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It still hurts! Persistent pain and use of pain medication one year after injury



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ABSTRACT

Background: Given the scarce literature data on chronic post-traumatic pain, we aim to identify early predictors of long-term pain and pain medication use after major trauma.

Methods: Major trauma patients (Injury Severity Score ≥ 9) from three Level I Trauma Centers at 12 months after injury were interviewed for daily pain using the Trauma Quality of Life questionnaire. Multivariate logistic regression models identified patient- and injury-related independent predictors of pain and use of pain medication.

Results: Of 1238 patients, 612 patients (49%) felt daily pain and 300 patients (24%) used pain medication 1 year after injury. Of a total of 8 independent predictors for chronic pain and 9 independent predictors for daily pain medication, 4 were common (pre-injury alcohol use, pre-injury drug use, hospital stay ≥ 5 days, and education limited to high school). Combinations of independent predictors yielded weak predictability for both outcomes, ranging from 20% to 72%.

Conclusions: One year after injury, approximately half of trauma patients report daily pain and one-fourth use daily pain medication. These outcomes are hard to predict.

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Introduction

Despite long-term pain being associated with severe injury, it has not been used as a patient outcome measure. Following blunt or penetrating trauma, patients may suffer from pain which lasts as long as 5–7 years after injury.¹ While research on this topic is sparse, a study conducted across 69 institutions, including trauma and non-trauma centers, reported that nearly two thirds of the patients had persistent pain 12 months after their hospitalization.² However, the use of pain medication was not reported; this outcome is important, especially in the context of the modern-day opioid epidemic. With 2 million Americans reporting a substance use disorder through use of prescription pain medication in 2015³ and the rate of substance use disorder treatment admission

increasing six-fold from 1999 to 2009,⁴ pain medication becomes increasingly necessary to monitor and regulate. Therefore, understanding the long-term use of pain medication after trauma becomes not only a medical need but possibly a public health priority.

The Functional Outcomes and Recovery for Trauma Emergencies (FORTE) project aims to collect and study long-term trauma outcomes from a consortium of academic trauma centers. Given the focus on 30-day patient outcome, as recorded in most regional or national databases, FORTE makes the argument that care will improve at a personal level and systems will advance at a broader level, only if we understand and treat the long-term, post-traumatic sequelae. In this study, we aim to determine the presence and predictors of chronic pain and long-term use of pain medication in a cohort of trauma patients 1 year after injury. Our hypothesis is that chronic pain affects a large portion of the trauma population, leading to high rates of pain medication use.

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Methods

This study includes all trauma patients, who were entered into the FORTE registry from December 1, 2015 to July 31, 2018. All data were entered prospectively at 3 Level 1 Trauma Centers of Boston, MA: the Brigham and Women's Hospital, Massachusetts General Hospital, and Boston Medical Center. The FORTE registry is maintained at the Center for Surgery and Public Health of the Brigham and Women's Hospital and includes patients older than 18 years old, with Injury Severity Score of 9 or higher, who were admitted in the hospital. The patients were contacted 12 months after their injury for a structured telephonic interview that assessed post-traumatic stress disorder, return to work, residential status, and health care utilization, using HRQoL (Short Form 12 [SF-12]) and PROs (Trauma Quality of Life).⁵ Specific members of the FORTE research team performed the interviews, after being trained in the questionnaire's format and proper interview behavior. In total, the interview consisted of 59 questions and lasted approximately 20 min. The outcomes of the study were daily pain and use of daily pain medication at 12 months after injury. These two questions were included in the structured questionnaires. Patients were excluded from the study if they had passed away, were not English or Spanish speakers, refused to participate in the study, could not be reached after 6 telephone call attempts, had not responded to either the pain or the pain medication question, or their caregiver had answered the interview in their place. Patients who provided a response to both these questions had their data cross-checked with the institutional trauma registry of each of the Trauma Centers included. Data collected from the trauma registries were demographics, injury type (blunt [road traffic accident, fall, other], penetrating [stab wound, gunshot wound, other]) and severity (Injury Severity Score [ISS]), location of injury, comorbidities, pre-injury use of alcohol and/or illicit drugs, operations, insurance status, Intensive Care Unit (ICU) and hospital stay, and ultimate disposition (home, rehabilitation center, other). The outcomes of the study were daily pain and use of daily pain medication at 12 months after injury.

