Utility of the injured trauma survivor screen to predict PTSD and depression during hospital admission

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Ann Marie Warren: grant money, Stanley Seeger Surgical Fund. The remaining authors have nothing to disclose.

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The reviewers have nothing to disclose.

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BACKGROUND: The brief, easily administered screen, the Injured Trauma Survivor Screen (ITSS), was created to identify trauma survivors at risk for development of posttraumatic stress disorder (PTSD) and depression.

METHODS: An item pool of PTSD risk factors was created and given, along with a previously created screen, to patients admitted to two Level 1 trauma centers. The Clinician Administered PTSD Scale for DSM-5, the PTSD Checklist for DSM-5, and the Center for Epidemiological Studies Depression Scale Revised were given during a 1-month follow-up. A total of 139 participants were included (n = 139; μ age = 41.06; 30.9% female; 47.5% White/Caucasian; 39.6% Black/African American; 10.1% Latino/Hispanic; 1.4% American Indian; and 1.4% other). Stepwise bivariate logistic regression was used to determine items most strongly associated with PTSD and depression diagnosis 1 month after injury.

RESULTS: Forty participants met criteria for a PTSD diagnosis and 28 for depression at follow-up (22 comorbid). ROC curve analysis was used to determine sensitivity (PTSD = 75.00, Depression = 75.00), specificity (PTSD = 93.94, Depression = 95.5), NPV (PTSD = 90.3, Depression = 80.8), and PPV (PTSD = 83.3, Depression = 93.8) of the final nine-item measure.

CONCLUSIONS: This study provides evidence for the utility of a predictive screen, the ITSS, to predict which injured trauma survivors admitted to the hospital are at the most risk for developing symptoms of PTSD and depression 1 month after injury. The ITSS is a short, easily administered tool that can aid in reducing the untreated cases of PTSD and depression. (*J Trauma Acute Care Surg.* 2017;82: 93–101. Copyright © 2016 Wolters Kluwer Health, Inc. All rights reserved.)

LEVEL OF EVIDENCE: Prognostic study, level III.

KEY WORDS: PTSD; depression; screen; traumatic injury; trauma centers.

Epidemiological studies have demonstrated lifetime prevalence of exposure to a traumatic event ranges from 51% to 89.6%[1,2] with an estimated lifetime prevalence rate of developing posttraumatic stress disorder (PTSD) ranging from 6.8% to 9.2% across the general population.[1,3,4] Subsumed in these numbers are single-incident trauma survivors who have experienced an acute injury. According to the National Trauma Institute, each year approximately 2.3 million people in the U.S. are involved in a single-incident traumatic experience resulting in hospitalization at a trauma center.[5]

Of these individuals, 10% to 42% will develop symptoms of PTSD within 1 year of injury.[6–11] Many studies have also consistently linked traumatic injury with the occurrence of comorbid PTSD and depression, or depression alone.[12–16] Despite the large numbers of trauma survivors that pass through Level 1 trauma centers in the U.S., most centers do not use this opportunity to screen for PTSD or depression risk. One major reason for this is the fact that most extant trauma measures focus on current symptoms and diagnosis rather than the future risk of developing PTSD.[17] To address the largely unmet mental health assessment need within this population, the American College of Surgeons Committee on Trauma[18] has recommended that trauma centers screen all trauma patients for PTSD and depression risk after traumatic injury. This recommendation has highlighted the need for a brief and easily administered screening measure.

To develop a screening tool, it is necessary to examine existing risk factor data for the development of PTSD and depression. There are many risk factors shown to have a relationship with the subsequent development of psychopathology after injury. These risk factors are delineated temporally into the categories of pretrauma, peritrauma, and posttrauma. Some of these predictors have emerged as more robust than others; for example, age is a sociodemographic variable that has been studied and found to have a large association with the development of PTSD. Yet, this effect is inconsistent, and a meta-analytic review found that the effect size for age was quite low (−0.01) across studies and that age likely was a proxy for other risk factors.[19]

With regard to current screens in the literature, there is one automated screen[20] that exists that was created for and normed on this population; however, no comparison was made in this study as the automated screen was not available at the time this study was conducted. The Predictive Screening Tool for Depression and PTSD after Injury is a measure created for and normed on an emergency department (ED) population, heretofore referred to as the Richmond et al. screen.[21] Although the ED non-admitted population is similar to the admitted population, they have significant differences as well. Distinctions include the types of potentially traumatic events that lead to inpatient hospitalization, the often invasive and frightening medical procedures involved in their treatment, and the time that passes between admission and discharge allowing patients to begin to process the impact of the event and the associated injuries emotionally, cognitively, financially, and interpersonally.

