

# Post-traumatic stress disorder (PTSD) symptoms and alcohol and drug use comorbidity at 25 US level I trauma centers

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## ABSTRACT

**Background** Questions regarding the extent to which post-traumatic stress disorder (PTSD) is comorbid with alcohol and drug use are particularly germane in an era when the American College of Surgeons Committee on Trauma (ACS-COT) is considering policy requiring screening, intervention and/or referral services for patients presenting with psychological sequelae of traumatic injury. Literature review revealed few multisite trauma-center-based investigations that have assessed the association between PTSD symptoms and alcohol and drug use comorbidities in injured patients.

**Methods** This investigation was a secondary analysis of baseline data collected prior to randomization in a 25-site trauma center pragmatic clinical trial. All 635 patients included in the investigation had elevated PTSD symptom levels at the time of trauma center admission. Self-report questionnaire screening, laboratory toxicology results, and electronic health record data were combined to assess the frequencies of alcohol, stimulant (i.e., amphetamine and cocaine), opioid and marijuana use comorbidities for injured patients. Logistic regression was used to assess the associations between demographic and injury characteristics and alcohol and drug use comorbidity.

**Results** The frequency of patients with one or more alcohol or substance use comorbidity was between 62% and 79%. Over 50% of patients were positive for one or more alcohol or cannabis comorbidity. Approximately 26% of patients were positive for stimulants and 10% for opioid comorbidity.

**Discussion** This multisite investigation suggests that between 62% and 79% of hospitalized injury survivors with elevated PTSD symptoms have one or more alcohol or drug use comorbidity. Orchestrated ACS-COT policy and trauma center service delivery development should incorporate the key finding that a substantial majority of patients with high levels of psychological distress (eg, elevated PTSD symptoms) may have alcohol and drug use comorbidities.

**Level of evidence** Level II (epidemiological investigation of untreated controls from a multisite randomized clinical trial)

**Trial registration number** NCT02655354.

## INTRODUCTION

In 2019, approximately 2.8 million Americans were so severely injured that they required inpatient hospital admission.<sup>1</sup> Multiple investigations now document a high prevalence of symptoms consistent

## WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Few multisite trauma-center-based investigations have assessed the association between post-traumatic stress disorder (PTSD) symptoms and alcohol and drug use comorbidities.

## WHAT THIS STUDY ADDS

⇒ Of 635 patients with elevated PTSD symptom levels recruited across 25 US level I trauma center sites, between 21% and 38% demonstrated no alcohol or drug use comorbidity. Over 50% of patients were positive for one or more alcohol or cannabis comorbidity; 26% of patients were positive for stimulants and 10% for opioid comorbidity.

## HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Orchestrated policy and trauma center service delivery development should incorporate the key finding that a substantial majority of patients with elevated PTSD symptoms have alcohol and drug use comorbidities.

with post-traumatic stress disorder (PTSD) at rates of 20% or greater among hospitalized US injury survivors.<sup>2–6</sup> Elevated early PTSD symptom levels after an injury have been shown to be associated with the later development of a clinical diagnosis of PTSD in the months after an injury hospitalization.<sup>7,8</sup> After injury, PTSD symptoms are associated with a broad profile of functional impairments and diminished quality of life.<sup>9–13</sup>

Similarly, extensive literature documents high frequencies of alcohol and drug use, including opioids, amphetamines, other stimulants (eg, cocaine) and marijuana, in trauma center patients. In an initial single-site level I trauma center study, over half of consecutively sampled injured trauma survivors displayed a lifetime alcohol or drug use disorder.<sup>14</sup> Subsequent investigations have also documented high frequencies of opioid, stimulant, and cannabis use comorbidity among hospitalized injury survivors.<sup>15–17</sup> A recent investigation conducted at three trauma center sites found that 30% of trauma patients screened positive for one or more psychoactive drugs, including methamphetamine, opioids, phencyclidine, methylenedioxymethamphetamine (ecstasy), cannabinoids, tricyclic antidepressants, benzodiazepines and

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barbiturates.<sup>15</sup> This investigation also documented an association between psychoactive drug use at admission and worsened physical and mental health outcomes after admission.<sup>15</sup>

