ORIGINAL ARTICLE

# The Injury Distress Index: Development and Validation

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ABSTRACT. Victorson DE, Enders CK, Burnett KF, Ouellette EA. The Injury Distress Index: development and validation. Arch Phys Med Rehabil 2008;89:1893-902.

**Objective:** To develop and validate a new measurement tool designed to assess self-reported distress responses after traumatic physical injury.

**Design:** A mixed-methods study design was used. Development of the Injury Distress Index (IDI) included input from patients and experts and a comprehensive literature review. The IDI and validity measures were administered by a trained research assistant at bedside within 1 week of admission. The internal structure (exploratory factor analyses [EFAs]), reliability (internal consistency), and associations with other variables (construct and criterion validity) were examined.

**Setting:** Hand, multiple trauma, and burn services at a large southeastern level-1 trauma center.

**Participants:** Multicultural cohort of 169 traumatically injured adults (31% hand, 21% burn, 48% multiple trauma).

**Interventions:** Not applicable.

**Main Outcome Measures:** IDI, Trauma Symptom Checklist−40, Short-Form McGill Pain Questionnaire, Perceived Stress Scale−10, Life Orientation Test−Revised, General Perceived Self-Efficacy Scale, Drug Abuse Screening Test−10, Brief Michigan Alcoholism Screening Test, Abbreviated Injury Scale, hospital length of stay (LOS), postdischarge emergency department visits, and days readmitted to hospital postdischarge.

**Results:** An item pool was developed from patient, expert, and literature review data. EFAs extracted 3 separate factors for posttraumatic stress (avoidance and numbing, re-experience, and hyperarousal: coefficient range, .31−.98), which is consistent with conceptual and diagnostic criteria. EFAs also produced single factors of depression (coefficient range, .44−.72), anxiety (coefficient range, .50−.75), and pain (coefficient range, .57−.79). Most IDI scales (except anxiety) could be differentiated between different levels of injury severity. IDI scales and subscales correlated highly and in a convergent pattern with validity measures of posttraumatic stress ($r$ range, .18−.50), depression ($r$ range, .24−.52), anxiety ($r$ range, .30−.57), and pain ($r$ range, .10−.42), as well as theoretically related variables, such as general distress ($r$ range, .32−.56), self-efficacy ($r$ range, −.15 to −.39), and optimism ($r$ range, −.21 to −.45). IDI scales correlated in a discriminant pattern with measures of drug and alcohol abuse ($r$ range, .02−.07; $r$ range, .09−.21, respectfully). Concurrent and predictive validity evidence was also supported with small associations with injury severity ($r$ range, .16−.30), hospital LOS ($r$ range, .05−.21), number of emergency department visits postdischarge ($r$ range, −.05 to .27), and number of days readmitted to the hospital postdischarge ($r$ range, .05–.21). Cronbach $\alpha$ coefficients were within the acceptable range ($\alpha$ range, .75−.92).

**Conclusions:** A new tool to examine injury-related distress after traumatic physical injury has been developed. Results suggest that IDI scores showed acceptable reliability and validity coefficients with this multicultural sample. Additional validation studies are recommended with larger sample sizes using similar populations to confirm these findings.

**Key Words:** Burns; Hand injuries; Multiple trauma; Rehabilitation; Stress, psychological; Validation study [publication type].



EACH YEAR IN THE UNITED STATES nearly 3 million Americans will sustain an injury that warrants inpatient hospitalization, with roughly 28 million people requiring emergency department attention.[1] Among these injuries, those involving multiple trauma, the upper-extremity (eg, arm, wrist, hand, fingers), and burn-related trauma can be remarkably debilitating[2]; their economic impact alone exceeding hundreds of billions of dollars each year.[1]

A substantial group of those injured will develop acute and chronic physical and psychologic symptomatology.[3,4] The most prevalent injury-related distress sequelae are symptoms of posttraumatic stress, depression, anxiety, and pain.[3-10] Medical staff often fail to recognize that a sizeable subset of traumatically injured patients experience moderate to severe injury-related distress symptoms.[11] It is important that screening and

**List of Abbreviations**

| | |
|---|---|
| AIS | Abbreviated Injury Scale |
| BMAST | Brief Michigan Alcoholism Screening Test |
| DAST-10 | Drug Abuse Screening Test–10 |
| DSM | *Diagnostic and Statistical Manual of Mental Disorders* |
| EFA | exploratory factor analysis |
| GPSES | General Perceived Self-Efficacy Scale |
| IDI | Injury Distress Index |
| LOS | length of stay |
| LOT-R | Life Orientation Test−R |
| PSS-10 | Perceived Stress Scale−10 |
| SCID-I/P | Structured Clinical Interview-I DSM-III (patient edition) |
| SF-MPQ | Short-Form McGill Pain Questionnaire |
| TSC-40 | Trauma Symptom Checklist−40 |

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detection efforts are undertaken in the acute phase of a patient's hospitalization to identify those at greatest risk to facilitate prompt and comprehensive interventions aimed at lessening the physical, functional, psychologic, social, and economic burden associated with traumatic physical injury.[12]

Over the past 3 decades, several self-report questionnaires have been used to assess important injury-related distress outcomes in medical settings. Some examples include the Beck Depression Inventory[13] after burn injury,[8] the Hospital Anxiety and Depression Scale[14] and Impact of Events Scale[15] after acute traumatic hand injury,[16] the Davidson Trauma Scale[17] after multiple trauma,[18] and the McGill Pain Questionnaire[19] after burn injury.[20,21] Existing measures used to determine the distress related to traumatic injury are limited for the following reasons: (1) no existing tool specifically deals with the full spectrum of patient distress related to their traumatic injury; (2) existing tools have different response options and periods and therefore the information captured is not systematically uniform; (3) the burden of applying a battery of scales would be too onerous for patients and therefore impractical and inefficient; and (4) none includes injury or accident specific item content, which would facilitate increased content relevance and specificity. For these reasons we concluded that a new scale measuring injury-related distress would be beneficial.

