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Inpatient rehabilitation utilization following firearm injury: A national trauma quality program analysis

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Abstract

Background: Firearm injury is a common cause of disability in the United States, but there is a lack of research on the use of rehabilitation services after major and disabling firearm injuries. This study analyzed the relationship between firearm mechanism of injury and disposition to inpatient rehabilitation (IPR) after hospitalization for acute traumatic injury using national trauma data.
Objective: We hypothesized that firearm mechanism of injury compared to all other traumatic mechanisms of injury would be associated with decreased likelihood of discharge to IPR after acute hospitalization for trauma.
Design: Retrospective cohort study.
Setting: Data were obtained from the Trauma Quality Program Participant Use file, which includes >700 participating Level I–IV trauma centers.
Participants: Patients evaluated at participating trauma centers within 14 days of traumatic injury.
Exposure: The exposure was mechanism of injury (firearm vs. other trauma).
Main outcome: The main outcome was acute care discharge disposition (IPR vs. other).
Results: Among patients who were alive at hospital discharge ($n = 1{,}010{,}113$), individuals with firearm injury were less likely to be discharged to IPR after acute hospitalization compared to individuals with other causes of trauma (6.5% vs. 11.4%, likelihood of discharge to IPR for firearm injury vs. other injury). After adjusting for relevant sociodemographic and injury-related factors, the risk ratio (RR) of discharge to IPR was 0.84 (95% CI, 0.80–0.87) for firearm injury versus other mechanism of injury. The association of mechanism of injury with IPR discharge differed by diagnosis ($p < .001$ analysis of variance F-statistic).
Conclusions: Despite a high incidence of disability and core rehabilitation diagnoses after firearm injury, there was a decreased likelihood of discharge to IPR compared to other mechanisms of trauma. Rehabilitation clinicians should consider interventions to improve equitable access to IPR for firearm injury survivors, and further research should investigate the impact of IPR on long-term outcomes in this underserved population.

INTRODUCTION

Firearm injury is a major public health crisis in the United States, resulting in 48,204 deaths in 2022.[1] In comparison to firearm fatalities, much less is known about nonfatal injuries,[2–4] but it is estimated that there are 2–3 nonfatal firearm injuries for each fatal injury.[3–5] Among those who survive firearm injury, there are high rates of functional impairment and disability.[6–9] One study found that 38.7% of firearm injury survivors developed a new functional limitation in an activity of daily living after injury.[7] Firearm injury also results in negative long-term impacts on physical functioning.[6,9] These studies suggest the need for substantial rehabilitation for individuals with firearm injuries. Previous research has also identified rehabilitation as a particular need and priority among survivors of firearm injury.[7,10,11] In particular, the use of inpatient rehabilitation (IPR) after acute hospitalization has been shown to improve functional outcomes among trauma patients,[12,13] but little is known about the access and use of IPR after firearm injury.

Outcomes among survivors of firearm injury are poorly understood, but the limited research in this area has found that firearm injury is associated with poor long-term outcomes, particularly among individuals with more severe or disabling injuries. For example, individuals with spinal cord injury (SCI) due to firearms have decreased educational attainment,[14,15] lower rates of employment,[14] higher rates of poverty,[15,16] and decreased financial independence[16] compared to individuals with other mechanisms of SCI. Traumatic brain injury (TBI) due to firearms is associated with frequent acute and chronic complications, including infections, posttraumatic epilepsy, mood disorders, and behavioral disturbances.[17] Lack of access to rehabilitation services in both inpatient and outpatient settings may contribute to these poor outcomes,[18] but there is a lack of research on the relationship between use of rehabilitation services and long-term outcomes. Inadequate access to IPR among marginalized populations may contribute to health disparities.

Improving long-term outcomes after firearm injury requires an understanding of current limitations in access to rehabilitation services, including access to IPR. To address this knowledge gap, we compared the use of IPR after firearm injury to other mechanisms of traumatic injury to determine the relationship between firearm mechanism of injury and access and utilization of IPR.

METHODS

This was a retrospective cohort study using data from the American College of Surgeons Trauma Quality Programs (TQP) data, which contains deidentified patient records from >700 participating Level I–V and undesignated trauma centers. It represents the largest source of aggregated trauma records and is an expansion of the prior National Trauma Database. Data are collected in accord with the National Trauma Data Standard (NTDS).[19] Data extracted from the TQP Participant Use File (PUF) included sociodemographic factors, details of emergency department (ED) and hospital course, injury and clinical details, hospital disposition, mechanism of injury, and intent of injury. The study used all encounters in the TQP PUF in 2022. Use of the TQP PUF for this study was approved by the American College of Surgeons TQP, and the study was determined to not involve human participants by the University of Washington institutional review board.

The main exposure of interest was the mechanism of injury. Mechanism of injury was categorized as firearm versus other. Intent of injury was classified as assault, self-inflicted, unintentional, undetermined, or other. Other intent injuries include injuries incurred due to legal intervention and injuries due to military/war operations, according to *International Classification of Diseases, Tenth Revision* (ICD-10) classifications.

The main outcome of interest was discharge to IPR compared to all other dispositions. Hospital disposition was transformed into a binary variable indicating disposition to an IPR facility or unit versus all other dispositions. An IPR facility (IRF) is a stand-alone facility that provides IPR services, and an IPR unit is a designated unit within a hospital that provides IPR services.

