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VA eScreening Program: Technology to Improve Care for Post-9/11 Veterans

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The Veterans Health Administration (VHA) provides health care services to a growing number of veterans. There is ample support for the use of technology-based self-screening to support health care delivery. We developed the VA eScreening program for veterans to directly provide self-report mental and physical health information through a veteran-facing portal that communicates with the electronic medical records system. A total of 1,372 newly enrolling veterans in 2 cohorts participated in a study to assess veteran satisfaction, determine accessibility and clinical processes, measure screening differences, and examine connection to care between eScreening and paper screening. Veterans who completed eScreening were slightly more satisfied with screening than those who completed paper screening. Accessibility, rate of screening completion, and clinical processes were significantly better with eScreening than paper screening. Except for higher alcohol use in the paper-based cohort, veterans who completed paper and eScreening were similar in the rates of positive health screens. Connection to VA services, rate and speed of vesting in the health care system, and time to document required suicide risk assessments were better with the VA eScreening program than paper screening. The VA eScreening program is a unique and promising tool that may leverage limited resources to improve screening and care for veterans.

Keywords: health screening, mental health, self-assessment, technology, veteran

The Veterans Health Administration (VHA) is charged with providing veterans the highest standard of care in the most efficient manner possible. VHA serves 8.76 million veterans each year with an estimated 8%–12% increase in the number of health care enrollees annually (Department of Veterans Affairs, 2013). Approximately 60% of the 2.7 million US troops who served after 9/11 (i.e., Iraq, Afghanistan, and other countries) have accessed VHA, and the number is expected to grow (Epidemiology Program, 2015; Institute of Medicine, 2013). Although nearly 29% of all veterans in VHA are also receiving mental health services, it is estimated that as many as 58% have a diagnosable mental illness (Epidemiology Program, 2015). Not surprisingly, the impact of mental health problems on veteran functioning is broad, including decreased quality of life, increased risk of substance use disorders and suicide, and increased physical health symptoms (Ahern et al., 2015; Pittman, Goldsmith, Lemmer, Kilmer, & Baker, 2012; Tanielian et al., 2008).

A growing body of research demonstrates that systematic screening can improve detection of mental health and other disorders (Dobie et al., 2006; Maguen, Madden, Cohen, Bertenthal, & Seal, 2012; Seal et al., 2011). In order to identify veterans with mental health symptoms and provide quality care, VA has several mandates to screen post-9/11 veterans upon enrollment into VA health care and all veterans annually for mental health symptoms, for example, through depression and posttraumatic stress disorder (PTSD) clinical reminders (Veterans Health Administration, 2008, 2010). Despite the mandates for mental health clinical reminders, the documentation process is often inefficient. One common practice in VHA is for a clinical staff member to interview patients with standardized screening questions while using Mental Health Assistant, Behavioral Health Laboratory, or other manual means to enter the patient responses into the computerized

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patient record system. Another customary method is to administer the screens to veterans on paper and manually enter the data into the electronic medical record and other relevant databases. Both of these methods use valuable clinician time to enter veteran self-report information into the medical record. Furthermore, verbal administration of screens has been shown to lead to measurement error as well as confounding due to social desirability (Bowling, 2005; Tourangeau & Yan, 2007).

Clinicians and researchers have looked to technology to aid in the provision of health care (Hjermstad et al., 2012; van Duinen, Rickelt, & Griez, 2008; Warren et al., 2010). There is a growing body of literature supporting the feasibility of technology to automate patient self-report health screening (Aktas et al., 2015; Brinkman et al., 2014; Hjermstad et al., 2012; Rayner et al., 2014; Rothman et al., 2014; Stukenborg et al., 2014; Weiner, Horton, Green, & Butler, 2015). Most studies have found that patients from a variety of settings (i.e., academic, general mental health, primary care, inpatient medical) and age groups find computerized assessment easy to use (Brinkman et al., 2014; Chinman et al., 2007; Choo, Ranney, Aggarwal, & Boudreaux, 2012; Cook et al., 2013; Grunauer et al., 2014; Noble et al., 2014; Weiner et al., 2015) regardless of the technology experience level of participants (Fuge et al., 2014). Some studies have reported that collecting personal and sensitive information using technology may even feel safer for patients than using paper questionnaires (Chinman, Young, Schell, Hassell, & Mintz, 2004; Dupont et al., 2009). From a business operations perspective, technology-based screening can lead to time savings, improved data capture, broader reach of early detection, and easy integration with electronic patient records (Fanning & McAuley, 2014; Holzner et al., 2012; Jensen et al., 2015; Lotfipour et al., 2013; Murphy, Bijur, Rosenbloom, Bernstein, & Gallagher, 2013). Finally, electronic self-report screening has been shown to be an effective tool in aiding triage and referral of patients who report suicidal ideation (Gardner et al., 2010; Lawrence et al., 2010).

