Title

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Association of PTSD Severity and Death by Suicide

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Abstract

Background: There is mixed evidence regarding the direction of a potential association between posttraumatic stress disorder (PTSD) and suicide mortality.

Aims: This is the first population-based study to account for both PTSD diagnosis and PTSD symptom severity simultaneously in the examination of suicide mortality.

Method: Retrospective study that included all US Department of Veterans Affairs (VA) patients with a PTSD diagnosis and at least one symptom severity assessment using the PTSD Checklist (PCL) between October 1, 1999, and December 31, 2018 (n = 754,197). We performed multivariable proportional hazards regression models using exposure groups defined by level of PTSD symptom severity to estimate suicide mortality rates. For patients with multiple PCL scores, we performed additional models using exposure groups defined by level of change in PTSD symptom severity. We assessed suicide mortality using the VA/Department of Defense Mortality Data Repository.

Results: Any level of PTSD symptoms above the minimal threshold for symptomatic remission (i.e., PCL >18) was associated with double the suicide mortality rate at one month after assessment. This relationship decreased over time but patients with moderate to high symptoms continued to have elevated suicide rates. Worsening PTSD symptoms were associated with a 25% higher long-term suicide mortality rate. Among patients with improved PTSD symptoms, those

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with symptomatic remission had a substantial and sustained reduction in the suicide rate compared to those without symptomatic remission (HR=0.56; 95% CI 0.37, 0.88).

Conclusions: Ameliorating PTSD can reduce risk of suicide mortality, but patients must achieve symptomatic remission to attain this benefit.

INTRODUCTION

Posttraumatic stress disorder (PTSD) is a chronic and debilitating condition associated with significant morbidity and mortality, as well as disruptions in family, workplace, and social contexts (1). Extensive research has documented negative sequelae of PTSD including other forms of psychopathology, poor physical health, poor health-related quality of life, and mortality (2). PTSD is particularly salient among United States (US) Veterans—the estimated lifetime prevalence is 11% to 12% (3). In addition to high rates of PTSD, veterans have increasingly high rates of suicide (4). Concern about increasing suicide rates among veterans has led to a proliferation of research on potential risk factors for suicide mortality.

While there is long-standing literature on the connection between PTSD and suicidal ideation and behaviors (5), less is known about the relationship between PTSD and suicide mortality. VA patients with current or past diagnosis of PTSD have been found to have an unadjusted rate of 50.7 deaths by suicide per 100,000 person years of risk (6), compared to a rate of 13.2 in the general adult population (7). However, meta-analyses have not demonstrated that PTSD is definitively associated with suicide mortality (5, 8). Furthermore, there is conflicting evidence regarding the direction of a potential association between PTSD and suicide mortality depending on the population and covariates used in analysis (9).

In veteran studies, analyses without adjustment for psychiatric comorbidities, such as depression or substance abuse, have reported positive associations between PTSD and suicide mortality (10–12), while analyses with adjustment for comorbidities have observed negative associations (12–14). Conversely in civilian samples, there is a strong association between PTSD and suicide mortality even after adjustment for psychiatric comorbidities (2). One explanation for the difference in adjusted findings between veteran and civilian studies may be that drivers of suicide risk are unique among veterans. Veteran-specific studies may help to clarify whether suicide mortality is elevated in the veteran population because of high risk comorbidities (9), or whether PTSD is itself an independent risk factor. Connor et al. surveyed diagnostic codes among VA patients and found that a clinical diagnosis of PTSD was associated with a lower risk of suicide mortality after accounting for psychiatric comorbidities (12). However, this study relied solely on PTSD diagnoses reported in the medical records. Using this methodology, PTSD was considered a dichotomous variable that existed at a specific cross-section in time rather than a continuum of severity or a condition that fluctuates over time. Therefore, it may be more informative to evaluate suicide mortality risk using self-reported PTSD symptoms.

Few studies have explored the association between PTSD symptom severity and suicide mortality. Cooper et al. examined the association between veteran-reported PTSD symptoms and suicide risk using the Primary Care-PTSD Screen (PC-PTSD; 15). Positive PC-PTSD results were associated with an increased suicide mortality risk, but the risk decreased over

time. This study did not assess depression or other comorbidities at the time of screening, which may have inflated the suicide mortality risk. Although this study used a self-reported symptomatic assessment in a large population, further limitations include lack of PTSD diagnostic confirmation, a small number of assessment items that are scored dichotomously rather than continuously (e.g. 5 dichotomous items on the PC-PTSD-5 screen (16) versus 20 continuous items on the PTSD Checklist-5 questionnaire (17)), and a narrow range of total assessment scores (e.g. 0–5 on PC-PTSD-5 screen (16) versus 0–80 on PTSD Checklist-5 questionnaire (17)). Because the PC-PTSD was designed to identify respondents with probable PTSD, those screening positive require a more comprehensive assessment, preferably with the psychometrically sound PTSD Checklist (PCL; 16).

Lee et al. compared both categorical (i.e., diagnostic status) and dimensional (i.e., symptom severity) approaches to measuring PTSD in predicting future suicide attempts among Post 9/11 Veterans (18). Veterans whose PTSD symptoms satisfied the diagnostic criteria had a higher risk of future suicide attempts, but the risk was even higher for veterans with symptom levels above the diagnostic threshold (18). This study underscores the importance of using diagnostic codes in conjunction with PTSD symptom severity assessments as potential indicators of suicide risk. However, this study did not use suicide mortality as a primary outcome and the sample size (n=1,649) was too small to accurately evaluate suicide risk.