We included sociodemographic and clinical covariates. Sociodemographic covariates included age (treated as a continuous variable, years), gender (male, female, nonbinary), insurance (commercial/private, Medicaid, Medicare, none/self-pay, other), race (White, Black, American Indian, Asian, Pacific Islander, Other), and ethnicity (Hispanic vs. non-Hispanic). Clinical covariates included Injury Severity Score (ISS: 0–8, 9–15, 16–24, 25–74), hospital length of stay (LOS: days), requirement for intensive care unit (ICU) admission (yes/no), and requirement for mechanical ventilation (yes/no). Core rehabilitation diagnoses were defined in accord with the Centers for Medicare and Medicaid (CMS) guidance,[20] which requires that 60% of patients admitted to an IPR facility or unit over the course of a year have 1 of 13 core rehabilitation diagnoses. We used the ICD-10 codes in the CMS Presumptive Payment System diagnosis list[21] to identify these core rehabilitation diagnoses as specified for each patient in the TQP PUF. Among all patients admitted to IPR, including both firearm and other mechanisms of injury, >80% had a diagnosis of SCI, TBI, or major orthopedic trauma. Therefore, in further statistical analyses, we categorized patients as having a core rehabilitation diagnosis of SCI, TBI, major orthopedic injury, or other (none of the three primary categories). Major orthopedic injury was defined in accordance with CMS criteria as hip fracture, femur fracture, pelvic fracture, or major multiple fractures. CMS criteria define major multiple fractures

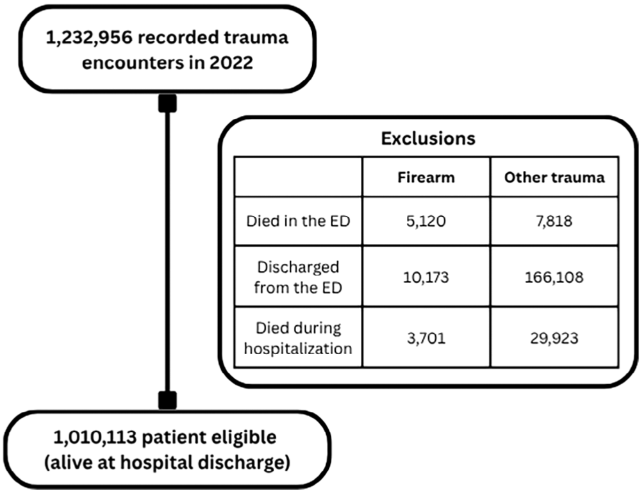

FIGURE 1 Flow diagram demonstrating study inclusion and exclusion criteria. ED, emergency department.

as any of the following: (1) bilateral lower extremity fractures, (2) lower extremity facture and upper extremity fracture, or (3) lower extremity fracture and rib/sternum fracture. Patients were classified as having a primary diagnosis of major orthopedic trauma only if they did not also have a diagnosis of significant neurologic trauma (SCI or TBI).

Descriptive statistics

We first characterized all patients in the TQP PUF in 2022 ($n = 1{,}232{,}956$) to provide baseline information, including incidence of firearm versus other mechanism of injury, mortality by mechanism of injury, and baseline demographics and clinical characteristics of the entire sample. Because only patients admitted to the hospital and alive at the time of hospital discharge could potentially discharge to IPR, we defined these patients as a specific cohort eligible for IPR ($n = 1{,}010{,}113$, see Figure 1 for study flow diagram). Descriptive statistics for both the total TQP PUF sample and the sample of patients eligible for IPR are also shown in Table 1.

Regression analysis

For assessment of disposition to IPR, we included only the sample of patients eligible for discharge to IPR in the regression analysis (those who were admitted to the hospital and alive on hospital discharge). Patients who discharged from the ED or who died during hospitalization were excluded from these analyses. Patients with missing values among the variables of interest (outcome, exposure, or covariates) were excluded from the regression analysis. This included all patients <1 year of age and > 89 years of age, whose ages are excluded from the database to ensure deidentification. Missing data were minimal (<5% per variable) and were handled using complete-case analysis.[22] To evaluate the association between of firearm mechanism of injury and likelihood of discharge to IPR, we used multivariable modified Poisson regression modeling with robust standard error. To examine whether the association between mechanism of injury and discharge IPR differed by diagnosis category, we fit a regression model that included an interaction term between mechanism of injury and diagnosis group. Risk ratios and risk differences were calculated using marginal effects.[23] A significance threshold of .05 was used, and 95% confidence intervals (CI) are displayed. All statistical analyses were performed using R version 4.4.2.

RESULTS

Among all 1,232,956 total trauma encounters at reporting institutions in 2022, there were 58,489 (4.7% of total) firearm injuries. Most firearm injuries in this sample were due to assault ($n = 41{,}018$, 70.1%). In comparison, there were 8668 unintentional injuries (14.8%), and 4300 self-inflicted injuries (7.4%). In addition, there were 3751 injuries with undetermined intent (6.4%) and 752 other intent injuries (1.3%).

Patients with firearm injuries differed from patients with other injury mechanisms in both demographic and clinical characteristics. Demographic differences (Table 1) included younger age (31.2 ± 14.1 vs. 52.2 ± 24.8 years), wider gender gap (85.6% vs. 56.8% male), higher percentage of Medicaid as a primary payor (41.7% vs. 16.4%), and higher percentage of patients with Black race (54.3% vs. 11.9%) and Hispanic ethnicity (15.3% vs. 12.4%) among patients with firearm injuries compared to other mechanisms of injury. Clinical differences (Table 2) included greater severity of injury based on ISS (12.1 ± 12.1 vs. 9.1 ± 7.8), inpatient LOS (8.3 ± 12.3 vs. 6.6 ± 8.7 days), need for mechanical ventilation (23.3% vs. 7.5%), and need for ICU admission (31.7% vs. 27.8%). Although firearm injury severity was greater, there was also greater variability in firearm injury severity, as evidenced by larger standard deviations in ISS and LOS. This heterogeneity in injury severity is also demonstrated by both higher mortality (ED mortality: 8.8% vs. 0.7% and hospital mortality: 8.6% vs. 3.0%) and higher proportion of direct discharge from the ED to the community (14.8% vs. 10.6%), among patients with firearm injuries compared to other mechanisms of injury. Given the higher incidence of both ED mortality and ED to community discharge, patients with firearm injury were less likely to be admitted to the hospital compared to other patients with other trauma (73.9% vs. 85.2%).

