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Correlates of personal health record registration and utilization among veterans with HIV

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ABSTRACT

Objective: We examined correlates of registration and utilization of the Veteran Health Administration's (VHA) personal health record (PHR), My HealtheVet (MHV), among a national cohort of veterans living with HIV.
Materials and Methods: Using VHA administrative data, we matched veterans with HIV who registered for MHV in fiscal year 2012–2018 ($n = 8589$) to 8589 veterans with HIV who did not register for MHV. We compared demographic and geographic characteristics, housing status, comorbidities, and non-VHA care between MHV registrants and nonregistrants to identify correlates of MHV registration. Among registrants, we examined the association between these characteristics and MHV tool use (prescription refill, record download, secure messaging, view labs, and view appointments).
Results: MHV registrants were more likely to be younger, women, White, and to have bipolar disorder, depression, or post-traumatic stress disorder diagnosis than nonregistrants. Having a substance use disorder (SUD) diagnosis or a higher Elixhauser score was associated with lower odds of MHV registration. Among registrants, women were less likely to use prescription refill. Patients who were at risk of homelessness in the past year were less likely to use secure messaging and, along with those who were homeless, were less likely to use view labs and prescription refill. Bipolar disorder and depression were associated with increased secure messaging use. Diagnoses of SUD and alcohol use disorder were both associated with lower rates of prescription refill.
Discussion: Among veterans living with HIV, we identified significant differences in PHR registration and utilization by race, sex, age, housing status, and diagnosis.

Key words: personal health records, HIV, veterans, patient characteristics, health information technology

LAY SUMMARY

Personal health records (PHRs) encourage patient self-management of chronic conditions, such as HIV. Identifying patient groups who are not reached by PHRs is an important first step to identifying strategies to promote PHR use. We explored the relationships between several patient factors and PHR registration and use among veterans living with HIV receiving care through the Veterans Health Administration from 2012 to 2018. Veterans who were younger, women, White, and who had bipolar disorder, depression or post-traumatic stress disorder were more likely to register for the PHR. Among registrants, women, patients who were unstably housed, and patients with a substance use disorder or alcohol use disorder diagnosis had lower rates of PHR utilization. Among veterans living with HIV, we identified significant differences in PHR registration and utilization by race, age, housing status, and diagnosis.

INTRODUCTION

Personal health records (PHR) encourage patient self-management of chronic conditions. Some evidence suggests that PHR use is associated with improved medication adherence and care outcomes among patients with depression and better glycemic control among patients with diabetes.[1–3] They may be particularly important for people living with HIV, for whom continuous engagement in care is critical for achieving viral suppression and reducing HIV-related morbidity, mortality, and transmission.[4] HIV treatment management can be complex, requiring tracking medications, monitoring labs, and managing clinical visits. PHRs provide tools that can facilitate HIV self-management. Previous studies suggest PHR use is associated with improved antiretroviral therapy (ART) adherence and viral suppression among patients with HIV.[5,6]

In the Veterans Health Administration (VHA), My HealtheVet (MHV) has been in use since 2003 and, as of August 2019, has over 5 million registered users.[7] Veterans can track their medications and request refills using the Rx Refill tool, view laboratory results and upcoming appointments, communicate with, and download copies of their complete health record. As of 2017, 49% of veterans with HIV have registered for MHV, and previous research of MHV reach in the VHA has found that veterans living with HIV have the highest levels of adoption (along with veterans with hyperlipidemia and spinal cord injury).[8,9] However, there is some evidence that some subgroups of patients are not reached by PHRs. A previous study among veterans living with HIV has described disparities in PHR adoption by race/ethnicity, with Black and Hispanic/Latinx veterans having lower rates of registration and utilization than White veterans.[9] More broadly, disparities in PHR adoption by age, race, income, and comorbidities (such as alcohol or other substance use disorder [SUD]) have also been previously described both within and outside the VHA.[10–13]

Previous studies have demonstrated that patient adoption and engagement with PHRs are strongly influenced by patient characteristics, including demographics (particularly, age and race/ethnicity), health status, and health care utilization.[14] Identifying specific subgroups (by age, sex, race, ethnicity, geographic factors, and health status) of patients not reached by PHRs is an important first step in identifying barriers to adoption and developing interventions to address these gaps. Using a national cohort of veterans living with HIV and receiving care in VHA, the goal of this study is to describe correlates of PHR registration and utilization among a national cohort of veterans living with HIV and receiving care in VHA.

MATERIALS AND METHODS

Study design and population

Using VHA administrative data, we identified all veterans who registered for MHV between October 2011 and September 2018 and who were diagnosed with HIV prior to their registration. We defined HIV diagnosis as presence of an HIV ICD-9 or ICD-10 code (Supplementary Appendix Table S1) on at least one inpatient hospitalization or at least 2 outpatient visits during the study period, which is consistent with a previously validated case definition of HIV using VHA administrative data.[15]

In analyses examining correlates of MHV registration, we identified veterans living with HIV who utilized VHA care during the study period, and who never registered for MHV through September 2018. We randomly matched a nonregistrant to each registrant, and for each pair, used the registrant's MHV registration date as an index date before which to assess potential correlates. Because we were interested in measuring correlates in the year prior to MHV registration for registrants, matching registrants and nonregistrants ensured that we measured potential correlates in a comparable time period for nonregistrants.

Primary outcomes

Our outcomes of interest were MHV registration and utilization of 5 MHV tools: Rx Refill, Secure Messaging, Blue Button (ie, downloads portions of the medical record), View Labs, and View Appointments. Supplementary Appendix Table S2 describes each tool's features and functionality. We defined the MHV registration date as the first date the patient had any MHV activity. Because our study population focused on veterans living with HIV, we also examined use of Rx Refill specifically for refilling ART prescriptions.