The purpose of the current study was to create a brief self-report screening tool to assess who among adult injured trauma survivors admitted to the hospital are at the most risk for the later development of PTSD and depression. The Richmond et al. screen was tested along with an original item pool to assess reliability across populations and to identify the most predictive risk factors among single-incident trauma survivors.

Submitted: July 6, 2016, Revised: September 28, 2016, Accepted: October 4, 2016, Published online: October 25, 2016.
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This study was presented at 75th annual meeting of the American Association for the Surgery of Trauma, September 14–17, 2016, in Waikoloa, Hawaii.
Supplemental digital content is available for this article. Direct URL citations appear in the printed text, and links to the digital files are provided in the HTML text of this article on the journal's Web site (www.jtrauma.com).
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DOI: 10.1097/TA.0000000000001306

METHODS

Participants

This sample consisted of adult injured trauma survivors admitted to the trauma service of two Level 1 trauma centers in the U.S. Potential participants were identified using the trauma census. Any individual admitted for traumatic injury was considered for inclusion in the study. Exclusion criteria were (1) younger than 18 years of age, (2) Glasgow Coma Scale score <13 on emergency department arrival, (3) self-inflicted injuries, (4) inability to communicate, and (5) non-English speaking.

Procedures

Step 1. Scale development began with an exhaustive and comprehensive review of the data with a focus on identifying risk factors for PTSD and depression that exhibited stable support in the literature.[22] These factors were delineated into 30 categories, of which 18 of these were consistently supported in prospective longitudinal studies. Questions based on each risk factor were devised and resulted in 48 items. A yes/no-binary response option was selected because of the nature of bedside hospital evaluation after a traumatic injury.

Step 2. This item pool was evaluated by experts to reduce redundancy and ambiguity while ensuring relevance, accuracy, and parsimony.[23] Expert reviewers were all professionals specialized in traumatic injury and consisted of one psychiatrist, one trauma surgeon, and two psychologists. Each reviewer received an email with instructions, a copy of the item pool, and a copy of the Richmond et al. screen (reviewers were blind to whether or not the items were a part of the Richmond et al screen). Reviewers were asked to rank each item on a scale from 1 to 5 (1 = not clear or appropriate; 5 = very clear or appropriate) and provided additional edits and suggestions.[24] Any item averaging less than three on the Likert scale was removed. Feedback and edits from these reviewers included changes to wording and rearranging of items for simplicity and clarity. Of the original 48 items, 39 were kept, reassessed, and altered as recommended.

Step 3. The prototype scale was given to a small pilot group of 15 participants who were asked to provide feedback regarding clarity and wording.[24] After approval from the Institutional Review Board (IRB) at the primary data collection site, data were collected at two Level 1 trauma centers in metropolitan settings. All materials were identical and reimbursement was provided at both institutions to ensure that all aspects and procedures of the protocol were congruent. On average, both recruitment centers admit greater than 2,000 patients annually with median lengths of stay of 4 days.

Recruitment

If a participant qualified for recruitment, a trained psychology graduate or undergraduate research associate approached the individual, explained the purpose and process of the study, and conducted the process of informed consent. If the individual agreed to participate, the participant was enrolled during hospitalization. The participant was then administered the Injured Trauma Survivor Screen (ITSS) item pool along with the items from the Richmond et al. screen. Two hundred seventy-six participants were enrolled and follow-up was conducted at 1 month with 139 participants completing this assessment. At this time, participants were administered the Clinician Administered PTSD Scale for *DSM-5* (CAPS-5), the PTSD checklist for *DSM-5* (PCL-5), and the Center for Epidemiological Studies Depression Scale Revised (CESD-R).

