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Evaluation of the Patient Activated Learning System (PALS) to improve knowledge acquisition, retention, and medication decision making among hypertensive adults: Results of a pilot randomized controlled trial

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ABSTRACT

Background: There are few engaging, patient centered, and reliable e-Health sources, particularly for patients with low health literacy.
Objectives: We tested the Patient Activated Learning System (PALS) against *WebMD*. We hypothesized that participants using PALS would have higher knowledge scores, greater perceived learning, comfort, and trust than participants using *WebMD*.
Methods: Participants with hypertension from an urban Internal Medicine practice were randomized to view 5 web pages in PALS or*WebMD* containing information about chlorthalidone. We assessed knowledge, learning perceptions, comfort, and trust through surveys immediately and one week following the intervention.
Results: 104 participants completed both survey sets (PALS = 51,*WebMD* = 53). Immediate post intervention mean knowledge scores were higher for the PALS participants [(4.33 vs. 3.62 (P = .003)]. A greater proportion of PALS participants answered ≥4/5 questions correctly (82% vs. 57%; IRR 1.46 [95% CI 1.13–1.89]). A greater proportion of PALS participants agreed they would feel comfortable taking chlorthalidone if prescribed to them (73% vs. 55%; IRR 1.38 [95% CI 1.04–1.84]). One-week recall and trust were similar in the two groups.
Conclusions: PALS may have advantages over*WebMD* for immediate knowledge acquisition, perceived learning, and comfort.
Implications: PALS is a promising new approach to eHealth patient education.
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1. Introduction

Educating patients about their health conditions is a fundamental component of the physician's role in healthcare, but it is especially critical for meaningful shared decision-making [1]. Only 12% of US adults have proficient health literacy and 36% have basic or lower health literacy, underscoring the need for effective patient education [2–6]. However, the median duration of a primary care visit remains under 20 min, limiting the opportunity for patient education during the physician encounter [7]. The need for optimal patient education strategies is made even more acute by the fact that half of US adults now live with at least one major chronic health condition and one in four live with multiple chronic conditions [8]. For patients to participate as full partners in shared decision-making, they need information that is easily accessed, easily understood, and reliable.

Because of the limited time spent with physicians, people increasingly look to the Internet for health related information (eHealth) [9]. In 2011, fully 59% of US adults reported using the Internet to look for health related information [9], but many have difficulty finding, understanding, and remembering health

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information obtained online. [10,11] Furthermore, information often does not address the specific questions patients have. In addition, the content is often delivered as complex formal text at a high reading level, which may not be optimal to promote understanding [12–17]. Many patients prefer their healthcare providers to recommend reliable eHealth sources, but medical education and training do not currently include recommendations about eHealth resources [11]. As a result, providers face challenges in finding engaging, appropriate, and reliable e-Health sources for patients, particularly for those with low health literacy.

The Patient Activated Learning System (PALS; palsforhealth.com) is a new platform currently under development that is intended to fill these gaps. The long-term goal of the PALS is to improve patients' understanding of their health conditions and treatment options to allow them to participate fully in shared decision-making. Ultimately, the PALS is intended to increase self-efficacy and commitment to self-care. It offers a highly patient-centered approach to health education delivery, incorporating best practices in adult education and combining several core features: 1) information is delivered through audiovisual as well as written content in an engaging, conversational style; 2) content is organized and driven by patients' questions; 3) content is organized into concise, discrete segments that cover a single learning objective ("reusable knowledge objects"); 4) content is presented at a 6-7th grade reading level; and 5) content delivery incorporates narratives and social modeling to enhance engagement and knowledge retention. The PALS is designed to be a resource that patients can access independently from a computer or mobile device with Internet access, as well as one that physicians can use to support their own in-office patient education efforts. Thus, the PALS is not only a means for educating patients, but also a way to promote discussions between the patient and their provider, increasing the quality of shared decision-making.

