

## Research article

# Perceptions of adopters versus non-adopters of a patient portal: an application of diffusion of innovation theory

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## ABSTRACT

**Background** Patient portals have emerged as an important tool through which patients can access online health information and engage in their health care. However, we know little about how patients perceive portals and whether patient perceptions might influence portal adoption.

**Objective** Apply the diffusion of innovation (DOI) theory to assess perceptions of adopters and non-adopters of a patient portal.

**Methods** We conducted a cross-sectional survey of adopters and non-adopters of the portal. Our survey consisted of perceived attributes from the DOI theory, socio-demographic characteristics and patient perceptions of technology adoption.

**Results** Three factors representing perceived attributes from DOI theory accounted for 73% of the variance in the data: Factor 1 – Relative Advantage (27%); Factor 2 – Ease of Use (24%) and Factor 3 – Trialability (22%). Adopters perceived greater Relative Advantage [mean (SD)] = 3.8 (0.71) *versus* 3.2 (0.89),  $p < 0.001$ , Ease of Use = 4.1 (0.71) *versus* 3.3 (0.95),  $p < 0.001$  and Trialability = 4.0 (0.57) *versus* 3.4 (0.99),  $p < 0.001$  than non-adopters. In multivariate modelling, age [OR = 3.75, 95% CI: (2.17, 6.46),  $p < 0.001$ ] and income [OR = 1.87, 95% CI: (1.17, 3.00),  $p < 0.01$ ] predicted adoption of the portal. Among DOI factors, Relative advantage predicted adoption of the portal [OR = 1.48, 95% CI: (1.03, 2.11),  $p < 0.05$ ].

**Conclusion** Patients will adopt a patient portal if they perceive it to offer a relative advantage over existing practices such as telephoning or visiting the doctor's office. Organisations seeking to increase the adoption of patient portals should implement strategies to promote the relative advantage of portals as, for example, through posters in waiting and exam rooms. A digital divide in the adoption of patient portals may exist with respect to age and income.

**Keywords:** patient portal, adoption, perceptions, diffusion of innovation, digital divide

## BACKGROUND

A patient portal is a tool tethered to an electronic health record (EHR) through which patients have access to the information in their provider's EHR, such as the problem list, medication list and test results.<sup>1,2</sup> Patient portals also allow patients to request appointments, refill medications and communicate with their care team about non-urgent medical issues. Over the past decades, patient portals have emerged as an important tool through which patients can access online health information and engage in their healthcare.<sup>3–12</sup> As a result, there has been a considerable interest in the adoption of patient portals in general and more specifically in the characteristics of patients who adopt (or do not adopt) a patient portal.

Both qualitative and quantitative studies have emerged on the adoption of patient portals. In a qualitative study, Ryan *et al.*<sup>13</sup> identified ease of use of the patient portal as a necessary condition for its adoption. Nguyen *et al.*<sup>14</sup> identified the perceived advantage of the patient portal, specifically the ability to be able to access the EHR anywhere, as an important factor in portal adoption. Quantitative studies have focused on rates of portal adoption and characteristics of patients who have adopted portals. A survey in the state of New York found a 50% increase in whether patients had ever used a portal from 11% in 2012 to 20% in 2013.<sup>7</sup> Neuner *et al.*<sup>8</sup> found that the patient enrolment in a patient portal increased from 13.2% in 2010 to 23.1% in 2012. The same study found that patients in the age group 50–65 years were more likely to adopt a portal than patients in other age groups. In a study of portal adoption, we found Caucasian patients and patients with higher income were more likely to adopt the portal.<sup>15</sup> In a study of the patient portal use, we found users of a portal were more educated and had a higher income than non-adopters of the portal.<sup>16</sup>

Beyond the patient characteristics, it is important to assess patient perceptions of the patient portal since the portal is in part an innovation adopted by the patient to partially replace the existing practice of telephoning or visiting the doctor's office.

For example, do patients adopt a portal because they perceive it to be easy to use, whereas non-adopters perceive a portal to be complicated and difficult to use? As Rogers<sup>17</sup> concluded in his influential diffusion of innovation (DOI) theory, it is perceptions of the innovation rather than its actual attributes that influence adoption. In his theory, Rogers identified five perceptions, or perceived attributes, that are most likely to influence the adoption of an innovation: (1) Relative Advantage, or the degree to which an innovation (such as a patient portal) is perceived as being better than the idea it supersedes (e.g. telephoning the doctor's office); (2) Compatibility, or the degree to which an innovation is perceived as consistent with existent values, past experiences and needs of potential adopters (as, e.g. past experience with using the Internet); (3) Complexity, or the degree to which an innovation is perceived as easy to understand and use as a whole or in incremental parts; (4) Trialability, or the degree to which an innovation can be experimented with on a limited basis (e.g. trying a patient portal for tasks such as appointment requests or secure messaging) and (5) Observability, or the degree to which the benefits of an innovation are visible to intended adopters. Rogers has provided an extensive summary of the literature showing that each of these five perceived attributes is positively related to the rate of adoption of an innovation.

