Beyond pain and disability: The lasting effects of trauma on life after injury

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AUTHORS/CONTRIBUTORS

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BACKGROUND: The impact of traumatic injury likely extends beyond direct physical consequences and lasts well beyond the acute injury phase. Data collection is sparse after hospital discharge, however. In this observational study, we hypothesized that sequelae of injury would last at least 6 months and sought to prospectively determine patient-reported physical, emotional, and social outcomes during this postinjury period.

METHODS: We surveyed patients admitted to our Level I trauma center (July 2019 to October 2020) regarding baseline functioning and quality of life after injury, using the Patient-Reported Outcomes Measurement Information System (PROMIS-29) instrument, a primary care posttraumatic stress disorder screen, and questions on substance use, employment, and living situation. Patients were re-surveyed at 6 months. PROMIS-29 scores are reported as *t* scores compared with the US population. Differences between groups were analyzed using χ^2, signed-rank, and *t* tests, with paired tests used for changes over time.

RESULTS: Three hundred sixty-two patients completed the baseline, 130 of whom completed 6-month follow-up. Those completing the 6-month survey were similar ages (43.3 ± 17.8 vs. 44.4 ± 19.0, $p = 0.57$), mechanism (24.7% vs. 28.0% shot or stabbed, $p = 0.61$), and severities (median Injury Severity Score, 9 vs. 9; $p = 0.15$) as those who only completed the baseline. There were 55.0% reported being hospitalized for an injury previously. Patients reported decreases in ability to participate in social roles and activities (mean *t* score 51.4 vs. 55.3; $p = 0.011$) and increases in anxiety (53.8 vs. 50.5, $p = 0.011$) and depression (51.0 vs. 48.7, $p = 0.025$). There were 26.2% that screened positive for posttraumatic stress disorder at 6 months. Employment decreased at 6 months, with 63.9% reporting being "occasionally" employed or unemployed at 6 months versus 44.6% preinjury ($p < 0.001$).

CONCLUSION: The effects of injury extend beyond pain and disability, impacting several realms of life for at least 6 months following trauma. These data support the development of screening and intervention protocols for postinjury patients. (*J Trauma Acute Care Surg.* 2022;93: 332–339. Copyright © 2022 Wolters Kluwer Health, Inc. All rights reserved.)

LEVEL OF EVIDENCE: Prognostic and Epidemiologic; Level IV.

KEY WORDS: Health-related quality of life; trauma outcomes; long-term outcomes; PTSD; patient-reported outcomes.

As trauma care has improved in the United States in the past few decades, there has been an increase in survival to discharge.[1,2] However, the majority of existing literature on trauma outcomes is limited to crude outcomes (i.e., mortality) in the acute phase.[3] There is a growing interest in long-term outcomes and psychological and social effects after trauma,[4] including a call for more "comprehensive" data collection after injury in the National Academies of Sciences, Engineering, and Medicine's *Zero Preventable Deaths* report.[5]

In response, the literature has begun to explore a variety of long-term outcomes. Some authors, including our group, have discussed the importance of patient-reported outcomes (PROs) in medicine[6,7] and surgery,[8] demonstrating poor health-related quality of life (HRQoL) outcomes after trauma,[9,10] emergency surgery,[11] and other surgical disciplines. Indeed, the National Quality Forum and other organizations, such as the Patient-Centered Outcomes Research Institute, have stressed the importance of measuring these outcomes. Much of the prior work on PROs, though, lacks longitudinal data at multiple time points. In addition, there is some evidence and reason to think that trauma patients—particularly victims of interpersonal violence—may suffer adverse mental health outcomes,[12,13] particularly posttraumatic stress disorder (PTSD).[14] Finally, previous work has identified detrimental effects of trauma on substance use[15,16] and employment[15,17] in particular subsets of trauma patients, including firearm-injured patients and those with severe injuries.