For the PALS to reach its full potential, a critical question is whether it offers advantages over existing widely used eHealth resources. We studied whether the PALS approach to eHealth delivery leads to better patient learning compared with one of the leading eHealth sources, *WebMD*. We tested the hypothesis that patients who learned about a new hypertension medication using the PALS would have higher immediate and 1-week knowledge scores compared to patients who learned the same information via *WebMD*. We also compared patient reports about medical decision-making, trust, user experience, and website satisfaction between PALS and *WebMD*. Because we had no prior evidence of efficacy of the PALS, we first conducted a pilot study, the results of which are reported here.

2. Methods

2.1. Theoretical framework for the PALS

The PALS was developed to fill gaps identified in current online health-related information platforms and was inspired by a decade of pragmatic intervention studies to improve health outcomes in individuals living with chronic disease in resource-poor remote settings. We designed the system to provide engaging, easily understood, and focused answers to health-related questions to a wide audience but targeted at populations with low health literacy. The site integrates adult learning theory, social cognitive theory, Bartle's taxonomy, knowledge reuse theory, and patient preferences for receiving health-related information from their doctor (Table 1). The theoretical elements and how the PALS addresses them are further discussed in the Supplementary Material.

A central feature of the PALS is the use of reusable knowledge objects (RKO) as the mode of presenting information, an example of after-the-fact filtering according to knowledge reuse theory [18]. The PALS RKO starts with a question derived from end users, with physicians serving as the senior author. It includes the articulation of a single learning objective, an evidence summary derived from a rigorous literature review including references, patient-facing text and/or video, and an assessment question and response set. Repetition of the question at the start and again at the end of the RKO is an intentional strategy to solidify learning, which culminates in the assessment question and response options that reinforce the short answer to the question. PALS-RKO's are peer reviewed by physicians for accuracy. To emphasize that content developers include healthcare professionals based at reputable academic institutions, the authors are displayed along with their photographs and institutional affiliations.

2.2. End-user engagement during early PALS development

A central objective of the PALS was to respond to user questions rather than providing information that healthcare professionals think their patients ought to know. Our research experience showed that some of the most profound information gaps surrounded medications. Patients often first want to know information about side effects and costs when new medications are introduced, whereas physicians often stress the longer-term benefits of the medication. We therefore asked 4 groups of 8–10 individuals living with at least one chronic condition treated with medications to list the questions that come to mind when their doctor recommends a new medication. Using this list, we asked a convenience sample of 35 individuals to rank order the 5 most important questions to them. This resulted in 25 end user

Table 1
Theories related to adult learning and how the PALS incorporates them.

Theory	Element of the Theory	How the PALS incorporates the element
Adult Learning Theory	Learning is self-directed	Users select a question that interests them after entering a word into the search bar
	Learning incorporates past experience	Videos depict individuals in familiar contexts (at home, in the park, in a café, etc.)
	Learning is problem-oriented	Searchable question/answer format rather than didactic, text-heavy material
	Learning is collaborative	Customizable curriculum encourages doctor-patient collaboration
		User feedback is solicited for each RKO
		New questions are solicited from users to drive new content development
Social cognitive theory	Learning by observing others	Videos include brief stories with real-world characters to encourage homophily
Bartle's taxonomy	Learning through entertainment	Videos are designed to be entertaining
	Learning enhanced by achievement	Users can track their progress compared with others
	Learning through collaboration	Collaboration with the doctor
		Chat rooms
	Learning through discovery	Additional content is suggested at the conclusion of viewing an RKO
		Searchable database of content
Knowledge Reuse Theory	After-the-fact filtering	Searchable database of reusable knowledge objects

questions that formed the nidus for initial content development relating to medications. Moving forward, content development is driven by this list of questions, end-user questions that are submitted through the website, national guidelines and consensus statements, and data available on Google Trends.

2.3. Web utilization

The PALS is in ongoing production with limited content currently. Nevertheless, we monitor web utilization using Google Analytics data to track the number of website visits, average page views per session, and geographic reach of the site.

2.4. Pilot RCT testing knowledge acquisition of the PALS vs. WebMD

2.4.1. Design

The pilot RCT was an un-blinded randomized controlled trial comparing the PALS to *WebMD*. Blinding of participants to their intervention arm assignment was not feasible. The study was designed to detect differences in mean knowledge assessment scores ranging from 0.14-0.42 based on SD's of 0.25-0.75, alpha of 0.05, and 80% power. This resulted in a total sample size of 100 with 50 in each study arm. To allow for 20% attrition, we aimed to recruit 120 participants.

