Published in final edited form as:

Ann Surg. 2017 May ; 265(5): 847–853. doi:10.1097/SLA.0000000000001823.

Trauma Recidivism Predicts Long-term Mortality:

Missed Opportunities for Prevention (Retrospective Cohort Study)

Bethany L. Strong, MD, MS, Christina R. Greene, MS, and Gordon S. Smith, MB, ChB, MPH

University of Maryland School of Medicine, Department of Epidemiology and Public Health and National Study Center for Trauma and EMS, Baltimore, MD

Abstract

Objectives—The objectives of this study were to determine the association between recurrent trauma admissions (recidivism) and subsequent long-term mortality, and to identify those in most need for preventive interventions.

Background—Patients with a single intentional injury have been shown to have a higher risk of future injury mortality than those with unintentional injury with 5-year mortality rates as high as 20% being reported for recurrent penetrating trauma. Trauma recidivism identifies a high-risk population, but its association with long-term mortality is largely unknown.

Methods—Patients with 1 or more previous admissions to an urban trauma center (recidivists) were identified and compared with those with single admissions (nonrecidivists) from 1997 to 2008. The trauma registry was linked to the National Death Index to determine both the cause and time to death after hospital discharge. Statistical analysis included chi-square tests, Kaplan-Meier survival curves, and Cox proportional-hazards models.

Results—Trauma recidivists were 7% of the total trauma population from 1997 to 2008, representing 3147 patients. Recidivists were more likely to be male ($P < 0.0001$), Black ($P < 0.0001$), have a blood alcohol content above 80mg/dL ($P < 0.0001$), and suffer a penetrating injury ($P < 0.0001$) compared with nonrecidivists. Recidivists with both initial blunt and penetrating injuries had higher rates of long-term mortality after discharge. Recidivists were more likely to die of any cause based on Cox proportional-hazard ratios [hazard ratio (HR) 1.77, 95% confidence interval (CI) 1.57–2.01], injury death (HR 2.02, 95% CI 1.66–2.47), and disease death (HR 1.65, 95% CI 1.41–1.92) than nonrecidivists.

Conclusions—Male sex, Black race, and elevated blood alcohol content and penetrating injury are associated with trauma recidivism which leads to a higher risk of death. There is a critical public health need to develop interventions to reduce trauma recidivism and preventable death.

Keywords

trauma; trauma recidivism; injury; violence; long-term mortality; mortality; repeat trauma; risk factors

Reprints: Bethany L. Strong, MD, MS, 75 Francis Street, Boston, MA, 02115. bethany.lauren.strong@gmail.com.

Conflicts of interest: There are no conflicts of interest including financial, consultant, or institutional.

Trauma recidivism, defined as the incidence of new, recurrent injuries requiring patient evaluation and treatment, accounts for thousands of high-risk trauma admissions annually in the United States, with 1 study reporting recurrent rates up to 44% in cases of urban violence.¹⁻⁴ Recurrent penetrating trauma has historically been associated with up to a 20% five-year mortality, with the likelihood of mortality increasing 2-fold with each additional visit.^{4,5}

Admissions for multiple injury episodes increase healthcare costs, with the estimated annual costs of a single center due to trauma recidivism of \$2.5 million and \$1.2 million for urban and rural trauma centers annually, respectively.^{6,7} One study found that the average time to reinjury for trauma recidivists was 18.4 months, creating a potential window for public health intervention.³ However, modifiable risk factors associated with trauma recidivism and potential targets for intervention are not well understood.

Whereas there have been improvements over the years in reducing in-hospital mortality after trauma, there is increasing attention to decrease the risk of death during the long-term follow-up period.⁸ In a systematic review conducted by Niven et al,⁹ it was concluded that long-term mortality after hospital discharge was especially significant in older patients, those with increased hospital length of stay, and those who were not discharged to home. Haider et al¹⁰ found that although patients who suffer a singular intentional injury have similar long-term mortality as those who suffer an unintentional injury, they are more likely to have a future injury-related death.

Although long-term mortality after a single trauma admission has been explored, trauma recidivism and its association with long-term mortality is poorly understood.^{8,10} In this study, we aim to better understand the association between trauma recidivism and future mortality risk. The specific objectives are to determine the burden of trauma recidivism in an urban trauma center, to define the characteristics of trauma recidivists compared with nonrecidivists, and to explore the association between trauma recidivism and long-term mortality from both injuries and disease. The public health implications of this study include improving the identification of a high-risk population for trauma recidivism to allow for treatment, intervention, and prevention of mortality.