Among patients who were alive at hospital discharge ($n = 1{,}010{,}113$), the overall likelihood of discharge to IPR

TABLE 1 Comparison of baseline characteristics of patient sample by mechanism of injury (firearm vs. other) and disposition (IPR vs. other).

	All patients		Patients eligible for IPR		Patients discharged to IPR	
	Firearm injuries (n = 58,489)	**Other traumatic injuries (n = 1,174,467)**	**Firearm injuries (n = 39,495)**	**Other traumatic injuries (n = 970,618)**	**Firearm injuries (n = 2592)**	**Other traumatic injuries (n = 111,124)**
Age (y)	*n* (%)	*n* (%)	*n* (%)	*n* (%)	*n* (%)	*n* (%)
1–14	2197 (3.8%)	91,823 (7.8%)	476 (1.2%)	38,691 (4.0%)	33 (1.3%)	411 (0.4%)
15–24	20,246 (34.6%)	103,772 (8.8%)	901 (2.3%)	22,141 (2.3%)	59 (2.3%)	439 (0.4%)
25–34	16,713 (28.6%)	116,715 (9.9%)	13,923 (35.3%)	78,534 (8.1%)	902 (34.8%)	5276 (4.7%)
35–44	9853 (16.8%)	106,349 (9.1%)	11,472 (29.0%)	91,153 (9.4%)	719 (27.7%)	6054 (5.4%)
45–54	4699 (8.0%)	101,254 (8.6%)	6750 (17.1%)	85,306 (8.8%)	426 (16.4%)	5909 (5.3%)
55–64	2716 (4.6%)	142,184 (12.1%)	3171 (8.0%)	83,631 (8.6%)	200 (7.7%)	7318 (6.6%)
65–89	1806 (3.1%)	429,591 (36.6%)	2716 (6.9%)	499,289 (51.4%)	248 (9.6%)	75,917 (68.3%)
Gender						
Male	50,086 (85.6%)	666,637 (56.8%)	33,848 (85.7%)	536,203 (55.2%)	2152 (83.0%)	53,952 (48.6%)
Female	8258 (14.1%)	506,540 (43.1%)	5560 (14.1%)	433,517 (44.7%)	436 (16.8%)	57,083 (51.4%)
Nonbinary	23 (0.0%)	362 (0.0%)	15 (0.0%)	285 (0.3%)	4 (0.2%)	28 (0.0%)
Race						
White	18,262 (31.2%)	876,723 (74.6%)	11,940 (30.2%)	733,709 (75.6%)	773 (29.8%)	90,291 (81.3%)
Black	31,780 (54.3%)	139,582 (11.9%)	21,853 (55.3%)	109,737 (11.3%)	1460 (56.3%)	10,148 (9.1%)
American Indian	587 (1.0%)	10,545 (0.9%)	437 (1.1%)	8355 (0.9%)	32 (1.2%)	733 (0.7%)
Pacific Islander	154 (0.3%)	3353 (0.3%)	110 (0.3%)	2760 (0.3%)	10 (0.4%)	216 (0.2%)
Asian	430 (0.7%)	29,212 (2.5%)	300 (0.8%)	24,629 (2.5%)	26 (1.0%)	2612 (2.4%)
Other	5426 (9.3%)	94,792 (8.1%)	3809 (9.6%)	75,587 (7.8%)	213 (8.2%)	5721 (5.1%)
Ethnicity						
Hispanic	8928 (15.3%)	146,034 (12.4%)	6207 (15.7%)	115,812 (11.9%)	370 (14.3%)	7817 (7.0%)
Non-Hispanic	46,502 (79.5%)	987,793 (84.1%)	31,537 (79.9%)	822,676 (84.8%)	2074 (80.0%)	99,820 (89.8%)
Primary insurance						
Medicaid	24,411 (41.7%)	193,141 (16.4%)	18,045 (45.7%)	150,889 (15.5%)	1333 (51.4%)	9866 (8.9%)
None/self-pay	15,131 (25.9%)	96,676 (8.2%)	8539 (21.6%)	71,001 (7.3%)	266 (10.3%)	2458 (2.2%)
Commercial	11,808 (20.2%)	366,100 (31.2%)	8298 (21.0%)	296,978 (30.6%)	638 (24.6%)	30,256 (27.2%)
Medicare	2481 (4.2%)	434,792 (37.0%)	1596 (4.0%)	385,322 (39.7%)	145 (5.6%)	62,625 (56.4%)
Other	2983 (5.1%)	63,226 (5.4%)	2029 (5.1%)	50,187 (5.2%)	148 (5.7%)	4331 (3.9%)
Intent of injury						
Assault	41,018 (70.1%)	61,201 (5.2%)	28,801 (72.9%)	44,949 (4.6%)	2029 (78.3%)	1047 (0.9%)
Self-inflicted	4300 (7.4%)	9822 (0.8%)	1606 (4.1%)	7848 (0.8%)	177 (6.8%)	263 (0.2%)
Unintentional	8668 (14.8%)	1,082,600 (92.2%)	6228 (15.8%)	901,915 (92.9%)	214 (8.3%)	108,507 (97.6%)
Undetermined	3751 (6.4%)	1951 (0.2%)	2366 (6.0%)	1415 (0.1%)	129 (5.0%)	61 (0.1%)
Other	752 (1.3%)	572 (0.0%)	494 (1.3%)	438 (0.0%)	43 (1.7%)	10 (0.0%)

Abbreviation: IPR, inpatient rehabilitation.

was 11.3%, similar to prior studies.[13,24] Individuals with firearm injury were less likely to be discharged to IPR after acute hospitalization compared to individuals with other causes of trauma (6.5% vs. 11.4%, likelihood of discharge to IPR for firearm injury vs. other injury, adjusted RR 0.84 [95% CI, 0.80–0.87], Table 3). Differences between patients with firearm injuries and patients with other mechanisms of injury included younger age (31.8 ± 14.8 vs. 64.5 ± 19.8 years), male predominance (83.0% vs. 48.6%), Medicaid insurance as the primary payor (51.4% vs. 8.9%), and Black race (56.3% vs. 9.1%) or Hispanic ethnicity (14.3% vs. 7.0%, see Table 1). Additionally, patients with firearm injuries were more severely injured compared to other IPR patients, with a higher overall ISS (22.0 ± 11.4 vs. 12.6 ± 8.8), longer total hospital LOS (22.3 ± 19.3 vs. 10.7 ± 10.9 days), and higher incidence of mechanical ventilation (23.3% vs. 7.5%) and ICU admission (31.7% vs. 21.8%, Table 2).