Studies have linked specific trauma center patient clinical and demographic characteristics with higher risk of alcohol and drug use comorbidity. One investigation found that trauma survivors with psychoactive drug use were more likely to be younger, have a lower income and education level, and have a history of tobacco and substance use.<sup>15</sup> Other single-site investigations have found that trauma survivors of younger age, Caucasian race and male sex were more likely to be suffering from alcohol and drug use comorbidity.<sup>16,17</sup> Additionally, an investigation of the Canadian Hospitals Injury Reporting and Prevention Program found that alcohol and drug use were more frequently associated with intentional injuries compared with unintentional injuries; the investigation also found that trauma survivors presenting with alcohol and drug use were more likely to be younger and male.<sup>18</sup>

Literature review revealed few trauma center-based investigations that have assessed the association between PTSD and alcohol and drug use comorbidities in injured patients. One prior investigation at a single level I trauma center found that among 878 randomly sampled hospitalized injury survivors, approximately 80% presented with either elevated PTSD symptom levels and/or alcohol, opioid, stimulant, and marijuana comorbidities.<sup>19</sup> Other investigations have documented that alcohol and drug use comorbidity at the time of trauma center admission do not predict the development of PTSD symptoms during the course of 6 months after injury.<sup>20,21</sup> Literature review revealed no previous multisite investigations that have assessed the extent to which surgical inpatients with elevated early postinjury PTSD symptom levels have comorbid alcohol and drug use comorbidity. Questions regarding the extent to which PTSD is comorbid with alcohol and drug use become particularly germane in an era when the American College of Surgeons Committee on Trauma (ACS-COT) is considering policy requirements for the screening and treatment of patients presenting with psychological sequelae of traumatic injury. A more comprehensive multisite examination of the comorbidity between PTSD and substance use could inform screening, intervention, and referral service delivery development at US trauma centers.

The current study sought to corroborate and extend previous investigations examining the inter-relationships between PTSD and alcohol and drug use comorbidities in injured trauma survivors. The investigation harnessed data previously collected in a 25-site trauma center study to describe the frequencies of alcohol, opioids, stimulant and cannabis use comorbidity among inpatients with elevated PTSD symptoms.<sup>22</sup> The investigation hypothesized that patients presenting with elevated levels of PTSD symptoms would also present with high rates of alcohol and drug use comorbidities. The demographic and clinical characteristics associated with specific patient alcohol and drug comorbidities were also described.

## PATIENTS AND METHODS

### Study design

This investigation was a secondary analysis of baseline data collected prior to randomization in a 25-trauma center site pragmatic clinical trial.<sup>22</sup> The 25 sites constituted a representative subsample of US level I trauma centers.<sup>23</sup> All study procedures were approved by the Western Institutional Review Board before the initiation of the investigation.<sup>24</sup> The complete study procedures have been described in previous publications<sup>22,23,25,26</sup> and are briefly summarized as follows.

### Study setting and participants

Between January 2016 and November 2018, 635 hospitalized traumatic injury survivors were recruited across the 25 sites. English-speaking survivors of intentional and unintentional injuries were screened. Patients were excluded if they displayed acute psychiatric symptoms that required immediate intervention (eg, suicidal ideation) or were currently incarcerated. The study team had previously developed a 10-domain electronic health record (EHR) screen to detect patients with a high likelihood of demonstrating PTSD symptomatic distress as hospitalized inpatients; patients with a score of  $\geq 3$  on the EHR screen were eligible to participate in the clinical portion of the study.<sup>22</sup> The 10-domain PTSD risk factor items pulled from the EHR are (1) Blood Alcohol Concentration (BAC) or drug toxicology positive or any substance disorder International Classification of Diseases (ICD) from EHR; (2) female sex; (3) non-white race/Hispanic ethnicity; (4) public insurance, Veterans' insurance, or uninsured; (5) treated in the intensive care unit (ICU) during the injury admission; (6) any psychiatric disorder ICD from EHR; (7) PTSD ICD from EHR; (8) tobacco use; (9) injury inflicted by another (ie, intentional injury); and (10) at least one prior emergency department or hospital inpatient visit. Research study staff identified potential patient subjects who met the criteria of having  $\geq 3$  PTSD EHR risk factor domains positive as potential candidates for approach for informed consent.