METHODS

Study Design, Data Source, and Study Population

We conducted a retrospective cohort study utilizing data from the R Adams Cowley Shock Trauma Center (STC) registry from January 1997 to December 2008 that was linked to the National Death Index (NDI). This registry contains data on over 60,000 admissions and extensive information on injuries, substance use, and pre-existing comorbid conditions. For this study, we included demographic and injury information related to the last recorded trauma admission during the study period including the most recent demographic data for each individual over 18 years of age.

Based on the last recorded admission to the hospital between 1997 and 2008, trauma recidivists were defined as patients with one or more previous admissions since the

commencement of the trauma registry in 1983 using a unique identification number for each new injury episode. Recidivists could not be detected using medical record alone as it was determined that a single patient could have multiple medical record numbers, even for the same admission. Recidivists were identified through a statistical programming code that incorporated the patient's name, medical record number, and social security number. Repeat admissions due to complications or follow-up treatment for the same injury were not considered new injuries.

Only patients discharged from the hospital alive were included in our study. Additionally, patients who died within 60 days of discharge were excluded to focus on deaths from new injuries and minimize inclusion of deaths due to complications of the original injury.^{11,12} Patients transferred from another hospital were also excluded, because complete details on admission evaluation, including alcohol and drug screening, were not available, and subsequent patient visits were thought more likely to occur at another facility.

The NDI was initially established in 1980 and has since been regarded as the gold standard for mortality data being more complete and easily accessible than individual death certificates.^{13–16} The NDI-Plus system was later developed to include both multiple cause mortality follow-up and demographic data. State Vital Statistics offices submit information from death certificates to the National Center for Health Statistics (NCHS) to compile the computerized record. Identifying information (social security number, date of birth, sex, and name) on all patients in the STC trauma registry was sent to the NCHS for linkage to the NDI-Plus system. NDI linkage of this nature has been shown to have greater than 95% sensitivity and 99% specificity.^{17,18} NDI data from 2008 were used, including cause of death by ICD-9 and ICD-10 codes and date of death, allowing for 1 to 11 years of follow-up depending on timing of last injury. Probability matches were returned to us for incorporation into our database. Patients without matches were assumed to be alive as in previous studies.^{10,19} This study protocol was approved by the Institutional Review Board at the University of Maryland School of Medicine.

Study Covariates

Covariates of interest potentially associated with both trauma recidivism and mortality were determined by a thorough assessment of the literature, clinical expertise, and unadjusted associations. Sociodemographic factors included age, sex (male or female), and race (White, Black, or other). The other race category was composed of Hispanics, Asians, American Indians/Alaskan Natives, and those whose race status was unknown. Injury-specific covariates included the following: mechanism of injury (blunt or penetrating), blood alcohol content (BAC, mg/dL), urine drug screen, Injury Severity Score (ISS), and pre-existing comorbidities. Urine drug screen was considered positive if the patient was identified as having any of the following substances in their urine: cocaine, opiates, amphetamines, benzodiazepines, or barbituates. Comorbidities including myocardial infarction, congestive heart failure, diabetes, hypertension, chronic obstructive pulmonary disease, cerebrovascular attack, liver problems, renal failure, and dementia were based on recorded medical history (determined by self-report, family report, and the medical record). Penetrating injuries were mostly knife-related (E-code 966) and gun-related (E-code 965). Blunt injuries were mostly

motor vehicle traffic crashes (E-code 810–819), falls (E-code 880–888), and assaults (E-code 960 and 968). Admission-specific covariates taken into account were hospital length of stay in days and discharge status to home, a hospital facility, or other facility including rehabilitation.

Statistical Analysis

Bivariate chi-square analysis was conducted to evaluate the potential relationships of both trauma recidivism and mortality with covariates. A covariate was considered as a potential confounder if significantly associated with both the outcome and exposure in preliminary analysis or in previous literature. Kaplan-Meier survival curves were constructed to compare rates of death overall and stratified by blunt and penetrating injury admissions. Time to death after trauma center discharge was compared between recidivists and nonrecidivists using the Wilcoxon rank-sum test. A Cox proportional-hazards model was utilized to determine the association between trauma recidivism and time to death, controlling for confounders. Findings were considered significant at a P value of <0.05 .

RESULTS

Sample Population

The final sample was 46,266 patients who were discharged alive as of December 2008. Trauma recidivists accounted for 7% of the sample trauma population, representing 3147 patients (Table 1). Recidivists were more likely to be younger ($P < 0.0001$), male ($P < 0.0001$), Black ($P < 0.0001$), have a BAC above 80 mg/dL ($P < 0.0001$), have a positive urine drug screen ($P < 0.0001$), and suffer a penetrating injury ($P < 0.0001$) compared with nonrecidivists (Table 1). Comorbidities, ISS, hospital length of stay, and discharge status did not significantly differ between recidivists and nonrecidivists (Table 1).