2.4.2. Participants and informed consent

Participants were recruited from an urban adult internal medicine clinic affiliated with an academic medical center in New York City between April and August 2017. We reviewed the electronic medical record for potentially eligible participants who were then contacted by phone or approached in the practice waiting room and invited to participate. Participants were eligible if they were identified as having a diagnosis of or being treated for hypertension, were able to speak and read in English, had been prescribed any antihypertensive medication except chlorthalidone, and were medically and cognitively capable of participating. The ability to read in English was added shortly after the study commenced. Those who did not meet these criteria were excluded. Computer / Internet literacy was not part of the eligibility criteria. Participants provided verbal informed consent and the protocol was approved by the Weill Cornell Medicine Institutional Review Board.

2.4.3. Randomization

Participants were randomized into either the PALS or the *WebMD* study arm after informed consent was obtained. One team member served as the randomization coordinator. We created a randomization plan using a third party website [19] Block randomization was employed to balance randomization across the study arms [20].

2.4.4. Interventions and data collection

The interventions were delivered during a face-to-face visit at the clinic, and 1-week follow-up was conducted over the telephone. At the intervention visit, after providing informed consent and randomization, each participant was asked demographic questions and completed the Rapid Estimate of Adult Literacy in Medicine –Short Form [(REALM-SF) with two additional short words added (Supplementary material)] [21]. The words "fat" and "flu" were added to help participants feel more comfortable prior to reading the words from the REALM-SF and as a way to add simple words for the participants to read. In addition to participant self-report, a participant's ability to read this modified REALM was used by the research assistant to determine qualitatively whether or not the participant was literate enough in English to proceed with the intervention.

Participants were then asked by a research assistant to view a series of 5 online web pages within their intervention of randomization that addressed 5 questions about the medication chlorthalidone using a laptop computer or tablet provided by the research assistant. Participants were not required to navigate the website as links to the pages were devised and loaded prior to the intervention. Before each webpage was viewed, the Qualtrics survey page presented the question that the content answered. For example, participants viewed "How much will chlorthalidone reduce my risk of blood pressure related problems like heart disease and stroke?" on the Qualtrics page, after which they followed a link to the webpage on their site of randomization that answered this question. The 5 PALS pages each answered one question about chlorthalidone. The *WebMD* pages were publicly available and contained the answers to the same 5 questions but the answer could occur anywhere on the page, and no attention was drawn to where the answer could be found to simulate the learning experience of most eHealth users. The PALS site lists the institutional affiliation of the content authors (primarily Weill Cornell Medicine) below their names at the bottom of each article. The institutional name is not otherwise displayed on the site. The PALS software was developed by CGI of Hoover, Alabama. Screenshots of the PALS pages are shown in the Supplementary material.

Participants were permitted to scroll freely throughout each web page, and they were permitted to view the site for an unlimited period of time. After viewing each page, they answered a corresponding knowledge assessment question (Supplementary Material). After viewing all 5 pages and completing the 5 corresponding assessment questions, they completed a survey with several components, which are described below. Participants were contacted by telephone one week after their in-clinic visit and asked the same 5 assessment questions again. They were also asked if they had visited the site on their own since receiving the intervention. All survey questions and responses were collected through Qualtrics (www.qualtrics.com). Participants were compensated $25 for their participation in the study, which they received immediately following delivery of the intervention.

2.5. Outcomes

2.5.1. Primary outcomes

The primary outcome measure was a knowledge assessment score comprised of a simple sum of correct responses on the 5 knowledge assessment questions, resulting in a score of 0-5. We measured the mean scores in each group as well as the proportion of participants in each group who answered $\geq$4 of the 5 questions correctly immediately and one week following the intervention.

