

## HEALTH CARE REFORM

# The Digital Divide in Adoption and Use of a Personal Health Record

Cyrus K. Yamin, BS; Srinivas Emani, PhD; Deborah H. Williams, MHA; Stuart R. Lipsitz, ScD; Andrew S. Karson, MD, MPH; Jonathan S. Wald, MD, MPH; David W. Bates, MD, MSc

**Background:** Personal health records (PHRs) offer the potential to improve the patient experience and the quality of patient care. However, the “digital divide,” the population-level gap in Internet and computer access, may prevent certain groups from accessing the PHR.

**Methods:** We conducted a cross-sectional analysis of a PHR within a northeastern health system. We compared adopters (ie, those activating a PHR account online) with nonadopters (ie, those who see a physician offering the PHR but do not activate an account). We further categorized adopters by intensity of PHR use, measured by number of log-ins and number of messages sent to physicians’ practices.

**Results:** As of September 30, 2009, among 75 056 patients, 43% had adopted the PHR since 2002. Blacks and Hispanics were less likely to adopt the PHR compared with whites (odds ratio [OR], 0.50; 95% confidence interval [CI], 0.45-0.55; and 0.64; 0.57-0.73, respectively), and those with

lower annual income were less likely to adopt the PHR than were those with higher income. Compared with nonadopters, adopters were more likely to have more than 2 comorbidities (OR, 1.27; 95% CI, 1.17-1.30). Use of an aggressive marketing strategy for PHR enrollment increased adoption nearly 3-fold (OR, 2.92; 95% CI, 1.58-5.40). Intensity of use was best predicted by increasing number of comorbidities, followed by race/ethnicity (whites more than blacks and Hispanics) and insurance status. We found no association between income and log-in frequency or secure messages sent.

**Conclusions:** Despite increasing Internet availability, racial/ethnic minority patients adopted a PHR less frequently than white patients, and patients with the lowest annual income adopted a PHR less often than those with higher incomes. Among adopters, however, income did not have an effect on PHR use.

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**T**HE PERSONAL HEALTH RECORD (PHR) is an “Internet-based set of tools that allows people to access and coordinate their lifelong health information.”<sup>1(p3)</sup> The spectrum of PHRs ranges from health care organization–tethered applications that build on a patient’s existing electronic health record to stand-alones in which the patient

## See Invited Commentary at end of article

supplies the bulk of medical information to the PHR.<sup>2</sup> Regardless of the architecture, however, all PHRs aim to increase patient access to personal health information in a secure fashion.<sup>3</sup> Some estimate that more than 70 million Americans already have access to some form of PHR, although this figure includes insurance-provided PHRs, of which the patient may be unaware.<sup>4</sup>

The potential benefits of PHRs are numerous. Patients can use PHRs to view personal health information, a traditionally burdensome task. At their convenience, patients can review laboratory test results, confirm medication lists, follow links to credible health information online, and communicate with providers. The asynchronous nature of secure messaging eliminates the need for both parties to be present at the same time during an exchange, facilitating provider-patient communication. Finally, practices benefit by the streamlining of administrative functions, such as scheduling appointments, filling prescriptions, and arranging referrals.<sup>2</sup>

The magnitude of potential improvement will be blunted, however, if patients cannot access PHRs because of the “digital divide,” the term often used to describe disparities in access to technology. Nationwide surveys estimate that 78% of Americans use the Internet, with 61% seeking health information online.<sup>4</sup> However, Americans least likely to have Internet ac-

**Author Affiliations:** Division of General Internal Medicine, Department of Medicine, Brigham and Women’s Hospital (Mr Yamin, Drs Emani, Lipsitz, Wald, and Bates, and Ms Williams), Harvard Medical School (Mr Yamin and Drs Emani and Karson), Division of General Internal Medicine, Department of Medicine, Massachusetts General Hospital (Dr Karson), and Partners Information Systems, Partners HealthCare (Drs Wald and Bates), Boston.

cess—racial/ethnic minorities, the elderly, the poor—receive lower-quality health care than those without these characteristics.<sup>5-7</sup> Furthermore, living with a chronic disease is associated with decreases in Internet access rate by 50%; this is of particular importance because the longitudinal engagement afforded by PHRs may enhance management of chronic diseases, which compose the bulk of health care costs.<sup>8</sup> Organizations may be able to target specific groups to encourage adoption of the PHR, as they may be able to identify individuals who might particularly benefit. While patient and physician attitudes surrounding PHRs are generally positive,<sup>9-11</sup> less is known about how many patients actually adopt PHRs or to what extent they use them after registering, which is important because the benefits of a PHR are unlikely to accrue unless it is used regularly.

