Original Research

An Evaluation of the Veterans Affairs Traumatic Brain Injury Screening Process Among Operation Enduring Freedom and/or Operation Iraqi Freedom Veterans

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Objective: The goal of this study was to describe the early results of the U.S. Department of Veterans Affairs (VA) screening program for traumatic brain injury (TBI) and to identify patient and facility characteristics associated with receiving a TBI screen and results of the screening.

Design: National retrospective cohort study.

Setting: VA Medical facilities.

Patients: A total of 170,681 Operation Enduring Freedom and/or Operation Iraqi Freedom (OEF/OIF) Veterans who sought care at VA medical facilities from April 2007 to September 30, 2008.

Methods: Data were abstracted from VA administrative and operational databases, including patient demographics, facility characteristics, and outcomes.

Main Outcome Measurements: The main outcomes were receipt of and results of the TBI screen.

Results: The majority of veterans eligible received the TBI screen (91.6%). Screening rates varied by patient and facility characteristics. In all, 25% of screened veterans had probable TBI exposure, in which the majority of the exposures were blasts (85.0%). The rate of a positive TBI screen was 20.5% for the screened cohort. Male gender, service in the army, multiple deployments, and mental health diagnoses in the previous year were associated with a positive screen.

Conclusions: TBI screening rates are high in VA; concomitant mental health diagnoses were highly prevalent in individuals with positive TBI screens. These data indicate that there will be a significant need for long-term health care services for veterans with TBI symptomatology.

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INTRODUCTION

It is estimated that 15%-20% of U.S. military personnel deployed to Iraq and Afghanistan (Operation Enduring Freedom [OEF], Operation Iraqi Freedom [OIF]) have experienced a mild traumatic brain injury (TBI) during deployment [1-3]. Mild TBI can result in impairments that present as cognitive and somatic symptoms, including the following: headaches; sleep disturbances; irritability; sensitivity to light; and impairments of balance, attention, and short-term memory [4]. Although these symptoms typically resolve within 3 months, many veterans continue to experience persistent and chronic debilitating symptoms. To identify OEF/OIF veterans who may benefit from health care services, the Department of Veterans Affairs (VA) implemented a national clinical reminder in April 2007 to screen for TBI. The TBI screen is mandatory and is administered to all OEF/OIF veterans during their initial VA visit, regardless of the reason for this initial visit. VA clinics throughout the United States have been trained about how and when to administer this systematic nationwide screening.

The TBI screen confirms OEF/OIF deployment and includes 4 questions on TBI-related exposures during deployment and immediate and ongoing symptoms. Affirmative re-

sponses to at least 1 question in each question set results in a positive screen; however, because veterans may respond positively to question items because of the presence of other symptoms or conditions, a positive screen is not a definitive diagnosis of TBI [5]. A recent study of 252 OEF/OIF veterans found that the VA's TBI screen had high sensitivity (0.94), with minimal false-negative results, but moderate specificity (0.59), which yielded many false-positive results for mild TBI [6]. Therefore, a comprehensive follow-up evaluation is critical to definitively diagnosing TBI.

Veterans with positive TBI screens are referred to a TBI specialist for a comprehensive TBI evaluation. At present, limited population-based data are available regarding screening rates, factors associated with whether or not veterans complete the screen and screen positive or negative, and how health care use patterns differ between those who have positive and negative screens. The objectives of this study were to describe veteran and facility characteristics associated with completion of the TBI screen and screening results for a national sample of OEF/OIF veterans who sought care at a VA facility and completed the TBI screen.

METHODS

Study Design and Setting

This was a national retrospective cohort study of OEF/OIF veterans who sought care at 153 VA facilities nationwide between April 14, 2007 (the onset of national implementation of TBI screen) and September 30, 2008.

Study Population

OEF/OIF veterans who use VA services were included in this study if (1) they were a member of the OEF/OIF roster; (2) their military service separation date was after September 11, 2001, and before September 30, 2008; (3) an inpatient or outpatient visit occurred between April 14, 2007, and September 30, 2008; and (4) they indicated "yes" on the TBI screen that they had been deployed to Afghanistan and/or Iraq (Figure 1) [5]. Veterans who did not receive a screen but who did receive a comprehensive TBI evaluation had missing key variables (distance to nearest VA facility and nearest VA facility type), and/or had discrepancies in the dates of screening or health care use and date of death were excluded from the sample (Figure 1). The final study population comprised 170,681 veterans.

TBI Screening Tool

The TBI screen is administered orally and can be completed by any VA clinician. It includes 4 sections (Figure 2) that address the following: (1) TBI-related exposures during deployment (eg, blasts, vehicular accidents); (2) the presence of symptoms immediately after an exposure (eg, losing consciousness, being dazed or confused); (3) manifestation of new symptoms and/or worsening of immediate symptoms (eg, memory problems, headaches); and (4) symptoms at the time of completing the VA TBI screening (eg, memory problems, headaches). Affirmative responses to at least 1 question in each question set or section results in a positive screen [5].

Data Sources and Measures

Study data were extracted from several VA administrative and operational databases. The National OEF/OIF roster was used to identify veterans who served in OEF/OIF, and includes the following characteristics: gender, race, ethnicity, marital status, branch of military service, education, number of deployments, VA priority level, and percent service connected (which indicates the extent that medical conditions are rated as related to military service). TBI screening data were obtained from the VA National TBI Health Factors database, which is managed by the VA Office of Patient Care Services and derived from the VA's electronic health record. Abstracted elements from this database included veterans' responses to all elements of the clinician-administered TBI screen, the date of screening, and date of military separation. Study variables were created by using these data, including an "index date" and "days since military separation," in which the index date is the date that the TBI screen was completed. For veterans not screened, the index date was the date of their first VA health care use after military separation and after April 14, 2007 (the date of national implementation of the TBI screen). The number of days since military separation was calculated as the difference between the index date and the separation date.