Recent efforts to synthesize these outcomes and describe them in a broad population deserve specific mention. Namely, the Functional Outcomes and Recovery After Trauma Emergencies study, which is a recent outstanding effort to explore multiple long-term outcomes, reports data at 6 months and 12 months following injury but does not compare these to baseline values.[4] The study population also differs significantly from those at other urban centers, most notably in that 94% of the participants suffered a blunt injury. The Measurement of Functional Outcomes in the Major Extremity Trauma Research Consortium studies several physical and mental outcomes, but is limited to extremity injuries.[18] These projects represent huge strides in the study of long-term effects of trauma, but there is room for continued growth.

Because prior studies have been limited in scope, population, and number of time points, we undertook this study to provide a comprehensive, longitudinal examination of HRQoL, social, and psychological effects of trauma over time in a diverse trauma population. We hypothesized that patients would report below average HRQoL and suffer from increased rates of PTSD symptoms and substance use at a 6-month timepoint after injury.

METHODS

We screened patients 18 years or older suffering a traumatic injury and admitted more than 24 hours at an urban, academic, Level I trauma center. Only those patients admitted to the Trauma service were included; those admitted to other services (e.g., geriatrics, orthopedics) were excluded. Specifically, this excludes patients with isolated hip fractures, who are otherwise excluded from our state trauma registry. There was no Injury Severity Score (ISS) threshold for inclusion. Patients who died in the hospital were excluded. Patients were screened from July 1, 2019, to October 31, 2020. Eligible patients were approached in person or by phone by trained study staff prior to or soon after

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TABLE 1. Demographic, Injury, and Management Characteristics of Patients Enrolling for Baseline Survey

	Not Enrolled	Enrolled	*p*
Number	2254	362	
Age, mean (SD)	49.4 (21.5)	44.0 (18.5)	<0.001
Sex			
Female	747 (33.1%)	113 (31.2%)	0.47
Male	1507 (66.9%)	249 (68.8%)	
Mechanism			
Fall	865 (38.4%)	106 (29.3%)	<0.001
Gunshot wound	300 (13.3%)	70 (19.3%)	
Motor vehicle accident	371 (16.5%)	73 (20.2%)	
Motorcycle accident	74 (3.3%)	22 (6.1%)	
Other	403 (17.9%)	49 (13.5%)	
Pedestrian accident	96 (4.3%)	15 (4.1%)	
Stabbing	129 (5.7%)	27 (7.5%)	
Missing	16 (0.7%)	0 (0.0%)	
ISS, median (IQR)	9 (4, 11)	9 (5, 14)	<0.001
Hospital LOS, median (IQR)	3 (1, 7)	4 (2, 7)	0.002
ICU LOS, median (IQR)	0 (0, 2)	0 (0, 2)	0.89
Underwent operation			
No	1356 (60.2%)	163 (45.0%)	<0.001
Yes	898 (39.8%)	199 (55.0%)	

SD, standard deviation; ICU, intensive care unit; IQR, interquartile range; LOS, length of stay.

hospital discharge, consented, and enrolled. Study staff, which includes trained research assistants, are led by an experienced clinical research nurse, who personally approached the majority of patients for initial enrollment. No member of the research team participates in clinical care. During the initial encounter, enrolled patients were asked to complete the Patient-Reported Outcomes Measurement Information System (PROMIS-29) v2.0 HRQoL instrument, the primary care PTSD screen (PC-PTSD-5), and additional standardized questions regarding substance use, employment, and living situation. All instruments are standardized and were administered in a scripted fashion.

The PROMIS-29 is one of several PROMIS instruments, which are extensively validated and made publicly available by the National Institutes of Health.[19,20] It surveys eight domains: ability to participate in social roles/activities, anxiety, depression, fatigue, pain interference, physical function, sleep disturbance, and pain intensity. Each domain except pain intensity contains four items, scored on a five-point scale. Pain intensity is scored on a 10-point scale. In each domain, a high score signifies "more" of the quality being measured; therefore, higher scores in negatively worded domains (i.e., anxiety) are worse, while higher scores in positively worded domains (i.e., physical function) are better. The full instrument is shown in Supplemental Digital Content, Figure 1, http://links.lww.com/TA/C526.[21]