## OBJECTIVE

In this study, we apply Rogers' DOI theory to assess and compare perceptions of adopters and non-adopters of a patient portal.

## METHOD

### The diffusion of innovation model

For this study, we adopted Rogers' first four perceived attributes (Relative Advantage, Compatibility, Ease of Use and Trialability). We dropped observability because new adopters

of a patient portal (those who have yet to use the portal) are unlikely to have the benefits of the innovation visible to them. For the four perceived attributes, we adopted items from a previous study in which we applied the DOI theory to understand perceptions of the use of a patient portal.<sup>16</sup> The items from the previous study were revised for this study to account for adoption than the use of the portal. For example, in the previous study, an item on ease of use was worded as: 'Overall, I find <the patient portal> easy to use'. In this study, this item read as: Overall, I will find <the patient portal> easy to use. Appendix 1 lists the items we used to capture the four perceived attributes of the DOI model.

## Patient characteristics

We also included a set of patient characteristics that have been reported as influencing the patient portal adoption: age, gender, race, education, income, marital status and health status.<sup>3–8,15,16</sup> Additionally, we assessed the patient use and perceptions of technology adoption through three items. We captured the patient use of the Internet. To capture patient perceptions of technology adoption, we assessed personal innovativeness in the domain of information technology (PIIT) defined as 'the willingness of an individual to try out new information technology'.<sup>18</sup> Appendix 1 lists the four items on PIIT used in this study. A third item on the perception of technology adoption pertained to the privacy and security of information in the patient portal as concerns about privacy and security can play a key role in whether patients adopt and use personal health records.<sup>1,4</sup> Appendix 1 shows the three items used to capture privacy and security.

## Survey implementation

We conducted a patient survey to capture information on the factors of interest in the study. Our survey implementation followed Dillman's<sup>19</sup> tailored design method (TDM) approach. TDM adopts concepts from the social exchange theory to enhance the response rate of surveys. For example, an incentive is provided in the TDM approach as a reward for responding to the survey. Similarly, the cost of responding to the survey is mitigated for the respondent by providing a return stamped envelope. Our implementation of the TDM approach in this study consisted of sending an initial survey with a \$5 cash incentive and a stamped return envelope. We followed the initial survey by a reminder post-card and then a reminder survey with a business reply envelope. Patients could refuse participation in the study by returning a blank survey with a note on the survey or by calling a telephone number assigned to the study. All study materials and methods were approved by the Partners HealthCare Institutional Review Board.

## Recruitment

We conducted the study at Partners HealthCare, an integrated delivery system located in eastern Massachusetts. The Partners patient portal, Patient Gateway, is similar to other widely available tethered patient portals and includes access to components of the EHR (such as laboratory and imaging results), requests for appointments and medication

refills and secure messaging with the provider and practice. We identified patients who were new adopters of the Partners patient portal (defined as those who signed up for a portal account). We identified new adopters on a weekly basis in order to survey the patients closest to the time of their adoption of the portal. On a weekly basis, we also identified a random sample of non-adopters of the portal for our survey.

## Statistical analysis

We present proportions and means for socio-demographic characteristics and technology use and perceptions. To assess differences between the adopter and non-adopter groups, we conducted chi-square tests of association for categorical variables and *t*-tests for continuous variables. For items capturing perceptions of technology adoption, we assessed Cronbach's alpha and created scales for each set of items. We used factor analysis to identify the factor structure of the items pertaining to perceived attributes of DOI theory. Given the exploratory nature of our study, our factor analysis was also exploratory and consisted of principal components analysis with varimax rotation and extraction based on eigenvalues greater than 1 and confirmed by examination of the scree plot. We reviewed the Kaiser-Meyer-Olkin measure of sampling adequacy and Bartlett's test of sphericity to ensure an appropriateness of factor analysis for the data.<sup>20</sup> Based on the results of the factor analysis, we created scales for the different factors using an average of the original data for the items comprising each scale. We employed the logistic regression analysis using a forced entry method to assess predictors of adoption of the patient portal and likelihood of using the portal. All analyses were conducted using the SPSS 23.0 statistical software package.

