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Posttraumatic Stress Disorder among Older Adults Experiencing Motor Vehicle Collision: a Multicenter Prospective Cohort Study

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Abstract

Objective—To characterize risk factors for and consequences of posttraumatic stress disorder (PTSD) among older adults evaluated in the emergency department (ED) following motor vehicle collision (MVC).

Design—Prospective multicenter longitudinal study (2011–2015).

Setting—9 EDs across the United States.

Participants—Adults aged 65 years and older who presented to an ED after MVC without severe injuries.

Measurements—PTSD symptoms were assessed 6 months after the ED visit using the Impact of Event Scale-Revised.

Results—Of 223 patients, clinically significant PTSD symptoms at 6 months were observed in 21% (95% CI 16%–26%). PTSD symptoms were more common in patients who did not have a college degree, had depressive symptoms prior to the MVC, perceived the MVC as life-threatening, had severe ED pain, and expected their physical or emotional recovery time to be greater than 30 days. Three factors (ED pain severity [0–10 scale], perceived life-threatening MVC [0–10 scale], and pre-MVC depressive symptoms [yes to either of two questions]), predicted 6 month PTSD symptoms with an area under the curve of 0.76. Compared to patients without PTSD symptoms, those with PTSD symptoms were at higher risk for persistent pain (72% vs. 30%), functional decline (67% vs. 42%), and new disability (49% vs. 18%).

Conclusions—Among older adults treated in the ED following MVC, clinically significant PTSD symptoms at 6 months were present in 21% of patients and were associated with adverse health outcomes. Increased risk for PTSD development can be identified with moderate accuracy using information readily available in the ED.

Keywords

Emergency medicine; Geriatrics; Aged; Stress disorders; post-traumatic; Multiple trauma; Trauma and stress disorders; Traffic accidents

OBJECTIVE

Motor vehicle collision (MVC) is one of the most common life-threatening traumatic events experienced in industrialized countries.¹ An estimated 1 million U.S. adults aged 65 years and older experience an MVC annually,¹ and over 250,000 come to the emergency department (ED) for care.² Due to rapid growth in the number of active and independent older adults, the number of older adults in the U.S. experiencing MVC each year is projected to double over the next two decades.² More than 80% of older adults presenting to the ED after MVC do not have severe or life-threatening injuries and are discharged home after the ED evaluation.² Persistent pain among older adults experiencing MVC has been described,³ but little is known about other adverse outcomes after this common injury mechanism in older adults.

Posttraumatic stress disorder (PTSD) is known to be a common and morbid sequela of MVC among younger adults.⁴⁻⁶ Among older adults, PTSD has been described as a residual of childhood or young adult trauma exposure or a result of a new trauma exposure occurring in later life,⁷⁻⁹ is estimated to have a community prevalence of 1%,⁹ and is associated with poor mental health¹⁰ and medical conditions including hypertension, stomach disorders, and arthritis.¹¹ However, prospective studies of the development of PTSD following trauma exposure in later life have been limited to natural disasters.^{7,12} No prospective studies have characterized PTSD development among older adults following MVC. Two meta-analyses describing predictors of PTSD in adults identified a number of risk factors associated with the development of PTSD after acute trauma, including prior trauma, education, prior psychiatric history, and peritraumatic dissociation.^{13,14} Other literature suggests that younger adults with higher perceived trauma severity¹⁵, depression¹⁶, and African American descent¹⁷ may be at higher risk for developing PTSD after acute trauma. Using the results of the literature review, a priori selection was used to select factors we hypothesized to be predictive of clinically significant PTSD symptoms in older adults after MVC.

We sought to estimate the frequency of clinically significant PTSD symptoms 6 months after MVC among older adults, examine predictors of PTSD symptoms, and characterize associations between PTSD symptoms and other adverse health outcomes.

METHODS

Study Design and Setting

We conducted a multicenter prospective longitudinal study of patients aged 65 years and older evaluated in an ED within 24 hours after an MVC. Patients were enrolled from nine EDs in five no-fault insurance states (Florida, Massachusetts, Michigan, New York, and New Jersey). These states were chosen to minimize the number of participants for whom on-going legal activity might promote symptom persistence.¹⁸ At each of our study sites, research assistants monitored the chief complaints of ED patients to identify individuals aged 65 years and older who presented following MVC. Research assistants approached these patients for screening, consent, and interview during the participant's ED visit. In all cases the ED evaluation occurred after a triage nurse had assessed the patient and in most cases after the initial assessment by an emergency physician. Follow-up assessments were completed by phone or mail at 2 weeks and six months. The study was approved by the institutional review board at each site, and each participant provided written informed consent. Additional details regarding the collection of ED and follow-up data have been published for the parent study.^{3,19}

Participants

Patients aged 65 years and older who presented to the ED within 24 hours after MVC were screened for enrollment. Only patients without severe or life-threatening injuries (i.e., fractures, major lacerations, intracranial injuries, intra-abdominal injuries, or spinal injuries) were enrolled, because such patients constitute the great majority of older adults presenting to the ED after MVC,² and no programmatic efforts currently exist to optimize the mental health outcomes of these patients. Patients were also excluded if they had moderate or severe

cognitive impairment based on a Six-Item Screener score ≥ 3 ,²⁰ were prisoners, were living in a nursing home, did not speak or read English, or were receiving end-of-life or comfort care. Recruitment took place between June 2011 and August 2015.

