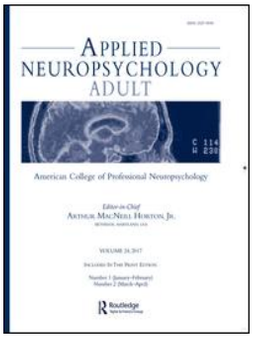

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An interdisciplinary approach to the screening, diagnosis, and treatment of OEF/OIF Veterans with mild traumatic brain injury

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ABSTRACT

Objective: To implement an Integrated TBI Screening Clinic (ITSC) during the mandatory TBI evaluation process at the Department of Veterans Affairs. Referral outcomes were examined regarding Veterans who were determined to need a full neuropsychological evaluation versus those for whom mental health treatment was clinically indicated. Correlations among cognitive measures, posttraumatic stress disorder (PTSD), anxiety, depression, and insomnia symptoms were also examined.

Method: This study was a retrospective chart review study that included 138 Veterans seen between 2011 and 2014 in a post-deployment primary care clinic. Descriptive statistics and correlations were completed using the: screening Module of the Neuropsychological Assessment Battery (S-NAB), PTSD Checklist-Military version (PCL-M), Beck Depression Inventory-II (BDI-II), Beck Anxiety Inventory (BAI), and Insomnia Severity Index (ISI).

Results: 19.8% of Veterans required a referral for a full neuropsychological exam and 72.7% were referred for additional mental health services (with some Veterans being referred to both). Significant correlations were found among higher PTSD, depression, anxiety symptoms, with poorer attention and memory (all $p < .05$). Only PTSD was significantly correlated with poorer executive functioning ($r = 0.19$, $p < .05$).

Conclusion: Integration of a multidisciplinary neuropsychological screening exam during a primary care visit with OEF/OIF Veterans may assist in better delineating symptoms.

KEYWORDS
Integrated health care; mental health; mild traumatic brain injury (mTBI); multidisciplinary clinic; neuropsychologist; OEF/OIF Veterans

Introduction

Approximately 6.7% (Taylor et al., 2012) of Operation Enduring Freedom/Operation Iraqi Freedom (OEF/OIF) Veterans return from deployment having sustained a traumatic brain injury (TBI), known as a signature injury of this conflict (Schneiderman et al., 2008). History of a TBI can be associated with a host of neuropsychological deficits, including problems with attention, memory, and executive functioning. Although most individuals who sustain a mild TBI (mTBI) have full recovery within days to weeks post injury (Schretlen & Shapiro, 2003), a small proportion report cognitive complaints that extend beyond one year (Spencer et al., 2010). In order to better detect the history of mTBI in returning Veterans and facilitate appropriate treatment, the Veterans Health Administration (VHA) implemented a mandatory national clinical reminder in 2007 to screen for a history of TBI during OEF/OIF Veterans' initial visit at the VHA, the Traumatic Brain Injury Screening Instrument (TBISI). At present, all Veterans with positive screens are automatically scheduled for a Second Level TBI Evaluation. This evaluation is conducted by a medical provider with TBI specific training (e.g., MD, DO, NP, or PA) in a primary care setting to further assess persistent symptoms following a TBI and to make recommendations, which often results in referring the Veteran for a full neuropsychological evaluation and other specialties as clinically indicated (Figure 1). Although these have been critically important steps toward identifying and treating persistent symptoms following a TBI, they have created additional conundrums, such as how to meet the demand of Veterans with positive TBI screenings; whether comprehensive neuropsychological evaluations for these Veterans are warranted; and how to determine more readily whether Veterans' self-reported persistent symptoms following a TBI are better accounted for by other sources of medical, emotional, or cognitive impairment.

As is the case with many screening tools, a positive TBI screen based on the TBISI is not a definitive diagnosis of history of TBI (Department of Veterans Affairs, 2010). The TBISI has been found to have high sensitivity, yielding minimal false-negative results, but offers only moderate specificity, resulting in many false-positive screens for TBI. For example, in one study, approximately 20% of Veterans had a

