Psychological Medicine, 2007, **37**, 1469–1480. © 2007 Cambridge University Press
doi:10.1017/S0033291707000943 First published online 11 June 2007 Printed in the United Kingdom

A nationwide US study of post-traumatic stress after hospitalization for physical injury

DOUGLAS F. ZATZICK[1,3]*, FREDERICK P. RIVARA[1], AVERY B. NATHENS[2], GREGORY J. JURKOVICH[1], JIN WANG[1], MING-YU FAN[3], JOAN RUSSO[3], DAVID S. SALKEVER[4] AND ELLEN J. MACKENZIE[4]

[1] *Harborview Injury Prevention and Research Center, University of Washington School of Medicine, Seattle, WA, USA*; [2] *St Michael's Hospital, University of Toronto, Canada*; [3] *Department of Psychiatry and Behavioral Sciences, University of Washington School of Medicine, Seattle, WA, USA*; [4] *Johns Hopkins Bloomberg School of Public Health, Center for Injury Research and Policy, Baltimore, MD, USA*

ABSTRACT

Background. Injured survivors of individual and mass trauma are at risk for developing post-traumatic stress disorder (PTSD). Few investigations have assessed PTSD after injury in large samples across diverse acute care hospital settings.

Method. A total of 2931 injured trauma survivors aged 18–84 who were representative of 9983 in-patients were recruited from 69 hospitals across the USA. In-patient medical records were abstracted, and hospitalized patients were interviewed at 3 and 12 months after injury. Symptoms consistent with a DSM-IV diagnosis of PTSD were assessed with the PTSD Checklist (PCL) 12 months after injury.

Results. Approximately 23% of injury survivors had symptoms consistent with a diagnosis of PTSD 12 months after their hospitalization. Greater levels of early post-injury emotional distress and physical pain were associated with an increased risk of symptoms consistent with a PTSD diagnosis. Pre-injury, intensive care unit (ICU) admission [relative risk (RR) 1·17, 95% confidence interval (CI) 1·02–1·34], pre-injury depression (RR 1·33, 95% CI 1·15–1·54), benzodiazepine prescription (RR 1·46, 95% CI 1·17–1·84) and intentional injury (RR 1·32, 95% CI 1·04–1·67) were independently associated with an increased risk of symptoms consistent with a PTSD diagnosis. White injury survivors without insurance demonstrated approximately twice the rate of symptoms consistent with a diagnosis of PTSD when compared to white individuals with private insurance. By contrast, for Hispanic injury survivors PTSD rates were approximately equal between uninsured and privately insured individuals.

Conclusions. Nationwide in the USA, more than 20% of injured trauma survivors have symptoms consistent with a diagnosis of PTSD 12 months after acute care in-patient hospitalization. Coordinated investigative and policy efforts could target mandates for high-quality PTSD screening and intervention in acute care medical settings.

* Address for correspondence: Douglas Zatzick, M.D., Associate Professor, Department of Psychiatry and Behavioral Sciences, Harborview Injury Prevention and Research Center, University of Washington, School of Medicine, Box 359896, 325 Ninth Ave, Seattle, WA 98104, USA.
(Email: dzatzick@u.washington.edu)

A preliminary version of this manuscript was presented at the National Institute of Drug Abuse Meeting on Disasters and Substance Abuse, Bethesda, MD, USA, on 7 December 2006.

INTRODUCTION

Each year in the USA approximately 2·5 million individuals incur injuries so severe that they require acute care hospital admissions (Bonnie *et al.* 1999). From a global perspective, approximately 16% of the world's burden of disease is attributable to traumatic injury (Krug *et al.*

2000). Trauma-exposed patients who are seriously injured and require extended in-patient hospital admission may be at highest risk for the development of post-traumatic stress disorder (PTSD) (Verger *et al.* 2004). After injury, PTSD is independently associated with a broad profile of functional impairments and diminished quality of life, above and beyond the impact of injury severity and other medical co-morbidities (Holbrook *et al.* 1999; Zatzick *et al.* 2002*a*; O'Donnell *et al.* 2005).

Previous investigation in adults demonstrates marked variability in 12-month PTSD rates across acute care hospital sites (O'Donnell *et al.* 2003). Schnyder *et al.* (2001) reported that only 1·9% of seriously injured Swiss patients were diagnosed with PTSD 12 months after their in-patient hospital admission. In a cohort of Australian injury survivors, O'Donnell *et al.* (2004) found a 12-month PTSD prevalence of 10·4%. Ehlers *et al.* (1998) documented that 16·5% of hospitalized British motor vehicle crash victims had symptoms consistent with a diagnosis of PTSD. Zatzick *et al.* (2002*b*) found that symptoms consistent with a diagnosis of PTSD occurred in 30% of a representative sample of injured trauma survivors after admission to a US level I trauma center. Koren *et al.* (1999) reported that 32% of Israeli motor vehicle crash survivors had a PTSD diagnosis, and Blanchard *et al.* (1995) found that 36% of US motor vehicle crash-injury survivors had a PTSD diagnosis 12 months post-injury. A number of explanations for these variations have been suggested, including differences in the clustering of PTSD risk factors across acute care hospital sites, disparate sampling methods, and variations in PTSD assessment procedures (O'Donnell *et al.* 2003).

Prior investigation has identified multiple risk factors for the development of PTSD in injured adults (Mayou *et al.* 1993, 1997; Ehlers *et al.* 1998; Shalev *et al.* 1998; Michaels *et al.* 1999; Holbrook *et al.* 1999; Bryant *et al.* 2000; Mellman *et al.* 2001; Marshall & Schell, 2002; Zatzick *et al.* 2002*b*; O'Donnell *et al.* 2004; Grieger *et al.* 2006; Koren *et al.* 2006). Greater levels of early post-traumatic emotional distress, including PTSD, depressive and peri-traumatic dissociative symptoms, have been consistently identified as risk factors for the subsequent development of PTSD (Shalev *et al.* 1996; Bryant *et al.* 2000; Zatzick *et al.* 2002*b*; Marshall & Schell, 2002; O'Donnell *et al.* 2004). Two prospective investigations that examined early post-injury PTSD, depressive and peri-traumatic dissociative symptom levels found greater levels of early PTSD symptoms to be the strongest predictor of greater PTSD symptom levels over the course of the year after injury (Marshall & Schell, 2002; Zatzick *et al.* 2002*b*).

Studies in other trauma-exposed populations have implicated racial-ethnic minority heritage and low socio-economic status (SES) as PTSD risk factors (Kulka *et al.* 1990; Brewin *et al.* 2000; Galea *et al.* 2004). One preliminary report identified significantly greater post-traumatic stress symptom levels in African American, American Indian, Asian and Hispanic injury survivors compared to white injury survivors in the days and weeks immediately following traumatic injury (Santos *et al.* 2003). Literature review, however, revealed few injury investigations that have systematically examined interactions between racial-ethnic minority status and SES in the prediction of PTSD (Breslau *et al.* 2005).

Substances of abuse and exogenously administered pharmacological agents have also been suggested as both causative and protective factors in PTSD symptom development after trauma (Chilcoat & Breslau, 1998). One study has implicated stimulant intoxication at the time of the injury in the development of later PTSD symptoms (Zatzick *et al.* 2002*b*). Other investigations suggest that adequate opiate pain control (Saxe *et al.* 2001) and alcohol intoxication at the time of the injury may be protective factors (Mellman *et al.* 1998; Maes *et al.* 2001).