Measures

The ED interview obtained information about patient demographics, pre-MVC health, MVC characteristics,²¹ and acute pain and distress symptoms. Sociodemographics included age, sex, race, level of formal education, and whether or not the patient had social support at home. Pre-MVC health encompassed self-rated general health, polypharmacy, baseline physical function, disability, depressive symptoms, and mild cognitive impairment. Polypharmacy was defined as taking ≥ 5 medications per day.²² Pre-MVC physical function (0–12 scale) was assessed based on self-reported ability to walk, climb stairs, and lift or carry 10–20 pounds during the week before the MVC.²³ Pre-MVC disability was defined as present if the patient reported at least some difficulty with one or more of the following activities of daily living (ADLs): bathing, dressing, transferring from bed to chair, rising from a chair, using the toilet, or eating.²⁴ Pre-MVC depressive symptoms were considered present if the patient answered “yes” to either 1) feeling down, depressed, or hopeless much of the time during the past month or 2) being bothered by having little interest or pleasure in doing things much of the time during the past month.²⁵ Mild cognitive impairment was defined as a score of 4 or 5 on the Six Item Screener.²⁰ Patients were asked their position in the vehicle, the main location(s) of vehicle damage, and to characterize the vehicle damage as mild, moderate, or severe. Patients were also asked to rate how life-threatening they believed the MVC to be on a scale of 0–10;²⁶ responses for this item that were equal to or above the median score of 5 were considered life-threatening. Pain severity was measured using the 0 to 10 numeric rating scale and categorized as mild (1–3), moderate (4–6), or severe (7–10).²⁷ Acute stress symptoms were assessed using the Peritraumatic Distress Inventory. Individual items from the Peritraumatic Distress Inventory (“I thought I might die”, “I felt helpless”) were dichotomized with a yes defined by responses of “slightly true,” “somewhat true,” “very true,” or “extremely true.”²⁸ Patients were asked to estimate their expected time in days for physical recovery and emotional recovery.

The 2-week interview assessed pain severity, pain interference, bed rest, and use of analgesics. Pain severity was measured using the 0 to 10 numeric rating scale and was considered MVC-related if the patient answered yes to the question, “Is this pain related to your motor vehicle collision?” Brief Pain Inventory questions were used to assess pain interference with general activity, walking ability, sleep, and enjoyment of life using a 0 (no interference) to 10 (complete interference) scale.²⁵ For each domain, pain interference was defined as present if the patient reported a score ≥ 4 .²³ Bed rest was considered present if participants answered “yes” to the question, “during the past two weeks, have you stayed in bed for at least half a day?”²⁹ Opioid use was defined by patient self-reported use of an opioid analgesic in the past 24 hours. Patients were given examples of opioids to assist identification and were also asked to name any pain medications they had taken in the past 24 hours.

At 6 months, PTSD symptoms were assessed using the Impact of Event Scale — Revised (IES-R), with an IES-R score ≥ 25 used to define patients with clinically concerning PTSD symptoms.³⁰ This cutoff was found by Asukai et al. to have high sensitivity, specificity, positive predictive value, and negative predictive value for clinically concerning PTSD symptoms across a diverse range of trauma exposures.³⁰ We assessed pain severity, pain interference, and use of analgesics using the same method as the 2-week interview. Additionally, at 6 months, we measured changes in physical function and disability, driving anxiety, and depressive symptoms. Functional decline was defined as any decrease (i.e. 1 point or more) in physical function between baseline and 6 months. Similarly, new disability was defined as any decrease in the composite ADL score between baseline and 6 months. Driving anxiety was considered present if the patient reported feeling “quite a bit” or “much more” nervous about driving compared to before the MVC. We assessed 6 month depressive symptoms with the same measure used to assess pre-MVC depression. Patients were also asked how many hours they slept in a 24-hour period, on average, in the past week.

Statistical Analysis

We calculated the percentage of the sample with clinically significant PTSD symptoms overall and by participant characteristics, including demographics, pre-MVC health, MVC characteristics, and acute pain. Confidence intervals were calculated using exact methods.³¹ We estimated risk ratios for PTSD symptoms based on demographics, MVC characteristics, ED symptoms, and 2 week symptoms and behaviors, adjusted for age and sex. We then derived a clinical prediction tool to identify older adults at increased risk of PTSD at 6 months using information readily available at the time of ED evaluation. Seventeen candidate predictors were considered based on literature review and expert opinion. These variables were tested with bivariate analysis, and those with an association with 6 month PTSD symptoms (IES-R score ≥ 25) at $p < 0.10$ were entered into a forward stepwise logistic regression using the Akaike information criterion (AIC) to assess model fit. Internal validation of the model was performed using 10-fold cross validation. We report area under the receiver operating characteristic curve (AUROC) with 95% confidence interval for this model.