## RESULTS

### Response rates

Of 582 new adopters of the patient portal we identified, 372 responded to our survey for a response rate of 63.9%. This response rate exceeds that in other studies on patient portals as well as our previous study applying DOI theory to the use of a patient portal.<sup>3,6,12,16</sup> In the case of non-adopters, we identified 659 patients, of whom 281 returned the survey for a response rate of 42.6%. No differences existed between non-responders and responders with respect to age or gender.

### Patient characteristics

Adopters were younger than non-adopters: 85.9% of adopters were less than 65 years of age compared to 46.2% of non-adopters ( $p < 0.001$ ) (Table 1). Adopters were more educated than non-adopters: 56% of adopters had a 4-year college degree or more compared to 40% of non-adopters ( $p < 0.001$ ). Adopters also had a greater income than non-adopters: 56% of adopters reported a total household income of \$75,000 or more compared to 33% of non-adopters ( $p < 0.001$ ). The overall rating of health among adopters (mean = 3.5) was greater than that of non-adopters (mean = 3.1,  $p < 0.001$ ). Cronbach's alpha for the items capturing PIIT was very good (0.87), and we created a scale by averaging the score on the

**Table 1 Comparison of adopters and non-adopters on patient characteristics**

	Adopters	Non-adopters	p value
Age (<65 years)	85.9% (317/369)	46.2% (129/279)	0.000
Gender (% Female) (n)	67.2% (250/372)	65.1% (183/281)	0.58
Race (% White) (n)	89.5% (324/362)	88.3% (241/273)	0.63
Education (4-year college graduate or more) (% respondents)	56.3% (206/366)	39.6% (106/268)	0.000
Income ( $\geq$ \$75,000 in total household income from all sources before taxes) (% respondents)	56.0% (182/325)	33.0% (75/227)	0.000
Marital status (% Married)	54.5% (198/363)	54.2% (150/277)	0.92
Rating of overall health <sup>a</sup> (mean) (SD)	3.5 (1.03)	3.1 (0.97)	0.000
Self-reported Comorbidities <sup>b</sup> (mean) (SD)	2.5 (1.70)	3.2 (2.06)	0.000
Internet use (% respondents) <sup>c</sup>	82.5 (296/359)	57.6 (129/224)	0.000
PIIT (mean) (SD)	3.5 (0.88)	2.9 (0.93)	0.000
Privacy security (mean) (SD)	3.84 (0.70)	3.52 (1.01)	0.000

<sup>a</sup>Rating of overall health is captured as Excellent (5), Very Good (4), Good (3), Fair (2) or Poor (1).

<sup>b</sup>Self-reported comorbidities included 11 conditions such as: allergies, high blood pressure, high cholesterol, diabetes, heart disease and asthma or emphysema.

<sup>c</sup>Internet use means that patient uses the Internet either daily or several times a day.

four items capturing PIIT. Adopters reported a greater level of PIIT (mean = 3.5) than non-adopters (mean = 2.9) ( $p < 0.001$ ).

We created a scale called Security Privacy by averaging the scores of the three items on perceptions of security and privacy (Cronbach's alpha = 0.90). Higher scores on this scale indicate more positive perceptions about the privacy and security of patient portals. Adopters were more positive that the privacy and security of data in the patient portal would be maintained (mean = 3.84) than non-adopters [mean = 3.52 ( $p < 0.001$ )].

## Diffusion of innovation theory

Our initial factor solution of the perceived items related to DOI theory yielded three factors. In this solution, however, Compatibility did not emerge as a separate factor. Similar to our previous study,<sup>16</sup> items from Compatibility loaded highly on several factors indicating that the items in this domain mixed with other domains such as Relative Advantage. We therefore removed items related to Compatibility and conducted the exploratory factor analysis with the remaining attributes of Relative Advantage, Ease of Use and Trialability. Three factors, each representing a perceived domain in DOI theory, emerged with eigenvalues greater than 1 and accounted for 73% of the variance in the data (Table 2): Factor 1 – Relative Advantage (27%); Factor 2 – Ease of Use (24%) and Factor 3 – Trialability (22%).