2.5.2. Secondary outcomes

The secondary outcomes were perceptions of learning, perceptions of medical decision-making, user experience, website satisfaction, and trust in the website. One set of questions assessed participants' perceptions of what they learned, comfort with and adequacy of the information to make a hypothetical decision about taking chlorthalidone. Since we found no validated questionnaires that assessed this domain, we developed these questions. Another set of questions assessing user experience and website satisfaction was adapted from the eHealth Impact Questionnaire Part 2 (eHIQ-Part 2) [22]. We also selected 8 relevant questions from a questionnaire developed by Harris et al to assess trust in eHealth in the four major categories of information quality, personalization, impartiality, and credible design [23]. Survey responses were on a 5-point Likert scale (Strongly Agree to Strongly Disagree). The survey questions are shown in the Supplementary Material.

2.5.3. Statistical analyses

Characteristics of participants were compared between the two study arms using t-tests for continuous variables and X^2 tests for categorical variables. Characteristics with imbalance across study arms were included as covariates to adjust for these differences in the analyses. Mean knowledge scores were assessed using a two-sample Wilcoxon rank sum test. A test of proportions was utilized to compare 80% or more (at least 4 of 5) correct for the knowledge assessment questions. Additionally, a test of proportions was used to compare responses to survey questions between the two study arms. The immediate knowledge scores and secondary outcomes were assessed at the intervention visit, thus these results were assessed for all randomized participants regardless of follow-up completion. Participants who completed both the intervention and follow up assessments were included in the follow up analysis. Likert scale responses of "agree" and "strongly agree" were combined, as were "disagree" and "strongly disagree". Combining the Likert responses was not pre-specified but was done for ease of interpretation of the data. The proportion of participants who agreed with each statement were compared between the PALS and *WebMD* groups. Poisson regression models were constructed to model the outcomes while controlling for differences in imbalance across the study arms, resulting in incidence rate ratios (IRR) along with their 95% confidence intervals (CI). Because of concerns that the knowledge acquisition scores could have been influenced by some participants in the PALS arm having the opportunity to view the assessment questions as part of the intervention, in a secondary (not-pre-specified) analysis we removed participants among whom any response options were clicked during the time period when they were viewing the site and conducted an analysis of only participants who did not view the assessment question as part of the intervention. All statistical analyses were performed using Stata version 14.

3. Results

3.1. Participant characteristics

The Consort diagram for the trial is shown in Fig. 1. A total of 668 participants were identified as potentially eligible for the study based on review of the clinic's electronic medical record. Of these, 263 were contacted to determine eligibility, 118 were enrolled and randomized, 113 completed the intervention, and 104 patients completed the 1-week follow up survey, 53 in the *WebMD* arm and 51 in the PALS arm.

The characteristics of the 104 trial participants who completed the 1-week follow-up are shown in Table 2. Their average age was 61 years; 53% were women; 68% were minorities; 68% had at least some college education; 74% were insured by Medicare, Medicaid, or a combination of the two; and the mean number of medical conditions listed in the electronic medical record was 13. The average REALM-SF score corresponded to about an 8th grade reading level. Only 23% of this sample reported never or very rarely going online to seek health related information. The only characteristic that was significantly different between study arms was frequency of Internet use, with 59% of PALS participants and 77% of *WebMD* participants reporting daily use (P = .011).

3.2. Main results

Table 3 shows the results of the trial's outcomes. Immediately following the intervention, mean knowledge scores were significantly higher for the PALS (4.33) than for *WebMD* (3.62, P = .003). A greater proportion of PALS (82%) than *WebMD* (57%) participants answered ≥4 of 5 questions correctly (IRR 1.46 [95% CI 1.13–1.89]). One week later, mean knowledge scores were lower and similar for both treatment arms (PALS 3.57, *WebMD* 3.47 [p = 0.73]), and 59% of PALS participants answered ≥4 of 5 questions correctly vs. 49% of

