, broadcasts, and likes) was recorded for each physician and patient. All users were given a user acceptance survey and all physicians were interviewed at the end of the trial.

Primary outcomes

AR patients were administered the RQLQ[8,9] within 24 hours after enrollment and at the end of the first month of the study. This questionnaire contains 28 questions related to symptoms, grouped into 7 domains (sleep, non–hay fever symptoms, practical problems, nasal problems, eye symptoms, activities that had been limited by nose or eye symptoms, and emotional function). Patients were asked to provide their responses on a 7-point scale (0 = no impairment, 6 = severe impairment). The overall mean score for all 28 questions was determined. A high score corresponds to a low quality of life.

Health outcomes in asthma patients were measured using the ACT.[10,11] The improvement in health outcomes was evaluated at diagnosis and by the end of third month with the ACT, which assesses the frequency of shortness of breath and general asthma symptoms, use of rescue medications, the effects of asthma on daily functioning, and overall self-assessment of asthma control. Patients answered 5 questions on a 5-point scale (for symptoms and activities: 1 = all the time to 5 = not at all; and for asthma control rating: 1 = not controlled at all to 5 = completely controlled). The scores range from 5 (poor control of asthma) to 25 (complete control of asthma). An ACT score >19 indicated well-controlled asthma.

Secondary outcomes

Patient-reported medication adherence rates were collected through the software. Numbers of follow-up visits for both intervention groups and number of emergency visits in the asthma group were collected separately by the outpatient clinics.

Statistical analysis

The SPSS software (version 16.0, 2007; SPSS Inc., Chicago, IL) was used. Using the Kolmogorov-Smirnov test, the values were not normally distributed. Thus, we used the nonparametric Mann-Whitney U-test and Wilcoxon signed rank test. In all tests, p values < 0.05 were considered to indicate statistical significance.

The difference between RQLQ scores of the POPET-AR and control-AR groups was analyzed with the Mann-Whitney U-test. In the POPET-AR and control-AR groups, the difference between pre-RQLQ and post-RQLQ scores was analyzed using the Wilcoxon signed rank test.

The difference between ACT scores in the POPET-Asthma and control-Asthma groups was analyzed with the Mann-Whitney I-test. In the POPET-Asthma and control-Asthma groups, the difference between pre-ACT and post-ACT scores was analyzed with the Wilcoxon signed rank test.

The difference between numbers of follow-up visits in the POPET-AR and control-AR groups, and the POPET-Asthma and control-Asthma groups separately was evaluated using the Mann-Whitney U-test.

Results

Patients

Of the 191 patients, 139 AR patients completed the study. Follow-up on 52 AR cases was lost because the patients wanted to be removed from the study, or they had moved to the other Turkish cities. In total, 88 AR patients (47 males, 41 females) were in the POPET-AR group. The mean age was 30.7 ± 5.9 years (range, 21.0 to 50.0 years) and all were smartphone users for at least 6 months prior to

enrollment. The control group comprised 51 AR patients (23 males, 28 females). The mean age was 31.9 ± 5.9 years (range, 23.0 to 46.0 years).

Of the 136 asthma patients, 89 completed the study. Follow-up on 47 asthma cases was lost because the patients requested to be removed from the study, or they moved to other Turkish cities. Sixty asthma patients (30 males, 30 females) were in the intervention group (POPET-Asthma). Their mean age was 32.0 ± 3.7 years (range, 25.0 to 41.0 years) and all had been smartphone users for at least 6 months prior to enrollment. The control group consisted of 29 asthma patients (12 males, 17 females). Their mean age was 34.5 ± 8.2 years (range, 25.0 to 41.0 years).

Clinical improvement

Patients who received intervention with POPET showed statistically significant overall improved clinical outcomes compared with the controls. These measured outcome improvements were especially significant in areas where the questionnaires assessed patients' productivity, perception of disease, and emotions toward their disease state.

The POPET-AR group showed better clinical improvement than the control group in the overall RQLQ score as well in the measures of sleep, general problems, nose symptoms, activity, symptoms other than nose/eye, and emotion domains ($p < 0.05$; Table 1).