Table 2 also shows the results of the reliability analysis (Cronbach's alpha) for the items loading on each factor. Cronbach's alpha was very good for all three factors:

Trialability (0.82; three items), Relative Advantage (0.86; four items) and Ease of Use (0.90; four items). We created a scale for each factor by averaging the scores of the items for that factor. Adopters perceived greater Relative Advantage, Ease of Use, and Trialability than non-adopters (Table 2).

## Multivariate modelling

We fitted a multivariate logistic regression model to assess predictors of adoption of the patient portal (Table 3). Our dependent variable was dichotomous (0-Non-Adopter, 1-Adopter). The patient characteristics predicting adoption of the patient portal are: age [OR = 3.75, 95% CI: (2.17, 6.46),  $p < 0.001$ ] and income [OR = 1.87, 95% CI: (1.17, 3.00),  $p < 0.01$ ]. Among DOI factors, only Relative Advantage predicted adoption of the patient portal [OR = 1.48, 95% CI: (1.03, 2.11),  $p < 0.05$ ].

## DISCUSSION

We applied DOI theory to assess and compare the patient perceptions of adopters versus and non-adopters of a patient portal and found three factors representing DOI theory: Relative Advantage, Ease of Use and Trialability. Furthermore, adopters of the patient portal perceived greater Relative Advantage, Ease of Use and Trialability than non-adopters. Of the three factors, Relative Advantage emerged as the top factor followed by Ease of Use and Trialability. In our previous study that applied DOI theory to assess perceptions of users of a patient portal, Ease of Use had emerged as the top factor followed by Relative Advantage.<sup>16</sup> It is possible that as adopters start using patient portals, their perceptions shift from the portal providing a relative advantage to that of the portal being easy to use. Greenhalgh *et al.*<sup>21</sup> pointed to the possibility that perceptions may not be stable and, instead, could change over time. Additionally, research on information systems use based on expectation-confirmation theory has examined the role that changes in perceptions and beliefs can play in the continued use of the systems.<sup>22,23</sup> For example, the initial perception of Relative Advantage can be disconfirmed upon the use of the portal resulting in a modified and negative perception of Relative Advantage which could then impact the continued use of the portal. Longitudinal studies of perceptions of patient portals are needed to better understand changes in perceptions about patient portals and their impact on portal usage.

As in our previous study, Compatibility did not emerge as a distinct factor. Other studies have also failed to distinguish between Compatibility and perceived domains of DOI theory such as Relative Advantage.<sup>24,25</sup> It is possible that it is simply not possible to discriminate between Compatibility and other perceived attributes in this patient population. The more likely explanation, as suggested by Karahanna *et al.*,<sup>26</sup> is that the construct of Compatibility as defined in DOI theory focuses on needs which are a sub-dimension of Relative Advantage. This logic could explain why Compatibility loaded onto other domains and did not emerge as a separate domain in our factor analysis. To better capture the construct of Compatibility,



**Table 2** Factor analysis of perception items (rotated component matrix)

Perception item	Factor		
	RA	EU	Trialability
Using Patient Gateway <sup>a</sup> will improve the quality of care I receive (RA <sup>b</sup> )	0.832	0.184	0.243
Using Patient Gateway will enable me to contact my doctor's office more easily (RA)	0.781	0.274	0.291
Using Patient Gateway will enable me to contact my doctor's office more quickly (RA)	0.747	0.250	0.318
Using Patient Gateway will give me greater control over my care (RA)	0.699	0.254	0.320
The effectiveness of care I receive will not improve by my using Patient Gateway (RA)	-0.642	-0.125	0.089
Using Patient Gateway will require a lot of mental effort (EU)	-0.154	-0.857	-0.087
Using Patient Gateway will be frustrating (EU)	-0.299	-0.833	-0.173
Learning to use Patient Gateway will be easy for me (EU)	0.253	0.726	0.436
Overall, I believe that Patient Gateway will be easy to use (EU)	0.355	0.712	0.423
I will not lose much by trying Patient Gateway, even if I do not like it (Trialability)	0.109	0.188	0.821
I will try Patient Gateway on a trial basis to see what it can do for me (Trialability)	0.168	0.158	0.814
I will have adequate opportunities to try Patient Gateway to see what it can do (Trialability)	0.287	0.274	0.725
Eigen value	6.2	1.3	1.1
Percent variance	26.5	23.7	21.9
Cronbach's Alpha for scale	0.86	0.90	0.82
Mean of scale (SD):			
Adopter	3.8 (0.71)	4.1 (0.71)	4.0 (0.57)
Non-adopter	3.2 (0.89)	3.3 (0.95)	3.4 (0.99)
p-value for adopter versus non-adopter	0.000	0.000	0.000

<sup>a</sup>Patient Gateway is the patient portal used by the practices and patients in this study. For non-adopters, we substituted the term electronic personal health record for Patient Gateway.