Given the significant need and the ample support for the use of technology-based self-screening to aid health care delivery, we developed a comprehensive mobile technology solution, the VA eScreening program, that provided both a veteran-facing user interface to collect self-reported mental and physical health information and a back-end technology to integrate that information into the electronic medical record system and related databases. The VA eScreening program was evaluated in the VA San Diego Health care System (VASDHS) Transition Care Management Program because this program was tasked with comprehensive screening of post-9/11 veterans newly enrolling for health care services. The overarching goal was to evaluate the usability and effectiveness of the eScreening program for early identification efforts and timely access to patient-centered care for newly enrolling post-9/11 veterans. In line with that goal, the specific aims were to: (a) assess veteran satisfaction with the use of the electronic system in comparison to paper screening; (b) compare accessibility, rate of screening completion, and the care management intake process between eScreening and paper screening; (c) assess potential differences in screening results based on eScreening versus paper screening; and (d) examine differences in connection to clinical care between eScreening and paper screening.

Method

Participants and Procedures

Because it was not feasible to conduct a randomized controlled trial, we used a quasi-experimental design with a comparison group but without pretest measurement (Harris et al., 2006) to evaluate eScreening as a health informatics intervention in our Transition Care Management Program. Each VA Medical Center has a Transition Care Management Program that welcomes post-9/11 veterans, conducts screening for mental health and care management needs, links veterans to services, and provides care management services to those in need of higher levels of assistance to navigate the health care system. In 2009, the VASDHS Care Management program implemented a paper-based comprehensive biopsychosocial screening packet to obtain information on mental and physical health symptoms to assist with triaging and identifying care management needs. The team had chosen to administer the comprehensive packet in paper form because it allowed veterans to complete the packet without the assistance of a clinician, while waiting for enrollment services. By 2012, the comprehensive screening packet was part of the standard of care for post-9/11 veterans enrolling for health care at VASDHS.

For this study, we compared two cohorts of post-9/11 veterans enrolling in VASDHS from March 2012 to December 2013, with one cohort undergoing the standard paper-based screening packet and the other cohort undergoing eScreening. Participants were post-9/11 veterans who presented to the VASDHS Member Services office for enrollment into VA health care. The vast majority of veterans presenting to enroll were walk-ins and did not have scheduled appointments with Member Services or the Care Management program. Newly enrolling veterans in the Member Services office were offered the opportunity to participate in this research study. The study participants had to be eligible for VA care and able to provide informed consent in order to participate in the study. Consistent with the established standard of care for newly enrolling post-9/11 veterans at VASDHS, clinicians from the Care Management program were required to conduct a comprehensive screening of self-reported mental and physical health, review the screening information, meet with the newly enrolling Iraq or Afghanistan veterans as needed, and provide triage or consults for any necessary services. A total of 1,372 veterans consented to participate in the study. Cohort one (n = 795 from March to December 2012) was recruited during development of VA eScreening technology and therefore received paper-based screening as usual, and cohort two (n = 577 from December 2012 to December 2013) completed clinical screening via the VA eScreening program. A chart review was conducted 6 months from the date of consent to gather information related to the Care Management intake process and clinical care post screening. Study-related anecdotal comments from patients and staff were noted when possible. No incentives or compensation were provided for participation. All study participants provided informed consent for collection of clinical screening data for research purposes and the 6-month chart review. The study was approved by the VASDHS Institutional Review Board and Research and Development Committee.

VA eScreening Program

The eScreening pilot system was developed by a contracted vendor in 15 months. Substantial input into development, testing, and integration of the software with the VHA information technology systems was provided by clinical, research, informatics, and technology subject matter experts at VASDHS. Once the device-agnostic eScreening software was completed and approved by leadership in Information Technology, Informatics, Information Security and Privacy offices, it was installed on 18 Samsung tablets to be used by veterans and 2 desktop computers to be used by study staff. For security purposes the tablets used special software that enabled them to connect to the VA secure Wi-Fi system. Research staff assisted clinical staff to implement and operate the eScreening program. They provided eScreening tablets to veterans and offered technical and user support to veterans and staff to use the program. The highlighted features of the eScreening program were (a) the ability for veterans to enter screening information directly without the involvement of a clinician; (b) immediate scoring of measures; (c) instant patient feedback via printable handout with patient-friendly summary results; (d) an editable note generated in the computerized medical record system; (e) proper storage of screening data completed by the system (i.e., ability to resolve clinical reminders); and (f) clinician alerts for positive PTSD and depression screens that required follow-up for suicide risk screening.

Measures

Sociodemographic and service history. Veteran's age, gender, ethnicity, race, highest level of education, relationship status, and primary sources of income were all assessed by self-report questionnaire. Service history was also assessed with self-report to obtain pay grade, branch of service, number of deployments, and exposure to combat.

Military sexual trauma (MST). MST was assessed by two VHA created questions (Veterans Health Administration, 2008): "When you were in the military, did you ever receive uninvited and unwanted sexual attention (i.e. touching, cornering, pressure for sexual favors, verbal remarks, etc.?)" and "When you were in the military, did anyone ever use force or the threat of force to have sex with you against your will?" A positive screen required an affirmative answer to either of these questions (Kimerling, Gima, Smith, Street, & Frayne, 2007).

Traumatic brain injury. History of TBI with concurrent related symptoms was assessed using the 4-item VA TBI (BTBIS) screen. A positive TBI screen required one or more positive responses in each of the following categories: a list of events in which an injury could have occurred, immediate symptoms following the event, new or worsening symptoms, and current symptoms. The VA TBI screen has high-internal consistency and test–retest reliability, high sensitivity, and moderate specificity (Donnelly et al., 2011). Screening for TBI with this measure is a clinical reminder for all newly enrolling veterans.