Long-term Mortality

There were 3292 patients (7.1%) who died during the follow-up period with 798 (24.7%) dying of injury and 2494 (75.8%) dying of disease. Seven per cent of nonrecidivists ($n = 3003$) died compared with 9% of recidivists ($n = 289$), with recidivists having a higher percentage of death from injuries compared with nonrecidivists (40% vs 23%). The top 5 causes of disease-related deaths among recidivists were heart disease (23.7%), cancer (15.0%), HIV (12.1%), chronic liver disease (6.4%), and stroke (5.2%). For nonrecidivists, the top 5 causes of disease-related deaths were heart disease (26.1%), cancer (21.2%), stroke (6.6%), HIV (4.6%), and influenza/pneumonia (3.9%). In the unadjusted analysis, recidivists were more likely to die from all causes than nonrecidivists ($P < 0.0001$) (Table 1). Kaplan-Meier curves showed significantly decreased survival of recidivists compared with nonrecidivists ($P < 0.0001$) with an increasing disparity in survival over time (Fig. 1). Similar results were found with stratification by mechanism of initial injury. Recidivists with blunt injury, however, had a 4% greater risk of future all-cause mortality over time when compared with those with penetrating injuries (Figs. 2 and 3).

Cox proportional-hazards models adjusted for age, sex, race, ISS, BAC, mechanism of injury, urine drug screen, discharge location, and number of comorbidities showed

recidivists were more likely to die of all causes [hazard ratio (HR) 1.77, 95% confidence interval (CI) 1.57–2.01], injury-related death (HR 2.02, 95% CI 1.66–2.47), and disease-related death (HR 1.65, 95% CI 1.41–1.92) when compared with nonrecidivists (Table 2). Median time to death for recidivists was 2.0 years for injury death and 2.8 years due to disease. Median time to death for nonrecidivists was 2.2 years for injury death and 3.1 years due to disease. While recidivists had a slightly shorter time to death compared with nonrecidivists, there was no statistically significant difference for injury ($P = 0.84$) or disease ($P = 0.18$). Sex was associated with long-term mortality, with male sex being a stronger predictor of injury death (HR 1.92, 95% CI 1.58–2.33) compared with disease mortality (Table 2). Race was a predictor of disease-related long-term mortality with higher rates in Blacks (HR 1.21, 95% CI 1.10–1.23), but not future injury mortality (Table 2). Elevated BAC and positive urine drug screen were associated with increases in both injury and disease long-term mortality. BAC over 80 mg/dL had a larger effect on increased HR for injury-related death compared with disease death (Table 2). Penetrating injury was a predictor of injury-related long-term mortality (HR 1.70, 95% CI 1.41–2.04), but not with future disease mortality (Table 2).

In the Cox proportional-hazards analysis stratified by mechanism of initial injury, recidivists were more likely to die than nonrecidivists after suffering blunt (HR 1.86, 95% CI 1.62–2.12) or penetrating injuries (HR 1.42, 95% CI 1.04–1.93) (Table 3). Male sex, Black race, and positive urine drug screen were predictive of long-term mortality for blunt but not penetrating trauma admissions. (Table 3) Positive BAC was predictive of long-term mortality for both blunt and penetrating injury admissions (Table 3).

DISCUSSION

Trauma recidivists, who represented 7% of the study sample, had a 77% higher risk for long-term mortality than nonrecidivists adjusting for confounders. The risk of injury-related death was 35% higher than that for disease-related death for trauma recidivists based on HRs. Recidivists suffering both blunt and penetrating injuries had a higher risk of death overall than their nonrecidivist counterparts. Recidivists with blunt injuries did, however, have a higher hazard for all-cause mortality than recidivists with initial penetrating injuries. Elevated BAC and positive urine drug screen were modifiable risk factors for recidivism and were also associated with increased long-term mortality.

Whereas rates of trauma recidivism in previous studies range from 1% to 44%, the majority of hospitals fall between 1% and 10% based on rural versus urban setting and age of study population.^{1–3,5,7,20–23} For this study, trauma recidivists were defined as patients with return admissions for a new injury to this specific trauma center. Although efforts were made to maximize the ability to capture new trauma injuries in those previously admitted by eliminating transferred patients, our trauma center is within close proximity of other trauma centers, potentially reducing the likelihood of patients returning here for care. Although our numbers are substantial, we may have underestimated our rates of trauma recidivism due to this and the potential limitations of the identifiers used to recognize recidivists in the database.