<sup>b</sup>Refers to the perceived attribute from the DOI model: RA, Relative Advantage; EU, Ease of Use.

**Table 3** Multivariate model predicting adoption of patient portal variables in the equation <sup>a</sup>

		B	SE	Wald	df	Sig.	Exp(B)	95% CI for EXP(B)	
								Lower	Upper
Step 1 <sup>b</sup>	Age	1.321	0.278	22.504	1	0.000 <sup>c***</sup>	3.746	2.171	6.464
	Education	-0.146	0.250	0.342	1	0.559	0.864	0.529	1.411
	Income	0.627	0.241	6.754	1	0.009 <sup>b**</sup>	1.871	1.167	3.001
	Internet use	0.306	0.287	1.138	1	0.286	1.358	0.774	2.381
	Overall health status	0.450	0.244	3.390	1	0.066	1.568	0.971	2.529
	Self-reported comorbidities	-0.020	0.064	0.098	1	0.754	0.980	0.864	1.111
	PIIT	0.112	0.145	0.595	1	0.441	1.118	0.842	1.486
	Security privacy	0.163	0.159	1.047	1	0.306	1.176	0.862	1.606
	Relative advantage	0.390	0.182	4.591	1	0.032 <sup>b*</sup>	1.477	1.034	2.110
	Ease of use	0.255	0.201	1.612	1	0.204	1.291	0.870	1.914
	Trialability	0.292	0.201	2.114	1	0.146	1.339	0.903	1.986
	Constant	-5.570	0.941	34.995	1	0.000	0.004		

<sup>a</sup>For definitions of variables refer to Tables 1 and 2.

<sup>b</sup>R square = 0.21 (Cox and Snell); R square = 0.29 (Nagelkerke); Chi-square = 109.0, df = 11, p < 0.001.

<sup>c</sup>\*p < 0.05; \*\*p < 0.01; \*\*\*p < 0.001

Karahanna *et al.*<sup>26</sup> proposed a new conceptualisation of Compatibility based on four distinct constructs: preferred work style, existing work practices, prior experience and values. Future studies that apply DOI theory to the adoption of patient portals should focus on one or more of these constructs to assess whether Compatibility emerges as a distinct domain that predicts adoption of the patient portal.

Our multivariate model identified three variables to be significant predictors of adoption: (1) patients less than 65 years of age were 3.75 times more likely to adopt the patient portal; (2) patients who had an annual income greater than \$75,000 were 1.87 more likely to adopt the patient portal and (3) Relative Advantage of the portal was perceived to be 1.48 times greater by adopters than non-adopters. In a previous study of our patient portal, we found income was associated with adoption of the portal but not age.<sup>15</sup> Neuner *et al.*<sup>8</sup> found that patients in the age group of 50–65 years were more likely to enrol in a portal than patients in other age groups. The patients who were younger and wealthier were the ones most likely to adopt an important issue, as the patients who might be expected to benefit the most would be those who are sicker and less well-off financially.

The significance of Relative Advantage makes intuitive sense as patients will adopt the patient portal if they perceive it to offer an advantage over existing practices such as telephoning or visiting the office. Another relative advantage offered by patient portals is the ability to access the EHR anywhere.<sup>14</sup> While this is one of the first studies to apply DOI theory to patient portal adoption, other studies have applied theoretical models with constructs similar to Relative Advantage to predict portal adoption. Noblin *et al.*<sup>27</sup> found perceived usefulness [a construct from the technology adoption model (TAM) which is similar to Relative Advantage] predicted intention to adopt a patient portal. Silvestre *et al.*<sup>3</sup> applied the TAM model and found that perceived usefulness predicted the use of a portal site. Tavares and Oliveira<sup>28</sup> applied the concept of performance expectancy (similar to Relative Advantage) and found that it predicted behavioural intention to use the portal. Further studies are needed but we believe that the construct of Relative Advantage plays a particularly important role in the adoption of a patient portal. Relative Advantage may also be particularly amenable to intervention by practices.