To date, no brief, comprehensive injury-related distress assessment tool has been designed and validated for traumatically injured patients. The purpose of this investigation was to develop a new tool to measure injury-related distress and gather initial psychometric evidence on its scales and subscales.

## METHODS

### Development of the IDI

After a 1-year rehabilitation psychology clinical rotation (completed by D.E.V.) with hand, burn, and multiple trauma patients at the hospital where this study was conducted, we reviewed and summarized clinical process notes from intake interviews and case summaries to identify common symptoms of injury-related distress as well as issues related to coping and adjustment. These issues and concerns were the basis of a guiding conceptual domain framework (fig 1), which underwent additional modification and refinement from a comprehensive literature review and expert input. Although a detailed review of the entire guiding framework is beyond the scope of this article, figure 1 offers a conceptual schematic to better understand the myriad of elements that were considered to increase one's risk of developing injury-related distress and impede recovery, or increase resilience, which may protect against developing injury-related distress and promote quicker recovery and adjustment. This framework became the basis for developing an item pool that reflected the key elements of the "reaction" domain represented by the triangle in figure 1, which included posttraumatic stress, depression, anxiety, and pain.

In addition to reviewing patient comments, we conducted a comprehensive literature review (using Medline, PsycArticles, Science Direct, Wiley InterScience) in which key terms such as *traumatic injury* and *depression*, *anxiety*, *posttraumatic stress*, *pain*, and other risk, resilience, and recovery variables were examined and incorporated in the framework. Expert input was also requested from a team of clinical rehabilitation specialists, which included rehabilitation psychologists, nurses, orthopedic surgeons, burn care specialists, occupational therapists, and physical therapists who were members of a multidisciplinary care team where this study was conducted. Through a multiphase, iterative review and series of discussions, members of this team provided ongoing clinical and theoretical guidance to the evolving concepts derived from their clinical expertise, patient comments, and literature review findings.

Subsequent items were added and modified per recommendations from a second panel of 5 experts who were recruited from a university's academic department of educational and psychologic studies and represented the areas of test construction, psychometrics, and behavioral medicine. We wrote addi-

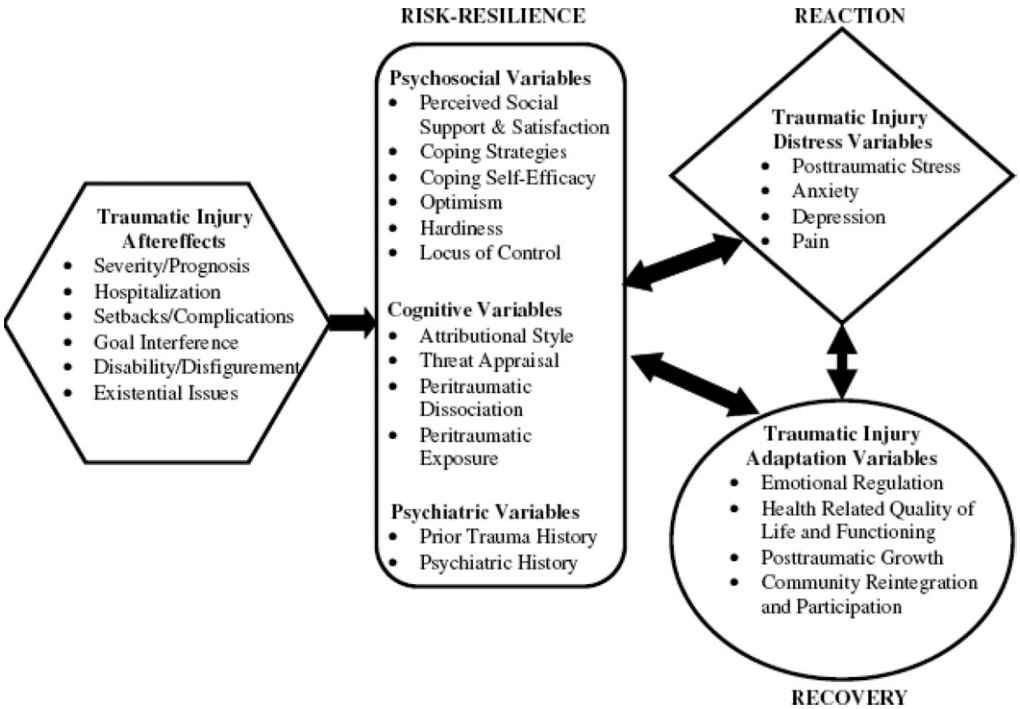


**Fig 1. Conceptual domain framework of risk-resilience, reaction, and recovery after traumatic physical injury.**

tional items to fill conceptual gaps based on criteria presented in the DSM-IV,[22] for posttraumatic stress disorder, depressive episode, generalized anxiety disorder, and pain disorder. Readability of items and directions was evaluated using the Fry Readability Graph.[23]

## Participants

We consecutively recruited participants on an ongoing basis from the hand, multiple trauma, and burn services at a large southeastern level-1 trauma center to complete the IDI and validity measures. Within the first few days of admission or when a patient was cognitively capable as determined by their attending physician (average, 8d), a trained graduate-level research assistant approached eligible participants (≥18y, English speaking, and admitted to the hand, multiple trauma, or burn service for a traumatic injury).

Three questions from the Psychotic Symptoms Module of the SCID-I/P[24] were asked to participants, which represented the 3 major domains of this module: delusions, visual hallucinations, and auditory hallucinations. If the participant responded positively to any of these questions and it could not be better explained by medical, cultural, or substance use-related reasons, administration of the full module was recommended to screen out those patients who reported experiencing current psychotic symptoms.

