

ORIGINAL RESEARCH

Suicide Attempts and Self-Inflicted Injury Among a National Cohort of Veterans with Post-Traumatic Stress Disorder and Traumatic Brain Injury

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Abstract

Background: Suicide rates are on the rise globally. Many suicide completers are previous attempters. Risk identification of attempters will provide an opportunity for prompt and targeted intervention towards suicide prevention. The aim of this study was to determine the incidence of suicide attempt and self-inflicted injury (SASI), and its associations with deployment-related PTSD and/or TBI and attempted suicide among a large national cohort of Veterans deployed pre and post-9/11 2001 who received care from the Veterans Health Administration (VHA) between 1998 - 2014.

Methods: Clinical data from over 1,400 VHA establishments provided by the Veterans Administrations Informatics and Computing Infrastructure (VINCI) were used for descriptive and Cox regression analyses.

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Results: There were 1,327,604 patients in the study - PTSD only (1,121,818), TBI only (100,033), both PTSD and TBI (105,753). The incidence of SASI in the entire cohort was 351 per 100,000 person years; PTSD only (323), TBI only (181), both PTSD and TBI (835). Compared to

TBI only group, the adjusted risk for SASI was higher in the PTSD only group (HR=1.129; 95% CI =1.063 - 1.200) and much higher in those with both PTSD and TBI (HR=2.283; 95% CI =2.136 - 2.441). The risk of SASI was higher if they were younger than 50 years, divorced or separated, non-Hispanic females, homeless, suffered adult abuse and neglect, had substance use, generalized anxiety and antisocial personality disorders, and if they were in the Pre-9/11 service period. Proportion of people attempting suicide increased every year post-diagnosis of PTSD and/or TBI.

Conclusion: We recommend prioritizing resources to prevent suicide among at risk groups. *Keywords:* suicide attempt, self-inflicted injury, post-traumatic stress disorder, traumatic brain injury, Veterans

Introduction

Suicide rates are on the rise globally and in the United States. According to the World Health Organization, 800,000 people die annually due to suicide, and many more people attempt suicide [1]. In the US general population, suicide is a leading cause of death with rates escalating from 1999 to 2016, and accounting for 45,000 deaths in 2016. There were 47,173 suicide related deaths and an estimated 1.4 million suicide attempts that cost the US \$69 billion in 2015 and 2017 [2, 3, 4]. Suicide attempt is “a nonfatal, self-directed, potentially injurious action with an intent to die. It may or may not result in injury” [3].

Data collected by Centers for Disease Control (CDC) through National Violent Death Reporting System in the year 2015 outlined many factors that might contribute to suicide with and without mental health conditions known to be associated with suicide. They include relationship problem, physical health problem, past or upcoming crisis, substance abuse, job/financial problem, criminal/legal problem and housing problem [5]. Strategies for identifying individuals at suicide risk include demographic identification, diagnostic identification, and treatment response

[6]. Researchers have implicated depression, post-traumatic stress disorder (PTSD), traumatic brain injury (TBI), concussion and other mental health problems as risk factors in suicide [7, 8, 9]. Depression and PTSD independently or in combination contributed towards increased risk of suicide [10]. Recent publication by Centers for Disease Control (CDC), however, concluded that more than half of people who died due to suicide did not have mental health diagnosis [11].

A large proportion of suicidal people have been found to have untreated or undiagnosed mental health problems, so it is uncertain if some of the individuals in CDC report belonged to the group with undiagnosed mental health conditions [12, 13]. Some researchers have opined that those who attempted suicide previously are more likely to attempt again [14], and that the single most important risk factor for suicide in the general population is a previous history of suicide attempt [1]. However, only 10.9% of previous attempters eventually completed suicide according to a report by Boggs et. al [15].

Previous studies with conflicting results have suggested an association between PTSD and/or TBI, and the risk or patterns of suicide attempt and self-inflicted injury (SASI) [16, 17, 18, 19]. Some of the previous studies focused on completed suicide while a number of them included relatively small samples spanning a shorter period of service. The goal of this study is to establish an association between deployment-related PTSD and/or TBI, psychiatric diagnoses, and attempted suicide among a large national cohort of Veterans deployed pre and post-9/11 2001 who received care from the Department of Veterans Affairs during the period of years 1998 – 2014.

