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Permalink

<https://escholarship.org/uc/item/6m3569j2>

Journal

The Journal of emergency medicine, 54(5)

ISSN

0736-4679

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Publication Date

2018-05-01

DOI

10.1016/j.jemermed.2017.12.060

Peer reviewed



<https://doi.org/10.1016/j.jemermed.2017.12.060>

Violence: Recognition, Management and Prevention

ANOTHER “LETHAL TRIAD” – RISK FACTORS FOR VIOLENT INJURY AND LONG-TERM MORTALITY AMONG ADULT VICTIMS OF VIOLENT INJURY

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Abstract—Background: Mental illness, substance abuse, and poverty are risk factors for violent injury, and violent injury is a risk factor for early mortality that can be attenuated through hospital-based violence intervention programs. Most of these programs focus on victims under the age of 30 years. Little is known about risk factors or long-term mortality among older victims of violent injury. **Objectives:** To explore the prevalence of risk factors for violent injury among younger (age < 30 years) and older (age 30 ≥ years) victims of violent injury, to determine the long-term mortality rates in these age groups, and to explore the association between risk factors for violent injury and long-term mortality. **Methods:** Adults with violent injuries were enrolled between 2001 and 2004. Demographic and injury data were recorded on enrollment. Ten-year mortality rates were measured. Descriptive analysis and logistic regression were used to compare older and younger subjects. **Results:** Among 541 subjects, 70% were over age 30. The overall 10-year mortality rate was 15%, and was much higher than in the age-matched general population in both age groups. Risk factors for violent injury including mental illness, substance abuse, and poverty were prevalent, especially among older subjects, and were each independently associated with increased risk of long-term mortality.

Conclusion: Mental illness, substance abuse, and poverty constitute a “lethal triad” that is associated with an increased risk of long-term mortality among victims of violent injury, including both younger adults and those over age 30 years. Both groups may benefit from targeted risk-reduction efforts. Emergency department visits offer an invaluable opportunity to engage these vulnerable patients. © 2018 Elsevier Inc. All rights reserved.

Keywords—violence; injury prevention; mental illness; substance abuse; poverty

INTRODUCTION

Background

Interpersonal violence is a major public health problem in America, leading to over 1.8 million injuries requiring medical attention, and generating nearly 9 billion dollars in medical costs annually (1). Well-documented risk factors for subsequent violent injury include prior violent injury, and ongoing mental illness, substance abuse, and poverty (2–4).

Innovative hospital-based violence intervention programs (HVIPs) have demonstrated effectiveness in reducing rates of violent injury recidivism among victims

This work was presented at the Society for Academic Emergency Medicine Annual Meeting, New Orleans, LA, May 13, 2016.

RECEIVED: 1 May 2017; FINAL SUBMISSION RECEIVED: 27 December 2017;
 ACCEPTED: 30 December 2017

of violent injuries by addressing these risk factors (5–7). Most HVIPs cater to younger victims of violent injury, with age cutoffs < 30 years (8–10). However, over 45% of victims of violent injuries in the United States are over 30 (11,12).

There has been little research about risk factors leading up to violent injury or long-term outcomes among victims of violent injury over age 30 years. Understanding these issues is essential for designing interventions with a potential for risk reduction, because risk-reduction efforts targeting adults over age 30 years may need significant modification from the well-founded strategies used in youth-focused programs.

Goals

This study tested the primary hypothesis that poverty, mental illness, and substance abuse are prevalent risk factors for violent injury, for both “younger” (age < 30 years) and “older” (age \geq 30 years) victims of violent injury. Further, two secondary hypotheses were tested. The first was that victims of violent injury treated in our department who were not currently receiving mental health services and who were not acutely psychotic or suicidal have an increased 10-year mortality compared with their general age cohort, whether they are “younger” or “older” patients. The second was that, among victims of violent injury who were not currently receiving mental health services and who were not acutely psychotic or suicidal, the separate risk factors of poverty, mental illness, and substance abuse each are associated with an increased probability of subsequent 10-year mortality.