No study has examined the association between PTSD symptom severity and suicide mortality rate in a population-based cohort using both diagnostic codes and PTSD symptoms documented in the PCL. We have developed a complete cohort of all VA patients diagnosed with PTSD over a nearly 20-year period with at least one PCL assessment. In doing this, we have created the largest available patient-level database on PTSD symptom severity. The goal of the current study is to evaluate whether: 1) PTSD symptom severity is associated with the suicide mortality rate among patients with a PTSD diagnosis, and 2) whether changes in PTSD symptom severity are associated with changes in the suicide mortality rate.

METHODS

Sample and Data Sources

We conducted a retrospective cohort study that included all VA patients with a clinical diagnosis of PTSD (International Classification of Diseases [ICD]-9: 309.81, ICD-10: F43.1x) plus at least one PCL score between the start of fiscal year 2000 (FY00; October 1, 1999) and the end of calendar year 2018 (December 31, 2018) in the VA corporate data warehouse (CDW) (n = 754,197). Patients entered the cohort in the year of their first VA use and remained in the cohort until death or December 31, 2018, whichever came first (minimum of 1 year and maximum of 20 years). We assessed suicide mortality using the VA/Department of Defense Mortality Data Repository (19). The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008. All procedures involving human subjects/patients were approved by the Veteran's Institutional Review Board of Northern New England (USA). A waiver of consent and authorization was granted for the study.

PTSD Symptom Data

We integrated two different versions of the PCL, captured from up to two data sources within the CDW. The two data sources included scores obtained from structured data produced by psychometric assessment software in the VA medical record and scores documented by clinicians in treatment notes. We used a previously published natural language processing (NLP) algorithm with 98% precision in identifying the correct score and version of the PCL to abstract scores from clinical notes (20). Scores abstracted from structured data and from NLP of clinical notes were integrated into a single dataset, which has been described in detail elsewhere (21). The two versions of the PCL included those aligned to the Diagnostic and Statistical Manual of Mental Disorders (DSM), Version IV and Version 5, which we will heretofore call the PCL-IV and the PCL-5 (17, 22). Validation work shows a correlation of 0.87 between PCL versions in a large sample of veterans (17). We used a validated crosswalk (ICC = 0.96) to convert all values to PCL-5 scoring (23).

The PCL-5 has a range of 0–80 and scores of 31–33 are considered diagnostic for PTSD (17). While a threshold for remission has not been established, the largest prospective treatment study using this version of the PCL allowed early termination due to symptomatic remission for scores of 18 or lower (24). The mean baseline score for VA patients starting PTSD treatment in this PCL dataset is approximately 50 (25). Based on these thresholds, we created exposure groups using four PCL score ranges including minimal (0–18), low (19–30), moderate (31–49), and high (50 or greater).

A clinically meaningful change in PCL score is approximately 15 points (26). Because this change criterion was calculated using the Jacobson and Truax Reliable Change Index (1.96 times the standard error of the difference in change, which is the “distribution of change scores that would be expected if no actual change had occurred”; 27), we used a corollary that changes of 7 points or less could be due to measurement error. Based on these thresholds, we created exposure groups using three PCL score ranges each delineating a change in PTSD symptom severity including worse (increase of 15 points or more), no change (change within 7 points), and improved (decrease of 15 points or more). For patients with more than two PCL scores, we defined the change category based on the last two consecutive PCL scores that were documented between eight weeks and one year apart, prioritizing the shorter period. Additionally, we performed subgroup analysis based on whether patients who improved achieved symptomatic remission, which we defined as a follow-up PCL score of 18 or lower.

Covariates

We measured patient characteristics at the time of their last PCL score, including age, sex, race, marital status, service-connected disability, and burden of mental and physical illness. In addition to PTSD diagnosis, we summarized physical and mental diagnoses in the prior two calendar years (Appendix) using counts of diagnostic categories developed in prior research using VA EMR data (28). Specifically, we used International Classification of Disease codes in patient medical records to create a modified Elixhauser Comorbidity Index for physical health (29), which was orthogonal to a mental health index based on the Diagnostic and Statistical Manual of Mental Disorders Fifth Edition diagnostic groups

(1). Patients were categorized as having a low, medium, or high burden of physical or mental illness if they had diagnoses from 0, 1–2, or 3+ relevant groups. We also specifically assessed whether patients had comorbid depressive or substance use disorder diagnoses.

Study Outcomes

We measured suicide mortality from 1 day after the last PCL administration date through December 31, 2018 using International Statistical Classification of Diseases and Related Health Problems, Tenth Revision codes U03, X60 to X84, Y87.0.

Statistical Analysis

For descriptive analyses, we calculated frequencies, both overall and by suicide mortality status, for all variables among patients in the cohort with at least one PCL score. We calculated suicide rates per 100,000 person-years at the patient level by multiplying the number of observed suicides by 100,000, then dividing that value by the number of person-years at risk from the day after each patient's last PCL until death or December 31, 2018, whichever occurred first.

For proportional hazards regression analyses examining the effect of PTSD symptom category or change in PTSD symptom category on suicide mortality rate, we used each patient's last PCL score or change in PCL score as the unit of analysis. The patient's time at risk began the day after the last PCL was administered and ended at death or on December 31, 2018, whichever occurred first. We used partially conditional proportional hazards regression models; by treating each PCL as the unit of analysis, the models were conditioned on the baseline covariates (age, sex, race, marital status, service-connected disability, and mental and physical health diagnoses) but not on the time varying covariates (PCL responses). We conducted a set of stratified analyses for patients with and without comorbid depressive or substance use disorders for the PTSD symptom severity analysis but not the change in severity analyses due to limitations in sample size.