During the course of the study, 171 303 trauma patients were admitted to the 25 US level I trauma center sites; 163 849 patients were not screened for the investigation. An additional 3256 patients were unable to undergo the study assessment (eg, cognitive impairment, non-English speaking). Seventeen hundred and six patients did not meet the EHR  $\geq 3$  domains positive screening criteria for the study and/or were excluded before consent was attempted. Eight hundred and eleven patients were discharged before consent was attempted; 617 patients declined to participate; 380 patients screened out of the study with a score of  $< 35$  on the PTSD Checklist; 46 patients were unable to complete the baseline interview and 3 patients withdrew, leaving 635 patients who completed the baseline surgical ward interview with scores of  $\geq 35$  on the PTSD Checklist.

After obtaining patient written informed consent, research staff administered a baseline interview that began with the PTSD Checklist–Civilian (PCL-C) Version, *Diagnostic and Statistical Manual of Mental Disorders*, Fourth Edition (DSM-IV) assessment. Patients with elevated levels of PTSD symptom as indicated by a score of  $\geq 35$  or higher on the PCL-C completed the baseline interview.<sup>7,27</sup> After completing all baseline measures, patients were entered into the longitudinal portion of the study and randomized. The current secondary analysis includes the baseline prerandomization data for 635 trauma surgical patients from the 25 sites with elevated PTSD symptom levels as indicated by a score of  $\geq 35$ .

### Measures

#### PTSD symptoms

The study's baseline interview used the 17-item PCL-C Version for the DSM-IV to assess initial PTSD symptom levels.<sup>7,27,28</sup> The PTSD Checklist asks patients about the intrusive, avoidant, and arousal symptoms that constitute a DSM-IV diagnosis of PTSD. For the purposes of the current investigation, the PTSD Checklist items were anchored to the injury event. For example, patients were asked, 'Since you were injured, how bothered have you been by repeated, disturbing memories, thoughts, or images of the event...?' The 17 items are asked on a 1 to 5 scale, with

'1' being not at all and '5' being extremely bothered; the 17-item scale score ranges from 17 to 85. Prior study team investigations have established the reliability and validity of this measure when used with hospitalized traumatic injury survivors; these prior investigations have also established a cut-off score of  $\geq 35$  as optimally predictive of later development of a PTSD diagnosis.<sup>7 28</sup>

### Alcohol use comorbidity

The baseline interview also included the Alcohol Use Disorder Identification Test Three-item Version (AUDIT-C) to assess alcohol use comorbidity in the 12 months before the injury hospitalization.<sup>29 30</sup> As recommended, a cut-off on the AUDIT-C of 4 or more for men and 3 or more for women was used to identify an alcohol use problem.<sup>29 30</sup> To develop a comprehensive indicator of alcohol use comorbidity at the time of trauma surgery inpatient admission,<sup>19</sup> the investigation supplemented the AUDIT-C self-report data with documented positive alcohol laboratory toxicology results and alcohol use disorder diagnoses derived from the EHR.

### Drug use comorbidity

The baseline interview included a single-item drug screen to assess the preinjury use of opioids, amphetamines, cocaine, and marijuana; amphetamine and cocaine use were collapsed into a single stimulant use comorbidity category.<sup>22 31</sup> As part of the baseline interview, injury survivors were asked, 'In the past 12 months prior to your injury, how often have you used each drug?' Response options included, 'never', 'monthly or less', 'two to four times a month', 'two to three times a week', or 'four or more times a week'. For the purposes of data analyses, responses were dichotomized as drug use (monthly or less or more frequent use) versus no use (never). With the exception of opioids, which are often administered in the prehospital or acute care setting by medical providers, to develop comprehensive indicators of drug use comorbidity, the study team augmented this self-report information with documentation of positive laboratory toxicology results. An additional, more conservative threshold for substance use comorbidity was also estimated that incorporated patients who endorsed use of any substance four or more times each week.

### Other assessments

Patient demographic characteristics such as age, sex, race, ethnicity, education, employment, and marital status were obtained from the baseline interview. Other demographic injury and clinical characteristics such as ICU stay, prior hospitalizations, insurance status and injury severity and medical

comorbidity scores were obtained from the EHR and from site trauma registry data.