Participants were also assessed for orientation (eg, person, place, time, situation) prior to completing the assessment battery. If the participant displayed marked difficulty in orientation, which was not otherwise explainable by injury or other medical reasons (eg, medications, injury affecting speech abilities) administration of the Folstein Mini-Mental State Examination[25] was recommended to screen out those patients currently experiencing cognitive difficulties or impairment.

After informed consent and psychiatric and cognitive screens, study candidates completed a comprehensive assessment battery, which included the IDI and other established validity measures. Participants were offered assistance with manually recording their responses if their injury precluded independence with this task. Finally, we gathered demographic and injury-related information from patients' medical charts such as: sex, age, ethnicity, education, relationship status, occupation, income, living situation, type of injury, and mechanism of injury. This study was approved by the participating university's institutional review board.

## Analysis

***Internal structure.*** We performed a series of EFAs to examine the internal structure of the IDI based on recommended guidelines.[26] These analyses were first conducted on individual scales and subscales, then on the entire set of retained IDI items. Because factors were expected to correlate with one another, principal axis factor analysis with direct oblimin (oblique) rotation was used for all EFAs ($\delta=0$). A correlation matrix was submitted for analyses and was assessed for factorability prior to running the analyses. The identification of factors was based on an examination of eigenvalues ($>1$), screeplots, and item content. For each identified factor, rotated structure coefficients and pattern weights were examined, and a $\pm.40$ threshold was loosely used to identify items that were salient in defining a given factor. Structural coefficients are correlations between the items and the factors, and pattern coefficients are partial regression weights, such that the impact of other factors on an item is being removed. In cases where items were discarded from the initial pool, the decision to do so was made after careful consideration of their psychometric properties, theoretical relevance, and clinical utility.

***Reliability (item analysis and internal consistency).*** The internal consistency reliability of test scores from the IDI scales was assessed using corrected item-total correlations and Cronbach $\alpha$ coefficients. A cutoff criterion of .30 or higher was used as a rule of thumb for item selection[27] and an $\alpha$ coefficient of .70 or higher was considered acceptable.

***Relationship to other variables (construct and criterion validity).*** We used Cohen's recommendations[28] to interpret the magnitude of Pearson $r$ coefficients (.10−.29 is small; .30−.49 is medium; 0.50−1.00 is large). Weaker relationships were expected between measures of different constructs, and stronger associations were expected between measures that addressed similar constructs.

Note that, for a variety of reasons, there was substantial missing data on many of the external correlates largely as a result of patient fatigue and pain, interruptions from family, medical or rehabilitation staff, being discharged after starting the testing, and patient or hospital staff error. This being the case, all correlations that were computed were obtained using the full information maximum likelihood estimator in Mplus.[a] Computer simulation studies have unequivocally confirmed the superiority of this technique.[29]

Three types of construct validity were examined: known-groups, convergent, and discriminant. To evaluate known-groups validity, we tested IDI scores to determine whether they could be differentiated by levels of injury severity. To evaluate convergent validity, we administered validity measures of instruments that measure similar constructs (posttraumatic stress, depression, anxiety, pain) as well as related constructs that would be expected to correlate moderately with injury-related distress (eg, perceived stress,[30] perceived self-efficacy,[31] optimism[32]). Discriminant validity evidence was examined by exploring the association between IDI scales and theoretically different constructs not expected to be related, such as drug and alcohol abuse. Even though there is a high comorbidity between substance abuse and general distress, it is generally recognized that substance abuse reflects the self-medication of distress symptoms.[33] Therefore, these constructs were expected to be theoretically unrelated during the acute hospitalization phase.

We examined 2 types of criterion validity: concurrent and predictive. To examine concurrent validity we examined the associations between IDI scales and injury severity and the one's hospital LOS; both of which have shown small to medium positive associations with variables of injury-related distress.[34-38] The AIS was used to determine injury severity, whereas hospital LOS was recorded from patients' medical charts and coded as the total number of days from admission to discharge from the hospital.

Predictive validity was examined by correlating IDI scales with the number of postdischarge emergency department visits as well as days patients were readmitted to the hospital after their initial discharge secondary to injury-related medical complications (between 3 and 6mo postdischarge). Previous research has shown that secondary medical complications and prolonged recovery are positively associated with distress symptomatology, albeit small in magnitude.[39-42] The number of postdischarge emergency department visits was recorded from patients' medical charts and the length of hospital readmissions postdischarge was recorded from patients' medical charts and coded as the total number of days readmitted after their initial discharge from the hospital. Because some of these concurrent and predictive variables have been shown to be equivocal in previous studies,[43-45] we hypothesized a small association (eg, ≤.29) between these measures and IDI scales.

### Validity Measures

***Abbreviated Injury Scale.*** The AIS[46] is an anatomic scoring system where injuries are ranked on a 5-point scale (1=minor, 2=moderate, 3=serious, 4=severe, 5=critical). AIS scores were assigned by trained attending physicians, medical residents, and nursing staff. In the case of multiple injuries, the most severely injured area was considered the index site. Due to disproportionate representation of certain injury classifications, AIS categories were trichotomized into minor/moderate (group 1), serious (group 2), and severe/critical (group 3).