Health care use that occurred before the index date was obtained from the VA Medical SAS Inpatient and Outpatient files [7,8]. Specific data elements extracted included date of birth, patient's ZIP code, geographic region of the facility, facility type, admissions, visits, and diagnoses via the International Classification of Diseases, Ninth Revision, Clinical Modification codes. Specific health diagnoses, including mental health diagnoses, were assessed at the index visit and up to 1 year before the index date. Travel time in minutes and hours was calculated by using the patient's ZIP code of residence to the nearest VA facility and geographic information system software (Network Analyst) from the Environmental Science Research Institute in Redlands, California (ArcGIS 9.3). Facility type included whether it was a VA medical center, a VA community-based outpatient clinic (CBOC), or other VA facility (eg, nursing home, residential rehabilitation treatment program, and independent outpatient clinic). The facilities were also categorized according to levels of care provided by the Polytrauma-TBI System of Care, which offers specialized rehabilitation care for veterans

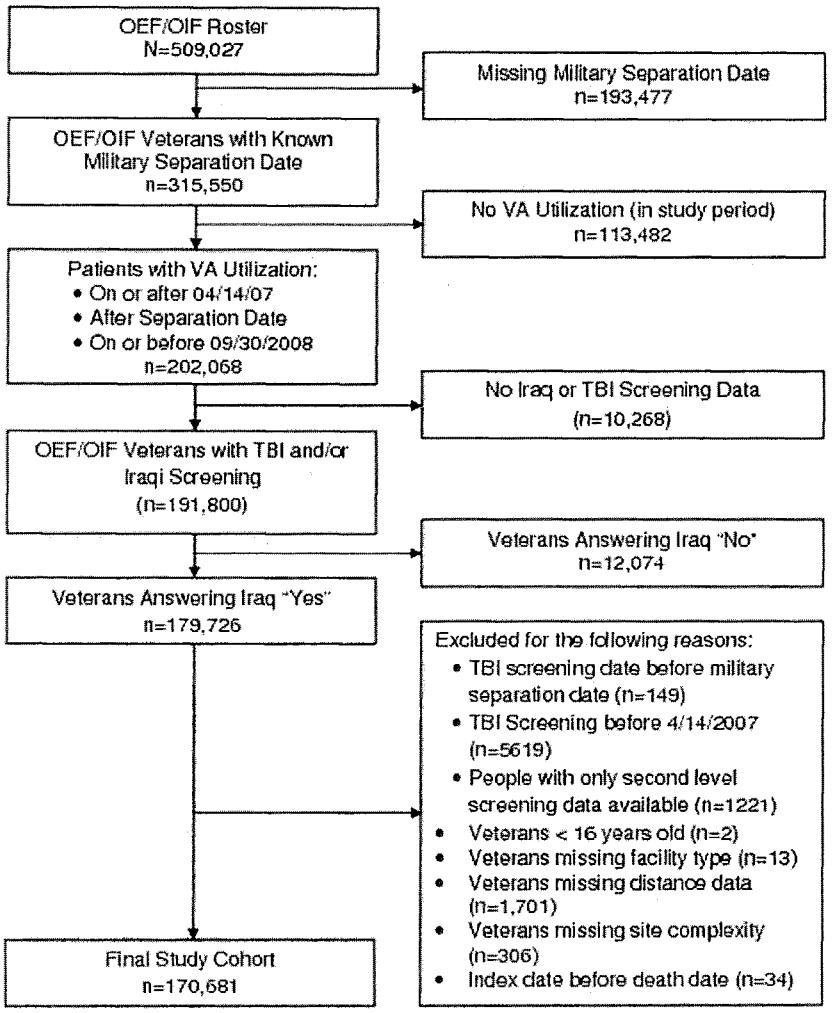

Figure 1. Selection of the study cohort and inclusion and exclusion criteria.

and service members with polytrauma (defined as 2 or more injuries sustained in the same incident that affect multiple body parts or organ systems) and TBI [9,10]. Currently, these include 5 polytrauma rehabilitation centers, 22 polytrauma network sites, 83 polytrauma support clinic teams, and 45 polytrauma point of contacts. The polytrauma rehabilitation centers are regional referral centers for acute medical and rehabilitative care, and serve as hubs for research and education related to polytrauma and TBI. Polytrauma network sites facilities provide some components of postacute medical rehabilitation, which can include inpatient and outpatient services, or rehabilitation day programs. Polytrauma support clinic team sites have provider teams that offer some specialty care for those with mild or stable functional deficits. Polytrauma point of contacts are identified in every VA facility that is not designated as one of the Polytrauma-TBI System of Care components and serves as a point of contact to refer veterans to facilities that will provide them with needed services [10].

For this study, VA enrollment data were used to obtain enrollment priority and/or copayment status, which was defined categorically as priority 1 (service-connected disability 50% or greater or unemployable due to service-related injury), priorities 2-6 (service-connected injuries, which ranged from 10% to 40%, or 0% service-connected disability with income below the VA set threshold, or a recognized status such as prisoner of war, Purple Heart recipient, World War I veteran, a veteran who served in combat in a war after the Gulf War, or other VA special consideration classification) or priority ≥7 (veterans with incomes below or above the VA set threshold, who agree to pay copayments). Health care use data were extracted up to 1 year before the index date and were used to create 2 variables: inpatient admission (yes or no) and the number of outpatient clinic visits. Diagnoses for these admissions or visits were also identified, including chronic health conditions, infectious diseases, and mental health diagnoses. These diagnoses were identified if they occurred at the index date or up to 1 year before the index date.