For this study, we had 3 objectives. First, we compared the demographic characteristics, including age, race/ethnicity, and socioeconomic status (SES), of individuals who registered to use the PHR (ie, adopters) with those who saw a physician offering a PHR but did not register (ie, nonadopters). Second, we assessed the intensity of use among adopters to determine whether the same demographic characteristics that predicted adoption also predicted intensity of use. Third, we assessed whether the presence of a chronic disease was associated with adoption or intensity of use.

## METHODS

### SETTING

Partners HealthCare is a large integrated delivery system in the Northeast that includes approximately 6000 physicians and 8 hospitals. Partners HealthCare began offering its PHR, Patient Gateway, in 2002. Partners HealthCare has since implemented Patient Gateway at more than 100 primary care and specialist practices, with more than 80 000 enrolled users as of 2010. Patients register at a Web site<sup>12</sup> and activate their account after receiving a password by postal mail. After logging in, patients can access medication lists, laboratory test results, and appointment information. They also may communicate electronically with the practice, using secure messaging. Before sending a message, patients assign their communication to one of the following categories: questions about care, medication refill requests, scheduling referral and appointment requests, address and telephone corrections, and payment-related inquiries.

### PATIENTS

The study included patients who received care from PHR-enabled Partners HealthCare primary care practices between January 1, 2007, and September 30, 2009. To allow sufficient time for a practice to implement the PHR and recruit patients, only sites that had offered the PHR for at least 365 days were included. This study was approved by the Partners HealthCare Institutional Review Board.

### STUDY DESIGN

This was a cross-sectional study. We selected patient adoption status (adopter vs nonadopter) as of September 30, 2009, as the primary outcome and intensity of use among adopters as the secondary outcome. Based on nationwide surveys of Inter-

net use,<sup>4</sup> we hypothesized that PHR adoption and use would be positively associated with white race, female sex, younger age, commercial insurance status, and a lower number of comorbidities.

## DEFINITIONS

We defined *adopters* as primary care patients who registered for the PHR on the Web site and activated their account online. We defined *nonadopters* as primary care patients who had visited a provider at a practice using the PHR but did not have a PHR account. Among adopters, we assessed the intensity of use by 2 means: the number of unique session log-ins and the number of secure messages. We excluded 1 clinic that lacked the functionality of secure messaging at the time of data collection.

Practices recruit patients to Patient Gateway through various means, including incorporation into automated greetings on the practice's telephone system, posters in waiting areas and examination rooms, postcard and letter mailings, staff speaking to the patient in the office or over the telephone, and on-site enrollment with a computer kiosk. In total, there were 16 different strategies. We classified a practice's marketing strategy as *aggressive* if it used more than 5 strategies and *normal* if it used 5 or fewer strategies.

## PATIENT DEMOGRAPHICS

We obtained information on patient age, sex, race/ethnicity, insurance status, chronic comorbidities, visit history, and street address from the electronic health record. We classified race according to the patient's response to 2 items upon registration: race (white, black or African American, Asian, American Indian or Alaska Native, Native Hawaiian or other Pacific Islander, or other or unknown) and ethnicity (Hispanic or Latino or neither). We excluded American Indian or Alaska Native and Native Hawaiian or other Pacific Islander from analyses owing to small numbers. Patients within the "other or unknown" category were also excluded from multivariate analysis because we were unable to determine the race of these individuals. Because of the complexity of determining the specific racial and ethnic makeup of Hispanic patients, we classified patients into 4 groups: self-identified Hispanics or Latinos, whites, blacks, and Asians. This approach to classification, used in prior studies at our health network,<sup>13</sup> is based on federal standards on race and ethnicity.<sup>14</sup>

We retrieved information on chronic comorbidities by looking for a set of diagnosis codes defining congestive heart failure, diabetes mellitus, asthma, and hypertension within a patient's problem list. These 4 diagnoses were selected because the conditions are common (hypertension, diabetes, and asthma) or expensive (congestive heart failure) and because disease management has been effective for them. These were assessed individually and also summed to form a cumulative comorbidity score, with lowest being 0 and highest being 4. We grouped insurance status into Medicare, Medicaid, private, or self-pay categories on the basis of the patient's status at the time of record retrieval.