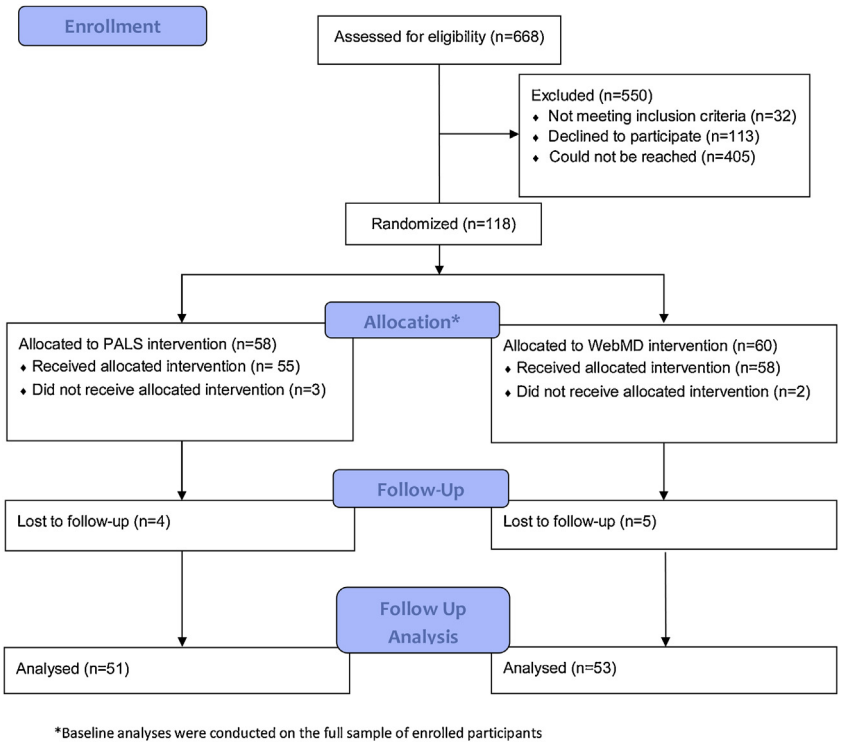

Fig. 1. Consort diagram.

Table 2
Characteristics of trial participants who completed 1-week follow-up, by treatment arm.

Characteristic	*WebMD*	PALS*	p-value
N	53	51	
Age, mean years [SD*]	59.8 [13.7]	61.3 [11.0]	0.54
Female gender, n (%)	28 (53%)	27 (53%)	0.99
Race, n (%)			0.45
White	16 (30%)	17 (33%)	
Black *or African American*	21 (40%)	24 (47%)	
Other	16 (30%)	10 (20%)	
Hispanic or Latino ethnicity, n (%)	10 (19%)	8 (16%)	0.67
Highest education achieved, n (%)			0.21
High School	19 (36%)	14 (27%)	
Some College	18 (34%)	13 (25%)	
College Graduate of More	16 (30%)	24 (47%)	
Medical insurance, n (%)			0.58
Commercial	11 (21%)	16 (31%)	
Medicaid or Medicaid Managed Care	18 (34%)	13 (25%)	
Medicaid and Medicare	8 (15%)	6 (12%)	
Medicare	16 (30%)	16 (31%)	
Mean number of medical conditions [SD]	13 [8.2]	13 [10.2]	0.89
Frequency of going online, n (%)			0.01
Never	7 (13%)	4 (8%)	
Monthly/Weekly	5 (9%)	17 (33%)	
Daily	41 (77%)	30 (59%)	
Frequency of going online to access health information, n (%)			0.79
Never/Yearly	13 (25%)	11 (22%)	
Monthly/Weekly	27 (51%)	28 (55%)	
Daily	6 (11%)	8 (16%)	
Missing	7 (13%)	4 (8%)	
Follow up days, mean [SD]	9 [3.9]	9 [3.3]	0.42
REALM-SF* Score [SD]	6.6 [1.17]	6.5 [1.08]	0.80

[a] Abbreviations: PALS = Patient Activated Learning System. REALM-SF = Rapid Estimate of Adult Literacy in Medicine-Short Form. SD = standard deviation.

Table 3
Differences in correct responses to knowledge assessment questions after the intervention and 1 week later, by treatment arm.

