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Long-term mortality of patients surviving firearm violence

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ABSTRACT

Objective We aim to calculate the 5-year mortality after surviving to hospital discharge after a firearm injury and estimate the association of firearm injury with later mortality.

Methods We performed a retrospective cohort study of patients from an urban emergency department (ED) and trauma centre in Oakland, California, USA, in 2007. We created three cohorts of patients presenting for (1) gunshot wound (GSW), (2) MVC and (3) assault without a firearm. Demographic and clinical information was obtained from the clinical chart, and the California Department of Public Health Vital Statistics and Social Security Death Master File (2007–2012) were queried to identify patients who died.

Results We analysed 516 GSW patients, 992 MVC patients and 695 non-GSW assault patients. Of the GSW patients, 86.4% were alive at 5 years. All-cause 5-year mortality among GSW victims surviving to discharge after injury was 5.1%. Compared with MVC patients, both GSW and non-GSW assault patients have higher risk of death at 5 years (HR 2.54 (95% CI 1.41 to 4.59) and HR 1.64 (95% CI 1.01 to 2.68), respectively), adjusting for age, sex and race. Risk of death was higher in the first year for the GSW cohort (HR 6.14 (95% CI 2.35 to 16.08) and HR 5.06 (95% CI 1.88 to 13.63) as compared with MVC and non-GSW assault cohorts, respectively). Homicide was the cause of death in 79.2% of GSW patients who died after surviving the index injury.

Conclusion Among individuals presenting to the ED after injury or assault and surviving to discharge, firearm injury exposure is an important predictor of death within 5 years and most pronounced in the first year after injury.

INTRODUCTION

Firearm violence is responsible for over 33 000 deaths and 84 000 injuries annually in the USA.[1] The ecology of this mortality and morbidity is heterogeneous, ranging from suicide to intimate partner violence, and criminal activity to perpetration of mass violence. While no setting is immune from this public health issue, urban communities—and by extension, emergency departments (EDs) and hospitals that serve these communities—deal with the health consequences of interpersonal firearm violence at higher rates.[2–5] Some studies suggest that firearm homicide rates among men may be rising in the USA, with the biggest increase among young, urban, black men.[6] Within select communities, this violence may be seen as a recurrent and chronic disease where there is an increased risk of repeat victimisation after initial violent injury.[7–9]

The long-term mortality risk for the survivors of firearm injury is poorly understood,[10] though recent data from inpatient firearm victims suggest that repeat hospitalisation and future death is dramatically higher than for the general population.[11] Better understanding of the course of high-risk patients released from the ED or after hospitalisation following firearm injury will allow healthcare professionals and public health officials to understand such firearm-related trauma. Services aimed at mitigating recidivism and reinjury, such as hospital-based violence intervention programmes, may benefit from better understanding of the period of highest risk for death after discharge from the hospital. Moreover, identification of factors associated with reinjury and later death, as well as opportunities to intervene on such factors, is crucial for developing clinical and public health strategies aimed at secondary prevention.[12]

This study evaluates 5-year mortality after surviving a gunshot wound (GSW) among patients presenting to an urban ED and trauma centre, stratified by yearly increments. We report the effect of being firearm-injured on long-term mortality, including cause of death, as compared with those involved in MVCs and those assaulted where a firearm was not used. We hypothesise that even after surviving firearm injury, later mortality is higher than in other groups. Further, we compare demographic and clinical factors between firearm-injured patients who died and those who did not.

METHODS

Study design and setting

This is a retrospective cohort study of patients presenting to Highland Hospital in 2007. This is the primary county medical centre and only trauma centre in Oakland, California, USA, with an annual ED census of over 90 000 visits, and nearly 3000 trauma activations.

The institutional review boards of Highland Hospital and the University of California, San Francisco, USA, approved this study. The study was also approved by the Committee for the Protection of Human Subjects from the California Office of Statewide Health Planning and Development.