Acute care clinical and service delivery characteristics may also impact PTSD after injury. Previous investigations suggest that acute care patients requiring intensive care unit (ICU) admission, intubation and mechanical ventilation are at risk for the development of PTSD (Shaw *et al.* 2002; Cuthbertson *et al.* 2004; Kapfhammer *et al.* 2004; Schelling *et al.* 2004). Of note, across multiple investigations, increasing injury severity has not been identified as a PTSD risk factor (Michaels *et al.* 1999; Holbrook *et al.* 2001; Zatzick *et al.* 2002*b*).

A substantial proportion of patients with mental disorders receive treatment in general medical settings (Wang *et al.* 2005). A comprehensive

literature that includes numerous multisite investigations exists on the detection and treatment of depressive and anxiety disordered patients in primary care medical settings (Katon *et al*. 1995; Simon *et al*. 1999; Wells *et al*. 2000; Taubman-Ben-Ari *et al*. 2001; Unutzer *et al*. 2002; Roy-Byrne *et al*. 2005). Although US acute care settings have been targeted for improvements in the detection and treatment of patients with psychiatric disorders (New Freedom Commission on Mental Health, 2003), a literature review revealed no multisite studies that have prospectively assessed clinical, demographic and service delivery characteristics as risk factors for the development of PTSD after injury.

The National Study on the Costs and Outcomes of Trauma (NSCOT) (MacKenzie *et al*. 2006) is the largest US investigation to date to follow PTSD symptom development after injury. The current investigation used the multisite NSCOT study to ascertain the prevalence of patients endorsing symptoms consistent with a diagnosis of PTSD 12 months after injury. The conceptual framework informing the analysis combined approaches derived from prior explorations of PTSD risk factors (Kessler *et al*. 1995; Brewin *et al*. 2000; Ozer *et al*. 2003; Breslau *et al*. 2004; Parslow *et al*. 2006), elements of multisite injury outcome studies (Nathens *et al*. 2000; Birkmeyer *et al*. 2003), and mental health services research studies targeting acute care policy initiatives (Katon *et al*. 2006). Previous PTSD-focused investigations have broadly categorized demographic, pre-trauma and post-trauma risk factors (Kessler *et al*. 1995; Brewin *et al*. 2000; Ozer *et al*. 2003; Breslau *et al*. 2004; Parslow *et al*. 2006). Large-scale injury outcome investigations necessarily account for the clustering of individual patient outcomes within acute care hospital sites (Nathens *et al*. 2000; Birkmeyer *et al*. 2003). Prior mental health services research in acute care settings has emphasized the importance of policy-relevant investigations that carefully document the independent contribution of psychiatric factors over and above the contribution of injury/medical co-morbidities on post-injury symptomatic and functional outcomes (Zatzick *et al*. 2002*a*; ACS/COT, 2006). The current investigative framework blended these prior approaches by accounting for the clustering of patient outcomes across hospital sites and by categorizing PTSD risk factors into demographic, injury/medical, acute care service delivery, and pre- and post-event psychiatric characteristics.

The investigation aimed to both inform acute care screening and early intervention procedures and influence acute care mental health services policy. The investigation sought to first document nationwide the prevalence of patients with symptoms consistent with a diagnosis of PTSD 12 months after injury hospitalization in the US. The study also sought to answer the question, what clinical and demographic characteristics are independently associated with symptoms consistent with a diagnosis of PTSD 12 months after injury hospitalization? It was hypothesized that variables previously associated with the development of PTSD (e.g. greater levels of early post-traumatic emotional distress) would again be associated with the development of PTSD. The multisite design and large NSCOT sample afforded the opportunity to assess previously unexamined PTSD predictors of particular relevance to acute care medical settings, such as ICU admission, and trauma center *versus* non-trauma center hospital status. The large sample also allowed for the examination of race-ethnicity and SES indicators as PTSD predictors after injury.

METHOD

Setting

The NSCOT was a multicenter prospective cohort study designed to compare the long-term outcomes of trauma center care to care at non-trauma center acute care hospitals (MacKenzie *et al*. 2006). All level I trauma centers and large non-trauma center hospitals within US Metropolitan Statistical Areas were identified. Each metropolitan statistical area has at least one urbanized area of 50 000 or more inhabitants. States included were California, Florida, Illinois, Indiana, Maryland, Massachusetts, Michigan, New Jersey, New York, North Carolina, Pennsylvania and Washington. Patients were enrolled from 69 hospitals. Eighteen of 27 (66·7%) level I trauma centers and 51 of 124 (40·8%) non-trauma center hospitals agreed to participate. Level I trauma centers were, on average, larger than non-trauma centers, were more likely to be members

https://doi.org/10.1017/S0033291707000943 Published online by Cambridge University Press

of the Council on Teaching Hospitals, and treated more patients with major trauma. The study was approved by the institutional review boards of each of the participating hospitals. Informed consent was obtained from all subjects prior to the conduct of NSCOT patient assessments.

Patient population

The recruitment and sampling procedures have been described previously (MacKenzie *et al.* 2006). Patient recruitment occurred between July 2001 and November 2002. English- and Spanish-speaking patients aged 18 to 84 were eligible for the study if they arrived alive at participating hospitals and were treated for moderate to severe injuries, as defined by at least one injury with an Abbreviated Injury Scale (AIS) score $\geqslant 3$. Both intentionally (e.g. injury events associated with malice, such as physical assault) and unintentionally (e.g. motor vehicle crashes, injuries on the job) injured patients were eligible. The current investigation exclusively focused on the weighted subsample of trauma survivors who were assessed for PTSD 12 months after injury. The NSCOT used a quota sampling strategy to ensure that there was adequate representation of injuries and age strata across centers. As a result, not all eligible subjects were enrolled. Subjects were not eligible for enrollment if they were $\geqslant 65$ years of age and had a first listed diagnosis of hip fracture, had a major burn, had treatment delays in excess of 24 hours, or were incarcerated at the time of injury.

Measures

Data regarding the episode of acute care were obtained by medical record review by trained nurse abstractors. Information on acute care service delivery characteristics [i.e. ICU admission, intubation, mechanical ventilation, hospital length of stay (LOS)] were obtained during these hospital record reviews. Data on emergency department heart rate were also obtained through medical record abstraction. Admission alcohol and drug toxicology results were similarly obtained through chart review, as were data pertaining to medical co-morbidities and pre-injury medication use. Severity of injury by body region was coded using the AIS, and the Injury Severity Score (ISS) was derived from the region-specific AIS scores (The Johns Hopkins Health Services Research and Development Center, 1989).

Telephone assessments at 3 and 12 months after discharge were conducted by trained survey interviewers. Standardized instruments assessing PTSD symptoms and functional status were administered during the telephone interviews. A series of investigations supported the equivalence of in-person and telephone assessments across a spectrum of anxiety and depressive disorders including PTSD (Wells *et al.* 1988; Dansky *et al.* 1995). Information on race-ethnicity, sociodemographic characteristics (e.g. income, education, insurance status) and medical co-morbidities derived from medical record abstraction were supplemented by patient-reported data at the 3-month telephone interview. The 3-month interview was also used to obtain self-report information on pre-injury health status, psychiatric (i.e. depression) and substance-related (i.e. alcohol and drug abuse/dependence) disorders, as well as tobacco use. Alcohol consumption in the year prior to the index injury was assessed with the Alcohol Use Disorders Identification Test (AUDIT), a 10-item self-report screening measure used in the acute care setting for early identification of problem drinking (Babor & Grant, 1989).