Associations between PTSD symptoms and other health outcomes at 6 months were reported as raw and adjusted percentages. We adjusted for variables that we thought, prior to analyses, would be likely to confound the relationship between PTSD and these other outcomes: age, gender, race, level of formal education, and ED pain severity. Adjusted percentages were estimated as mean values for covariates using the *predxcat* command in STATA. Finally, we explored associations between PTSD symptom domains and health outcomes at 6 months. PTSD symptom domains of intrusion, hyper-arousal, and avoidance were defined following Weiss et al.,³² which categorizes each of the 22 IES-R questions into one of these three domains. Because past literature has found associations between these domains and the development of specific PTSD symptoms, we conducted exploratory analyses of the strength of associations between PTSD domains and pain severity, pain interference, functional decline, new disability, depression, and sleep at 6 months. These associations were examined using linear regressions and are reported using the coefficient of

determination (R^2) with and without adjustment for the covariates listed above. All statistical analyses were conducted using STATA 14.1 (StataCorp LP, College Station, TX).

RESULTS

Of 1232 patients screened, 542 were eligible and 256 consented to participate (Figure 1). Of eligible patients who declined participation, the most common reason was that the study would take too much time ($N=82$). Fifty-four eligible patients stated they did not want to participate because they were too stressed or overwhelmed. Of the 256 consenting participants, 3 had incomplete ED interviews and were excluded from analysis. An additional 30 participants were lost to follow-up at 6 months, leaving a total of 223 participants (88%) for analysis. There were no significant differences between the participants lost to follow-up and the study sample with regard to age and gender: of the participants lost to follow-up ($N=30$), 33% (vs. 35%) were aged ≥ 75 years and 50% (vs. 56%) were female. However, those lost to follow-up had a greater percentage of African Americans compared to the study sample (33% vs. 16%) and a lower percentage of individuals with college degrees (37% vs. 65%).

At 6 months, 21% (47/223) of participants had clinically severe PTSD symptoms (IES-R ≥ 25). The patient characteristics associated with the highest risk of PTSD were African American ethnicity and severe pain in the ED; the characteristic associated with the lowest risk of PTSD was college education (Table 1). After adjusting for age and sex, other ED findings associated with clinically significant PTSD symptoms at 6 months ($p \leq 0.05$) were depressive symptoms prior to the MVC, an MVC that was perceived to be life-threatening, a positive response to the statement “I thought I might die” from the peritraumatic distress inventory, and patient estimate in the ED of expected time to physical or emotional recovery of greater than 30 days (Table 2). Neither pain severity, opioid use, nor bed rest at 2 weeks were significantly associated with PTSD symptoms at 6 months.

Nine of the 19 ED variables tested had bivariate associations with 6 month PTSD at $p < 0.10$ (Appendix 1). Forward stepwise logistic regression identified a predictive model with 3 variables: pain severity in the ED, perceived life-threat of the MVC, and pre-MVC depressive symptoms (Table 3; Figure 2). Internal validation of this model using 10-fold cross-validation yielded an AUROC of 0.76. A representative cutoff had a sensitivity of 86% and a specificity of 47%.

Compared to study participants without PTSD symptoms at 6 months, those with clinically concerning PTSD symptoms were more likely to experience moderate or severe pain, pain interference, a decline in physical function since the MVC, and driving anxiety and depressive symptoms after the MVC (Table 4). In addition, such individuals were more likely to sleep an average of ≈ 6 hours per night. These associations were only slightly attenuated after adjusting for patient age, gender, race, level of formal education, and pain severity in the ED.

Coefficients of determination (R^2) between PTSD subscale scores and outcomes are shown in Appendix 2. All correlations for these values were positive. In general, intrusion and

hyperarousal symptoms were more strongly associated with adverse health outcomes at 6 months than were avoidance symptoms. For example, R^2 values for moderate to severe pain at 6 months were intrusion = 0.39, avoidance = 0.33, and hyperarousal = 0.39.

DISCUSSION

We present the results of the first prospective study of the incidence of clinically significant PTSD symptoms among older adults experiencing MVC, predictors of these symptoms, and other adverse health outcomes associated with PTSD symptoms. Twenty-one percent of adults aged 65 years and older in this sample who presented to the ED following MVC had clinically significant symptoms of PTSD at 6 months. This finding suggests that PTSD occurs in approximately 50,000 U.S. older adults annually who present to the ED after MVC and are discharged home after evaluation (20% of 250,000). This incidence is equivalent to that of younger adults hospitalized after severe MVC (18–23%),^{4,33,34} and higher than some estimates of PTSD among young combat veterans (8–18%).^{35,36} As has been described for younger adults,^{37,38} clinically significant PTSD symptoms at 6 months were associated with persistent pain. Patients in this study with PTSD symptoms were also more likely to report functional decline and disability, even after adjustment for potential confounders. These results are consistent with previously reported findings that older adults with PTSD spend more days in bed and are less satisfied with life compared to older adults without PTSD.³⁹

After adjustment for age and sex, a number of patient characteristics predicted clinically significant PTSD symptoms, including no college degree, pre-MVC depressive symptoms, perception that the MVC was life-threatening, and expectation of prolonged (>30 days) physical or emotional recovery. The 3 patient characteristics that together most strongly predicted clinically significant PTSD symptoms at 6 months were pain severity in the ED, perceived life-threat of the MVC, and pre-MVC depressive symptoms (area under the curve = 0.76). Previously investigated risk factors of PTSD in the elderly include neuroticism and adverse childhood events; we did not assess these characteristics in our sample.⁹ Each of the 3 patient characteristics identified in our study can be assessed in the ED by asking 1 or 2 questions, and the answers to all 3 questions can be obtained in less than a minute. Identifying these factors in the ED may prompt physicians to refer patients to psychiatrists for early preventative intervention. The optimal length and sensitivity and specificity cut-offs for ED-based tools to identify older adults at high risk of PTSD would be expected to vary based on pre-test probability, type of intervention, and use of the tool as an initial screening tool vs. a tool to select individuals for secondary preventive interventions. The fairly good AUROC for the above example derivation instrument suggests that in the future such relatively simple ED-based tools may indeed be useful and feasible for ED care providers to employ.