Methods

Study design

A retrospective cohort study was conducted using national data obtained using the Veterans Administrations Informatics and Computing Infrastructure (VINCI) workspace. Specifically, data were extracted from Veterans Administrations Corporate Data Warehouse (CDW) and National Patient Care Database [20]. The study was approved by the Institutional

Review Board of and work was supported by resources from both Kansas City VA Medical Center and Midwest Biomedical Research Foundation.

Study setting and population

The Veterans Health Administration (VHA) provides care to Veterans at over 1,400 establishments across the United States organized in a system of 21 Veterans Integrated Service Networks (VISN). In the longitudinal and relational database, each Veteran has a unique identifier. The quality of data from these sources is well documented, and the data have been widely used by many investigators for retrospective studies. This analysis includes Veterans who received care through these VA establishments during the period of December 1998 to May 2014.

The three diagnosis groups identified were:

1. PTSD only cohort – having ICD-9 code for PTSD (309.81) without the ICD-9 codes for TBI.
2. TBI only cohort – having at least one of ICD-9 code(s) for TBI (850.0 to 859.9; v15.52) without the ICD-9 code for PTSD.
3. PTSD & TBI cohort – having ICD-9 code for PTSD and at least one of ICD-9 codes for TBI. This cohort excludes those in cohorts 1 and 2.

Key exposure and outcome measures

The main exposures for this study were the diagnosis of PTSD, diagnosis of TBI, or anyone having a combination of both diagnoses. Primary outcome was suicide attempt and self-inflicted injury (SASI) occurring after the diagnosis of PTSD and/or TBI. An individual was determined to have SASI if they carried at least one of ICD-9 codes E950-E959. As the focus of this study was suicide attempts occurring after PTSD/TBI, previous attempters were excluded leaving only a prior diagnosis of PTSD and/or TBI as the baseline criteria for inclusion into this study.

Data analysis

Patients' characteristics and the frequencies of SASI were described using absolute numbers, proportions and means. The incidence of SASI was determined for each of the diagnosis groups previously defined. Rates of SASI every year for each of the five years post diagnosis of

PTSD and/or TBI were determined and plotted in a bar chart.

Cox proportional hazard regression analysis was conducted to determine the adjusted risk of SASI with the diagnosis of PTSD/TBI as main effect. Covariates in the model included age, gender, marital status, homelessness (where 'PatientType' was reported as 'Homeless Veteran' and/or where 'BadAddressIndicator' was reported as 'Homeless'), ethnicity, service period (Pre-9/11 - those that entered and left service prior to September 1, 2001; Post-9/11 - those that first entered after September 1, 2001; Overlap-9/11 - those that entered prior to 2001 and left service after September 1, 2001; Re-entered - those that first entered and left service prior to September 1, 2001). Other covariates included in the model were depression, adult abuse and neglect, substance use disorder, generalized anxiety disorder, and antisocial personality disorder which were determined using their respective ICD 9 codes.

Kaplan-Meier curve was plotted to depict and compare the time to SASI among the diagnosis groups. Other results were presented in tables, figures and charts as appropriate. Analyses were done using SAS Enterprise Guide 7.1 supported on SAS 9.4. All hypotheses were 2-sided at 95% confidence interval.