Covariates were included in the models to adjust for potential confounding variables in the association between PCL responses and suicide mortality. We adjusted for covariates using a stepped process to better understand the associations between the covariates, the exposure groups, and the outcome. Data collection and analyses were conducted from May 1, 2021, to September 9, 2021. Data analyses were performed using SAS software, version 9.4 and the SAS Enterprise Guide, version 7.1 (SAS Institute Inc).

RESULTS

Across our 20-year period of examination, 754,197 VA patients with a PTSD diagnosis had at least one PCL score (Table 1). The distribution of patients by number of PCL scores is as follows: 347,111 patients had only one PCL score; 407,145 patients had two or more PCL scores (249,687 of these patients had at least two *usable* PCL scores); 267,244 patients had three or more PCL scores. For patients with two or more PCL scores, we defined usable pre-post score pairs as those documented at least 8 weeks apart and we disregarded pairs documented under 8 weeks apart. Among patients with at least one PCL score, 62.1% were White, 52.4% were married, 87.3% were male, 36.2% were 35–54 years old, and 46.4%

served in post 9/11 conflicts. Patients were followed for a median of 3.1 years (interquartile range 4.5 years) after the last PCL assessment.

Among patients with at least one PCL score, a total of 2,097 (0.3%) died by suicide within the follow-up period. The unadjusted suicide mortality rate was 77.6 deaths per 100,000 person-years. The unadjusted suicide mortality rate was highest in patients with high PTSD symptoms (PCL ≥ 50). Patients with high PTSD symptoms were more commonly male, 35–54 years old, married, White, Post-9/11 Veterans, and had greater numbers of mental health comorbidities, especially depression. The unadjusted suicide mortality rate was lowest in patients with minimal PTSD symptoms (PCL ≤ 18). Patients with minimal PTSD symptoms were more common in the 55–74 age group and had fewer mental health comorbidities.

In proportional hazards models for suicide mortality by PTSD symptom severity (Table 2), any level of PTSD symptoms (low, medium, or high) compared to minimal levels of PTSD symptoms were associated with over double the suicide mortality rate at one month after assessment. As symptom category increased from low to high, there was a pattern of increasing rates compared to the minimal symptom group, but the confidence intervals overlapped. Covariate adjustment did not change these general patterns of associations at one month. In models including all available follow-up time, the strength of the association between PTSD symptoms and suicide rate was diminished but still indicated a pattern of 20–40% increased long-term rate for moderate or high symptoms compared to those with minimal symptoms across models. In stratified analyses, patients with comorbid depression or substance abuse who had any PTSD symptoms at one month had a two-to-three-fold elevated rate of suicide at one month compared to those with minimal PTSD symptoms, but the relationship was attenuated in models including all available follow-up time (Table 3). However, among patients without comorbid depression or substance abuse, the relationships persisted: patients with moderate PTSD symptoms (HR=1.74, 95% CI: 1.21, 2.51) and high PTSD symptoms (HR=2.01, 95% CI: 1.39, 2.89) had a meaningfully higher long-term suicide rate compared to those with minimal PTSD symptoms.

Among patients with repeated PCL measurements (n=190,822), those with worsening PTSD symptoms compared to patients with no change in PTSD symptoms had an approximately 25% higher suicide rate in models including all available follow-up time (Table 4), although there was no association in models truncated at one month. There did not appear to be a corresponding decrease in long-term suicide rate when PTSD symptoms improved. However, when we added a requirement for symptomatic remission, the rate reduction became apparent (Table 5): among patients with improvements in PTSD symptoms, those whose final PCL score was 18 or lower had a substantially diminished rate of suicide in the model including all available risk time compared to those with a final PCL score of greater than 18 (HR=0.56; 95% CI: 0.37, 0.88).

DISCUSSION

This study was the first to examine suicide mortality rates among a national sample of veterans with PTSD using both diagnostic codes and symptom severity. Compared to negligible PTSD symptoms, having PTSD symptoms increases the rate of suicide mortality,

even after adjusting for mental and physical health comorbidities. We observed a modest gradient effect whereby higher levels of PTSD symptoms increase the long-term rate. Although comorbid depression or substance abuse increase the suicide mortality rate in veterans with PTSD, veterans without these comorbidities and moderate to severe PTSD symptoms continue to have high suicide rates. PTSD symptom severity alone may be an independent risk factor for suicide mortality. Compared to not having a clinically meaningful change in PTSD symptoms, worsening PTSD symptoms increase the suicide rate. Although improved PTSD symptoms alone cannot predict suicide rates, improving to the point of symptomatic remission does seem to lower the suicide rate. These findings have critical implications in treatment planning and clinical assessment for patients with PTSD: we must do more to treat patients to remission and develop better treatments for those whose symptoms do not remit with available treatments. For practitioners who work directly with veterans with PTSD, associating higher PTSD symptom severity with higher suicide risk may help guide clinical decisions and identify priorities for prevention.

The finding that veterans with PTSD are at elevated risk for suicide mortality is consistent with several studies (6). However, the unadjusted suicide rate was higher at 77.6 deaths per 100,000 person years of risk compared to the unadjusted 50.7 deaths per 10,000 person years of risk previously reported (6). Compared to studies that analyzed PTSD symptom severity, the results of this study align with both Cooper et al. who found that positive PC-PTSD screening results were associated with an increased suicide mortality risk (15), and Lee et al. who found that the risk of suicide attempts was higher for veterans with PTSD symptom levels above the diagnostic threshold (18).