In the POPET-Asthma group, more patients (49%) achieved a well-controlled asthma score (ACT > 19) than in the control group (27%); this was statistically significant ($p < 0.05$). Furthermore, the total ACT score and scores for Q1, Q4, and Q5 at the third month were significantly better for the POPET-Asthma patients ($p < 0.05$). The improvement in the total ACT score was 6.0 points for the POPET-Asthma group and 2.0 points in the control group (medians). Patients in the POPET-Asthma group felt less impaired in their activities (Q1), used less rescue inhaler medication (Q4), and felt they had better control of their asthma (Q5).

Also, of the patients using POPET, more users completed the study than in the control groups. In the POPET AR group, 92% of patients completed the trial; of the control patients, 54% completed the trial. This was also the case in the asthma group, in which 88% of POPET-Asthma patients and 43% of the control group patients completed the trial. There were also significantly fewer unplanned hospital visits in both POPET groups ($p = 0.015$, $z = -2.438$). Additionally, the percentage of emergency visits by asthma patients was also lower in the POPET-Asthma group (1.7%) than the control group (6.9%).

AR group

In total, 92% (n = 88) of the POPET-AR group and 54% (n = 51) of control group AR patients finished the trial (Fig. 1). There was no significant difference between the ages of the POPET-AR and the control group finishing the trial ($p = 0.300$).

RQLQ scores of the control and POPET groups are shown in Table 1. The RQLQ data analysis showed the 2 groups to be similar in all domains (activity, sleep, symptoms other than nose or eye, general problems, nose symptoms, eye symptoms, emotional status) and total RQLQ score at baseline ($p > 0.05$). In both the control and POPET-AR groups, posttreatment values were better than pretreatment values ($p < 0.05$).

The posttreatment total RQLQ score and other RQLQ domain scores were significantly lower in the POPET-AR group than the control group ($p < 0.05$), with the exception of sleep and eye symptoms. The POPET-AR group showed greater clinical improvement than the control group in the overall RQLQ score and in the general problems, activities, symptoms other than nose/eye, and emotions domains ($p < 0.05$) (Fig. 3).

Follow-up visits

The planned number of follow-up visits for all patients was 1.0. The number of follow-up visits were 1.0 (median; range, 1.0 to 3.0) in the control group and 1.0 (median; range, 0.0 to 2.0) in the POPET-AR group. The difference between visit numbers in the groups was not statistically significant ($p = 0.081$). However in the control group, 12% of the subjects had unplanned control visits, compared with 5% in the POPET-AR group.

Status updates and patient satisfaction scores

In the POPET-AR group, patients shared 12.0 status updates (median; range, 3.0 to 27.0). The patient satisfaction score was 4.0 (median; range, 2.0 to 5.0) on a 6-point scale (5 = very good, 0 = extremely bad).

Asthma group

In total, 88.2% (n = 60) of the intervention group and 42.6% (n = 29) of the control group of asthma patients finished the trial. There was no significant difference in the age or gender of the POPET and control group subjects finishing the trial ($p = 0.239$). In both the control and POPET-Asthma groups, posttreatment values were better than pretreatment values ($p < 0.05$).

ACT scores of the control and POPET groups are shown in Table 2. In the POPET-Asthma group, more patients (49%) achieved a well-controlled asthma score (>19) than in to the control group (27%), which was statistically significant ($p < 0.05$). There were also statistically significant differences between the control and POPET groups posttreatment (third month evaluation) in the total ACT score and for questions 1, 4, and 5 ($p < 0.05$). The total ACT scores of the POPET-Asthma group improved by 6.0 points, whereas in the control group the improvement was 2.0 points (median). Patients who used POPET felt less impaired in their activities (Q1), used less rescue inhaler medications (Q4), and more felt their asthma to be under control (Q5) (Fig. 4).