Measures

The Predictive Screening Tool for Depression and PTSD after Injury (Richmond et al. screen)

This measure was created for and normed on a U.S. sample in an urban setting administered in the emergency department.[21] It consists of eight questions and utilizes a yes/no item response format developed to measure risk for PTSD and depression concurrently. ROC curve analysis was used to determine the optimal cut-point offering the best balance for sensitivity (PTSD = 1.00) and specificity (0.66) in their sample.

PTSD

The PCL-5 consists of 20 items and it takes 5 to 10 minutes to administer. Participants are instructed to answer items based on their experience of symptoms since the trauma (hospitalization) or in the last month (1 month). Each item corresponds to a symptom in the *DSM-5*.[25] It has demonstrated strong internal consistency ($\alpha = 0.94$), good retest reliability ($r = 0.82$), and good convergent ($r = 0.74$–0.85) and divergent ($r = 0.31$–0.60) validity.[26]

The CAPS-5 is a clinician-administered structured diagnostic interview that is considered the gold standard for assessing and diagnosing PTSD. The CAPS has been studied primarily in veteran samples, and in one large study ($n = 838$), the CAPS yielded intraclass correlations for the symptom clusters from 0.86 to 0.87 for frequency (total frequency = 0.93, $\alpha = 0.93$), 0.86 to 0.92 for intensity (total intensity = 0.95, $\alpha = 0.94$), and 0.88 to 0.91 for severity (total severity = 0.95, $\alpha = 0.94$).[27] In a study of survivors of motor vehicle accidents, Blanchard et al.[6] found evidence for interrater reliability ranging from 0.82 to 0.99 with a kappa of 0.81 for PTSD diagnosis.

Depression

Depression was measured with the CESD-R. The psychometric properties of this measure were tested in a large community and student sample yielding strong internal consistency among the community sample ($\alpha = 0.923$, $n = 6{,}971$).[28] Among this sample, it was also positively correlated with the State-Trait Inventory for Cognitive and Somatic Anxiety (STICSA; $r = 0.737$, $p < 0.01$) with 4.6% of the participants meeting criteria for depression, corresponding very closely to the rate of 4.98% to 5.57% found in a large epidemiological study.[28,29] In the current study, the diagnostic algorithm described by the creators of the CESD-R was used rather than a cutoff score, ensuring that those diagnosed with depression met criteria for a major depressive episode.[30]

Statistical Analyses

At both sites, the CAPS-5 were administered and scored by doctoral level students. The Midwestern team along with one of the previously mentioned experts scored five assessments independently and achieved 100% accuracy with regard to PTSD diagnosis. Inter-rater reliability was assessed by audio recording a subsample of CAPS-5 administrations (1 from the

TABLE 1. Injury Type by PTSD Diagnosis at 1 Month Follow-Up

	PTSD Criteria Met?	
	No	Yes
Injury Type	% (n)	% (n)
GSW	43.5% (10)	56.5% (13)
MVC	68.3% (28)	31.7% (13)
Stabbing	41.7% (5)	58.3% (7)
MCC	87% (20)	13% (3)
PSV	75% (6)	25% (2)
Fall	89% (16)	11% (2)
Industrial accident	100% (2)	0% (0)
Recreational	100% (8)	0% (0)
Other	100% (4)	0% (0)
Total	71.3% (99)	28.7% (40)

GSW, gunshot wound; MVC, motor vehicle crash; MCC, motorcycle crash; PSV, pedestrian struck by vehicle.

Southwestern site n = 17 and 10 from the Midwestern site n = 122, ~8%) and having those measures scored by a team member who did not conduct the initial interview.