MHV registrants' access to tools is dependent on the type of account they have. An *Advanced* account, which is given to all veterans at registration, provides access to Rx Refill, and the ability to access limited, self-entered data through Blue Button. In contrast, a *Premium* account allows full access and functionality to all 5 of the tools we studied, but requires veterans verify their identity through a process known as In-Person Authentication (IPA). For the purposes of the study, we defined IPA date as the earlier of either the recorded IPA date or the first use date of MHV functionality requiring a *Premium* account.

We calculated the utilization rate for each tool by dividing the number of tool uses by the duration of access. We counted each veteran's number of distinct days of use of Rx Refill, Rx Refill for ART, Blue Button, View Appointments, and View Labs, and number of unique Secure Messaging threads initiated during the study period. For Rx Refill and Rx Refill for ART, we calculated the duration of access as the number of days between the Veteran's registration date and the earlier of either the end of the study period or their date of death. For the other 4 tools, which require a *Premium* MHV account, we defined duration of access as the number of days between the Veteran's IPA date and the earlier of either the end of the study period or their death date.

Independent variables

Demographic and geographic characteristics

We obtained measures of age (as of registration date for registrants and index date for nonregistrants), sex, and race/ethnicity using VHA administrative data. Using methods described in the National Veterans Health Equity Report—FY13 Technical Appendix,[16] we mapped race and ethnicity values to a combined race/ethnicity variable. Veterans were categorized as Hispanic/Latinx or one of the following non-Hispanic categories: Asian, Black, Native American/Alaska Native, Native Hawaiian/other Pacific Islander, White, and unknown.

We measured rurality and neighborhood socioeconomic status at the ZIP code level. Each veteran's residential ZIP code was assigned based on the residential ZIP code most often reported at infectious disease care or primary care visits in the year prior to their registration or index date. We defined rurality using Rural Urban Commuting Area codes, which were dichotomized as "urban" and "rural or highly rural." The Area Deprivation Index (ADI) was used as a proxy measure for neighborhood socioeconomic status. The methods used to develop and validate the ADI are described elsewhere.[17] Briefly, the ADI is calculated using neighborhood-level data on income, education, employment, and housing quality from the 2013 American Community Survey. We aggregated census tract-level ADIs to the ZIP code level. ADI scores were assigned to each patient based on their residential ZIP code.

Housing status

We defined housing status using a 4-category measure with the following categories: at risk of homelessness, currently homeless, formerly homeless and in long-term supportive housing, and housed.[18] We ascertained housing status in the year prior to their registration or index date using data from the Homeless Operations Management and Evaluation System (HOMES) database, Supportive Services for Veterans and Families (SSVF) database, VHA administrative data on homeless program utilization, and responses to the VHA Homelessness Clinical Screening Reminder.[19–21] Together, the HOMES, SSVF, and administrative data include utilization data for all VHA homeless programs. Furthermore, the VHA Homelessness Clinical Screening Reminder screener identifies VHA patients for housing instability and homelessness. Since patients could be categorized into multiple categories over time, we assigned each patient to one category using a tiered approach, using an approach previously published on by Byrne et al. In this approach, indication of former homelessness superseded that of current homelessness, which superseded being at risk of homelessness. If patients had no indication of housing instability or homelessness, they were classified as "housed."[18]

Comorbidities and care utilization

We defined history of depression, bipolar disorder, psychoses, posttraumatic stress disorder (PTSD), SUD, and alcohol use disorder (AUD) as the presence of at least 2 outpatient ICD diagnosis codes or one inpatient ICD diagnosis code in the year prior to the registration or index date (Supplementary Appendix Table S3). These metrics are well-validated in previous work.[22–26] We measured the presence of physical comorbidities using the Elixhauser Comorbidity Index, excluding the following categories: HIV/AIDS, depression, psychosis, SUD, and AUD.[27] We defined receipt of non-VHA care as the presence of any Fee Basis invoice in the year prior to the registration or index date. Fee Basis invoices indicate receipt of care outside of the VHA that was paid for by the VHA. We considered VHA care utilization as the number of outpatient visits to VHA facilities in the year prior to the registration or index date.

Statistical analysis

Registration models

To examine the association between each independent variable and MHV registration, we compared MHV-registered veterans living with HIV to matched veterans living with HIV who never registered for MHV. We used conditional logistic regression to estimate adjusted odds ratios (OR) while accounting for our matching scheme. For each independent variable, we selected confounding variables using directed acyclic graphs (Supplementary Appendix Figure S1) based on literature review and discussion with subject matter experts.[9–14] We constructed separate models for each independent variable (or set of variables), instead of constructing a single model with all variables, because we were interested in the total effect of each independent variable on MHV registration. Using a single model to estimate OR for multiple independent variables may lead to "table 2 fallacy," in which direct-effect estimates are conflated with total-effect estimates.[28] Table 1 outlines the confounding variables we adjusted for in models examining each independent variable.

Utilization models

To examine associations between each independent variable and MHV tool utilization, we restricted our study population to MHV registrants and who had a tool exposure length of at least 1 day. For Rx Refill, we included registrants who had either a Premium or Advanced MHV account. For Secure Messaging, Blue Button, View Appointments, and View Labs, we restricted the study sample further to only patients with a Premium MHV account, since a Premium account was needed to use these tools. For each individual, we calculated the annual utilization rate for each tool, which we defined as the number of tool uses divided by the length of exposure to the tool. To identify correlates of the annual utilization rate of each of the 5 MHV tools, we estimated incidence rate ratios (IRR) using quasi-Poisson regression. Cluster robust standard errors were estimated using the sandwich estimator to account for the correlation between veterans receiving care at the same VHA facility.