PTSD symptoms

Symptoms consistent with a diagnosis of PTSD were assessed at the 12-month post-injury telephone interview with the civilian version of the PTSD Checklist (PCL; Weathers *et al.* 1991). The PCL is a 17-item self-report Likert response (1–5) questionnaire that assesses the intrusive, avoidant and arousal PTSD symptom clusters. The measure has established reliability and validity across trauma-exposed populations (Blanchard *et al.* 1996; Hoge *et al.* 2004) and has been used extensively to assess PTSD in the acute care setting (Marshall & Schell, 2002; Zatzick *et al.* 2002*b*). In a study of motor vehicle crash survivors, Blanchard *et al.* (1996) reported that the PCL has a correlation of 0·93 with continuous scores on the Clinician-Administered PTSD Scale (CAPS; Blake *et al.* 1990). The PCL can be used to create an algorithm consistent with a diagnosis of PTSD by rating 1 intrusive, 3 avoidant, and 2 arousal symptoms with a score $\geqslant 3$ as a symptom

https://doi.org/10.1017/S0033291707000943 Published online by Cambridge University Press

consistent with the diagnostic criteria. This algorithm was used to derive PCL symptoms consistent with a diagnosis of PTSD 12 months after injury.

Symptomatic distress and pain

The Medical Outcomes Study Short Form 36 (SF-36) was administered during the telephone interview 3 months post-injury. The SF-36 has established reliability and validity (Ware *et al.* 1993) and has been used extensively to assess functioning and quality-of-life outcomes in injured patients (MacKenzie, 2001; Zatzick *et al.* 2002*a*). The SF-36 contains eight subscales that assess a broad profile of outcomes; subscales are scored from 0 to 100 with 100 equal to the best possible health state. The mental health subscale evaluates global symptomatic distress and includes items that assess hopelessness, lack of energy, nervousness, insomnia, and difficulty concentrating. The current investigation used the mental health subscale to assess global psychological distress within 3 months after the injury. The investigation also used the SF-36 bodily pain subscale to assess self-reports of physical pain 3 months post-injury.

Statistical analysis

As in previously published NSCOT reports, we used 10 multiply-imputed data sets for all statistical analyses (MacKenzie *et al.* 2006). Sampling weights were formed based on the following procedure. First, each individual subject was weighted to the population of eligible patients admitted (for further details see MacKenzie *et al.* 2006). Second, weights were created to adjust for observable differences between trauma center and non-trauma center patients (MacKenzie *et al.* 2006; D'Agostino & D'Agostino, 2007).

We next compared the demographic and clinical characteristics of patients who did and did not complete the 12-month telephone interview, using χ^2 analyses and t tests for categorical and continuous variables respectively. Because of differences between those who were and were not followed at 12 months, in addition to sampling weights, non-response propensity weights were developed using logistic regression techniques, with the outcome being those who completed the 12-month follow-up in comparison to those lost to 12-month follow-up (the variables used to develop the propensity weights are detailed in Table 1). Propensity scores were calculated separately for each of the 10 imputed data sets. The propensity weights, which equaled the reciprocal of the propensity scores, were then multiplied by the sample weights to construct the new sample weights within each imputed data set. All the analyses were first performed on each imputed data set. We then combined the 10 analysis results according to Rubin's rule to yield the final result (Rubin, 1987).

We next calculated the frequency of patients who had symptoms consistent with a diagnosis of PTSD on the PCL at the 12-month post-injury assessment. We determined the association between PCL PTSD status and each demographic, injury/medical, psychiatric, and acute care clinical and service delivery characteristic (Table 1). We used weighted Poisson regression with robust error variance to estimate unadjusted relative risks (RRs) and 95% confidence intervals (CIs) (Zou, 2004).

To determine which characteristics were independently associated with PTSD symptoms, we developed an adjusted Poisson regression model using the robust error variance procedure. All demographic, injury/medical, psychiatric and service delivery characteristics that were statistically significant at $p \leqslant 0{\cdot}15$ (Hosmer & Lemeshow, 1989) in the unadjusted analyses were entered together into the model. Backwards elimination was then used to individually remove the most non-significant characteristic. After the elimination of each non-significant ($p > 0{\cdot}05$) characteristic, the model was refit. This adjusted model contained only statistically significant variables, although age, gender and ISS were retained because of the importance of these variables in injury research (Zatzick *et al.* 2002*b*). All variables that were significant in the unadjusted regressions, but not included in the final model, were tested again for statistical significance in this adjusted model. No other characteristics were found to be statistically significant.

In this adjusted model, African American, American Indian, and Hispanic injury survivors had significantly elevated risks of developing 12-month symptoms consistent with a diagnosis of PTSD, relative to white injury survivors; this observation, when combined with prior investigation documenting racial-ethnic minority

https://doi.org/10.1017/S0033291707000943 Published online by Cambridge University Press

Table 1. *Demographic, clinical and service delivery characteristics of NSCOT patients*

	n	Weighted *n*	% PTSD[a] negative	% PTSD[a] positive	RR (95% CI)
Demographic characteristics					
Gender					
Male	1906	8698	77	23	1·01 (0·79–1·30)
Marital status					
Separated or living alone[b]	1572	7294	75·3	24·7	1·20 (1·01–1·42)
Education					
College degree/post-graduate work	475	1733	89	11	—
Some college	741	3002	79·9	20·1	1·83 (1·20–2·79)
High school graduate	942	4038	74·7	25·3	2·31 (1·66–3·20)
Less than high school	773	3836	72	28	2·55 (1·73–3·77)
Household income (thousands)					
<30	1152	4860	71·5	28·5	1·54 (1·11–2·15)
30–50	662	2818	77·7	22·3	1·20 (0·82–1·78)
50–70	399	1827	82·6	17·4	0·93 (0·57–1·54)
70–100	441	1872	82·3	17·7	0·95 (0·64–1·42)
⩾100	278	1232	81·5	18·5	—
Insurance status					
Private insurance	1675	6490	84·1	15·9	—
Public insurance	602	2374	71·7	28·3	1·78 (1·56–2·04)
No insurance	653	3745	68·3	31·8	2·00 (1·53–2·61)
Ethnicity					
Non-Hispanic, white	1968	7480	82	18	—
Asian/Pacific Islander	48	257	86·5	13·5	0·75 (0·41–1·40)
Hispanic	395	2175	73·4	26·6	1·48 (1·09–2·01)
African American	477	2499	66·5	33·5	1·86 (1·50–2·31)
American Indian	43	196	50·7	49·3	2·74 (1·61–4·66)
Age, mean (S.D.)	2931	12 609	42·7 (38·9)	40·2 (33·9)	0·994 (0·990–0·998)
Injury and medical characteristics					
Injury type					
Intentional[c]	404	2338	65·6	34·4	1·69 (1·34–2·14)
Pre-injury health status					
Mean (S.D.)	2931	12 609	2·1 (2·1)	2·4 (2·8)	1·22 (1·15–1·29)
Excellent	970	4462	79·5	20·5	—
Very good	897	3913	80·5	19·5	0·95 (0·75–1·21)
Good	648	2607	79·3	20·7	1·01 (0·78–1·31)
Fair	317	1260	59·4	40·6	1·98 (1·54–2·55)
Poor	99	367	55·1	44·9	2·19 (1·57–3·06)
No. of pre-injury medical conditions, mean (S.D.)	2931	12 609	0·49 (2·32)	0·63 (2·97)	1·07 (1·01–1·13)
Injury Severity Score, mean (S.D.)	2931	12 609	16·9 (20·0)	17·1 (21·3)	1·00 (0·99–1·01)
Maximum AIS score, mean (S.D.)	2931	12 609	3·4 (1·6)	3·3 (1·8)	0·99 (0·91–1·08)
Initial heart rate, mean (S.D.)	2931	12 609	101·5 (42·3)	103·7 (46·1)	1·004 (1·001–1·007)
Psychiatric characteristics					
Pre-injury					
Alcohol abuse/dependence – Yes[d]	460	2159	65·5	34·5	1·68 (1·38–2·05)
Drug abuse/dependence – Yes[d]	79	401	52·2	47·8	2·16 (1·68–2·78)
Depression – Yes[d]	452	1846	60·9	39·1	1·94 (1·63–2·31)
Cigarette smoking – Yes[d]	1083	5230	69·7	30·3	1·71 (1·42–2·05)
Pre-injury medication prescription					
Anticonvulsants – Yes[d]	119	474	69·6	30·4	1·34 (0·91–1·99)
Antidepressants – Yes[d]	283	990	75·1	24·9	1·09 (0·69–1·72)
Benzodiazepines – Yes[d]	99	356	59·7	40·3	1·80 (1·34–2·41)
Beta-blocker – Yes[d]	244	801	79·6	20·4	0·88 (0·63–1·23)
Narcotics – Yes[d]	103	348	64·1	35·9	1·59 (1·18–2·15)
AUDIT score, mean (S.D.)	2931	12 609	8·5 (21·7)	7·9 (21·9)	0·996 (0·988–1·004)
Admission toxicology results					
Alcohol positive[d]	851	3962	74·4	25·6	1·18 (0·96–1·44)
CNS depressants[e] positive[d]	172	887	70·7	29·3	1·30 (1·01–1·68)
Marijuana positive[d]	140	589	69·4	30·6	1·35 (0·95–1·93)
Opiates positive[d]	284	1674	70·9	29·1	1·32 (1·09–1·60)
Stimulants[f] positive[d]	144	667	59·4	40·6	1·85 (1·49–2·29)