TABLE 1. RQLQ scores of the control and POPET groups in allergic rhinitis

	Group 1 (Control) (n = 51)			Group 2 (POPET) (n = 88)			
	Median	Minimum	Max	Median	Minimum	Maximum	p^*
Activity							
Pre	13.0	9.0	17.00	13.0	8.0	18.0	0.772
Post	5.0	1.0	7.00	3.0	0.0	5.0	0.000
p^{**}		$p = 0.000$			$p = 0.000$		
Improvement	8.0	3.0	13.0	10.0	5.0	15.0	0.000
Sleep							
Pre	9.0	2.0	14.00	10.0	3.00	14.0	0.792
Post	5.0	1.0	11.00	5.0	0.00	13.0	0.120
p^{**}		$p = 0.000$			$p = 0.000$		
Improvement	3.0	11.0	−1.0	5.0	10.0	0.0	0.032
Symptoms other than nose or eye							
Pre	12.0	8.0	15.0	13.0	5.00	17.0	0.441
Post	7.0	2.0	11.0	4.0	1.00	9.0	0.000
p^{**}		$p = 0.000$			$p = 0.000$		
Improvement	5.0	1.0	8.0	8.0	4.0	16.0	0.000
General problems							
Pre	9.0	3.0	15.0	10.0	1.0	15.0	0.181
Post	5.0	1.0	10.0	4.0	0.00	9.0	0.041
p^{**}		$p = 0.000$			$p = 0.000$		
Improvement	4.0	0.0	10.0	6.0	1.0	10.0	0.000
Nose symptoms							
Pre	17.0	13.0	21.0	17.0	13.0	22.0	0.966
Post	6.0	3.0	11.0	6.0	1.0	12.0	0.021
p^{**}		$p = 0.000$			$p = 0.000$		
Improvement	10.0	7.0	15.0	11.0	6.0	17.0	0.026
Eye symptoms							
Pre	8.0	4.0	13.0	8.0	4.0	19.0	0.853
Post	4.0	0.0	8.0	4.0	1.0	9.0	0.541
p^{**}		$p = 0.000$			$p = 0.000$		
Improvement	4.0	0.0	10.0	4.0	−2.0	12.0	0.305
Emotional status							
Pre	13.0	9.0	20.0	13.0	7.0	21.0	0.797
Post	7.0	2.0	12.0	3.0	0.0	6.0	0.000
p^{**}		$p = 0.000$			$p = 0.000$		
Improvement	6.0	1.0	14.0	10.5	7.0	19.0	0.000

(*Continued*)

TABLE 1. Continued

	Group 1 (Control) (n = 51)			Group 2 (POPET) (n = 88)			
	Median	Minimum	Max	Median	Minimum	Maximum	p^*
Total RQLQ							
Pre	81.0	66.0	103.0	84.0	65.0	105.0	0.149
Post	39.0	30.0	55.0	28.0	16.0	46.0	0.000
p^{**}		$p = 0.000$			$p = 0.000$		
Improvement	42.0	26.0	54.0	55.5	42.0	72.0	0.000

*Mann-Whitney U test results.
**Wilcoxon signed rank test results.
POPET = physician on call patient engagement trial; Post = 1 month after initiation of study; Pre = initiation of study; RQLQ = Rhinitis Quality of Life Questionnaire.

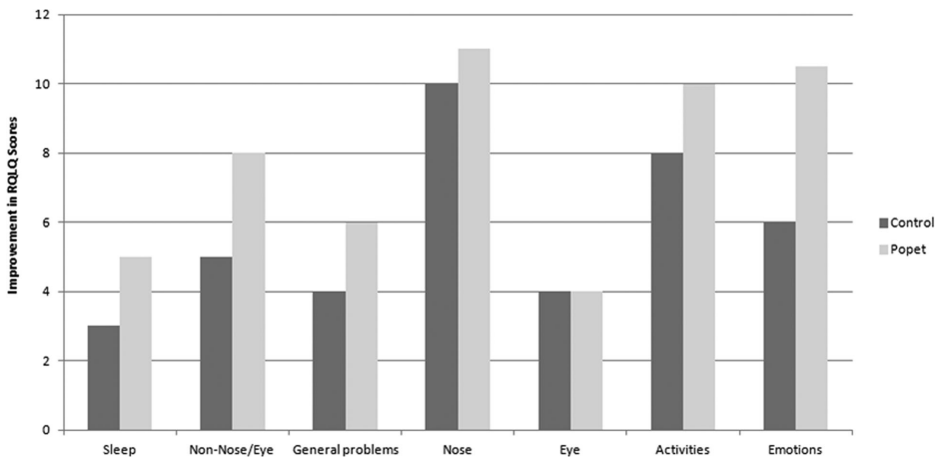

FIGURE 3. Comparison of improvement in the RQLQ scores of the groups. *Values are medians. POPET = "physician on call patient engagement trial"; RQLQ = Rhinitis Quality of Life Questionnaire.