Patient with and without the measured outcomes were compared. The Student t-test was used for continuous variables and Chi-square or Fisher's exact tests for categorical variables. Clinically meaningful cut off points were used to dichotomize multiple continuous variables, whereas others were dichotomized according to the points of population separation when distribution curves were drawn. Following the univariate analysis, all variables were entered into a reverse selection multivariate logistic regression to identify independent predictors of each outcome. The odds ratios (OR) and 95% confidence intervals (CI) of each independent predictor were calculated. Combinations of the independent predictors were used to explore the predictive ability of the model for the outcomes. A p-value of equal to or less than 0.05 was considered statistically significant. The study was approved by the Institutional Review Boards of all institutions.

Results

Of 3431 eligible patients, 1537 (44%) participated in the 12-month interview, and 1238 (36%) were enrolled into the study (Fig. 1). When participating and non-participating patients were compared, participants were more likely to be African-American (13% vs. 10%, $p = 0.04$) and discharged to rehabilitation (36% vs. 33%, $p = 0.029$). No statistical difference was found in any other of the collected variables. The interview was conducted at an average of 12 months (range: 11–13 months). Of the 1238 study patients, 612 (49%) felt daily pain and 300 (24%) reported use of pain medication. The following variables achieved statistical

significance on univariate analysis for the outcome of pain (Table 1): age, education, preinjury drug use, preinjury smoking habits, preinjury major psychiatric illness, work-related injury, injury type, head injury, extremity injury, orthopedic operation, mechanical ventilation, length of hospital stay, and discharge to rehabilitation. The following variables achieved statistical significance on univariate analysis for the outcome of daily pain medication (Table 2): age, education, insurance status, number of comorbidities, preinjury alcoholism, preinjury major psychiatric illness, preinjury work status, injury type, length of hospital stay, and discharge to rehabilitation.

Tables 3 and 4 show the independent predictors of pain and daily pain medication respectively 12 months after injury. Of note, of a total of 8 independent predictors for pain and 9 independent predictors for daily pain medication, only 4 were common (pre-injury alcohol use disorder, pre-injury drug use disorder, length of hospital stay ≥ 5 days, and education limited to or lower than high school). We constructed numerous predictive models of the two outcomes, using different combinations of the different independent predictors, particularly focusing on combinations of the four predictors that were common for both outcomes. The best combination for the prediction of pain included age < 65 years, low education, and orthopedic operation; in the absence of all three predictors, daily pain was reported in 32% of the patients and in the presence of all predictors in 72% of patients. For daily pain medication, the best combination included drug use, alcohol abuse, and falls, which identified the outcome in 20% of patients when all three predictors were absent and in 32% when they were all present.

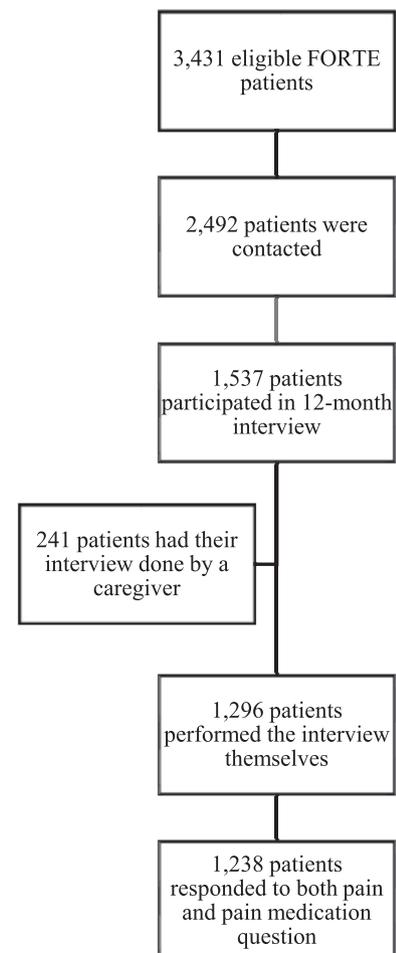


Fig. 1. Flowchart of study patients.

Table 1
Characteristics of patients with and without pain 1 year after injury.