RESULTS

Study population characteristics

Between FY 2012 and FY 2018, 8589 veterans living with HIV registered for MHV, representing 47% of the 18 346 veterans living with HIV who had not registered for MHV prior to FY12 (Table 2). Most registrants were above age 50 (65%). Half of registrants were Black, 38% were White, and 6.7% were Hispanic/Latinx. About 16% of registrants and 15% of nonregistrants resided in a rural/highly rural area. The mean average ADI for registrants and nonregistrants was similar (54 vs 56). A greater proportion of veterans who registered for MHV were under 50 years of age (35% vs 15%) and White (38% vs 29%). Most veterans living with HIV in the registrant and nonregistrant groups were stably housed in the prior year (84% among registrants and 86% among nonregistrants).

Registrants had a lower mean Elixhauser Index than nonregistrants (1.07 vs 1.31). The most prevalent mental health comorbidities among both registrants and nonregistrants were depression (25% vs 19%), followed by SUD (15% in both groups), and AUD (11% in both groups).

Table 1. Model setup and confounder adjustment

Model	Covariate of interest	Confounder adjustment
Model 1	Age	None
Model 2	Sex, race/ethnicity, residential rurality	Age, sex, race/ethnicity
Model 3	Area deprivation index, housing status	Age, sex, race/ethnicity, residential rurality
Model 4	Mental illness indicators, substance use disorder, alcohol use disorder Elixhauser Index, non-VHA care utilization	Age, sex, race/ethnicity, residential rurality, area deprivation index, housing status, mental illness indicators, substance use disorder, alcohol use disorder, Elixhauser Index, non-VHA care utilization, VHA care utilization

VHA, Veteran Health Administration.

Table 2. Characteristics of veterans by MHV registration status

	Registered *N* (%)	Not registered *N* (%)
N	8589	8589
Demographic characteristics		
Age		
18–34	846 (9.8)	212 (2.5)
35–49	2182 (25.4)	1112 (12.9)
50–64	4346 (50.6)	5152 (60.0)
65+	1215 (14.1)	2113 (24.6)
Female sex	333 (3.9)	269 (3.1)
Race/ethnicity		
American Indian/Alaska Native	48 (0.6)	50 (0.6)
Asian	44 (0.5)	22 (0.3)
Black or African American	4268 (49.7)	5104 (59.4)
Hispanic or Latinx	573 (6.7)	450 (5.2)
Native Hawaiian/Other Pacific Islander	58 (0.7)	32 (0.4)
White	3251 (37.9)	2503 (29.1)
Unknown	347 (4.0)	428 (5.0)
Geographic characteristics		
Rural/highly rural	1344 (15.6)	1265 (14.7)
Area Deprivation Index (mean, SD)	53.6 (21.0)	56.0 (21.3)
Housing status (past year)		
Housed	7220 (84.1)	7361 (85.7)
At risk of homelessness	119 (1.4)	102 (1.2)
Currently homeless	532 (6.2)	474 (5.5)
Formerly homeless and in long-term supportive housing	718 (8.4)	652 (7.6)
Comorbidities		
Bipolar	373 (4.3)	248 (2.9)
Depression	2177 (25.3)	1599 (18.6)
Psychoses	318 (3.7)	471 (5.5)
PTSD	922 (10.7)	678 (7.9)
Alcohol use disorder	958 (11.2)	929 (10.8)
Substance use disorder	1255 (14.6)	1309 (15.2)
Elixhauser Index (mean, SD)[a]	1.07 (1.50)	1.31 (1.68)
Utilization		
Non-VA care (past year)	903 (10.5)	946 (11.0)
Outpatient visits (past year)	23.4 (27.6)	22.3 (26.7)

[a]Elixhauaser Index calculated after excluding the following conditions: HIV/AIDS, depression, psychosis, psychosis, substance use disorder, and alcohol use disorder.

MHV, My HealtheVet; PTSD, post-traumatic stress disorder; SD, standard deviation.

Among the 17 636 total veterans included in the study population, 440 (2.5%) were excluded from the registration models because of missing data. The majority were excluded because they were missing rurality (83; 0.5%), ADI (70; 0.4%), or because they had no outpatient utilization (82; 0.5%) during the study period. In our utilization models, we excluded 191 of 8818 registrants (2.2%) because they were missing rurality (61; 0.7%), ADI (32; 0.4%), or outpatient utilization data (81; 0.9%). We also excluded 4 (0.04%) registrants who were missing MHV data, and 15 registrants who died before FY13 (0.2%).

MHV registration

Demographic and geographic characteristics

Compared to veterans from 18 to 34 years of age, veterans who were 35–49 had 0.49 (95% CI: 0.44, 0.56) times lower odds of registering for MHV, veterans who were 50–64 years of age had 0.21 (95% CI: 0.19, 0.24) times lower odds, and veterans who were 65+ years of age had 0.14 (95% CI: 0.13, 0.17) times lower odds to register for MHV (Table 3). Women had 1.17 (95% CI: 1.01, 1.35) times greater odds to register for MHV than men, after adjusting for age and race/ethnicity. White veterans had a higher odds of MHV registration than all other racial/ethnic groups, after adjusting for age and sex. Notably, Black veterans had 0.6 (95% CI: 0.55, 0.66) times the odds of MHV registration and Hispanic/Latinx veterans had 0.87 (95% CI: 0.76, 0.99) times the odds of MHV registration as White veterans. After adjusting for age, sex, and race/ethnicity, there was no association between rurality (OR: 1.00, 95% CI: 0.9, 1.1) and MHV registration. A one standard deviation increase in ADI was associated with 0.91 (95% CI: 0.88, 0.94) times lower odds of MHV registration, after adjusting for age, sex, race/ethnicity, and rurality.

Housing status

There was no association between housing status and MHV registration after adjusting for age, sex, race/ethnicity, rurality, ADI, comorbidities, VHA care utilization, and non-VHA care utilization.