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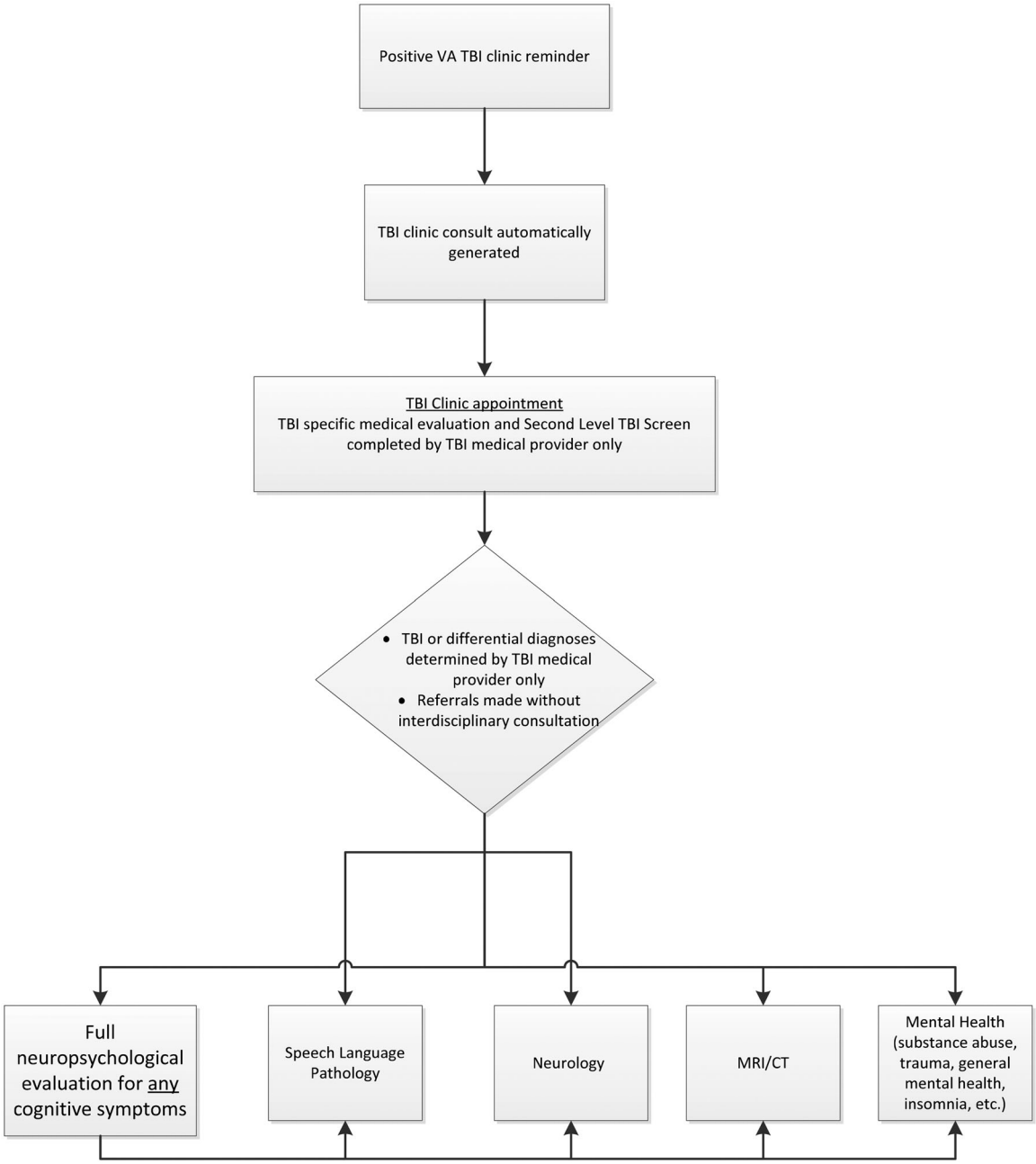


Figure 1. Clinic process without ITSC for the Second Level TBI Evaluation+.

positive TBISI, but of those, only 55% were later identified as having sustained a TBI (Donnelly et al., 2011). Another concern about the TBISI is its low test-retest reliability with regard to type of event, injuries sustained, and resulting sequelae (Van Dyke et al., 2010). Van Dyke and colleagues (2010) also point out, "a measure that fails to obtain the same information about the same events is not a dependable tool for an accurate referral process." Consequently, many Veterans may unnecessarily undergo comprehensive neuropsychological evaluations at times when a direct referral for other services (e.g., mental health) may be more appropriate (Sayer, 2012).

In addition to the TBISI, the VA has implemented additional formal services for symptoms relating to TBI throughout the system. The VA Polytrauma/TBI System of Care offers rehabilitative care to Veterans in varying degrees, depending on the Veteran's needs and location (United States Department of Veterans Affairs, 2015). This system includes 5 Polytrauma Rehabilitation Centers (Level 1), 19 Polytrauma Network Sites (Level 2), 87 Polytrauma Support Clinic Teams (Level 3), and 39 Polytrauma Point of Contact sites (Level 4). The Phoenix VA transitioned from a Level 4 to Level 3 site in 2010. Notably, the majority of VA hospitals do not have formal polytrauma services established; therefore, a polytrauma support team may not be available at each site to conduct an appropriate assessment of and subsequent treatment recommendations for Veterans' persistent symptoms following a TBI.