Major orthopedic trauma, SCI, and TBI accounted for the majority of IPR discharges from acute care after

TABLE 2 Comparison of clinical characteristics of patient sample by mechanism of injury (firearm vs. other) and disposition (IPR vs. other).

	All patients		**Patients eligible for IPR**		**Patients discharged to IPR**	
	Firearm injuries (*n* = 58,489)	**Other traumatic injuries (*n* = 1,174,467)**	**Firearm injuries (*n* = 39,495)**	**Other traumatic injuries (*n* = 970,618)**	**Firearm injuries (*n* = 2592)**	**Other traumatic injuries (*n* = 111,124)**
Injury severity (ISS)	*n* (%)	*n* (%)	*n* (%)	*n* (%)	*n* (%)	*n* (%)
0–8	23,116 (39.5%)	559,825 (47.7%)	13,483 (34.1%)	422,272 (43.5%)	129 (5.0%)	26,337 (23.7%)
9–15	18,138 (31.0%)	434,533 (37.0%)	16,068 (40.6%)	400,654 (41.3%)	678 (26.2%)	54,097 (48.7%)
16–24	7067 (12.1%)	107,795 (9.2%)	5509 (13.9%)	96,576 (9.9%)	580 (22.4%)	17,608 (15.8%)
25–75	10,105 (17.3%)	69,136 (5.9%)	4430 (11.2%)	49,545 (5.1%)	1205 (46.5%)	13,016 (11.7%)
ICU admission	*n* (%)	*n* (%)	*n* (%)	*n* (%)	n (%)	*n* (%)
Yes	18,528 (31.7%)	255,931 (21.8%)	15,674 (39.7%)	231,030 (23.8%)	2108 (81.3%)	41,700 (37.5%)
Mechanical ventilation	*n* (%)	*n* (%)	*n* (%)	*n* (%)	*n* (%)	*n* (%)
Yes	13,651 (23.3%)	88,351 (7.5%)	8958 (22.7%)	63,301 (6.5%)	1449 (55.9%)	14,905 (13.4%)
Length of stay	**Mean ± SD**		**Mean ± SD**		**Mean ± SD**	
Days	8.3 ± 12.3	6.6 ± 8.7	8.7 ± 12.5	6.5 ± 8.6	22.3 ± 19.3	10.7 ± 10.9

Abbreviations: ICU, intensive care unit; IPR, inpatient rehabilitation; ISS, Injury Severity Score.

both firearm injury and other mechanisms of injury (81.6% firearm injury and 85.1% other trauma). The distribution of SCI, TBI, and orthopedic diagnoses among patients discharged to IPR was significantly different ($p < .001$, χ^2 test) according to mechanism of injury (See Figure 2). SCI was much more common among patients discharged to IPR after firearm injury compared to patients with other mechanisms of injury (28.8% vs. 6.0%) and major orthopedic trauma was much less common (29.7% vs. 56.4%). In our regression model including an interaction term for the combined effect of mechanism of injury and diagnosis category, we found that the association between firearm mechanism of injury and discharge to IPR differed by diagnosis ($p < .001$, analysis of variance F statistic). Among patients with SCI or TBI, firearm mechanism of injury was associated with a higher likelihood of discharge to IPR versus other mechanism of injury (RR 1.97 [95% CI, 1.82–2.14] for SCI; 1.63 [95% CI, 1.49–1.78] RR for TBI). In contrast, firearm mechanism of injury in patients with major orthopedic trauma or other diagnoses was associated with a decreased likelihood of discharge to IPR versus other mechanisms of injury (RR 0.61 [95% CI, 0.57–0.66] for major orthopedic trauma; 0.51 [95% CI, 0.47–0.56] for other diagnoses). Details of these analyses are shown in Table 4.

In both the models (with and without interaction), other factors associated with discharge to IPR included more severe injury (as measured by ISS, need for ICU admission, and need for mechanical ventilation), older age, and Medicare or private/commercial insurance. Medicaid insurance and lack of insurance/self-pay status were negatively associated with discharge to IPR. Documentation of racial category of Asian or Pacific Islander was associated with decreased likelihood of discharge to IPR, but there was minimal associations between other racial categories and IPR discharge. Hispanic ethnicity was negatively associated with IPR discharge.

DISCUSSION

To our knowledge, this is the first study to directly evaluate the relationship between firearm injury and use of IPR. We found that patients were less likely to discharge to IPR after firearm injury than after other types of traumatic injury; however, the likelihood of discharge to IPR after firearm injury varied by rehabilitation diagnosis. Patients with SCI or TBI were more likely to discharge to IPR after firearm injury than after other mechanism of injury. In contrast, patients with major orthopedic trauma or without one of these three diagnoses were much less likely to discharge to IPR after firearm trauma in comparison to patients with other mechanisms of injury. Given that major orthopedic trauma was the most common diagnosis in overall incidence and as an indication for IPR, the disparity in the overall likelihood of discharge to IPR between individuals with firearm injury versus other mechanisms of trauma was likely driven by trends in the major orthopedic trauma population. Further research is needed to understand the reasons for disparities in access to IPR and the impact on long-term outcomes among individuals with firearm injury.

The association between firearm injury and discharge to IPR was strongest in the SCI diagnosis group. This may be due to a higher incidence of complete versus incomplete SCI after firearm injury, which has been noted in multiple studies.[25,26] Complete SCI more definitively necessitates acute or intensive rehabilitation while incomplete injuries, which often occur with other injury

TABLE 3 Factors associated with discharge from acute hospitalization for trauma to inpatient rehabilitation among all eligible patients.