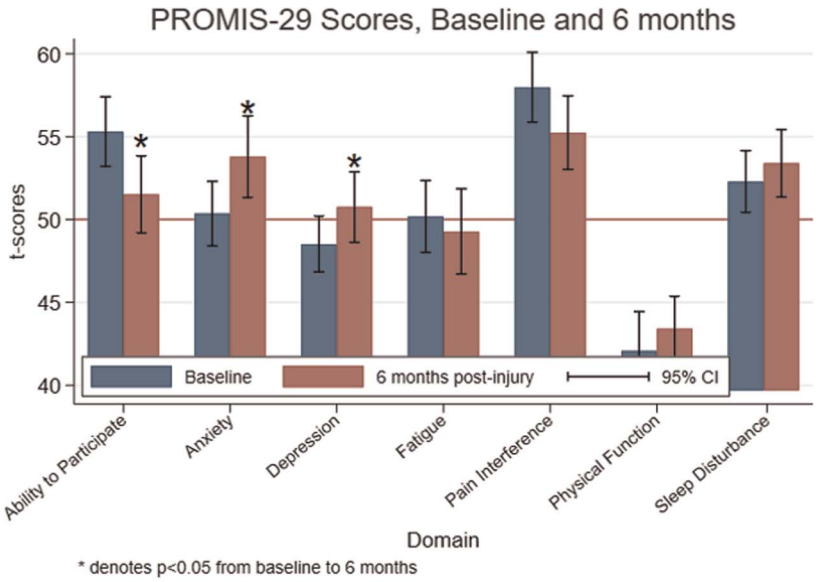
The PC-PTSD-5 was designed as a screening tool for primary care settings to identify patients at high risk for PTSD as defined in the *Diagnostic and Statistical Manual of Mental Disorders (Fifth Edition)*. It begins by asking the subject whether he or she has experienced an event that is "unusually or especially frightening, horrible, or traumatic," and might predispose to PTSD. If so, another five questions regarding symptoms over the preceding 1 month are administered. An answer of "yes" to three or more of these five questions may be considered a positive screen for PTSD, although the cut point may be altered, particularly in certain populations.[22] While a formal diagnosis of PTSD requires a more extensive interview with a psychiatrist, this instrument is validated and is highly accurate (area under the curve, 0.941).[23] The full instrument is shown in Supplemental Digital Content, Figure 2, http://links.lww.com/TA/C527.[24]

We readministered the questionnaires to subjects 6 months following injury. Subjects were contacted by telephone. A maximum of three attempts were made to contact subjects for 6-month data. All baseline and 6-month data were maintained using the Research Electronic Data Capture secure web application hosted by our institution.[25,26] Baseline survey data were merged with clinical registry data maintained in accordance with Pennsylvania state trauma center requirements. Specifically, we collected demographic, injury mechanism, injury severity, and treatment data.

As intended per the design of the instrument, we converted PROMIS-29 scores into t-scores referent to the US population. Differences between groups were analyzed using χ^2, signed-rank, and Student's *t* tests. Paired tests were used to analyze changes in responses over time. All statistical analyses were performed using Stata version 15.1 (College Station, TX). Data were maintained in an unidentified fashion on password-protected computers. This study was approved by our center's institutional review board, and the study design and results are reported in accordance with the Enhancing the QUAlity and Transparency Of health Research (EQUATOR) network Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines. A complete STROBE checklist is uploaded (Supplemental Digital Content, Table 1, http://links.lww.com/TA/C528). In

TABLE 2. Demographic, Injury, and Management Characteristics of Patients Completing 6-Month Follow-Up vs. Patients Completing Only Baseline Survey

	Baseline Only	Baseline + 6 Months	*p*
Number	232	130	
Age, mean (SD)	44.4 (19.0)	43.3 (17.8)	0.57
Sex			
Female	74 (31.9%)	39 (30.0%)	0.71
Male	158 (68.1%)	91 (70.0%)	
Mechanism			
Fall	67 (28.9%)	39 (30.0%)	0.61
Gunshot wound	46 (19.8%)	24 (18.5%)	
Motor vehicle accident	48 (20.7%)	25 (19.2%)	
Motorcycle accident	14 (6.0%)	8 (6.2%)	
Other	32 (13.8%)	17 (13.1%)	
Pedestrian accident	6 (2.6%)	9 (6.9%)	
Stabbing	19 (8.2%)	8 (6.2%)	
ISS, median (IQR)	9 (5, 14)	9 (5, 11)	0.15
Hospital LOS, median (IQR)	4 (2, 7)	4 (2, 7)	0.77
ICU LOS, median (IQR)	0 (0, 2)	0 (0, 1)	0.44
Underwent operation			
No	106 (45.7%)	57 (43.8%)	0.74
Yes	126 (54.3%)	73 (56.2%)	