***Trauma Symptom Checklist−40.*** The TSC-40[47] is a 40-item self-report instrument used to measure traumatic stress symptomatology and consists of 6 subscales (anxiety, depression, dissociation, sexual abuse trauma index, sexual problems, sleep disturbance). It was used to examine convergent validity and is rated on a 4-point Likert scale according to the frequency of symptoms over the past 2 months (0 [never] to 3 [often]). Scores from this measure have shown internal consistency subscale $\alpha$ coefficients between .66 and .77 and full scale coefficients between .89 and .91.[48] Because it has been primarily used with trauma populations other than traumatic injury (eg, sexual assault, perpetrators of violence), we examined its internal structure with this current study's injury sample using principal axis EFA with direct oblimin rotation ($\delta$=0). Factors were identified through examination of eigenvalues, screeplots, and item content. A slightly modified version of the TSC-40 was observed, which largely reflected original subscales and item content. A new factor emerged (which we labeled *posttraumatic stress*) that included items representing avoidance ("spacing out" [going away in your mind]), dissociation (dizziness; feeling that things are "unreal"; feelings that you are not always in your body) and re-experiencing trauma ("flashbacks" [sudden, vivid, distracting memories]; nightmares). Another exception was the sexual abuse trauma index, in which items related to sexual abuse did not perform well (eg, fear of men, bad thoughts, feelings during sex) and were thus removed.

In this study, the TSC-40 subscales used to examine convergent validity of IDI scales were depression ($\alpha$=.76), anxiety ($\alpha$=.80), and posttraumatic stress ($\alpha$=.76). Based on previous research with traumatized populations,[49] large, positive correlations (eg, ≥.50) were expected with instruments that measure similar constructs and medium to large associations were hypothesized between instruments that measure dissimilar constructs.

***Short-Form McGill Pain Questionnaire.*** The SF-MPQ[50] was used to examine convergent validity of the IDI pain scale and is a brief version of the McGill Pain Questionnaire.[19] It measures intensity, sensory, and affective components of pain and has been used with a variety of populations. Previous studies have reported Cronbach $\alpha$ internal consistency estimates ranging between .72 and .88[51,52] and scores have correlated strongly with the long form.[50,53] A large positive correlation (eg, ≥.50) was expected with the IDI pain scale and medium positive associations (eg, .30−.49) were hypothesized with the other IDI scales of depression, anxiety, and posttraumatic stress.

***Perceived Stress Scale−10.*** The PSS-10[54] is a brief, global measure of perceived stress appraisals and was used to examine convergent validity across IDI scales in general. Scores from this measure have shown Cronbach $\alpha$ coefficients between .84 and .86, as well as construct validity.[54] Because of the conceptual similarity between IDI scales and global perceived stress, medium positive correlations (eg, .30−.49) were expected.

***General Perceived Self-Efficacy Scale.*** The GPSES[55] is a 10-item self-report instrument designed to measure perceived personal competence in a variety of stressful situations. Previous studies using the GPSES have reported Cronbach $\alpha$ coefficients between .75 and .90 as well as construct validity.[55] Due to the distress-mediating effects of self-efficacy,[56,57] medium negative associations (eg, .30−.49) were expected with IDI scales.

***Life Orientation Test−R.*** The LOT-R[58] is a brief self-report measure designed to assess individual differences in dispositional optimism. The Cronbach $\alpha$ was .78 and scores have also shown construct validity.[58] Because optimism has been shown to be inversely related to distress,[59] we expected medium, negative correlations (eg, .30−.49) with IDI scales.

***Brief Michigan Alcoholism Screening Test.*** The BMAST[60] is a 10-item version of the 25-item Michigan Alcoholism Screening Test. It was designed to identify alcohol use-related problems. Internal consistency has been reported (Cronbach $\alpha$ range, .83−.93) as well as construct validity.[61,62]

***Drug Abuse Screening Test–10.*** The DAST-10 is a brief version of the 28-item DAST[63] and was designed to identify drug use-related problems. Ten items are answered with yes and no responses. DAST-10 scores from a previous study reported internal consistency (Cronbach $\alpha$=.94) and discriminant validity.[64]

## RESULTS

### Development of the IDI

The final number of items that were tested was 49, which were estimated to be at a seventh- and eighth-grade reading level. There was neither item overlap nor need for recoding prior to scoring because all items were positively phrased. Items were rated on a 5-option Likert response format (0=strongly disagree; 1=disagree; 2=neither agree nor disagree; 3=agree; 4=strongly agree). Directions instructed respondents to indicate the extent to which they agreed with the following statements since the accident. The IDI was constructed so that scores could be produced at the subscale level (posttraumatic stress subscales: avoidance and numbing, re-experience, hyperarousal), scale level (posttraumatic stress, depression, anxiety, pain) and index level (total IDI = posttraumatic stress + depression + anxiety + pain). Higher scores indicate higher levels of injury-related distress.

### Demographic and Clinical Characteristics

The distribution of injury severity included: minor (10%), moderate (14%), serious (36%), severe (32%), and critical (8%). Several patients underwent varying medical procedures including closed reduction and fixation (41%), irrigation and debridement (22%), multiple procedures (15%), skin grafts or flaps (11%), tendon or nerve repair (7%), and amputation (5%). Forty percent of the total sample had a loss of consciousness as a result of their injury. Sixty-one percent of injuries were to the lower extremity and 65% were to the upper extremity. Percentage of burn area ranged from 2% to 43%. Twenty-five percent had either second- or third-degree burns and 26% had multiple burn depths. The majority of patients were currently using prescribed pain medications and antibiotics (86%). Administration of the full SCID I/P psychotic symptoms module or the full Mini-Mental State Examination was not warranted. See table 1 for demographic and clinical characteristics of the sample.