	Risk ratio	Risk difference
	RR [95% CI]	**RD [95% CI]**
Firearm mechanism		
No	1.00 reference	0.00 reference
Yes	0.84 [0.80–0.87]	−1.84% [−2.22%, −1.46%]
Age		
+ 1 y	1.02 [1.02–1.02]	1.82% [1.77%, 1.87%]
Gender		
Male	1.00 Reference	0.00 Reference
Female	1.17 [1.15–1.18]	1.72% [1.58%, 1.85%]
Nonbinary	1.04 [0.71–1.53]	0.42% [−3.76%, 4.59%]
Race		
White	1.00 Reference	0.00 Reference
American Indian	0.96 [0.90–1.03]	−0.41% [−1.18%, 0.36%]
Asian	0.85 [0.82–0.88]	−1.68% [−2.04%, −1.13%]
Black	1.03 [1.01–1.05]	0.30% [0.07%, 0.54%]
Multiple race	1.05 [0.94–1.18]	0.60% [−0.89%, 2.10%]
Other race	0.97 [0.94–1.00]	−0.38% [−0.71%, −0.05%]
Pacific Islander	0.81 [0.70–0.93]	−2.14% [−3.39%, −0.90%]
Unknown race	0.89 [0.83–0.96]	−1.21% [−1.94%, −0.48%]
Ethnicity		
Non-Hispanic	1.00 Reference	0.00 Reference
Hispanic	0.82 [0.80–0.84]	−2.08% [−2.32%, −1.84%]
Insurance		
Commercial	1.00 Reference	0.00 Reference
Medicaid	0.78 [0.76–0.80]	−2.60% [−2.82%, −2.39%]
None/self-pay	0.40 [0.38–0.41]	−7.08% [−7.30%, −6.86%]
Medicare	1.05 [1.03–1.07]	0.58% [0.39%, 0.78%]
Other	0.83 [0.80–0.85]	−2.03% [−2.36%, −1.70%]
Injury severity (ISS)		
0–8	1.00 Reference	0.00 Reference
9–15	1.81 [1.78–1.84]	5.41% [5.27%, 5.54%]
16–24	2.51 [2.46–2.56]	10.06% [9.80%, 10.33%]
25–75	3.11 [3.03–3.19]	14.07% [13.66%, 14.48%]
ICU admission		
No	1.00 Reference	0.00 Reference
Yes	1.26 [1.24–1.28]	2.64% [2.46%, 2.81%]
Mechanical ventilation		
No	1.00 Reference	0.00 Reference
Yes	1.40 [1.37–1.43]	4.29% [3.98%, 4.61%]
Length of stay		
+1 day	1.01 [1.01–1.01]	0.13% [0.12%, 0.13%]

Note: Risk ratio, risk difference, and confidence intervals were calculated using marginal effects.
Abbreviations: CI, confidence interval; ICU, intensive care unit; IPR, inpatient rehabilitation; ISS, Injury Severity Score; RD, risk difference; RR, risk ratio.

mechanisms, may not require the same intensity of rehabilitation. Because most ICD-10 codes used to identify SCI do not specify completeness of injury, we were unable to determine the relationship between completeness of injury, mechanism of injury, and IPR discharge. This limitation highlights the lack of SCI-specific information in trauma registries and the need for integration of rehabilitation data into trauma data. Similar factors may affect the relationship between mechanism of injury and discharge to IPR in the TBI population. TBI resulting from firearm injury is mechanistically distinct from blunt TBI. Firearm-related TBI has a high risk of cerebrovascular injury, which may result in greater secondary injury and neurologic deficits,[27,28] and potentially a higher need for IPR.

The factors other than mechanism of injury most associated with discharge to IPR across the sample population included older age, more severe injury, and favorable payor source (Medicare or commercial vs. Medicaid or no insurance). More severe injury and older age are likely associated with overall clinical indication for IPR. Patients with more severe injuries are likely to have more deficits and functional impairments at the time of discharge requiring intensive rehabilitaiton,[12] and older patients require increased rehabilitation to return to their prior functional status compared to younger patients.[29] Insurance type or lack of insurance may be considered by both acute and postacute care facilities in determining disposition due to financial and administrative considerations. Increased likelihood of discharge to IPR with Medicare insurance is likely related both to the age of beneficiaries and administrative policies, including no requirement for prior authorization for IPR for traditional Medicare beneficiaries. Additionally, the relationship between age and likelihood of discharge to IPR may explain the fairly high proportion of women in the overall population discharged to IPR, as traumatic injuries among women typically occur at an older age compared to men.[30]

Race as categorized by the NTDS was used as a proxy for the overall effects of the structural and individualized racism, which underlie both exposure to firearm violence[31] and disparities in health care access.[32] In this study, there was a significant negative association with IPR admission for Asian and Pacific Islander groups compared to the reference category of White. There is a lack of research on use of IPR among Asian American and Pacific Islander populations, and the racial category of Asian as used in databases obscures health disparities and creates challenges for public health and health equity researchers.[33] Recent research has demonstrated unique patterns of violence and firearm injury and death among Asian Americans, particularly with the rise in anti-Asian racism surrounding the COVID-19 pandemic,[34–36] which may affect the results of this study. It is also notable that there was not a disparity in discharge to IPR in Black compared to White patients in this study, despite extensive prior evidence of such disparities.[37–42] Black compared to White racial categorization in our study was associated with a very small increase in likelihood of IPR discharge. In contrast to Black as a racial category, Hispanic ethnicity was