## CONCLUSIONS

We found the DOI theory to be a good fit for the study of the adoption of patient portals. Three factors from the theory emerged that distinguished adopters from non-adopters: Relative Advantage, Ease of Use and Trialability. In places such as the UK one of the biggest issues that patients have is contacting their practice efficiently, so patient portal implementation might be especially helpful there. Furthermore, demonstrating the relative advantage of a patient portal is likely to be a key factor in efforts to increase the uptake of adoption of patient portals. For example, posters in waiting and exam rooms can highlight the relative advantage of patient portals for tasks like appointment requests, medication

refill requests and asking the care team a non-urgent medical question. In Appendix 2, we provide an example of a poster demonstrating Relative Advantage of prescription refills via the patient portal.

Beyond the DOI theory, we continue to find a digital divide in the adoption of patient portals with respect to age and income. At the same time, health systems may be especially interested in getting older and sicker patients to adopt patient portals. As such, there may need extra efforts aimed to demonstrate the relative advantage of portals to such groups. We also found adopters had greater personal innovativeness in the domain of information technology (PIIT) than non-adopters and the findings were remarkably similar to our previous study. This raises the concern whether PIIT is a characteristic of the digital divide in the adoption of patient portals. So far, efforts to understand the digital divide in patient portals have focused on socio-demographic characteristics, access to technology and health literacy. Further studies should explore whether PIIT is also a characteristic of this digital divide and its implications for adoption and use of patient portals.

Finally, this study contributed to the existing literature through the application of a theoretical framework, the DOI theory, to the study of patient portals. The application of theoretical models in the patient portal research has been lacking as we have pointed out in our previous studies.<sup>12,16</sup> The relevance of a theoretical model such as DOI extends beyond the study of perceived attributes such as Relative Advantage and Ease of Use. Through the DOI model, Rogers<sup>17</sup> has cautioned about the positivist bias in adoption research and the need to understand how and why innovations may be rejected. We believe that this also applies to patient portal adoption and use. We need to better understand rejection and discontinuance in the context of patient portals.<sup>21,23</sup> We also encourage the application of DOI theory in the patient portal research in other social and cultural contexts. Most of the reported research on patient portals is from North America. Portal developers, researchers and practitioners would benefit from learning experiences and findings of other social and cultural contexts.

## LIMITATIONS

This study has several limitations. It was conducted in only one system and one region, and the results may not be generalizable to other settings. Our concept of Compatibility in DOI theory focused on compatibility with needs. A different concept, such as compatibility with prior experience with computers and the Internet, may be a better fit for the application of DOI theory to the patient portal research. Other predictors that may play a role in the adoption of the patient portal which were not included in this study include self-efficacy and health literacy. Finally, we only included one component of the DOI theory, perceived attributes, in this study. Rogers discusses other components in the theory such as the role of change agents which can be considered in patient portal research. Change agents with respect to patient portals include

physicians and practices that are interested in increasing the adoption of the portal. For example, patient perceptions of patient portals may be influenced by the marketing activities adopted by practices.<sup>29</sup>