## AREA-BASED SOCIOECONOMIC MEASURE

We converted a table of patient mailing addresses to latitude and longitude coordinates and then mapped these coordinates onto US census block groups, a process known as *geocoding*. We selected block groups, which contain between 600 and 3000 people, as opposed to census tracts or zip codes, because block groups provide the most granular level of information reported by the census. As a proxy for SES, we selected median annual house-

**Table 1. Characteristics of PHR Nonadopters and Adopters<sup>a,b</sup>**

Characteristic	%	
	Nonadopters (n=42 782)	Adopters (n=32 274)
Sex		
Female	59	63
Age, y		
18-35	17	14
36-50	30	35
51-65	28	33
>65	26	17
Race/ethnicity		
White	73	84
Black	9	4
Hispanic	7	2
Asian	6	3
Insurance status		
Commercial	69	85
Medicare	24	12
Medicaid	6	1
Self-pay	2	2
Comorbidities		
Asthma	7	9
CHF	1	1
Diabetes mellitus	10	7
Hypertension	25	24
Comorbidities, total		
0	64	67
1	28	27
2-4	9	6
Marketing intensity		
Aggressive	50	75
Annual household income, quartile		
1, High SES	20	29
2	22	29
3	26	25
4, Low SES	33	18

Abbreviations: CHF, congestive heart failure; PHR, personal health record; SES, socioeconomic status.

<sup>a</sup> $P < .001$  for all comparisons.

<sup>b</sup>Race/ethnicity data total 100% after addition of other/excluded race category. Other variables do not total 100% because of rounding.

hold income of the block group. We excluded patients whose mailing addresses were post office boxes from analyses because these addresses do not reflect the actual residence. When an address could not be geocoded to a specific block group, we imputed location based on the next highest geographic region (census tract or zip code). We used ESRI Streetmap 2009 projections for estimates of US Census Bureau 2000 data. We used ArcGIS software (version 9; ESRI) for geocoding and mapping.

### STATISTICAL ANALYSIS

We used SAS statistical software (version 9.1; SAS Institute, Inc, Cary, North Carolina) for all analyses. We calculated results using proportions or counts because all variables were categorical. We used Pearson  $\chi^2$  tests, adjusted for clustering within physician,<sup>15</sup> to compare characteristics of adopters and nonadopters. We used logistic regression to model the probability of PHR adoption as a function of predictors. Among adopters, we modeled intensity of use (log-ins and messaging counts over a 33-month period) with a Poisson regression model. The variables from the Poisson regression model can be interpreted as intensity ratios (IRs) (ratios of intensity of use for one group

relative to a reference group). Our logistic and Poisson regression models included the following predictors: age group, sex, race/ethnicity, insurance status, presence of the selected chronic comorbidities and total comorbidity score, annual household income quartile, and number of visits to a primary care provider between January 1, 2007, and September 30, 2009. We accounted for clustering within physicians and clinics using generalized estimating equations.<sup>16</sup> For intensity of use, we experimented with inclusion of an offsetting time variable to scale for the number of days a patient had been registered for the PHR; this resulted in similar findings.

## RESULTS

We identified 76 810 patients who visited primary care providers whose practices offered Patient Gateway. We excluded 1754 patients (2%) who had post office box addresses, since we could not identify their residence through geocoding; these patients were similar to the remainder of the population in terms of age, race/ethnicity, and sex. We used geocoding for the remaining 75 056 patients—96% to census block group and 4% to zip code centroid. In sensitivity analyses, we included the 1754 individuals who we were not able to locate through geocoding and performed regressions without the geocoding variable; the results with and without these 1754 excluded patients were similar. Thus, we present results with the 75 056 patients categorized with geocoding. Of these patients, 43% had adopted the PHR. Adopters and nonadopters differed in a number of characteristics, including sex, age, race/ethnicity, and insurance status (**Table 1**).