Question Topic	Immediate				1 week follow up			
	WebMD	PALS*	p-value	Adjusted[a] IRR*, PALS Compared to *WebMD*, [95% CI*]	*WebMD*	PALS	p-value	Adjusted[a] IRR, PALS Compared to *WebMD*, [95% CI]
N	58	55			53	51		
How much will chlorthalidone reduce my risk of blood pressure related problems like heart disease and stroke?	45 (78%)	51 (93%)	0.02	1.20 [1.03,1.40]	33 (62%)	38 (75%)	0.18	1.26 [0.97,1.64]
What are the side effects of chlorthalidone?	53 (91%)	39 (71%)	<0.01	0.79* [0.65,0.95]	47 (89%)	35 (69%)	0.01	0.79 [0.63,0.98]
How does chlorthalidone work?	37 (64%)	50 (91%)	<0.01	1.45 [1.18,1.77]	34 (64%)	35 (69%)	0.63	1.09 [0.83,1.44]
Are there any activities I should avoid while taking chlorthalidone?	38 (66%)	47 (85%)	0.01	1.33 [1.07,1.65]	38 (72%)	39 (76%)	0.58	1.05 [0.84,1.31]
Are there over the counter medications I should avoid when taking chlorthalidone?	37 (64%)	51 (93%)	<0.01	1.45 [1.19,1.78]	32 (60%)	35 (69%)	0.38	1.15 [0.86,1.54]
≥4 of 5 Correct	33 (57%)	45 (82%)	<0.01[b]	1.46 [1.13,1.89]	26 (49%)	30 (59%)	0.32[b]	1.27 [0.88,1.84]
Mean Knowledge Score [SD*]	3.62 [1.32]	4.33 [0.82]	0.003[c]		3.47 [1.35)	3.57 [1.27]	0.73[c]	

[a]Adjusted for frequency of internet usage.
[b]p-value is from the test of proportions.
[c]p-value is the two sample Man-Whitney (Wilcoxson rank-sum) test.
*PALS = Patient Activated Learning System. SD = standard deviation. IRR = incidence rate ratio. CI = confidence interval.

WebMD participants, (IRR 1.27 [95% CI 0.88–1.84]). A significantly greater proportion of *WebMD* participants answered the question about the side effects of chlorthalidone correctly during both the immediate (PALS 71%, *WebMD* 91%, IRR 0.79 [0.65,0.95]) and one-week follow up assessments (PALS 69%, *WebMD* 89%, IRR 0.79 [0.63,0.98]).

Although repetition is an essential component of the PALS approach to learning, we wanted to learn whether knowledge uptake was better with the PALS among those who chose not to click on a response to the assessment question at the end of the RKO. Therefore, in a secondary analysis that was not pre-specified, we removed 24 participants among whom any response options were clicked during the time period when they were viewing the site (which would have included information about whether their response was correct or not). The results of this secondary analysis were similar to the main results: the mean knowledge score for the 31 PALS participants who did not click on any responses was 4.1 [SD 0.87] and the mean knowledge score for the 58 WebMD participants was 3.62 [SD 1.32] (p = 0.075). A greater proportion of the 31 PALS participants who had not clicked on a response (74%)

than WebMD participants (57%) answered ≥4 out of 5 questions correctly (IRR 1.16 [95% CI 1.03,1.30]).

3.3. Secondary outcomes

Table 4 shows the results for the perceptions of learning, comfort, and readiness to make decisions. A significantly greater proportion of PALS participants agreed that they learned enough about the side effects of chlorthalidone (PALS 87%, *WebMD* 71%, IRR 1.25 [1.03–1.53], about how common chlorthalidone side effects are (PALS 93%, *WebMD* 76%, IRR 1.23 [95% CI 1.03–1.46]), and which activities to avoid when taking chlorthalidone (PALS 95%, *WebMD* 76%, IRR 1.22 [1.04,1.44). A significantly greater proportion also indicated they learned which over-the-counter medications to avoid while taking chlorthalidone (PALS 93%, *WebMD* 69%, IRR 1.31 [95% CI 1.08–1.59]). In addition, more PALS participants indicated they would feel comfortable taking chlorthalidone if prescribed to them (PALS 73%, *WebMD* 55%, IRR 1.38 [95% CI 1.04–1.84]). There were not statistically significant differences in the other questions assessed.

Table 5 presents the results related to trust of the website materials. A significantly greater proportion of PALS participants indicated that the PALS site had an attractive design (IRR 1.50 [95% CI 1.13, 2.00]). There were no statistically significant differences between participant responses for the remainder of the questions.

Survey results for questions related to user experience were overall favorable and not significantly different between the PALS and *WebMD* groups (data not shown).