Although it may seem that a history of TBI would be the most likely source of Veterans' cognitive complaints after combat-related blast exposures, multiple factors can contribute to these complaints. Reports of cognitive complaints are

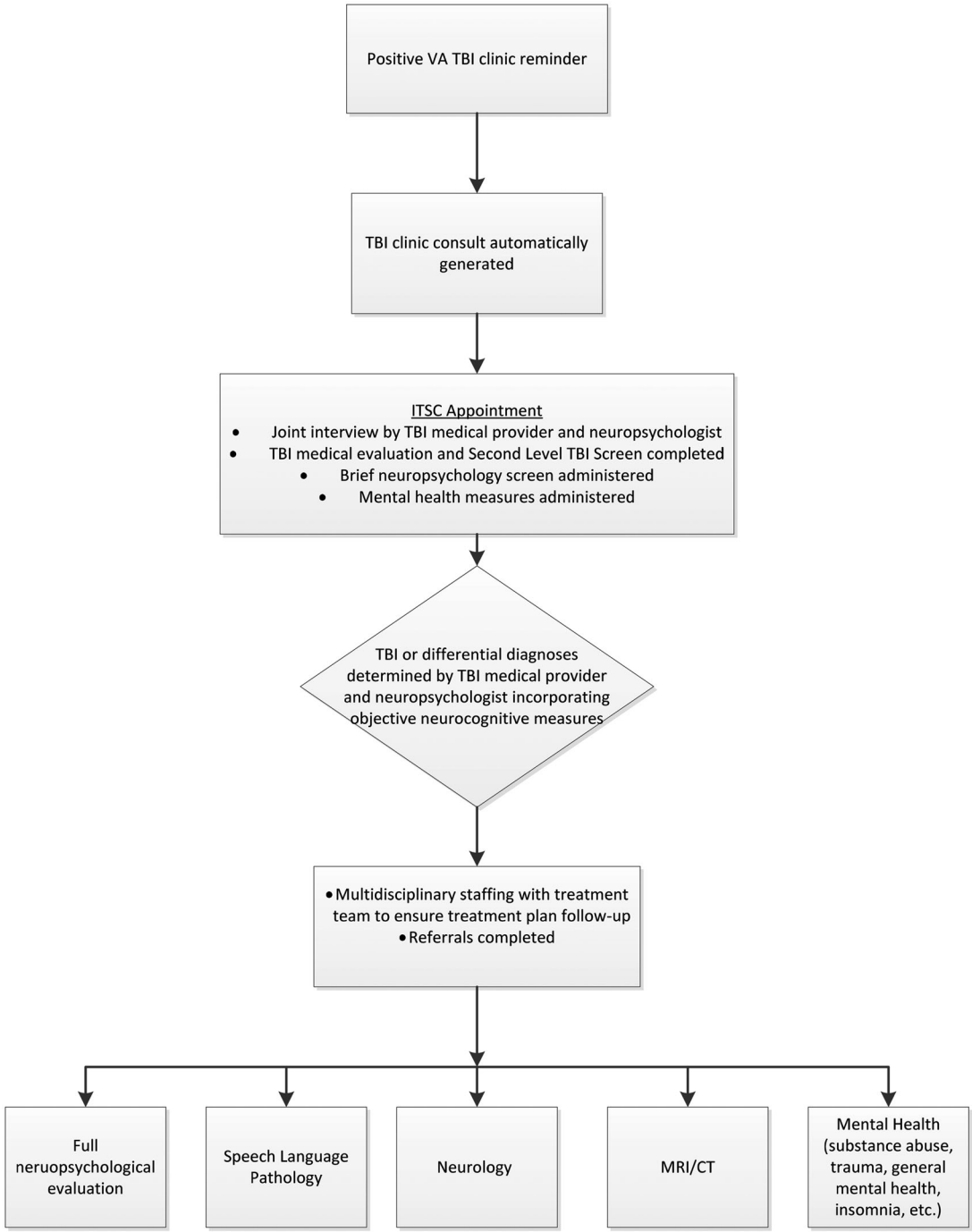


Figure 2. Clinic process with ITSC integrated during the Second Level TBI Evaluation.

often complicated by co-occurring mental health symptoms, such as posttraumatic stress disorder (PTSD), anxiety, and depressive symptoms, which are highly prevalent among OEF/OIF Veterans with positive TBI screens (Evans et al., 2013). Sleep complaints, which also can contribute to perceived cognitive deficits (Riley et al., 2019) are one of the most common presenting clinical issues and prevalent in 70% of newly returned Veterans (Cozza et al., 2004). During the Second Level TBI Evaluation, a more thorough, template-based interview is conducted. The questions asked by TBI medical providers may overlap with symptoms of PTSD and depression (e.g., past exposure to a blast or explosion, irritability, sleep problems), making it difficult to distinguish between cognitive residuals secondary to a sustained TBI versus cognitive residuals secondary to other commonly reported diagnoses in OEF/OIF combat Veterans (Hill et al., 2009).

In order to facilitate differential diagnosis and appropriate treatment planning among returning Veterans with positive initial TBI screens, neuropsychologists at the Phoenix VA developed and tested the feasibility of an Integrated TBI Screening Clinic (ITSC) by (1) including a neuropsychologist along with the TBI medical provider during the Second Level TBI Evaluation, and (2) implementing a relatively brief (35–45 min) neuropsychological evaluation during this appointment. The ITSC was piloted in the Phoenix VA

Health Care System as a response to the nationally mandated Second Level TBI evaluation process (Figure 2).