Unlike Connor et al. who found that PTSD was associated with a lower suicide mortality risk after accounting for psychiatric comorbidities (12), this study found that PTSD may serve as an independent risk factor for suicide mortality. Connor et al. found that depression had the largest influence on the association between PTSD and suicide. However, without longitudinal measurements of psychiatric comorbidities, it is difficult to establish the temporal ordering of variables and avoid collider bias. Collider bias occurs through inappropriate adjustment for a psychiatric comorbidity, such as adjustment for variables that are affected by PTSD and share common causes with suicide. Adjustment for depression may have introduced collider bias in the association between PTSD and suicide, thus potentially biasing the strength and direction of the association.

Limitations

This study has several limitations, primarily related to sample selection. First, the approach did not account for potentially relevant confounders including patient-level treatment characteristics. Additional multiyear longitudinal cohorts are required to assess whether implementation of evidence-based treatment for PTSD or other mental health conditions influenced suicide mortality outcomes for VA patients with PTSD.

Second, our cohort only included veterans with a PTSD diagnosis. We did not compare veterans with PTSD to veterans with just depression or substance abuse. Although comorbidities were assessed in the two years prior to the last PCL score, it may be difficult to establish a temporal relationship between PTSD and depression or substance abuse.

Depression or substance abuse may act as a mediator between PTSD and suicide mortality, and adjustment for these variables may diminish the impact of PTSD symptom severity alone.

Finally, the study population was limited to VA patients. The veteran population has demonstrated characteristics that make it unique from other PTSD populations (30). Notably, veterans are predominantly older and male (30). Veterans who access the VA healthcare system are more likely to have poorer health, lower SES, and more medical conditions than the general population (30). Therefore, these findings may not be generalizable to civilians with PTSD. It will be important that other studies replicate these results in non-veteran populations and adjust for relevant confounders.

Conclusions

To our knowledge, this is the first population-based study to examine the association between PTSD symptom severity and suicide mortality risk in a large cohort of VA patients using both diagnostic codes and PCL scores. PTSD symptoms were associated with an increase in the rate of suicide mortality independent of comorbid depression and substance abuse. Worsening PTSD symptoms increased the rate of suicide, while lowering PTSD to the point of symptomatic remission lowered the suicide rate.

Funding Statement:

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Data Availability:

The VA Corporate Data Warehouse (CDW) contains electronic medical record data compiled from individual VA facilities and is described at http://www.hsrd.research.va.gov/for_researchers/vinci/cdw.cfm. Researchers with VA network access can obtain descriptions of CDW data at http://vaww.virec.research.va.gov/.

Appendix: Diagnostic Codes used for Mental and Physical Health Comorbidity Indexes

Mental Health Index: Modified DSM-5	
Neurodevelopmental Disorders	
ICD-10	F70, F71, F72, F73, F78, F79, F80, F81, F82, F84, F88, F89, F90, F930, F939, F949, F95, F984, F988, F989
ICD-9	299, 3072, 3073, 31381, 31382, 3139, 3139, 3140, 3141, 3148, 3149, 3150, 3151, 3152, 31531, 31532, 31535, 31539, 3154, 3155, 3158, 3159, 317, 318, 319, 78461
Psychotic Disorders	
ICD-10	F060, F061, F062, F20 F21, F22, F23, F24, F25, F28, F29, F531
ICD-9	2908, 2909, 29381, 29382, 29389, 295, 297, 298, 7801, V110
Bipolar Disorders	
ICD-10	F0633, F0634, F30, F31, F340

ICD-9	2960, 2961, 2964, 2965, 2966, 2967, 29680, 29681, 29689, 30113
Depressive Disorders	
ICD-10	F0630, F0631, F0632, F32, F33, F341, F348, F3481, F3489, F349, F39, F530, O906, R452, R453, R4581, R4583, R4584, R4589
ICD-9	29383, 2962, 2963, 29682, 2969, V111, 3004, 311, 6254, V6282
Anxiety Disorders	
ICD-10	F064, F40, F41, F930, F940, R450, R451, R4582
ICD-9	29384, 3000, 3002, 30921, 3130, 31321, 31322, 31323, V112
Obsessive Compulsive Disorders	
ICD-10	F42, F4522, F633, L981, R4681
ICD-9	3003, 31239, 6984
Trauma and Stress Related Disorders	
ICD-10	F430, F4310, F4311, F4312, F4320, F4321, F4322, F4323, F4324, F4325, F4329, F438, F439, F941, F942, R454, R457, Z8651,
ICD-9	308, 309, 31389, V114
Dissociative Disorders	
ICD-10	F440, F441, F442, F4481, F4489, F449, F481
ICD-9	30012, 30013, 30014, 30015, 3006
Somatic Disorders	
ICD-10	F444, F445, F446, F447, F450, F451, F4520, F4521, F4529, F458, F459, F481, F488, F489, F54, F59, F681
ICD-9	30010, 30011, 30016, 30019, 3008, 306, 30754, 30780, 3007, 30789,
Eating Disorders	
ICD-10	F50, F982, F983
ICD-9	3071, 30750, 30751, 30752, 30753, 30759,
Elimination Disorders	
ICD-10	F980, F981, N39498, R159, R32
ICD-9	3076, 3077, 78830, 78839, 78760
Sleeping Disorders	
ICD-10	F51, G2581, G470, G471, G472, G473, G474, G475, G4763, G4769, G478, G479, R063
ICD-9	3074, 327, 33394, 347, 7805, 78604, V694, V695
Sexual Disorders	
ICD-10	F52
ICD-9	3027
Gender-Related Disorders	
ICD-10	F640, F641, F642, F648, F649
ICD-9	3020, 3025, 3026, 30285
Conduct Disorders	
ICD-10	F631, F632, F638, F639, F91, R4587
ICD-9	3013, 3017, 3120, 3121, 3122, 31230, 31232, 31233, 31234, 31235, 31239, 3124, 3128, 3129, 31381
Substance Disorders	
ICD-10	F10, O9931, F11, F12, F13, F14, F15, F16, F18, F19, F550, F551, F552, F553, G312, F554, F558, F630, Z726, O9932