Results

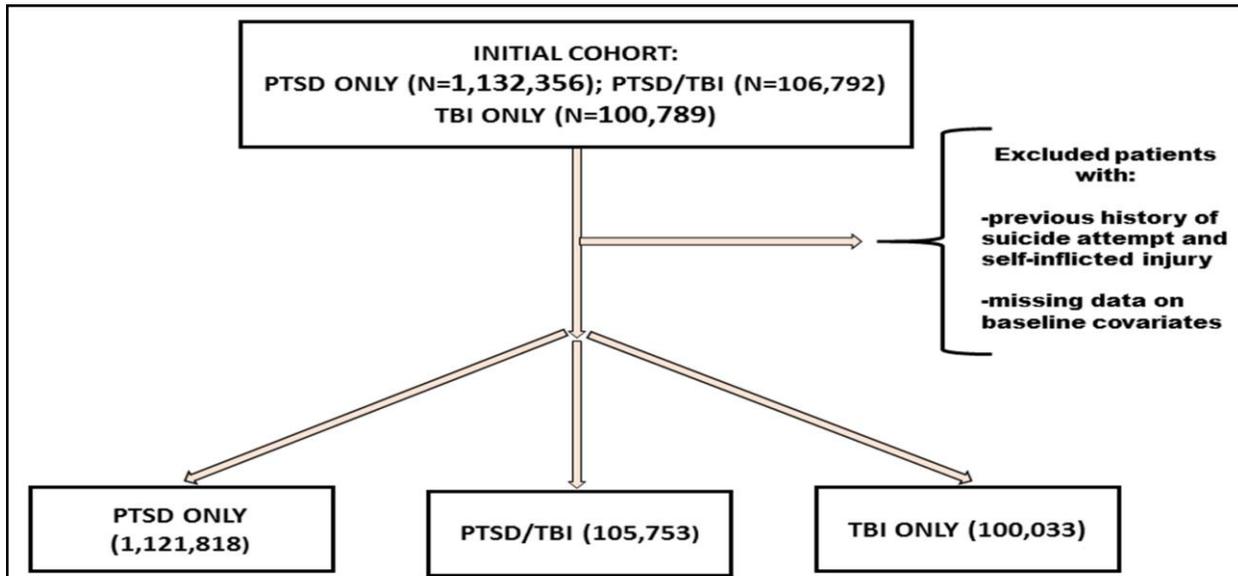
Cohort description

As shown in Figure 1, the initial cohort consisted 1,339,937 patients (PTSD only - 1,132,356; TBI only - 100,789; both PTSD and TBI - 106,792). Of these, individuals with (1) previous history of SASI before PTSD/TBI diagnosis (2) missing data on matching baseline variables, were excluded. Final cohort comprised of 1,327,604 patients (PTSD only - 1,121,818; TBI only - 100,033; both PTSD and TBI - 105,753).

Baseline Characteristics of the Patients

Table 1 presents the characteristics of patients in the study. The mean age of the entire cohort was 59.2 years (SD 16.2), and for PTSD only (60.1 years, SD 15.4), TBI only (63.7 years, SD 18.4) and both PTSD and TBI (46.0 years, SD

Figure 1.
Patients' selection for the study



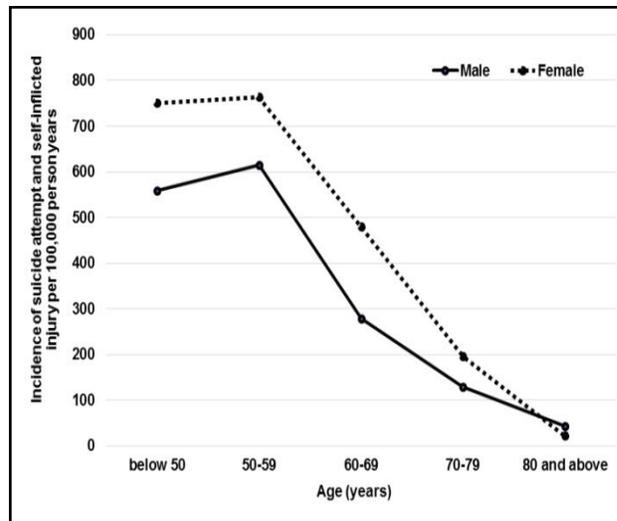
16.0). The larger proportion was older than 60 years while the rate of SASI was higher in the 50-60 years age category. In this predominantly male population (1,228,484; 92.5%), more males attempted suicide. However, a higher proportion of female patients attempted suicide in the combined groups (3.4% vs 1.8%, $P < .001$). In the diagnosis groups, the proportions of female versus male with SASI were: PTSD only (female vs. male: 1.7% vs 3.2%, $P < .001$), TBI only (1.24% vs 1.22%, $P = .90$), PTSD and TBI (4.5% vs 7.0%, $P < .001$). Many (50%) of the patients in this study were married. However, a significantly lower proportion of the married had SASI. Higher proportions of SASI were also found among the homeless, not Hispanic or Latino, those with both PTSD and TBI, the depressed, abused, reentered service group; and those with diagnosis of substance use disorder, generalized anxiety disorder and antisocial personality disorder.