Domain	Number of Respondents	Baseline	6 months	p-value
Ability to participate in Social Roles and Activities	120	55.3 [53.1, 57.4]	51.4 [49.1, 53.7]	0.011
Anxiety	123	50.5 [48.5, 52.5]	53.8 [51.3, 56.3]	0.011
Depression	120	48.7 [47.0, 50.4]	51.0 [48.8, 53.2]	0.025
Fatigue	115	50.2 [47.9, 52.4]	49.2 [46.6, 51.7]	0.494
Pain Interference	122	57.6 [55.5, 59.7]	55.1 [52.8, 57.4]	0.067
Physical Function	124	41.7 [39.3, 44.1]	43.4 [41.5, 45.4]	0.252
Sleep Disturbance	118	52.1 [50.2, 54.0]	53.3 [51.3, 55.3]	0.297

Figure 1. PROMIS-29 scores by domain, baseline and 6-month follow-up. Scores reported as mean *t* scores with 95% confidence intervals.

addition, because the outcomes in the study are patient-reported, we have in corporated the applicable EQUATOR Consensus-Based Checklist for Reporting of Survey Studies (CROSS) guidelines.[27] A complete CROSS checklist is also uploaded (Supplemental Digital Content, Table 2, http://links.lww.com/TA/C529).

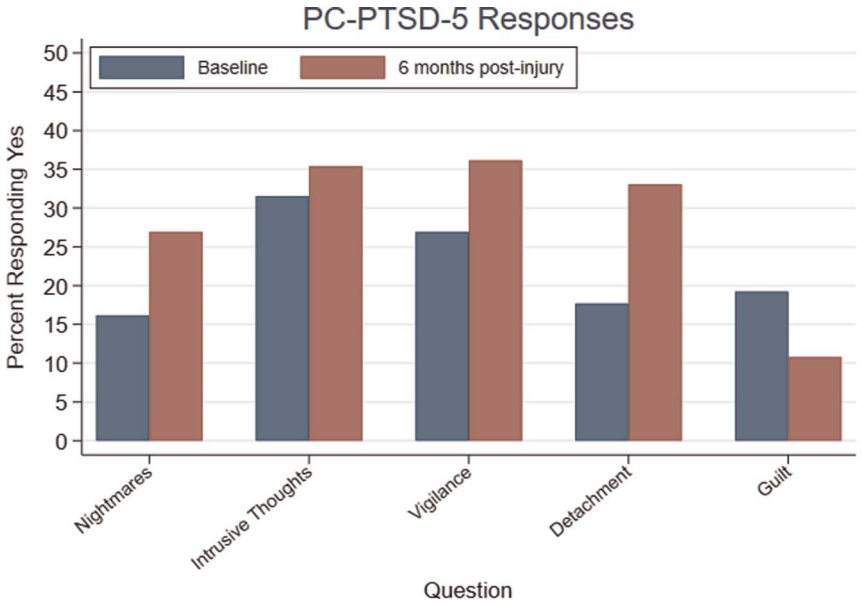


Figure 2. Preinjury and postinjury responses to questions on the PC-PTSD-5. Full wording of each question is shown in Appendix 2. Overall percentage screening positive for PTSD increased from 21.5% at baseline to 26.2% at 6-month follow-up ($p = 0.023$).