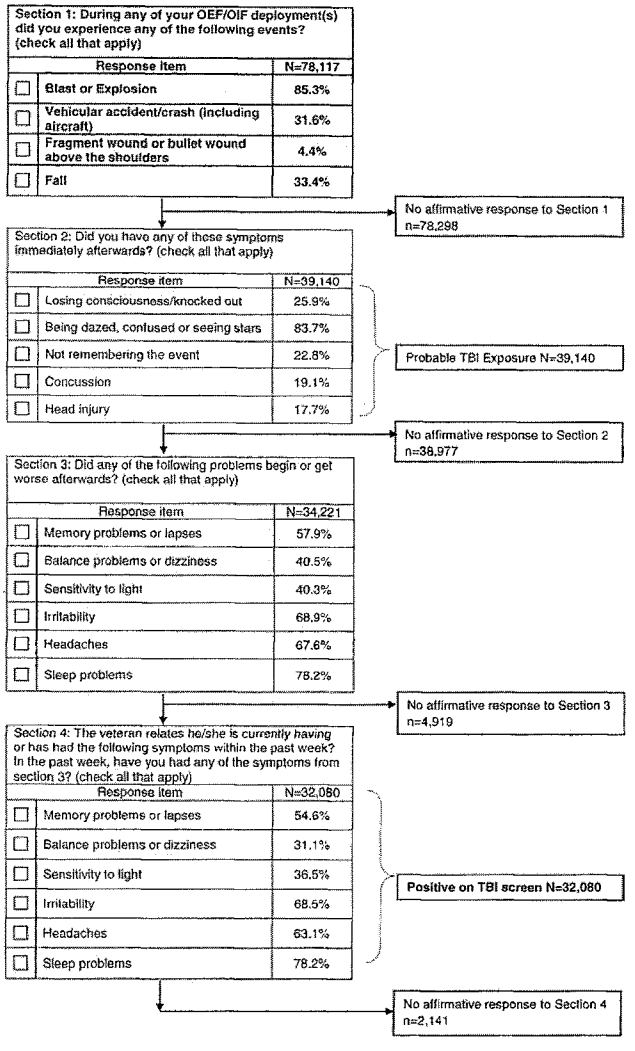

Figure 2. Summary of 4 question response sets to traumatic brain injury clinical reminder screening for 156,415 veterans screened.

Screening Outcome Variables

The primary outcome variables were receipt of the TBI screen, categorized as a dichotomous variable and a positive or negative TBI screen. The results of the 4 question sets within the TBI screen were also described by their responses.

Statistical Analysis

Bivariate analyses were adjusted for clustering of veterans within facilities by using multilevel logistic regression. Because patients are clustered within facilities and facility-level characteristics may affect the outcomes, we used mixed models to account for both individual veteran and facility-level variation for the outcomes [11,12]. A random effect was included to account for multilevel clustering, in which each veteran was the first level and the most frequent VA facility that each veteran received care was the second level. Each covariate was assessed individually in these models, in which odds ratios and 99% confidence intervals were calculated. Specifically, models assessed the relationship between receipt of the TBI screen and veteran demographics, prior health care use, and facility characteristics. Similar analyses were conducted to assess differences among screening results (positive or negative) and veteran and facility characteristics.

Multilevel multivariable logistic regression models were fit to assess the adjusted association between veteran characteristics, receipt of the TBI screen, and the screening results. All covariates were included in these models. In addition, the proportion of variance due to variations between facilities was also reported (ρ); a log-likelihood test was used to examine whether the proportion differed significantly from zero. Given the multiple comparisons and large sample size, all analyses used a .01 significance level. Analyses were conducted in SAS version 9.2 (SAS Institute, Cary, NC) and STATA SE version 11.0 (StataCorp LP, College Station, TX).

RESULTS

Description of Veteran Characteristics

Our sample included 170,681 veterans eligible for the screen during the study time period. The majority of veterans were male, white, with a high school education or a Graduation Equivalency Degree or less, and a mean age of 32.9 years. More than two-thirds had served in the Army, and nearly half were married at the index visit. Approximately one-third of the total sample had service-connected medical conditions, and more than three-fourths had a copayment priority status of 2-6. Twenty-six percent of the sample had more than 1 deployment, and the average time between military separation date and index date (initial VA visit or TBI screening) was 608.1 days.

The first visit or admission to the VA occurred at VA medical centers (68.4%), followed by CBOCs (29.4%). Nearly two-thirds of facilities were fewer than 60 minutes from the veteran's residence. Veterans on average had 4.5 outpatient visits 1 year before the index date. More than one-fourth of veterans had a mental health diagnosis; posttraumatic stress disorder (PTSD) was the most prevalent mental health disorder, followed by depression.

Factors Associated With TBI Screening

The vast majority (91.6% or 156,415) of veterans eligible to receive the TBI screen during the study time period were screened. In multilevel random-effect logistic regression analyses, adjusting for all covariates, OEF/OIF veterans screened for TBI were significantly different from those who were not screened (Table 1). Race, service connectedness, copayment priority status, number of deployments, facility

Table 1. *Completion of the TBI screening for eligible veterans, by patient and facility characteristics (n = 170,681)**