Somatic symptoms. The Patient Health Questionnaire-15 (Kroenke, Spitzer, & Williams, 2002) was used to assess somatic symptoms. The PHQ-15 measures the extent that participants were bothered by any of 15 somatic problems (e.g., pain in various areas, dizziness, cardiovascular problems, gastrointestinal issues, and fatigue or sleep problems) in the four weeks prior to assessment. Each item on the PHQ-15 is scored on a 3-point scale with a maximum total score of 30; higher scores indicate greater somatic symptom severity. A score of 10 or higher was used as the cutoff for clinically significant somatic symptoms. This measure has acceptable psychometric properties (Kroenke et al., 2002).

Pain intensity. Pain intensity was assessed using a numerical rating scale from 0 to 10, anchored at "no pain at all" and "worst pain ever," respectively. A rating of 4 or greater was considered to be clinically significant pain (Haskell et al., 2010).

Tobacco and alcohol use. Per standard VHA screening, tobacco use was assessed using one item, "Do you use tobacco currently?" Veterans could respond, "Yes, currently", "No, but I have quit", or "Never". Veterans who were lifetime nonusers or stated that they have quit using tobacco were classified as nonusers. The Alcohol Use Disorders Identification Test, a VHA national clinical reminder for alcohol use, was used to assess hazardous alcohol consumption. Items are scored on a 4-point scale with a maximum total score of 12 points. Scores of 4 or greater and 3 or greater suggest alcohol misuse in men and women, respectively (Meneses-Gaya et al., 2010). This instrument has high internal consistency, reliability, and validity (Meneses-Gaya et al., 2010).

Posttraumatic stress disorder symptoms. In compliance with the VHA policy to screen for PTSD (Veterans Health Administration, 2010), the PTSD Checklist—Civilian Version (PCL-C) was used to screen for PTSD symptoms. The PCL-C is a 17-item measure, with items scored on a 5-point scale indicating the degree to which respondents were bothered by a particular PTSD symptom over the past month. The maximum score is 85; higher scores indicate greater severity. A score of 44 was used as the cutoff for a positive PTSD screen based on previous research in military populations (Weathers, Litz, Herman, Huska, & Keane, 1993) and standard of care at VASDHS. The PCL-C was chosen because it has high internal consistency in both military and nonclinical populations (Conybeare, Behar, Solomon, Newman, & Borkovec, 2012).

Depression symptoms. The Patient Health Questionnaire 9-Item Depression Module (PHQ-9) was used as a measure of depression symptom severity. The PHQ-9 was chosen because it is a more robust measure than the two item version, and it satisfies the VHA mandate to screen for depression (Veterans Health Administration, 2008). Items are rated on a 4-point scale with a maximum score of 27. Higher scores indicate greater severity. A cutoff score of 10 was used for a positive depression screen. The PHQ-9 has had high internal consistency (Kroenke et al., 2002).

Anxiety symptoms. Patient Health Questionnaire-anxiety (PHQ-anxiety) was used to capture anxiety symptoms. The PHQ-anxiety consists of the 7 items with corresponding response options for low, moderate, or high anxiety symptoms. Each item is scored "Not at all," "Several days" or "More than half the days." The first question is a screen-out question followed by 6 additional questions. A positive screen requires a response of "several days" or "more than half the days" on question 1 and that three or more of the subsequent questions are rated "more than half the days" (Kroenke, Spitzer, Williams, & Löwe, 2010).

Insomnia. Sleep related symptoms were measured using the Insomnia Severity Index (ISI), a widely used measure of insomnia with well-established reliability and validity (Morin, Belleville, Belanger, & Ivers, 2011). The ISI consists of seven items, assess-

ing severity of insomnia as well as satisfaction with sleep pattern, effect of sleep on daytime and social functioning, and concern about current sleep. A positive screen was determined by a score of 15 or higher, in order to reduce the risks of possible false positive screens (Morin et al., 2011).

Satisfaction ratings. In order to address satisfaction, we designed a 5-item Likert satisfaction scale that queried veterans on the extent to which individuals found the process (either paper or eScreening) satisfactory, comprehensible, reasonable in length, useful in communication about health care needs, and useful in improving care. Each item was rated on a 5-point scale from 0 "strongly disagree" to 4 "strongly agree". Higher scores indicated greater satisfaction. Overall satisfaction scores ranged from 0 to 20. Questions included items such as "The instructions for completing this screening form were easy to understand" and "I am satisfied with my experience completing this screening form during my enrollment visit."

Accessibility, screening completion, and the Care Management intake process. In order to address accessibility, we calculated the proportion of veterans from each cohort who did not complete the screens for the domains that are mandated to be screened (i.e., TBI, Alcohol use, PTSD, Depression) upon VASDHS enrollment when offered to do so as part of this study. We captured rate of screening completion from the proportion of consented veterans with electronic medical record documentation of completed clinical reminders in the domains mandated to be assessed. In order to assess potential differences in the Care Management intake process based on the type of screening, we used chart review data to obtain 3 indices. These included 1) the amount of time that Care Management program clinicians spent face to face with veterans of each cohort in order to review the self-reported information and provide triage to necessary clinics; 2) the number of business days to document clinical reminders in the electronic medical record system; and 3) the number of business days for a Care Management clinician to follow-up with veterans.