In our sample, point estimates for the frequency of PTSD symptoms were higher in African Americans than whites (31% vs. 19%), but this difference was not statistically significant. In a nationally-representative U.S. survey (n=11,710), PTSD was slightly more common among African Americans than whites (3.8% vs. 3.5%); however, among individuals aged 60 years and older PTSD was more than twice as common among African Americans (2.1% vs. 1.0%).¹⁷ Cultural, experiential, and/or biological factors may contribute to this

difference. For example, African Americans are more likely to experience feelings of victimization due to race-related stressors⁴⁰ and are also more likely to have experienced previous violent assault.⁴¹ In addition, ethnic variations in the frequency of genetic polymorphisms may contribute to increased PTSD rates in African Americans vs. European Americans.^{42,43}

This study has several strengths. Participants were enrolled from multiple distinct regions of the U.S., supporting the generalizability of study findings. Consistent with this, 20% of participants were minorities, which is similar to the percentage of minorities among older adults seeking care in U.S. EDs nationally (24%).⁴⁴ In addition, the 6 month follow-up rate of 88% is quite good and reduces the potential for non-response bias. Predictor variables were assessed in the ED, which would be the optimal setting to identify older adults at high risk for developing PTSD for secondary preventive interventions. There is burgeoning evidence that pharmacologic therapies such as hydrocortisone, propranolol, or morphine may prevent the development of PTSD symptoms when administered in the early aftermath of trauma.^{45–48} Additionally, prolonged exposure therapy initiated in the ED setting has been shown to reduce the severity of posttraumatic stress reactions 4 and 12 weeks following acute trauma compared to the control group.^{48,49} Our exploratory analysis of IES-R PTSD symptom domains showed that intrusion and hyperarousal symptoms were more strongly associated with pain and pain interference at 6 months than were avoidance symptoms. Although these results are preliminary and require additional investigation, they may suggest that pain and PTSD symptoms are linked by an underlying degree of anxiety-associated symptoms rather than avoidance behavior. If confirmed, these findings may inform the types of early treatments that are most effective for preventing PTSD in this population.

This study also has several limitations. Our results do not provide estimates of the 6-month prevalence of PTSD symptoms for *all* older adults experiencing MVC who do not require hospitalization because only about one-third of older adults experiencing an MVC receive emergency care (the other two-thirds are not treated in an ED).⁵⁰ Because pain and distress symptoms that contribute to care-seeking are also risk factors for persistent PTSD symptoms, risk for PTSD symptoms is likely lower in patients who do not seek emergency care. Non-response bias resulting from eligible subjects not consenting to participate may have led us to over- or under-estimate the percentage of older patients experiencing MVC who develop PTSD symptoms. In particular, patients who declined to participate because they were too stressed or overwhelmed (n=54) probably had an increased risk of developing PTSD as compared to those who did participate. We used the IES-R to identify patients with clinically significant PTSD symptoms, and not clinician assessment. The IES-R definition of PTSD used in this manuscript is not the same as a DSM-5 diagnosis, which is the clinical standard for the diagnosis of PTSD. Further development and validation of predictions instruments should consider defining presence or absence of PTSD symptoms using the Posttraumatic Stress Disorder Checklist for DSM-5 (PCL-5). The IES-R definition also differs from the recently developed Research Domain Criteria (RDoC), which use a range of symptoms across multiple dimensions to characterize mental illness. Further, although validated and widely-used, the cutoff of 25 has not been validated in an English-speaking population. We conducted multiple tests to identify potential candidate variables, increasing the chance of type I error. In addition, although internal validation of our predictive model

using 10-fold cross validation showed good discriminative ability, we did not perform external validation. It is possible that in some patients, an experience other than the MVC contributed to the PTSD symptoms observed at 6 months as participants were not assessed at baseline for previous trauma history or PTSD symptoms. In the future, we seek to refine and validate our model with a larger sample in order to better evaluate performance in clinical settings.

In this prospective multicenter study of older adults receiving care in the ED after MVC, we found high rates of clinically significant PTSD symptoms and strong associations between such symptoms and other adverse mental and physical health outcomes. These findings add to the growing body of evidence indicating that a substantial subset of older adults develop chronic adverse health outcomes after being seen in the ED without severe or life-threatening injuries.^{51,52} The identification of several characteristics readily available at the time of the ED evaluation suggests the potential to use the ED visit to identify older patients at high risk for PTSD following MVC in order to initiate early preventive therapies.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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References