Comorbidities and care utilization

Veterans with a diagnosis of bipolar disorder (OR: 1.19; 95% CI: 1.02, 1.40), depression (OR: 1.38; 95% CI: 1.29, 1.48), and PTSD (OR: 1.23; 95% CI: 1.13, 1.34) had a higher odds of MHV registration, after adjusting for age, sex, race/ethnicity, rurality, ADI, VHA and non-VHA care utilization, and other comorbidities. In contrast, veterans with a previous SUD (OR: 0.77; 95% CI: 0.69, 0.85) or psychoses (OR: 0.66; 95% CI: 0.58, 0.74) diagnosis had lower odds of MHV registration. Veterans with a greater Elixhauser Index score had lower odds of registering for MHV (OR: 0.96, 95% CI: 0.94, 0.98). We did not observe an association between MHV registration and previous AUD diagnosis (OR: 1, 95% CI: 0.91, 1.11) or non-VHA care utilization (OR: 0.93, 95% CI: 0.85, 1.02).

Table 3. Correlates of MHV registration

Covariate	OR (95% CI)
Age	
18–34	Ref.
35–49	0.49 (0.44, 0.56)
50–64	0.21 (0.19, 0.24)
65+	0.14 (0.13, 0.17)
Sex[a]	
Male	Ref.
Female	1.17 (1.01, 1.35)
Race/ethnicity[b]	
White	Ref.
American Indian/Alaska Native	0.65 (0.48, 0.89)
Asian	0.9 (0.59, 1.38)
Black/African American	0.6 (0.55, 0.66)
Hispanic/Latinx	0.87 (0.76, 0.99)
Native Hawaiian or Other Pacific Islander	1.14 (0.83, 1.56)
Unknown	0.6 (0.53, 0.68)
Rurality[c]	
Urban	Ref.
Rural/highly rural	1 (0.9, 1.1)
Area Deprivation Index (per SD)[d]	0.91 (0.88, 0.94)
Housing status[e]	
Housed	Ref.
Homeless: at risk	1.06 (0.83, 1.35)
Homeless: currently	1.11 (0.99, 1.25)
Homeless: former	1.06 (0.97, 1.15)
Bipolar[e]	1.19 (1.02, 1.4)
Depression[e]	1.38 (1.29, 1.48)
Psychoses[e]	0.66 (0.58, 0.74)
PTSD[e]	1.23 (1.13, 1.34)
SUD[e]	0.77 (0.69, 0.85)
AUD[e]	1 (0.91, 1.11)
Elixhauser Index (per unit change)[e]	0.96 (0.94, 0.98)
Non-VA Care[e]	0.93 (0.85, 1.02)

[a]Adjusted for age and race/ethnicity.
[b]Adjusted for age and sex.
[c]Adjusted for age, sex, and race/ethnicity.
[d]Adjusted for age, sex, race/ethnicity, and rurality.
[e]Adjusted for age, sex, race/ethnicity, rurality, housing status, VHA and non-VHA care utilization, Elixhauser Index, mental health comorbidities, substance use disorder, and alcohol use disorder.

AUD, alcohol use disorder; MHV, My HealtheVet; PTSD, post-traumatic stress disorder; SD, standard deviation; SUD, substance use disorder; VHA, Veteran Health Administration.

MHV tool utilization

Among veterans living with HIV who registered for MHV, utilization rates varied considerably from tool to tool (Table 4). Overall, the most frequently used tool was View Appointments (2.8 uses per person-year), followed by Rx Refill (2.4 uses per person-year). The least frequently used tool was Blue Button (0.9 uses per person-year). About 67% ($n = 5812$) of patients who registered for MHV had used at least one of the MHV tools. However, all the tools had a high percentage of patients with no tool uses. Secure Messaging had the highest proportion of nonusers (57%), and View Appointments had the lowest (40%). Tool utilization rates varied considerably across subgroups, as described in Supplementary Appendix Tables S4 and S5.

Table 4. MHV tool utilization rates

Tool	Use rate[a]	Zero tool uses (%)
View Appointments	2.81	40%
Rx Refill	2.42	56%
Rx Refill (ART only)	1.22	62%
View Labs	1.45	50%
Secure Messaging	1.42	57%
Blue Button	0.92	56%

[a]Uses per person-year.
ART, antiretroviral therapy; MHV, My HealtheVet.

Secure Messaging

Among veterans living with HIV who registered for MHV, we observed differences in Secure Messaging by race/ethnicity, housing status, and history of bipolar disorder, depression, and SUD (Table 5). Black veterans were 0.43 (95% CI: 0.36, 0.51) times as likely and Hispanic/Latinx veterans were 0.58 (95% CI: 0.46, 0.73) times as likely as White veterans to use Secure Messaging, after adjusting for age and sex. Secure Messaging was lower among veterans who were at risk of homelessness (IRR: 0.52; 95% CI: 0.31, 0.89) in the past year compared to veterans who were stably housed. Further-