Selection of participants

All patients presenting to the ED at Highland Hospital from 1 January 2007 through 31 December 2007 were eligible for inclusion. We identified three cohorts of patients: (1) patients presenting for care after sustaining a GSW; (2) patients

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presenting for care after involvement in a MVC, including cars and motorcycles, as well as pedestrians struck by a moving vehicle and (3) patients presenting for care after assault without firearm involvement (non-GSW assault). We anticipated that the MVC cohort would have a wide range of injury severity, typically blunt trauma or deceleration injuries, and generally not expected to be related to assault or violent activities. Non-GSW assault victims were included as a comparison cohort in order to adjust for overall victimisation and injury as an exposure while attempting to isolate the effect of firearms on mortality.

Patients were identified using a search of electronic medical records for *International Classification of Diseases, Ninth Revision* (ICD-9) cause of injury codes (E-codes) relating to GSW, assaults and MVC. Only the first, or primary, ICD-9 codes were used. Additionally, the presenting complaint text field of the electronic records was searched to identify subjects who may have been missed through search of ICD-9 codes only. A summary of these search terms are listed in online supplementary material 1.

We excluded individuals from the non-GSW assault cohort if they were a victim of sexual assault and not otherwise physically assaulted. Patients were excluded from GSW, non-GSW assault or MVC cohorts if their presentation was not the initial visit for the injury (ie, it was a follow-up visit). If a patient presented more than once during 2007 with another injury of interest, we included them only in the cohort that corresponded to their initial ED visit in 2007.

Methods of measurement

Key demographic covariate information at the time of the index visit in 2007 for all cohorts was extracted from the electronic medical record into a secure database, including name, social security number (SSN), date of birth, date of visit, sex, race/ethnicity (self-identified), homelessness, mode of arrival to the hospital, whether or not the patient was trauma-activated, triage acuity score (5-Emergency Severity Index scale), disposition from the ED and whether or not the patient died during the index visit. For the GSW cohort, we also collected location of the injury (head/neck, chest, abdomen/pelvis, extremity, multiple locations or other/unknown) as well as insurance status at the time of injury. For the non-GSW assault cohort, we categorised injury types into penetrating (ie, stabbed), blunt assault by person (ie, punched or kicked), blunt strike by object (ie, bottle, 'pistol-whipped', baseball bat, etc) and other (ie, human bite, pepper spray, etc).

For variables not easily or reliably extracted automatically from the electronic records (whether or not trauma-activated, death during index visit, injury location, insurance status and mechanism of injury), three trained investigators performed all data abstraction from electronic and paper charts, as well as from administrative and billing data. Quality of the abstraction process was ensured by primary investigators in four ways: (1) initial training meeting, (2) being available for questions from abstractors, (3) periodic monitoring of the abstraction and (4) and detailed review of the abstraction after 50 records had been entered into the database by each abstractor. Approximately 10% of charts were reviewed in duplicate for quality assessment. Inter-rater agreement was excellent (Cohen's $\kappa=0.92$).

Outcome measures

Our primary outcome was all-cause mortality within 5 years of the index visit in 2007. Death was ascertained through two methods. First, we performed a search of California Department of Public Health Vital Statistics death records. Death records from 2007 to 2012 were queried based on name, sex, date of birth and SSN of included subjects. Death was confirmed through a direct match of SSN or an exact match of first and last name, sex and date of birth. A match was considered when first name, last name and date of birth varied by one or two characters. (eg, 'Steven' vs 'Steve'). These records were then reviewed by an investigator for true matches. For those who died, date and cause of death was collected from the death records. We reported the proportion of deaths due to homicide, suicide, toxicological causes and MVCs. Second, we queried the Death Master File (DMF) from the USA Social Security Administration. Death was confirmed through an exact match on SSN; because of the large number of records in this dataset and potential for false positive matches, we did not match on name. Cause of death was not available in the DMF.

Secondary outcomes relating to healthcare utilisation were ascertained for the GSW cohort including number of hospital days, intensive care unit (ICU) days, inpatient rehabilitation days, number of operative procedures, number of repeat ED visits and number of inpatient hospitalisations. For each unique individual, we counted the number of ED visits prior to their injury (between 2004 and 2007) and after (2007–2012). These data were only collected from Highland Hospital and do not represent care received at other facilities.