4. Discussion and conclusion

4.1. Discussion

The PALS is a novel patient education platform that may be able to fill a critical gap. Despite very limited content and no advertising, the site has already had over 30,000 visitors from 153 different countries around the world. The results of this pilot trial suggest that the PALS may have advantages over *WebMD* in terms of immediate knowledge acquisition, perceptions of learning, and readiness to engage in shared decision-making. Results also suggested the PALS is a well-trusted site.

Consumers consider the quality of information on a website high when it is complete, understandable, professional, unbiased, and up to date [23–30]. Websites run by personal doctors, followed by medical universities and the federal government were the most trusted sources to obtain health information [24,28]. However, a national survey indicates that nearly three quarters of Americans seeking health information online use commercial websites, with *WebMD* being reported as the most common specific website that consumers turn to [31]. Search engines may be most optimized to lead to commercial websites, but one recent study found that academic sites contained more accurate information than the majority of commercial websites regarding information about Graves Disease [32]. Moreover, a systematic review reports that advertising on commercial websites has a negative effect on consumers [33]. Nevertheless, academic sites often suffer from being text heavy and less readable [32,34]. The PALS is unique in that it combines the high quality of information present in many academic sites with an engaging presentation style that is patient centered, accessible, readable for those with lower literacy, and free from advertising. Furthermore, trust in online patient education materials is critical for patient engagement. With the large number of online options to view health information, consumers largely use trust as a key determinant in choosing which websites they will turn to access and utilize information [35]. Our findings showed that the PALS was as trusted as *WebMD*, one of the most popular eHealth sources.

Patient education is a key component of a physician's role and information sharing forms the basis of shared decision making. The results of this trial suggest that the PALS confers benefits for immediate knowledge acquisition but possibly not longer term retention. The PALS uses several strategies that are unusual in other patient education materials, including the solicitation of questions from patients to drive content; the repetition of the question in the RKO with a set of responses to the question at the end of the RKO, designed to solidify learning; generous use of videos and other visuals; and language at the middle school level. Given that the PALS is an online system that can be visited repeatedly, and that the PALS may be used as a tool within or between clinical encounters to support shared decision making, it may be that short term learning rather than longer term recall is more important for achieving this goal. In our future work, we intend to investigate further the use of the PALS within and between clinical encounters and its impact as a tool for shared decision-making.

Information also has value to patients beyond its use as decision aid. In particular, information can provide patients with reassurance and reduced uncertainty [5,36]. Our data suggest that PALS content led to enhanced perception of the adequacy of the information in several of the questions assessed, including for making a hypothetical decision about taking chlorthalidone. The relationship between knowledge acquisition, satisfaction with information, and medication adherence is complex and needs investigation. In fact, Hofer et al found that satisfaction with medication information but not knowledge was associated with improvements in medication adherence in a study of two models of community health worker–led diabetes medication decision support for low-income Latino and African American adults with diabetes [37]. Thus, by conferring confidence in and satisfaction with medication information, PALS may have a positive impact on

Table 4
Responses for questions on perceptions of learning, comfort and readiness for medication decision making of trial participants, by treatment arm.

Statement	*WebMD*	PALS*	p-value[a]	Adjusted[b] IRR*, PALS Compared to *WebMD*, [95% CI*]
N	58	55		
I have the info I need to talk to my doctor about starting chlorthalidone	52 (90%)	48 (87%)	0.69	0.96 [0.83,1.12]
I learned enough about the side effects of chlorthalidone	41 (71%)	48 (87%)	0.03	1.25 [1.03,1.53]
I know about how common the side effects of chlorthalidone are	44 (76%)	51 (93%)	0.01	1.23 [1.03,1.46]
I learned about how much chlorthalidone lowers risk of heart disease and stroke	43 (74%)	47 (85%)	0.14	1.15 [0.95,1.39]
I learned which kinds of activities I may need to avoid on chlorthalidone	44 (76%)	52 (95%)	<0.01	1.22 [1.04,1.44]
I learned which over the counter medicines to avoid on chlorthalidone	40 (69%)	51 (93%)	<0.001	1.31 [1.08,1.59]
I would feel comfortable taking chlorthalidone if it were prescribed to me	32 (55%)	40 (73%)	0.05	1.38 [1.04,1.84]
I disagree that I need more information before I would feel comfortable taking chlorthalidone	16 (28%)	24 (44%)	0.07	1.62 [0.96,2.74]

a p-value is from the test of proportions (agree vs. disagree).
b Adjusted for frequency of internet usage.
*Abbreviations: PALS = Patient Activated Learning System. IRR = incidence rate ratio. CI = confidence interval.