Table 5. Correlates of MHV tool utilization

Covariate	MHV Tool (IRR [95% CI])					
	Secure Message	Blue Button	View Appointments	View Labs	Rx Refill	Rx Refill (ARV)
Age						
18–34	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
35–49	1.22 (0.93, 1.62)	0.83 (0.52, 1.32)	1.18 (0.9, 1.53)	0.74 (0.55, 0.98)	1.39 (1.19, 1.63)	1.15 (1, 1.33)
50–64	1.14 (0.88, 1.47)	0.7 (0.45, 1.11)	1.07 (0.84, 1.37)	0.53 (0.39, 0.72)	1.21 (1.04, 1.4)	0.83 (0.73, 0.94)
65+	1.13 (0.83, 1.52)	0.66 (0.4, 1.06)	1.08 (0.85, 1.38)	0.55 (0.38, 0.81)	1.42 (1.17, 1.72)	0.94 (0.78, 1.13)
Sex[a]						
Male	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Female	1.35 (0.83, 2.21)	1.11 (0.62, 1.97)	0.78 (0.51, 1.19)	1.03 (0.65, 1.61)	0.71 (0.54, 0.94)	0.62 (0.48, 0.78)
Race/ethnicity[b]						
White	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
American Indian/ Alaska Native	0.35 (0.17, 0.71)	0.3 (0.16, 0.59)	0.46 (0.23, 0.94)	0.32 (0.13, 0.83)	0.47 (0.26, 0.87)	0.57 (0.28, 1.16)
Asian	0.65 (0.43, 0.99)	0.61 (0.19, 2.01)	0.76 (0.46, 1.26)	1.03 (0.48, 2.19)	0.78 (0.51, 1.2)	1 (0.64, 1.56)
Black/African American	0.43 (0.36, 0.51)	0.53 (0.42, 0.68)	0.51 (0.43, 0.6)	0.46 (0.38, 0.56)	0.5 (0.44, 0.57)	0.54 (0.47, 0.62)
Hispanic/Latinx	0.58 (0.46, 0.73)	0.62 (0.43, 0.89)	0.79 (0.58, 1.07)	0.78 (0.57, 1.06)	0.57 (0.45, 0.71)	0.58 (0.46, 0.74)
Native Hawaiian or Other Pacific Islander	1.02 (0.54, 1.92)	0.93 (0.35, 2.52)	0.68 (0.39, 1.18)	0.63 (0.33, 1.21)	0.55 (0.38, 0.8)	0.79 (0.53, 1.18)
Unknown	0.59 (0.44, 0.79)	0.9 (0.52, 1.56)	0.62 (0.49, 0.8)	0.67 (0.47, 0.96)	0.69 (0.57, 0.84)	0.79 (0.62, 0.99)
Rurality[c]						
Urban	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Rural/highly rural	0.88 (0.74, 1.06)	0.94 (0.7, 1.25)	0.93 (0.74, 1.16)	0.93 (0.73, 1.18)	0.91 (0.76, 1.1)	0.95 (0.79, 1.13)
Area Deprivation Index[d]	0.91 (0.84, 0.99)	0.92 (0.83, 1.03)	1.02 (0.95, 1.08)	1.02 (0.95, 1.1)	0.99 (0.93, 1.06)	0.99 (0.91, 1.07)
Housing status[e]						
Housed	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Homeless: at risk	0.52 (0.31, 0.89)	0.57 (0.25, 1.3)	0.83 (0.48, 1.44)	0.43 (0.2, 0.93)	0.64 (0.44, 0.92)	0.62 (0.43, 0.89)
Homeless: currently	0.8 (0.6, 1.07)	0.95 (0.63, 1.44)	0.89 (0.67, 1.19)	0.7 (0.5, 0.98)	0.81 (0.62, 1.07)	0.71 (0.56, 0.9)
Homeless: former	1.1 (0.71, 1.71)	1.31 (0.86, 1.98)	1.4 (1.02, 1.93)	1.18 (0.79, 1.75)	0.73 (0.55, 0.97)	0.68 (0.54, 0.86)
Bipolar[e]	1.53 (1.04, 2.24)	0.71 (0.46, 1.1)	0.93 (0.65, 1.32)	1.01 (0.69, 1.48)	1.17 (0.85, 1.61)	0.83 (0.64, 1.09)
Depression[e]	1.22 (1, 1.5)	0.97 (0.77, 1.21)	1 (0.84, 1.19)	0.98 (0.82, 1.16)	1.12 (1, 1.26)	1.02 (0.92, 1.14)
Psychoses[e]	0.74 (0.5, 1.11)	0.86 (0.51, 1.47)	0.88 (0.62, 1.26)	1.21 (0.75, 1.95)	1.23 (0.92, 1.64)	1.18 (0.86, 1.6)
PTSD[e]	0.94 (0.71, 1.24)	1.3 (0.93, 1.8)	1.13 (0.84, 1.53)	0.87 (0.69, 1.1)	1.08 (0.88, 1.32)	1.04 (0.87, 1.24)
SUD[e]	0.72 (0.56, 0.93)	0.79 (0.55, 1.14)	0.71 (0.52, 0.97)	0.89 (0.63, 1.25)	0.78 (0.64, 0.94)	0.82 (0.68, 1)
AUD[e]	0.75 (0.53, 1.06)	1 (0.69, 1.45)	1.07 (0.73, 1.58)	0.86 (0.61, 1.21)	0.77 (0.63, 0.95)	0.75 (0.62, 0.92)
Elixhauser Index[e]	1 (0.93, 1.07)	1.06 (0.97, 1.15)	1.05 (1, 1.1)	0.99 (0.93, 1.06)	1.03 (0.98, 1.08)	1.01 (0.96, 1.06)
Non-VA Care[e]	1.19 (0.91, 1.56)	1.12 (0.75, 1.67)	1.17 (0.93, 1.48)	1.05 (0.75, 1.48)	1.25 (1.05, 1.49)	1.1 (0.94, 1.29)

[a]Adjusted for age and race/ethnicity.

[b]Adjusted for age and sex.

[c]Adjusted for age, sex, and race/ethnicity.

[d]Adjusted for age, sex, race/ethnicity, and rurality.

[e]Adjusted for age, sex, race/ethnicity, rurality, housing status, VHA and non-VHA care utilization, Elixhauser Index, mental health comorbidities, substance use disorder, and alcohol use disorder.

AUD, alcohol use disorder; CI, confidence interval; IRR, incidence rate ratios; MHV, My HealtheVet; PTSD, post-traumatic stress disorder; SUD, substance use disorder; VHA, Veteran Health Administration.

more, we observed higher rates of Secure Messaging among veterans with a history of bipolar disorder (IRR: 1.53; 95% CI: 1.04, 2.24) and depression (IRR: 1.22; 95% CI: 1.00, 1.5), and lower rates among veterans with a history of psychoses (IRR: 0.74; 95% CI: 0.5, 1.11), SUD (IRR: 0.72; 95% CI: 0.56, 0.93), and AUD (IRR: 0.75; 95% CI: 0.53, 1.06), after adjusting for age, sex, race/ethnicity, rurality, housing status, ADI, comorbidities, VHA utilization, and receipt of non-VHA care.