Black race was a predictor of elevated all-cause future mortality, but this was due to disease not injury, even after adjusting for confounders such as age. Interestingly, White patients had both a higher number of comorbidities and older average age than Blacks. Although the direct cause of the racial differences in disease-related mortality is unclear, undiagnosed and poorly managed comorbidities could be a part of the issue as we were only able to adjust for known comorbidities. It is unlikely that the diseases that led to an increased risk of death in recidivists are related to the initial traumatic injury due to the types of diseases being common to the overall US population and the average time to death being 2 to 3 years. The disease-related causes of death in recidivists are also not consistent with potential complications of traumatic injury such as septicemia and pneumonia. In addition to acute care trauma services, close follow-up with primary care physicians after discharge for trauma is necessary. The “other” race category had a lower hazard of both injury and disease mortality when compared with Whites, but the variability of this group, which consists of Hispanics, Asians, Native Americans, and those of unidentified race or ethnicity, makes this result difficult to interpret.

We found penetrating trauma to be associated with recidivism as seen in previous studies, but those recidivists with blunt injuries had a higher HR for long-term mortality. Penetrating trauma has been shown to have up to a 20% 5-year mortality rate with an increase in mortality for each recurrent admission to that given trauma center.⁵ Although deaths in the first 60 days after discharge were excluded, a death due to prolonged complications of an initial injury which is more common after blunt injuries can persist for up to 1 year afterwards.^{11,12}

In Haider et al's¹⁰ study of the association between single incidence of trauma and long-term mortality, there was no significant difference found in the hazard for death among those admitted with unintentional compared with intentional injuries. There was, however, a higher risk for injury death for the patients with intentional injuries. Their study did not exclude deaths within 60 days of discharge for initial injury and this may have allowed deaths due to complications to be left in the results. Additionally, our study had a much larger sample size and greater follow-up period to allow for a higher number of events with 3292 deaths over the study period compared with 302 in the earlier study.

Our study focused on those high-risk patients with recurrent injuries and on mechanism of initial injury not intent. We classified injuries as penetrating or blunt instead of due to injury intent. We believe this is a particular strength as intent can be misclassified or difficult to determine.^{24–26} Looking at mechanism of injury, by blunt or penetrating, also enables us to see exactly how history of a previous traumatic injury can play a role in the risk of death on the basis of type of injury sustained in a future trauma admission. We also did not stratify by injury causes due to limitations in power.

Female sex was protective against long-term mortality which is consistent with previous studies. It has previously been found that women demonstrate a 21% lower adjusted risk of death after trauma compared with males with similar injuries [odds ratio (OR) 0.79, 95% CI 0.76–0.83].^{10,27} Female sex, in and of itself, is also associated with a lower risk of repeat injury, with the majority of trauma recidivists being male.^{5,28,29}

Strengths of this study included the high sensitivity and specificity of linkage with the NDI, a focus on a high-risk population, a large sample size with extended follow-up, and high rates of alcohol testing at 94% compared with 43% in the National Trauma Data Bank in 2008.³⁰ None of the earlier studies included detailed testing for alcohol or other drugs, both factors which we found to be highly predictive of subsequent mortality. Limitations included a focus on a single, urban trauma center limiting generalizability, lack of covariates to estimate socioeconomic status such as insurance status or median household income data, and no objective information on mental health comorbidities which have been shown to be associated with trauma recidivism.^{28,29,31} In addition, the small number of deaths from specific causes prevented us from examining deaths by injury cause groups, and the high cost of linking to the NDI restricted obtaining additional data. Although the NDI provided extensive long-term mortality data, the outcomes of traumatic injury could be broad and potentially include psychological disability and limited functional status which are not quantified by this study.

One example that could be a model for developing interventions to reduce the risk of all recurrent injuries regardless of cause is hospital-based violence intervention programs (HVIPs). There is increasing evidence that these HVIPs are effective in reducing injury recidivism.^{28,32,33} These programs focus on the social circumstances of the patient and modifiable risk factors for recidivism including employment, mental health services, and substance abuse counseling. There is greatest efficacy of these programs when focusing on the highest risk populations such as trauma recidivists.^{28,33} In a randomized control trial of a HVIP assessing patients with recurrent injuries on parole or probation, Cooper et al²⁸ found lower rates of injury recidivism (5% vs 36%), lower rates of future arrests (Relative Risk 0.4, 95% CI 0.28, 0.67), and higher rates of employment (+43% vs -25%) in the intervention group compared with the control. Additionally, Duncan et al³³ found a 16% decrease in assaults in the area around a given trauma center after the implementation of a program that included mentoring, counseling, job placement, and education components.

Our study identified modifiable risk factors for trauma recidivism and the characteristics associated with long-term mortality. As we move toward to appreciating and implementing more preventive services in this country, there is a critical public health need to focus our efforts on reducing trauma recidivism and subsequent preventable death.

Acknowledgments

We would like to thank our colleagues Deborah M. Stein, MD, MPH, Jamila M. Torain, MPH, and Ilynn Bulatao, MD, who provided helpful advice and comments on the manuscript.