Primary data analysis

We reported overall counts and proportions of covariates stratified by our outcome of interest. Continuous data were represented with medians with IQRs and categorical data with proportions with 95% CIs.

We performed a Kaplan–Meier survival analysis to estimate the cumulative incidence of death among patients who survived to hospital discharge after the index visit (as such, anyone who died during the index visit was excluded from this analysis). The risk period started on the date of the index visit in 2007 where patients entered one of the cohorts and ended on the date of death or at 5 years after the index visit, whichever occurred first. The Kaplan–Meier curve reflects the unadjusted results. A multivariable Cox proportional hazards model was used to report HR and 95% CIs for the association of cohort group on death, adjusting for age (in deciles), sex, race and cohort assignment that may be associated with death. Variables were selected for inclusion in the model through maximum likelihood ratio testing; though sex was not found to improve the model, we included it on face validity as an important covariate. Using the Schoenfeld's test, we found a decrease in non-proportional hazards when the overall model was broken down into 1-year intervals (a post-hoc analysis). As such, we report HRs from both the full 5-year model with all three cohorts together (MVC as reference) and yearly interval hazards of death comparing the GSW cohort with the non-GSW assault and MVC cohorts.

We subsequently reported the distribution of covariates among the GSW cohort stratified by outcome (died on index visit, died during 5-year follow-up or presumed alive at 5 years). Causes of death among patients from each cohort who survived the initial index visit but later died were tabulated. Fisher's exact test was used to examine differences between groups.

Missing data were coded as missing, and no values were imputed. Tabulation of missing values was as follows: age (21), race/ethnicity (3), triage acuity (2), mode of arrival (681), insurance status (9) and injury location (2); for all other variables, no data were missing. We considered $p<0.05$ as statistically significant. All statistical analysis was performed using Stata SE (V.11, StataCorp, College Station, Texas, USA).

RESULTS

Our search of medical records identified 520 GSW patients, 743 non-GSW assault patients and 1015 MVC patients. After exclusion criteria were applied, there remained 516 GSW patients, 695 non-GSW assault patients and 992 MVC patients. Demographic and clinical features of the cohorts, as well as the proportion of patients alive at 5 years, can be seen in table 1. The cohorts varied greatly in age, sex, racial composition and injury severity at index visit. The GSW cohort tended to be younger, had a higher percentage of male and minority patients and was more severely injured on index visit evidenced by a higher percentage of operating room (OR)/ICU admissions and deaths during index visit. Among patients who were transported or presented to an ED after firearm injury (including deaths that occurred during the index visit), 86.4% were alive at 5 years. After excluding those who died on the index ED visit or hospitalisation, all-cause 5-year mortality was 5.1% among GSW victims, 5.0% among non-GSW assaults victims and 3.1% among those involved in an MVC.

Mechanism of injury among the 695 non-GSW assault victims was predominantly blunt trauma, including 291 who were physically struck by another individual (ie, punched or kicked) (41.9%) and 161 who were struck by an object (23.2%); 35 victims (5.0%) were struck by both. Only 32 were penetrating, non-firearm, assault victims (4.6%).

Table 1 Characteristics of cohorts

Variable	Cohort		
	GSW n=516	MVC n=992	Non-GSW assault n=695
Age, median (IQR)	23.0 (19.3–30.1)	30.4 (22.2–45.4)	32.7 (23.9–44.7)
Male, n (%)	457 (88.6)	608 (61.3)	477 (68.6)
Race, n (%)			
White, non-Hispanic	15 (2.9)	155 (15.6)	84 (12.1)
Black, non-Hispanic	325 (63.4)	425 (42.8)	328 (47.2)
Hispanic	159 (31.0)	213 (21.5)	182 (26.2)
Other	14 (2.7)	199 (20.1)	101 (14.5)
Homeless, n (%)	11 (2.1)	9 (0.9)	45 (6.5)
Mode of arrival, n (%)			
Ambulance	221 (56.8)	304 (49.9)	273 (52.2)
Walk-in/ambulatory	133 (34.2)	214 (35.1)	231 (44.2)
Transfer/other facility	34 (8.7)	0 (0.0)	0 (0.0)
Law enforcement	1 (0.3)	91 (14.9)	19 (3.6)
Triage acuity, n (%)			
Level 1–2, most urgent	339 (66.0)	397 (40.0)	224 (32.2)
Level 3	144 (28.0)	280 (28.2)	284 (40.9)
Level 4–5, least urgent	31 (6.0)	315 (31.7)	187 (26.9)
ED disposition, n (%)			
Home	239 (46.3)	690 (69.6)	550 (79.1)
Admit, not ICU/OR	85 (16.5)	100 (10.1)	37 (5.3)
Admit, ICU/OR	151 (29.3)	50 (5.0)	20 (2.9)
Other*	11 (2.1)	147 (14.8)	88 (12.7)
Died in ED	30 (5.8)	5 (0.5)	0 (0.0)
Died index visit, n (%)	46 (8.9)	5 (0.5)	1 (0.1)
Alive at 5 years, n (%)	446 (86.4)	956 (96.4)	659 (94.8)