### EFA of the Posttraumatic Stress Scale

On each posttraumatic stress subscale (avoidance and numbing, re-experience, hyperarousal), we first conducted EFAs,

**Table 1: Demographic and Clinical Characteristics**

| Characteristics[†] | Total (N-169*) | | Hand (n-51) | | Multiple Trauma (n-81) | | Burn (n-36) | |
|---|---|---|---|---|---|---|---|---|
| | n | % | n | % | n | % | n | % |
| Male | 111 | 66.1 | 37 | 72.5 | 55 | 67.9 | 19 | 61.3 |
| Mean age ± SD (y) | 34.5±11.1 | | 35.2±9.83 | | 34.2±12.0 | | 34±11.0 | |
| Race/ethnicity | | | | | | | | |
| White | 56 | 33.3 | 18 | 35.3 | 20 | 24.7 | 18 | 58.1 |
| Black | 53 | 31.5 | 18 | 35.3 | 26 | 32.1 | 9 | 29.0 |
| Hispanic | 37 | 22.0 | 11 | 21.6 | 20 | 24.7 | 6 | 19.4 |
| Other | 16 | 9.5 | 2 | 3.9 | 12 | 14.8 | 2 | 6.5 |
| Relationship status | | | | | | | | |
| Married | 47 | 28.0 | 14 | 27.5 | 21 | 25.9 | 12 | 38.7 |
| Significant other | 23 | 13.7 | 5 | 9.8 | 13 | 16.0 | 5 | 16.1 |
| Single | 69 | 41.1 | 19 | 37.3 | 39 | 48.1 | 11 | 35.5 |
| Widowed | 4 | 2.4 | 2 | 3.9 | 1 | 1.2 | 1 | 3.2 |
| Divorced/separated | 25 | 14.9 | 11 | 21.6 | 7 | 8.6 | 7 | 22.6 |
| Living status | | | | | | | | |
| Home alone | 28 | 16.7 | 11 | 21.6 | 12 | 14.8 | 5 | 16.1 |
| Home with support | 128 | 76.2 | 34 | 66.7 | 63 | 77.8 | 31 | 100.0 |
| Education | | | | | | | | |
| < High school | 29 | 17.3 | 9 | 17.6 | 26 | 32.1 | 5 | 16.1 |
| = High school | 54 | 32.1 | 14 | 27.5 | 25 | 30.9 | 14 | 45.2 |
| > High school | 80 | 47.6 | 26 | 51.0 | 13 | 16.0 | 16 | 51.6 |
| Income ($) | | | | | | | | |
| <30,000 | 107 | 63.7 | 31 | 60.8 | 53 | 65.4 | 23 | 74.2 |
| 30,000−90,000 | 44 | 26.2 | 17 | 33.3 | 18 | 22.2 | 9 | 29.0 |
| >90,000 | 7 | 4.2 | 1 | 2.0 | 5 | 6.2 | 1 | 3.2 |
| Type of injury | | | | | | | | |
| Blunt | 52 | 31.0 | 10 | 19.6 | 42 | 51.9 | 0 | 0.0 |
| Penetrating | 35 | 20.8 | 20 | 39.2 | 15 | 18.5 | 0 | 0.0 |
| Explosive | 2 | 1.2 | 0 | 0.0 | 2 | 2.5 | 0 | 0.0 |
| De-gloving | 3 | 1.8 | 2 | 3.9 | 1 | 1.2 | 0 | 0.0 |
| Crush | 23 | 13.7 | 6 | 11.8 | 17 | 21.0 | 0 | 0.0 |
| Amputation | 4 | 2.4 | 2 | 3.9 | 2 | 2.5 | 0 | 0.0 |
| Thermal burn | 29 | 17.3 | 1 | 2.0 | 0 | 0.0 | 28 | 90.3 |
| Chemical burn | 1 | 0.6 | 0 | 0.0 | 0 | 0.0 | 1 | 3.2 |
| Electrical burn | 2 | 1.2 | 0 | 0.0 | 0 | 0.0 | 2 | 6.5 |
| Mechanical burn | 6 | 3.6 | 1 | 2.0 | 0 | 0.0 | 5 | 16.1 |
| Complicated infections[‡] | 8 | 4.8 | 8 | 15.7 | 0 | 0.0 | 0 | 0.0 |
| Mechanism of injury | | | | | | | | |
| Self-inflicted | 3 | 1.8 | 2 | 3.9 | 1 | 1.2 | 0 | 0.0 |
| Motor vehicle collision | 77 | 45.8 | 15 | 29.4 | 56 | 69.1 | 6 | 19.4 |
| Human bite | 3 | 1.8 | 2 | 3.9 | 0 | 0.0 | 1 | 3.2 |
| Sharp/shearing | 5 | 3.0 | 5 | 9.8 | 0 | 0.0 | 0 | 0.0 |
| Fall | 6 | 3.6 | 3 | 5.9 | 3 | 3.7 | 0 | 0.0 |
| Combustibles | 3 | 1.8 | 0 | 0.0 | 1 | 1.2 | 2 | 6.5 |
| Assault | 4 | 2.4 | 1 | 2.0 | 2 | 2.5 | 1 | 3.2 |
| Gunshot wound | 21 | 12.5 | 10 | 19.6 | 11 | 13.6 | 0 | 0.0 |
| Occupational | 14 | 8.3 | 7 | 13.7 | 3 | 3.7 | 4 | 12.9 |
| Fireworks | 1 | 0.6 | 0 | 0.0 | 0 | 0.0 | 1 | 3.2 |
| Animal bite | 6 | 3.6 | 3 | 5.9 | 3 | 3.7 | 0 | 0.0 |
| Fire/flames | 16 | 9.5 | 0 | 0.0 | 0 | 0.0 | 16 | 51.6 |
| Scald | 6 | 3.6 | 1 | 2.0 | 0 | 0.0 | 5 | 16.1 |
| Other | 3 | 1.8 | 2 | 3.9 | 1 | 1.2 | 0 | 0.0 |

*Data on the service were unavailable for 1 participant.
[†]Data were missing for some demographic variables.
[‡]These were primarily the result of a sharp/shearing or puncture wounds from humans or animals and resulted in surgical intervention.

prior to analyzing the posttraumatic stress scale in its entirety. A total of 6 items were removed from 2 of the 3 subscales; 3 items were omitted from the re-experience subscale due to their theoretical redundancy with other highly similar items (eg, "Disturbing mental images about the accident pop into my head"; "I have actually heard sounds from the accident while awake"; "My chest feels tighter than normal when something reminds me of the accident"). One item reflecting foreshortened future and 2 items dealing with memory loss were removed from the avoidance and numbing subscale due to low