Stepwise logistic regression was used to identify the best fitting model of the 39 original risk factor items and 8 Richmond et al. screen items that predicted PTSD and depression using Minitab 17 statistical software. This method was chosen for this study because it was (1) primarily exploratory in nature; (2) the relationships between the outcome variables and many of the predictors are not well established; and (3) in these cases in which many predictors are being tested for their association with the outcome, stepwise entry is a suitable and parsimonious option.[31]

ROC curve analysis was conducted to determine the cut-off point for the measure that provided the highest sensitivity and specificity. The ROC curve analysis is a graph that plots various thresholds of discrimination. The plot consists of the true-positive rate (TPR, Sensitivity) and the false-positive rate (1 − specificity) plotted in various threshold settings, which allows for the calculation of the negative predictive value (NPV = true negatives/true negatives + false positives) and the positive predictive value (PPV = true positives/true positives + false negatives).[31]

RESULTS

Descriptive Statistics

One hundred thirty-nine participants completed the original questionnaire while inpatient and completed the 1-month follow-up interview conducted on the phone. The retention rate was 50% with 276 participants consenting to the study while inpatient, eight of whom formally withdrew. Among participants who completed the baseline and follow-up assessments, the average age was 41.06 (SD = 17.53), there were 10 (7.2%) Veterans, and average education level was 13.12 (12 = high school graduate; SD = 2.3). Results indicated no significant differences among completers and non-completers based on sex ($\chi^2(1) = 1.991$, $p = 0.158$), age ($U = 7{,}928.00$, $p = 0.124$), race/ethnicity (LR(5) = 6.742, $p = 0.241$), or mechanism of injury (MOI) (LR(9) = 15.365, $p = 0.081$). The rates of PTSD by MOI are presented in Table 1 and additional descriptive statistics are presented in Table 2.

Average time from injury to the first data collection time point (while the participant was on the inpatient trauma/critical care service) was 4 days (SD = 3.96). Average time from injury to the second data collection period in which they were evaluated for PTSD was 41 days (1 month needed for diagnosis; SD = 13.12). The rate of depression was 20% (n = 28/139) and the rate of PTSD was 28.7% (n = 40/139) of those who met PTSD criteria at 1 month based on their CAPS-5 score; 55% (n = 22/40) met criteria for comorbid depression based on their score responses to the CESD-R ($\chi^2(1) = 42.418$, $p < 0.001$, $\varphi = 0.552$).

Of those with PTSD, 35% (n = 14/40) were female, 65% (n = 26/40) were male, 73% (n = 29/40) self-identified as Black or African American, 13% (n = 5/40) as Latino or Hispanic, 13% (n = 5/40) as White or Caucasian, <1% (n = 1/40) as American Indian, and one was a Veteran. The group with the highest rate of PTSD was Black or African American males (n = 20/40) followed by Black or African American females (n = 9/40). Within the PTSD group, 28% (n = 11/40) had experienced another traumatic event since their injury and 25% (n = 10/40) had received psychotherapy, 10% (n = 4/40) were taking psychotropic medication, and 5% (n = 2/40) had both psychotropic and psychotherapeutic intervention.

TABLE 2. Demographic Data (N = 276)

	Completers (n = 139)	Non-completers (n = 137)
	M (SD)	
Age	41.06 (17.53)	37.30 (15.01)
	Median (IQR)	
Education	12 (12–14)	12 (12–14)
Time to data collection (inpatient)	3 (2–5)	3 (1–4)
	Percentage	
Sex: male	69.1%	76.70%
Race		
Caucasian/White	47.5%	53.5%
African American/Black	39.6%	35.7%
Hispanic/Latino	10.1%	8.5%
Native American	1.4%	0.0%
Other	1.4%	0.8%
Asian	0.0%	1.6%
Mechanism of injury		
MVC	29.5%	22.5%
GSW	16.5%	21.7%
MCC	16.5%	9.3%
Fall	12.9%	14.0%
Stabbing	8.6%	11.6%
PSV	5.8%	3.9%
Recreational	5.8%	6.2%
Other	2.9%	3.9%
Industrial accident	1.4%	2.3%
Blunt assault	0.0%	4.7%

GSW, gunshot wound; MVC, motor vehicle crash; MCC, motorcycle crash; PSV, pedestrian struck by vehicle.