*Other disposition includes patients who left against medical advice, eloped before completion of their visit, were transferred to another facility (including psychiatric facility) or were discharged in the custody of law enforcement.
ED, emergency department; GSW, gunshot wound; ICU, intensive care unit; OR, operating room.

As compared with patients involved in an MVC, both GSW patients and non-GSW assault patients who survived to hospital discharge have higher adjusted risk of death at 5 years (HR 2.54 (95% CI 1.41 to 4.59) and HR 1.64 (95% CI 1.01 to 2.68), respectively), after controlling for age, sex and race. Results of the full 5-year multivariate analysis can be seen in table 2. Risk of death was markedly higher in the first year for the GSW cohort (HR 6.14 (95% CI 2.35 to 16.08) as compared with MVC and HR 5.06 (95% CI 1.88 to 13.63) as compared with non-GSW assault) as shown in table 3 where the risk periods are broken into 1-year intervals. A Kaplan–Meier survival curve can be seen in figure 1.

For GSW patients, there was no statistically significant difference between distribution of demographic factors among those who died on the index visit, those who survived to discharge but ultimately died and those who remained alive at 5 years. Arrival by ambulance, higher triage acuity and likelihood of trauma activation were highest for those who died on the index visit and lowest for those who remained alive during the study period. Among those who died on the index visit, 65% died in the ED. Location of injury was strongly associated with outcome among GSW patients—those shot in the head/neck or chest were more likely to die on the index visit, and those who were alive at 5 years were more likely to be shot in the extremities. Details of the demographic and clinical variables stratified by outcome can be seen in table 4. Overwhelmingly, the cause of death for the GSW cohort patients who died after their initial injury was attributed to homicide (table 5). All 19 of the GSW cohort homicides were firearm-related, as were two of the four non-GSW cohort homicides and both MVC cohort homicides.

The majority of GSW patients had few hospital, ICU and inpatient rehabilitation days, as well as no operative procedures or repeat hospitalisations. However, data were highly skewed with some individuals having significant healthcare use. Usage outcomes among the GSW cohort, including ED use both before and after injury, are reported in online supplementary material 2.

DISCUSSION

Among a population of patients from the primary trauma centre in Oakland, California, those who present as victims of firearm violence have a 14% overall risk of death. When limiting to those who survived the initial ED visit or hospitalisation after

Table 2 Multivariate associations between demographic factors and all-cause 5-year mortality after excluding those died on index visit

Variable	HR (95% CI)
Cohort	
MVC	Reference
GSW	2.54 (1.41 to 4.59)
Non-GSW assault	1.64 (1.01 to 2.68)
Age (per 10-year increase)	1.65 (1.45 to 1.88)
Female	0.74 (0.45 to 1.22)
Race	
White, non-Hispanic	Reference
Black, non-Hispanic	0.82 (0.47 to 1.42)
Hispanic	0.39 (0.18 to 0.84)
Other	0.25 (0.09 to 0.68)

GSW, gunshot wound.