Blue Button

Black veterans were 0.53 (95% CI: 0.42, 0.68) times and Hispanic/Latinx veterans were 0.62 (95% CI: 0.43, 0.89) times as likely to use Blue Button to view or download their medical records compared to White veterans, after adjusting for age and sex. Veterans with a history of PTSD were more likely to use Blue Button than those without PTSD (IRR: 1.3; 95% CI: 0.93, 1.8).

Prescription Refills

We observed differences in Rx Refill utilization by sex, race/ethnicity, and housing status. Women veterans were 0.71 (95% CI: 0.54, 0.94) times as likely to use the Rx Refill tool as men. Black (IRR: 0.5, 95% CI: 0.44, 0.57) and Hispanic/Latinx (IRR: 0.57; 95% CI: 0.45, 0.71) veterans were less likely to use Rx Refill as White veterans. Compared to veterans who were stably housed in the previous year, veterans who were formerly homeless and in long-term supportive housing (IRR: 0.73; 95% CI: 0.55, 0.97) or at risk of homelessness (IRR: 0.64; 95% CI: 0.44, 0.92) in the previous year were less likely to use Rx Refill. There were similar differences in ART-

specific Rx Refill utilization by sex, race/ethnicity, and housing status. In addition, veterans aged 50–64 (IRR: 0.83; 95% CI: 0.73, 0.94) and veterans aged 65 or older (IRR: 0.94; 95% CI: 0.78, 1.13) had lower ART-specific Rx Refill utilization rates than veterans from 18 to 34.

There was variation in Rx Refill utilization by comorbidities and non-VHA care utilization. Patients with a history of SUD (IRR: 0.78; 954% CI: 0.64, 0.94) or AUD (IRR: 0.77; 95% CI: 0.63, 0.95) were less likely to use Rx Refill. Similarly, SUD and AUD were associated with lower rates of ART-specific Rx Refill utilization.

View Appointments and View Labs

Compared to veterans age 18–34, veterans aged 35–49 (IRR: 0.74, 95% CI: 0.55, 0.98), veterans aged 50–64 (IRR: 0.53; 95% CI: 0.39, 0.72), and veterans aged 65 or older (IRR: 0.55; 95% CI: 0.38, 0.81) were less likely to use View Labs. Black veterans were 0.51 (95% CI: 0.43, 0.6) times as likely to use View Appointments and 0.46 (95% CI: 0.38, 0.56) times as likely to use View Labs compared to White veterans. Hispanic/Latinx veterans were also less likely to use View Appointments compared to White veterans (IRR: 0.79; 95% CI: 0.58, 1.07). Patients who experienced homelessness (IRR: 0.7; 95% CI: 0.5, 0.98), or who were at risk of homelessness (IRR: 0.43; 95% CI: 0.2, 0.93), in the past year were less likely to use View Labs compared to patients who were stably housed in the past year.

DISCUSSION

Our study provides a comprehensive description of PHR adoption and utilization among veterans living with HIV and identifies several demographic and health factors associated with PHR adoption. By combining multiple VHA and non-VHA data sources, we were able to examine multiple demographic, geographic, and clinical predictors of PHR adoption and use, allowing us to explore a broad range of potential intervention targets and can inform future work (in particular, qualitative work) on the specific barriers and needs of subgroups not reached by PHRs.

Among veterans living with HIV, there are differences in PHR registration and utilization by age, race/ethnicity, sex, housing status, and clinical and mental health comorbidities. Veterans who were older, men, belonging to a racial/ethnic minority group, or had an SUD had lower odds of MHV registration. In terms of use of MHV tools, we observed that Black and Hispanic/Latinx veterans and veterans currently living homeless or unstably housed generally had lower rates of PHR tool use. While bipolar disorder and depression were associated with increased tool use, particularly of Secure Messaging, SUD and AUD were associated with decreased tool use.

These findings indicate that there are gaps to PHR adoption beyond registration. For nearly all of the tools examined, over half of registrants had zero tool uses, indicating that there may be other factors, such as usability and perceived utility, which influence PHR adoption beyond just registration.[14] In addition, we found that women and unstably housed veterans had lower rates of utilization of some MHV tools (Secure Messaging and Rx Refill), despite being more likely to register for MHV, suggesting that these groups are likely not receiving the full benefit of the PHR. Furthermore, there may be correlation between the use of multiple tools. For example, some patients may opt to primarily use the prescription refill tool and not use any of the others. Future research should examine the characteristics associated with combinations of tool use to better characterize these typologies of PHR use and the reasons why some patient subgroups use some tools and not others.

Understanding the reasons why patients with certain diagnoses are using their PHR more may be useful for developing interventions for better incorporating PHR use into the clinical management of other conditions. We identified several differences in PHR registration and use by health status. Bipolar disorder and depression were associated with increased Secure Messaging use. This is consistent with previous findings that depression and bipolar disorder were associated with increased PHR adoption.[8,29–31] In contrast, veterans with SUD and AUD had lower rates of PHR use, especially Rx Refill. These conditions are known barriers to HIV care, ART adherence, and viral suppression.[32–34] Rx Refill use may facilitate ART adherence among patients with SUD and AUD by simplifying the ART prescription refill process and removing barriers to care, which may, in turn, promote viral suppression.

The observed differences in PHR registration by race, sex, and housing status among veterans living with HIV may underscore disparities in HIV care and viral suppression. Women veterans, Black veterans, and veterans experiencing housing instability have worse care engagement and viral suppression than their counterparts.[33,35–39] PHR use, in particular use of secure messaging and prescription refill tools, has been previously shown to improve ART adherence and viral suppression among veterans with HIV.[6] This suggests that promoting PHR use among these groups may reduce disparities in HIV care outcomes. However, low PHR uptake among groups already marginalized in HIV care may be indicative of larger structural factors, including stigma, structural racism, and gender discrimination, and other sociopolitical and geographic factors that adversely affect HIV care.[40,41] Without addressing these underlying factors, improving PHR use may have little impact on overall HIV care outcomes for marginalized groups.