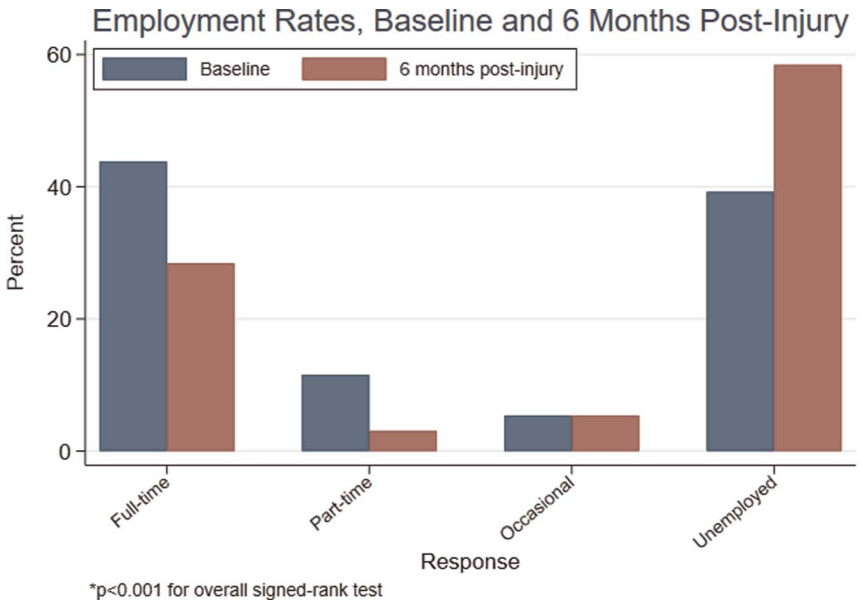


Figure 3. Baseline and 6-month employment status.

TABLE 3. Alcohol and Drug Use, Relationship Status, and Living Situation at Baseline and 6-Month Time Points

Question	Response	Baseline, n (%)	6 Months, n (%)	*p*
What best describes your alcohol intake?				0.001
	Every day	14 (10.8%)	4 (3.1%)	
	Every other day	4 (3.1%)	4 (3.1%)	
	1–2 days per week	16 (12.3%)	12 (9.2%)	
	Occasional	46 (35.4%)	41 (31.5%)	
	Never	49 (37.7%)	64 (49.2%)	
	Did not answer	1 (0.8%)	5 (3.9%)	
What best describes your drug use?				0.091
	Every day	10 (7.7%)	6 (4.6%)	
	Every other day	3 (2.3%)	3 (2.3%)	
	1–2 days per week	7 (5.4%)	3 (2.3%)	
	Occasional	12 (9.2%)	9 (6.9%)	
	Never	97 (74.6%)	104 (80.0%)	
	Did not answer	1 (0.8%)	5 (3.9%)	
What best describes your relationship status?				<0.001
	Married	35 (26.9%)	36 (27.7%)	
	Divorced	11 (8.5%)	6 (4.6%)	
	Widow/widower	5 (3.9%)	4 (3.1%)	
	In a relationship	15 (11.5%)	21 (16.2%)	
	Single	64 (49.2%)	58 (44.6%)	
	Did not answer	0 (0%)	5 (3.9%)	
What best describes your living conditions?				<0.001
	Private residence with family	97 (74.6%)	87 (66.9%)	
	Private residence, alone	30 (23.1%)	32 (24.6%)	
	Private residence with outside help	1 (0.8%)	4 (3.1%)	
	Assisted living	1 (0.8%)	0 (0%)	
	Community housing	1 (0.8%)	0 (0%)	
	Homeless	0 (0%)	0 (0%)	
	Did not answer	0 (0%)	7 (5.4%)	

p Values for alcohol and drug use are for signed-rank test. Relationship status is analyzed using χ^2 test on dichotomized responses (in a relationship or not). Living conditions analyzed using overall χ^2 test for the distribution.

RESULTS

Out of a total 2,616 patients meeting criteria during the study period, 362 were enrolled and completed baseline surveys. Compared with patients who declined the study, those who enrolled were younger (44.0 ± 18.5 vs. 49.4 ± 21.5, $p < 0.001$), more often shot (19.3% vs. 13.3%) ($p < 0.001$), and had more often undergone operation than those who did not (55.0% vs. 39.8%, $p < 0.001$) (Table 1). There were 55.0% that were reported being hospitalized for an injury previously. Of those completing the baseline, 130 completed follow-up. Those completing 6-month follow-up were similar ages (43.3 ± 17.8 vs. 44.4 ± 19.0, $p = 0.57$), mechanism (24.7% vs. 28.0% shot or stabbed; $p = 0.61$), and severities (median ISS, 9 vs. 9; $p = 0.15$) as those who only completed the baseline (Table 2) (Supplemental Digital Content, Figure 3, http://links.lww.com/TA/C530).