1. Lyman S, Ferguson SA, Braver ER, Williams AF. Older driver involvements in police reported crashes and fatal crashes: Trends and projections. *Inj Prev*. 2002; 8(2):116–20. [PubMed: 12120829]
2. Platts-Mills TF, Hunold KM, Esserman DA, Sloane PD, McLean SA. Motor vehicle collision-related emergency department visits by older adults in the united states. *Acad Emerg Med*. 2012; 19(7):821–827. DOI: 10.1111/j.1553-2712.2012.01383.x [PubMed: 22724382]
3. Platts-Mills TF, Flannigan SA, Bortsov AV, et al. Persistent pain among older adults discharged home from the emergency department after motor vehicle crash: A prospective cohort study. *Ann Emerg Med*. 2016; 67(2):166–176 e1. [PubMed: 26092559]
4. McLean SA, Clauw DJ, Abelson JL, Liberzon I. The development of persistent pain and psychological morbidity after motor vehicle collision: Integrating the potential role of stress response systems into a biopsychosocial model. *Psychosom Med*. 2005; 67(5):783–790. [PubMed: 16204439]
5. Dougall AL, Ursano RJ, Posluszny DM, Fullerton CS, Baum A. Predictors of posttraumatic stress among victims of motor vehicle accidents. *Psychosom Med*. 2001; 63(3):402–411. [PubMed: 11382267]
6. Frommberger UH, Stieglitz R, Nyberg E, Schlickewei W, Kuner E, Berger M. Prediction of posttraumatic stress disorder by immediate reactions to trauma: A prospective study in road traffic accident victims. *Eur Arch Psychiatry Clin Neurosci*. 1998; 248(6):316–321. [PubMed: 9928912]
7. Averill PM, Beck JG. Posttraumatic stress disorder in older adults: A conceptual review. *J Anxiety Disord*. 2000; 14(2):133–56. [PubMed: 10864382]

8. Ogle CM, Rubin DC, Siegler IC. The impact of the developmental timing of trauma exposure on PTSD symptoms and psychosocial functioning among older adults. *Dev Psychol.* 2013; 49(11): 2191. [PubMed: 23458662]
9. van Zelst WH, de Beurs E, Beekman AT, Deeg DJ, van Dyck R. Prevalence and risk factors of posttraumatic stress disorder in older adults. *Psychother Psychosom.* 2003; 72(6):333–42. doi: 73030. [PubMed: 14526136]
10. Chopra MP, Zhang H, Kaiser AP, et al. PTSD is a chronic, fluctuating disorder affecting the mental quality of life in older adults. *The American Journal of Geriatric Psychiatry.* 2014; 22(1):86–97. [PubMed: 24314889]
11. Pietrzak RH, Goldstein RB, Southwick SM, Grant BF. Physical health conditions associated with posttraumatic stress disorder in US older adults: Results from wave 2 of the national epidemiologic survey on alcohol and related conditions. *J Am Geriatr Soc.* 2012; 60(2):296–303. [PubMed: 22283516]
12. Bei B, Bryant C, Gilson K, et al. A prospective study of the impact of floods on the mental and physical health of older adults. *Aging & mental health.* 2013; 17(8):992–1002. [PubMed: 23711204]
13. Ozer EJ, Best SR, Lipsey TL, Weiss DS. Predictors of posttraumatic stress disorder and symptoms in adults: A meta-analysis. *Psychol Bull.* 2003; 129(1):52. [PubMed: 12555794]
14. Brewin CR, Andrews B, Valentine JD. Meta-analysis of risk factors for posttraumatic stress disorder in trauma-exposed adults. 2000
15. March JS. The criterion A issue. Posttraumatic stress disorder: DSM-IV and beyond. 1993:37–56.
16. Flory JD, Yehuda R. Comorbidity between post-traumatic stress disorder and major depressive disorder: Alternative explanations and treatment considerations. *Dialogues in clinical neuroscience.* 2015; 17(2):141. [PubMed: 26246789]
17. Himle JA, Baser RE, Taylor RJ, Campbell RD, Jackson JS. Anxiety disorders among african americans, blacks of caribbean descent, and non-hispanic whites in the united states. *J Anxiety Disord.* 2009; 23(5):578–590. DOI: 10.1016/j.janxdis.2009.01.002 [PubMed: 19231131]
18. McLean SA, Ulirsch JC, Slade GD, et al. Incidence and predictors of neck and widespread pain after motor vehicle collision among US litigants and nonlitigants. *PAIN®.* 2014; 155(2):309–321. [PubMed: 24145211]
19. Platts-Mills TF, Ballina L, Bortsov AV, et al. Using emergency department-based inception cohorts to determine genetic characteristics associated with long term patient outcomes after motor vehicle collision: Methodology of the CRASH study. *BMC Emerg Med.* 2011; 11:14.doi: 10.1186/1471-27X-1-4 [PubMed: 21943293]
20. Callahan CM, Unverzagt FW, Hui SL, Perkins AJ, Hendrie HC. Six-item screener to identify cognitive impairment among potential subjects for clinical research. *Med Care.* 2002; 40(9):771–81. DOI: 10.1097/01.MLR.0000024610.33213.C8 [PubMed: 12218768]
21. Lee C, Straus WL, Balshaw R, Barlas S, Vogel S, Schnitzer TJ. A comparison of the efficacy and safety of nonsteroidal antiinflammatory agents versus acetaminophen in the treatment of osteoarthritis: A meta-analysis. *Arthritis Rheum.* 2004; 51(5):746–54. DOI: 10.1002/art.20698 [PubMed: 15478167]
22. Gallagher PF, Barry PJ, Ryan C, Hartigan I, O'Mahony D. Inappropriate prescribing in an acutely ill population of elderly patients as determined by beers' criteria. *Age Ageing.* 2008; 37(1):96–101. DOI: 10.1093/ageing/afm116 [PubMed: 17933759]
23. Forchheimer MB, Richards JS, Chiodo AE, Bryce TN, Dyson-Hudson TA. Cut point determination in the measurement of pain and its relationship to psychosocial and functional measures after traumatic spinal cord injury: A retrospective model spinal cord injury system analysis. *Arch Phys Med Rehabil.* 2011; 92(3):419–24. DOI: 10.1016/j.apmr.2010.08.029 [PubMed: 21353824]
24. Boonstra AM, Schiphorst Preuper HR, Balk GA, Stewart RE. Cut-off points for mild, moderate, and severe pain on the visual analogue scale for pain in patients with chronic musculoskeletal pain. *Pain.* 2014; 155(12):2545–2550. DOI: 10.1016/j.pain.2014.09.014 [PubMed: 25239073]
25. Spitzer RL, Williams JB, Kroenke K, et al. Utility of a new procedure for diagnosing mental disorders in primary care. the PRIME-MD 1000 study. *JAMA.* 1994; 272(22):1749–1756. [PubMed: 7966923]