This augmented approach may have several advantages. First, including the Integrated TBI Screening Clinic (ITSC) may provide a more thorough evaluation and achieve greater diagnostic clarity than the Second Level TBI Evaluation on its own, without requiring a full neuropsychological evaluation. This may, in turn, reduce system-level and Veteran burden with decreased utilization of unneeded lengthy appointments. Second, having both a TBI medical provider and neuropsychologist present serves as an important opportunity to answer the Veteran's questions and to provide psychoeducation regarding the expected trajectory of recovery from persistent symptoms following mTBI and possible overlay of mental health symptoms; this in itself can be useful in reducing symptoms (Roberts et al., 2020). Third, the ITSC may also provide a more conducive primary care setting for engagement and introduction of mental health services for OEF/OIF Veterans (Seal et al., 2011), which would allow for Veterans to be potentially identified, triaged, and connected to the most appropriate care more rapidly.

Although other studies have examined abbreviated questionnaires to help facilitate briefer evaluations to help delineate cognitive complaints from psychiatric symptoms (Flaherty et al., 2015), we tested whether a similar approach would be effective using brief neuropsychological measures along with self-report. We also examined the occurrence of, and relationships among, neurocognitive deficits per the brief neuropsychological tests and self-reported symptoms of PTSD, depression, anxiety, and insomnia. This provided an opportunity to test whether previously documented relationships between neurocognitive functioning and mental health symptoms were present in our sample and detectable with a shorter neuropsychological battery. Finally, we sought to explore whether implementing this process could help to clarify or refine the symptoms captured by the TBISI and yield more efficient and precise treatment plans earlier in the assessment process.

Methods

Participants

Participants in this study were Veterans receiving services through the Veterans Health Administration (VHA) post-deployment clinic from 2011 to 2014. All were referred for a Second Level TBI Evaluation following a positive screen on the TBISI. A total of 361 Veterans were seen during this time frame. Of these, 142 (39%) were seen by a neuropsychologist (the Principal Investigator of the present study) during a shared medical appointment with a TBI medical provider, and 138 completed the neuropsychological screening measures at this appointment. In accordance with VHA directives, the TBI medical provider completes specific training to complete these assessments and provide appropriate diagnoses and treatment recommendations. Thus, our final sample comprised 138 (95% male) OEF/OIF combat Veterans with an average of two deployments ($SD = 1.40$; range 1–14) and a mean age of 30.5 years ($SD = 6.81$; range 21–58). The racial/ethnic background of the sample was 71% Caucasian, 15% Hispanic, 7% African American, 5% Native American/Alaska Native, 1% Asian Pacific Islander, and 1% other. Forty-five percent of the sample was married, 34% never married, 13% divorced, and 7% separated.

Procedure

The present study was based on a retrospective chart review of archival data. All procedures were approved by the Phoenix VA institutional review board and conducted in accordance with the American Psychological Association's ethical guidelines. The screening battery used in the ITSC clinic was designed to assess cognitive domains commonly impacted by traumatic brain injury (described below). Self-report questionnaires were also administered to assess symptoms of posttraumatic stress disorder, depression, anxiety, and insomnia. In addition to these measures, a clinical interview was administered. The clinical interview and assessment results helped to determine if patients would benefit from a comprehensive neuropsychological evaluation or required other types of referrals. Following the assessment, Veterans were also provided education jointly by the neuropsychologist and medical TBI provider. This education included: the different types of traumatic brain injury (mild, moderate, severe), the fact that TBI is a historical diagnosis and the expected recovery course of TBI, and various factors that might be contributing to ongoing cognitive difficulties (e.g., insomnia, pain, mood disorders, etc.). Lastly, information on various evidence-based treatments were also discussed in alignment with the assessment findings and treatment recommendations.

All data were collected for clinical care purposes. Responses subsequently were entered into an Excel database and were fully de-identified.

Measures

Select measures from the Screening Module of the Neuropsychological Assessment Battery (S-NAB) were administered to assess cognitive functioning (Stern & White, 2003). This test assesses the cognitive domains of memory, attention, and executive functioning and takes approximately 35–45 min to administer. The selected subtests from this screening measure that were administered were as follows: to assess attention: Screening Digits Forward, Screening Digits Backward, Screening Numbers and Letters (Parts A and B); to assess memory: Screening Shape Learning Immediate Recognition, Screening Story Learning Immediate Recall, Screening Shape Learning Delayed Recognition, Screening Story Learning Delayed Recall; and to assess executive functioning: Screening Mazes and Screening Word Generation. Each screening score is scaled to have a mean of 100 and a standard deviation of 15, with higher scores indicating better performance. Screening domain scores below 85 are categorized in the impaired range and scores of 85 or greater are considered to be in the

Table 1. Means, standard deviations, and correlations among study variables.