**Table 2: Posttraumatic Stress Pattern and (Structure) Coefficients, Eigenvalues, and Percentage of Variance**

| Items | Coefficients | | | $h^2$ |
|---|---|---|---|---|
| | Intrusion | Detached | Hyper-Vigilant | |
| Upsetting thoughts about the accident pop into my mind. | **.489 (.551)** | .015 (.220) | −.181 (−.344) | .365 |
| I have bad dreams about the accident. | **.765 (.757)** | .006 (.195) | .031 (−.218) | .553 |
| Sometimes it feels like the accident is happening all over again. | **.737 (.761)** | .132 (.312) | .035 (−.258) | .590 |
| I have actually "seen" parts of the accident happen again while awake. | **.648 (.652)** | .049 (.208) | .029 (−.200) | .451 |
| I get more nervous than normal when something reminds me of the accident. | **.794 (.780)** | −.121 (.112) | −.056 (−.260) | .638 |
| My heart beats faster than normal when something reminds me of the accident. | **.816 (.808)** | −.055 (.169) | −.022 (−.261) | .659 |
| I feel disconnected from other people. | .014 (.213) | **.728 (.741)** | −.022 (−.335) | .491 |
| I feel emotionally "numb" inside. | .142 (.282) | **.691 (.741)** | .132 (−.206) | .455 |
| I feel distant from my friends and family. | −.045 (.112) | **.569 (.566)** | −.019 (−.246) | .320 |
| I talk to very few people about the accident. | −.034 (.101) | **.451 (.463)** | −.049 (−.229) | .237 |
| Things I was interested in before the accident (hobbies, recreation, etc.) no longer seem interesting to me. | .153 (.276) | **.478 (.514)** | .010 (−.242) | .280 |
| I try to keep my emotions to myself about the accident. | −.149 (.014) | **.513 (.511)** | −.089 (−.258) | .307 |
| I am watchful for anything bad that might happen. | .098 (.295) | −.027 (.267) | **−.633 (−.653)** | .447 |
| I feel jumpy. | .065 (.266) | .250 (.445) | **−.420 (−.547)** | .401 |
| I feel "on the lookout" for anything harmful that could happen to me. | −.073 (.234) | −.030 (.366) | **−.978 (−.942)** | .558 |
| I am frightened easily by sudden noises. | .212 (.372) | .229 (.417) | **−.311 (−.476)** | .344 |
| Eigenvalues | 4.9 | 2.4 | 1.4 | |
| Percentage of variance | 31.0 | 15.2 | 8.8 | |

NOTE. Eigenvalues and percentage of variance is prerotation; coefficients in boldface reflect primary factor loading; structure coefficients are given in parentheses; $h^2$ is initial communalities; the negative loadings are an artifact of the rotation, and do not have an important substantive interpretation.

factor pattern coefficients. After omission of these items, EFA revealed 3 factors (table 2) representing each individual subscale ($r$=.34 between factors 1 and 2; $r$=.33 between factors 1 and 3; $r$=.41 between factors 2 and 3) with pattern coefficients that ranged between .49 and .82 for factor 1; .45 and .73 for factor 2; and .31 and .98 for factor 3. The final subset of posttraumatic stress items is shown in table 2. As seen in the tables, the communality values were typically quite high (eg, >.50), which indicates that a given item shared a substantial amount of variation with other items on the scale.

## EFA of the Depression Scale

An EFA conducted on the depression items revealed a set of items that performed poorly. These items represented primarily somatic and neurovegetative aspects of depression such as poor sleep, changes in appetite, and psychomotor retardation and agitation, but 1 item was related to guilt about the accident and another dealt with difficulty concentrating. After removal of 6 items dealing with these concepts, an EFA extracted 1 clear factor with factor pattern coefficients ranging between .44 and .72 (table 3). The final subset of depression items is shown in table 3.

Most depression items were excluded, based on the rationale that issues of poor sleep and concentration and changes in appetite can also be attributed to the experience of hospitalization, related to side effects from medication or to multiple visits and procedures from nursing throughout the night. Guilt may not have associated highly with other items of depression in part because it is a complex derivative of the emotion disgust.[65] That is, guilt requires a person to appraise what occurred as a personal failure, which might not be possible given the use of denial and avoidance immediately after traumatic injury.

## EFA of the Anxiety Scale

After the first analysis it became clear that, like the depression scale, those items reflecting somatic and neurovegetative aspects of anxiety such as fatigue and muscle tension (eg, "My

**Table 3: Depression Pattern Coefficients, Eigenvalues, and Percentage of Variance**

| Items | Coefficients | $h^2$ |
|---|---|---|
| I have little desire to do much of anything. | .721 | .423 |
| I feel absent-minded. | .580 | .332 |
| I feel sad. | .666 | .400 |
| I find myself on the verge of crying. | .586 | .344 |
| I feel worthless. | .443 | .177 |
| I have questioned my ability to continue living. | .566 | .250 |
| Eigenvalues | 2.8 | |
| Percentage of variance | 46.3 | |

NOTE. Eigenvalues and percentage of variance is pre-rotation; $h^2$ is initial communalities; with a single factor, the structure coefficients and pattern weights are identical (ie, both are correlations, because there are no other factors being partialled out).

**Table 4: Anxiety Pattern Coefficients, Eigenvalues, and Percentage of Variance**

| Items | Coefficients | $h^2$ |
|---|---|---|
| I'm bothered by little things. | .575 | .27 |
| I'm on the verge of "blowing up." | .504 | .272 |
| I have difficulty focusing my attention on anything for too long. | .533 | .237 |
| I have difficulty controlling my worry. | .706 | .467 |
| I feel "on edge." | .749 | .525 |
| I feel restless. | .622 | .345 |
| Eigenvalues | 2.9 | |
| Percentage of variance | 48.4 | |

NOTE. Eigenvalues and percentage of variance is prerotation; $h^2$ is initial communalities; with a single factor, the structure coefficients and pattern weights are identical (ie, both are correlations, because there are no other factors being partialled out).