Incidence and rates of suicide attempt and self-inflicted injury

The incidence of SASI in the entire cohort was 351 per 100,000 person years (py). In the PTSD/TBI diagnosis groups, incidences per 100,000 py were: PTSD only (323), TBI only (181), both PTSD and TBI (835). In the age-stratified analysis of incidence of SASI (Figure 3), for both male and female, the incidence increased

from below age 50, peaked at the 50-59 age category, and thereafter declined as age increased. The incidence was consistently higher in the female across all age categories, except among those aged 80 and above.

Figure 2.
Incidence of suicide attempts and self-inflicted injury by age and sex



As shown in Figure 2, in the immediate five years post-diagnosis of PTSD/TBI, there was sustained increase in the rate of SASI in each

Table 1.
Characteristics of patients in the study

	Overall N (%) N=1327604	Having at least one episode of suicidal attempt N (% in category) (% of total population)
Age		
<50	352323 (26.5)	8704 (2.5) (0.7)
50 - 60	433400 (32.7)	12716 (2.9) (1.0)
>60	541580 (40.8)	4515 (0.8) (0.3)
Gender		
Male	1228484 (92.5)	22622 (1.8) (1.7)
Female	99100 (7.5)	3315 (3.4) (0.3)
Marital status		
Single	184230 (14.2)	5129 (2.8) (0.4)
Married	671615 (51.8)	7546 (1.1) (0.6)
Divorced	327159 (25.2)	10001 (3.1) (0.8)
Separated	54907 (4.2)	1937 (3.5) (0.2)
Widowed	59696 (4.6)	942 (1.6) (0.1)
Homelessness		
Yes	841 (0.1)	75 (8.9) (0.01)
No	1326763 (99.9)	25862 (2.0) (2.0)
Ethnicity		
Hispanic or Latino	89275 (7.4)	1540 (1.7) (0.1)
Not Hispanic or Latino Vs Hispanic	1125976 (92.7)	23347 (2.1) (1.9)
Service period		
Pre-9/11	1020297 (76.9)	20086 (2.0) (1.5)
Overlap-9/11	203005 (15.3)	3970 (1.7) (0.3)
Post-9/11	89310 (6.7)	1553 (2.0) (0.1)
Re-entered	14992 (1.1)	328 (2.2) (0.02)
PTSD/TBI diagnosis		
PTSD only	1121818 (84.5)	19808 (1.8) (1.5)
PTSD and TBI	105753 (8.0)	4894 (4.6) (0.4)
TBI only	100033 (7.5)	1235 (1.2) (0.1)
Depression		
Yes	452989 (34.1)	13867 (3.1) (1.0)
No	874615 (65.9)	12070 (1.4) (0.9)
Adult abuse and neglect		
Yes	23553 (1.8)	1571 (6.7) (0.1)
No	1304051 (98.2)	24366 (1.9) (1.8)
Substance use disorder		
Yes	763492 (57.5)	23381 (3.1) (1.8)
No	564112 (42.5)	2556 (0.5) (0.2)
Generalized anxiety disorder		
Yes	159972 (12.0)	5844 (3.7) (0.4)
No	1167632 (88.0)	20093 (1.7) (1.5)
Antisocial personality disorder		
Yes	24510 (1.9)	3904 (15.9) (0.3)
No	1303094 (98.1)	22033 (1.7) (1.7)