### Data analysis

The investigation first described the frequencies of self-report, EHR and/or toxicology documented alcohol, opioid, stimulant, and marijuana use for the 635 patients with elevated PTSD symptom levels. Next, the study team estimated two thresholds for substance use comorbidity, a comprehensive threshold that incorporated AUDIT-C, BAC/toxicology positive, and monthly or less self-report use of any drug (ie, opioid, stimulant, or marijuana) and a conservative threshold that included only AUDIT-C alcohol use problem criteria cutoffs combined with any self-report drug use four or more times each week. The extent to which alcohol, opioid, stimulant, and marijuana use occurred as comorbid conditions was assessed using the more comprehensive threshold. Finally, the associations between demographic and clinical characteristics and individual alcohol, opioid, stimulant and marijuana use comorbidity were assessed. Baseline demographic, injury and clinical characteristics including age, sex, race, ethnicity, insurance status, employment status, educational status, marital status, injury type, injury severity, prior hospitalizations, ICU stays, current tobacco use, psychiatric diagnosis, and medical comorbidities were entered into a logistic regression model using a stepwise backwards elimination procedure.<sup>32</sup> Variables with significant independent associations at the  $p < 0.05$  level were retained in the final models that accounted for the clustering of characteristics across sites.

### RESULTS

At baseline, 54.2% of patients were positive for one or more alcohol indicator, and 50.2% were positive for one or more cannabis indicator (table 1). Approximately 26% of patients were positive for one or stimulant indicator and 9.8% endorsed self-reported opioid use. Of note, 11.8% of patients were missing trauma registry-derived urine toxicology values.

Approximately 21% of patients demonstrated no alcohol or drug use comorbidity (figure 1). Twenty percent of patients only used alcohol; 16.5% used alcohol and cannabis; 12.0% used alcohol, cannabis, opioids, and stimulants; and 5.4% used alcohol, opioids, and stimulants. Twelve percent of patients reported using cannabis only and 3.1% of patients reported using stimulants and opioids only. Incorporation of the more conservative thresholds for substance use comorbidity identified 62% of the sample as having an alcohol or substance use comorbidity.

The final study cohort consisted of 308 women (48.5%) and 327 men (51.5%) (table 2). The mean age of the cohort was 39.0 years (SD=14.2) (table 2). Over 50% of participants were non-white and 16% were Hispanic. Fifty six percent of participants

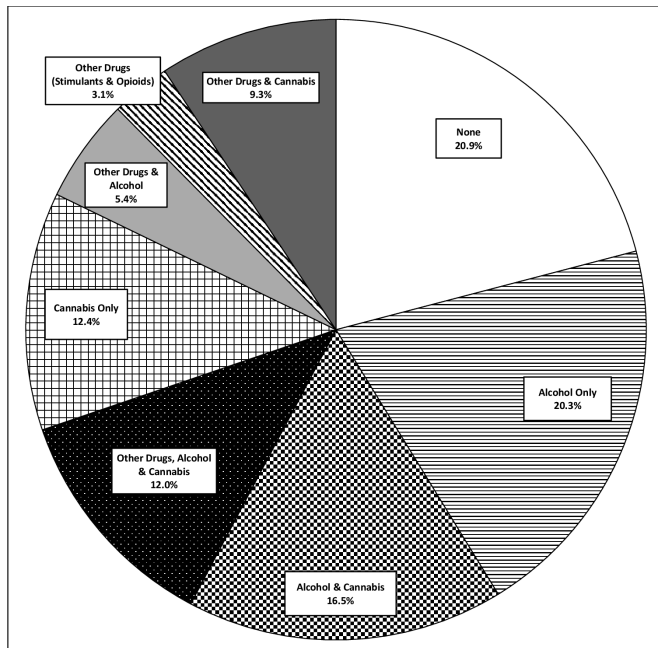
**Table 1** Alcohol, stimulant, \* opioid and cannabis comorbidities in trauma center patients with Post-traumatic Stress Disorder Checklist scores  $\geq 35$  (N=635)

Comorbidity	Self-report, n (%)	Positive toxicology screen, n (%)	Electronic medical record, n (%)	$\geq 1$ positive indicator, n (%)
Alcohol†	319 (50.2)	157 (28.4)	49 (9.1%)	344 (54.2)
Stimulant‡	135 (21.4)	81 (14.5)	–	163 (25.7)
Opioid‡	62 (9.8)	–	–	62 (9.8)
Cannabis‡	302 (47.7)	89 (15.9)	–	319 (50.2)

\*Stimulants include amphetamine and/or cocaine use.