Follow-up visits

The number of planned follow-up visits for all patients was 1.0. The numbers of follow-up visits were 1.0 (median; range, 1.0 to 3.0) in the control group and 1.0 (median; range, 0.0 to 2.0) in the POPET-Asthma group. In the control group 32.1% of the subjects had unplanned control visits vs 10.9% in the POPET-AR group. This difference was statistically significant ($p = 0.015$, $z = -2.438$).

Status updates and patient satisfaction scores

POPET-Asthma patients shared 28.5 status updates (median; range, 3.0 to 89.0). The patient satisfaction score was 4.0 (median; range, 3.0 to 5.0) on a 6-point scale (5 = very good, 0 = extremely bad). The frequency of POPET input and use was 90.0 times (median; range, 70.0 to 154.0), indicating that the patients used POPET frequently.

Communication times and messages

We found that 86% of communications were between 8:00 AM and 6:00 PM, indicating that physicians did not have to spend significant time outside working hours to follow up on their patients. In our trial patients shared a total of 3288 status updates and asked for specific advice in 546 messages; 32 messages were marked as urgent. In total, 92% of patient messages were relevant to the disease and the remaining were marked as ~4% expressing gratitude, 2% appointment requests, 1% random chatter, and 1% "other," as categorized and reported by individual physicians. In total, 92% of physicians responded to all urgent messages and severe health status submissions.

Discussion

Physicians have less time to spend with individual patients as the volume of patients continues to increase and subsequently have limited time for telephone consultations, in contrast to the past, when patients' questions related to chronic disease management could be answered. Also, according to World Health Organization (WHO) reports, ~50% of all patients fail to take their medication correctly (2003) and in the United States, medication nonadherence is considered to be the cause of 33% to 69% of medication-related hospital admissions, and 23% of all nursing home

TABLE 2. ACT scores of the control and POPET groups in asthma

	Group 1 (Control) (n = 29)			Group 2 (POPET) (n = 60)			
	Median	Minimum	Maximum	Median	Minimum	Maximum	p^*
Q1							
Pre	3.0	1.0	5.0	3.0	1.0	5.0	0.627
Post	3.0	2.0	5.0	4.0	3.0	5.0	0.000
p^{**}		$p = 0.001$			$p = 0.000$		
Improvement	0.0	0.0	2.0	1.0	0.0	3.0	0.000
Q2							
Pre	3.0	1.0	5.0	3.0	1.0	5.0	0.818
Post	4.0	2.0	5.0	4.0	2.0	5.0	0.502
p^{**}		$p = 0.000$			$p = 0.000$		
Improvement	1.0	0.0	3.0	1.0	0.0	3.0	0.250
Q3							
Pre	3.0	2.0	4.0	3.0	1.0	5.0	0.638
Post	4.0	2.0	5.0	4.0	2.0	5.0	0.261
p^{**}		$p = 0.001$			$p = 0.000$		
Improvement	1.0	−1.0	2.0	1.0	−1.0	4.0	0.175
Q4							
Pre	3.0	1.0	4.0	3.0	1.0	5.0	0.777
Post	4.0	2.0	5.0	5.0	3.0	5.0	0.000
p^{**}		$p = 0.001$			$p = 0.000$		
Improvement	1.0	−1.0	2.0	1.0	0.0	4.0	0.001
Q5							
Pre	3.0	1.0	5.0	3.0	1.0	5.0	0.585
Post	4.0	2.0	5.0	4.0	3.0	5.0	0.000
p^{**}		$p = 0.042$			$p = 0.000$		
Improvement	0.0	−3.0	3.0	1.0	0.0	3.0	0.000
Total ACT Score							
Pre	15.0	9.0	23.0	15.5	6.0	23.0	0.597
Post	18.0	14.0	24.0	21.0	15.0	25.0	0.000
p^{**}		$p = 0.000$			$p = 0.000$		
Improvement	2.0	−1.0	7.0	6.0	1.0	14.0	0.000

*Mann-Whitney U test results.
**Wilcoxon signed rank test results.
ACT = Asthma Control Test; POPET = physician on call patient engagement trial; Post = 3 months after initiation of study; Pre = initiation of study.