TABLE 3. Results of the Regression Analysis for PTSD and Depression

	β Coefficients	SE	95% CI	Z-statistic	p	VIF
Results of the regression analysis for PTSD						
Constant	−4.397	0.710	−5.788, −3.005	−6.19	0.000	
Perceived life threat	1.844	0.573	0.722, 2.966	3.22	0.001	1.04
Intentional injury	1.446	0.677	0.120, 2.772	2.14	0.033	1.11
Hyperarousal	1.669	0.604	0.486, 2.853	2.76	0.006	1.13
Trait worry/rumination	1.470	0.586	0.322, 2.618	2.51	0.012	1.05
Negative alteration in cognitions	1.708	0.562	0.606, 2.810	3.04	0.002	1.01
Results of the regression analysis for depression						
Constant	−5.588	0.996	−7.539, −3.636	−5.61	0.000	
Pre-existing psychopathology	2.359	0.784	0.823, 3.895	3.01	0.003	1.53
Premorbid depression	1.330	0.664	0.028, 2.631	2.00	0.045	1.10
Perceived life threat	2.271	0.740	0.821, 3.721	3.07	0.002	1.27
Negative alteration in mood	2.084	0.770	0.575, 3.593	2.71	0.007	1.16
Mood/depression	2.217	0.674	0.895, 3.539	3.29	0.001	1.12

SE, standard error; CI, confidence interval; VIF, variance inflation factor.

Agreement and Reliability

Inter-rater agreement was calculated via a Kappa statistic, which produced a Kappa of 1.00 at the level of diagnosis. Given that there are little data on the psychometric properties of the CAPS-5 and PCL-5, a test of alternate forms reliability was used as an additional assessment of the reliability for diagnosis. The first step in this process was comparing scores on the PCL-5 with diagnosis on the CAPS-5 via ROC curve analysis. This produced a Youden's *J* of 22 on the PCL-5 for PTSD diagnosis at 1 month. The usefulness of this output is twofold: (1) it provided a possible cut-off score for a provisional diagnosis of PTSD using the PCL-5 among the injured trauma population; and (2) this allowed for the calculation of Kappa at the level of diagnosis between these two measures, which was found to be moderate for this sample at 0.749.

Logistic Regression Results

A stepwise logistic regression was used to explore the relationship between the 47 dichotomous predictor variables at hospitalization and the dichotomous outcome variables separately (PTSD/no PTSD, and Depression/no Depression) at approximately 1 month posttrauma. The stepwise logistic regression of all 47 items resulted in a model (step five for both PTSD and Depression, $\alpha = 0.05$ to enter or remove) in which five covariates were retained for PTSD and five for Depression. The z-statistics and their associated *p* values are provided for each predictor retained in the model in Table 3. Table 4 presents the odds ratios (95% CI) for the covariates retained in the model. The odds ratio is an effect size measure for categorical data and is the alternative to the correlation coefficient used with continuous variables.[32]

ROC Curve Analysis

The ROC curve analysis for depression showed a statistically significant difference between the Richmond et al. screen and the ITSS in predicting which participants were diagnosed with depression at 1 month (ITSS area under the curve [AUC] for depression = 0.927, 95% CI = 0.870, 0.964; Richmond screen AUC for depression = 0.813, 95% CI = 0.738, 0.874, $p = 0.0005$). The ROC curve analysis for PTSD also found a statistically significant difference between the AUCs for the Richmond et al. screen and the ITSS (ITSS AUC for PTSD = 0.915, 95% CI = 0.856, 0.956; Richmond et al. screen AUC for PTSD = 0.783, 95% CI = 0.705, 0.848, $p = 0.0007$). The Youden index ($J = 0.6894$ for ITSS PTSD; $J = 0.7050$ for ITSS Depression) yielded a cut-point of scores greater than or equal to 2 for both the ITSS PTSD and depression subscores. Given this cut-off, 48.9% of the sample screened positive for PTSD risk and 43.9% screened positive for depression risk.

Sensitivity Specificity NPV and PPV

The sensitivity of the ITSS was 75% for both PTSD and depression. The specificity for PTSD was 93.94% and for depression was 95.50%.