	M	SD	1	2	3	4	5	6	7
1. Attention[a]	88.68	17.88	–						
2. Memory	92.81	15.57	.40**	–					
3. Executive functioning	101.33	14.88	.50**	.43**	–				
4. PTSD[b]	51.73	15.95	**−.24***	**−.34****	**−.19***	–			
5. Depression	23.94	13.29	**−.19***	**−.29****	**−.07**	.68**	–		
6. Anxiety	18.14	11.20	**−.20***	**−.20***	**−.14**	.77**	.71**	–	
7. Insomnia	16.22	6.86	**−.14**	**−.17**	**−.08**	.68**	.47**	.60**	–

*$p < .05$; **$p < .01$.

[a]Cognitive tests for attention, memory, and executive functioning were measured as subtests of the NAB. Subtests are normed where typical $M = 100$, $SD = 15$, <85 = impaired, ≥ 85 = unimpaired. Correlations among key variables are bolded.

[b]PTSD, depression, anxiety, and insomnia symptoms were measured via self-report measures PCL-M,BDI-II, BAI, and ISI, respectively.

non-impaired range (Stern & & White, 2003). For the purposes of the ITSC, screening sores were not used to assess impairment or be diagnostic, but rather to help determine if a more comprehensive neuropsychological assessment was warranted. Similar uses of the S-NAB have demonstrated good validity and reliability in samples with acute (Hacker et al., 2017) or moderate to severe symptoms (Zgaljardic & Temple, 2010) following a TBI. PTSD symptoms were assessed with the PTSD Checklist-Military version (PCL-M; Weathers et al., 1991), a 17-item self-report measure (items rated from 1 = not at all to 5 = extremely) corresponding with *DSM-IV* criteria for PTSD. PCL-M total scores below 34 suggest no PTSD; 34–43 some trauma-related distress but likely not a PTSD diagnosis; 44–54 significant distress and a probable PTSD diagnosis; and 55 and above a definitive PTSD diagnosis. Most patients with scores suggesting probable or definitive PTSD meet criteria for either the full diagnosis or subclinical levels of symptoms that are associated with significant clinical impairment (Kimerling, 2008)

Symptoms of depression were assessed with the Beck Depression Inventory-II (BDI-II; Beck et al., 1996), a 21-item self-report questionnaire. Responses for each item are scored as 0, 1, 2, or 3. BDI-II total scores of 0–13, 14–19, 20–28, and 29–63 suggest minimal, mild, moderate, and severe depressive symptoms, respectively.

Anxiety symptoms were measured with the Beck Anxiety Inventory, a 21-item self-report measure. Responses for each item are scored as 0, 1, 2, or 3. Total scores of 0–7, 8–15, 16–25, and 26–63 suggest minimal, mild, moderate, and severe anxiety, respectively (Beck & Steer, 1993).

The Insomnia Severity Index (ISI); is a 7-item self-report measure of insomnia symptoms (scale anchors for most items are 0 = none or not at all to 4 = very severe or very much), including difficulty falling asleep, staying asleep, or awakening too early. Total scores of 0–7, 8–14, 15–21, and 22–28 suggest an absence of insomnia, subthreshold insomnia, moderate insomnia, and severe insomnia, respectively (Yang et al., 2009).

Data analyses

We conducted descriptive analyses to characterize the neurocognitive and clinical functioning of the present sample, and we examined correlations among neuropsychological subscale performance and self-reported mental health symptoms. We also examined percentages of referrals to specialty services and type of referral (i.e., additional neuropsychological testing versus further mental health services) following the augmented Second Level TBI Evaluation with the ITSC. Exploratory analyses were used to probe differences in groups of Veterans referred for further neuropsychological evaluations, mental health services, or a combination. Two multivariate analyses of variance (MANOVAs) were conducted to explore whether these three main referral groups differed in neurocognitive performance and clinical symptoms, respectively.

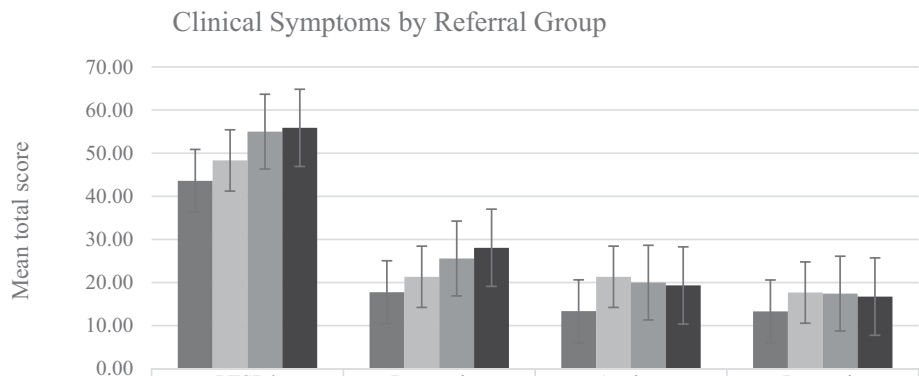
Due to the cross-sectional design of the study and in-person administration of the measures, missing data was limited and ranged from 0% to 10% on variables. Pairwise deletion was used when exploring correlations or percentages, and listwise deletion was used for the MANOVAs.