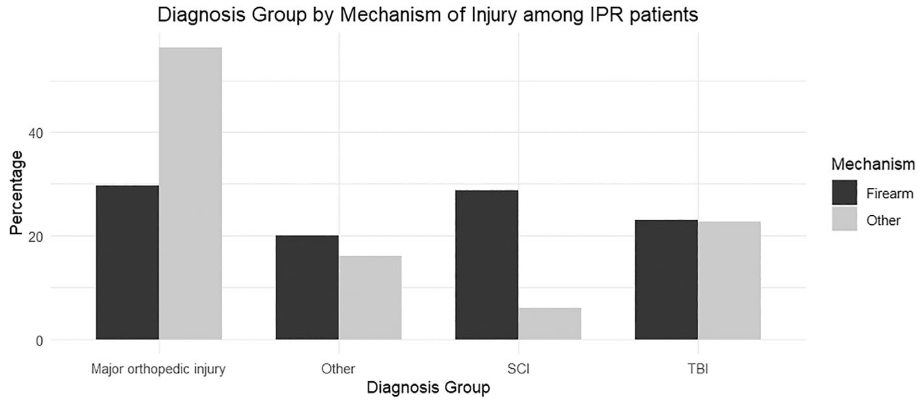

FIGURE 2 Diagnoses by mechanism of injury among inpatient rehabilitation (IPR) patients. Each bar shows the percentage of patients admitted to IPR with each diagnosis out of the total number of patients admitted to IPR within each mechanism. SCI, spinal cord injury; TBI, traumatic brain injury.

TABLE 4 Association of firearm mechanism of injury with discharge to inpatient rehabilitation by diagnostic group in the interaction model.

	Major orthopedic injury ($n = 472,233$; 46.8%)		Spinal cord injury ($n = 20,207$; 2.0%)		Traumatic brain injury ($n = 185,556$; 18.0%)		Other diagnosis ($n = 335,529$; 33.2%)	
Risk ratio: Firearm vs. other mechanism of injury								
	RR	**CI**	**RR**	**CI**	**RR**	**CI**	**RR**	**CI**
No	1.00	Reference	1.00	Reference	1.00	Reference	1.00	Reference
Yes	0.61	[0.59–0.64]	1.97	[1.89–2.05]	1.63	[1.56–1.70]	0.51	[0.49–0.53]
Risk difference: Firearm vs. other mechanism of injury								
	RD	**CI**	**RD**	**CI**	**RD**	**CI**	**RD**	**CI**
No	0%	Reference	0%	Reference	0%	Reference	0%	Reference
Yes	−5.19%	−5.53%, −4.85%	34.4%	31.6%, 37.6%	8.71%	7.80%, 9.61%	−2.60%	−2.71%, −2.48%

Note: Risk ratio, risk difference, and confidence intervals were calculated using marginal effects.
Abbreviations: CI, confidence interval; RD, risk difference; RR, risk ratio.

negatively associated with IPR discharge in this study. Another recent study also noted attenuation in the negative association of Black race with rehabilitation services when including violence as a cause of injury.[43] These findings suggest that there are likely complex relationships between firearm injury, race, and health disparities, including disparities in access to IPR.

Access to rehabilitation depends on many factors, including availability of services, affordability, and acceptability, as well as other considerations,[44,45] many of which are not captured by variables in the NTDS. These factors may include patient-related factors (such as pain, psychological trauma, participation), family or community-level factors (caregiver support, resources available, home and community accessibility), facility or system level factors (availability of physical medicine and rehabilitation consultation, IPR bed availability/density), and provider-related factors (bias, practice differences, knowledge about IPR and other postacute care options). Firearm and other violence-related injury may result in stigma and bias against patients[43,46] and reduced acceptance by postacute care facilities based on often poorly defined "safety concerns."[18,43] Understanding the mechanisms by which firearm injury directly or indirectly contributes to decreased likelihood of discharge to IPR requires further investigation, including obtaining the perspectives of patients and providers on barriers to IPR for this population.

Given the disparity in access to IPR among firearm injury survivors and the potential impact on long-term outcomes, further research and interventions are needed. Clinicians should be aware of the vulnerability and potential for inequitable care in this population. Targeted interventions to improve access to IPR and other rehabilitation services should be considered. Interventions could include increased integration of rehabilitation services and existing support services for individuals with violence-related injuries, such as hospital-based violence intervention programs, which may improve patient health and social outcomes.[47] Rehabilitation staff report a need for education about the unique needs of firearm injury survivors and available community resources to improve care for this population.[48] Additionally, further research is needed to understand the factors that affect access to IPR, including differences among facilities and potential provider biases, and the impact of access to IPR on long-term outcomes in this population.

LIMITATIONS

This work has several limitations. First, participation in the TQP is voluntary, and participating centers include an overrepresentation of Level I and II trauma centers, compared to Level III–V centers. The TQP data available for this study did not include any facility identification or geographic data; facility and regional factors may also influence discharge to IPR, and future work with different data available should consider further investigation of these effects. Additionally, this work does not address the outcomes of patients with firearm injury following discharge either to rehabilitation or another setting as the TQP PUF dataset does not contain data after acute hospitalization. Further work to understand the outcomes after firearm injury is necessary but is limited by the lack of information in rehabilitation data on firearm injury as a cause of injury. Firearm injury is not an identified comorbidity that is required to be reported by IPR facilities; thus, national rehabilitation databases do not contain reliable accounting of firearm injury. To fully understand outcomes after firearm injury, as well as other types of traumatic injury, integration of outcomes measures, inpatient rehabilitation data, and acute care data is critical.

CONCLUSION

Individuals with firearm injury represent a unique population among trauma survivors. Despite a high incidence of disability after firearm injury, there is a decreased likelihood of discharge to IPR compared to other mechanisms of trauma. The association of discharge to IPR with firearm injury varied by rehabilitation diagnosis, with a positive association in the SCI population but a negative association in the major orthopedic trauma population. Lack of access to IPR may impact long-term functional outcomes and worsen health disparities among disadvantaged populations.

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from American College of Surgeons. Restrictions apply to the availability of these data, which were used under license for this study. Data are available from https://www.facs.org/quality-programs/data-and-registries/acs-nsqip/participant-use-data-file/ with the permission of American College of Surgeons.