https://doi.org/10.1017/S0033291707000943 Published online by Cambridge University Press

Table 1 (*cont.*)

	n	Weighted *n*	% PTSD[a] negative	% PTSD[a] positive	RR (95% CI)
Post-injury					
SF-36 Mental Health Subscale 3 months, mean (S.D.)	2931	12 609	49·7 (23·1)	36·0 (30·1)	0·950 (0·945–0·955)
SF-36 Pain Subscale 3 months, mean (S.D.)	2931	12 609	43·5 (22·9)	34·4 (24·4)	0·946 (0·938–0·954)
Acute care clinical and service delivery characteristics					
Trauma center[g]	1647	9134	75·6	24·4	1·28 (1·00–1·64)
ICU admission – Yes[d]	1413	5751	74·2	25·8	1·26 (1·07–1·48)
Ventilator – Yes[d]	723	3354	72·9	27·1	1·26 (1·11–1·44)
Intubation – Yes[d]	517	2339	72·5	27·5	1·26 (1·07–1·47)
In-patient length of stay (days), mean (S.D.)	2931	12 609	9·3 (22·9)	11·9 (29·6)	1·011 (1·007–1·015)

NSCOT, National Study on the Costs and Outcomes of Trauma; PTSD, post-traumatic stress disorder; RR, relative risk; CI, confidence interval; AIS, Abbreviated Injury Scale; AUDIT, Alcohol Use Disorders Identification Test; CNS, central nervous system; ICU, intensive care unit; S.D., standard deviation.

[a] Symptoms consistent with a diagnosis of PTSD as assessed with the PTSD Checklist (Weathers *et al.* 1991): the 12-month prevalence of symptoms consistent with a diagnosis of PTSD was 22·9%.

[b] Comparison group was married or living with partner.

[c] Comparison group was those unintentionally injured.

[d] Comparison group was absence of those with condition or medication.

[e] CNS depressants were barbiturates and benzodiazepines.

[f] Stimulants were cocaine and amphetamines.

[g] Comparison group was admission to non-trauma center.

status as a significant PTSD predictor after injury (Santos *et al.* 2003), informed the decision to further explore the associations between race-ethnicity, SES indicators, and PTSD. In the adjusted model we tested the interactions of race-ethnicity by (1) educational attainment, (2) insurance status, and (3) income. To increase the power of our tests we dichotomized educational attainment into greater than or less than high school (Breslau *et al.* 2005). The final adjusted model included all significant effects and interaction terms. Observations in all Poisson regressions were clustered within hospitals. Analyses were performed with the Stata statistical software program (Stata Corporation, College Station, TX, USA).

RESULTS

The 12-month NSCOT telephone assessment was completed by 2931 injury survivors. Using the NSCOT sampling and weighting approach, the reference population to which inferences could be made consisted of 9983 patients (Fig. 1). The investigation attained 81% 12-month follow-up of eligible injury survivors. Gender did not significantly differ between patients lost to follow-up and those completing the 12-month assessment. Patients lost to follow-up at 12 months were more likely to be African

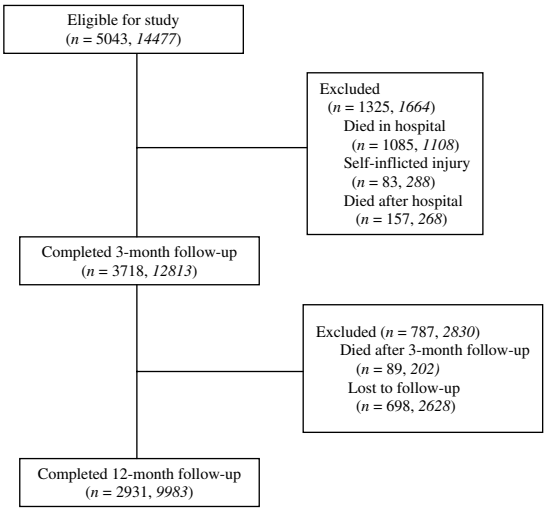

FIG. 1. Patient flow through the National Study on Costs and Outcomes of Trauma (NSCOT) (*n* = unweighted and *weighted*).

American (26% missing *versus* 18% not missing, $\chi^2(1) = 7{\cdot}9$, $p < 0{\cdot}01$) and Hispanic (24·7% *v.* 15·4, $\chi^2(1) = 71{\cdot}6$, $p < 0{\cdot}001$), when compared to non-Hispanic whites (48·5% *v.* 62·6%), were more likely to be intentionally injured (29·9% *v.* 15·5%, $\chi^2(1) = 329$, $p < 0{\cdot}001$), were significantly younger [mean age = 40·6 (36·4) *v.* 43·0 (34·2), $t(3716) = 4{\cdot}8$, $p < 0{\cdot}01$], and were less

https://doi.org/10.1017/S0033291707000943 Published online by Cambridge University Press

Table 2. *Demographic, clinical and service delivery characteristics associated with 12-month PTSD*[a]