Results

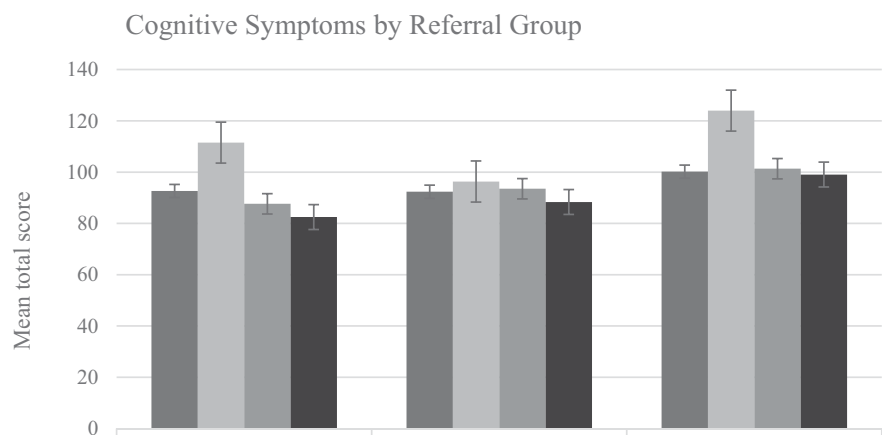
In the present sample, mean scores on the S-NAB for attention, memory, and executive functioning all fell within normal limits (Table 1). With respect to clinical symptoms, 44.6% of Veterans reported clinically elevated levels of PTSD symptoms (PCL-M $\geq$ 50); 56.9% reported moderate or severe levels of depression (BDI-II$\geq$ 20); 54.2% reported moderate or severe levels of anxiety (BAI $\geq$ 16); and 64.9% reported moderate or severe levels of insomnia (ISI $\geq$ 15).

Correlations between neurocognitive performance and psychiatric symptoms are presented in Table 1. With respect to patterns of statistical significance, higher levels of PTSD, depression, and anxiety symptoms were associated with lower attention and memory scores. PTSD symptoms also were associated with significantly lower executive functioning scores. Insomnia symptoms were not significantly related to performance in any of the cognitive domains, although correlations were in the expected direction. With respect to the clinical relevance of the correlations based on their magnitude (see Nordahl-Hansen et al., 2018 and Schober et al., 2018, for a full discussion), the neuropsychological/cognitive measures showed moderate within-domain relationships (*r*s = .40–.50 among attention, memory, and executive function); clinical symptom measures showed strong relationships among PTSD, depression, and anxiety (*r*s = .68–.77) and moderate to strong relationships for insomnia (*r*s = .47–.68). Overall, the cross-domain relationships were relatively weaker and not clinically-meaningful, with correlation coefficients of .34 or below.

At the conclusion of the ITSC, only 19.8% of Veterans required a referral for a full neuropsychological exam to further evaluate cognitive symptoms. On the other hand, 72.7% were referred for additional mental health services (with some Veterans being referred to both). At the time of our archival chart review, only 46.7% of the Veterans in our sample had a chart history of TBI in the medical record. Thus, even though all Veterans in this sample showed a positive initial TBISI screen, slightly less than half were determined to have



	PTSD*	Depression	Anxiety	Insomnia
No referrals (n=35)	43.60	17.76	13.36	13.31
Neuropsych only (n=3)**	48.33	21.33	21.33	17.67
MH only (n= 68)	55.00	25.57	19.98	17.43
MH and Neuropsych (n= 21)	55.88	28.05	19.33	16.73



	Attention	Memory	Executive Functioning
No referrals (n=35)	92.65	92.35	100.2
Neuropsych only (n=3)**	111.5	96.33	124
MH only (n= 68)	87.66	93.53	101.35
MH and Neuropsych (n= 21)	82.48	88.33	99.05

Figure 3. Symptoms measures by referral groups.

sustained symptoms following TBI by the conclusion of our augmented Second-level TBI Evaluation.