Sources of funding: This work is funded by a grant from the U.S. National Institute on Alcohol Abuse and Alcoholism (R01AA18707), National Institutes of Health.

References

1. Buss TF, Abdu R. Repeat victims of violence in an urban trauma center. *Violence Vict.* 1995; 10:183–194. [PubMed: 8777185]
2. Caufield J, Singhal A, Moulton R, et al. Trauma recidivism in a large urban Canadian population. *J Trauma.* 2004; 57:872–876. [PubMed: 15514545]

3. Smith RS, Fry WR, Morabito DJ, et al. Recidivism in an urban trauma center. *Arch Surg.* 1992; 127:668–670. [PubMed: 1596166]
4. Sims DW, Bivins BA, Obeid FN, et al. Urban trauma: a chronic recurrent disease. *J Trauma.* 1989; 29:940–946. [PubMed: 2746704]
5. Brooke BS, Efron DT, Chang DC, et al. Patterns and outcomes among penetrating trauma recidivists: it only gets worse. *J Trauma.* 2006; 61:16–19. [PubMed: 16832245]
6. Tellez MG, Mackersie RC, Morabito D, et al. Risks, costs, and the expected complication of re-injury. *Am J Surg.* 1995; 170:660–663. [PubMed: 7492022]
7. Toschlog EA, Sagraves SG, Bard MR, et al. Rural trauma recidivism: a different disease. *Arch Surg.* 2007; 142:77–81. [PubMed: 17224504]
8. Dutton RP, Stansbury LG, Leone S, et al. Trauma mortality in mature trauma systems: are we doing better? An analysis of trauma mortality patterns, 1997–2008. *J Trauma.* 2010; 69:620–626. [PubMed: 20093983]
9. Niven DJ, Kirkpatrick AW, Ball CG, et al. Long-term mortality after admission to hospital for trauma: a review. *Trauma.* 2013; 15:228–238.
10. Haider AH, Young JH, Kisat M, et al. Association between intentional injury and long-term survival after trauma. *Ann Surg.* 2014; 259:985–992. [PubMed: 24487746]
11. Fleischman RJ, Adams AL, Hedges JR, et al. The optimum follow-up period for assessing mortality outcomes in injured older adults. *J Am Geriatr Soc.* 2010; 58:1843–1849. [PubMed: 20831727]
12. Shafi S, Renfro LA, Barnes S, et al. Chronic consequences of acute injuries: worse survival after discharge. *J Trauma Acute Care Surg.* 2012; 73:699–703. [PubMed: 22710768]
13. Edlavitch SA, Baxter J. Comparability of mortality follow-up before and after the National Death Index. *Am J Epidemiol.* 1988; 127:1164–1178. [PubMed: 3369416]
14. Gildea TR, Cook WC, Nelson DR, et al. Predictors of long-term mortality in patients with cirrhosis of the liver admitted to a medical ICU. *Chest.* 2004; 126:1598–1603. [PubMed: 15539733]
15. Lash TL, Silliman RA. A comparison of the National Death Index and social security administration databases to ascertain vital status. *Epidemiology.* 2001; 12:259–261. [PubMed: 11246590]
16. Sesso HD, Paffenbarger RS, Lee IM. Comparison of National Death Index and World Wide Web death searches. *Am J Epidemiol.* 2000; 152:107–111. [PubMed: 10909946]
17. Stampfer MJ, Willett WC, Speizer FE, et al. Test of the National Death Index. *Am J Epidemiol.* 1984; 119:837–839. [PubMed: 6720679]
18. Williams BC, Demitrack LB, Fries BE. The accuracy of the National Death Index when personal identifiers other than social security number are used. *Am J Public Health.* 1992; 82:1145–1147. [PubMed: 1636839]
19. Wu C, Zhao S, Wechsler AS, et al. Long-term mortality of coronary artery bypass grafting and bare-metal stenting. *Ann Thorac Surg.* 2011; 92:2132–2138. [PubMed: 22014747]
20. McCoy AM, Como JJ, Greene G, et al. A novel prospective approach to evaluate trauma recidivism: the concept of past trauma history. *J Trauma Acute Care Surg.* 2013; 75:116–121. [PubMed: 23778450]
21. Allan BJ, Davis JS, Pandya RK, et al. Exploring trauma recidivism in an elderly cohort. *J Surg Res.* 2013; 184:582–585. [PubMed: 23578752]
22. Davis JS, Pandya RK, Sola JE, et al. Pediatric trauma recidivism in an urban cohort. *J Surg Res.* 2013; 182:326–330. [PubMed: 23312811]
23. Kaufmann CR, Branas CC, Brawley ML. A population-based study of trauma recidivism. *J Trauma.* 1998; 45:325–331. [PubMed: 9715190]
24. Breiding MJ, Wiersema B. Variability of undetermined manner of death classification in the US. *Inj Prev.* 2006; 12:ii49–ii54. [PubMed: 17170172]
25. Boscoe FP. Persistent and extreme outliers in causes of death by state, 1999–2013. *Peer J.* 2015; 3:e1336. [PubMed: 26623181]