Connection to clinical care. Chart reviews were conducted at 6 months postscreening also to obtain information on the rates of consults/referrals and number of referrals veterans received as a result of screening, rates of attendance for specialty care services, and rate of and time to vesting appointment. A veteran who has a "vesting appointment" is a veteran who has had a comprehensive medical examination or used inpatient services in a VHA facility in the previous three years. The number of vested patients in a VHA facility is tied directly to funding, through the veterans Equitable Resource Allocation (VERA) System (Department of Veterans Affairs, 2015). Chart review data also were used to capture rates of and time to comprehensive suicide risk assessment when indicated by a positive PTSD or depression screen (Veterans Health Administration, 2008).

Statistical Analyses

Data were examined for assumptions of normality. For the sociodemographic continuous variables that were not normally distributed (i.e., age and years of service), the data were log-transformed. Pearson chi-square analysis (χ^2) and *t* tests were used to compare cohorts across categorical and continuous sociodemographic, service history, and symptom variables, respectively. The assumption of normality was violated for the satisfaction scores, so the nonparamedic *Mann–Whitney u*-test was used to compare median satisfaction scores between cohorts. We used pairwise deletion, in which cases with missing variables were excluded from only the analyses that used those variables. Pearson chi-square analysis (χ^2) was used to compare the proportion of veterans who refused to participate in screening and the proportion of mandatory domain screens documented in the medical record by screening type. *u*-tests were also used to compare the median amount of clinician face to face time, time to documentation of clinical reminders, and time to follow-up between cohorts. Pearson chi-square analysis (χ^2) and *u*-tests were used to compare the two cohorts on the chart reviewed clinical care variables. All Pearson chi-square assumptions were met, including sample size. Because of multiple comparisons, a modified Bonferroni correction was used and statistical significance level was set at $\leq .002$. Phi coefficient (φ) was used for effect size. All analyses were conducted using SPSS 16.0.1.

Results

Veteran Characteristics

Of the 795 veterans who consented to complete the paper screening, 619 (78%) had available data; all of the 577 veterans who completed eScreening had data available. Veterans' self-reported sociodemographic and service history characteristics are provided in Table 1. The majority of veterans were White, non-Hispanic men in their early 30s who had completed some college and were married or living with a partner. Close to [3/4] of the sample was unemployed, but substantial portions received unemployment, disability, or GI Bill income. Consistent with local demographics, the majority had served in the Navy or Marine Corps, most ranked as non-commissioned officers (pay Grade E4–E6) deployed once, and the majority had combat exposure (e.g., firing weapon, being attacked, seeing dead bodies, etc.). Except for the number of deployments, there were no significant differences between cohorts on sociodemographic and service history measures. eScreening veterans were less likely to have been deployed, $\chi^2(1, N = 1158) = 9.558$, $p < .001$, $\varphi = .235$, and paper screening veterans had significantly higher rates of multiple deployments (all $ps \leq .002$, with effect sizes ranging from .071–.106).

Satisfaction Ratings

There was a significant but modest difference between cohorts on satisfaction ratings, $U(1056) = 124129$, $Z = -3.18$, $p < .001$, $r = .1$. eScreening veterans were slightly more satisfied (Md = 15.00, $n = 542$, $M = 14.86$, $SD = 3.91$) with the screening process than paper screening veterans (Md = 15.00, $n = 516$, $M = 14.35$, $SD = 3.59$).

Accessibility, Rate of Screening Completion, and the Care Management Intake Process

In terms of accessibility, of the 904 veterans who were approached for paper screening, 30% either refused to complete the screening or did not return their packets, compared to 18%

Table 1
Sociodemographic and Service History Characteristics of Veterans Undergoing Paper and eScreening