Variable	RR (95% CI)	S.E.	*z*	*p*
Demographic characteristics				
Gender (Female)	1·09 (0·92–1·30)	0·10	0·98	0·325
Age	1·00 (0·99–1·00)	0·00	−1·84	0·065
Injury characteristics				
Injury Severity Score	1·00 (0·99–1·00)	0·00	−0·81	0·421
Intentional injury	1·32 (1·04–1·67)	0·16	2·30	0·022
Psychiatric characteristics				
SF-36 Mental Health Subscale 3 months	0·97 (0·96–0·98)	0·01	−7·05	0·000
SF-36 Pain Subscale 3 months	0·97 (0·96–0·98)	0·01	−5·64	0·000
Pre-injury benzodiazepine prescription	1·46 (1·17–1·84)	0·17	3·28	0·001
Pre-injury depression	1·33 (1·15–1·54)	0·10	3·83	0·000
Acute care clinical and service delivery characteristics				
ICU admission	1·17 (1·02–1·35)	0·08	2·27	0·023
Race-ethnic group[b]				
Hispanic	1·51 (0·98–2·33)	0·33	1·85	0·064
African American	1·69 (1·15–2·48)	0·33	2·66	0·008
American Indian	1·17 (0·27–5·20)	0·90	0·20	0·840
Asian/Pacific Islander	0·48 (0·74–3·16)	0·46	−0·76	0·448
Insurance status[c]				
No insurance	1·46 (0·98–2·16)	0·29	1·87	0·061
Public insurance	1·30 (0·86–1·95)	0·27	1·24	0·216
Race-ethnic group by insurance status interactions				
Hispanic × no insurance	0·58 (0·39–0·86)	0·12	−2·71	0·007
Hispanic × public insurance	1·00 (0·49–2·03)	0·36	−0·00	0·999
African American × no insurance	0·66 (0·39–1·11)	0·18	−1·56	0·118
African American × public insurance	0·73 (0·46–1·15)	0·17	−1·37	0·170
American Indian × no insurance	1·53 (0·62–3·75)	0·70	0·92	0·358
American Indian × public insurance	1·14 (0·44–2·98)	0·56	0·27	0·787
Asian/Pacific Islander × no insurance	2·76 (0·30–25·02)	3·10	0·90	0·367
Asian/Pacific Islander × public insurance	2·92 (0·63–13·64)	2·30	1·36	0·172

PTSD, Post-traumatic stress disorder; RR, relative risk; CI, confidence interval; ICU, intensive care unit; S.E., standard error.
[a] Symptoms consistent with a diagnosis of PTSD as assessed with the PTSD Checklist (Weathers *et al.* 1991).
[b] In comparison to non-Hispanic white.
[c] In comparison to private insurance.

severely injured [ISS = 16·4 (S.D. = 18·4) *v.* 17·2 (S.D. = 18·2), $t(3627) = 1{\cdot}9$ $p < 0{\cdot}05$].

Twelve months after the injury admission 22·9% of injured survivors endorsed symptoms consistent with a diagnosis of PTSD on the PCL. The frequency of patients with symptoms consistent with a diagnosis of PTSD on the PCL varied across individual acute care hospital sites, ranging from 0% to 44·3% (median = 17·2%). Unadjusted analyses revealed that multiple demographic, injury/medical, psychiatric, and service delivery characteristics were associated with symptoms consistent with a diagnosis of PTSD (Table 1).

Poisson regression identified demographic, injury, psychiatric and service delivery characteristics that were independently associated with an elevated risk of symptoms consistent with a diagnosis of PTSD 12 months after the injury (Table 2). Greater levels of global symptomatic distress and pain, as indicated by lower SF-36 mental health and pain subscale scores, were associated with a significantly increased risk of symptoms consistent with a diagnosis of PTSD. Pre-injury benzodiazepine prescription, pre-injury depression, ICU admission and intentional injury were associated with elevated risks of PTSD symptoms ranging from 1·17 to 1·46. White injury survivors without insurance demonstrated approximately twice the rate of symptoms consistent with a diagnosis of PTSD 12 months after the injury when compared to white individuals with private insurance. By contrast, for Hispanic injury survivors rates of symptoms consistent with a diagnosis of PTSD were approximately equal between uninsured

and privately insured groups. No other insurance status by race-ethnicity interactions were statistically significant (Table 2).

DISCUSSION

This investigation documents that across US acute care hospitals, over 20% of moderately to severely injured adults had symptoms consistent with a diagnosis of PTSD 12 months after their injury admission. The 69-site investigation yields insight into previously observed variability in 12-month PTSD prevalences reported in single-site investigations. Using a standardized sampling and assessment procedure, the investigation documented a 0–44% range in the frequency of symptoms consistent with PTSD across individual acute care hospital sites. Literature review demonstrates that all previous single-site acute care investigations fall within this range (Blanchard *et al.* 1995; Ehlers *et al.* 1998; Koren *et al.* 1999; Michaels *et al.* 1999; Holbrook *et al.* 2001; Schnyder *et al.* 2001; Zatzick *et al.* 2002*b*; O'Donnell *et al.* 2004). The elucidation of demographic, clinical and service delivery characteristics independently associated with an increased risk of 12-month symptoms consistent with a diagnosis of PTSD across sites suggests factors that may explain some of the reported variability in PTSD prevalences (O'Donnell *et al.* 2003).

This is the first investigation to suggest that ICU admission during the in-patient injury hospitalization is independently associated with an increased risk of symptoms consistent with a diagnosis of PTSD. Other acute care clinical and service delivery characteristics, including mechanical ventilation, intubation, level I trauma center hospital admission, increasing hospital length of stay, and increasing injury severity, were not independently associated with the development of PTSD. There are a number of characteristics associated with ICU admission, such as multiple, prolonged procedures, that may constitute secondary traumatic stressors, and exogenous administration of catecholamines, that may explain the independent contribution of ICU stays on the later development of PTSD (Shaw *et al.* 2002; Cuthbertson *et al.* 2004; Kapfhammer *et al.* 2004; Schelling *et al.* 2004). Future investigation could elucidate which ICU characteristics are most strongly related to the development of post-hospitalization PTSD and whether ICU-based preventive interventions can curb the development of PTSD (Schelling *et al.* 2004).

The investigation found that greater global psychological distress after injury is strongly and independently associated with an increased risk for the later development of symptoms consistent with a diagnosis of PTSD. In addition to mental health symptoms, greater physical pain at 3 months after the injury was also independently associated with an increased risk for symptoms consistent with a diagnosis of PTSD 12 months post-injury. These findings corroborate and extend previous investigations by suggesting that a constellation of post-injury psychological distress including PTSD, anxiety, depressive, peri-traumatic dissociative and pain symptoms may be associated with the development of enduring PTSD (Shalev *et al.* 1996; Bryant *et al.* 2000; Marshall & Schell, 2002; Zatzick *et al.* 2002*b*; O'Donnell *et al.* 2003; Ozer *et al.* 2003). One prior investigation in burn-injured children suggests that adequate opiate pain control is associated with diminished PTSD symptoms 3 months post-injury (Saxe *et al.* 2001). These findings, when considered in conjunction with clinical epidemiological data demonstrating the ubiquitous use of analgesic medication in acute care settings, might suggest the exploration of interventions targeting pain control in the secondary prevention of PTSD (Zatzick & Roy-Byrne, 2006). To our knowledge, this is the first investigation to identify an association between pre-injury benzodiazepine prescription and the development of PTSD. Of note, pre-injury benzodiazepine prescription could be serving as a proxy for pre-injury anxiety disorders.