26. Gjertsen F, Bruzzone S, Vollrath ME, et al. Comparing ICD-9 and ICD-10: the impact on intentional and unintentional injury mortality statistics in Italy and Norway. *Injury*. 2013; 44:132–138. [PubMed: 22341556]
27. Haider AH, Crompton JG, Oyetunji T, et al. Females have fewer complications and lower mortality following trauma than similarly injured males: a risk adjusted analysis of adults in the national trauma data bank. *Surgery*. 2009; 146:308–315. [PubMed: 19628090]
28. Cooper C, Eslinger D, Nash D, et al. Repeat victims of violence: report of a large concurrent case-control study. *Arch Surg*. 2000; 135:837–843. [PubMed: 10896379]
29. Kwan RO, Cureton EL, Dozier KC, et al. Gender differences among recidivist trauma patients. *J Surg Res*. 2011; 165:25–29. [PubMed: 20828752]
30. American College of Surgeons Committee on Trauma. National Trauma Data Bank Report 2008 [American College of Surgeons website]. 2008. Available at: <http://www.facs.org/~media/files/quality20%programs/trauma/ntdb/ntdbannualreport2008.ashx>. Accessed December 1, 2015
31. Wan JJ, Morabito DJ, Khaw L, et al. Mental illness as an independent risk factor for unintentional injury and injury recidivism. *J Trauma*. 2006; 61:1299–1304. [PubMed: 17159669]
32. Juillard C, Smith R, Anaya N, et al. Saving lives and saving money: hospital-based violence intervention is cost-effective. *J Trauma Acute Care Surg*. 2015; 78:252–257. [PubMed: 25757108]
33. Duncan TK, Waxman K, Romero J, et al. Operation PeaceWorks: a community program with the participation of a level II trauma center to decrease gang-related violence. *J Trauma Acute Care Surg*. 2014; 76:1208–1213. [PubMed: 24747450]

FIGURE 1. Unadjusted Kaplan-Meier survival curves based by recidivism status. Recidivists are represented by the dashed line. Nonrecidivists are represented by the solid line. $P < 0.0001$.

FIGURE 2. Unadjusted Kaplan-Meier survival curves for initial blunt injuries. Recidivists are represented by the dashed line. Nonrecidivists are represented by the solid line. $P < 0.0001$.

FIGURE 3. Unadjusted Kaplan-Meier survival curves for initial penetrating injuries. Recidivists are represented by the dashed line. Nonrecidivists are represented by the solid line. $P < 0.0001$.

TABLE 1

Characteristics of Trauma Patients by Recidivism Status

	All Patients [46,226 (%)]	Nonrecidivists [43,079 (93%)]	Recidivists [3147 (7%)]	<i>P</i> *
Age, yrs				<0.0001
18–29	17,167 (37.1%)	16,067 (37.3%)	1100 (35%)	
30–44	15,026 (32.5%)	13,721 (31.9%)	1305 (41.5%)	
45–54	6858 (14.8%)	6386 (14.8%)	472 (15%)	
55–64	3345 (7.2%)	3190 (7.4%)	155 (4.9%)	
65+	3830 (8.3%)	3715 (8.6%)	115 (3.7%)	
Sex †				<0.0001
Female	13,766 (29.8%)	13,270 (30.8%)	496 (15.8%)	
Male	32,455 (30.2%)	29,804 (69.2%)	2651 (84.2%)	
Race				<0.0001
White	26,978 (58.4%)	25,356 (58.9%)	1622 (51.5%)	
Black	15,723 (34.0%)	14,278 (33.1%)	1445 (45.9%)	
Other	3,525 (7.6%)	3498 (8.0%)	83 (2.5%)	
ISS				0.97
Missing	1615 (3.5%)	1510 (3.5%)	105 (3.3%)	
1–8	25,413 (55.0%)	23,663 (54.6%)	1750 (55.6%)	
9–15	10,250 (22.2%)	9556 (22.2%)	694 (22.1%)	
16–24	5425 (11.7%)	5060 (11.8%)	365 (11.6%)	
25–49	3297 (7.1%)	3078 (7.2%)	219 (7.0%)	
50+	226 (0.5%)	212 (0.5%)	14 (0.4%)	
BAC				<0.0001
Negative	31,460 (68.1%)	29,624 (68.8%)	1836 (58.3%)	
<80 mg/dL	2339 (5.1%)	2129 (4.9%)	210 (6.7%)	
80 mg/dL	9604 (20.8%)	8666 (20.1%)	938 (29.8%)	
Unknown	2823 (6.1%)	2660 (6.2%)	163 (5.2%)	
Mechanism of injury				<0.0001
Blunt	39,807 (86.1%)	37,402 (86.8%)	2405 (76.4%)	
Penetrating	6419 (13.9%)	5677 (13.2%)	742 (23.6%)	
Urine toxicology				<0.0001
Negative	14,149 (30.6%)	13,351 (31.0%)	798 (25.4%)	
Positive	8855 (19.2%)	8005 (18.6%)	850 (27.0%)	
Unknown	23,222 (50.2%)	21,723 (50.4%)	1499 (47.6%)	
Discharge status				0.21
Home	38,402 (83.1%)	35,752 (83.0%)	2650 (84.2%)	
Hospital	7649 (16.5%)	7164 (16.6%)	485 (15.4%)	
Other/unknown	175 (0.4%)	163 (0.4%)	12 (0.4%)	
Comorbidities				0.78
None	42,816 (92.6%)	39,903 (92.6%)	2913 (92.6%)	
One	2911 (6.3%)	2706 (6.3%)	205 (6.5%)	