MATERIALS AND METHODS

Study Design and Setting

This is a retrospective cohort study nested within a randomized controlled trial that was conducted at San Francisco General Hospital (SFGH), the main public hospital and the only Level I trauma center in San Francisco, CA (13). SFGH serves as the city’s medical safety net and treats over 95% of all trauma patients in the city. The study protocol was approved by the University of California, San Francisco Committee on Human Research.

Selection of Participants

Between 2001 and 2004, adult victims of violent injury presenting to SFGH for medical treatment were systematically approached and recruited for a study to evaluate the impact of trauma-informed mental health services (defined as mental health services that acknowledge and

address the impact of trauma on victims’ mental health) on mental health outcomes (13). Exclusion criteria included age < 18 years, lack of English proficiency, residence outside the city of San Francisco, victims of sexual assault, patients with acute psychosis or suicidality, and those already enrolled in mental health services at the time of injury. A total of 1140 patients treated in the emergency department (ED) at SFGH were identified by the hospital staff as potentially eligible, based upon having suffered an apparent violent injury. Of those 1140, 695 (61%) did not fulfill any exclusion criteria and were deemed to be eligible for the study after screening by our study personnel. Of these, 541 (47% of the 1140 or 78% of the 695) were enrolled in the study after granting their informed consent.

Methods and Measurements

Subjects underwent an intake interview to collect demographic information within 1 month of the index injury. The details of these interviews, including methods of making probable diagnoses of mental illness and substance abuse disorders, have been described previously (14). Injury mechanism and injury severity, defined dichotomously by the need for hospital admission, were identified during intake interviews. Dates of death were identified using subjects’ electronic medical records at SFGH and data from the National Social Security Death Index. Data were tabulated in Microsoft Excel (Microsoft Corporation, Redmond, WA) and imported to Stata 13 (StataCorp LLC, College Station, TX) for analysis.

Analysis

We quantified risk factors for violent injury at the time of index injury using probable diagnoses of posttraumatic stress disorder (PTSD), major depression, anxiety disorder, and panic disorder as markers of mental illness, alcohol syndrome and illicit drug use as markers of substance abuse, and homelessness and unemployment as markers of poverty. Baseline PTSD preceding index injury was diagnosed using the PTSD Checklist—Civilian Version (15). We compared the demographic characteristics, risk factors for violent injury, and mortality rates of younger adults (ages 18–29 years old) and older adults (age 30 years and older) using Pearson’s chi-squared test for categorical variables and Student’s *t*-test for continuous variables. We compared all-cause mortality rates in this cohort with age-matched expected 10-year all-cause mortality rates to a hypothetical age-matched cohort from the general U.S. population created using data from the National Vital Statistics Report (NVSr) to calculate relative risk of mortality (i.e., observed mortality/expected mortality) and excess rate of

mortality (i.e., observed mortality – expected mortality) in our cohort (16). We constructed bivariable and multivariable logistic regression models to evaluate associations between risk factors for violent injury and 10-year mortality in our study cohort. We considered p -values < 0.05 to be statistically significant, and calculated that a sample size of at least 473 was sufficient to demonstrate a 5% difference in 10-year mortality rates between age groups.

RESULTS

Characteristics of Study Subjects (Table 1)

In total, 541 victims of violent injury were enrolled in the study. The median age of subjects was 37 years (interquartile range 27–45), and 70% of subjects ($n = 376$) were age ≥ 30 years. The median age among older adults was 43 years (interquartile range 36–48), and only 13 were over age 60. Males accounted for 75% of the sample ($n = 405$), and were equally distributed across age groups. The majority of subjects in both age groups were African American, but older adults were more likely to be White and less likely to be Latino. Blunt assault was the most common injury mechanism, although gunshot wounds were significantly more common among younger adults. About half of subjects were injured severely enough to require admission, and need for admission was significantly more common among younger adults.