Exploratory analyses were conducted to further probe differences in referrals for Veterans after their ITSC evaluation. Only three cases warranted a referral to neuropsychology for a full evaluation without a co-occurring mental health referral; 21 Veterans were referred for a full neuropsychological evaluation and mental health services; 68 were referred for mental health services; and 35 were not referred for either of these major categories of service. The pattern of means for the three largest groups revealed that clinical symptom levels were highest in the groups referred to mental health or both mental health and neuropsychology, further reinforcing mental health symptoms as a driver for referrals and cognitive complaints (see Figure 3). This pattern of means was further probed with MANOVAs to formally assess if there were significant differences in clinical symptoms among the three largest groups: Veterans referred for mental health services only, those referred for both mental health and neuropsychology services, or no referrals. The MANOVA for the clinical symptom measures was trending toward significance ($F(8, 226) = 1.88$; $p = .06$; partial $\eta^2 = .06$). Univariate tests were significant for each clinical symptom measure (ps $= .003$–$.03$). With respect to specific group comparisons, PTSD symptoms were significantly higher among Veterans referred for mental health only ($p = .001$) or both mental health and neuropsychology ($p < .01$), when compared to the no referral group. PTSD symptoms did not differ between the mental health only and combined referral groups ($p = .77$). This pattern was similar for depressive symptoms. Veterans who were referred for mental health ($p < .01$) or both mental health and neuropsychological evaluations ($p < .01$) had significantly greater levels of depressive symptoms than the no referral group. There was no significant difference in depressive symptoms between Veterans who were referred to mental health only versus to both mental health and neuropsychology ($p = .66$). Anxiety symptoms were significantly higher in the group referred to mental health only ($p < .01$) compared to no referrals ($p < .01$). There was no

difference in anxiety symptoms between Veterans referred to both mental health and neuropsychology ($p = .07$) versus to no services or mental health only ($p = .84$). This pattern was similar for insomnia symptoms; there were significantly greater insomnia symptoms in the mental health referral group than in the no referral group ($p = .01$). However, the combined mental health and neuropsychology referral group did not differ in insomnia symptoms from the no referral group ($p = .10$) or the mental health only group ($p = .72$). The MANOVA for the neurocognitive measures was not significant ($F(6, 238) = 1.07$; $p = .38$; partial $\eta^2 = .03$; see Figure 3 for uncorrected means for all symptom measures).

Discussion

The current study sought to explore a process for evaluating persistent symptoms following an mTBI event and the presence of mental health comorbidities among OEF/OIF Veterans with positive initial TBI screens at the VAHCS. A new Integrated TBI Screening Clinic was implemented wherein we used a combination of a brief and objective screen for cognitive functioning along with self-reported symptom measures of PTSD, depression, anxiety, and insomnia during the mandated Second Level TBI Evaluation medical appointment. One primary goal of this new clinic procedure was to have a shared medical appointment with both a TBI medical provider and a neuropsychologist, rather than waiting for an unnecessary full neuropsychological evaluation during a separate clinical encounter. Findings in the present sample are consistent with research indicating a high comorbidity of PTSD and depressive symptoms among OEF/OIF Veterans with persistent symptoms following mTBI (Ramchand et al., 2010) and additionally offer support for comorbidity of anxiety and insomnia symptoms. We found that based on a brief (less than one hour) neuropsychological evaluation during the ITSC appointment, only 20% of Veterans required a comprehensive follow-up neuropsychological evaluation. This is in sharp contrast to the prior approach at the study site, where nearly all Veterans were referred directly for a comprehensive neuropsychological evaluation after reporting cognitive complaints to their TBI medical provider during the Second Level TBI screen. Given the burden of costs incurred by persistent symptoms following mTBI and associated comorbidities (Taylor et al., 2012), including an ITSC may reduce medical costs and wait times, improve patient health outcomes and satisfaction with services received, as well as reduce provider burden.

Notably, even though participants in our sample reported a level of cognitive complaints sufficient to warrant further evaluation for history of TBI, objective cognitive performance was, on average, within normal limits for all domains assessed. This is consistent with previous findings that cognitive complaints are often not borne out by objective measures and instead are highly related to psychological distress (Spencer et al., 2010). Lower attention, memory, and executive functioning performance were related to co-occurring mental health symptoms. Although these effects were relatively small in our sample, memory and attention were significantly and negatively correlated with PTSD, anxiety and depression, and executive functioning was significantly and negatively correlated with PTSD. Depression, anxiety, and posttraumatic stress are widely understood to have a direct impact on attention and thus memory (Burt et al., 1995; Roberts et al., 2020; Samuelson, 2011). Some studies, however, have not found associations between PTSD, attention, and memory (Wrocklage et al., 2016), or have found that depression accounts for observed memory deficits in PTSD (Burriss et al., 2008). The association of PTSD symptoms and memory impairment in OEF/OIF Veterans has been shown in previous studies (Trudeau et al., 1998); however, depression and memory specific to this sample has been less explored. Other research has supported and highlighted the unique effects between PTSD symptoms, arousal, and impaired communication between the prefrontal and limbic/subcortical areas of the brain, which has a negative impact on executive functioning. Interestingly, there is evidence of concurrent improvement in PTSD symptoms and executive functioning with trauma-focused therapy (Nijdam et al., 2018). The present study provides some support for connections between executive functioning and PTSD, and broader associations between mental health symptoms and cognitive symptoms using brief neuropsychological measures. This has clinical relevance as it may guide appropriately to neuropsychological testing, which may yield more refined associations among clinical and neurocognitive symptoms. Further research is needed to understand these complex relationships and the utility of brief neuropsychological screening tests measure them.