Table 3 Hazard of death comparison between GSW and each MVC and non-GSW assault individually broken into 1-year intervals, controlling for age, sex and race

Cohort Comparison	HR (95% CI) MVC reference	HR (95% CI) Non-GSW assault reference
GSW		
Year 1	6.14 (2.35 to 16.08)	5.06 (1.88 to 13.63)
Year 2	0.44 (0.05 to 3.65)	0.36 (0.04 to 3.07)
Year 3	2.01 (0.33 to 12.38)	0.71 (0.14 to 3.61)
Year 4	2.01 (0.55 to 7.41)	1.05 (0.31 to 3.60)
Year 5	1.13 (0.29 to 4.40)	0.68 (0.18 to 2.59)

GSW, gunshot wound.

injury, both GSW and non-GSW assault victims appear to have an approximate 5% risk of death at 5 years, though those involved in a GSW tend to be younger. After controlling for demographic variables, the point estimates for the hazard of death in the GSW-exposed cohort are higher than in the non-GSW assault group, though this difference is not statistically significant at 5 years. Our adjusted models, however, suggest that both groups have a higher hazard of death at 5 years than those involved in MVCs.

The most pronounced effect of firearm exposure can be seen in the early period after initial injury. Individuals victimised by firearms have a statistically significant fivefold to sixfold higher hazard of death during the first year after discharge as compared with both those injured in MVCs and assaulted individuals where a firearm was not used. Our decision to report yearly hazards of death was driven largely by statistical considerations to improve our model, as well as by visual inspection of our survival curve—the pronounced early mortality in the GSW group was not an a priori considered hypothesis. Nonetheless, these data are consistent with and further corroborate recent reports of dramatically increased long-term mortality among firearm violence victims who were hospitalised as compared with those hospitalised without injury.[11] Our analysis expands the findings by including a population of individuals treated and released in the ED and sheds light on the timing of risk of death after firearm injury. Our findings are likely generalisable to similar urban, hospitals and EDs situated in communities with high rates of violent crime.

It is no surprise that victimisation, with or without firearms, is associated with higher likelihood of later death. Beyond being male, part of a racial minority group and uninsured,

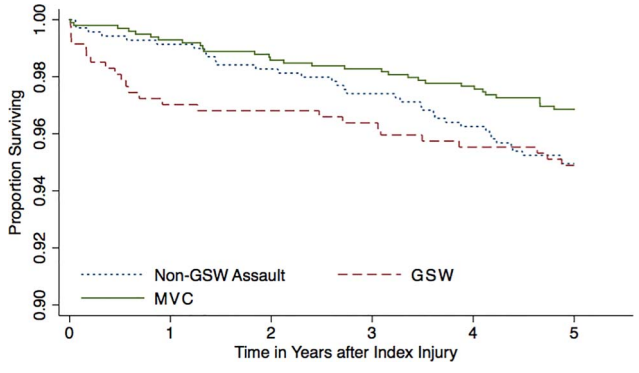

Figure 1 Kaplan–Meier survival curves by cohort after excluding those who died during index visit. GSW, gunshot wound.

violent injury and homicide in this group may be predicted by such factors as being part of high-risk social networks, recidivism, delinquency and drug usage.[8 13–19] However, the risk of death after non-GSW assault appears to be constant, whereas the deaths in the GSW cohort occurred differentially in the early period after discharge. The differing trajectories may reflect a unique property of firearm violence. Beyond the exposures noted above, GSW victims may also experience higher rates of short-term adverse physical and psychological outcomes, including disabilities, declines in functional status and post-traumatic stress disorder or depression.[20 21] Furthermore, these individuals are at higher risk to be reinjured and re-hospitalised (both for injury and non-injury reasons).[11 15] This suggests that the first year may offer an opportunity to alter the life course of these patients, and violence intervention programmes and healthcare practitioners who may treat patients on subsequent encounters, should focus on this early, critical period. Further, as there is an eventual catch-up in overall mortality among the non-GSW assault cohort with the GSW cohort at 5 years, longitudinal interventions should be aimed at all assaulted patients, whether or not a firearm was involved.