**Table 5: Pain Pattern Coefficients, Eigenvalues, and Percentage of Variance**

| Items | Coefficients | $h^2$ |
|---|---|---|
| My pain interferes with my ability to function normally in life. | .573 | .266 |
| I am in a lot of pain. | .670 | .357 |
| My injury causes me debilitating pain. | .785 | .462 |
| I have been in agony because of my pain. | .729 | .413 |
| Eigenvalues | 2.4 | |
| Percentage of variance | 60.6 | |

NOTE. Eigenvalues and percentage of variance is prerotation; $h^2$ is initial communalities; with a single factor, the structure coefficients and pattern weights are identical (ie, both are correlations, because there are no other factors being partialled out).

muscles feel tense"; "My body feels stiff") did not fit well. After the removal of 3 items related to somatosensory issues, an exploratory factor analysis revealed 1 clear factor with pattern structure coefficients ranging between .50 and .75 (table 4). The final subset of anxiety items is shown in table 4.

### EFA of the Pain Scale

EFA yielded 1 factor with pattern coefficients ranging between .57 and .79 (table 5). No items were removed from this scale. The final subset of pain items is shown in table 5.

### Summary of EFAs

After reducing the initial pool of 49 items, we believed that the remaining 32 items continued to show adequate content validity, as relevant aspects of posttraumatic stress, depression, anxiety, and pain were represented in the final item pool (see tables 2−5). Except for the omitted items reflecting foreshortened future and memory loss, the posttraumatic stress scale was represented by intrusive experiences, avoidance and numbing, and hyperarousal. Several major symptom categories were retained for the depression scale: depressed mood, anhedonia, low energy, low self-worth, and thoughts of death. Major symptom categories were represented by the anxiety scale: excessive worry, restlessness, poor concentration, and irritability. Pain items reflected aspects of sensory, affective and perceived functional impairment, all of which contribute to pain severity, exacerbation, and maintenance.

### Internal Consistency Reliability

The internal consistency reliability of test scores from the EFA-derived IDI scales was assessed using corrected item-total correlations and $\alpha$ coefficients (table 6). Corrected item-total correlations for all IDI items ranged between .38 and .72. Internal consistency reliability estimates were computed for each of the IDI scale and subscale scores, as well as the total IDI score computed from the final pool of 32 items. As seen in table 6, coefficient $\alpha$ values ranged between .75 and .92. These values were within a range that is generally considered acceptable.[27,66]

### Other Validity Evidence

Table 7 provides observed values for convergent, discriminant, concurrent, and predictive validity coefficients between the IDI scales and a number of validity measures along with their significance levels.

## DISCUSSION

This study focused on the development and psychometric evaluation of the scales that comprise the IDI. All retained items qualitatively represented adequate content area of their specific domains, each with multiple symptom categories reflecting important theoretical and clinical criteria. One point of interest was that items pertaining to neurovegetative and somatic aspects of depression or anxiety (eg, sleep, psychomotor retardation/agitation, appetite, energy) did not seem to perform well with this population in the EFAs. In total, 7 depression items and 3 anxiety items were excluded from further analyses based on the rationale that somatic preoccupation and neurovegetative symptomatology are common experiences of hospitalization and therefore may not be the best discriminators of injury-related distress.[67] After modifications such as these were made, clear factor structures with adequate pattern and structure coefficients were observed among all individual scales. Use of confirmatory factor analytic methods would be important to evaluate the revised model in a new sample.

Internal consistency reliability coefficients were within an acceptable range for research purposes. Possible sources of error in scores may have been related to environmental factors (eg, hospital rooms were possibly noisy, dimly lit, excessively warm or cool), examinee characteristics (some may have been more fatigued or less motivated than others) or test administrator inaccuracies. Finally, factors such as item placement within the test may have affected interitem correlations.[68] Further empirical evaluation of IDI scale reliability with similar patient populations and settings is needed.

Small positive associations were observed between IDI scales and injury severity, hospital LOS, and postdischarge rehospitalizations. Based on equivocal findings with these variables in previous studies, we were not surprised that these correlations were not higher in magnitude given their likely theoretical relatedness. Others have recommended examin-

**Table 6: IDI Subscale, Scale, and Index Characteristics**

| Subscale/Scale | No. of Items | Cronbach $\alpha$ | Mean ± SD | | | |
|---|---|---|---|---|---|---|
| | | | Minor/Moderate Injury (n=38) | Serious Injury (n=60) | Severe/Critical Injury (n=65) | Total |
| Re-experience | 6 | .86 | 8.3±4.7 | 10.5±5.3 | 12.8±6.4 | 10.9±5.9 |
| Avoidance and numbing | 6 | .75 | 9.7±5.2 | 9.8±4.6 | 9.4±4.8 | 9.6±4.8 |
| Hyperarousal | 4 | .76 | 6.9±3.9 | 7.9±4.0 | 8.7±3.5 | 8.0±3.8 |
| Posttraumatic stress | 16 | .85 | 24.9±9.7 | 28.1±10.6 | 30.9±11.2 | 28.5±10.8 |
| Depression | 6 | .76 | 7.8±4.6 | 8.5±4.6 | 9.8±4.8 | 8.9±4.7 |
| Anxiety | 6 | .79 | 8.5±4.2 | 9.8±5.1 | 10.5±5.2 | 9.8±4.9 |
| Pain | 4 | .78 | 8.8±4.1 | 10.2±3.5 | 10.9±3.4 | 10.1±3.7 |
| Total IDI | 32 | .92 | 50.0±19.0 | 56.7±20.6 | 62.1±20.1 | 57.3±20.5 |

NOTE. Mean ± SD values are presented by level of injury severity followed by the total.