ICD-9	291, 2921, 2922, 29281, 29284, 29285, 29289, 2929, 303, 304, 3050, 3052, 3053, 3054, 3055, 3056, 3057, 3058, 3059, 31231, 980, V113, V693, 6483, V6542
Dementias	
ICD-10	A8100, A8101, A8109, A812, A8182, A8189, A819, F0150, F0151, F0280, F0281, F0390, F0391, G231, G300, G301, G308, G309, G3101, G3109, G3183, G903
ICD-9	04611, 04619, 0463, 04671, 04679, 0469 2900, 29010, 29011, 29012, 29013, 29020 29021, 2903, 29040, 29041, 29042, 29043, 29282, 2941, 29410, 29411, 29420, 29421, 3310, 33111, 33119, 33182
Traumatic Brain Injuries	
ICD-10	S020, S021, S060, S061, S062, S0630, S0631, S0632, S0633, S071, S09
ICD-9	800, 801, 803, 804, 850, 851 852, 853, 8540, 8541, 95901
Personality Disorders	
ICD-10	F070, F0789, F079, F21, F60, F688, F69
ICD-9	3010, 30110, 30111, 30112, 30120, 30121, 30122, 3014, 30150, 30159, 3016, 3017, 30181, 30182, 30183, 30184, 30189, 3019, 3101, 3131, V7101
Paraphilic Disorders	
ICD-10	F65, F66
ICD-9	3021, 3022, 3023, 3024, 30280, 30281, 30282, 30283, 30284, 30289, 3029
Other Mental Health Disorders	
ICD-10	F068, F09, F985, F99, R460, R461, R462, R463, R464, R465, R466, R467, R4689, Z8659, R4586
ICD-9	29389, 2939, 2948, 2949, 3009, 3070, 3079, 3101, 3108, 31089, 3109, 316, 64840, 64841, 64842, 64843, 64844 78469, 7992, V118, V119, V402, V409, V7109, V663
Medication-Induced Disorders	
ICD-10	G210, G2111, G2119, G212, G240, G2401, G2402, G2409, G251, G254, G256, G2561, G257, T43205, T50905,
ICD-9	3321, 3331, 33372, 33385, 33392, 33399, 99520, 99529
Physical Health Index: Modified Elixhauser	
Cerebrovascular Disease	
ICD-10	I60, I61, I62, I63, I64, I65, I66, I67, I68, I69
ICD-9	430, 431, 432, 433, 434, 435, 436, 437, 438
Congestive Heart Failure	
ICD-10	I099, I110, I130, I132, I255, I420, I425, I426, I427, I428, I429, I43, I50, P290
ICD-9	39891,40201,40211,40291,40401,40403,40411,40413,40491,40493,4254,4255,4257,4258,4259,428
Cardiac Arrhythmia	
ICD-10	I441, I442, I443, I456, I459, I47, I48, I49, R000, R001, R008, T821, Z450, Z950
ICD-9	4260, 42613, 4267, 4269, 42610, 42612, 4270, 4271, 4272, 4273, 4274, 4276, 4278, 4279, 7850, 99601, 99604, V450, V533
Valvular Disease	
ICD-10	A520, I05, I06, I07, I08, I091, I098, I34, I35, I36, I37, I38, I39, Q230, Q231, Q232, Q233, Z952, Z953, Z954
ICD-9	0932, 394, 395, 396, 397, 424, 7463, 7464, 7465, 7466, V422, V433
Pulmonary Circulation Disorder	
ICD-10	I26, I27, I280, I288, I289
ICD-9	4150, 4151, 416, 4170, 4178, 4179
Peripheral Vascular Disorder	