DISCLOSURES

The authors have no conflicts of interest to declare.

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REFERENCES

1. Villarreal S, Kim R, Wagner E, Somayaji N, Davis A, Crifasi CK. *Gun Violence in the United States 2022: Examining the Burden among Children and Teens*. Johns Hopkins Center for Gun Violence Solutions, Johns Hopkins Bloomberg School of Public Health; 2024.
2. Hink AB, Bonne S, Levy M, et al. Firearm injury research and epidemiology: a review of the data, their limitations, and how trauma centers can improve firearm injury research. *J Trauma Acute Care Surg*. 2019;87(3):678-689. doi:10.1097/TA.0000000000002330
3. Kaufman EJ, Wiebe DJ, Xiong RA, Morrison CN, Seamon MJ, Delgado MK. Epidemiologic trends in fatal and nonfatal firearm injuries in the US, 2009-2017. *JAMA Intern Med*. 2021;181(2):237-244. doi:10.1001/jamainternmed.2020.6696
4. Kaufman EJ, Song J, Xiong R, Seamon MJ, Delgado MK. Fatal and nonfatal firearm injury rates by race and ethnicity in the United States, 2019 to 2020. *Ann Intern Med*. 2024;177(9):1157-1169. doi:10.7326/M23-2251
5. Annest JL, Mercy JA, Gibson DR, Ryan GW. National estimates of nonfatal firearm-related injuries: beyond the tip of the iceberg. *JAMA*. 1995;273(22):1749-1754. doi:10.1001/jama.1995.03520460031030
6. Vella MA, Warshauer A, Tortorello G, et al. Long-term functional, psychological, emotional, and social outcomes in survivors of firearm injuries. *JAMA Surg*. 2020;155(1):1-9. doi:10.1001/jamasurg.2019.4533
7. Herrera-Escobar JP, De Jager E, McCarty JC, et al. Patient-reported outcomes at 6 to 12 months among survivors of firearm injury in the United States. *Ann Surg*. 2021;274(6):e1247-e1251. doi:10.1097/SLA.0000000000003797
8. Raza S, Thiruchelvam D, Redelmeier DA. Death and long-term disability after gun injury: a cohort analysis. *CMAJ Open*. 2020;8(3):E469-E478. doi:10.9778/cmajo.20190200
9. Greenspan AI, Kellermann AL. Physical and psychological outcomes 8 months after serious gunshot injury. *J Trauma*. 2002;53(4):709-716. doi:10.1097/00005373-200210000-00015
10. Baker NS, Wical W, Ricks TN. Disability and racial justice go hand in hand: a commentary on black men and firearm violence. *Am J Mens Health*. 2024;18(5):15579883241266507. doi:10.1177/15579883241266507
11. Patton D, Sodhi A, Affinati S, Lee J, Crandall M. Post-discharge needs of victims of gun violence in Chicago: a qualitative study. *J Interpers Violence*. 2019;34(1):135-155. doi:10.1177/0886260516669545
12. Nehra D, Nixon ZA, Lengenfelder C, et al. Acute rehabilitation after trauma: does it really matter? *J Am Coll Surg*. 2016;223(6):755-763. doi:10.1016/j.jamcollsurg.2016.09.001
13. Lancaster CW, DiMaggio C, Marshall G, Wall S, Ayoung-Chee P. Functional outcomes after inpatient rehabilitation for trauma—improved but unable to return home. *J Surg Res*. 2018;222:187-194.e3. doi:10.1016/j.jss.2017.09.024
14. Krause JS, Kewman D, DeVivo MJ, et al. Employment after spinal cord injury: an analysis of cases from the model spinal cord injury systems. *Arch Phys Med Rehabil*. 1999;80(11):1492-1500. doi:10.1016/S0003-9993(99)90263-0
15. Pruente J, Heinemann AW, Zebracki K, Mukherjee S, Gaebler-Spira D. Adult outcomes for children who sustained firearm-related spinal cord injuries. *J Spinal Cord Med*. 2021;46(1):66-74. doi:10.1080/10790268.2021.1943250
16. January AM, Kirk S, Zebracki K, Chlan KM, Vogel LC. Psychosocial and health outcomes of adults with violently acquired