admissions, repeat visits to physicians, emergency department (ED) visits, and the related loss in productivity.[12]

Digital communication represents an important healthcare tools of the future. It has become increasingly important to determine best practices for the development and use of digital communications to educate and communicate with patients. Improving the communicative relationship between patients and both clinical and nonclinical healthcare personnel that provide the full care cycle for any given patient's condition is the key to delivering better health outcomes. Thus, creating shared value for the healthcare system while improving the relationship and then building and enabling an information technology (IT) platform is a key component of this necessary strategy.[13] The use of

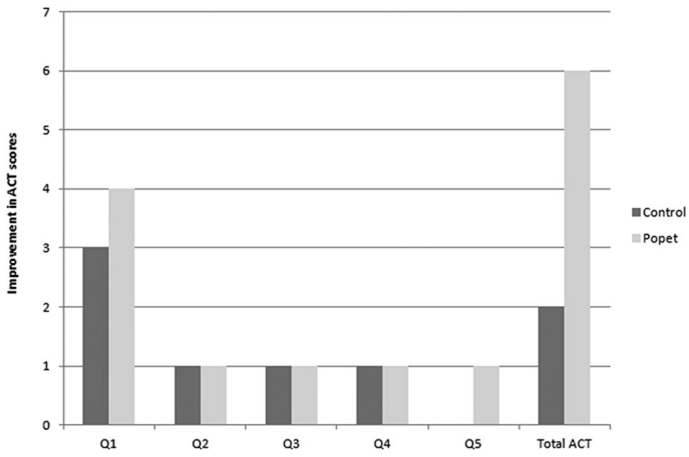

FIGURE 4. Comparison of improvement in the ACT values of the groups. *Values are medians. ACT = Asthma Control Test; POPET = "physician on call patient engagement trial".

mobile phones and social media to efficiently engage and educate large numbers of patients is 1 potential component of such IT platforms.

Mobile technologies have the potential to transform healthcare by allowing clinicians to address patient's healthcare needs in real-time.[14] Research on the use of smartphones in medicine is growing rapidly, but there are very few good-quality studies to answer the many questions about the use of technology and the impact it may have. Although several studies have aimed to create an interactive system for patients, they generally did so by gathering data from patients through relatively basic mechanisms (eg, touch-tone keypad) and sending back automated, albeit customized, feedback designed to educate and counsel. Furthermore, these studies required a substantial degree of patient motivation, which may be unrealistic or at least pose a barrier.[15]

As the next generation of patients enter the healthcare marketplace, there is a large majority of patients familiar with online or mobile collaboration and education, indicating a need for the development of mobile applications to support communications regarding the management of chronic medical conditions. Research and studies attempting to understand potential online/mobile channels to interact with patients is growing rapidly, but the studies are not yet conclusive. It is quite possible that these types of interventions may be effective only for certain subsets of patients; communication content, user motivation, compliance, and the software itself all likely affect the clinical setting and the results.

In the present study, we used a mobile patient engagement software as part of the management and care in the treatment of AR and asthma patients. The intervention group received a mobile phone application, which was specifically designed for the trial by collaborators of the principal investigators and the developer, POPET LLC, whereas the control group was given only traditional care.

Studies have shown varied results when attempting to better understand the best means of delivering patients' needs and interprofessional communications using both online and mobile technologies. The internal medicine program at Toronto General Hospital conducted a study using dedicated BlackBerries for each medical team.[16] Nurses could call the team or use a web-based program to send e-mails to these phones for less urgent issues. Overall, surveys from residents reported improvements in communication and decreased workflow disruption. Nurses reported decreased time spent attempting to contact physicians; however, there was no change in response time for urgent issues. Another study by this group also illustrated the efficiency of smartphones over pagers but noted a perceived increase in interruptions and weakened interprofessional relationships.[17] They also reported value in the ability to receive non-urgent messages via e-mail; however, there has been disagreement as to what types of messages are appropriate for various communication methods.[18]

Previous studies specifically with asthma patients using reminder systems and online interventions have shown that medication adherence improved in the intervention groups. However, no study reported a change in asthma-related quality of life or clinical asthma outcomes.[19]