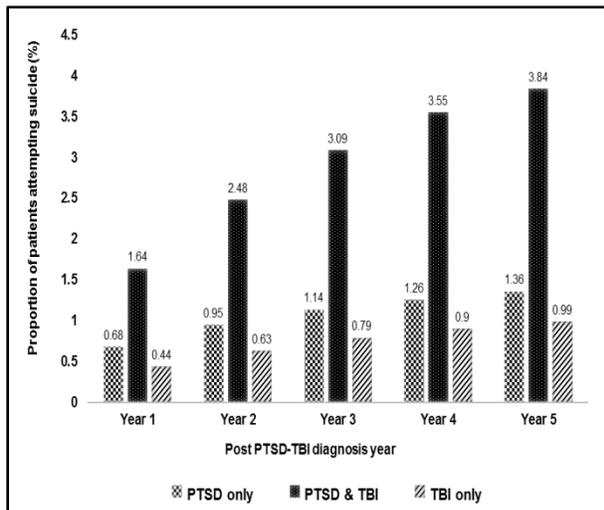
Chi square P-value for each covariate <0.001

diagnosis group. Further, there was consistently higher proportion of individuals with SASI every year for the first five post-diagnosis years in both PTSD and TBI group compared to the other two groups. TBI only group has the lowest proportion of individuals attempting suicide in each and all the immediate five post-diagnosis years.

Risk of suicide attempt and self-inflicted injury among PTSD/TBI patients

As presented in Table 2, when compared to TBI only group, the adjusted risk for SASI was higher in the PTSD only group (HR=1.129; 95% CI =1.063 - 1.200) and much higher in those with both PTSD and TBI (HR=2.283; 95% CI =2.136 - 2.441). Similar pattern is observed in the Kaplan Meier curve (Figure 4) which showed that SASI free survival probability was higher in the TBI only group as compared to the other diagnosis groups (Log rank *p* <.001). Older patients (>60 years), were least likely to attempt suicide compared to other age categories. The risk was particularly higher among those younger than 50 years (HR=2.993; 95% CI =2.850 - 3.143).

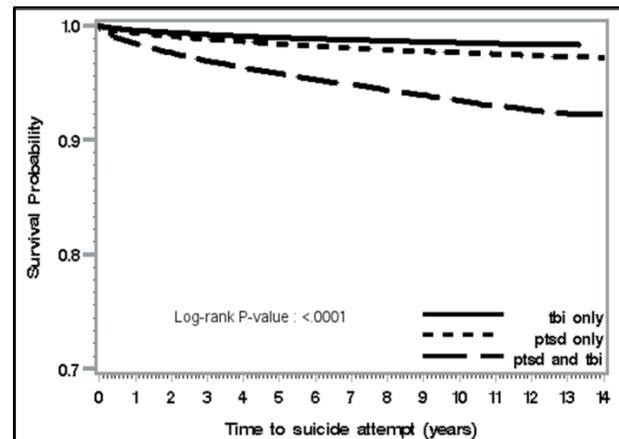
Figure 3.
Proportion of patients attempting suicide in the first 5 years post PTSD/TBI diagnosis



Other attributes found to correlate positively with the risk of SASI were depression (HR=1.775; 95% CI =1.727 - 1.825), being female (HR=1.294; 95% CI 1.239 - 1.351); homelessness

(HR=1.576; 95% CI =1.235 - 2.012), not Hispanic/Latino ethnicity (HR=1.103; 95% CI =1.045 - 1.165), adult abuse and neglect (HR=1.871; 95% CI =1.765 - 1.984), substance use disorder (HR=4.294; 95% CI =4.100 - 4.498), generalized anxiety disorder (HR=1.480; 95% CI =1.434 - 1.527), and antisocial personality disorder (HR=4.315; 95% CI =4.157 - 4.479).

Figure 4.
Kaplan Meier curve comparing the time to suicide attempt by PTSD/TBI diagnosis groups.