At the 6-month time point, patients reported a significant decrease in their ability to participate in social roles and activities (mean t-score 51.4 at 6 months vs. 55.3 baseline, $p = 0.011$), as well as increases in anxiety (53.8 at 6 months vs. 50.5 baseline, $p = 0.011$) and depression (51.0 at 6 months vs. 48.7 baseline, $p = 0.025$) (Fig. 1). There were no significant changes from baseline to 6-month time point in fatigue, pain interference, physical function, or sleep disturbance, but it is notable that, at both time points, patients reported above-average levels of pain interference and sleep disturbance and below-average levels of physical function. Patients reported a decrease in pain intensity at 6 months (4.2 vs. 5.5 on a 10-point scale, $p = 0.001$).

Of the patients completing 6-month follow-up, 21.5% screened positive for PTSD at postinjury baseline. This increased to 26.2% at the follow-up time point ($p = 0.023$). There was no significant difference in percentage reporting PTSD between those suffering a penetrating assault (gunshot wound or stabbing) versus not (31.3% vs. 24.5%; $p = 0.450$). Responses by question at each time point are summarized in Figure 2.

When we analyzed employment status, we found that 63.9% reported being "occasionally" employed or unemployed at 6 months versus 44.6% preinjury ($p < 0.001$ by χ^2 test and signed-rank test) (Fig. 3). Patients reported less frequent alcohol consumption ($p = 0.001$) and no difference in drug use ($p = 0.091$) at 6 months postinjury versus baseline. Relationship status was reported as married, in a relationship, divorced, widowed, or single; this was dichotomized for analysis into groups that were either currently in a relationship or not. We found that more patients reported being married or in a relationship at 6 months (43.9% vs. 38.5%, $p < 0.001$) than preinjury. The distribution of living conditions changed slightly at the 6 months as well ($p < 0.001$). Alcohol consumption, drug use, relationship status, and living conditions are shown in Table 3.

DISCUSSION

In this study, we sought to describe patients' long-term outcomes after traumatic injury, with the hypothesis that patients would experience detrimental effects on HRQoL, mental health, and social outcomes 6 months following injury. Using the PROMIS-29 instrument, patients reported worsening of their ability to participate in social roles in activities, anxiety, and depression. While there was a high rate of PTSD symptoms at postinjury baseline, patients also reported an increase in PTSD at the 6-month time point. Finally, we found that there was a higher rate of unemployment 6 months following injury.

These results are in line with previous work on the subject. Our group has written previously about PROs in both emergency general surgery[11] and trauma patients. In trauma, we showed that patients reported significantly lower scores than the population mean in every domain of the PROMIS-29 at the time of the initial clinic follow-up visit.[10] These visits often occur within a few weeks of discharge; thus, the current study adds to this work by describing a change from baseline and demonstrating a worsening of responses in multiple domains over 6 months. In addition, this study adds to our prior work by also examining mental health and social outcomes. The results of the Functional Outcomes and Recovery After Trauma Emergencies study were similar to both our prior work and the current study, using the short form 12 and the Breslau 7-item questionnaire to measure HRQoL and PTSD, respectively.[4] Patients reported HRQoL scores below population means as well as high rates of PTSD and unemployment. The current study builds on this evidence by measuring outcomes at multiple time points. Outside of the United States, Gabbe et al.[9] showed ongoing high rates of problems with pain, mobility, and anxiety/depression up to 3 years postinjury using the EuroQol questionnaire. This Australian population, however, is distinctly different from that at our institution, with the former being composed of 93% blunt injuries and less than 10% intentional injuries in the cohort that was followed up.

This is a prospective, observational study. While we lack a comparison group (i.e., uninjured subjects), the longitudinal follow-up is a significant and unique aspect of this project. Prior work showing that HRQoL outcomes are worse than population means are indeed important, but it may be difficult to know if such detriments are present at baseline or are a product of injury. Although this study does not entirely answer that question, its longitudinal nature does shed some light on the issue.