26. McLean SA, Clauw DJ, Abelson JL, Liberzon I. The development of persistent pain and psychological morbidity after motor vehicle collision: Integrating the potential role of stress response systems into a biopsychosocial model. *Psychosom Med.* 2005; 67(5):783–790. [PubMed: 16204439]
27. Fejer R, Jordan A, Hartvigsen J. Categorising the severity of neck pain: Establishment of cut-points for use in clinical and epidemiological research. *Pain.* 2005; 119(1–3):176–82. DOI: 10.1016/j.pain.2005.09.033 [PubMed: 16298059]
28. Brunet A, Weiss DS, Metzler TJ, et al. The peritraumatic distress inventory: A proposed measure of PTSD criterion A2. *Am J Psychiatry.* 2001; 158(9):1480–5. [PubMed: 11532735]
29. Platts-Mills TF, Nicholson RJ, Richmond NL, et al. Restricted activity and persistent pain following motor vehicle collision among older adults: A multicenter prospective cohort study. *BMC geriatrics.* 2016; 16(1):1. [PubMed: 26729190]
30. Asukai N, Kato H, Kawamura N, et al. Reliability and validity of the japanese-language version of the impact of event scale-revised (IES-R-J): Four studies of different traumatic events. *J Nerv Ment Dis.* 2002; 190(3):175–182. [PubMed: 11923652]
31. Clopper C, Pearson ES. The use of confidence or fiducial limits illustrated in the case of the binomial. *Biometrika.* 1934:404–413.
32. Weiss, D., Marmar, C. The impact of event scale-revised. In: Wilson, JP., Keane, TM., editors. *Assessing psychological trauma and PTSD: A handbook for practitioners.* New York: Guilford Press; 1997. p. 399–411.
33. Bryant RA, Harvey AG, Guthrie RM, Moulds ML. A prospective study of psychophysiological arousal, acute stress disorder, and posttraumatic stress disorder. *J Abnorm Psychol.* 2000; 109(2): 341. [PubMed: 10895573]
34. Beck JG, Coffey SF. Assessment and treatment of posttraumatic stress disorder after a motor vehicle collision: Empirical findings and clinical observations. *Professional Psychology: Research and Practice.* 2007; 38(6):629.
35. Smith TC, Ryan MA, Wingard DL, et al. New onset and persistent symptoms of post-traumatic stress disorder self reported after deployment and combat exposures: Prospective population based US military cohort study. *BMJ.* 2008; 336(7640):366–371. DOI: 10.1136/bmj.39430.638241.AE [PubMed: 18198395]
36. Card JJ. Epidemiology of PTSD in a national cohort of vietnam veterans. *J Clin Psychol.* 1987; 43(1):6–17. [PubMed: 3558841]
37. Zatzick D, Jurkovich GJ, Rivara FP, et al. A national US study of posttraumatic stress disorder, depression, and work and functional outcomes after hospitalization for traumatic injury. *Ann Surg.* 2008; 248(3):429–437. DOI: 10.1097/SLA.0b013e318185a6b8 [PubMed: 18791363]
38. Zatzick DF, Jurkovich GJ, Gentilello L, Wisner D, Rivara FP. Posttraumatic stress, problem drinking, and functional outcomes after injury. *Archives of Surgery.* 2002; 137(2):200–205. [PubMed: 11822960]
39. van Zelst WH, de Beurs E, Beekman AT, van Dyck R, Deeg DD. Well-being, physical functioning, and use of health services in the elderly with PTSD and subthreshold PTSD. *Int J Geriatr Psychiatry.* 2006; 21(2):180–188. [PubMed: 16416457]
40. Schwartz AC, Bradley RL, Sexton M, Sherry A, Ressler KJ. Posttraumatic stress disorder among african americans in an inner city mental health clinic. *Psychiatric Services.* 2014
41. Breslau N, Chilcoat HD, Kessler RC, Davis GC. Previous exposure to trauma and PTSD effects of subsequent trauma: Results from the detroit area survey of trauma. *Am J Psychiatry.* 2014
42. Chrousos GP. Stress and disorders of the stress system. *Nature Reviews Endocrinology.* 2009; 5(7): 374–381.
43. Garakani A, Mathew S, Charney DS. Neurobiology of anxiety disorders and implications for treatment. *Mount Sinai Journal of Medicine.* 2006; 73(7):941–949. [PubMed: 17195879]
44. Pines JM, Mullins PM, Cooper JK, Feng LB, Roth KE. National trends in emergency department use, care patterns, and quality of care of older adults in the united states. *J Am Geriatr Soc.* 2013; 61(1):12–17. Accessed 7/27/2015 12:19:30 PM. [PubMed: 23311549]