	All Patients [46,226 (%)]	Nonrecidivists [43,079 (93%)]	Recidivists [3147 (7%)]	<i>P</i> *
Two	422 (0.9%)	397 (0.9%)	25 (0.8%)	0.22
Three or more	77 (0.2%)	73 (0.2%)	4 (0.1%)	
Length of stay				
Under 24 h	26,205 (56.7%)	24,377 (56.6%)	1828 (58.1%)	<0.0001
24–48 h	4226 (9.1%)	3939 (9.1%)	287 (9.1%)	
>48 h	16,280 (35.2%)	14,763 (34.3%)	1032 (32.8%)	
Follow-up status				
Alive	42,934 (92.9%)	40,076 (93.0%)	2858 (90.8%)	
Dead	3292 (7.1%)	3003 (7.0%)	289 (9.2%)	
Injury-related	798 (24.2%)	690 (23%)	116 (40%)	
Disease-related	2494 (75.8%)	2313 (77%)	173 (60%)	

* Significant at *P* value <0.05.

† Missing data on 5 patients.

TABLE 2

Adjusted Cox Proportional-hazards Ratios for Mortality by Injury and Disease Death

	All-cause Hazard Ratio [*]	Injury Death Hazard Ratio [*]	Disease Death Hazard Ratio [*]
Recidivism status			
Single visitor	Ref (1.0)	Ref (1.0)	Ref (1.0)
Recidivist	1.77 (1.57–2.01) [†]	2.02 (1.66–2.47) [†]	1.65 (1.41–1.92) [†]
Age, yrs			
18–29	Ref (1.0)	Ref (1.0)	Ref (1.0)
30–44	2.22 (1.95–2.53)	1.40 (1.19–1.65) [†]	4.86 (3.82–6.19) [†]
45–54	4.18 (3.65–4.79) [†]	1.15 (0.91–1.44)	13.80 (10.87–17.51) [†]
55–64	5.97 (5.21–6.84) [†]	0.84 (0.59–1.19)	21.91 (17.14–28.00) [†]
65+	18.38 (16.09–20.99) [†]	0.93 (0.65–1.33)	70.75 (55.97–89.42) [†]
Sex			
Female	Ref (1.0)	Ref (1.0)	Ref (1.0)
Male	1.26 (1.17–1.37) [†]	1.92 (1.58–2.33) [†]	1.16 (1.06–1.26) [†]
Race			
White	Ref (1.0)	Ref (1.0)	Ref (1.0)
Black	1.12 (1.04–1.22) [†]	0.89 (0.76–1.04)	1.21 (1.10–1.33) [†]
Other	0.53 (0.43–0.65) [†]	0.44 (0.29–0.66) [†]	0.56 (0.44–0.71) [†]
ISS			
1–8	Ref (1.0)	Ref (1.0)	Ref (1.0)
9–15	0.92 (0.84–1.00)	1.00 (0.83–1.21)	0.89 (0.80–0.98) [†]
16–24	0.91 (0.82–1.01)	1.26 (1.01–1.57) [†]	0.82 (0.72–0.93) [†]
25+	1.16 (1.02–1.32) [†]	1.69 (1.33–2.15) [†]	0.98 (0.84–1.15)
Missing	0.77 (0.62–0.97) [†]	0.74 (0.45–1.23)	0.78 (0.61–1.00)
BAC			
Negative	Ref (1.0)	Ref (1.0)	Ref (1.0)
<80 mg/dL	1.41 (1.20–1.66) [†]	1.34 (1.03–1.76) [†]	1.44 (1.17–1.77) [†]
80 mg/dL	1.48 (1.35–1.62) [†]	1.42 (1.21–1.67) [†]	1.48 (1.32–1.65) [†]
Unknown	1.07 (0.92–1.24)	0.91 (0.64–1.30)	1.10 (0.99–1.18)
Mechanism of injury			
Blunt	Ref (1.0)	Ref (1.0)	Ref (1.0)
Penetrating	1.22 (1.08–1.38) [†]	1.70 (1.41–2.04) [†]	0.95 (0.80–1.13)
Urine drug screen			
Negative	Ref (1.0)	Ref (1.0)	Ref (1.0)
Positive	1.25 (1.13–1.39) [†]	1.71 (1.40–2.08) [†]	1.10 (0.97–1.24)
Unknown	1.11 (1.02–1.20) [†]	1.23 (1.02–1.47) [†]	1.08 (0.99–1.18)
Discharge location			
Home	Ref (1.0)	Ref (1.0)	Ref (1.0)