It is important not to interpret our findings to suggest that the overall mortality of all assaulted patients is ultimately similar. While our data suggest that 14% of all GSW victims who presented to the ED were dead within 5 years, this is certainly an underestimate of the lethality of firearms used in violent acts. In 2007, estimates of the number of firearm-related homicides in Oakland range from 106 to 114.[22 23] Even if 100% of the deaths in our cohort occurred in 2007, this would only account for 70 firearm homicides, suggesting the efficiency of firearms in killing renders many victims dead on the scene without transport to the hospital.

This study has a number of important limitations. Chief among them is the inevitability of unmeasured confounding. Most specifically, additional covariates relating to socioeconomic status, chronic disease, concomitant alcohol and drug use, and injury severity would improve such an analysis with mortality as the primary outcome. Among GSW victims who survived the initial hospitalisation, the relatively small number of patients who ultimately died precluded us from a multivariate analysis to identify risk factors for death after discharge. Univariate analysis suggests, not surprisingly, that location of injury is associated with later mortality.

We took great care to ensure the fidelity and reliability of datasets; however, we cannot ensure that every death was captured. Data from the California Department of Public Health would not capture deaths from individuals who migrated out of the state during the follow-up period; however, we attempted to capture these through query of national death data from the Social Security Administration DMF. Further, the coding of cause of death within the California state records is based on coroners' reports and death certificates, which may have inaccuracies and inconsistencies.[24] A death coded as a homicide could reflect an immediate death from a firearm injury or could represent a death due late sequelae many years after the GSW. Finally, incomplete matching of records may have occurred in instances where patient SSN was not available in the medical records, California death records or both, though we attempted to mitigate through careful examination of identifying data.

While estimates of healthcare usage suggest that most patients injured by firearms have overall low use, these findings underestimate the burden of injury in two ways. First, we have only

Table 4 Comparison of outcomes among GSW cohort stratified by demographic and clinical variables

Variable	Outcomes			p Value
	Died on index visit n=46	Survived to hospital discharge but died on 5-year follow-up n=24	Alive on 5-year follow-up n=446	
Age (years), n (%)				0.091
<18	5 (10.9)	5 (20.8)	66 (14.8)	
18–24	20 (23.5)	9 (37.5)	198 (44.4)	
25–34	12 (26.1)	6 (25.0)	103 (23.1)	
35–44	2 (4.4)	2 (8.3)	51 (11.4)	
45–64	3 (6.5)	1 (4.2)	24 (5.4)	
>65	4 (8.7)	1 (4.2)	4 (0.9)	
Male, n (%)	41 (89.1)	22 (91.7)	394 (88.4)	1.000
Race, n (%)				0.65
White, non-Hispanic	0 (0.0)	0 (0.0)	15 (3.4)	
Black, non-Hispanic	30 (65.2)	16 (66.7)	279 (63.0)	
Hispanic	13 (28.3)	8 (33.3)	138 (31.2)	
Other	3 (6.5)	0 (0.0)	11 (2.5)	
Insurance status, n (%)				0.105
Private	1 (2.3)	1 (4.2)	33 (7.5)	
Medicare	0 (0.0)	1 (4.2)	4 (0.9)	
Medicaid	2 (4.6)	5 (20.8)	80 (18.3)	
Uninsured	41 (93.2)	17 (70.8)	318 (72.6)	
Other	0 (0.0)	0 (0.0)	3 (0.7)	
Mode of arrival, n (%)				<0.001
Ambulance	34 (94.4)	12 (63.2)	175 (52.4)	
Walk-in/ambulatory	1 (2.8)	4 (21.1)	128 (38.3)	
Transfer/other facility	1 (2.8)	3 (15.8)	30 (9.0)	
Law enforcement	0 (0.0)	0 (0.0)	1 (0.3)	
Triage acuity, n (%)				0.005
Level 1–2, most urgent	42 (91.3)	16 (66.7)	281 (63.3)	
Level 3	4 (8.7)	6 (25.0)	134 (30.2)	
Level 4–5, least urgent	0 (0.0)	2 (8.3)	29 (6.5)	
Trauma activation, n (%)	45 (97.8)	21 (87.5)	347 (77.8)	0.003
ED disposition, n (%)				<0.001
Home	0 (0.0)	11 (45.8)	228 (51.1)	
Admit, not ICU/OR	0 (0.0)	4 (16.7)	81 (18.2)	
Admit, ICU/OR	16 (34.8)	9 (37.5)	126 (28.3)	
Other*	0 (0.0)	0 (0.0)	11 (2.5)	
Died in ED	30 (65.2)	0 (0.0)	0 (0.0)	
Injury location, n (%)				<0.001
Head/neck	15 (33.3)	6 (25.0)	40 (9.0)	
Chest	18 (40.0)	2 (8.3)	41 (9.2)	
Abdomen/pelvis	3 (6.7)	0 (0.0)	65 (14.6)	
Extremity	1 (2.2)	7 (29.2)	204 (45.8)	
Multiple locations	8 (17.8)	9 (37.5)	95 (21.4)	