		% TBI Screening Completed			
	% Screened	Yes (n = 156,415)	No (n = 14,266)	OR and 99% CI*	Multilevel Multivariable Logistic Model Adjusted OR and 99% CI†
Overall	91.6				
Age (at index date)					
<25 y	92.5	21.1	19.4	Reference	Reference
25-29 y	90.6	31.6	35.8	**0.81 (0.76-0.87)**	0.96 (0.90-1.03)
30-34 y	91.3	12.9	13.5	**0.87 (0.80-0.94)**	1.00 (0.92-1.09)
≥35 y	92.3	34.4	31.3	0.97 (0.90-1.03)	**1.13 (1.05-1.23)**
Race					
White	92.0	71.3	68.2	Reference	Reference
Black	91.5	16.3	16.7	0.96 (0.89-1.03)	0.99 (0.93-1.07)
Other	90.5	4.8	5.6	0.94 (0.85-1.05)	0.96 (0.86-1.07)
Unknown	89.7	7.5	9.5	**0.79 (0.73-0.86)**	**0.86 (0.78-0.94)**
Hispanic ethnicity					
No	91.7	88.3	87.7	Reference	Reference
Yes	91.2	11.7	12.3	1.07 (0.99-1.16)	**1.10 (1.01-1.20)**
Service connected					
No	91.3	63.2	66.2	Reference	Reference
Yes	92.3	36.8	33.8	**1.16 (1.10-1.22)**	**1.08 (1.02-1.14)**
Copayment priority					
Priority 1	93.2	19.4	15.5	Reference	Reference
Priority 2-6	91.5	76.3	77.7	**0.76 (0.71-0.81)**	**0.87 (0.81-0.94)**
Priority ≥7	87.2	4.3	6.8	**0.47 (0.42-0.52)**	**0.55 (0.49-0.62)**
Branch of service					
Army	92.0	68.3	65.4	Reference	Reference
Air Force	91.6	7.5	7.5	0.97 (0.88-1.06)	1.02 (0.93-1.11)
Marine Corps	91.2	14.1	15.0	1.01 (0.94-1.08)	1.02 (0.95-1.10)
Navy	90.2	10.2	12.2	**0.91 (0.84-0.98)**	0.94 (0.87-1.01)
No. deployments					
1	91.5	73.7	75.5	Reference	Reference
2	91.7	21.4	21.4	**1.06 (1.00-1.13)**	**1.07 (1.01-1.14)**
≥3	94.5	4.9	3.2	**1.74 (1.53-1.99)**	**1.65 (1.44-1.89)**
Days from separation to index date					
0-6 mo	95.3	21.9	10.7	Reference	Reference
7-12 mo	93.1	18.7	14.9	**0.67 (0.61-0.74)**	**0.61 (0.55-0.66)**
13-18 mo	90.3	10.8	12.7	**0.47 (0.43-0.51)**	**0.41 (0.38-0.45)**
>1.5 y	89.6	48.7	61.8	**0.43 (0.43-0.46)**	**0.37 (0.35-0.40)**
Index facility type					
VAMC	90.6	67.6	77.1	Reference	Reference
CBOC	94.2	30.2	20.4	**2.64 (1.98-3.53)**	**2.92 (2.19-3.90)**
Other (IOC, RRTP, VANH)	90.3	2.2	2.6	2.08 (0.84-5.16)	2.07 (0.84-5.11)
Travel time to nearest VA facility					
<30 min	90.6	35.2	40.0	Reference	Reference
30-60 min	91.4	25.6	26.4	0.96 (0.90-1.02)	**0.92 (0.87-0.98)**
≥60 min	92.7	39.2	33.6	**0.89 (0.84-0.95)**	**0.83 (0.77-0.89)**
More than 1 outpatient visit before index date					
No	91.2	49.1	51.8	Reference	Reference
Yes	92.0	50.9	48.2	**1.14 (1.09-1.20)**	**1.22 (1.16-1.29)**
Inpatient admission before index date					
No	91.6	96.8	97.1	Reference	Reference
Yes	92.3	3.2	2.9	**1.17 (1.02-1.35)**	1.00 (0.87-1.16)
Having a chronic condition (Charlson)					
No	91.6	98.4	98.9	Reference	Reference
Yes	93.5	1.5	1.1	**1.41 (1.14-1.76)**	**1.37 (1.10-1.71)**

Table 1. *Continued*

	% Screened	% TBI Screening Completed: Yes (n = 156,415)	% TBI Screening Completed: No (n = 14,266)	OR and 99% CI*	Multilevel Multivariable Logistic Model Adjusted OR and 99% CI†
PTSD					
No	91.0	81.8	88.8	Reference	Reference
Yes	94.7	18.2	11.2	**1.84 (1.72–1.98)**	**1.66 (1.54–1.79)**
Depression					
No	91.2	88.5	93.6	Reference	Reference
Yes	95.1	11.5	6.4	**1.90 (1.74–2.09)**	**1.66 (1.51–1.83)**
Anxiety disorders (other than PTSD)					
No	91.5	95.3	97.0	Reference	Reference
Yes	94.5	4.7	3.0	1.61 (1.41–1.84)	**1.45 (1.27–1.67)**
Adjustment disorders and/or stress reactions					
No	91.6	96.3	97.4	Reference	Reference
Yes	94.0	3.7	2.6	144 (1.25–1.66)	**1.40 (1.21–1.62)**
Substance-related disorders					
No	91.6	95.7	96.7	Reference	Reference
Yes	93.6	4.3	3.3	1.41 (1.24–1.60)	**1.18 (1.04–1.35)**

TBI = traumatic brain injury; OR = odds ratio; CI = confidence interval; SD = standard deviation; VAMC = Veterans Affairs Medical Center; CBOC = community-based outpatient clinic; IOC = independent outpatient clinic; RRTP = residential rehabilitation treatment program; VANH = Veterans Affairs Nursing Home; VA = Veterans Affairs; PTSD = posttraumatic stress disorder.

Reference is the reference group used in comparisons.

Bolded items are associations that are statistically significant at the 0.01 level.

*P values for unadjusted multilevel logistic regression models.

†P values for multilevel logistic regression models adjusted for all variables listed and gender, marital status, education level, infection, polytrauma facility type. $\rho = 0.29$; $P = .0001$.

type, travel distance, more than 1 outpatient visit, having a chronic disease diagnosis, and having a mental health diagnosis were significantly associated with screening. Being older was associated with higher odds of screening. The number of days since military separation was shorter for those screened compared with those not screened.