Risk Factors for Violent Injury (Table 2)

Mental illness, substance abuse, and poverty were prevalent in the cohort, being numerically greater among older adults. Homelessness, unemployment, and probable prior diagnoses of PTSD, panic disorder, and alcohol disorder were significantly more prevalent among older adults.

Table 1. Subject Characteristics

	Total n = 541	Younger Adults n = 165	Older Adults n = 376	p -Value
Age, median (IQR)	37 (27–45)	24 (21–26)	43 (36–48)	
Male, n (%)	405 (75)	126 (76)	279 (74)	0.63
Race, n (%)				
White	112 (21)	21 (13)	91 (24)	$<0.01^*$
African American	281 (52)	87 (53)	194 (52)	0.88
Latino	66 (12)	29 (18)	37 (10)	0.01
Other	82 (15)	28 (17)	54 (14)	0.41
Mechanism, n (%)				
Blunt assault	327 (60)	69 (42)	258 (68)	$<0.01^*$
Gunshot wound	98 (18)	61 (37)	37 (10)	$<0.01^*$
Stab wound	94 (17)	25 (15)	69 (18)	0.39
Vehicular assault	22 (4)	9 (5)	13 (3)	0.27
Admitted, n (%)	282 (52)	98 (60)	184 (49)	0.02*

IQR = interquartile range.

* These p -values are < 0.05 , and considered statistically significant.

Table 2. Risk Factors for Violent Injury

Risk Factor, n (%)	Total n = 541	Younger Adults n = 165	Older Adults n = 376	p -Value*
Mental Illness				
PTSD	260 (48)	67 (41)	193 (51)	0.03*
Major depression	191 (35)	51 (31)	140 (37)	0.17
Anxiety disorder	165 (31)	47 (29)	118 (31)	0.53
Panic disorder	70 (13)	12 (7)	58 (15)	0.01*
Any mental illness	343 (63)	97 (59)	246 (65)	0.18
Substance abuse				
Alcohol disorder	233 (43)	59 (36)	174 (46)	0.03*
Illicit drugs	314 (58)	102 (62)	212 (56)	0.21
Any substance abuse	392 (72)	119 (73)	273 (72)	0.97
Poverty				
Homeless	221 (41)	23 (14)	198 (53)	$<0.01^*$
Unemployed	342 (63)	93 (57)	249 (66)	0.04*
Any marker of poverty	391 (72)	98 (60)	293 (78)	$<0.01^*$
At least one risk factor	508 (94)	150 (91)	358 (95)	0.12

PTSD = posttraumatic stress disorder.

* These p -values are < 0.05 , and considered statistically significant.

Mortality

The 1-, 5-, and 10-year mortality rates in this cohort were 1.9%, 8.3%, and 15.3% (Figure 1). These rates were higher for older adults compared with their younger counterparts, and were statistically significantly different at 10 years (18.0% vs. 9.2%, $p < 0.01$). According to data from the NVSR, the expected 10-year mortality rate in a sample from the general U.S. population matched by age with the subjects in our cohort would be 3.4%, with a 0.96% 10-year mortality rate among an age-matched sample of younger adults and a 4.4% 10-year mortality rate among an age-matched sample of older adults.

The relative risk of mortality (i.e., observed mortality/expected mortality) was 4.5 and the excess rate of mortality (i.e., observed mortality – expected mortality) was 12.0% among the subjects in our cohort. Mortality rates

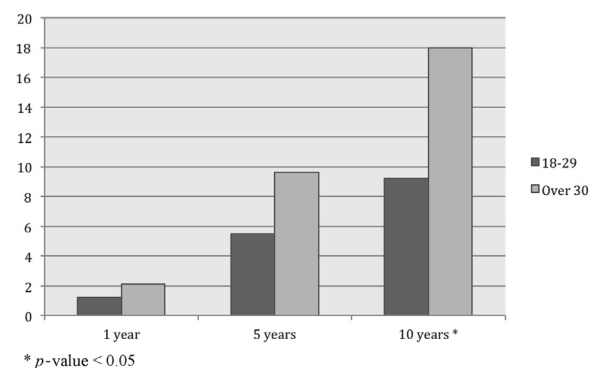


Figure 1. Deaths per 100 subjects among victims of violent injury, compared by age group over 1, 5, and 10 years after their index injury.

in both the younger adult and older adult subgroups of our cohort were significantly elevated in comparison with the general U.S. population. Whereas the relative risk of mortality was higher among younger adults, the excess rate of mortality was higher among older adults (Table 3).