When compared with white patients, the likelihood of adoption was lower among all racial and ethnic minorities (**Table 2**), with the most pronounced effect in blacks (odds ratio [OR], 0.50; 95% confidence interval [CI], 0.45-0.55). Moving from the highest annual household income quartile to the lowest decreased the odds of adoption by 14% (OR, 0.86; 95% CI, 0.82-0.92). However, patients with multiple comorbidities adopted the PHR at a higher rate compared with those without the selected comorbidities (1 comorbidity: OR, 1.23; 95% CI, 1.22-1.30 and 2-4 comorbidities: 1.27; 1.17-1.30). We rebuilt our model with individual comorbidity status instead of total comorbidities; presence of these factors was not correlated with adoption rate. Contrary to our a priori hypothesis, patients with increasing visit frequency were less likely to adopt PHR (2-4 visits: OR 0.67; 95% CI, 0.63-0.73 and  $\geq 5$  visits: 0.49; 0.44-0.55). Use of an aggressive marketing strategy increased the odds of PHR adoption nearly 3-fold (OR, 2.92; 95% CI, 1.58-5.40).

Of the 32 274 adopters, we recorded 290 662 log-ins to the PHR. We classified 51% of users as very low users, logging into the PHR 0 or 1 time in the past 2 years (**Table 3**). The second-largest group was the high users, with 10 or more log-ins, at 27%. Patients from 51 to 65 years of age composed the majority of the high user group, at 41%.

Among PHR adopters, neither high annual household income nor female sex predicted increased log-in frequency (Table 3). Increased visitation to a PHR pro-

vider predicted use intensity most strongly, trending upward with 2 to 4 visits (IR, 1.73; 95% CI, 1.68-1.77) followed by 5 or more visits (2.02; 1.96-2.08). Blacks were 24% less likely to fall into the high user group compared with whites (IR, 0.76; 95% CI, 0.71-0.82).

We recorded 32 274 unique message exchanges, also known as *threads*. When including each message within a thread, we calculated a total of 206 610 messages. Questions about care, medication refill requests, coordination of referrals and appointments, address corrections, and payment-related inquiries made up 32%, 33%, 21%, 9%, and 3% of the threads, respectively. We identified 70% of PHR adopters as low-messaging users, accessing the service 0 or 1 time (**Table 4**). With increasing comorbidities, patients escalated the intensity of messaging. Compared with those having no chronic diseases, patients with 1 chronic disease of the 4 recorded were 1.21 times more likely to send messages (95% CI, 1.16-1.26), while those with 2 to 4 of the select chronic diseases were 1.42 times more likely to send messages (1.33-1.52).

### COMMENT

Personal health records have great potential to improve care, but this potential will go unrealized unless patients adopt PHRs and then use them with some frequency, making evaluation of both adoption and use important. Moreover, the potential benefits may be greatest in groups that are less likely to adopt the PHR. We found that blacks and Hispanics were half as likely to adopt the PHR compared with whites, and patients in the lowest quartile of SES were 14% less likely to adopt than were those in the highest quartile. However, once patients had adopted the PHR, race/ethnicity was much less strongly associated with number of log-ins and SES had no association, suggesting that the key target for bridging the digital divide may be at the adoption level. In our adjusted models, patients with chronic diseases were about 25% more likely to adopt the PHR than were those without these diseases. Robust, practice-wide marketing strategies to increase adoption rates were associated with higher rates of adoption.

Other studies have been conducted in this area, although most prior data come from managed care. One study<sup>17</sup> of 1777 patients 35 to 59 years old in a managed care organization found that, even after adjusting for education, annual income, and Internet access, these factors did not account for lower PHR use by blacks (30.1%) compared with that of whites (41.7%). Our population included all ages and all types of insurance, and we also found that a racial digital divide exists. In our study, patients older than 65 years actually adopted a PHR to a greater extent than patients aged between 18 and 35 years. Hsu and colleagues<sup>18</sup> examined adoption of a Web site offering drug refill and appointment scheduling and found that increased patient clinical "need," assessed by comorbidity, was associated with higher adoption rates. We found similar associations with comorbidity, although a converse relationship existed with visits because those who visited the clinic more often tended to adopt the PHR less, suggesting that patients' health needs (comorbidities)