**Table 7: Validity Information of IDI Scales and External Correlates**

| Validity Measure | Injury Distress Index Subscales and Scales | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Re-Experience | Avoidance and Numbing | Hyperarousal | Posttraumatic Stress | Depression | Anxiety | Pain | Total |
| Convergent coefficients | | | | | | | | |
| TSC-40 posttraumatic stress | .50† | .19† | .38† | .49† | .42† | .42† | .18 | .49† |
| TSC-40 depression | .36† | .31† | .29† | .43† | .52† | .48† | .24* | .51† |
| TSC-40 anxiety | .30† | .30† | .37† | .43† | .44† | .57† | .32† | .52† |
| SF-MPQ (pain) | .13 | .07 | .16* | .10† | −.01 | .12† | .42† | .16† |
| PSS-10 (distress) | .37† | .45† | .32† | .51† | .45† | .45† | .39† | .56† |
| LOT-R (optimism) | −.29† | −.42† | −.23† | −.42† | −.44† | −.34† | −.21† | −.45† |
| GPSES (self-efficacy) | −.22† | −.37† | −.21† | −.36† | −.39† | −.32† | −.15 | −.39† |
| Discriminant coefficients | | | | | | | | |
| DAST-10 (drug abuse) | .04 | −.25* | .05 | −.07 | −.04 | −.02 | −.06 | −.06 |
| BMAST (alcohol abuse) | .09 | −.04 | .09 | .09 | .18 | .10 | .06 | .12 |
| Concurrent-criterion coefficients | | | | | | | | |
| Injury severity | .30† | −.01 | .18* | .22† | .17† | .16* | .22† | .22† |
| Hospital LOS | .16 | .12 | .05 | .16† | .21† | .09 | .15 | .18† |
| Predictive-criterion coefficients | | | | | | | | |
| Postdischarge ED visits | −.05 | .25† | .08 | .11 | .27† | .21† | .12 | .19† |
| Postdischarge days readmitted | .11 | .18* | .06 | .16† | .21† | .13† | .05 | .17† |

NOTE. Due to missing data, correlations were estimated using the maximum likelihood routine in Mplus.
Abbreviation: ED, emergency department.
*$P<.05$; †$P<.01$.

ing additional reference criteria (eg, visibility of scarring, coping strategies, perceived social support) in addition to severity or hospitalization variables.[38,44,69] Large positive associations were observed between IDI scales of depression and anxiety TSC-40 subscales measuring similar constructs ($r=.52$, $r=.57$, respectively). It was somewhat surprising that the IDI scales of pain and posttraumatic stress were only moderately correlated with validity scales measuring similar constructs ($r=.42$, $r=.49$, respectively) as one would expect 2 measures of the same construct to show correlations perhaps exceeding .70 or .80. One possibility is that items from our injury-distress specific scale captured more narrowly defined content than items from the validity measures that were used. For example, in the assessment of posttraumatic stress disorder there are several specific scales to measure posttraumatic stress disorder from different types of stressful experiences such as combat,[70] torture,[71] or sexual abuse.[47] It may be possible that injury-related distress is a more targeted concept, requiring specific situation-dependent items. IDI scales evidenced small to large correlations with related constructs such as general distress, optimism, and self-efficacy, which were expected. Finally, as anticipated from the small associations, DAST-10 and BMAST scores were weakly related with IDI scales.

### Study Limitations

A limitation of this study was the small sample size of 169 participants, which eliminates use of a hold-out sample for cross-validation of the modified instrument. Due to the limited funding period and available personnel on this project, participant recruitment ended after accrual of 169 English-speaking patients. Nevertheless, due to the comprehensive nature of the validation plan and the large number of external criteria, the sample size was deemed acceptable for pilot purposes. A post hoc power analysis for a medium correlation ($r=.30$) indicated that 84 participants were necessary to achieve a power of .80. The sample size of this study exceeded this for every relationship of interest, except the GPSES, which only had 69 available cases. Probably the biggest limitation of this study is that model modifications were made (eg, items were removed) based on the data. Given the small sample size, there was no way to replicate the model modifications on a fresh sample of data or to do a random split of the sample, modify the instrument on one half, and then confirm the modifications on the other half.

## CONCLUSIONS

At this point, no brief, comprehensive assessment tool exists that examines injury-related distress after traumatic physical injury. Overall, the results were promising, given the reliability and validity evidence presented. Similar and dissimilar outside constructs correlated adequately with IDI scales in a largely expected manner. Because this was a preliminary investigation, our next step is to collect additional validity data with larger samples ($N\geq500$) of injured patients over multiple time points where more sophisticated analytic techniques such as confirmatory factor analysis and differential item functioning may be performed. It is anticipated that in the future, these scales could provide important clinical assessment of injury-related distress during the acute phase of hospitalization, which could facilitate decision making and targeted recommendations among rehabilitation medical personnel.[72] Future empirical studies might examine the association between IDI scale profiles and specifically tailored, supportive rehabilitation counseling, and psycho-educational coping skills training for patients and family members. Further, the IDI might serve well as a fixed length patient-reported outcome measure (or highly performing items may become integrated into an item response theory-based bank of calibrated items) in rehabilitation clinical research dealing with the short- and long-term psychologic sequelae and adjustment after various types of traumatic physical injury.

Overall, findings from this investigation suggest that the IDI has the potential to make an important contribution to the measurement of injury-related distress in rehabilitation settings. Future studies would benefit from testing this instrument with larger sample sizes using additional validity measures.

Finally, given the make-up of this present sample, subsequent studies may benefit from including different injury populations.

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**Supplier**

a. Version 2.13; Muthén & Muthén, 3463 Stoner Ave, Los Angeles, CA 90066.