Predictors of Mortality (Tables 4 and 5)

We used probable diagnoses of PTSD, major depression, anxiety disorder, and panic disorder at markers of mental illness, alcohol syndrome and illicit drug use as markers of substance abuse, and homelessness and unemployment as markers of poverty. In an unadjusted analysis, markers for mental illness, substance abuse, and poverty were all associated with increased risk of 10-year mortality. Over 90% of subjects in both age groups had a risk factor in at least one category.

Subjects with markers in one category of risk factors had a 6.7% risk of 10-year mortality. This increased to 13.7% among those with markers in two categories of risk factors, and 21.5% among those with markers in all three categories of risk factors. Similar trends were present in the younger adult and older adult age groups. Increasing age and more severe index injury were also associated with increased 10-year mortality, whereas specific injury mechanisms were not.

When considering age, a need for admission to the hospital after being injured, mental illness, substance abuse, and poverty as potential risk factors for 10-year mortality, all factors were numerically more prevalent among those who subsequently died in the next 10 years. However, only age, a need for admission to the hospital, and any marker for poverty yielded an odds ratio (OR) that achieved statistical significance. Adding interaction terms suggested especially poor outcomes in those with concurrent mental illness and substance abuse (OR 1.92, 95% confidence interval 0.53–6.99) and concurrent mental illness and poverty (OR 1.71, 95% confidence interval 0.39–7.44), though those findings did not achieve statistical significance.

In bivariable logistic regression models including subjects of all ages, increasing age, more severe index injury, preexisting panic disorder, preexisting major depression,

Table 3. Increased 10-Year All-Cause Mortality Among Adult Victims of Violent Injury, in Comparison With a Hypothetical Age-Matched Sample of the General U.S. Population

	Total	Younger Adults	Older Adults
Expected mortality (%)	3.4	0.96	4.4
Observed mortality (%)	15.4	9.1	18.1
Relative risk of mortality	4.5	9.5	4.1
Excess rate of mortality (%)	12.0	8.2	13.7

Table 4. Multivariable Logistic Regression Model Predicting 10-Year All-Cause Mortality, Considering Mental Illness, Substance Abuse, and Poverty as Separate Covariates

Variable	OR	p-Value
Age (per year)	1.05*	<0.01*
Need for admission	2.04*	<0.01*
Any mental illness	1.55	0.12
Any substance abuse	1.49	0.21
Any marker of poverty	2.31*	0.02*

OR = odds ratio.

* These values reached statistical significance.

preexisting alcohol disorder, homelessness, and unemployment were significantly associated with increased odds of 10-year mortality. Subgroup analyses among the younger and older age groups revealed several differences in the pattern of associations between risk factors and 10-year mortality. For example, risk of death among younger adults was strongly associated with major depression and anxiety disorder, whereas among older adults, risk of death was more strongly associated with panic disorder and PTSD. Illicit drug abuse was strongly associated with risk of death among younger adults but not older adults. Homelessness was strongly associated with risk of death among older adults but not younger adults.