45. Argolo FC, Cavalcanti-Ribeiro P, Netto LR, Quarantini LC. Prevention of posttraumatic stress disorder with propranolol: A meta-analytic review. *J Psychosom Res.* 2015; 79(2):89–93. [PubMed: 25972056]
46. Holbrook TL, Galarneau MR, Dye JL, Quinn K, Dougherty AL. Morphine use after combat injury in Iraq and post-traumatic stress disorder. *N Engl J Med.* 2010; 362(2):110–117. [PubMed: 20071700]
47. Bryant RA, Creamer M, O'Donnell M, Silove D, McFarlane AC. A study of the protective function of acute morphine administration on subsequent posttraumatic stress disorder. *Biol Psychiatry.* 2009; 65(5):438–440. [PubMed: 19058787]
48. Kearns MC, Ressler KJ, Zatzick D, Rothbaum BO. Early interventions for PTSD: A review. *Depress Anxiety.* 2012; 29(10):833–842. [PubMed: 22941845]
49. Rothbaum BO, Kearns MC, Price M, et al. Early intervention may prevent the development of posttraumatic stress disorder: A randomized pilot civilian study with modified prolonged exposure. *Biol Psychiatry.* 2012; 72(11):957–963. [PubMed: 22766415]
50. Hunold KM, Sochor MR, McLean SA, Mosteller KB, Fernandez AR, Platts-Mills TF. Ambulance transport rates after motor vehicle collision for older vs. younger adults: A population-based study. *Accid Anal Prev.* 2014; 73:373–9. DOI: 10.1016/j.aap.2014.09.026 [PubMed: 25310339]
51. Nagurney JM, Fleischman W, Han L, Leo-Summers L, Allore HG, Gill TM. Emergency department visits without hospitalization are associated with functional decline in older persons. *Ann Emerg Med.* 2017
52. LaMantia MA, Platts-Mills TF. Bending the curve of health trajectories for older adults discharged from the emergency department. *Ann Em Med.* 2017

Figure 1.

Flow diagram of the screening and enrollment process.

*Reason ineligible not mutually exclusive

†Six Item Screener score ≥ 3

Figure 2.
10-fold cross validated receiver operating curve of predictive model of PTSD symptoms.

Table 1

Incidence of post-traumatic stress disorder (PTSD) symptoms among adults aged ≥ 65 years six-months after emergency department (ED) evaluation for motor vehicle collision, overall and by patient collision characteristics.

	PTSD ¹ Symptoms		
Characteristic	N	%	(95% CI)
All patients	223	21	(16–26)
Age			
65–74	144	24	(18–32)
≥ 75	79	14	(8–23)
Gender			
Male	95	18	(11–27)
Female	128	23	(16–31)
Race			
White	180	19	(14–26)
Black	36	31	(18–48)
Other	7	0	(0–35)
Education			
College	77	13	(7–23)
No college	146	24	(18–32)
Collision ²			
Severe	125	22	(16–30)
Moderate	71	16	(10–27)
Mild	19	26	(10–51)
Missing	8	13	(2–55)
Position in vehicle			
Driver	178	19	(13–25)
Passenger	45	27	(16–42)
MVC life-threatening ³			
Yes	132	28	(21–36)
No	91	9	(5–17)
ED pain ⁴			
Severe	85	31	(22–42)
Moderate	77	18	(11–28)
Mild	61	8	(4–18)
Missing	7	14	(2–57)

¹ Defined using an Impact of Event Scale-Revised (IES-R) score ≥ 25.

² As reported by patients during emergency department visit.

³ Defined as a median score of 5 on a scale of 0–10.

⁴Categories based on numeric pain severity scores of: 0=none; 1–3=mild; 4–6=moderate; 7–10=severe.

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Relative risk of significant post-traumatic stress disorder symptoms (IESR 25), adjusted for age and sex, among adults aged 65 years six-months following emergency department (ED) visit after motor vehicle collision by patient and collision characteristics.