Characteristics	Overall (N = 1,196) n (%)	Paper screening (n = 619) n (%)	eScreening (n = 577) n (%)	p
Age, M (SD)	31.63 (8.05)	31.26 (8.17)	32.02 (7.92)	.052
Male gender	1019 (85.3)	521 (84.3)	498 (86.3)	.329
Hispanic/Latino	274 (29.8)	123 (31.9)	151 (28.2)	.233
Race				
White	670 (58.9)	348 (59.6)	322 (58.1)	.615
Black	189 (16.6)	93 (15.9)	96 (17.3)	.525
Asian	151 (13.3)	74 (12.7)	77 (13.9)	.542
Native Hawaiian/Pacific Islander	22 (1.9)	12 (2.1)	10 (1.8)	.760
American Indian	43 (3.8)	23 (3.9)	20 (3.6)	.772
Other	41 (3.8)	15 (2.6)	21 (4.9)	.055
Education				
High school or equivalent	284 (24.2)	166 (27.4)	118 (20.8)	.008
Some college	585 (49.9)	289 (47.8)	296 (52.2)	.129
Associates degree	130 (11.1)	56 (9.3)	74 (13.1)	.039
4-year degree	129 (11.0)	70 (11.6)	59 (10.4)	.524
Master's or higher	44 (3.8)	24 (4.0)	20 (3.5)	.692
Employment Status				
Unemployed	878 (74.7)	451 (74.5)	427 (74.8)	.926
Full time	214 (18.2)	107 (17.7)	107 (18.7)	.640
Part time	84 (7.1)	47 (7.8)	37 (6.5)	.391
Income Source				
Unemployment	312 (22.7)	180 (29.8)	132 (23.1)	.010
GI bill	365 (26.6)	169 (28.0)	196 (34.3)	.019
Income from work	268 (19.5)	135 (22.4)	133 (23.3)	.701
No income	216 (15.7)	121 (20.1)	95 (16.6)	.133
Other	169 (12.3	91 (15.1)	78 (13.7)	.492
Disability	153 (11.2)	66 (10.9)	87 (15.2)	.028
Relationship Status				
Never married	404 (34.2)	213 (35.0)	191 (33.3)	.538
Married/living with partner	562 (47.6)	297 (48.8)	265 (46.2)	.371
Separated or divorced	215 (18.2)	98 (16.1)	117 (20.4)	.056
Years in military, M (SD)	9.64 (7.05)	9.59 (7.06)	9.69 (7.06)	.825
Branch of service				
Navy/Coast Guard	615 (52.4)	328 (56.1)	287 (52.2)	.189
Marines	339 (28.9)	164 (27.1)	175 (31.8)	.164
National Guard	3 (.3)	2 (.3)	1 (.2)	.601
Army	150 (12.8)	76 (12.6)	74 (13.5)	.818
Air Force	28 (2.4)	15 (2.5)	13 (2.4)	.828
Multiple branches	38 (3.2)	20 (3.3)	18 (3.2)	.895
Pay grade at last discharge				
E1-E3	121 (10.3)	56 (9.2)	60 (11.3)	.208
E4-E6	864 (73.5)	454 (74.7)	410 (72.2)	.334
E7-E9	105 (8.9)	50 (8.2)	55 (9.7)	.380
Officer	86 (7.3)	48 (7.9)	38 (6.7)	.428
Number of deployments				
None*	94 (8.1)	11 (1.9)	83 (14.7)	<.001
1	508 (43.9)	245 (41.2)	263 (46.6)	.065
2*	306 (26.4)	184 (31.0)	122 (21.6)	<.001
3–4*	207 (17.9)	122 (20.5)	85 (15.1)	<.001
5 or more*	43 (3.7)	32 (5.4)	11 (2.0)	.002
Combat exposed	756 (65.1)	369 (62.2)	387 (68.1)	.035

Note. M = mean; SD = standard deviation. Because of missing data the N varied slightly for each comparison. The paper screening cohort varied from 584 to 619 of the 795 veterans who were consented for paper screening. The eScreening cohort varied from 554 to 577 of the 577 who were consented for eScreening. Phi coefficient was used for effect size. For age and years in military, the test statistics are based on analyses with log-transformed data; however, the means and standard deviations are presented untransformed for ease of interpretation.
* $p \leq .002$.

who refused to undergo screening when approached for eScreening, $\chi^2(1, N = 1555) = 41.75$, $p < .001$. Table 2 presents the proportion of consented veterans who had documentation of completed key clinical reminders in their electronic medical record by type of screening. Nearly all eScreening veterans had documentation of these clinical reminders in their medical record, compared to 89%–93% paper screening veterans (all ps $< .001$).

Table 2
Proportion of Consented Veterans With 6-Month Medical Record Documentation of Screens in Mandated Domains, by Type of Screening

Clinical reminder	Paper screening (n = 795) n (%)	eScreening (n = 577) n (%)	p	Effect size
TBI*	708 (89.0)	574 (99.5)	<.001	.208
Alcohol use*	729 (91.6)	572 (99.3)	<.001	.166
PTSD*	740 (93.1)	567 (98.4)	<.001	.125
Depression*	734 (93.0)	574 (99.7)	<.001	.168

Note. TBI = traumatic brain injury; PTSD = posttraumatic stress disorder. Because of missing data the N varied slightly for each comparison. The paper screening cohort varied from 791 to 795 and the eScreening cohort varied from 576 to 577. Phi coefficient was used for effect size.
* $p \leq .002$.

In terms of the Care Management intake process, the amount of time in minutes per patient that clinicians spent processing the screening information and meeting with veterans did not differ for eScreening (Md = 0.00, n = 551, M = 17.74, SD = 24.98) and paper screening (Md = 0.00, n = 782, M = 14.59, SD = 22.25), $U(1331) = 208476.5$, $Z = -1.11$ $p = .266$. Table 3 presents the median number of days to documentation of key clinical reminders in the medical record. The range was 10–11 days (ns ranging from 730 to 692) for paper screening veterans versus a one day median (ns ranging from 571 to 546) for eScreening veterans (all ps < .001). The average median time savings was 10.5 days. Finally, there was a significantly fewer number of business days between screening and Care Management clinician follow-up for eScreening veterans (Md = 1.0, n = 280) than for paper screening veterans (Md = 5.0, n = 547); $U(827) = 51770$, $Z = -8.06$, $p <$ .001, $r = .28$.