Given the variability in previous research indicating a prevalence range of 10% to 42% of single-incident trauma survivors developing PTSD, the 28% prevalence rate from this sample

TABLE 4. Odds Ratios for Individual ITSS Items Predictive of PTSD and Depression

	Odds Ratio	95% CI
Odds ratios for individual ITSS items predictive of PTSD		
Perceived life threat	6.3224	2.0585, 19.4189
Intentional injury	4.244	1.1270, 15.9842
Hyperarousal	5.3084	1.6250, 17.3409
Trait worry/rumination	4.497	1.3800, 13.7102
Negative alteration in cognitions	5.5173	1.8333, 16.6044
Odds ratios for individual ITSS items predictive of depression		
Pre-existing psychopathology	10.5793	2.2767, 49.1602
Premorbid depression	3.7793	1.0283, 13.8907
Perceived life threat	9.6920	2.2734, 41.3193
Negative alteration in mood	8.0339	1.7766, 36.3293
Mood/depression	9.1788	2.4478, 34.4183

CI, confidence interval.

was used to calculate the NPV and PPV as it fell in the middle of this prevalence range.[6–11] The NPV for PTSD was 90.3% and for depression was 80.8%. The PPV for PTSD was 83.3% and for depression was 93.8%.

DISCUSSION

Some trauma centers and researchers are currently using early symptoms of PTSD as their primary means of screening for the later development of PTSD and/or posttraumatic psychopathology. This is a less effective means of assessing risk given that these measures are designed to make provisional diagnoses, and early symptoms of acute stress alone are not the best predictors of later PTSD development.[33] Additionally, posttrauma trajectory research has found that high levels of psychological distress in the early stages of recovery do not necessarily predict high levels of distress later on, and conversely, endorsing no or minimal symptoms of distress early on does not ensure that one will not develop PTSD later.[34]

The current study presents a solution to these obstacles. The ITSS (see Chart, Supplemental Digital Content 1, http://links.lww.com/TA/A831) is comprised of a total of nine items in a yes/no response format constituting a quickly administered screen that can be easily integrated into current trauma center screening procedures, such as those currently being done for alcohol use. The ITSS performed well in this sample and produced strong specificity, sensitivity, NPV, and PPV for both PTSD and depression. These strong results are likely due to the type of risk factors the ITSS was designed to measure. That is, following the comprehensive literature review, variables that were shown to be consistent predictors in more comprehensive investigations were used exclusively. This method involved the creation of self-report items, and therefore these items would not lend themselves to an automated procedure like the screen developed by Russo[20] and colleagues. However, the ITSS likely increases diagnostic accuracy as it does not rely on the existence of pre-existing admission data in patients' medical charts (e.g., recurrent admission and previous diagnoses), possibly providing a more robust assessment of risk and a reduction of false negatives.

As previously mentioned, certain risk factors may serve as proxies for more robust predictors. For example, in an intervention study by Zatzick and colleagues,[35] their sample consisted of a disproportionate number of female participants that screened positive for PTSD risk, whereas our sample consisted of significantly more men than women (which is an accurate representation of the proportion of men to women at the enrolling site). This difference between their sample and ours may be explained by critical findings showing that intentionality is associated with increased risk for psychopathology. Previous research indicates that men are more likely to experience an injury as a result of an accident or assault,[3] higher rates of assaultive violence exist among some minority populations,[36] and an increased risk for the development of PTSD exists when traumatic injury is a result of an intentional act of violence.[1,11,34,35] Notably, the current sample had proportionally more individuals of racial/ethnic minority status (49% in the current study as compared to 40% in the Zatzick et al. sample). Additionally, 32 of the 35 assaultive/intentional injuries in this sample were participants of racial/ethnic minority status. Thus, it is likely that the nature of injury more accurately accounts for a portion of the variability in risk for PTSD when included as a research variable rather than any individual demographic characteristic such as race or gender.