DISCUSSION

Key Findings

The lethal triad of acidosis, hypothermia, and coagulopathy is a well-known constellation of factors that predict poor outcomes in trauma patients. Here, we describe another “lethal triad,” consisting of untreated mental illness, ongoing substance abuse, and poverty (Figure 2). As was reported previously by Buss and Abdu, in this study these elements were prevalent among both younger victims of violent injury and those over 30 years of age (3). In this study we showed that, like the classic lethal triad, each element of this “lethal triad” is an independent risk factor for premature death, and there is a tragic synergy between the components when

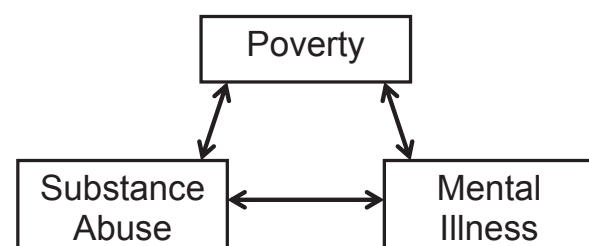


Figure 2. Another “lethal triad.”

Table 5. Bivariable Logistic Regression Models Predicting 10-Year All-Cause Mortality

Variable	All Ages		Younger Adults†		Older Adults	
	OR	p-Value	OR	p-Value	OR	p-Value
Age (per year)	1.05*	<0.01*	1.07	0.36	1.05*	<0.01*
Need for admission	1.77*	0.02*	10.83	0.02*	1.52	0.12
Mental illness						
Anxiety disorder	1.38	0.20	3.22	0.03*	1.08	0.77
Major depression	1.62*	0.05*	2.82	0.06	1.36	0.26
Panic disorder	2.41*	<0.01*	0.90	0.92	2.47*	<0.01*
PTSD	1.46	0.12	0.96	0.94	1.51	0.13
Any mental illness	1.57	0.09	2.01	0.25	1.42	0.24
Substance abuse						
Alcohol disorder	1.85*	0.01*	4.01*	0.01*	1.44	0.18
Illicit drug abuse	1.12	0.64	2.70	0.14	0.98	0.95
Any substance abuse	1.58	0.11	–	–	1.18	0.60
Poverty						
Unemployment	3.04*	<0.01*	5.61*	0.03*	2.51*	<0.01*
Homelessness	2.07*	<0.01*	1.61	0.49	1.78*	0.04*
Any marker of poverty	3.14*	<0.01*	4.89*	0.04*	2.36*	0.03*

OR = odds ratio; PTSD = posttraumatic stress disorder.

* These values highlight correlations that reached statistical significance.

† Among younger adults, there were no deaths among those with no form of substance abuse at the time of injury.

they coexist, resulting in especially high mortality rates. As with the classic lethal triad, recognizing the components of this “lethal triad” early in care may help providers to initiate targeted life-saving interventions.

This study highlights the high prevalence of mental illness, substance abuse, and poverty among adult victims of violent injury, among younger and older age groups. It also supports the premise that violent victimization is often a marker of overall poor psychosocial well-being. In our cohort, the 10-year mortality rate among subjects over age 30 years was twice as high as that of younger subjects. Although increased age itself contributes to increased mortality, after adjusting for age-based expected mortality using NVSR data, we still found 66% more excess deaths among victims of violent injury over age 30 compared with their younger counterparts, suggesting that victims of violent injury over age 30 constitute a highly vulnerable population. We identified key differences in the specific risk factors associated with long-term mortality among younger and older subjects.

Relationship to Previous Studies

Previous studies have identified mental illness, substance abuse, and poverty as risk factors for violent injury and violent injury recidivism. Cooper et al. identified poverty, unemployment, and drug and alcohol abuse as key risk factors (4). McCoy et al. found high rates of recidivism among trauma patients with violent injuries, mental illness, unemployment, and alcohol and drug use (17). Poole et al. found that victims of intentional trauma

were more likely than victims of unintentional trauma or other surgical patients to use alcohol or illicit drugs, be unemployed, and to meet diagnostic criteria for psychopathology; however, the impact of these risk factors on long-term mortality among victims of violent injury has not been well studied previously (18).