Although this study provides important insight into variations in use of a PHR by veterans living with HIV, there are some limitations. Because this work was largely exploratory, additional confirmatory studies are needed to better understand the mechanisms through which the correlates we identified impact MHV adoption. Second, we defined housing status using, in part, indication of receipt of housing support services, which may affect the interpretation of our findings related to housing stability. We may have misclassified some veterans experiencing housing instability if they were not connected to VA care or not receiving housing support services. Thus, our finding that housing instability was associated with increased PHR registration may be because these veterans were more engaged with VHA services in general. Third, although our study population is representative of the general population of veterans living with HIV and receiving care in the VA, the population demographics are skewed toward older individuals and men, indicating that it may not be externally generalizable to populations outside of the VA Finally, ADI may not capture the correct dimensions of geographic factors that may be associated with PHR uptake. ADI may not be a strong predictor of other neighborhood-level factors that may affect PHR use, such as broadband access or availability of public transportation options.

Future research should focus on understanding the mechanisms behind the identified differences in PHR use among veterans living with HIV and extending our findings to other groups living with chronic conditions and receiving care in other settings. Qualitative research investigating barriers to PHR use by sex, race/ethnicity, housing status, and clinical diagnoses can help us understand why

those barriers exist and how to target interventions to improve PHR utilization. In addition, further research is needed to determine whether disparities in PHR use are related to larger structural and institutional barriers that are also related to worse health outcomes among marginalized subgroups.

In conclusion, among veterans living with HIV, we identified significant differences in PHR uptake by race, sex, age, housing status, and comorbid diagnoses. Better understanding the barriers to PHR registration and identifying strategies to improve utilization may be important for improving HIV care management and outcomes among already marginalized groups.

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AUTHOR CONTRIBUTIONS

All authors participated in the conception, design, analysis, writing, or review of the manuscript. Specifically, AMM, LT, SS, and KM were involved in the conception of the study. TA, AMM, LT, and SC designed the study and conducted all analysis. TA, LT, and SC wrote the manuscript. All authors reviewed and approved of the final manuscript draft. All authors agree to be accountable for all aspects of the work.

SUPPLEMENTARY MATERIAL

Supplementary material is available at *Journal of the American Medical Informatics Association* online.

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CONFLICT OF INTEREST STATEMENT

None declared.

VA DISCLAIMER

The views expressed in this article are those of the authors and do not necessarily reflect the position or policy of the Department of Veterans Affairs or the US government.

DATA AVAILABILITY STATEMENT

The data underlying this article were accessed from the Department of Veterans Affairs Corporate Data Warehouse. The derived data generated in this research will be shared on reasonable request to the corresponding author.

REFERENCES

1. Shimada SL, Allison JJ, Rosen AK, Feng H, Houston T. Sustained use of patient portal features and improvements in diabetes physiological measures. *J Med Internet Res* 2016; 18 (7): e179.
2. Simon GE, Ralston JD, Savarino J, Pabiniak C, Wentzel C, Operskalski BH. Randomized trial of depression follow-up care by online messaging. *J Gen Intern Med* 2011; 26 (7): 698–704.
3. Ralston JD, Hirsch IB, Hoath J, Mullen M, Cheadle A, Goldberg HI. Web-based collaborative care for type 2 diabetes a pilot randomized trial. *Diabetes Care* 2009; 32 (2): 234–9.
4. Kay ES, Batey DS, Mugavero MJ. The HIV treatment cascade and care continuum: updates, goals, and recommendations for the future. *AIDS Res Ther* 2016; 13 (1). doi:10.1186/s12981-016-0120-0
5. Kahn JS, Hilton JF, Van Nunnery T, *et al.* Personal health records in a public hospital: Experience at the HIV/AIDS clinic at San Francisco General Hospital. *J Am Med Inform Assoc* 2010; 17 (2): 224–8.
6. McInnes DK, Shimada SL, Midboe AM, *et al.* Patient use of electronic prescription refill and secure messaging and its association with undetectable HIV viral load: a retrospective cohort study. *J Med Internet Res* 2017; 19 (2): e34.
7. United States Department of Veterans Affairs. My HeatlheVet Statistics. 2019. https://vaww.va.gov/MYHEALTHEVET/statistics.asp Accessed November 15, 2019.
8. Shimada SL, Brandt CA, Feng H, *et al.* Personal health record reach in the Veterans Health Administration: a cross-sectional analysis. *J Med Internet Res* 2014; 16 (12): e272.
9. Javier SJ, Troszak LK, Shimada SL, *et al.* Racial and ethnic disparities in use of a personal health record by veterans living with HIV. *J Am Med Inform Assoc* 2019; 26 (8–9): 696–702.
10. Goel MS, Brown TL, Williams A, Hasnain-Wynia R, Thompson JA, Baker DW. Disparities in enrollment and use of an electronic patient portal. *J Gen Intern Med* 2011; 26 (10): 1112–6.
11. Sarkar U, Karter AJ, Liu JY, *et al.* Social disparities in internet patient portal use in diabetes: Evidence that the digital divide extends beyond access. *J Am Med Inform Assoc* 2011; 18 (3): 318–21.
12. Ancker JS, Hafeez B, Kaushal R. Socioeconomic disparities in adoption of personal health records over time. *Am J Manag Care* 2016; 22 (8): 539–40.
13. Gordon NP, Hornbrook MC. Differences in access to and preferences for using patient portals and other eHealth technologies based on race, ethnicity, and age: a database and survey study of seniors in a large health plan. *J Med Internet Res* 2016; 18 (3): e50.
14. Irizarry T, DeVito DA, Curran CR. Patient portals and patient engagement: a state of the science review. *J Med Internet Res* 2015; 17 (6): e148.
15. Fultz SL, Skanderson M, Mole LA, *et al.* Development and verification of a "virtual" cohort using the national VA health information system. *Med Care* 2006; 8 Suppl. 2: 44.
16. VA Office of Health Equity. 2016. National Veteran Health Equity Report—FY2013. US Department of Veterans Affairs, Washington, DC. Available online at http://www.va.gov/healthequity/NVHER.asp.
17. Kind AJH, Buckingham WR. Making neighborhood-disadvantage metrics accessible - The neighborhood atlas. *N Engl J Med* 2018; 378 (26): 2456–8.
18. Byrne T, Troszak L, Midboe AM, *et al.* A novel measure to assess variation in hepatitis C prevalence among homeless and unstably housed veterans. *Public Health Rep* 2019; 134 (2): 126–31.
19. US Department of Veterans Affairs. Supportive Services for Veteran Families. https://www.va.gov/homeless/ssvf/ Accessed December 20, 2019.
20. US Department of Veterans Affairs. *Homeless Operations Management and Evaluation System (HOMES) User Manual—Phase 1*. 2011. http://www.adldata.org/wp-content/uploads/2016/07/homes.pdf.
21. Montgomery AE, Fargo JD, Byrne TH, Kane VR, Culhane DP. Universal screening for homelessness and risk for homelessness in the Veterans Health Administration. *Am J Public Health* 2013; 103 (S2): S210–1.
22. Oliva EM, Bowe T, Tavakoli S, *et al.* Development and applications of the Veterans Health Administration's Stratification Tool for Opioid Risk Mitigation (STORM) to improve opioid safety and prevent overdose and suicide. *Psychol Serv* 2017; 14 (1): 34–49.