Physical and Mental Health Symptoms

Table 4 presents the proportion of veterans who were above the clinically significant threshold for all of the measured mental and physical health symptoms by type of screening. Except for alcohol use, paper and eScreening veterans had similar rates of positive screens. eScreening veterans were less likely to have a positive alcohol use screen than paper screening veterans, $\chi^2(1, N = 1145) = 9.526$, $p = .002$, $\varphi = 0.091$. However, this difference had a very small effect size. Differences in PTSD ($\varphi = 0.089$) and insomnia ($\varphi = 0.078$) symptoms were not significant with small effect sizes.

Table 3
Median Number of Work Days From Collection to Entry of Screens in the Mandated Domains (Clinical Reminders) in the Medical Record

Clinical reminder	N	Paper screening Md (n)	eScreening Md (n)	P	Effect size
TBI*	1268	11.00 (697)	1.00 (571)	<.001	.55
Depression*	1293	10.00 (724)	1.00 (569)	<.001	.53
PTSD*	1296	10.00 (730)	1.00 (566)	<.001	.55
Alcohol use*	1251	11.00 (705)	1.00 (546)	<.001	.55

Note. Md = Median; TBI = traumatic brain injury; PTSD = posttraumatic stress disorder. Phi coefficient was used for effect size.
* $p \leq .002$.

Table 4
Proportion of Veterans Above the Clinically Significant Threshold for Physical and Mental Health Symptoms by Type of Screening

Health screen	Overall (N = 1,194) n (%)	Paper screening (n = 617) n (%)	eScreening (n = 577) n (%)	p
MST	86 (7.4)	41 (6.7)	45 (8.1)	.365
Missing	33 (2.8)	9 (1.5)	24 (4.2)	
TBI	273 (24.5)	128 (22.9)	145 (26.1)	.217
Missing	79 (6.6)	58 (9.4)	21 (3.6)	
Somatic symptoms	382 (35.6)	175 (33.7)	207 (37.4)	.204
Missing	120 (10.1)	97 (15.7)	23 (4.0)	
Pain intensity	537 (68.1)	165 (65.7)	372 (69.3)	.321
Missing	406 (34.0)	366 (59.3)	40 (6.9)	
Tobacco use	292 (25.3)	154 (25.9)	138 (24.7)	.653
Missing	41 (3.4)	22 (3.6)	19 (3.3)	
Alcohol use*	521 (45.5)	294 (49.9)	227 (40.8)	.002
Missing	49 (4.1)	28 (4.5)	21 (3.6)	
PTSD	285 (26.2)	123 (22.3)	162 (30.2)	.003
Missing	106 (8.9)	66 (10.7)	40 (6.9)	
Depression	382 (34.0)	184 (32.1)	198 (36.1)	.156
Missing	71 (5.9)	43 (7.0)	28 (4.9)	
Anxiety	248 (22.1)	114 (19.9)	134 (24.4)	.406
Missing	73 (6.1)	45 (7.3)	28 (4.9)	
Insomnia	353 (34.0)	190 (37.8)	163 (30.4)	.011
Missing	156 (13.1)	115 (18.6)	41 (7.1)	

Note. MST = military sexual trauma; TBI = traumatic brain injury; PTSD = posttraumatic stress disorder.
* $p \leq .002$.

Connection to Clinical Care

Table 5 provides the 6-month chart review clinical care outcomes by screening type. Significantly more eScreening veterans received at least one consult to a specialty clinic from the Care Management program than paper screening veterans, $\chi^2(1, N = 1372) = 17.709$, $p < .001$, and had significantly more consults, $U(1370) = 206738$, $Z = -4.00$, $p < .001$, $r = .11$. Rates of attendance at scheduled specialty clinic appointments did not differ, $\chi^2(1, N = 545) = 1.138$, $p = .286$ between the groups. The proportion of eScreening veterans who attended their vesting appointment was significantly higher than paper screening veterans, $\chi^2(1, N = 1130) = 20.46$, $p < .001$, and time to vesting after enrollment was significantly faster for eScreening veterans, $U(918) = 230937$, $Z = -3.60$, $p < .001$, $r = .12$. Time to documentation of suicide risk assessment in days was significantly shorter for eScreening veterans than paper screening veterans, $U(388) = 14257$, $Z = -4.59$, $p < .001$, $r = .23$. There were no significant differences in the rate of comprehensive suicide risk assessment for those veterans who were positive for PTSD, depression, or had indicated suicidal ideation on the PHQ-9, $\chi^2(1, N = 483) = 8.67$, $p = .003$, or same-day suicide risk assessment for those with suicidal ideation, $\chi^2(1, N = 110) = 4.91$, $p = .026$.