Early screening for posttraumatic psychological distress, such as that provided by the ITSS, has important implications for clinical practice. Indeed, such a screen would allow providers to identify those individuals who are most likely to benefit from interventions to prevent psychopathology. Based on this sample, just under half of those screened indicated positive risk for PTSD and/or depression. A positive screen would then alert treatment providers of the need for consultation from a mental health provider to manage the care of these patients and increase the likelihood of better overall posttraumatic health outcomes. With regard to mental health outcomes specifically, studies examining various intervention approaches have found that relative to treatment as usual, there are better mental health outcomes for those receiving early interventions.[37–39]

Zatzick and colleagues have focused on implementing stepped interventions that begin by screening for at-risk patients in an effort to provide the least intrusive and most cost-effective interventions first, and they have found that stepped interventions can increase the overall population impact in a cost-effective way.[20,38,40] There is also evidence that psychotherapeutic intervention provided within hours of an injury while patients are in the emergency department can reduce rates of PTSD, and this finding holds up regardless of genetic risk.[41,42] Although emerging evidence suggests that early interventions are beneficial, interventions are only needed for those at risk, and based on the data presented herein, the ITSS has the potential to accurately predict up to 83.3% of individuals who will go on to develop PTSD 1 month after injury.

Limitations and Future Directions

It is possible that the ITSS will perform quite differently in another sample, in patients at Level 2 to 4 trauma centers, and at different time points after injury. These results indicate sample characteristic differences between ED patients and those admitted to the trauma service for example, as evidenced by the performance of the ITSS in comparison to the Richmond et al. screen. This difference is clearly demonstrated by the fact that perceived threat to life was maintained in this sample as predictive of both PTSD and depression, but not predictive in the ED sample. Cross-validation within a larger sample and replication studies are needed to increase confidence in the findings and to provide evidence for the predictive validity of the measure. Research examining the rates of PTSD 6 months after injury and beyond has shown that not all of those who meet criteria for PTSD at 1 month after injury will meet criteria at later time points, and that some of those who do not screen positive early may go on to develop PTSD.[39,43] A larger randomized sample with an extended longitudinal design would address many of the limitations present in this study. Regardless, the nine-item ITSS presents as a valid and parsimonious tool for predicting risk in an injured hospital population.

Finally, although the ITSS demonstrated strong fit statistics in this population, there are also some disadvantages

to implementing a manual screen; primarily, the requirement for person-to-person administration. When choosing a screen, trauma centers will have to balance a number of factors, including availability of personnel to screen and number of admissions per year. Identifying those at risk for the development of PTSD and depression among single-incident trauma survivors is becoming a priority for mental health treatment providers in medical settings and physicians alike. The ITSS is a brief nine-item tool with yes/no responses that could be easily integrated into current screening procedures, such as alcohol screening, while trauma survivors are in the hospital, thereby streamlining efforts to identify and prioritize mental health intervention for those with the most acute need.

AUTHORSHIP

J.C.H. contributed to the literature search, study design, data collection, data analysis, data interpretation, writing, and revision. T.A.d-C. contributed to the study design, data collection, data analysis, data interpretation, and revision. M.S. contributed to the study design, data analysis, and data interpretation. C.W. contributed to the study design, data analysis, and data interpretation. K.B. contributed to the writing and revision. A.M.W. contributed to the data collection, writing, and revision.

DISCLOSURE

The authors declare no conflicts of interest.

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DISCUSSION

Dr. Ronald Stewart (San Antonio, Texas): I congratulate the authors on a very nice paper. In chapter 12 of the *Optimal Resource for the Care of Injured Patient* the authors write:

"Early screening and referral for psychotherapy and pharmacologic treatment of PTSD and related comorbidity and depression following injury have the potential to improve symptomatic and functional outcomes.

"The incorporation of routine trauma center-based screening and intervention for PTSD and depression is an area that could benefit from the ongoing integration of emerging data and the evolving expert opinion."

So thank you very much for working on this important problem. But to move this from a recommendation to a criteria for trauma centers, not a mandate—we don't like to use the word "mandate"—to criteria for trauma surgeons generally requires solid data on outcome or efficacy and, two, ease of implementation into practice. So my questions center around these two factors.

The follow-up period was about a month, a mean of 41 days, in the manuscript. Is that time period right? Or, specifically, would a better time point to assess PTSD be six months after injury? Or is a month about the right time?

Second, as you note in the manuscript there is an automated screen that's been developed that doesn't require administration of a face-to-face questionnaire. What's the role of this type of screening? And is this tool complementary? And do you have plans to compare these types of screening?