To evaluate the long-term impact of these types of interventions and to understand the design implications of the engagement software, our trial assessed the effect of a mobile patient engagement tool on clinical outcomes, specifically the quality of life in AR and asthma patients. To overcome potential motivation barriers of physicians and patients, the POPET application user experience is similar to everyday social media apps and had simple interaction capabilities. A trial coordinator was also available to both physicians and patients (control and intervention groups) for usage questions and trial maintenance. In our trial, all patients were given recommended treatment guidelines and medications during office visits. However, the intervention groups could also communicate with their physician using the POPET system. With this intervention, patient satisfaction scores were significantly higher than those of patients in the control group, presumably due to physician access. Patients used the POPET application and subsequently required fewer additional office visits than the controls. During the posttreatment period, the POPET groups also had better RQLQ and ACT results than the control group.

The majority of communications via the POPET application were between 8:00 AM and 6:00 PM, indicating that physicians did not have to spend significant time outside working hours to follow up with their patients. Also, 92% of physicians responded to all urgent messages and serious health status submissions.

Healthcare apps will play an important role in physician-patient relations in the future. We recommend that such patient engagement applications be designed following these criteria: having a familiar user experience (thus, decreasing the digital learning curve for both the patient and the physician), maintaining a simple motivational and engaging

interface, and available on a mobile/cellular device to ensure real-time interaction, allowing for appropriate triage, and ultimately leading to presumably decreased physician response time for urgent needs.

When smartphones were used for clinical communication, residents perceived an improvement in communication. Residents also strongly preferred e-mails, as opposed to telephone calls, as the primary method of communication. Further objective evaluation is necessary to determine whether our intervention improves efficiency and, more importantly, quality of care.[16]

Lo et al.[20] reported that the use of smartphone technology was well received among clinicians. Specifically, healthcare professionals valued the use of e-mails when communicating non-urgent issues and the availability of the phone function that enabled access to clinicians, especially in urgent situations. Dissatisfaction, however, was expressed over the suitability of these smartphone features in different communication contexts, as well as discrepancies between clinicians over the appropriate use of the communication modes. Future interventions in communication technology should take into consideration the impact of communication media and situational contexts (eg, urgent vs non-urgent patient issues) on interprofessional interactions.

Our recommendations are that patient engagement applications should be designed to provide a familiar user experience, have motivational and visual user interfaces to simplify usage and keep the users engaged, and, finally, to include mobile phone interfaces to ensure real-time interaction, allowing automated triaging and, in turn, presumably reduce the physician response time for urgent requests.

One limitation of our study is that the number of subjects lost to follow-up was higher in the control group than in the POPET group. We consider that, in the POPET group, due to the close communication with the physician and patient, there was no problem in following the patients, whereas in the control group, communication was more difficult. As a result, the control group's communication with the physicians was at a low level; subjects in both the AR and asthma groups requested to leave the study.

This trial shows that the POPET application can deliver value in physician-patient communications, was easy to use, and contributed to an improvement in the overall quality of life outcomes in AR and asthma patients. However, future trials should measure the effects of trial coordination on physician usage rates to better understand potential usage in the clinical (non-trial) setting. The use of the POPET application in our trial also showed a decrease in attrition rates; thus the use of such applications may have the potential to prevent loss to follow-up. In future trials, we will evaluate use of such applications in long-term compliance and patient participation in health maintenance; our current data suggest that the results would likely be similar.

Smartphones, mobile technologies, and software systems are technologies of the future and must be integrated into healthcare delivery. Using these systems, patients could be better informed and connected, especially those with chronic diseases such as AR and asthma. Moreover, patients' satisfaction with their care could be enhanced by such applications.

Conclusion

AR and asthma are 2 chronic diseases for which enhanced patient support, medication compliance, and lifestyle management can have positive impacts on the health status achieved, how patients experience the process of recovery, and ultimately the sustainability of their health. Our study showed that use of a mobile engagement platform, such as POPET, can have a considerable impact on health outcomes and quality of life in both AR and asthma, thus potentially decreasing the number of hospital admissions, repeat doctor visits, and loss in productivity. The most marked improvements in both disease groups were in domains related to activity, productivity, and perception of disease and emotion, all of which can be classified as outcomes of high importance to the patients. Also, the lower attrition rates in the POPET groups suggest that the application has the potential to reduce patient loss to follow-up.

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