Results of the Screen

Probable TBI Exposure and Reported Symptoms. Half (n = 78,117) of the 156,415 veterans screened for TBI reported experiencing an event such as a blast during OEF/OIF deployment (Figure 2, Section 1) and 50.1% of those exposed (n = 39,140) reported at least 1 symptom immediately afterward (Figure 2, Section 2). Thus, 25.0% of OEF/OIF veterans screened had a probable TBI exposure, based on the first 2 TBI screen questions. The most common symptoms reported at screening were sleep problems (78.2%), irritability (68.5%), and headaches (63.1%) (Figure 2, Section 3), and these symptoms continued to be current problems (Figure 2, Section 4). Overall, 20.5% (n = 32,080) of the screened veterans provided affirmative responses to at least 1 question in each question set to meet the VHA definition for a positive screen.

Factors Associated With a Positive Screen. There were statistically significant differences in bivariate (adjusted for clustering) and multilevel random effect regression analyses between veterans who screened positive (n = 32,080) and negative (n = 124,335) (Table 2). A positive screen was associated with younger age, being male, service connected, having had multiple deployments, living farther from a VA facility, and having a mental health disorder diagnosis at the index date or up to 1 year before the index date. The odds of a positive screen were lower among black (versus white) veterans, whereas individuals in other categories of race were no longer significantly different from white veterans. Hispanic ethnicity was not significantly associated with a positive screen, but being married was associated with higher odds of screening. A positive screen was less likely in those veterans from the Air Force, Navy, or Marine Corps (compared with the Army) and those separated from duty for more than 18 months (versus <6 months), in those seen in CBOCs compared with VA medical facilities, or in those with a chronic disease diagnosis.

DISCUSSION

The goals of this study were to evaluate the VA TBI screening program and to identify predictors associated with screening and having a positive screen. To date, there have been no national data that evaluated factors associated with the screen or screening positive. TBI screening completion rates are high in the VA: more than 90% of eligible veterans were

Table 2. *TBI screening results by patient and facility characteristics (n = 156,415)**

	% Positive	TBI Screening Result: Positive (n = 32,080)	TBI Screening Result: Negative (n = 124,335)	OR and 99% CI*	Multilevel Multivariable Logistic Model Adjusted OR and 99% CI†
Overall	20.5				
Age (at index date)					
<25 y	24.7	25.4	20.0	Reference	Reference
25-29 y	21.4	32.9	31.3	**0.82 (0.78-0.86)**	**0.85 (0.81-0.90)**
30-34 y	21.0	13.2	12.8	**0.80 (0.76-0.85)**	**0.82 (0.78-0.88)**
35+ y	17.0	28.5	35.6	**0.63 (0.60-0.66)**	**0.69 (0.66-0.73)**
Gender					
Female	10.10	6.1	14.1	Reference	Reference
Male	22.0	93.9	85.9	**2.52 (2.36-2.69)**	**2.24 (2.10-2.40)**
Race					
White	21.4	74.5	70.5	Reference	Reference
Black	17.5	13.9	17.0	**0.78 (0.74-0.82)**	**0.91 (0.86-0.96)**
Other	18.5	4.3	4.9	**0.86 (0.79-0.93)**	1.00 (0.92-1.09)
Unknown	19.8	7.3	7.6	**0.92 (0.86-0.98)**	0.96 (0.90-1.03)
Hispanic ethnicity					
No	20.5	88.3	88.3	Reference	Reference
Yes	20.5	11.7	11.7	**1.10 (1.03-1.16)**	1.04 (0.97-1.11)
Marital status					
Married	20.7	47.3	46.8	1.03 (0.99-1.06)	**1.04 (1.00-1.08)**
Not married	20.3	52.7	53.2	Reference	Reference
Education					
HS/GED or less	21.9	85.3	78.5	Reference	Reference
Some college	17.1	8.6	10.8	**0.74 (0.70-0.79)**	**0.91 (0.86-0.97)**
College	13.3	5.0	8.3	**0.56 (0.52-0.60)**	**0.68 (0.63-0.73)**
Beyond college	11.2	1.2	2.4	**0.46 (0.40-0.53)**	**0.58 (0.50-0.67)**
Service connected					
No	18.8	58.1	64.5	Reference	Reference
Yes	23.4	41.9	35.5	**1.33 (1.29-1.38)**	**1.07 (1.03-1.12)**
Copayment priority					
Priority 1	30.3	28.7	17.1	Reference	Reference
Priority 2-6	18.3	68.0	78.5	**0.51 (0.49-0.53)**	**0.61 (0.58-0.64)**
Priority ≥7	16.2	3.4	4.5	**0.44 (0.40-0.48)**	**0.60 (0.54-0.66)**
Branch of service					
Army	22.6	75.1	66.5	Reference	Reference
Air Force	7.1	2.6	8.7	0.25 (0.88-1.06)	**0.31 (0.28-0.34)**
Marine Corps	25.7	17.7	13.2	**1.17 (1.12-1.23)**	**0.94 (0.89-0.99)**
Navy	9.3	4.6	11.6	**0.91 (0.84-0.98)**	**0.39 (0.36-0.42)**
No. deployments					
1	18.8	67.6	75.2	Reference	Reference
2	24.1	25.1	20.4	1.06 (1.00-1.13)	**1.25 (1.19-1.30)**
≥3	30.3	7.3	4.3	**1.74 (1.53-1.99)**	**1.47 (1.36-1.58)**
Days from separation to index date					
0-6 mo	20.1	27.4	28.0	Reference	Reference
7-12 mo	21.0	13.0	12.6	1.04 (0.99-1.10)	1.00 (0.94-1.06)
13-18 mo	21.1	11.6	11.2	1.05 (0.99-1.12)	0.96 (0.90-1.02)
>1.5 y	20.5	48.6	48.7	1.01 (0.97-1.05)	**0.90 (0.86-0.94)**
Index facility type					
VAMC	21.3	70.0	67.0	Reference	Reference
CBOC	18.9	27.8	30.8	**0.77 (0.70-0.85)**	**0.74 (0.67-0.81)**
Other (IOC, RRTP, VANH)	20.5	2.2	2.2	1.01 (0.74-1.37)	0.94 (0.69-1.27)
Travel time to nearest VA facility					
<30 min	19.1	32.7	35.8	Reference	Reference
30-60 min	20.6	25.8	25.6.	**1.11 (1.06-1.17)**	**1.07 (1.02-1.12)**
≥60 min	21.	41.6	38.6	**1.24 (1.19-1.30)**	**1.10 (1.05-1.16)**
More than 1 outpatient visit before index date					
No	21.6	54.5	51.2	Reference	Reference
Yes	21.6	54.5	51.2	**1.15 (1.12-1.19)**	1.00 (0.96-1.04)