As noted above, Veterans who presented for this second level TBI evaluation appointment already had scored positive on the TBISI. As other studies have suggested, the TBISI may have poor specificity and require more thorough evaluation of symptoms prior to initiating a host of specialty services for these concerns (Donnelly et al., 2011). The current study supports this finding of poor specificity. Following the ITSC evaluation, 73% of Veterans' persistent symptoms following TBI were determined to be more attributable to psychiatric complaints and were referred for further mental health treatment. This also underscores the need for and benefits of multidisciplinary team appointments, involving TBI medical providers and mental health professionals when screening for cognitive residuals for mTBI symptoms. It is reasonable to expect that the implementation of the ITSC for Veterans will likely reduce the number of referrals placed for full neuropsychological assessments or other specialty services that are not clinically indicated. This may be especially noteworthy for the majority of VA sites without formal or higher level polytrauma services, as the ITSC clinic was found to be both feasible and effective to facilitate more accurate diagnosis and treatment planning during earlier stages of Veterans' care.

In addition to possible logistical and cost-effective advantages of the ITSC process, other bodies of research suggest the benefits of providing psychoeducational intervention for patients with TBI symptoms, as iatrogenic effects have been

found to take place due to over-pathologizing nomenclature in this population (Roth & Spencer, 2013). Interventions that have focused on providing education on the association between cognitive complaints and psychological distress have found significant decreases in memory complaints (Floyd & Scogin, 1997). Among Veterans reporting mTBI symptoms, additional screening and early education may also serve as an additional layer of mental health intervention and possibly suicide prevention. In one sample of Veterans, having a history of mild TBI with comorbid PTSD symptoms increased the risk of suicide (Barnes et al., 2012). This research underscores the need for prompt education and intervention in this high-risk sample and highlights the potential benefits of an integrated clinic process that the Veteran is willing and able to access.

It is also important to note that the current study conducted evaluations in a primary care setting. This type of environment has been found to be particularly beneficial for OEF/OIF Veterans, for whom stigma and access continue to be cited as significant barriers to care. Research suggests that this specific subset of Veterans may prefer to initiate mental health care within a primary care setting, which may strengthen future engagement in services (Seal et al., 2011). This supports that a primary care clinic may be the ideal environment to implement abbreviated neuropsychological screenings, as done in the current study.

Limitations and future directions

Limitations of this study include the cross-sectional nature of the data and inability to examine these symptoms across time or infer causality among symptom clusters. The findings and implications of this study may also have limited generalizability to female and minority Veterans, as most of the sample was younger, Caucasian, and male. It was also surprising that insomnia symptoms were not significantly correlated with any cognitive domains, although were significantly correlated with other mental health symptoms. Given the amount of literature that supports cognitive functioning, emotional health, and sleep (Fortier-Brochu & Morin, 2014) more research is needed in Veterans presenting with persistent symptoms following an mTBI to better understand this finding. At the time of this study, the ITSC did incorporate symptom validity measures into the battery, which is a notable weakness. They have since been incorporated, but not presented with this data and should be considered for future studies to publish as part of their findings.

Future research may continue to expand these findings by following Veterans who present to screening clinics longitudinally to better capture cost reduction and patient outcomes (e.g., improved mental health and quality of life). Additional weaknesses in the present study could also be captured by longitudinal study design, such as objective changes in referrals following ITSC implementation compared to pre-ITSC state, and the course of symptomatology following an ITSC clinic process, as a large majority were referred for mental health treatment. Clinical decision making regarding referrals for cognitive or psychiatric evaluations is inherently a complex process, as was the case with the ITSC. In addition to neuropsychological screening scores, many cases involve factors including biopsychosocial needs (e.g., homelessness) and other clinical factors (severe PTSD, insomnia, substance abuse), which led to prioritizing other care needs. In such cases, it was often recommended that neuropsychological testing be deferred until after these needs were stabilized. The complexity of the decision to refer someone for comprehensive neuropsychological testing involves a significant amount of clinical judgment informed by patient presentation, injury history, and duration/course of symptoms, among other factors unique to each patient. Our findings underscore the utility of a TBI medical provider and neuropsychologist navigating these complex clinical processes together as a valuable gain for the Veteran and hospital system. Additional metrics for evaluating the efficacy of the ITSC process are being incorporated for future study. More cross-sectional work could also compile qualitative feedback from Veterans to better understand the suitability and assistance of the ITSC during the Second Level TBI Evaluation.

Overall, this study supports our current understanding of the high comorbidity between mental health symptoms and cognitive complaints. It also provides further understanding on the utility and feasibility of implementing brief neuropsychological screening evaluations within the Second Level TBI Evaluation to improve the assessment, diagnosis, and treatment of OEF/OIF Veterans with persistent symptoms following an mTBI to more effectively specify the etiology of symptoms. Most notably, implementation of an abbreviated neuropsychological exam may improve access to care, health outcomes, and satisfaction with services, while reducing medical costs, as well as patient and provider burden.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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