ICD-10	I70, I71, I731, I738, I739, I771, I790, I792, K551, K558, K559, Z958, Z959
ICD-9	0930, 4373, 440, 441, 4431, 4432, 4438, 4439, 4471, 5571, 5579, V434
Hypertension	
ICD-10	I10, I11, I12, I13, I15
ICD-9	401, 402, 403, 404, 405
Paralysis	
ICD-10	G041, G114, G801, G802, G81, G82, G830, G831, G832, G833, G834, G839
ICD-9	3341, 342, 343, 3440, 3441, 3442, 3443, 3444, 3445, 3446, 3449
Other Neurological Disorders	
ICD-10	G10, G11, G12, G13, G20, G21, G22, G254, G255, G312, G318, G319, G32, G35, G36, G37, G40, G41, G931, G934, R470, R56
ICD-9	3319, 3320, 3321, 3334, 3335, 33392, 334, 335, 3362, 340, 341, 345, 3481, 3483, 7803, 7843
Chronic Pulmonary Disease	
ICD-10	I278, I279, J40, J41, J42, J43, J44, J45, J46, J47, J60, J61, J62, J63, J64, J65, J66, J67, J684, J701, J703
ICD-9	4168, 4169, 490, 491, 492, 493, 494, 495, 496, 500, 501, 502, 503, 504, 505, 5064, 5081, 5088
Diabetes	
ICD-10	E100, E101, E109, E110, E111, E119, E120, E121, E129, E130, E131, E139, E140, E141, E149, E102, E103, E104, E105, E106, E107, E108, E112, E113, E114, E115, E116, E117, E118, E122, E123, E124, E125, E126, E127, E128, E132, E133, E134, E135, E136, E137, E138, E142, E143, E144, E145, E146, E147, E148
ICD-9	2500, 2501, 2502, 2503, 2504, 2505, 2506, 2507, 2508, 2509
Hypothyroidism	
ICD-10	E00, E01, E02, E03, E890
ICD-9	243, 244
Other Thyroid Disorders	
ICD-10	E04, E05, E06, E07
ICD-9	240, 241, 242, 245, 246
Renal Failure	
ICD-10	I120, I131, N18, N19, N250, Z490, Z491, Z492, Z940, Z992
ICD-9	40301, 40311, 40391, 40402, 40403, 40412, 40413, 40492, 40493, 585, 586, 5880, V420, V451, V56
Liver Disease	
ICD-10	B18, I85, I864, I982, K70, K711, K713, K714, K715, K717, K72, K73, K74, K760, K762, K763, K764, K765, K766, K767, K768, K769, Z944
ICD-9	07022, 07023, 07032, 07033, 07044, 07054, 0706, 0709, 4560, 4561, 4562, 570, 571, 5722, 5723, 5724, 5728, 5733, 5734, 5738, 5739, V427
Peptic Ulcer Disease (without bleeding)	
ICD-10	K257, K259, K267, K269, K277, K279, K287, K289
ICD-9	5317, 5319, 5327, 5329, 5337, 5339, 5347, 5349
AIDS/HIV	
ICD-10	B20, B21, B22, B24
ICD-9	042, 043, 044
Leukemia	
ICD-10	C901, C91, C92, C93, C94, C95

ICD-9	2031, 204, 205, 206, 207, 208
Lymphoma	
ICD-10	C81, C82, C83, C84, C85, C88, C96, C900, C902
ICD-9	200, 201, 202, 2030, 2386
Metastatic Cancer	
ICD-10	C77, C78, C79, C80
ICD-9	196, 197, 198, 199
Solid Tumor without Metastasis	
ICD-10	C00, C01, C02, C03, C04, C05, C06, C07, C08, C09, C10, C11, C12, C13, C14, C15, C16, C17, C18, C19, C20, C21, C22, C23, C24, C25, C26, C30, C31, C32, C33, C34, C37, C38, C39, C40, C41, C43, C45, C46, C47, C48, C49, C50, C51, C52, C53, C54, C55, C56, C57, C58, C60, C61, C62, C63, C64, C65, C66, C67, C68, C69, C70, C71, C72, C73, C74, C75, C76, C97
ICD-9	140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189, 190 191, 192, 193, 194,
Rheumatoid Arthritis	
ICD-10	L940, L941, L943, M05, M06, M08, M120, M123, M30, M310, M311, M312, M313, M32, M33, M34, M35, M45, M461, M468, M469
ICD-9	446, 7010, 7100, 7101, 7102, 7103, 7104, 7108, 7109, 7112, 714, 7193, 720, 725, 7285, 72889, 72930
Coagulopathy	
ICD-10	D65, D66, D67, D68, D691, D693, D694, D695, D696
ICD-9	286, 2871, 2873, 2874, 2875
Obesity	
ICD-10	E66
ICD-9	2780
Weight Loss	
ICD-10	E40, E41, E42, E43, E44, E45, E46, R634, R64
ICD-9	260, 261, 262, 263, 7832, 7994
Anemia (Blood Loss)	
ICD-10	D500
ICD-9	2800
Anemia (Deficiency)	
ICD-10	D508, D509, D51, D52, D53
ICD-9	2801, 2808, 2809, 281

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Table 1.

Characteristics of VHA patients with PTSD diagnosis and at least one PCL score[a]