Table 2. *Continued*

	% Positive	TBI Screening Result: Positive (n = 32,080)	TBI Screening Result: Negative (n = 124,335)	OR and 99% CI*	Multilevel Multivariable Logistic Model Adjusted OR and 99% CI†
Inpatient admission before index date					
No	20.3	95.7	97.1	Reference	Reference
Yes	27.4	4.3	2.9	**1.44 (1.32–1.56)**	1.03 (0.94–1.13)
Having chronic condition (Charlson)					
No	20.5	98.6	98.5	Reference	Reference
Yes	19.5	1.4	1.5	0.94 (0.82–1.08)	**0.84 (0.73–0.98)**
PTSD					
No	16.5	65.8	85.9	Reference	Reference
Yes	38.5	34.2	14.1	**3.29 (3.16–3.41)**	**2.49 (2.39–2.60)**
Depression					
No	19.6	84.4	89.6	Reference	Reference
Yes	27.9	15.6	10.4	**1.59 (1.51–1.66)**	**1.19 (1.13–1.25)**
Anxiety disorders (other than PTSD)					
No	20.3	94.1	95.6	Reference	Reference
Yes	25.6	5.9	4.4	**1.34 (1.25–1.44)**	**1.16 (1.08–1.25)**
Adjustment disorders and/or stress reactions					
No	20.3	95.1	96.6	Reference	Reference
Yes	27.0	4.9	3.4	**1.46 (1.35–1.58)**	**1.51(1.39–1.64)**
Substance-related disorders					
No	20.1	93.6	96.2	Reference	Reference
Yes	30.0	6.4	3.8	**1.71(1.59–1.83)**	**1.09 (1.01–1.17)**

TBI = traumatic brain injury; OR = odds ratio; CI = confidence interval; HS = high school; GED = Graduate Education Development test; SD = standard deviation; VAMC = Veterans Affairs Medical Center; CBOC = community-based outpatient clinic; IOC = independent outpatient clinic; RRTP = residential rehabilitation treatment program; VANH = Veterans Affairs Nursing Home; VA = Veterans Affairs; Charlson = Charlson Comorbidity Index; PTSD = posttraumatic stress disorder.

Reference is the reference group used in comparisons.

Bolded items are associations that are statistically significant at the 0.01 level.

*P values for unadjusted multilevel logistic regression models.

†P values for multilevel logistic regression models adjusted for all variables listed and adjusted for infection and polytrauma facility type. $\rho = 0.04$, $P = .0001$.

screened. Findings based on multivariable regression analyses indicated that patient attributes, use-related factors, and facility characteristics were associated with completing a TBI screen.

Older age was associated with higher screening. Younger veterans may have competing activities, such as school and work, that make them less inclined to come to the VA. They could also have private insurance that provides other options for health care. This is contrary to findings by Sayer et al [13], which showed that veterans aged 40 years and older were less likely to be screened. The differences may be due to how the investigators categorized age as well as to geographic differences. Sayer et al [13] focused on veterans in VA facilities in the upper Midwest, whereas our study included OEF/OIF veterans across the nation.

Less than 10% of the sample was missing information on race. Racial data can be ascertained at each health care encounter; therefore, those veterans missing racial information may have fewer health care encounters when compared with those with complete data [14]. This idea is supported by the finding that veterans with unknown race had lower screening rates than white veterans. Furthermore, longer travel time to the nearest VA facility was associated with lower odds of screening, which suggests that there were fewer opportunities for screening because there was less VA health care use. This is consistent with the findings that higher health care use in the year prior was associated with higher odds of screening. Similar to findings by Sayer et al [13], it is not surprising that decreased time since separation from the military was associated with higher screening rates, because this suggests that the longer veterans wait to come in for their first visit after separation, the less likely they are to be screened. Those in a lower level of service-connected disability were less likely to be screened than those in priority 1. Veterans given priority 1 status have one or more health conditions for which the VA provides medical services and the veteran's copayment is not required. Therefore, veterans with priority 1 status are likely receiving more medical care services at the VA and increasing their opportunities for screening. However, these individuals may not be experienc-

ing ongoing symptoms that would lead them to seek health care in the VA. The high screening rates of veterans who had multiple deployments, previous chronic conditions, and mental health diagnoses suggests that these patients may have higher medical needs for VA care and a greater opportunity to be screened. In addition, VA providers are being vigilant about identifying these veterans and ensuring that they are screened.

There was significant variability in screening rates by facility type. CBOCs, which provide primary care, had the highest screening rates, which suggests that primary care visits may be opportune times for screening to occur. Sayer et al [13] found that, in the upper Midwest, veterans were more likely to be screened in VA medical centers. These differences in the findings are likely due to the significant variation in screening rates found among facilities (29% of total variance), which suggests that the facility at which an individual veteran receives services could have a significant impact on the receipt of the screen and that this may vary across geographic region.