The investigation assessed interactions between race-ethnicity and SES indicators as post-injury PTSD predictors. Of interest, for Hispanic injury survivors, rates of symptoms consistent with a diagnosis of PTSD were approximately equal for uninsured and privately insured individuals. By contrast, uninsured white injury survivors demonstrated elevated rates of PTSD when compared to white injury survivors with private insurance. Prior research and commentary suggest that trauma-exposed Hispanic individuals may be particularly vulnerable to the development of PTSD (Ruef *et al.* 2000; Galea *et al.* 2004; Pole *et al.* 2005). In the current

post-injury context this vulnerability may be serving to equalize other sociodemographic factors, such as being uninsured. One limitation of the NSCOT investigation was the lack of an assessment of Hispanic subgroups and acculturation levels; future investigation could productively explore these factors in the development of post-injury PTSD (Marshall & Orlando, 2002; Galea *et al*. 2004; Breslau *et al*. 2007).

The investigation has other limitations. One limitation is that many pre-trauma attributes (e.g. pre-injury health status) were assessed by patient self-report at the 3-month post-injury interview; these retrospective reports can be biased by current levels of distress and impairment. The health services research approach used global symptom screens rather than structured diagnostic assessments in a large sample of injured patients across acute care hospital sites. Using symptom screens to assess PTSD may inflate PTSD symptom endorsements (e.g. patients with organic amnesia secondary to traumatic brain injury endorsing screen items assessing psychogenic amnesia). In addition, single-site trauma-focused clinical investigations have used early in-depth assessments of specific symptom clusters including PTSD, depressive and peri-traumatic dissociative symptoms (Shalev *et al*. 1996; Ursano *et al*. 1999; Marshall & Schell, 2002; O'Donnell *et al*. 2004). We acknowledge that in the NSCOT, SF-36 mental health subscale scores may be serving as a proxy for early post-injury PTSD. The exclusion of important subgroups of injured trauma survivors (e.g. burn injury) may also impact PTSD prevalence estimates and the generalizability of study results. Finally, the multiple imputation method has limitations, as do all methods for handling missing data. The multiple imputation approach is the optimal method for data that are missing at random (MAR; Rubin, 1987). If data are not Missing Completely at Random (MCAR), or if missing values are associated with unobserved covariates, then the multiple imputation method is likely to introduce bias. As other alternatives (e.g. complete case analysis or single imputation method) have been demonstrated to yield less satisfactory results than the multiple imputation method, we believe that the multiple imputation method is the optimal approach for handling missing data in the current investigation.

The investigative findings have important implications for US acute care policy. Nationwide, more than 20% of hospitalized patients had symptoms consistent with a diagnosis of PTSD 12 months after injury, and readily identifiable clinical risk factors were documented. In the National Comorbidity Survey (NCS) the survival curve for PTSD after trauma exposure decreased most rapidly in the first 12 months (Kessler *et al*. 1995). The NCS data suggest that more than 50% of individuals who are symptomatic at 12 months will remain symptomatic at the 5-year post-trauma time point. Thus, early PTSD screening and intervention may have the potential to mitigate chronic PTSD after injury.

The American College of Surgeons (ACS) has mandated that level I trauma centers must have on-site alcohol screening and brief intervention services as a requisite for trauma center accreditation (ACS/COT, 2006). This policy mandate derives from a series of acute care screening and intervention studies documenting improved outcomes for patients receiving clinical interventions targeting post-injury alcohol consumption (ACS/COT, 2006). Thus, investigations that refine early PTSD screening and intervention procedures have the potential to improve the quality of mental health care for injured survivors of individual and mass trauma (Zatzick *et al*. 2004), as they may inform future ACS policy mandates for sustainable mental health services in acute care medical settings. Policy efforts targeting early post-injury screening and intervention have the potential to substantially decrease the individual and societal burden of chronic PTSD.

ACKNOWLEDGMENTS

This work was funded by grant R49/CCR316840 from the National Center for Injury Prevention and Control and the Centers for Disease Control and Prevention, grant R01/AG20361 from the National Institute of Aging, and grant R01/MH073613 from the National Institute of Mental Health.

DECLARATION OF INTEREST

None.

REFERENCES

ACS/COT (2006). *Resources for the Optimal Care of the Injured Patient: 2006*. American College of Surgeons Committee on Trauma: Chicago, IL.

Babor, T. F. & Grant, M. (1989). From clinical research to secondary prevention: international collaboration in the development of the Alcohol Use Disorders Identification Test. *Alcohol Health and Research World* **13**, 371–374.

Birkmeyer, J. D., Stukel, T. A., Siewers, A. E., Goodney, P. P., Wennberg, D. E. & Lucas, F. L. (2003). Surgeon volume and operative mortality in the United States. *New England Journal of Medicine* **349**, 2117–2127.

Blake, D., Weathers, F., Nagy, L., Kaloupek, D., Klauminzer, G., Charney, D. & Keane, T. (1990). Clinician-Administered PTSD Scale (CAPS). National Center for Post-Traumatic Stress Disorder, Behavioral Science Division: Boston, MA.

Blanchard, E. B., Hickling, E. J., Taylor, A. E. & Loos, W. (1995). Psychiatric morbidity associated with motor vehicle accidents. *Journal of Nervous and Mental Disease* **183**, 495–504.

Blanchard, E. B., Jones-Alexander, J., Buckley, T. C. & Forneris, C. A. (1996). Psychometric properties of the PTSD Checklist. *Behaviour Research and Therapy* **34**, 669–673.

Bonnie, R. J., Fulco, C. E. & Liverman, C. T. (eds) (1999). *Reducing the Burden of Injury: Advancing Prevention and Treatment*. National Academy Press: Washington, DC.

Breslau, J., Aguilar-Gaxiola, S., Borges, G., Castilla-Puentes, R. C., Kendler, K. S., Medina-Mora, M. E., Su, M. & Kessler, R. C. (2007). Mental disorders among English-speaking Mexican immigrants to the US compared to a national sample of Mexicans. *Psychiatry Research* **151**, 115–122.

Breslau, J., Kendler, K. S., Su, M., Gaxiola-Aguilar, S. & Kessler, R. C. (2005). Lifetime risk and persistence of psychiatric disorders across ethnic groups in the United States. *Psychological Medicine* **35**, 317–327.

Breslau, N., Peterson, E. L., Poisson, L. M., Schultz, L. R. & Lucia, V. C. (2004). Estimating post-traumatic stress disorder in the community: lifetime perspective and the impact of typical traumatic events. *Psychological Medicine* **34**, 889–898.

Brewin, C. R., Andrews, B. & Valentine, J. D. (2000). Meta-analysis of risk factors for posttraumatic stress disorder in trauma-exposed adults. *Journal of Consulting and Clinical Psychology* **68**, 748–766.

Bryant, R. A., Harvey, A. G., Guthrie, R. M. & Moulds, M. L. (2000). A prospective study of psychophysiological arousal, acute stress disorder, and posttraumatic stress disorder. *Journal of Abnormal Psychology* **109**, 341–344.

Chilcoat, H. D. & Breslau, N. (1998). Investigations of causal pathways between PTSD and drug use disorders. *Addictive Behaviors* **23**, 827–840.

Cuthbertson, B. H., Hull, A., Strachan, M. & Scott, J. (2004). Post-traumatic stress disorder after critical illness requiring general intensive care. *Intensive Care Medicine* **30**, 450–455.

D'Agostino Jr., R. B. & D'Agostino Sr., R. B. (2007). Estimating treatment effects using observational data. *Journal of the American Medical Association* **297**, 314–316.