Being married was protective against SASI compared to single patients (HR=0.690; 95% CI =0.664-0.717). However, compared to the singles, the risk of SASI was higher among the divorced (HR=1.131; 95% CI =1.091 - 1.173), and separated (HR=1.219; 95% CI =1.153 - 1.288). Those that entered and left service before September 1, 2001 (Pre-9/11 group) were more likely than others to attempt suicide.

Discussion

In this cohort, the incidence and risk of SASI is highest among those with both PTSD and TBI. The risk of SASI was higher if they were younger than 50 years, divorced or separated, non-Hispanic females, homeless, suffered adult abuse and neglect, had substance use, generalized anxiety and antisocial personality disorders, and if they were in the Pre-9/11 service period. Every passing year post-diagnosis of PTSD and/or TBI, the proportion of people attempting suicide increased, more so among those with dual diagnosis of PTSD and TBI. Before answering the

Table 2.
Risk of suicide attempt and self-inflicted injury

	Hazard Ratio	95% CI	p-value
PTSD/TBI diagnosis (ref: TBI only)			
PTSD only	1.129	1.063 - 1.200	< 0.001
PTSD and TBI	2.283	2.136 - 2.441	< 0.001
Age (ref: >60 yrs.)			
<50	2.993	2.850 - 3.143	< 0.001
50 - 60	2.117	2.037 - 2.200	< 0.001
Depression (Yes vs No)	1.775	1.727 - 1.825	< 0.001
Female vs. Male	1.294	1.239 - 1.351	< 0.001
Service period (ref: Pre-9/11)			
Overlap-9/11	0.749	0.704 - 0.798	< 0.001
Post-9/11	0.831	0.792 - 0.873	< 0.001
Re-entered	0.874	0.776 - 0.984	0.026
Marital status (ref: single)			
Divorced	1.131	1.091 - 1.173	< 0.001
Married	0.690	0.664 - 0.717	< 0.001
Separated	1.219	1.153 - 1.288	< 0.001
Widowed	1.051	0.975 - 1.133	0.195
Homelessness	1.576	1.235 - 2.012	< 0.001
Not Hispanic or Latino vs Hispanic	1.103	1.045 - 1.165	< 0.001
Adult abuse and neglect (Yes vs No)	1.871	1.765 - 1.984	< 0.001
Substance use disorder (Yes vs No)	4.294	4.100 - 4.498	< 0.001
Generalized anxiety disorder (Yes vs No)	1.480	1.434 - 1.527	< 0.001
Antisocial personality disorder (Yes vs No)	4.315	4.157 - 4.479	< 0.001

question whether suicide can be prevented, behavioral scientists must first address the complexity of identifying individuals with risk for suicide.

A recently released VA Office of Public and Intergovernmental Affairs veteran suicide statistics report of 2017 outlined that age and sex adjusted risk for suicide was 22% higher among Veterans as compared to US non-Veteran male and that after adjusting for differences in age, risk for suicide was 2.5 times higher among female Veterans as compared to US non-Veteran women [21]. The rates of SASI in this PTSD/TBI cohort are exceedingly higher than those reported in other national studies involving the emergency department visits [22, 23]. The rates in this study are comparable to rates among enlisted active-duty regular Army soldiers from January 1, 2004, through December 31, 2009 (377 per 1000,000 py), but the rates among active-duty regular army

officers were lower (27.9 per 1000,000 py) [24]. The incidence of SASI observed in this and other studies do not necessarily translate to the incidence of completed suicide. This is because it has been estimated that there were 25 attempts for every suicide death in the US general population [25].

Results of many previous studies suggest that though a higher proportion of females attempt suicide, more males complete and die of suicide [22, 26]. Recent study published in 2017 suggested that though females attempted 3 times more than males, for each female death by suicide an estimated 3.5 male died because of suicide [25]. In addition, the odds of suicide attempts were significantly higher among women reporting sexual assault [27]. Younger and non-Hispanic people were most at risk for suicide attempts in most studies, including ours. In both sexes, the rates peaked in the 50-60-year old's and then

declined with age. This is a major challenge to the VHA resources as one-thirds of people in this cohort were in the age category and ethnicity group, and the same is true for many Veterans in VHA care [28, 29]. Some have hypothesized gender differences in the risk factors for suicide attempt, while others found that suicide attempters are younger than completers. Whether these are true across board or in certain populations warrant further research [30, 31].