Table 2

Characteristic	Adj. Relative Risk	(95% CI)	Wald χ^2	(DF)	p-value
Sociodemographics					
Age 65–74 (vs 75) ¹	1.8	(1.0–3.3)	3.28	(1)	0.07
Female ¹	1.3	(0.7–2.2)	0.75	(1)	0.39
African American ²	1.7	(1.0–3.1)	2.78	(1)	0.10
No college degree	1.9	(1.0–3.5)	3.63	(1)	0.06
Social support	1.4	(0.8–2.5)	0.58	(1)	0.45
Pre-MVC Health					
Poor self-rated general health	1.6	(0.9–2.8)	2.81	(1)	0.09
Polypharmacy ³	1.5	(0.9–2.5)	1.96	(1)	0.16
Depressive symptoms	2.7	(1.6–4.8)	11.67	(1)	<0.001
Mild cognitive impairment ⁴	1.6	(1.0–2.7)	3.02	(1)	0.08
ADL impairment	1.5	(0.8–2.9)	2.35	(1)	0.13
MVC Characteristics					
Passenger in vehicle	1.4	(0.8–2.5)	1.55	(1)	0.21
Rear-ended	1.1	(0.7–1.9)	0.15	(1)	0.70
MVC life-threatening ⁵	2.7	(1.4–5.3)	10.06	(1)	0.002
Not my fault	1.2	(0.5–2.5)	0.17	(1)	0.68
I thought I might die ⁶	3.2	(1.8–5.8)	19.10	(1)	<0.001
I felt helpless	1.1	(0.6–1.9)	0.01	(1)	0.93
ED Symptoms					
Severe pain ⁷	2.2	(1.3–3.8)	9.93	(1)	0.002
Prolonged physical recovery ⁸	2.0	(1.2–3.3)	5.65	(1)	0.02
Prolonged emotional recovery ⁸	3.8	(2.1–7.0)	21.65	(1)	<0.001
2 Weeks Symptoms and Behaviors					

Characteristic	Adj. Relative Risk	(95% CI)	Wald χ^2	(DF)	p-value
Severe pain ⁷	1.4	(0.7–2.7)	5.08	(1)	0.02
Severe pain interference ⁹	1.7	(0.9–3.4)	3.16	(1)	0.08
Opioid use within past 24 hours	1.2	(0.6–2.4)	2.75	(1)	0.10
Stayed in bed for half a day in past week	1.1	(0.6–2.1)	1.43	(1)	0.23

Note: P-values for relative risks determined using a Wald chi-squared test.

- ¹Not adjusted.
- ²Defined as 5 medications.
- ³Risk ratio for PTSD symptoms for Black compared to White. This analysis excludes 7 patients who were neither Black or White.
- ⁴Defined by a score of 4 or 5 on the Six Item Screener; all other patients (n=165) got all six questions correct.
- ⁵Defined as a median score of 5 on a scale of 0–10.
- ⁶“Yes” defined as responses of “slightly true,” “somewhat true,” “very true,” or “extremely true” to the statement, “I thought I might die.”
- ⁷Defined as a numeric pain severity scores of 7–10.
- ⁸Defined as expected time >30 days.
- ⁹Defined as scores of 7–10 for pain interference with general activity, walking, sleep, or enjoyment of life.

Optimal predictive model of PTSD symptoms at 6 months. Multivariable logistic regression model derived using stepwise forward selection based on the Akaike information criterion.

Table 3

Predictor	OR ¹	(95% CI)	χ ²	(DF)	p-value
ED pain (0–10) ²	1.25	(1.04–1.50)	14.19	(1)	<0.001
MVC life-threatening (0–10) ³	1.22	(1.07–1.39)	8.67	(1)	0.003
Depressive symptoms (y/n)	3.65	(1.53–8.70)	8.58	(1)	0.003

Note: Chi-squared values, degrees of freedom, and p-values derived from final model.

¹ Odds ratio.

² Pain assessed during ED interview using a numeric rating scale from 0 to 10.

³ How life-threatening patient believed the MVC to be on a scale from 0–10.

Table 4

Health outcomes 6 months after motor vehicle collision (MVC) for patients aged ≥ 65 years with and without symptoms of post-traumatic stress disorder (PTSD) at 6 months, defined by an Impact of Event Scale-Revised (IES-R) score ≥ 25 (0–88 scale). Estimated probabilities of outcomes adjusted for participant age, gender, race, level of formal education, and ED pain severity.

	% (95% CI)			
	Unadjusted		Adjusted	
Outcome at 6 months	PTSD (N=46)	No PTSD (N=177)	PTSD (N=46)	No PTSD (N=177)
Moderate or severe pain ¹	72 (57–83)	30 (24–37)	63 (46–78)	29 (23–37)
Pain interference ¹				
General activity	60 (45–73)	27 (20–34)	50 (34–67)	26 (19–33)
Walking ability	64 (49–77)	28 (22–36)	63 (47–77)	28 (22–36)
Sleep	58 (43–71)	25 (19–32)	50 (34–65)	25 (19–32)
Enjoyment of life	59 (44–72)	28 (22–35)	52 (36–67)	27 (21–35)
Functional decline ²	67 (49–80)	42 (34–50)	63 (45–78)	42 (34–51)
New disability ³	49 (32–65)	18 (13–26)	44 (27–62)	17 (12–25)
Driving anxiety ⁴	50 (36–64)	14 (10–20)	53 (37–68)	13 (09–19)
Depressive symptoms	67 (50–80)	20 (15–28)	68 (51–82)	19 (13–26)
6 hours of sleep ⁵	61 (38–87)	36 (27–46)	56 (25–83)	34 (24–45)

¹For both pain severity and pain interference, defined as a score ≥ 4 (0–10 scale).

²Decrease in total score assessing patient's ability to walk, climb stairs, and carry groceries.

³New difficulty or inability in one of six activities of daily living.

⁴Defined as “quite a bit more” or “much more” nervous about driving than before the collision.

⁵Adjusted values are adjusted for baseline sleep assessed at the time of the ED interview as well as age, gender, race, level of formal education, and ED pain severity.