Discussion

The purpose of this study was to examine the usability and effectiveness of a comprehensive electronic screening system, VA

Table 5
Six-Month Chart Review Clinical Connection to Care Outcomes by Screening Type

Clinical care outcome	*N*	Paper screening	eScreening	*p*	Effect size
Rate of 1 or more consults*, %	1372	183 (23.0)	192 (33.3)	<.001	.114
Number of consults per veteran[a]*, *M* (*SD*)	1372	.345 (.718)	.480 (.794)	.001	.107
Rate of attendance to specialty clinic, %	545	137 (52.5)	162 (57.0)	.286	
Rate of vesting*, %	1130	465 (76.1)	450 (86.7)	<.001	.135
Days to vesting*, Md (*n*)	920	25.5 (470)	19.00 (450)	.001	.119
Rate of suicide risk assessment for those with risk, %	483	177 (75.3)	213 (85.9)	.003	
Days to suicide risk assessment for those with risk[a]*, *M* (*SD*)	390	12.22 (20.77)	6.31 (16.23)	<.001	.232
Rate of same day suicide risk assessment for those with suicidal ideation, %	110	23 (48.9)	44 (69.8)	.026	

Note. Md = median; *M* = mean; *SD* = standard deviation.
[a] Non-parametric testing was performed, but means and standard deviation were reported for ease of interpretation, because the medians for the two groups were equivalent. Phi coefficient was used for effect size.
* $p \leq .002$.

eScreening, compared to traditional paper and pencil screening in a sample of post-9/11 veterans enrolling for VA health care. Although there are other technology-based programs that VA clinicians can use to screen for symptoms, the VA eScreening program is the first veteran-facing system to collect self-report information from patients and push patient-provided information directly into the VA computerized medical record system and associated databases to complete clinical reminders. We also are not aware of previous VA studies to examine the usability and effectiveness of a comprehensive electronic screening system that collects veteran-directed data, provides immediate scoring and feedback, and inputs information directly into the VA computerized medical record system. We found that veterans were slightly more satisfied with eScreening than paper screening. Accessibility, rate of screening completion, and some clinical processes were significantly better with eScreening than paper screening. Rates of positive screens were comparable across the cohorts, yet the VA eScreening program had higher rates of follow-up consults, vesting in the health care system, and shorter time to document needed suicide risk assessments. These findings suggest that eScreening could be a viable tool for screening veterans and may facilitate clinical screening and follow-up for veterans.

The characteristics of our sample were consistent with the population of veterans in the geographic area. A significant proportion of the sample was unemployed, likely due in part to the fact that post-9/11 veterans registering for VA health care may have recently separated from active duty and had not found civilian employment yet. Additionally, close to half of the veterans was receiving income from the GI Bill or for disabilities (45%), which suggests that they were full time students or potentially disabled and unable to work. This is consistent with the estimate that 45.6% of veterans have utilized GI Bill benefits (Department of Veterans Affairs, 2014; Tanielian et al., 2008). The rates of positive mental or physical health screens in our sample also were similar to rates seen in other recent veteran samples (Deyton & Kang, 2009; Seal, Bertenthal, Miner, Sen, & Marmar, 2007; Tanielian et al., 2008). Furthermore, the 2 cohorts were similar in their rates of positive screens, suggesting that the cohorts were comparable and the rates of positive screens were likely not affected by completion of screens electronically versus paper.

However, there was an unexpected difference in the number of deployments by type of screening. Whereas both cohorts appeared to have similar levels of exposure to combat, a greater number of eScreening veterans indicated not having been deployed. These contradicting findings could be the result of potential differences in the draw-down of troops from 2012 to 2013 or related to the eScreening tool. Anecdotal comments of usability by some veterans who completed eScreening suggested that the "write-in" interface for entering the number of deployments was "clunky" and not well liked. Thus, it is possible that the validity of tablet-based electronic screening with veterans could be affected by the type of interface used, with standardized and multiple choice questions leading to more accurate data collection than open-ended or write-in questions.

Our finding on satisfaction with eScreening is consistent with the majority of the research that electronic screening is feasible and acceptable to patients in various settings (Aktas et al., 2015; Brinkman et al., 2014; Cook et al., 2007; Rayner et al., 2014; Weiner et al., 2015). The relatively young age of the veterans in this sample and their presumed familiarity with technology may have contributed to the acceptability of the technology (Hjermstad et al., 2012; Ybarra & Suman, 2008). However, age may only partially explain this acceptability as some research suggests that older adults are also open to using technology in screening (Fanning & McAuley, 2014; Tao, Or, & Li, 2014).

We found that veterans were more likely to complete electronic screening over paper-based screening. Consistent with prior research (Asch, Jedrziewski, & Christakis, 1997; Cook et al., 2007), some explanations for this difference could be that electronic screening is easier to use and that paper packets may be removed and not returned. eScreening was only available in waiting areas at the VA medical center so veterans could not walk away with the tablets. However, veterans who received paper screening may have left intending to complete paper screening but did not return their packet, or else the packets were lost or mishandled. The likelihood of nonreturned or mishandled paper screens may also be related to the finding that veterans who used eScreening had higher rates of documentation for key clinical reminders in the medical record. This is similar to other studies that have found technology to increase completion of health assessments compared to paper (Mitchell, Hedt-Gauthier, Msellemu, Nkaka, & Lesh, 2013). Data captured electronically also may reduce errors and missing information because electronic systems like eScreening can be programmed to include prompts to com-

plete missing items, list additional questions, and limit answers to logic responses.