	All-cause Hazard Ratio [*]	Injury Death Hazard Ratio [*]	Disease Death Hazard Ratio [*]
Hospital/other	1.77 (1.62–1.92) [†]	1.79 (1.50–2.15) [†]	1.78 (1.62–1.95) [†]
Comorbidities			
None	Ref (1.0)	Ref (1.0)	Ref (1.0)
One	2.05 (1.87–2.25) [†]	1.61 (1.21–2.14) [†]	2.15 (1.95–2.38) [†]
Two	3.68 (3.19–4.25) [†]	0.71 (0.23–2.24)	3.94 (3.40–4.56) [†]

^{*} Adjusted for age, sex, race, ISS, BAC, mechanism of injury, urine drug screen, discharge location, and number of comorbidities.

[†] Significant at *P* value <0.05

TABLE 3

Adjusted Cox Proportional-hazards Ratios for Mortality by Mechanism of Injury *

	Blunt Injury Admissions Hazard Ratios	Penetrating Injury Admissions Hazard Ratios
Recidivism status		
Single visitor	Ref (1.0)	Ref (1.0)
Recidivist	1.86 (1.62–2.12) [†]	1.42 (1.04–1.93) [†]
Age, yrs		
18–29	Ref (1.0)	Ref (1.0)
30–44	2.33 (2.00–2.72) [†]	1.95 (1.51–2.51) [†]
45–54	4.46 (3.82–5.21) [†]	3.38 (2.43–4.69) [†]
55–64	6.55 (5.54–7.73) [†]	3.02 (1.78–5.12) [†]
65+	19.90 (17.14–23.10) [†]	11.23 (6.81–18.54) [†]
Sex		
Female	Ref (1.0)	Ref (1.0)
Male	1.27 (1.18–1.38) [†]	1.11 (0.81–1.53)
Race		
White	Ref (1.0)	Ref (1.0)
Black	1.15 (1.05–1.25) [†]	0.83 (0.65–1.05)
Other	0.56 (0.45–0.69) [†]	0.28 (0.12–0.65) [†]
ISS		
1–8	Ref (1.0)	Ref (1.0)
9–15	0.92 (0.83–1.01)	0.93 (0.72–1.21)
16–24	0.90 (0.80–1.00)	1.03 (0.69–1.54)
25+	1.10 (0.96–1.27)	1.67 (1.17–2.38) [†]
Missing	0.79 (0.63–0.99) [†]	0.28 (0.04–1.97)
BAC		
Negative	Ref (1.0)	Ref (1.0)
<80 mg/dL	1.45 (1.21–1.75) [†]	1.32 (0.92–1.89)
80 mg/dL	1.49 (1.35–1.64) [†]	1.46 (1.14–1.88) [†]
Unknown	1.03 (0.87–1.21)	1.34 (0.91–1.98)
Urine drug screen		
Negative	Ref (1.0)	Ref (1.0)
Positive	1.27 (1.14–1.42) [†]	1.17 (0.83–1.66)
Unknown	1.10 (1.01–1.20) [†]	1.22 (0.91–1.64)
Discharge location		
Home	Ref (1.0)	Ref (1.0)
Hospital/other	1.77 (1.62–1.94) [†]	1.73 (1.34–2.24) [†]
Comorbidities		
None	Ref (1.0)	Ref (1.0)

	Blunt Injury Admissions Hazard Ratios	Penetrating Injury Admissions Hazard Ratios
One	2.06 (1.87–2.26) [†]	1.90 (1.23–2.93) [†]
Two	3.67 (3.17–4.24) [†]	4.12 (1.76–9.65) [†]

* Adjusted for age, sex, race, ISS, BAC, urine drug screen, discharge location, and number of comorbidities.

[†]Significant at *P*value <0.05.