One-fifth of eligible veterans screened positive, which is slightly higher than other reports [13,15], and which could be due to sampling differences in this national sample and previous samples of small regions within the continental United States. Two regional studies reported a positive screening rate of 17.3% [12,13]. A positive screen was more likely when the service member had multiple deployments, which puts service members at additional risk of being exposed to blasts and other trauma. Positive screens were lower among those in the Air Force, Marines, or Navy compared with those in the Army. Those service members in the Army are responsible for ground combat and more likely to be exposed to blasts, which was the most common cause of TBI in our sample. Although the unadjusted positive screening rate for Marines was 25%, after multivariable adjustment, it was slightly lower than those in the Army. Higher education levels and older age is likely protective, because these individuals have a greater opportunity to serve in noncombat positions. Positive screens were lower among veterans of black race/ethnicity and among women. Both groups reported lower rates of exposure to blasts. In the civilian population, the frequency of TBI is twice as high in men as in women [16]. Furthermore, women are less likely to serve in combat positions than are men; however, more recent data have shown that active duty women are experiencing more combat exposure than in prior war cohorts [17].

Not surprisingly, service connection and priority 1 copayment status were associated with a positive screen, as these designations suggest that these veterans often have significant medical complications associated with combat. Positive screens were lower among those separated from duty for more than 18 months (versus <6 months) and in those seen in CBOCs compared with VA medical centers. Veterans who have significant symptoms may be more likely to be screened earlier because they are symptomatic. The difference in positive screening between CBOCs and VA medical centers may confirm the point that individuals attending CBOCs are there for primary care and are captured for screening.

Similar to findings reported in the literature, our findings showed that mental health diagnoses were common and were associated with higher rates of a positive TBI screen. Prevalent mental health diagnoses have been previously documented in veterans [2,15] and in the civilian population with mild TBI [4]. In particular, PTSD was seen in 30.7% of OEF/OIF veterans with a positive TBI screen compared with 14.2% in those with a negative screen. A positive screen suggests exposure not only to TBI risk-related events but also to traumatic life-threatening events that significantly increase the risk of mental health conditions, for example, PTSD [1,18]. Other mental health diagnoses, for example, depression, were comorbid with TBI symptoms as well. Symptoms attributed to TBI may also be a result of symptoms from other mental health diagnoses. Therefore, it is key that those individuals screening positive be further evaluated to determine whether they truly have TBI or whether their symptoms are due to concurrent mental health conditions.

Blast or explosion was the most common exposure reported in those screened for our population, similar to other findings [13]. Other investigators have reported that blast-related TBI may be associated with more mental health issues than other causes of TBI [13,15]. Although there is little empirical evidence to unequivocally delineate differences, blast and nonblast TBI in combat zones differ according to etiology, and it is also thought that they differ according to pathology and symptom manifestation [19]. Although both exposures involve psychological trauma, a blast injury may result in cognitive processing difficulties and an inability to inhibit the experience of the episode, which could include the trauma of seeing fellow military personnel injured or killed. These issues may result in the association between blast and PTSD development. Our findings confirm that PTSD and depression were more common in veterans with blast-related positive TBI screening compared with those with nonblast exposure.

Sleep problems, headaches, and irritability were the most common current symptoms that were reported at the screening, which is consistent with results from another study of U.S. soldiers in which these symptoms were highly associated with injury and loss of consciousness [1] and with a recent evaluation of the VA screening program in the upper Midwest [13]. Ongoing TBI symptoms as well as co-occurring mental health diagnoses indicate that tens of thousands of veterans and service members will need ongoing health care services.

Screening rates were higher at CBOC facilities, which suggests that veterans may seek care that is convenient and accessible for them. In addition, this finding is relevant for non-VA settings in that it demonstrates that general medical

clinics can effectively administer the screen. Providers do not need to be acute rehabilitation experts to administer the screen. To increase the screening receipt rate to 100%, outreach may be best addressed locally, within the community, and could perhaps involve the use of telehealth applications or other eHealth technologies to support screening, evaluation, and management. Data on the use of telehealth for TBI screening, evaluation, and treatment are limited in the VA, but studies of nonveterans treated for cognition and/or memory [20,21], and posttraumatic symptom amelioration [22] using telehealth yielded favorable outcomes. Furthermore, patients with TBI generally rate being satisfied with treatment when using telehealth [23,24].

We recognize that the VA's evaluation program was implemented a few years after the OEF/OIF conflicts began. Existing medical literature would suggest that early identification and referral for appropriate care tend to demonstrate better outcomes for individuals with TBI and other common comorbid conditions such as depression and PTSD. Future research should investigate the clinical services received between a patient's service separation date and the date of the TBI screen to determine whether patients who were delayed in being identified through the TBI screening process also experienced delays in receiving clinically indicated services.

There are several limitations to this study. It is based on VA administrative data, and therefore there may be errors in reporting of screening results as well as other characteristics. In addition, these data focus only on the first 18 months of implementation of the screen, and more recent data may show different results. TBI screening is a high priority, and screening rates have increased in the past several years [13]. However, the strengths of these data are that it is generalizable and involves a national sample of OEF/OIF veterans eligible for screening who have not previously been analyzed.

CONCLUSION

The implementation of the TBI screening program was an important goal for VA in serving returning OEF/OIF veterans. Identifying similarities and differences between veterans who do and do not complete the TBI screen provides valuable feedback to the VHA as to how to ensure that all veterans, regardless of VA facility, are screened for TBI. Insights regarding associations between veteran characteristics and positive and negative screening results can also assist providers who are charged with implementing the TBI screen and follow-up comprehensive evaluation to optimize services for veterans with mild TBI. The results of this study are also generalizable to a non-VA setting in that the screen can be effectively administered in any health care environment. The frequent occurrence of ongoing postconcussive symptoms, and a combination of mental health diagnoses points to both the importance of screening for early intervention as well as the need to prepare for ongoing health care needs of our newest veterans. These data can be used by the VA and other policymakers in determining future long-term funding and care for OEF/OIF veterans.