†Assessed with the AUDIT-C for the 12 months before the injury.<sup>30</sup>

‡Assessed with single-item drug screen for the month before the injury.<sup>31</sup>  
AUDIT-C, Alcohol Use Disorder Identification Test Three-Item Version.



**Figure 1** Breakdown of alcohol, stimulant, opioid and cannabis comorbidity for all patients (N=635).

endorsed using tobacco. Further demographic and clinical details are provided in [table 2](#).

The frequency of the 10-domain EHR risk factors among the n=635 patients is detailed in [table 3](#). Of particular note, 397 (63) of patients had a positive blood alcohol/urine toxicology or alcohol or drug use diagnosis during the hospitalization ([table 3](#)).

The mean PTSD Checklist score for the entire cohort was 52.1 (SD=12.2). Patients with one or more positive indicators for opioids (mean=54.5, SD=13.1; mean=54.6, SD=12.2) and stimulants had on average higher PTSD Checklist scores when compared with patients with one or more positive indicators for alcohol (mean=52.0, SD=12.2) and cannabis (mean=52.8, SD=11.9).

Tobacco use was associated with a significantly increased odds of alcohol use comorbidity, whereas preinjury unemployment

**Table 3** Frequency of 10-domain electronic health record risk factors among N=635 patients

EHR risk factor	Yes n (%)
Female gender	308 (49)
Non-white ethnicity	327 (51)
Intentional Injury	238 (38)
Uninsured, public or veteran insurance	438 (69)
ICU admission	377 (59)
Prior inpatient hospitalization	249 (39)
Tobacco use	456 (72)
+BAC/toxicology or admission diagnosis	397 (63)
Prior psychiatric disorder diagnosis	246 (39)
Prior PTSD diagnosis	115 (18)

EHR, electronic health record; ICU, intensive care unit; PTSD, post-traumatic stress disorder.

was associated with a significantly decreased odds of alcohol use comorbidity ([table 4](#)). Preinjury unemployment was associated with a significantly increased odds of opioid use, whereas non-white race, being female, and increasing age were associated with a significantly decreased odds of opioid use. Tobacco use, intentional injury, not being married, and preinjury unemployment were associated with a significantly increased odds of stimulant comorbidity, whereas older age was associated with a significantly decreased odds of stimulant comorbidity. Finally, tobacco use and intentional injury were associated with a significantly increased odds of cannabis comorbidity, whereas attending college, less severe injury, and increasing age were associated with a significantly decreased odds of cannabis comorbidity.

## DISCUSSION

This investigation combined self-report screening, laboratory toxicology results, and EHR data to assess the frequencies of alcohol, stimulant, opioid and marijuana use comorbidity among 635 trauma surgery inpatients with elevated PTSD symptom levels recruited from 25 US level I trauma center sites. The investigation found that 79% of the hospitalized trauma survivors with elevated PTSD symptom levels had one or more positive

**Table 2** Demographic and clinical characteristics of Patients with alcohol and drug use comorbidities

Demographics and clinical characteristics	N (%)				
	All patients (n=635)	Alcohol (n=344)	Opioids (n=62)	Stimulants (n=163)	Cannabis (n=319)
Age (years), mean (SD)	39.0 (14.2)	38.4 (13.4)	34.3 (11.7)	35.7 (11.1)	34.2 (12.2)
Female	308 (49)	148 (43)	22 (36)	64 (39)	130 (41)
Non-white race	327 (52)	184 (54)	19 (31%)	88 (54)	186 (58)
Hispanic ethnicity	102 (16)	52 (15)	3 (5)	25 (15)	51 (16)
Uninsured	438 (69)	234 (68)	46 (74)	119 (73)	236 (74)
Preinjury unemployment	255 (40)	120 (38)	31 (50)	82 (51)	120 (38%)
Education—at least some college	195 (31)	104 (30)	16 (26)	37 (23)	71 (22)
Marital status—not married	456 (72)	241 (70)	47 (76)	133 (82)	243 (76)
Intentional injury	238 (38)	137 (39)	26 (42)	80 (49)	151 (47)
At least one prior inpatient hospitalization	249 (33)	137 (40)	28 (45)	66 (40)	118 (37)
Intensive care unit	377 (59)	194 (56)	40 (64)	99 (61)	174 (55)
Current tobacco use	356 (56)	218 (63)	46 (74%)	111 (68)	196 (61)
Prior psychiatric diagnosis	246 (39)	128 (37)	30 (48)	68 (42)	114 (36)
Number of medical comorbidities, mean (SD)	2.3 (2.6)	2.1 (2.4)	2.4 (2.7)	2.2 (2.6)	2.0 (2.6)
Injury severity score, mean (SD)	15.4 (11.0)	14.8 (10.6)	15.8 (11.1)	15.2 (11.1)	14.2 (10.9)