Variables	Patients with Pain (n = 612)	Patients without Pain (n = 626)	p value
Male	337 (55.06%)	357 (57.02%)	0.486
Age < 65 years	375 (61.27%)	310 (49.52%)	<0.0001
Caucasians ^a	444 (72.54%)	460 (73.48%)	0.233
High school graduate or lower ^a	310 (50.65%)	250 (39.93%)	<0.0001
Public insurance ^a	289 (47.22%)	311 (49.68%)	0.175
Preinjury alcoholism	75 (12.25%)	84 (13.42%)	0.541
Preinjury smoking	100 (16.33%)	75 (11.98%)	0.035
Preinjury drug use	59 (9.64%)	37 (5.91%)	0.014
Preinjury psychiatric illness	76 (12.41%)	51 (8.14%)	0.016
Preinjury employment	314 (51.30%)	295 (47.12%)	0.126
No preinjury comorbidities ^a	101 (16.50%)	102 (16.29%)	0.121
Blunt mechanism of injury	572 (93.46%)	590 (94.25%)	0.565
Work-Related injury	554 (90.52%)	588 (93.92%)	0.009
Type of Injury: Falls ^a	330 (53.92%)	389 (62.14%)	0.018
Type of Injury: Road Traffic Incident ^a	203 (33.17%)	160 (25.56%)	0.018
Injury Severity Score > 16	196 (32.03%)	203 (32.43%)	0.933
Traumatic Brain Injury	191 (31.21%)	267 (42.65%)	<0.0001
Thoracic Injury	136 (22.22%)	120 (19.16%)	0.185
Abdominal Injury	80 (13.06%)	60 (9.58%)	0.053
Extremity Injury	456 (74.51%)	359 (57.35%)	<0.0001
Spinal Cord Injury ^a	15 (2.20%)	10 (2.08%)	0.281
Amputation ^a	19 (3.19%)	14 (2.30%)	0.342
Polytrauma	540 (88.23%)	570 (91.05%)	0.103
Orthopedic operation ^a	337 (56.64%)	244 (40.07%)	<0.001
Intensive Care Unit admission	227 (37.09%)	247 (39.46%)	0.392
Mechanical ventilation	89 (14.54%)	67 (10.70%)	0.042
Hospital stay < 5 days	244 (39.87%)	346 (55.27%)	<0.0001
Discharge to rehabilitation	252 (41.18%)	185 (29.96%)	<0.0001

^a Indicates that less than 1238 patients had data recorded for pain, pain medication, and the selected characteristic.

Discussion

Nearly half of the interviewed trauma patients reported daily pain and one quarter used daily pain medications 12 months after injury. This result may come as a surprise to many health care takers, who are used to consider the success or failure of their

treatment within the short, post-traumatic hospital phase. Although a number of studies^{6–8} have underscored the importance of evaluating trauma outcomes beyond the 28-day mortality and morbidity, most local and national databases do not collect relevant data. Traumatic brain injury, spinal cord injury, and possibly severe extremity injuries (particularly those resulting in amputations) are

Table 2
Characteristics of patients using and not using pain medication 1 year after injury.

Variables	Patients using Pain Meds (n = 300)	Patients not using Pain Meds (n = 938)	p value
Male	149 (49.67%)	545 (58.10%)	0.01
Age < 65 years	145 (48.33%)	540 (54.94%)	0.005
Caucasians ^a	220 (73.33%)	684 (72.92%)	0.942
High school graduate or lower ^a	153 (51.00%)	407 (43.39%)	0.022
Public insurance ^a	169 (56.33%)	431 (45.94%)	0.002
Preinjury alcoholism	27 (9.00%)	132 (14.07%)	0.022
Preinjury smoking	48 (16.00%)	127 (13.54%)	0.317
Preinjury drug use	29 (9.66%)	67 (7.14%)	0.155
Preinjury psychiatric illness	42 (14.00%)	85 (9.06%)	0.017
Preinjury employment	112 (37.33%)	497 (52.99%)	<0.0001
No preinjury comorbidities ^a	38 (12.67%)	165 (17.59%)	0.002
Blunt mechanism of injury	285 (95%)	877 (93.49%)	0.345
Work-Related injury	279 (93.00%)	863 (92.00%)	0.866
Type of Injury: Falls ^a	200 (66.67%)	519 (55.33%)	0.009
Type of Injury: Road Traffic Incident ^a	72 (24.00%)	291 (31.02%)	0.009
Injury Severity Score > 16	99 (33.00%)	300 (31.98%)	0.908
Traumatic Brain Injury	99 (33.00%)	359 (38.27%)	0.1
Thoracic Injury	73 (36.50%)	183 (19.51%)	0.073
Abdominal Injury	42 (14.00%)	98 (10.44%)	0.091
Extremity Injury	203 (67.67%)	612 (65.25%)	0.441
Spinal Cord Injury ^a	10 (4.26%)	15 (2.07%)	0.068
Amputation ^a	7 (2.38%)	26 (2.81%)	0.690
Polytrauma	266 (88.67%)	844 (89.97%)	0.516
Orthopedic operation ^a	146 (49.66%)	443 (47.94%)	0.608
Intensive Care Unit admission	121 (40.33%)	353 (37.63%)	0.402
Mechanical ventilation	45 (15.00%)	111 (11.83%)	0.15
Hospital stay < 5 days	116 (38.67%)	474 (50.53%)	<0.0001
Discharge to rehabilitation	125 (41.67%)	312 (33.26%)	0.009

^a Indicates that less than 1238 patients had data recorded for pain, pain medication, and the selected characteristic.