Hospital-based violence intervention programs that address these risk factors are effective in reducing the frequency of recurrent violent injuries in adolescents and young adults. For example, victims of violent injury enrolled in the Wraparound Project at San Francisco General Hospital had a fourfold decrease in the violent injury recidivism rate of a cohort of historical controls (7). Victims of violent injury randomized to participate in the Violence Intervention Program at the R. Adams Cowley Shock Trauma Center in Baltimore were six times less likely to be hospitalized for recurrent violent injuries compared with controls (19). Several cost-effectiveness analyses have demonstrated that HVIPs save money by averting future injuries (20–22). These programs cater specifically to younger victims of violent injury, and little research has been done about the effectiveness or cost-effectiveness of HVIPs among older victims.

Although there are some differences in specific risk factors in this older cohort, and they may require different risk-reduction interventions, there is evidence that ED- and hospital-based programs can be effective among older victims of violent injury. In a cohort of trauma patients, Gentilello et al. found that hospital-based alcohol interventions were associated with reduced alcohol intake and a nearly 50% reduction in injury recidivism at 1 year

(23). We have shown that older victims of violent injury can be successfully recruited into comprehensive psychosocial services through the ED at SFGH (13). These “teachable moments” in the aftermath of violent injury may provide the ideal opportunity to reach out to these vulnerable, socially marginalized patients (24).

Limitations

This study has several limitations. Important subgroups including patients with acute psychosis and non-English speakers were excluded from the original trial from which this study was developed. This exclusion occurred due to the retrospective nature of this study, nested within a randomized controlled trial with different research objectives. Previous studies have shown increased rates of poor health outcomes among non-English speakers and patients with psychosis, but further research addressing mortality after violent injury and risk factor modification in these groups is needed (25,26). In particular, excluding suicidal and acutely psychotic patients likely resulted in an underestimation of the impact of mental illness on the long-term mortality of victims of violent injury. These especially vulnerable populations may still benefit from targeted risk-reduction interventions, and should be included in future prospective studies when possible. In addition, we were unable to distinguish injury-related deaths in this cohort. Finally, our relatively low sample size may have resulted in a study that was underpowered to discern some of the smaller but potentially important associations and interactions upon subgroup and multivariable analysis. Despite these limitations, this analysis is important in drawing attention to a socially and medically vulnerable population of ED patients who have a very high burden of premature mortality.

CONCLUSIONS

Victims of violent injury presenting to the ED have significantly increased risk for long-term mortality compared with the general population, and those over 30 years of age constitute a previously undescribed subgroup who may benefit from targeted risk-reduction interventions. Mental illness, substance abuse, and poverty compose another “lethal triad” of risk factors associated with long-term mortality in both younger and older victims of violent injury, although some differences in risk factors exist between age groups.

ED visits offer an invaluable opportunity to engage not only younger victims of violent injury, but also those over age 30 in risk-reduction interventions. Trauma-informed mental health services, substance abuse counseling, and

employment and housing resources may be effective in attenuating the impact of this “lethal triad” in both victims over age 30 and their younger counterparts. If we hope to improve outcomes in this highly vulnerable population, further research is needed to explore the effectiveness of risk-reduction interventions.

Acknowledgments—The authors appreciate the support of Phuoc Le at the University of California Berkeley School of Public Health, who reviewed an early draft of this manuscript and provided invaluable feedback.

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ARTICLE SUMMARY

1. Why is this topic important?

Victims of violent injury are at high risk for long-term mortality and may benefit from targeted risk-reduction interventions.

2. What does this study attempt to show?

Victims of violent injury over age 30 years have a high prevalence of risk factors for violent injury and a high rate of long-term mortality similar to their younger counterparts.

3. What are the key findings?

Mental illness, substance abuse, and poverty constitute a “lethal triad” of risk factors for violent injury, which are associated with increased long-term mortality. Although they are prevalent among both younger and older victims of violent injury, there are important differences that can help to inform appropriate risk-reduction interventions.

4. How is patient care impacted?

Emergency department visits offer an invaluable opportunity to engage victims of violent injury over age 30 years in targeted risk-reduction interventions.