pediatric spinal cord injury. *Top Spinal Cord Inj Rehabil*. 2018; 24(4):363-370. doi:10.1310/sci17-00012
17. Harris KA, Yonclas P. Acute and long-term complications of gunshot wounds to the head. *Curr Phys Med Rehabil Rep*. 2020; 8(4):436-442. doi:10.1007/s40141-020-00301-4
18. Barnett HM, Wilson JM, Kunapaisal T, et al. Utilization of rehabilitation services in violent versus nonviolent traumatic spinal cord injury. *PM&R*. 2024;16(7):679-686. doi:10.1002/pmrj.13105
19. National Trauma Data Standard Data Dictionary, 2023 Admissions. 2022.
20. Inpatient Rehabilitation Facility Patient Assessment Instrument (IRF-PAI) Manual. 2024.
21. Centers for Medicare & Medicaid Services. Impairment Group Codes That Meet Presumptive Compliance Criteria-3 (ICD-10-CM). 2022 Accessed January 21, 2025. https://www.cms.gov/medicaremedicare-fee-service-paymentinpatientrehabfacppsirf-rules-and-related-files/cms-1748-f
22. Dettori JR, Norvell DC, Chapman JR. The sin of missing data: is all forgiven by way of imputation? *Glob Spine J*. 2018;8(8):892-894. doi:10.1177/2192568218811922
23. Arel-Bundock V, Greifer N, Heiss A. How to interpret statistical models using **marginaleffects** for *R* and *python*. *J Stat Softw*. 2024;111(9):1–32. doi:10.18637/jss.v111.i09
24. Lussiez A, Montgomery JR, Sangji NF, et al. Hospital effects drive variation in access to inpatient rehabilitation after trauma. *J Trauma Acute Care Surg*. 2021;91(2):413-421. doi:10.1097/TA.0000000000003215
25. Chen Y, Tang Y, Vogel L, DeVivo M. Causes of spinal cord injury. *Top Spinal Cord Inj Rehabil*. 2013;19(1):1-8. doi:10.1310/sci1901-1
26. Roach MJ, Chen Y, Kelly ML. Comparing blunt and penetrating trauma in spinal cord injury: analysis of long-term functional and neurological outcomes. *Top Spinal Cord Inj Rehabil*. 2018;24(2):121-132. doi:10.1310/sci2402-121
27. Takahashi CE, Virmani D, Chung DY, Ong C, Cervantes-Arslanian AM. Blunt and penetrating severe traumatic brain injury. *Neurol Clin*. 2021;39(2):443-469. doi:10.1016/j.ncl.2021.02.009
28. Dawoud FM, Feldman MJ, Yengo-Kahn AM, et al. Traumatic cerebrovascular injuries associated with gunshot wounds to the head: a single-institution ten-year experience. *World Neurosurg*. 2021;146:e1031-e1044. doi:10.1016/j.wneu.2020.11.078
29. Weber DC, Fleming KC, Evans JM. Rehabilitation of geriatric patients. *Mayo Clin Proc*. 1995;70(12):1198-1204. doi:10.4065/70.12.1198
30. Gioffrè-Florio M, Murabito LM, Visalli C, Pergolizzi FP, Famà F. Trauma in elderly patients: a study of prevalence, comorbidities and gender differences. Il Giornale di Chirurgia. *J Ital Surg Assoc*. 2018;39(1):35.
31. Buggs SAL, Kravitz-Wirtz ND, Lund JJ. Social and structural determinants of community firearm violence and community trauma. *Ann Am Acad Pol Soc Sci*. 2022;704(1):224-241. doi:10.1177/00027162231173324
32. Yearby R. Structural racism and health disparities: reconfiguring the social determinants of health framework to include the root cause. *J Law Med Ethics*. 2020;48(3):518-526. doi:10.1177/1073110520958876
33. Yi SS. Taking action to improve Asian American health. *Am J Public Health*. 2020;110(4):435-437. doi:10.2105/AJPH.2020.305596
34. Wu TY, Hsieh HF, Chow CM, Yang X, Resnicow K, Zimmerman M. Examining racism and firearm-related risks among Asian Americans in the United States during the COVID-19 pandemic. *Prev Med Rep*. 2022;27:101800. doi:10.1016/j.pmedr.2022.101800
35. Wu TY, Hsieh HF, Resnicow K, Carter PM, Chow CM, Zimmerman M. Understanding the intersectionality of COVID-19 racism, mental distress, alcohol use, and firearm purchase behavior among Asian Americans. *J Racial Ethn Health Disparities*. 2025;12(1):310-319. doi:10.1007/s40615-023-01874-1
36. Tran W, Thomas MB, Garofalo D, et al. The characterization of violent deaths among Asian and Pacific islander Americans. *J Surg Res*. 2024;297:109-120. doi:10.1016/j.jss.2023.12.019
37. Meagher AD, Beadles CA, Doorey J, Charles AG. Racial and ethnic disparities in discharge to rehabilitation following traumatic brain injury. *J Neurosurg*. 2015;122(3):595-601. doi:10.3171/2014.10.JNS14187
38. Freburger JK, Holmes GM, Ku LJE. Postacute rehabilitation care for hip fracture: who gets the most care? *J Am Geriatr Soc*. 2012;60(10):1929-1935. doi:10.1111/j.1532-5415.2012.04149.x
39. Asemota AO, George BP, Cumpsty-Fowler CJ, Haider AH, Schneider EB. Race and insurance disparities in discharge to rehabilitation for patients with traumatic brain injury. *J Neurotrauma*. 2013;30(24):2057-2065. doi:10.1089/neu.2013.3091
40. Freburger JK, Holmes GM, Ku LJE, Cutchin MP, Heatwole-Shank K, Edwards LJ. Disparities in postacute rehabilitation care for stroke: an analysis of the state inpatient databases. *Arch Phys Med Rehabil*. 2011;92(8):1220-1229. doi:10.1016/j.apmr.2011.03.019
41. Jaffe KM, Jimenez N. Disparity in rehabilitation: another inconvenient truth. *Arch Phys Med Rehabil*. 2015;96(8):1371-1374. doi:10.1016/j.apmr.2015.04.017
42. Holmes GM, Freburger JK, Ku LJE. Decomposing racial and ethnic disparities in the use of postacute rehabilitation care. *Health Serv Res*. 2012;47(3):1158-1178. doi:10.1111/j.1475-6773.2011.01363.x
43. Georges MR, Courtepatte A, Hibara A, et al. Health care practitioner bias and access to inpatient rehabilitation services among survivors of violence. *JAMA Netw Open*. 2025;8(4):e254074. doi:10.1001/jamanetworkopen.2025.4074
44. Penchansky R, Thomas JW. The concept of access: definition and relationship to consumer satisfaction. *Med Care*. 1981; 19(2):127-140. doi:10.1097/00005650-198102000-00001
45. Saurman E. Improving access: modifying Penchansky and Thomas's theory of access. *J Health Serv Res Policy*. 2016;21(1):36-39. doi:10.1177/1355819615600001
46. Peak J, Johns M, Shepherd M. Attitudes towards assault patients. *Arch Emerg Med*. 1991;8:286-287. doi:10.1136/emj.8.4.286
47. Gorman E, Coles Z, Baker N, et al. Beyond recidivism: hospital-based violence intervention and early health and social outcomes. *J Am Coll Surg*. 2022;235(6):927-939. doi:10.1097/XCS.0000000000000409
48. Kroll T. Rehabilitative needs of individuals with spinal cord injury resulting from gun violence: the perspective of nursing and rehabilitation professionals. *Appl Nurs Res*. 2008;21(1):45-49. doi:10.1016/j.apnr.2006.06.001

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