**Table 4** Significant associations between demographic and clinical characteristics and alcohol and drug use comorbidities

Comorbidity and variables	OR	95% CI
<b>Alcohol</b>		
Tobacco Use	2.01	1.37 to 2.96
Preinjury unemployment	0.67	0.48 to 0.93
<b>Opioids</b>		
Preinjury unemployment	2.09	1.26 to 3.47
Female	0.40	0.22 to 0.72
Age	0.96	0.94 to 0.98
Non-white race	0.24	0.12 to 0.48
<b>Stimulants</b>		
Tobacco use	1.95	1.33 to 2.84
Not married	1.89	1.19 to 3.02
Preinjury unemployment	1.84	1.29 to 2.62
Intentional Injury	1.80	1.24 to 2.62
Age	0.98	0.96 to 0.99
<b>Cannabis</b>		
Tobacco use	1.52	1.06 to 2.19
Intentional injury	1.73	1.24 to 2.40
Age	0.96	0.94 to 0.97
At least some college	0.59	0.40 to 0.87
Injury severity score	0.98	0.97 to 0.99

All variables presented are statistically significant with  $p < 0.05$ .

alcohol, opioid, stimulant or cannabis comorbidity. Sensitivity analyses that used a more conservative threshold for comorbidity inclusion identified that 62% of patients had one or more comorbidity. The investigation documented particularly high frequencies of alcohol and cannabis comorbidities, with over 50% of patients having one or more positive indicators. Approximately one-quarter of patients had one or more positive indicators for stimulant use, and approximately 10% of patients had a positive indicator for opioid use.

The current study findings corroborate and extend reports from prior investigations of PTSD symptom and alcohol and drug use comorbidities among injured trauma survivors. In a prior single-site study of 878 randomly sampled trauma center inpatients, approximately 80% of inpatients presented with one or more alcohol or drug comorbidity and/or elevated PTSD symptom-level comorbidities.<sup>19</sup> The current investigation extends these previous findings by documenting that in a sample of 635 trauma inpatients with elevated baseline PTSD symptom levels derived from 25 US level I trauma center sites, between 62% and 79% of patients had one or more positive indicators for an alcohol, stimulant, opioid or cannabis use comorbidity. Prior investigations beyond the trauma center setting also document high rates of substance use comorbidity in patients with PTSD.<sup>33 34</sup>

These observations have important implications for the development screening, intervention, and referral procedures for patients with elevated levels of PTSD symptoms at US trauma centers. A recent national survey documented that approximately 30% of US trauma center sites were routinely screening for PTSD symptoms after injury admission.<sup>35</sup> Over half of sites that were conducting PTSD screening were building PTSD services on existing alcohol screening and intervention services. The results of the current investigation suggest that building PTSD screening and intervention services on existing trauma center alcohol service delivery is an optimal approach, given the very high rates of PTSD and alcohol comorbidity. Also, of note,