Table 5
Responses from the modified general web trust questionnaire for participants randomized to PALS* compared to *WebMD*.

Statement	*WebMD*	PALS	p-value	Adjusted[a] IRR*, PALS Compared to *WebMD*, [95% CI*]
N	58	55		
The information on the website was easy for me to understand	52 (90%)	53 (96%)	0.16	1.08 [0.98,1.21]
The information appeared to be prepared by an expert	41 (71%)	42 (76%)	0.49	1.09 [0.86,1.37]
The information appeared to be impartial and independent	40 (69%)	40 (73%)	0.66	1.06 [0.83,1.35]
The site was free from advertisements	43 (74%)	48 (87%)	0.08	1.24 [1.03,1.49]
The information seemed objective (i.e. no hidden agenda)	48 (83%)	44 (80%)	0.71	0.97 [0.81,1.17]
Information seemed credible	56 (97%)	48 (87%)	0.07	0.88 [0.78,1.00]
The site had a professional design	43 (74%)	45 (82%)	0.33	1.09 [0.88,1.35]
The site had an attractive design	31 (53%)	44 (80%)	0.003	1.50 [1.13,2.00]

[a]Adjusted for frequency of internet usage.
*Abbreviations: PALS = Patient Activated Learning System. IRR = incidence rate ratio. CI = confidence interval.

self-efficacy and adherence. Our prior work has shown improvement in patient self efficacy related to barriers surrounding discharge medications with the use of the PALS during hospital discharge [38]. In future work, we intend to further measure the impact of the PALS on these outcomes.

4.1.1. Limitations

Several limitations of this study are worth noting. This was a single site study, which may limit generalizability. Although the sample had a high proportion of minorities, educational attainment was fairly high. The pilot nature of the trial resulted in a small sample size, which limited the power to detect potentially important clinical differences. Because the research assistants stayed with the participants during the assessment, and some were authors of the content viewed, it is possible that social desirability bias may have played a role. In addition, an inherent part of the design of the PALS is learning through repetition; the question being answered is seen at the top of the learning segment and appears again at the end with clickable response options. Although *WebMD* arm participants saw the question prior to viewing the WebMD web pages, neither the question nor the clickable response options were presented again in WebMD. Therefore, it is not possible to tease out the possible effect of seeing the same question twice or some other way of depicting the information with the PALS that led to increased knowledge uptake. The analysis excluding those who may have clicked on a response to the question at the end of the PALS segment in part addressed this issue, showing better knowledge uptake with the PALS. While this could be considered a bias in favor of the PALS, it is an intentional design feature in that repetition is a specific learning strategy in the PALS not taken by other sites like WebMD.

We assessed hypothetical rather than actual decision-making. English literacy was not assessed formally, some survey questions were not from validated instruments, and patients did not need to navigate to the webpages themselves.

4.2. Conclusion

This pilot trial suggests that the PALS holds promise as a new approach to eHealth patient education. The number of visitors to the site at this early stage of production suggests that the site is filling an important need.

4.3. Implications

Future work will assess how to integrate the PALS into the clinical care process to facilitate and enrich the process of shared decision-making, and, ultimately, its impact on treatment adherence.

Conflicts of interest

The creators of the PALS are Monika M. Safford, MD and Jeffrey Curtis, MD. The authors (except the data analyst, Deanna Jannat-Khah, DrPH, MSPH) have all worked on content development for the PALS. Dr.'s Safford, Carmel, Sinha, and Pelzman all have intellectual property but not financial interests in the PALS. The PALS is a joint effort between Weill Cornell Medicine (WCM) and the University of Alabama at Birmingham (UAB), who own the code.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.pec.2019.03.001.

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