Third, thank you for describing the individual odds ratio for each of the factors. You used a parsimonious technique. My question is could you make it more parsimonious? Did you model a shorter screening tool—say, three questions? My experience is I can remember three things and my experience with the people I teach, also, they seem to be able to remember three things. Have you modeled such a shorter screen?

And then, lastly, do you have plans for a randomized, multi-center evaluation of this tool to see if it makes a difference in outcome?

I'd like to thank the AAST Program Committee for the privilege of discussing this very interesting and provocative paper. Thank you.

Dr. Ajai K. Malhotra (Burlington, Vermont): I really enjoyed that study. Excellent work. But my slight question is something in the last sentence you had written that the conflict sometimes between sensitivity and specificity, you are calling this a screening tool. By definition a screening tool should be able to pick up almost everybody. And a sensitivity of 75% is not a good screening tool.

On the other hand, the specificity is 96%, which is pretty good, so it's almost a diagnostic tool as opposed to a screening tool. And I would agree with Ronnie that maybe if you reduced the questions, increased the sensitivity, then it would be a true screening tool.

Dr. Samir Fakhry (Charleston, South Carolina): To follow up on the question you just heard, we've used Kessler VI as a screening tool to identify people with psychological distress, just broadly speaking.

And it even dawned on me that since about half of our patients have come out as a positive for either depression, PTSD, etc, why not just consider your entire population at-risk?

The second question is, are you just doing this while they're in-house or do you follow them up? At least in our experience, we can't capture all of them while they're still in the hospital.

And, finally, a third question, what do you do with your traumatic brain injury patients? We struggled to figure out how do we incorporate a screening mechanism for them and so far all we can come up with is to just catch them in the two to three months after they've been discharged.

Dr. Stephen Lu (Albuquerque, New Mexico): Yes, just to be brief, so do you feel your instrument is consistent or validated across ethnicity and gender also given that 70% of your population was male and that also it is predominantly white and African-American. So if a center has, say, Native American or Hispanic populations can we use this same tool?

Dr. Deborah A. Kuhls (Las Vegas, Nevada): Two brief questions, first, does your tool captured the delayed presentation? And if so, how? Second is, is there a role for group therapy for these types of patients to make this more affordable for trauma centers?

Dr. Terri A. deRoon-Cassini (Milwaukee, Wisconsin): I want to thank everybody for the thoughtful questions. Dr. Stewart, the one-month time period was chosen to get those who meet criteria.

After that time point, the American Psychiatry Association says that we need to allow for normal responding and not over-pathologize those who experience distress after being through a traumatic event, and so we wanted to capture that time point.

Absolutely, we need to further validate at six months, and I would even argue a year out to pick up on those who are most chronic in their distress. I should say another arm of our research is where we study emotion regulation using fMRI and how that predicts long-term, chronic PTSD. And what we see is that at that one-month time period under-activation of the frontal lobe and over-activation of the amygdala predicts chronic PTSD. So when it's evident at one month, it's evident more likely long-term.

Doug Zatzick's work on his automated screen absolutely can be beneficial. You jeopardize even further sensitivity and specificity with the automated screen, as he published with Joan Russo in 2013.

Doug and I are presenting together in a couple of months at the International Society for Traumatic Stress Studies to talk about the balance of using an automated screen to try to reach as many trauma survivors as possible versus an in-person screen where you might not get to everybody but your sensitivity and specificity is improved.

And to kind of jump out of Dr. Stewart's questions and to the one that was asked about the screener, it's a little different with psychology and psychological disorders. Like I said, the 75% sensitivity and 96% specificity is actually pretty good in the psychological literature.

To consider an even shorter screen, actually Karen Brasel and I did a study a couple of years ago of using the PC PTSD which is four items—you go from five to four. And the sensitivity and specificity of those items was even less. And so the five items is actually out-performing the shorter items.

Further validation on gender and ethnicity is definitely needed and we are interested in moving forward with a multi-center trial.

One last comment about the TBI patients, we include mild traumatic brain injury as there is high comorbidity between negative outcomes after TBI and PTSD. But further exploration is needed in patients with more severe brain injury. Thank you.