Dansky, B. S., Saladin, M. E., Brady, K. T., Kilpatrick, D. G. & Resnick, H. S. (1995). Prevalence of victimization and posttraumatic stress disorder among women with substance abuse disorders: comparison of telephone and in-person assessment samples. *International Journal of Addictions* **30**, 1079–1099.

Ehlers, A., Mayou, R. A. & Bryant, B. (1998). Psychological predictors of chronic posttraumatic stress disorder after motor vehicle accidents. *Journal of Abnormal Psychology* **107**, 508–519.

Galea, S., Vlahov, D., Tracy, M., Hoover, D. R., Resnick, H. & Kilpatrick, D. (2004). Hispanic ethnicity and post-traumatic stress disorder after a disaster: evidence from a general population survey after September 11, 2001. *Annals of Epidemiology* **14**, 520–531.

Grieger, T. A., Cozza, S. J., Ursano, R. J., Hoge, C., Martinez, P. E., Engel, C. C. & Wain, H. J. (2006). Posttraumatic stress disorder and depression in battle-injured soldiers. *American Journal of Psychiatry* **163**, 1777–1783.

Hoge, C. W., Castro, C. A., Messer, S. C., McGurk, D., Cotting, D. I. & Koffman, R. L. (2004). Combat duty in Iraq and Afghanistan, mental health problems, and barriers to care. *New England Journal of Medicine* **351**, 13–22.

Holbrook, T. L., Anderson, J. P., Sieber, W. J., Browner, D. & Hoyt, D. B. (1999). Outcome after major trauma: 12-month and 18-month follow-up results from the trauma recovery project. *Journal of Trauma* **46**, 765–773.

Holbrook, T. L., Hoyt, D. B., Stein, M. B. & Sieber, W. J. (2001). Perceived threat to life predicts posttraumatic stress disorder after major trauma: risk factors and functional outcome. *Journal of Trauma* **51**, 287–293.

Hosmer, D. W. & Lemeshow, S. (1989). *Applied Logistic Regression*. Wiley: New York.

Kapfhammer, H. P., Rothenhausler, H. B., Krauseneck, T., Stoll, C. & Schelling, G. (2004). Posttraumatic stress disorder and health-related quality of life in long-term survivors of acute respiratory distress syndrome. *American Journal of Psychiatry* **161**, 45–52.

Katon, W., Von Korff, M., Lin, E., Walker, E., Simon, G. E., Bush, T. B., Robinson, P. & Russo, J. (1995). Collaborative management to achieve treatment guidelines: impact on depression in primary care. *Journal of the American Medical Association* **273**, 1026–1031.

Katon, W., Zatzick, D., Bond, G. & Williams Jr., J. (2006). Dissemination of evidence-based mental health interventions: importance to the trauma field. *Journal of Traumatic Stress* **19**, 611–623.

Kessler, R. C., Sonnega, A., Bromet, E., Hughs, M. & Nelson, C. B. (1995). Posttraumatic stress disorder in the National Comorbidity Survey. *Archives of General Psychiatry* **52**, 1048–1060.

Koren, D., Arnon, I. & Klein, E. (1999). Acute stress response and posttraumatic stress disorder in traffic accident victims: a one-year prospective, follow-up study. *American Journal of Psychiatry* **156**, 367–373.

Koren, D., Hemel, D. & Klein, E. (2006). Injury increases the risk for PTSD: an examination of potential neurobiological and psychological mediators. *CNS Spectrums* **11**, 616–624.

Krug, E. G., Sharma, G. K. & Lozano, R. (2000). The global burden of injuries. *American Journal of Public Health* **90**, 523–526.

Kulka, R. A., Schlenger, W. E., Fairbank, J. A., Hough, R. L., Jordan, B. K., Marmar, C. R. & Weiss, D. S. (1990). *Trauma and the Vietnam War Generation: Report of Findings from the National Vietnam Veterans Readjustment Study*. Brunner/Mazel: New York, NY.

MacKenzie, E. J. (2001). Measuring disability and quality of life postinjury. In *Injury Control: A Guide to Research and Program Evaluation* (ed. F. P. Rivara, P. Cummings, T. D. Koepsell, D. C. Grossman and R. V. Maier), pp. 250–269. Cambridge University Press: Cambridge.

MacKenzie, E. J., Rivara, F. P., Jurkovich, G. J., Nathens, A. B., Frey, K. P., Egleston, B. L., Salkever, D. S. & Scharfstein, D. O. (2006). A national evaluation of the effect of trauma-center care on mortality. *New England Journal of Medicine* **354**, 366–378.

Maes, M., Delmeire, L., Mylle, J. & Altamura, C. (2001). Risk and preventive factors of post-traumatic stress disorder (PTSD): alcohol consumption and intoxication prior to a traumatic event diminishes the relative risk to develop PTSD in response to that trauma. *Journal of Affective Disorders* **63**, 113–121.

Marshall, G. N. & Orlando, M. (2002). Acculturation and peritraumatic dissociation in young adult Latino survivors of community violence. *Journal of Abnormal Psychology* **111**, 166–174.

Marshall, G. N. & Schell, T. L. (2002). Reappraising the link between peritraumatic dissociation and PTSD symptom severity: evidence from a longitudinal study of community violence survivors. *Journal of Abnormal Psychology* **111**, 626–636.

Mayou, R., Bryant, B. & Duthie, R. (1993). Psychiatric consequences of road traffic accidents. *British Medical Journal* **307**, 647–651.

Mayou, R., Tyndel, S. & Bryant, B. (1997). Long-term outcome of motor vehicle accident injury. *Psychosomatic Medicine* **59**, 578–584.

Mellman, T. A., David, D., Bustamante, V., Fins, A. I. & Esposito, K. (2001). Predictors of post-traumatic stress disorder following severe injury. *Depression and Anxiety* **14**, 226–231.

Mellman, T. A., Ramos, J., David, D., Williams, L. & Augenstein, J. S. (1998). Possible inhibition of early PTSD symptoms by alcohol intoxication. *Depression and Anxiety* **7**, 145.

Michaels, A. J., Michaels, C. E., Zimmerman, M. A., Smith, J. S., Moon, C. H. & Peterson, C. (1999). Posttraumatic stress disorder in injured adults: etiology by path analysis. *Journal of Trauma* **47**, 867–873.

Nathens, A. B., Jurkovich, G. J., Cummings, P., Rivara, F. P. & Maier, R. V. (2000). The effect of organized systems of trauma care on motor vehicle crash mortality. *Journal of the American Medical Association* **283**, 1990–1994.

New Freedom Commission on Mental Health (2003). *Achieving the Promise: Transforming Mental Health Care in America*. DHHS: Rockville, MD.

O'Donnell, M. L., Creamer, M., Bryant, R. A., Schnyder, U. & Shalev, A. Y. (2003). Posttraumatic disorders following injury: an empirical and methodological review. *Clinical Psychology Review* **23**, 587–603.

O'Donnell, M. L., Creamer, M., Elliott, P., Atkin, C. & Kossmann, T. (2005). Determinants of quality of life and role-related disability after injury: impact of acute psychological responses. *Journal of Trauma* **59**, 1328–1335.

O'Donnell, M. L., Creamer, M. & Pattison, P. (2004). Posttraumatic stress disorder and depression following trauma: understanding comorbidity. *American Journal of Psychiatry* **161**, 1390–1396.

Ozer, E. J., Best, S. R., Lipsey, T. L. & Weiss, D. S. (2003). Predictors of posttraumatic stress disorder and symptoms in adults: a meta-analysis. *Psychological Bulletin* **129**, 52–73.