**Table 2. Adjusted Odds Ratios of PHR Adoption<sup>a</sup>**

Characteristic	Odds Ratio (95% CI)
Sex	
Male	1 [Reference]
Female	1.15 (1.08-1.21)
Age, y	
18-35	0.79 (0.73-0.86)
36-50	0.94 (0.89-0.99)
51-65	1 [Reference]
>65	0.84 (0.79-0.90)
Race/ethnicity	
White	1 [Reference]
Black	0.50 (0.45-0.55)
Hispanic	0.64 (0.57-0.73)
Asian	0.74 (0.68-0.80)
Insurance status	
Commercial	1 [Reference]
Medicare	0.59 (0.52-0.74)
Medicaid	0.66 (0.58-0.74)
Self-pay	1.21 (1.09-1.32)
Comorbidities, total	
0	1 [Reference]
1	1.23 (1.22-1.30)
2-4	1.27 (1.17-1.30)
Marketing intensity	
Normal	1 [Reference]
Aggressive	2.92 (1.58-5.40)
Annual household income, quartile	
1, High SES	1 [Reference]
2	0.98 (0.93-1.02)
3	0.96 (0.91-1.00)
4, Low SES	0.86 (0.82-0.92)
Visits	
0-1	1 [Reference]
2-4	0.67 (0.63-0.73)
≥5	0.49 (0.44-0.55)

Abbreviations: CI, confidence interval; PHR, personal health record; SES, socioeconomic status.

<sup>a</sup>Logistic model with predictors: age group, sex, race/ethnicity, insurance status, presence of select chronic conditions (asthma, diabetes, hypertension, and congestive heart failure), total comorbidity score, annual household income quartile, and total number of visits to primary care provider.

ties) and their health utilization (visits) affect adoption through different mechanisms. It is also possible that if patients frequently visit their primary care practice they may perceive less need to use the PHR to communicate with their practice. Whether this is the case must be examined via survey-based research relating frequency of visits with perceived value of the PHR.

As Hsu and colleagues<sup>18</sup> recognized, the eHealth services they studied may have been achieved with ease by alternative means, such as using the telephone instead of the Internet to make appointments. However, our PHR included services that previously were highly inconvenient, namely, the ability to view one's medical record. We suspect that patients may be using these additional services extensively. The total number of messages was 70% of the total number of log-ins, suggesting that in roughly one-third or more of log-in sessions, patients do not send messages; rather, they may read messages or view information such as laboratory test results, medication history, or health library information. At the time of this study, we could not track specifically what people were

**Table 3. Intensity of Use of PHR Adopters by Log-in Frequency<sup>a</sup>**

Characteristic	Log-in Frequency, % <sup>b</sup>				Intensity Ratio (95% CI) <sup>c</sup>
	Very Low, 0 or 1 Log-in (n=16 556)	Low, 2-4 Log-ins (n=3351)	Medium, 5-9 Log-ins (n=3668)	High, ≥10 Log-ins (n=8699)	
Sex <sup>d</sup>					
Female	65	60	62	62	0.99 (0.97-1.02)
Age, y					
18-35	17	13	13	10	0.75 (0.73-0.78)
36-50	40	35	34	28	0.75 (0.78-0.82)
51-65	28	35	37	41	1 [Reference]
>65	15	16	16	21	0.94 (0.90-0.98)
Race/ethnicity					
White	81	85	86	87	1 [Reference]
Black	4	3	3	4	0.76 (0.71-0.82)
Hispanic	2	2	1	2	0.83 (0.75-0.93)
Asian	4	3	3	3	0.88 (0.82-0.95)
Insurance					
Commercial	85	87	87	83	1 [Reference]
Medicare	11	11	11	15	0.90 (0.86-0.94)
Medicaid	1	1	0	1	0.73 (0.64-0.85)
Self-pay	3	2	2	2	0.73 (0.67-0.80)
Comorbidities, total					
0	71	69	67	57	1 [Reference]
1	24	26	28	34	1.11 (1.08-1.14)
2-4	5	5	5	9	1.15 (1.10-1.20)
Marketing strategy <sup>e</sup>					
Aggressive	71	76	77	82	1.54 (1.49-1.58)
Annual household income, quartile					
1, High SES	28	33	32	30	1 [Reference]
2	28	28	28	29	0.98 (0.95-1.01)
3	25	24	24	25	0.98 (0.95-1.01)
4, Low SES	19	15	16	16	0.97 (0.94-1.01)
Visits					
0-1	69	54	50	37	1 [Reference]
2-4	18	27	30	29	1.73 (1.68-1.77)
≥5	14	19	21	24	2.02 (1.96-2.08)

Abbreviations: CI, confidence interval; PHR, personal health record; SES, socioeconomic status.

<sup>a</sup>Frequency tallied across 33 months (January 1, 2007, to September 30, 2009).