Table 3
Independent predictors for presence of daily pain in patients 1 year after injury.

Pain		
Independent Predictors	OR (95% CI)	p value
Drug Use Disorder	1.73 (1.03–2.9)	0.035
Alcohol Use Disorder	1.64 (1.1–2.45)	0.015
Hospital stay \geq 5 days	1.62 (1.27–2.08)	<0.001
Age < 65	1.58 (1.22–2.06)	0.001
Orthopedic Operation	1.55 (1.15–2.1)	0.004
Low education	1.53 (1.18–1.96)	0.001
Extremity Injury	1.52 (1.11–2.09)	0.009

Table 4
Independent predictors for use of pain medication in patients 1 year after injury.

Pain Meds		
Independent Predictors	OR (95% CI)	p value
Alcohol Use Disorder	1.97 (1.17–3.32)	0.011
Drug Use Disorder	1.91 (1.1–3.34)	0.022
Fall	1.89 (1.32–2.68)	<0.001
Unemployed	1.73 (1.27–2.37)	0.001
Smoker	1.65 (1.07–2.53)	0.021
Hospital stay \geq 5 days	1.6 (1.2–2.14)	0.002
Chest injury	1.53 (1.06–2.21)	0.023
Low education	1.39 (1.03–1.87)	0.031
1 or more comorbidities	0.72 (0.54–0.96)	0.025

known to cause long-term effects,^{9–11} but beyond these types of injury the chronic outcomes of polytrauma are inadequately studied. The FORTE project aims to do exactly that, i.e. collect and analyze data on 12-month outcomes after injury.¹² The project has begun to accumulate information in its registry since December 1, 2015. Overcoming logistical problems, the consortium of academic centers is in the process of expanding from the initial three (Brigham and Women's Hospital, Massachusetts General Hospital, Boston Medical Center) to now seven that contribute prospective data in a robust registry. FORTE especially focuses on outcomes such as pain, post-traumatic stress disorder, and quality of life, which are rarely recorded elsewhere in the long term.

As expected, a multitude of factors were independently associated with the two measured outcomes, ranging from the pre-existing use of alcohol, cigarettes, and drugs to comorbidities, type of injuries, operations, clinical outcomes, and social conditions. However, the discrepancy of predictors between the two outcomes was unexpected. Whereas one would have assumed that the factors predicting daily pain would also predict daily pain medication, this was not the case. Most predictors of pain were different from predictors of the use of pain medication, with only four applying to both outcomes: pre-injury alcohol use disorder, pre-injury drug use disorder, education limited to high school, and hospital length of stay \geq 5 days. Other factors, like older age, type of injury, operations, and comorbidities predicted one but not the other outcome, indicating a number of possibilities: a) pain is a subjective feeling, which may be reported differently by different patients, but pain medication use is an objective fact; b) the intensity of pain was not recorded and this could certainly affect use of relief medication; c) patients did not disclose the truth about pain medication use on a telephonic interview as deliberately as their feeling of pain. No matter what the explanation is, this finding of our study points to the need for recording outcomes that are objective to the greatest possible extent, as any related subjective outcomes may paint misleading pictures.

A second unexpected finding was the absence of injury severity from the group of predictors. We would have certainly thought that more severe injuries cause more long-term pain. A number of

explanations may account for this result: a) others surrogates of injury severity, such as the length of hospital stay, may have excluded ISS in the multivariate analysis because they combined the impact of severity of injury with the complexity of the hospital course; b) ISS was created to predict mortality accurately but not the outcomes we were exploring in this study. In a prior FORTE study on post-traumatic stress disorder, a similar conclusion was made: ISS did not predict that outcome.¹³

Another notable finding of this study was the poor predictive power of the different combination of predictors. While we were hoping that a certain combination would allow to predict pain and pain medication use with nearly 100% accuracy and the absence of all the chosen predictors would mean a nearly zero likelihood of the outcome, this assumption did not prove true after the analysis of our data. Even the most powerful combination of predictors identified the presence of the outcome (pain medication use) in about two thirds of the cases; when all these predictors were absent the outcome was absent in two thirds of the cases again. In other words, the presence or absence of the combination of predictors were wrong in identifying the outcome in one third of the cases. Although disappointing, this finding possibly indicates the complexity of assessing long-term outcomes and the need to explore a variety of additional factors that may influence the outcomes over such long periods.