a recent national survey documents that social workers appear to conduct the majority of trauma center alcohol and drug use screening. With regard to screening, optimal procedures may need to incorporate EHR efficiencies to be able to simultaneously screen for PTSD risk and also incorporating multiple alcohol and drug comorbidities.<sup>7</sup> The current study findings also have important implications for research on optimal PTSD intervention strategies for US trauma centers. Collaborative care interventions that combine elements of substance use treatments<sup>36 37</sup> (eg, motivational interviewing for alcohol) and PTSD focused treatments (eg, PTSD pharmacotherapy, cognitive behavioral therapy elements embedded within care management) have demonstrated effectiveness in simultaneously addressing comorbid PTSD symptoms and alcohol use.<sup>8 22 38 39</sup> In contrast, acute care psychotherapeutic interventions with an isolated focus on PTSD symptoms, such as session-based cognitive behavioral therapies, have demonstrated mixed results with some<sup>40 41</sup> but not all<sup>42–44</sup> randomized trials reporting treatment effectiveness in injury survivors. Meta-analysis has identified collaborative care interventions as the optimal treatment approach for injured trauma survivors with PTSD and comorbidities when compared with cognitive behavioral therapy, as the collaborative care combination of effective evidence-based medication and psychotherapeutic treatments with care management results in expanded intervention reach and greater overall population impact for patients presenting to trauma center settings.<sup>45 46</sup> Collaborative care interventions have the additional potential advantage of being able to flexibly incorporate new developments in the acute care treatment of drug use comorbidity (eg, medications for opioid use disorder).<sup>47 48</sup> With regard to trauma center-to-primary care and community referral for patients with PTSD, these linkages may need to incorporate treatment planning for alcohol and drug use comorbidities.<sup>8 22 38 39</sup>

The investigation also assessed the associations between demographic and clinical characteristics of patients with elevated PTSD symptoms and alcohol, opioid, stimulant and cannabis comorbidity [table 4](#). Tobacco use was associated with an increased odds of alcohol, stimulant, and cannabis use comorbidity. Older age was associated with decreased odds of opioid, stimulant, and cannabis comorbidity. Preinjury unemployment was associated with an increased risk of amphetamine and opioid use comorbidity, and a decreased risk of alcohol comorbidity. These findings suggest that, along with specific demographic characteristics, the social determinants of health that impact patients with mental health and substance use disorders nationally also affect injured patients presenting to US trauma centers.

### Limitations

This investigation has limitations. The study indicators for substance use include the association of a positive urine drug screen toxicology screen with trauma center inpatient admission. The study team is aware that, in some cases (eg, cannabis use), toxicology positive screens may span weeks and may not be directly associated with injury events that constitute drug use problems by precipitating trauma center inpatient admissions. This could result in an overestimate of drug use comorbidity, particularly for cannabis; to mitigate this concern the study team has included a sensitivity analysis that conservatively estimates drug use comorbidity through endorsement of use four or more times each week. Similarly, unlike prior epidemiologically focused studies of PTSD and substance use comorbidity,<sup>19</sup> the current investigation did not employ a random sampling frame, and the 10-domain EHR screen that prioritized patients

for assessment included an alcohol and drug use domain; thus, the observation of 62%–79% substance use comorbidity among patients with elevated PTSD symptom levels does not represent a prevalence estimate. Moreover, with regard to comorbidity, it is acknowledged that prescribed use of marijuana may constitute some of the marijuana consumption described in the article, and thus, estimates of marijuana use comorbidity may be inflated. An additional limitation was that approximately 12% of patients were missing urine toxicology data derived from the trauma registry. Finally, as a cross-sectional investigation of trauma surgery inpatients, the investigation did not assess alcohol and drug use as predictors of the development of PTSD symptoms<sup>20,21</sup> or the temporal sequencing of the development of PTSD symptoms and substance use comorbidity.<sup>49</sup>

## CONCLUSION

Beyond these considerations, the investigation has important implications for ACS-COT policy regarding mental health and substance use disorders. The ACS-COT has previously required alcohol screening and intervention at US level I and II trauma centers.<sup>50</sup> Recent investigation has established widespread adherence among trauma centers nationally to the ACS-COT alcohol requirement.<sup>35</sup> Orchestrated ACS-COT policy and trauma center service delivery development should incorporate the key finding that a substantial majority of patients with high levels of psychological distress (eg, elevated PTSD symptoms) may have alcohol and drug use comorbidities.

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**Competing interests** DFZ has provided forensic expert consultation/testimony related to post-traumatic stress disorder for the Washington State Attorney General, the City of Seattle, and other agencies/firms.

**Patient consent for publication** Not applicable.

**Ethics approval** This study involves human participants and was approved by Western Institutional Review Board (study number 1155305). Participants gave informed consent to participate in the study before taking part.

**Provenance and peer review** Not commissioned; externally peer reviewed.

**Data availability statement** Data are available upon reasonable request. The study data will be shared; details of data sharing are currently being worked out by the investigative team.

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