It is important to mention that marital statuses do change over time, especially in this study population. With such a long follow up time, it is possible that their marital statuses could have changed at one time or the other. However, marital statuses used in this study were those obtained in the records at the time data were accessed. Being married is generally protective against suicidality, though some say that completers tend to be married or separated/divorced compared to attempters; others say that multiple attempters tend to be married compared to first attempters [31, 32, 33]. These distinctions were not included in our study.

The proportion of homelessness captured in the data accessed for this study appears unexpectedly small, and may be an underestimate, considering results from others [34]. A systematic review did not find a strongly positive association between PTSD and homelessness among Veterans, which may explain the low proportion of homelessness in this predominantly PTSD population [35]. Homeless Veterans were more likely to attempt suicide. The rate of suicide attempt among homeless Veterans was 7.8 times higher than non-homeless Veterans. The rate was higher among veterans as compared to US non-Veterans [36]. It is possible that other factors might be contributing to suicide rates among Veterans. Other contributing factors that have been positively correlated with an increase in incidence of SASI include adult abuse and neglect, substance use disorder, generalized anxiety disorder, and antisocial personality disorder [15, 37, 38, 39, 40].

A randomized controlled trial among a highly suicidal self-harming adolescents group upheld dialectical behavior therapy for reducing self-harm and suicide attempts. It nevertheless admitted that the benefit seemed to weaken over time [41]. Perhaps a more definitive claim to

reduction in suicide attempts was the youth suicide prevention program among the White Mountain Apache of Arizona where a general downward trend in suicide attempts was observed in both male and female between 2001 and 2014 [42]. The cost of care for PTSD/TBI at the VA is very high [43]. High incidence of SASI observed in this group seems to provide more justification for the expenses. However, soaring costs also raise questions about the effectiveness of current therapies. Attempters should be provided increased access to mental health treatments [44]. Modifiable factors that are positively associated with increased risk of SASI are opportunities for intervention.

This retrospective study relies on data collected at different times by different providers in various locations throughout the VHA healthcare system. Although criteria (e.g. ICD-9 codes) used to ascertain diagnosis and other exposure/outcome measures in this study are standardized, it is possible that data could be missing, incomplete, or deviate in interpretation across providers. Large databases with real time entry of data, provide data not previously available. While sampling error, sampling bias, and duplication can be avoided with data extracted through VINCI, issues of veracity particularly when using dynamic data must be addressed. Questions as to how to address missing data is a key example of a confounding or hidden bias that may or may not be present. Thus, while unmeasured, confounding, or hidden biases might be present, nevertheless, key factors relevant to policy making and clinical practice were included in this study.

Suicidal behaviors have far-reaching effects on family members, friends, and the community [3]. Suicide attempters provide helpful data and should not be overlooked given they share an intent to die with those who are completers [45]. Identifying the changing characteristics of those in a high-risk group for suicide requires continued research [46]. The goal of this longitudinal study of a nationally representative sample of US Veterans diagnosed with PTSD and/or TBI is to shed light on the risk and patterns of SASI. The independent and relative associations between SASI and other clinical or demographic variables in this study population are explored, as a step towards

formulating a predictive model for suicide attempters [47].

The relatively high incidence of suicide attempt and self-inflicted injury found in this PTSD/TBI cohort suggests a high rate of completed suicide in this population. Every policy or clinical resource that would mitigate this high incidence should be implemented without further delay. In these days of limited resources, risk identification would help to prioritize interventions. Not only has this study shown an increasingly high incidence of suicide attempt with every additional mental health diagnosis, important risk factors that are amenable to intervention have been identified. Findings provide opportunity for stakeholders in healthcare to provide targeted care.

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Disclosures

The contents of this article are those of authors and do not necessarily reflect the position and policy of the Department of Veterans Affairs.

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