*Other disposition includes patients who left against medical advice, eloped before completion of their visit, were transferred to another facility (including psychiatric facility) or were discharged in the custody of law enforcement.
ED, emergency department; GSW, gunshot wound; ICU, intensive care unit; OR, operating room.

measured the impact on a single county healthcare system. Second, some patients may have extremely high use, as evidenced by the upper range of usage. As civilian mortality rates from penetrating injuries have fallen due to advances in trauma care, more patients are living with long-term sequelae of firearm violence.[25] In these patients, the intensity and frequency of care may be especially great.

Our analysis shows that among individuals who present to a trauma centre for care after firearm injury and who do not die on the index visit, the overall 5-year mortality is much higher than for patients injured in MVCs and similar to other assaulted patients. The majority of deaths after firearm injury occur early, with the cause of death mostly firearm-related homicide, suggesting that the first year may be a critical period to alter the life course of these patients. We postulate that factors such as social networks, family support and structure and neighbourhood exposures will also play critically important roles in further defining the trajectory of firearm-injured patients.[13 14 19] Future prospective analyses with more detailed measurement of social, spatial and clinical variables should focus on the first year after firearm injury to identify modifiable factors that influence death after injury.

Table 5 Comparison of causes of death between patients who died from within each cohort and those who survived to discharge from index visit

	Cohort		
Outcome	GSW	Non-GSW assault	MVC
Survived index visit, n	470	694	987
Died on 5-year follow-up, n (%)	24	35	31
Death captured in CA records, n*	24	34	28
Homicide, n (%)†	19 (79.2)‡	4 (11.8)	2 (7.1)
Suicide, n (%)†	1 (4.2)	1 (2.9)	0 (0)
Toxicologic-related, n (%)†	0 (0)	6 (17.6)	2 (7.1)
Motor vehicle-related, n (%)†	0 (0)	1 (2.9)	3 (10.7)

*Cause of death only available in deaths identified through California Department of Public Health Vital Statistics (not in Social Security Administration Death Master File).
†Percentage of those who died within each cohort among deaths identified through California Department of Public Health Vital Statistics.
‡All 19 deaths were firearm-related.
GSW, gunshot wound.

What is already known on the subject

Death and injury from firearms is a large public health problem in the USA. There is limited understanding of the long-term mortality after surviving interpersonal violence perpetrated by firearms within urban communities.

What this study adds

This study shows that among those who survive initial injury in a violent, urban community, assault with or without firearms carries a 5% risk of death at 5 years. However, firearm violence as an exposure is strongly associated with death in the first year after injury, and the majority of deaths are attributed to homicide.

Contributors JF, IY and HJA conceived the study. JF, HJA, EL, EA and CDS designed the study. EL, WH-A, EA and CDS collected and managed the data. JF and HJA supervised all data collection, including quality control. JF and EL analysed the data. JF, EL and WH-A drafted the manuscript and all authors contributed substantially to its revision. JF takes responsibility for the paper as a whole.

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Competing interests None declared.

Ethics approval Institutional review boards of Highland Hospital and the University of California, San Francisco; the Committee for the Protection of Human Subjects from the California Office of Statewide Health Planning and Development.

Provenance and peer review Not commissioned; externally peer reviewed.

Data sharing statement Additional data cannot be shared from this study in accordance with policies from the California Department of Public Health Vital Statistics.

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Long-term mortality of patients surviving firearm violence

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