<sup>b</sup>*P* < .001 for all comparisons of log-in frequency. Race/ethnicity data total 100% after addition of other/excluded race category. Other variables do not total 100% because of rounding.

<sup>c</sup>Poisson model with predictors: age group, sex, race/ethnicity, insurance status, presence of select chronic conditions (asthma, diabetes, hypertension, and congestive heart failure), total comorbidity score, annual household income quartile, and total number of visits to primary care provider.

<sup>d</sup>Male sex is the reference category.

<sup>e</sup>Normal marketing strategy is the reference category.

viewing in their medical record. However, we did record information on use of patient messaging. A comparable case report<sup>3</sup> detailing Boston's Beth Israel-Deaconess Medical Center's messaging use within a PHR noted that general messaging and prescription request messages were the most popular functions, similar to the findings in our study. We went on to calculate odds-adjusted ratios for messaging, as well as log-ins, which showed that presence of chronic comorbidities and visits was associated with increased messaging. These results reinforce those shown by Ralston and colleagues<sup>19</sup> in their study of a secure messaging system separate from a PHR. Yet, when including race/ethnicity data, we found that blacks and Hispanics were less likely to use messaging compared with whites, even after adopting the PHR.

We found that blacks and Hispanics—who generally receive lower-quality health care in the United States—also adopted the PHR less frequently. Possible explanations may

fall along a pathway that includes Internet access, computer literacy, and knowledge and perceived benefits of the PHR. Data on Internet access nationally indicate a gap, with minority racial/ethnic groups less likely to have Internet access compared with whites.<sup>8</sup> Another issue is that of trust. Black populations have traditionally been shown to be less trusting with respect to the health care system, which may lead to weaker health-seeking behaviors.<sup>20</sup> With PHRs, however, patients have the ability to seek out health information on their own, although the extent to which this increases access is unknown.

That SES had minimal effect on PHR adoption is a positive finding for the potential of PHRs. We know that disparities in Internet access are decreasing as Internet use becomes more common outside the home, for example, in the workplace, community centers, and schools.<sup>21</sup> We used home addresses to assign an area-based socioeconomic measure, although many individuals may have used Internet and com-

**Table 4. Intensity of Use of PHR Adopters by Messaging Frequency<sup>a</sup>**

Characteristic	Messaging Frequency, % <sup>b</sup>			Intensity Ratio (95% CI) <sup>c</sup>
	Low, 0 or 1 Message (n=22 700)	Medium, 2-5 Messages (n=6025)	High, ≥6 Messages (n=3549)	
Sex <sup>d</sup>				
Female	82	87	88	1.00 (0.98-1.02)
Age, y				
18-35	15	14	8	0.75 (0.70-0.80)
36-50	37	33	27	0.80 (0.77-0.84)
51-65	31	38	44	1 [Reference]
>65	17	16	20	0.83 (0.77-0.90)
Race/ethnicity				
White	82	87	88	1 [Reference]
Black	4	3	2	0.66 (0.58-0.74)
Hispanic	2	1	1	0.73 (0.62-0.87)
Asian	3	3	2	0.86 (0.77-0.96)
Insurance				
Commercial	84	87	83	1 [Reference]
Medicare	13	11	14	0.83 (0.77-0.90)
Medicaid	1	1	1	0.88 (0.72-1.07)
Self-pay	2	2	2	0.78 (0.67-0.89)
Comorbidities, total				
0	69	65	52	1 [Reference]
1	25	30	36	1.21 (1.16-1.26)
2-4	6	5	13	1.42 (1.33-1.52)
Marketing strategy <sup>e</sup>				
Aggressive	72	83	83	1.76 (1.67-1.84)
Annual household income, quartile				
1, High SES	29	30	28	1 [Reference]
2	28	29	30	1.03 (0.98-1.08)
3	25	24	26	1.01 (0.96-1.06)
4, Low SES	18	17	17	1.00 (0.95-1.06)
Visits				
0-1	66	52	37	1 [Reference]
2-4	15	28	27	1.79 (1.72-1.87)
≥5	19	20	36	2.25 (2.15-2.35)

Abbreviations: CI, confidence interval; PHR, personal health record; SES, socioeconomic status.

<sup>a</sup>Frequency tallied across 33 months (January 1, 2007, to September 30, 2009).

<sup>b</sup>*P* < .001 for all comparisons of messaging frequency. Race/ethnicity data total 100% after addition of other/excluded race category. Other variables do not total 100% because of rounding.