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REFERENCES

1. Hoge CW, McGurk D, Thomas JL, Cox AL, Engel CC, Castro CA. Mild traumatic brain injury in U.S. soldiers returning from Iraq. N Engl J Med 2008;358:453-463.
2. Tanielian T, Jaycox LH, eds. Invisible Wounds of War: Psychological and Cognitive Injuries, Their Consequences and Services to Assist Recovery. Santa Monica, CA: RAND Corporation, Center for Military Health Policy Research; 2008.
3. Schneiderman AI, Braver ER, Hang HK. Understanding sequelae of injury mechanisms and mild traumatic brain injury incurred during the conflicts in Iraq and Afghanistan: Persistent postconcussive symptoms and posttraumatic stress disorder. Am J Epidemiol 2008;167:1446-1452.
4. Vanderploeg RD, Curtiss G, Luis CA, Salazar AM. Long-term morbidities following self-reported mild traumatic brain injury. J Clin Exp Neuropsychol 2007;29:585-598.
5. Veterans Health Administration, Department of Veterans Affairs. Screening and Evaluation of Possible Traumatic Brain Injury in Operation Enduring Freedom (OEF) and Operation Iraqi Freedom (OIF) Veterans. VHA Directive 2010-012, March 8, 2010. Available at http://www.va.gov/vhapublications/viewpublication.asp?pub_ID=2176. Accessed March 14, 2012.
6. Donnelly KT, Donnelly JP, Dunnam M, et al. Reliability, sensitivity, and specificity of the VA traumatic brain injury screening tool. J Head Trauma Rehabil 2011;26:439-453.
7. VIReC Research User Guide: FY2002 VHA Medical SAS® Inpatient Datasets. Edward J. Hines, Jr. VA Hospital. Hines, IL: Veterans Affairs Information Resource Center; 2003.
8. VIReC Research User Guide: FY2002 VHA Medical SAS® Outpatient Datasets. Edward J. Hines, Jr. VA Hospital. Hines, IL: Veterans Affairs Information Resource Center; 2003.
9. Sigford BJ. "To Care for Him Who Shall Have Borne the Battle and for His Widow and His Orphan" (Abraham Lincoln): The Department of Veterans Affairs Polytrauma System of Care. Arch Phys Med Rehabil 2008;89:160-162.
10. Veterans Health Administration, Department of Veterans Affairs. Polytrauma- traumatic brain injury (TBI) system of care. VHA Directive 2009-028, June 9, 2009. Available at http://www.va.gov/vhapublications/viewpublication.asp?pub_ID=2032. Accessed March 14, 2012.
11. Carey K. A multilevel modeling approach to analysis of patient costs under managed care. Health Econ 2000;9:435-446.
12. Diez-Roux AV. Multilevel analysis in public health research. Annu Rev Public Health 2000;21:171-192.
13. Sayer NA, Nelson D, Nugent S. Evaluation of the Veterans Health Administration Traumatic Brain Injury Screening Program in the Upper Midwest. J Head Trauma Rehabil 2011;26:454-467.
14. Stroupe KT, Tarlov E, Zhang Q, Haywood T, Owens A, Hynes DM. Use of Medicare and DOD data for improving VA race data quality. J Rehabil Res Dev 2010;47:781-795.

15. Carlson KF, Nelson D, Orazem RJ, Nugent S, Cifu DX, Sayer NA. Psychiatric diagnoses among Iraq and Afghanistan war veterans screened for deployment-related traumatic brain injury. J Trauma Stress 2010;23:17-24.
16. Langlois JA, Rutland-Brown W, Thomas KE. Traumatic Brain Injury in the United States: Emergency Department Visits, Hospitalizations, and Deaths. Atlanta, GA: Dept. of Health and Human Services (US), Centers for Disease Control and Prevention, National Center for Injury Prevention and Control; 2004. Available at http://www.cdc.gov/ncipc/pub-res/TBI_in_US_04/TBI_ED.htm. Accessed April 15, 2012.
17. Maguen S, Luxton DD, Skopp NA, Madden E. Gender differences in traumatic experiences and mental health in active duty soldiers redeployed from Iraq and Afghanistan. J Psychiatr Res 2012;46:311-316.
18. Nemeroff CB, Bremner JD, Foa EB, Mayberg HS, North CS, Stein MB. Post-traumatic stress disorder: A state-of-the-science review. J Psychiatr Res 2006;40:1-21.
19. Cernak I, Noble-Haeusslein L. Traumatic brain injury: An overview of pathobiology with emphasis on military populations. J Cereb Blood Flow Metab 2010;30:255-266.
20. Bergquist T, Gehl C, Mandrekar J, et al. The effect of Internet-based cognitive rehabilitation in persons with memory impairments after severe traumatic brain injury. Brain Inj 2009;23:790-799.
21. Bourgeois MS, Lenius K, Turkstra L, Camp C. The effects of cognitive teletherapy on reported everyday memory behaviors of persons with chronic traumatic brain injury. Brain Inj 2007;21:1245-1257.
22. Bell KR, Hoffman JM, Temkin NR, et al. The effect of telephone counselling on reducing post-traumatic symptoms after mild traumatic brain injury: A randomised trial. J Neurol Neurosurg Psychiatry 2008;79:1275-1281.
23. Brennan DM, Georgeadis AC, Baron CR, Barker LM. The effect of videoconference-based telerehabilitation on story retelling performance by brain-injured subjects and its implications for remote speech-language therapy. Telemed J E Health 2004;10:147-154.
24. Bergquist TF, Thompson K, Gehl C, Munoz Pineda J. Satisfaction ratings after receiving Internet-based cognitive rehabilitation in persons with memory impairments after severe acquired brain injury. Telemed J E Health 2010;16:417-423.

Footnotes Continued From Page 1.

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