## REFERENCES

1. Irizarry T, DeVito Dabbs A and Curran CR. Patient portals and patient engagement: a state of the science review. *Journal of Medical Internet Research* 2015;17(6):e148. <https://doi.org/10.2196/jmir.4255>. PMID:26104044; PMCID:PMC4526960.
2. Kannry J, Beuria P, Wang E and Nissim J. Personal health records: meaningful use, but for whom? *The Mount Sinai Journal of Medicine* 2012;79:593–602. <https://doi.org/10.1002/msj.21334>. PMID:22976365.
3. Silvestre A-L, Sue VM and Allen JY. If you build it, will they come? the Kaiser Permanente model of online health care. *Health Affairs (Millwood)* 2009;28(2):334–44. <https://doi.org/10.1377/hlthaff.28.2.334>. PMID:19275988.
4. Goel MS, Brown TL, Williams A, Cooper AJ, Hasnain-Wynia R and Baker DW. Patient reported barriers to enrolling in a patient portal. *Journal of the American Medical Informatics Association* 2011;18:i8–12. <https://doi.org/10.1136/amiajnl-2011-000473>. PMID:22071530; PMCID:PMC3241181.
5. Goldzweig CL, Orshansky G, Paige NM, Towfigh AA, Haggstrom DA and Miake-Lye I, et al. Electronic patient portals: evidence on health outcomes, satisfaction, efficiency, and attitudes systematic review. *Annals of Internal Medicine* 2013;159(10):677–87. <https://doi.org/10.7326/0003-4819-159-10-201311190-00006>. PMID:24247673.
6. Nazi KM, Hogan TP, McInnes DK, Woods SS and Graham G. Evaluating patient access to electronic health records: results from a survey of veterans. *Medical Care* 2013;51(3 Suppl 1):S52–56. <https://doi.org/10.1097/MLR.0b013e31827808db>. PMID:23407012.
7. Ancker JS, Silver M and Kaushal R. Rapid growth in use of personal health records in New York. *Journal of General Internal Medicine* 2014;29(6):850–4. <https://doi.org/10.1007/s11606-014-2792-2>. PMID:24519102; PMCID:PMC4026516.
8. Neuner J, Fedders M, Caravella M, Bradford L and Schapira M. Meaningful use and the patient portal: patient enrollment, use, and satisfaction with patient portals at a later-adopting center. *American Journal of Medical Quality* 2015;30(2):105–13.
9. Ford EW, Hesse BW and Huerta TR. Personal health record use in the United States: forecasting future adoption levels. *Journal of Medical Internet Research* 2016;18(3):e73. <https://doi.org/10.2196/jmir.4973>.
10. Ralston JD, Coleman K, Reid RJ, Handley MR and Larson EB. Patient experience should be part of meaningful-use criteria. *Health Affairs (Millwood)* 2010;29(4):607–13. <https://doi.org/10.1377/hlthaff.2010.0113>. PMID:20368589.
11. Kruse CS, Bolton K and Freriks G. The effect of patient portals on quality outcomes and its implications for meaningful use: a systematic review. *Journal of Medical Internet Research* 2015;17(2):e44. <https://doi.org/10.2196/jmir.3171>. PMID:25669240; PMCID:PMC4342639.
12. Emani S, Healey M, Ting DY, Lipsitz SR, Ramelson H, Suric V, et al. Awareness and use of the after-visit summary through a patient portal: evaluation of patient characteristics and an application of the theory of planned behavior. *Journal of Medical Internet Research* 2016;18(4):e77. <https://doi.org/10.2196/jmir.5207>. PMID:27076485; PMCID:PMC4848387.
13. Ryan BL, Brown JB, Terry A, Cejic S, Stewart M and Thind A. Implementing and using a patient portal: a qualitative exploration of patient and provider perspectives on engaging patients. *Journal of Innovation in Health Informatics* 2016;23(2):534–40. <https://doi.org/10.14236/jhi.v23i2.848>. PMID:27869582.
14. Nguyen Q, Bartlett G, Teller P-P and Rodriguez C. Young adults on the perceived benefits and expected use of personal health records: a qualitative descriptive study. *Journal of Innovation in Health Informatics* 2016;23(10):466–75.
15. Yamin CK, Emani S, Williams DH, Lipsitz SR, Karson AS and Wald JS, et al. The digital divide in the adoption and use of a personal health record. *Archives of Internal Medicine* 2011;171(6):568–74. <https://doi.org/10.1001/archinternmed.2011.34>. PMID:21444847.
16. Emani S, Yamin CK, Peters E, Karson AS, Lipsitz SR and Wald JS, et al. Patient perceptions of a personal health record: a test of the diffusion of innovation model. *Journal of Medical Internet Research* 2012;14(6):e150. <https://doi.org/10.2196/jmir.2278>. PMID:23128775; PMCID:PMC3517342.
17. Rogers EM. *Diffusion of Innovations*, 5th edition. New York, NY: Free Press, 2003.
18. Agarwal R and Prasad J. A conceptual and operational definition of personal innovativeness in the domain of information technology. *Information Systems Research* 1998;9(2):204–15. <https://doi.org/10.1287/isre.9.2.204>.
19. Dillman D. *Mail and Internet Surveys: The Tailored Design Method*, 2nd edition. Hoboken, NJ: Wiley, 2007. PMCID:PMC2206000.
20. Field A (Ed). *Discovering Statistics Using SPSS*, 2nd edition. London, UK: Sage, 2005.
21. Greenhalgh T, Hinder S, Stramer K, Bratan T and Russell J. Adoption, non-adoption, and abandonment of a personal electronic health record: case study of HealthSpace. *The BMJ* 2010;341:c5814. <https://doi.org/10.1136/bmj.c5814>. PMID:21081595; PMCID:PMC2982892.
22. Bhattacharjee A. Understanding information systems continuance: an expectation-confirmation model. *Management Information Systems Quarterly* 2001;25(3):351–70. <https://doi.org/10.2307/3250921>.
23. Bhattacharjee A and Premkumar G. Understanding changes in belief and attitude toward information technology usage: a theoretical model and longitudinal test. *Management Information Systems Quarterly* 2004;28(2):229–54. <https://doi.org/10.2307/25148634>.