Limitations include a low enrollment rate. This has been a challenge both in our previous work and in the work of others.[4,10,11] Exact reasons for this remain unclear. Challenges to enrollment in trauma research studies are longstanding, likely multifactorial, and may include physiology/injury severity, mental state, or lack of trust in the health care and research systems.[28] It is notable that there were differences in distribution of injury mechanisms among those who enrolled and those who did not (Table 1); it is possible that this may reflect some unmeasured selection bias (e.g., those who fall may be less likely to enroll secondary to a cognitive impairment). In addition, we did not analyze our data for the effects of injury severity, physiologic, or operative/postoperative factors on long-term outcomes, as small sample size may have led to unstable estimates. Martino et al.[29] demonstrated an association between poorer Extended Glasgow Outcomes Scale and low presentation GCS and high ISS; on the other hand, the Haider study showed almost no association between injury severity and long-term outcomes, with the exception of extremity AIS.[4] This question remains unanswered and will be an interesting area of study for the future.

There are two additional limitations to note. First, much of this data collection was done during the COVID-19 pandemic. It is hard to know what effects this may have had on responses; in particular, we have some concerns that this external factor may

have contributed to postinjury unemployment rates.[30] Unemployment after trauma has been described before[17] and is likely to be a true finding here, but the pandemic may have augmented the magnitude of the finding. We plan to continue studying this going forward and determine whether this effect remains. Second, our baseline questionnaire was asked at a relatively immediate postinjury time point, while the changes over time are informative, it would also be helpful to know about patients' *preinjury* status. For example, this may contribute to our finding of high baseline levels of PTSD; it may be interesting to know how 6-month levels compare with a preinjury baseline. Similarly, one might expect that reported PROMIS scores would be different preinjury than they are immediately postinjury and that even the preinjury scores may differ from US population norms. Of course, the assessment of trauma patients prior to injury presents a logistical challenge, but in our future work on this topic, we hope to glean more information regarding patients' preinjury status.

As noted, the PC-PTSD-5 is a screening tool; a positive screen on this questionnaire does not confer a formal diagnosis of PTSD. We chose to use a cutpoint of 3 based on initial validation in veterans,[23] although the same group of authors subsequently suggested a cut point of 4 may also be acceptable, albeit with a higher proportion of false negatives (33.3%) in women.[22] Even if a cutpoint of 4 were used in the current study, there will still be a statistically significant increase in positive PTSD screens from baseline (17.1% vs. 10.1%, $p = 0.001$).

Despite some limitations, these results are important and should influence the care of trauma patients moving forward. As we continue to better define the long-term effects of traumatic injury, it will be important to describe risk factors for poor outcomes, identify high-risk patients early, and design appropriate interventions to mitigate these effects. These interventions may come in the form of violence and injury prevention initiatives,[31] the resources and personnel for which may be lacking at many trauma centers.[32] Violence prevention initiatives may include case management referrals or brief counseling, both of which have been shown to have a positive effect.[33,34] Interventions focused on nonintentional trauma may also be of use.[35] Postinjury interventions might include informational and peer support,[36] or mental health initiatives to help decrease rates of PTSD, anxiety, and depression going forward, particularly in high-risk patients.[37] There is relatively sparse evidence in this realm, and a recent meta-analysis found no decrease in these disorders in trauma patients treated with cognitive behavioral theory-base interventions.[38] Certainly, further research into potential effective interventions is warranted.

CONCLUSION

Trauma patients continue to experience poor HRQoL outcomes, PTSD, and unemployment up to 6 months postinjury. As we continue to refine trauma care beyond the prevention and treatment of morbidity and mortality, it will be important to screen for and intervene upon high-risk patients soon after injury.

AUTHORSHIP

J.S.H., E.J.K., M.J.S. participated in the conceptualization and study design. D.B., Ka.C., Kr.C., S.J., M.J.S. participated in the data collection. J.S.H., E.J.K., M.J.S. participated in the data analysis and interpretation. J.S.H., E.J.K., M.J.S. participated in the drafting of the article. D.B., K.C., K.C., S.J., P.M.R. participated in the critical review and revision.

DISCLOSURE

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