There was substantial time savings in documentation of key screens in the medical record. Clinicians told us that they often triaged paper screens that indicated higher need to document first into the medical record, which likely resulted in a backlog of lower need paper screens awaiting documentation. Alternately, all eScreening measures were scored and were immediately available to be pushed into the medical record, reviewed, and signed. We did find a slight delay (median of 1 day) in documentation of eScreening results in the medical record even though results were instantaneously available. This delay may be accounted for by the need for staff to click a link in order to save the eScreening results to the electronic medical record. Time to follow-up care was also significantly shorter with eScreening than paper screening. Although it is possible that care managers were quicker to respond to the second cohort because they were less busy, it is also likely that the rapid availability of screening data and alerts for positive depression, PTSD, and suicidal ideation from eScreening may be related to timeliness of follow-up. Together, these findings are consistent with others that electronic screening systems are efficient for screening processes (Holzner et al., 2012), and suggest that veterans who are screened using technology-based screening that integrates directly into the medical record may be more likely to be screened, miss fewer items, and more likely to have results documented in the medical record much more quickly. We did not find a significant difference in time spent between clinicians and veterans by type of screening, and our data do not speak to any differences in the quality of interactions with veterans. Previous research has suggested that electronic screening prior to meeting with a health care professional can promote quality communication between patients and providers (Fothergill et al., 2013).

We also examined the potential clinical value of this technology. Although clinical need as indicated by positive screens of the two cohorts were similar, veterans who were screened with eScreening were more likely to receive consults for specialty care, increasing their chances of receiving needed health care services. Previous literature has also found that instantaneous availability of patient concerns can increase recognition of those problems, compared with the deferred delivery of results (Stevens et al., 2008). Veterans who used eScreening similarly seemed to be more engaged in overall health care access by having vesting appointments (an appointment with an M.D. or Nurse Practitioner) faster and at a higher rate. The immediate availability of screening information and feedback may have helped to engage veterans in their care. This is consistent with research concluding that electronic screening improves patient-centered care and patient outcomes (Conybeare et al., 2012; Hess et al., 2014; Sadler et al., 2013), including reduced symptom distress and reduced need for case management support (Ruland et al., 2010). Finally, the speed with which eScreening veterans received comprehensive suicide risk assessment is particularly valuable given the 41%–61% higher suicide rates among veterans compared to civilians (Kang et al., 2015). Our findings support prior research suggesting that use of technology in screening for suicide risk can allow for timely detection and intervention for this life-threatening condition (Lawrence et al., 2010).

Limitations

While this study had strengths such as a large sample size and use of longitudinal data, there were several limitations. First, the nonrandomized design of the study limits the interpretation of results because of several potential threats to internal validity such as cohort effects, unknown changes to processes unrelated to the informatics intervention, and other confounding factors. For example, the lower positive rates for alcohol misuse with eScreening may be due to the nature of electronic screening or potential differences in cohorts. Other possible explanations may be related to perceived anonymity of paper screening or the demand characteristics of electronic screening. Furthermore, we were not able to examine the difference in burden of screening for veterans because reliable data on time to completion for the paper screening were not available. Future research should use eScreening in a randomized controlled trial to better examine differences between groups attributable to the system. Second, we used a convenience sample of veterans enrolling for VA health care in one facility and in only one clinical setting. The benefit of piloting in a somewhat controlled clinical setting offers a more natural understanding of the processes involved, but that benefit is offset by the need for additional research support that is not typically part of the clinical environment. Third, the present study primarily used research staff to aid clinical staff in the implementation of eScreening, so we have limited information on the potential challenges associated with implementation of technology-based screening in an organization like the VHA.

Clinical and Research Implications

The use of technology such as eScreening can have implications for clinical care. The Web-based and device-agnostic nature of eScreening may make integration with a VHA patient portal like MyHealtheVet or kiosks within the medical center, a convenient way for patients to complete screening from anywhere. Broader use of eScreening and other technology-based tools can help health care systems identify and refer a larger proportion of individuals who may need clinical services. Once receiving treatment, eScreening also could be helpful in overcoming challenges related to measurement-based mental health care, such as limited clinician time to administer measures before treatment sessions (Scott & Lewis, 2015). These potential clinical benefits could also impact administrative and operational practices. Introducing a clinical tool such as eScreening may require adaptation of practices and policies such as how administrators allocate resources, staff training, equipment storage, and usage policies, and policies related to workload and productivity.

This initial study of eScreening also has prompted many additional questions worthy of further investigation. For example, the comprehensive screening described in this study exceeds the VHA mandated screening requirements, and future research should examine the benefits for case-finding and challenges for resource-allocation of more comprehensive screening. Qualitative studies could help us better understand the nuanced opinions of veterans' experience using technology for screening and the potential changes to the quality of the clinical encounter. Future research demonstrating utility in multiple settings, especially in the context of monitoring health outcomes for veterans in evidence-based mental health treatment, could clearly establish the benefits of this

technology for VHA. Finally, implementation research is critical to provide the field direction on how to adopt technology-based screening such as eScreening (Jensen et al., 2015), such as generalizability of eScreening, importance of stakeholder feedback or support, and facilitators or barriers to gaining provider and administrative support.

Conclusions

The VA eScreening program is unique in the VHA system in that it offers patient-facing electronic screening, real time alerts and feedback, and incorporation of data directly into the VA electronic medical record system. Findings suggest that eScreening is feasible to use with veterans and can yield potential improvements in operations, processes, and connection to clinical care for veterans. The VA eScreening program is a promising tool that may leverage limited resources to improve screening and care for veterans.

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