Our study is limited by certain factors such as the reliability of the telephonic interviews and patient pain medication information. Even if face-to-face assessments may intuitively seem to result in a more candid retrieval of information, research has shown the telephonic interviews to be adequately reliable.^{14,15} Another limitation is the lack of detailed information about the type and dose of pain medication used. At the initial conception of the FORTE registry, these specific details were not collected. We intend to add relevant questions to our telephonic interviews and re-analyze the data when we have an adequate sample size to draw valid conclusions. Finally, the patients who did not participate in the study had two significant differences with those who participated: African-Americans and rehabilitation-bound patients were more likely to participate in the study. However, none of the remaining 57 variables were different between the two groups.

In conclusion, our study uncovered a significant issue in post-traumatic outcomes evaluation, since 49% of the interviewed trauma patients reported daily pain and 24% daily pain medication use 12 months after injury. Although multiple demographical, social, injury-related, and care-related characteristics were relevant to the outcomes, their predictive power was limited, allowing assumptions about the presence of additional factors which require further exploration. The FORTE project will continue to collect long-term, post-traumatic outcomes with the intent to introduce them as standard practice in the evaluation of trauma care and the efforts to improve it.

Conflicts of interest

None.

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None.

References

- Mkandawire NC, Boot DA, Braithwaite IJ, Patterson M. Musculoskeletal recovery 5 years after severe injury: long-term problems are common. *Injury*. 2002;33:111–115.
- Rivara FP, Mackenzie EJ, Jurkovich GJ, Nathens AB, Wang J, Scharfstein DO. Prevalence of pain in patients 1 Year after major trauma. *Arch Surg*. 2008;143:

- 282–287.
- Center for Behavioral Health Statistics and Quality. *Key Substance Use and Mental Health Indicators in the United States: Results from the 2015 National Survey on Drug Use and Health*. 2016. HHS Publication NO. SMA 16-4984 NSDUH Series H-51.
 - Paulozzi LJ, Jones CM, Mack KA, Rudd RA. *Vital Signs: Overdoses of Prescription Opioid Pain Relievers – United States, 1999-2008*. vol. 60. Division of Unintentional Injury Prevention, National Center for Injury Prevention and Control, Center for Disease Control and Prevention; 2011:5.
 - Rios-Diaz AJ, Herrera-Escobar JP, Lilley EJ, et al. *J Trauma Acute Care Surg*. 2017;83:97–104.
 - Holbrook TL, Anderson JP, Sieber WJ, Browner D, Hoyt D. Outcome after major trauma: 12-month and 18-month follow-up results from the trauma recovery project. *J Trauma*. 1999;46:765–773.
 - Michaels AJ, Michaels CE, Smith JS, Moon CH, Peterson C, Long WB. Outcome from injury: general health, work status, and satisfaction 12 Months after trauma. *J Trauma*. 2000;48:841–850.
 - Gabbe BJ, Cameron PA, Hannaford AP, Ann M, McNeil JJ. Routine follow up of major trauma patients from trauma registries: what are the outcomes? *J Trauma*. 2006;61:1393–1399.
 - Colantonio A, Ratcliff G, Chase S, Kelsey S, Escobar M, Vernich L. Long term outcomes after moderate to severe traumatic brain injury. *Disabil Rehabil*. 2004;26:253–261.
 - Frankel HL, Coll JR, Charlifue SW, et al. Long-term survival in spinal cord injury: a fifty year investigation. *Spinal Cord*. 1998;36:266–274.
 - MacKenzie EJ, Bosse MJ. Factors influencing outcome following limb-threatening lower limb trauma: lessons learned from the lower extremity assessment project (LEAP). *JAAOS*. 2006;14:205–210.
 - Haider AH, Herrera-Escobar JP, Al Rafai SS, et al. Factors associated with long-term outcomes after injury: results of the functional outcomes and recovery after trauma Emergencies (FORTE) multicenter cohort study. *Ann Surg*. 2018.
 - Herrera-Escobar JP, Al Rafai SS, Seshadri AJ, et al. A multicenter study of post-traumatic stress disorder after injury: mechanism matters more than injury severity. *Surgeon*. 2018;164:1246–1250.
 - Fenig S, Levav I, Kohn R, Yelin N. Telephone vs face-to-face interviewing in a community psychiatric survey. *Am J Public Health*. 1993;83:896–898.
 - Sturges JE, Hanrahan KJ. Comparing telephone and face-to-face qualitative interviewing: a research note. *Sage J*. 2004;4:107–118.