23. Frayne SM, Miller DR, Sharkansky EJ, *et al.* Using administrative data to identify mental illness: what approach is best? *Am J Med Qual* 2010; 25 (1): 42–50.
24. Gravely A, Cutting A, Nugent S, Grill J, Carlson K, Spoont M. Validity of PTSD diagnoses in VA administrative data: comparison of VA administrative PTSD diagnoses to self-reported PTSD Checklist scores. *J Rehabil Res Dev* 2011; 48 (1): 21–30.
25. Lurie N, Popkin M, Dysken M, Moscovice I, Finch M. Accuracy of diagnoses of schizophrenia in Medicaid claims. *Hosp Community Psychiatry* 1992; 43: 69–71.
26. Midboe AM, Lewis ET, Paik MC, *et al.* Measurement of adherence to clinical practice guidelines for opioid therapy for chronic pain. *Behav Med Pract Policy Res* 2012; 2 (1): 57–64.
27. Quan H, Sundararajan V, Halfon P, *et al.* Coding algorithms for defining comorbidities in ICD-9-CM and ICD-10 administrative data. *Med Care* 2005; 43 (11): 1130–9.
28. Westreich D, Greenland S. The table 2 fallacy: presenting and interpreting confounder and modifier coefficients. *Am J Epidemiol* 2013; 177 (4): 292–8.
29. Barnett K, Mercer SW, Norbury M, Watt G, Wyke S, Guthrie B. Epidemiology of multimorbidity and implications for health care, research, and medical education: a cross-sectional study. *Lancet* 2012; 380 (9836): 37–43.
30. Dobscha SK, Denneson LM, Pisciotta MK, *et al.* Predictors of viewing progress notes among users of VA's electronic health portal who receive mental health care. *JAMIA Open* 2018; 1 (1): 122–7.
31. Abel EA, Shimada SL, Wang K, *et al.* Dual use of a patient portal and clinical video telehealth by veterans with mental health diagnoses: retrospective, cross-sectional analysis. *J Med Internet Res* 2018; 20 (11): e11350.
32. Bulsara SM, Wainberg ML, Newton-John TRO. Predictors of adult retention in HIV care: a systematic review. *AIDS Behav* 2018; 22 (3): 752–64.
33. Dombrowski JC, Simoni JM, Katz DA, Golden MR. Barriers to HIV care and treatment among participants in a public health HIV care relinkage program. *AIDS Patient Care STDs* 2015; 29 (5): 279–87.
34. Govindasamy D, Ford N, Kranzer K. Risk factors, barriers and facilitators for linkage to antiretroviral therapy care: a systematic review. *AIDS* 2012; 26 (16): 2059–67.
35. Anderson AN, Higgins CM, Haardörfer R, Holstad MM, Nguyen MLT, Waldrop-Valverde D. Disparities in Retention in Care Among Adults Living with HIV/AIDS: A Systematic Review. *AIDS Behav* 2020; 24 (4): 985–97.
36. Mugavero MJ, Amico KR, Horn T, Thompson MA. The state of engagement in HIV care in the United States: from cascade to continuum to control. *Clin Infect Dis* 2013; 57 (8): 1164–71.
37. Althoff KN, Rebeiro P, Brooks JT, *et al.*; for the North American AIDS Cohort Collaboration on Research and Design (NA-ACCORD). Disparities in the quality of HIV care when using US Department of Health and Human Services indicators. *Clin Infect Dis* 2014; 58 (8): 1185–9.
38. Matson TE, McGinnis KA, Rubinsky AD, *et al.* Gender and alcohol use: influences on HIV care continuum in a national cohort of patients with HIV. *AIDS* 2018; 32 (15): 2247–53.
39. Vaughan SMS, Ohl ME, Richardson KK, Asch SM, Gifford AL, Bokhour BG. Patient and facility correlates of racial differences in viral control for black and white veterans with HIV infection in the Veterans Administration. *AIDS Patient Care STDs* 2018; 32 (3): 84–91.
40. Williams DR, Mohammed SA. Racism and health I: pathways and scientific evidence. *Am Behav Sci* 2013; 57 (8): 1152–73.
41. Nosyk B, Zang X, Krebs E, *et al.* Ending the HIV epidemic in the USA: an economic modelling study in six cities. *Lancet HIV* 2020; 7 (7): e491–503.