		PTSD Symptom Severity by Last PCL Score[b]			
Characteristic	**Total**	**Minimal**	**Low**	**Moderate**	**High**
Patients, No. (%)	754 197 (100)	71 513 (9.5)	94 698 (12.6)	251 813 (33.4)	336 173 (44.6)
Suicide Mortality					
Died, No. (%)	2097 (0.3)	179 (0.25)	238 (0.25)	708 (0.28)	972 (0.29)
Rate per 100 000 person-years	77.6	62.3	67.6	78.5	83.8
Sex					
Male	658 261 (87.3)	61 993 (86.7)	83 133 (87.8)	221 746 (88.1)	291 389 (86.7)
Female	95 936 (12.7)	9520 (13.3)	11 565 (12.2)	30 067 (11.9)	44 784 (13.3)
Age					
18–34	211 535 (28.1)	20 986 (29.4)	28 122 (29.7)	72 244 (28.7)	90 183 (26.8)
35–54	272 900 (36.2)	22 846 (32.0)	31 266 (33.0)	87 113 (34.6)	121 675 (39.2)
55–74	256 953 (34.1)	25 502 (35.7)	32 968 (34.8)	87 875 (34.9)	110 608 (32.9)
≥75	12 809 (1.7)	22 179 (3.1)	2342 (2.5)	4581 (1.8)	3707 (1.1)
Marital Status					
Divorced	174 725 (23.2)	16 183 (22.6)	20 712 (21.9)	56 792 (22.6)	81 038 (24.1)
Married	395 304 (52.4)	36 800 (51.5)	50 655 (53.5)	134 395 (53.4)	173 454 (51.6)
Single	128 389 (17.0)	13 467 (18.8)	16 513 (17.4)	42 303 (16.8)	56 106 (16.7)
Separated	35 475 (4.7)	2881 (4.0)	4016 (4.2)	11 365 (4.5)	17 213 (5.1)
Widowed	14 280 (1.9)	1675 (2.3)	1974 (2.1)	4854 (1.9)	5777 (1.7)
Unknown	6024 (0.8)	507 (0.7)	828 (0.9)	2104 (0.8)	2585 (0.8)
Race					
White (non-Hispanic)	467 979 (62.1)	48 292 (67.5)	63 999 (67.6)	163 585 (65.0)	192 103 (57.1)
Black (non-Hispanic)	164 512 (21.8)	12 644 (17.7)	16 512 (17.4)	49 814 (19.8)	85 542 (25.5)
Hispanic	76 373 (10.1)	6597 (9.2)	8702 (9.2)	23 885 (9.5)	37 189 (11.1)
Pacific Islander	20 877 (2.8)	1841 (2.6)	2458 (2.6)	6387 (2.5)	10 191 (3.0)
American Indian	11 267 (1.5)	953 (1.3)	1359 (1.4)	3749 (1.5)	5206 (1.6)
Unknown	13 189 (1.8)	1186 (1.7)	1668 (1.8)	4393 (1.7)	5942 (1.8)
Service Era					
Vietnam	126 917 (16.8)	12 143 (17.0)	16 690 (17.6)	44 546 (17.7)	53 538 (15.9)
OEF/OIF/OND[c]	349 995 (46.4)	32 644 (45.7)	45 831 (48.4)	119 806 (47.6)	151 714 (45.1)
Service-Connected Disability					
None	403 328 (53.4)	38 619 (54.0)	49 991 (52.8)	133 243 (52.9)	181 475 (54.0)
0–60%	103 941 (13.7)	12 994 (18.2)	15 906 (16.8)	37 045 (14.7)	37 996 (11.3)
70–100%	246 928 (32.7)	19 900 (27.8)	28 801 (30.4)	81 525 (32.4)	116 702 (34.7)
Burden of Physical Illness[d]					
Low: 0 conditions	314 200 (41.7)	29 388 (41.1)	40 181 (42.4)	106 085 (42.1)	138 546 (41.2)
Medium: 1–2 conditions	298 122 (39.5)	27 625 (38.6)	36 399 (38.4)	99 073 (39.3)	135 025 (40.2)

Characteristic	Total	PTSD Symptom Severity by Last PCL Score[b]			
		Minimal	Low	Moderate	High
High: 3+ conditions	141 875 (18.8)	14 500 (20.3)	18 118 (19.1)	46 655 (18.5)	62 602 (18.6)
Burden of Mental Illness[d]					
Low: 0 conditions	14 528 (1.9)	3347 (4.7)	2451 (2.6)	4604 (1.8)	4126 (1.2)
Medium: 1–2 conditions	297 390 (39.4)	33 662 (47.1)	42 698 (45.1)	104 678 (41.6)	116 352 (34.6)
High: 3+ conditions	442 279 (58.6)	34 504 (48.3)	49 549 (52.3)	142 531 (56.6)	215 695 (64.2)
Mental Health Comorbidities[d]					
Depression Only	312 352 (41.4)	25 198 (35.2)	36 374 (38.4)	103 169 (41.0)	147 611 (43.9)
Substance Use Only	58 668 (7.8)	6093 (8.5)	7665 (8.1)	19 732 (7.8)	25 178 (7.5)
Depression + Substance Use	158 967 (21.1)	11 786 (16.5)	16 019 (16.9)	48 936 (19.4)	82 226 (24.5)
Neither	224 210 (29.7)	28 436 (39.8)	34 640 (36.6)	79 976 (31.8)	81 158 (24.1)
Time After Last PCL	median 3.1 years (interquartile range 4.5 years)				

[a]VHA patients with at least one documented PTSD Clinician Checklist (PCL)

[b]PTSD symptom severity is categorized by four PCL score ranges:

Minimal PTSD Symptoms = ≤ 18 on PCL

Low PTSD Symptoms = 19–30 on PCL

Moderate PTSD Symptoms = 31–49 on PCL

High PTSD Symptoms = ≥ 50 on PCL

[c]OEF/OIF/OND Operations Enduring Freedom/Iraqi Freedom/New Dawn

[d]Burden of mental and physical illness and mental health comorbidities in the 2 years prior to the last PCL

Table 2.