Parslow, R. A., Jorm, A. F. & Christensen, H. (2006). Associations of pre-trauma attributes and trauma exposure with screening positive for PTSD: analysis of a community-based study of 2,085 young adults. *Psychological Medicine* **36**, 387–395.

Pole, N., Best, S. R., Metzler, T. & Marmar, C. R. (2005). Why are hispanics at greater risk for PTSD? *Cultural Diversity and Ethnic Minority Psychology* **11**, 144–161.

Roy-Byrne, P. P., Craske, M. G., Stein, M. B., Sullivan, G., Bystritsky, A., Katon, W., Golinelli, D. & Sherbourne, C. D. (2005). A randomized effectiveness trial of cognitive-behavioral therapy and medication for primary care panic disorder. *Archives of General Psychiatry* **62**, 290–298.

Rubin, D. (1987). *Multiple Imputation for Nonresponse in Surveys*. Wiley: New York.

Ruef, A. M., Litz, B. T. & Schlenger, W. E. (2000). Hispanic ethnicity and risk for combat-related posttraumatic stress disorder. *Cultural Diversity and Ethnic Minority Psychology* **6**, 235–251.

Santos, M., Russo, J. & Zatzick, D. (2003). Ethnocultural variations in immediate posttraumatic distress [Abstract]. In *Proceedings of the 19th Annual Meeting of the International Society for Traumatic Stress Studies*, Chicago, IL, p. 126.

Saxe, G., Stoddard, F., Courtney, D., Cunningham, K., Chawla, N., Sheridan, R., King, D. & King, L. (2001). Relationship between acute morphine and the course of PTSD in children with burns. *Journal of the American Academy of Child and Adolescent Psychiatry* **40**, 915–921.

Schelling, G., Kilger, E., Roozendaal, B., de Quervain, D. J., Briegel, J., Dagge, A., Rothenhausler, H. B., Krauseneck, T., Nollert, G. & Kapfhammer, H. P. (2004). Stress doses of hydrocortisone, traumatic memories, and symptoms of posttraumatic stress disorder in patients after cardiac surgery: a randomized study. *Biological Psychiatry* **55**, 627–633.

Schnyder, U., Moergeli, H., Klaghofer, R. & Buddeberg, C. (2001). Incidence and prediction of posttraumatic stress disorder symptoms in severely injured accident victims. *American Journal of Psychiatry* **158**, 594–599.

Shalev, A. Y., Freedman, S., Peri, T., Brandes, D., Sahar, T., Orr, S. P. & Pitman, R. K. (1998). Prospective study of posttraumatic stress disorder and depression following trauma. *American Journal of Psychiatry* **155**, 630–637.

Shalev, A. Y., Peri, T., Canetti, L. & Schreiber, S. (1996). Predictors of PTSD in injured trauma survivors: a prospective study. *American Journal of Psychiatry* **153**, 219–225.

Shaw, R. J., Robinson, T. E. & Steiner, H. (2002). Acute stress disorder following ventilation. *Psychosomatics* **43**, 74–76.

Simon, G. E., Von Korff, M., Piccinelli, M., Fullerton, C. S. & Ormel, J. (1999). An international study of the relation between somatic symptoms and depression. *New England Journal of Medicine* **341**, 1329–1335.

Taubman-Ben-Ari, O., Rabinowitz, J., Feldman, D. & Vaturi, R. (2001). Post-traumatic stress disorder in primary-care settings: prevalence and physician's detection. *Psychological Medicine* **31**, 555–560.

The Johns Hopkins Health Services Research and Development Center (1989). *Determining Injury Severity from Hospital Discharges: A Program to Map ICD-9CM Diagnoses into AIS and ISS Severity Scores*. The Johns Hopkins University Press: Baltimore, MD.

Unutzer, J., Katon, W., Callahan, C. M., Williams Jr., J. W., Hunkeler, E., Harpole, L., Hoffing, M., Della Penna, R. D., Noel, P. H., Lin, E. H., Arean, P. A., Hegel, M. T., Tang, L., Belin, T. R., Oishi, S. & Langston, C. (2002). Collaborative care management of late-life depression in the primary care setting: a randomized controlled trial. *Journal of the American Medical Association* **288**, 2836–2845.

Ursano, R. J., Fullerton, C. S., Epstein, R. S., Crowley, B., Kao, T., Vance, K., Craig, K. J., Dougall, A. L. & Baum, A. (1999). Acute and chronic posttraumatic stress disorder in motor vehicle accident victims. *American Journal of Psychiatry* **156**, 589–595.

Verger, P., Dab, W., Lamping, D. L., Loze, J. Y., Deschaseaux-Voinet, C., Abenhaim, L. & Rouillon, F. (2004). The psychological impact of terrorism: an epidemiologic study of posttraumatic stress disorder and associated factors in victims of the 1995–1996 bombings in France. *American Journal of Psychiatry* **161**, 1384–1389.

Wang, P. S., Lane, M., Olfson, M., Pincus, H. A., Wells, K. B. & Kessler, R. C. (2005). Twelve-month use of mental health services in the United States: results from the National Comorbidity Survey Replication. *Archives of General Psychiatry* **62**, 629–640.

Ware, J. E., Snow, K. K. & Kosinski, M. (1993). *SF-36 Health Survey: Manual and Interpretation Guide*. The Health Institute, New England Medical Center: Boston, MA.

Weathers, F. W., Huska, J. A. & Keane, T. M. (1991). *The PTSD Checklist – Civilian Version*. The National Center For PTSD, Boston VA Medical Center: Boston MA.

Wells, K. B., Burnam, M. A., Leake, B. & Robbins, L. N. (1988). Agreement between face-to-face and telephone-administered version of the depression section of the NIMH Diagnostic Interview Schedule. *Journal of Psychiatric Research* **22**, 207–220.

Wells, K. B., Sherbourne, C., Schoenbaum, M., Duan, N., Meredith, L., Unutzer, J., Miranda, J., Carney, M. F. & Rubenstein, L. V. (2000). Impact of disseminating quality improvement programs for depression in managed primary care: a randomized controlled trial. *Journal of the American Medical Association* **283**, 212–220.

Zatzick, D., Jurkovich, G. J., Gentilello, L. M., Wisner, D. H. & Rivara, F. P. (2002*a*). Posttraumatic stress, problem drinking and functioning 1 year after injury. *Archives of Surgery* **137**, 200–205.

Zatzick, D., Kang, S. M., Muller, H. G., Russo, J. E., Rivara, F. P., Katon, W., Jurkovich, G. J. & Roy-Byrne, P. (2002*b*). Predicting posttraumatic distress in hospitalized trauma survivors with acute injuries. *American Journal of Psychiatry* **159**, 941–946.

Zatzick, D. & Roy-Byrne, P. (2006). From bedside to bench: how the epidemiology of clinical practice can inform the secondary prevention of PTSD. *Psychiatric Services* **57**, 1726–1730.

Zatzick, D., Roy-Byrne, P., Russo, J., Rivara, F., Droesch, R., Wagner, A., Dunn, C., Jurkovich, G., Uehara, E. & Katon, W. (2004). A randomized effectiveness trial of stepped collaborative care for acutely injured trauma survivors. *Archives of General Psychiatry* **61**, 498–506.

Zou, G. (2004). A modified Poisson regression approach to prospective studies with binary data. *American Journal of Epidemiology* **159**, 702–706.