<sup>c</sup>Poisson model adjusting for age group, sex, race/ethnicity, insurance status, presence of select chronic conditions (asthma, diabetes, hypertension, and congestive heart failure), total comorbidity score, annual household income quartile, and total number of visits to primary care provider.

<sup>d</sup>Male sex is the reference category.

<sup>e</sup>Normal marketing strategy is the reference category.

puting resources outside their home. We expect that the role SES plays in the digital divide will likely diminish, as the Federal Communication Commission estimates that 90% of Americans will have Internet access by 2020.<sup>22</sup>

As populations become more comfortable with use of the Internet, we hope that increased age, similar to low SES, will play a smaller role in the digital divide. That PHRs were adopted more readily by the elderly than by other age groups in our study is another positive finding because the elderly patient population continues to grow and will likely use health care to a greater extent.

As noted earlier, patients with a higher number of chronic conditions were more likely to adopt the PHR. A confounder is that PHRs' enhanced communication and result delivery are more important for some diseases than others. For example, patients with diabetes monitoring their hemoglobin A<sub>1c</sub> values might find more use in checking laboratory test results than a patient with hyperten-

sion, although our analysis did not suggest that having a specific condition increased adoption of a PHR more than another. The use of personalized tools that enable patients to track their condition, the creation of disease communities, or the expansion of disease-specific online resources links may act as mechanisms that encourage PHR adoption and use. Ultimately, we identified aggressive marketing by practice as the strongest predictor of patient-level adoption, a strategy that may mitigate population-level disparities.

The variables correlated with adoption did not have as strong an effect on intensity of PHR use as gauged by log-in and messaging frequency. Minority racial/ethnic status was associated with a modestly lower intensity of use, whereas female sex and SES lost their effect. This finding suggests that the key gap on which to focus may be adoption of the PHR, although use is likely to be an issue among, for example, patients with low literacy. In-

creased tor of PHR use. While patients who visit their physician may have greater need to follow up on the PHR, perhaps, as functionality and comfort with technology improve, PHR use in itself may lessen the need for in-person visits. The opportunity to learn about one's health record in the privacy of the home is a new possibility afforded by PHRs.

This study has several limitations. The data come from a single integrated delivery system, which may not represent systems elsewhere. In addition, the specific functionality of this PHR may differ from that of others. Primary language of the patient was not evaluated, and although there is no literature on the matter, we suspect the patients who do not speak English are likely to have lower adoption rates of English-only PHRs. If patients were Spanish speaking, for example, the physician may not have suggested that the patient sign up for a PHR. Our inclusion of the marketing variable sought to adjust for physician biases, since aggressively marketed practices used techniques that targeted patients uniformly, such as mailings. Also, we did not consider the provider's use, which might indirectly increase patient adoption. Finally, our definition of adopters deserves qualification; a patient might never have used the PHR beyond the first log-in but would fall under our adopter category. These single-log-in users did not return to PHR, although they did demonstrate a baseline level of computer access in initially logging into the service. Of note, we conducted a subsequent subanalysis of this single-log-in population; the characteristics were similar to those of the other adopters (data not shown).

In this study, we found the presence of the digital divide in a diverse population. Specifically, racial/ethnic minorities and patients with lower SES were less likely to adopt a PHR. However, both of these groups used the PHR as much as other groups if they were able to adopt it. Whether the digital divide was caused by barriers in access to technology or reflects long-standing disparities in health-seeking behavior is less clear. Further studies are needed to better understand and promote use of PHRs among adopters and to design interventions to increase PHR uptake among populations likely to benefit most.

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**Correspondence:** David W. Bates, MD, MSc, Division of General Internal Medicine, Brigham and Women's Hospital, 1620 Tremont St, Boston, MA 02120 (dbates@partners.org).

**Author Contributions:** Dr Bates had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. *Study concept and design:* Yamin, Emani, Lipsitz, Karson, and Bates. *Acquisition of data:* Williams and Bates. *Analysis and interpretation of data:* Yamin, Emani, Lipsitz, Wald, and Bates. *Drafting of the manuscript:* Yamin, Emani, Lipsitz, and Bates. *Critical revision of the manuscript for important intellectual content:* Emani, Williams, Lipsitz, Karson, Wald, and Bates. *Statistical analysis:* Yamin and

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