24. Moore GC and Benbasat I. Development of an instrument to measure the perceptions of adopting an information technology innovation. *Information Systems Research* 1991;2(3):192–222. <https://doi.org/10.1287/isre.2.3.192>.
25. Karahanna E, Straub DW and Chervany NL. Information technology adoption across time: a cross-sectional comparison of pre-adoption and post-adoption beliefs. *Management Information Systems Quarterly* 1999;23(2):183–213. <https://doi.org/10.2307/249751>.
26. Karahanna E, Agarwal R and Angst CM. Reconceptualizing compatibility beliefs in technology acceptance research. *Management Information Systems Quarterly* 2006;30(4):781–804. <https://doi.org/10.2307/25148754>.
27. Noblin AM, Wan TTH and Fottler M. Intention to use a personal health record: a theoretical analysis using the technology acceptance model. *International Journal of Healthcare Technology and Management* 2013;14(1/2):73–89. <https://doi.org/10.1504/IJHTM.2013.055085>.
28. Tavares J and Oliveira T. Electronic health record patient portal adoption by health care consumers: an acceptance model and survey. *Journal of Medical Internet Research* 2016;18(3):e49. <https://doi.org/10.2196/jmir.5069>. PMID:26935646; PMCID:PMC4795321.
29. Wald JS. Variations in patient portal adoption in four primary care practices. *AMIA Annual Symposium Proceedings* 2010;837–41.

## APPENDIX 1: ITEMS ON DOI ATTRIBUTES, PIIT AND PERCEPTIONS OF PRIVACY AND SECURITY

- 1) Using Patient Gateway will enable me to contact my doctor's office more quickly (RA<sup>b</sup>).
- 2) Using Patient Gateway will improve the quality of care I receive (RA).
- 3) Using Patient Gateway will enable me to contact my doctor's office more easily (RA).
- 4) The effectiveness of care I receive will **not** improve by using my Patient Gateway (RA).
- 5) Using Patient Gateway will give me greater control over my care (RA).
- 6) Using Patient Gateway will fit in with all aspects of my health care coordination (Comp).
- 7) Using Patient Gateway will fit into my personal and work life (Comp).
- 8) I think that using Patient Gateway will **not** fit well with the way I like to receive care (Comp).
- 9) Using Patient Gateway will require a lot of mental effort (EU).
- 10) Learning to use Patient Gateway will be easy for me (EU).
- 11) Using Patient Gateway will be frustrating (EU).
- 12) Overall, I believe that Patient Gateway will be easy to use (EU).
- 13) I will try Patient Gateway on a trial basis to see what it can do for me (Trial).
- 14) I will **not** lose much by trying Patient Gateway, even if I do not like it (Trial).
- 15) I will have adequate opportunities to try Patient Gateway to see what it can do (Trial).
- 16) If I heard about a new information technology, I would look for ways to experiment with it (PIIT).
- 17) Among my peers, I am usually the first to try out new information technologies (PIIT).
- 18) In general, I am hesitant to try out new information technologies (PIIT).
- 19) I like to experiment with new information technologies (PIIT).
- 20) The identity of anyone using Patient Gateway will be carefully confirmed by my doctor's office to prevent any unauthorised access or any cases of mistaken identity (Privacy/Security).
- 21) The information in my Patient Gateway account will only be seen by my health care providers and not by others who are not authorised to see the information such as employers and insurance companies (Privacy/Security).
- 22) My doctor's office will immediately notify me if there is a privacy or security breach related to the information in my Patient Gateway account (Privacy/Security).

<sup>a</sup>All items rated on the following scale: Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree.

<sup>b</sup>RA = Relative Advantage; Comp = Compatibility; EU = Ease of Use; Trial = Trialability; PIIT = Personal Innovativeness in the domain of information technology.



## APPENDIX 2: REFILLING A MEDICATION USING A PATIENT PORTAL (EXAMPLE OF RELATIVE ADVANTAGE)



*He's refilling a prescription.*



Introducing Patient Gateway - the fast, efficient, and secure way to reach your doctor's office. Developed by Partners HealthCare System, Patient Gateway uses the power of the Internet, so you can renew prescriptions, request referral authorizations for specialist appointments, and access quality health and wellness information - at your convenience. With Patient Gateway, connecting with your doctor's office has never been easier!



Enroll online today at: **[www.patientgateway.org](http://www.patientgateway.org)**

or



email us at: **[patientgateway@partners.org](mailto:patientgateway@partners.org)**



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