Unadjusted and adjusted proportional hazards models for suicide mortality by PTSD symptom severity

Risk of Suicide by Last PCL Score (n= 754 197)				
Comparisons based on PTSD Symptom Severity	**1 month**		**All Time**[a]	
	HR	**95% CI**	**HR**	**95% CI**
Model 1: Unadjusted				
Low v Minimal	2.27	(0.83–6.24)	1.07	(0.88–1.30)
Moderate v Minimal	**2.68** *	(1.07–6.73)	**1.23** *	(1.05–1.45)
High v Minimal	**2.57** *	(1.03–6.39)	**1.31** **	(1.11–1.53)
Model 2: Adjusted for age, sex, race				
Low v Minimal	2.22	(0.81–6.10)	1.05	(0.87–1.28)
Moderate v Minimal	**2.70** *	(1.07–6.79)	**1.25** **	(1.06–1.48)
High v Minimal	**2.83** *	(1.12–7.04)	**1.44** ***	(1.23–1.69)
Model 3: Adjusted for age, sex, race, marital status, service-connected disability				
Low v Minimal	2.21	(0.80–6.07)	1.05	(0.87–1.28)
Moderate v Minimal	**2.70** *	(1.07–6.79)	**1.25** **	(1.06–1.47)
High v Minimal	**2.84** *	(1.14–7.10)	**1.43** ***	(1.22–1.68)
Model 4: Adjusted for age, sex, race, marital status, service-connected disability, burden of mental and physical illness				
Low v Minimal	2.13	(0.77–5.86)	1.02	(0.84–1.24)
Moderate v Minimal	**2.52** *	(1.00–6.35)	1.18	(0.99–1.39)
High v Minimal	**2.56** *	(1.03–6.41)	**1.29** **	(1.10–1.52)

Notes: Boldface indicates statistical significance (*p<0.05; **p<0.01; ***p<0.001)

[a]Length of follow-up after last PCL: median 3.1 years, IQR 4.5 years

PTSD symptom severity is categorized by four PTSD Clinician Checklist score ranges:

Minimal PTSD Symptoms = ≤ 18 on PTSD Clinician Checklist

Low PTSD Symptoms = 19–30 on PTSD Clinician Checklist

Moderate PTSD Symptoms = 31–49 on PTSD Clinician Checklist

High PTSD Symptoms = ≥ 50 on PTSD Clinician Checklist

Table 3.

Proportional hazards models for suicide mortality adjusted for age, sex, and race by PTSD symptom severity

Risk of Suicide by Last PCL Score				
Comparisons based on PTSD Symptom Severity	**1 month**		**All Time**	
	HR	**95% CI**	**HR**	**95% CI**
Patients with PTSD with either Depressive Disorders and/or Substance Use Disorders (n= 529 987)				
Low v Minimal	2.32	(0.64–8.42)	0.98	(0.79–1.21)
Moderate v Minimal	2.90	(0.89–9.41)	1.05	(0.88–1.27)
High v Minimal	2.96	(0.92–9.50)	1.15	(0.96–1.38)
Patients with PTSD without either Depressive Disorders or Substance Use Disorders (n= 224 210)				
Low v Minimal	2.01	(0.39–10.38)	1.21	(0.79–1.86)
Moderate v Minimal	2.19	(0.49–9.78)	**1.74** **	(1.21–2.51)
High v Minimal	2.19	(0.48–9.87)	**2.01** ***	(1.39–2.89)

Notes: Boldface indicates statistical significance (*p<0.05; **p<0.01; ***p<0.001)

PTSD symptom severity is categorized by four PTSD Clinician Checklist score ranges:

Minimal PTSD Symptoms ≤ 18 on PTSD Clinician Checklist

Low PTSD Symptoms = 19–30 on PTSD Clinician Checklist

Moderate PTSD Symptoms = 31–49 on PTSD Clinician Checklist

High PTSD Symptoms ≥ 50 PTSD Clinician Checklist

Table 4.

Unadjusted and adjusted proportional hazards models for suicide mortality by change in PTSD symptom severity

Risk of Suicide by Change in PCL Score (n= 190 822)				
Change in PTSD Symptom Severity	**1 month**		**All Time**	
	HR	**95% CI**	**HR**	**95% CI**
Model 1: Unadjusted				
Worse v No Change	1.04	(0.46–2.34)	1.26	(0.99–1.60)
Improved v No Change	0.94	(0.48–1.85)	1.10	(0.90–1.35)
Model 2: Adjusted for age, sex, race				
Worse v No Change	1.01	(0.45–2.28)	1.24	(0.98–1.58)
Improved v No Change	0.91	(0.46–1.79)	1.08	(0.88–1.33)
Model 3: Adjusted for age, sex, race, marital status, service-connected disability				
Worse v No Change	1.05	(0.47–2.38)	1.28	(1.01–1.62)
Improved v No Change	0.95	(0.48–1.87)	1.11	(0.91–1.36)
Model 4: Adjusted for age, sex, race, marital status, service-connected disability, burden of mental and physical illness				
Worse v No Change	1.04	(0.46–2.34)	1.25	(0.98–1.59)
Improved v No Change	0.94	(0.47–1.84)	1.09	(0.89–1.34)

Notes: Boldface indicates statistical significance (*p<0.05; **p<0.01; ***p<0.001)

Change in PTSD symptom severity is categorized by three PTSD Clinician Checklist score ranges:

PTSD Symptoms Worse = 15 points or more increase

No Change = 7 or fewer points in either direction

PTSD symptoms Improved = 15 points or more reduction

Table 5.

Proportional hazards models for suicide mortality adjusted for age, sex, and race by change in PTSD symptom severity and final PTSD symptom severity

Risk of Suicide by Change in PCL Score and Final PCL Score				
	1 month		**All Time**	
	HR	**95% CI**	**HR**	**95% CI**
Patients with PCL scores that improved by ≥15 points (n=41 652)				
Final PCL ≤18 versus Final PCL >18	0.28	(0.04–2.17)	**0.56***	(0.37–0.88)

Notes: Boldface indicates statistical significance (*p<0.05; **p<0.01; ***p<0.001)