



OPEN Understanding and promoting equitable post-discharge care in firearm injury survivors: a retrospective chart review

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Patients that survive firearm injuries frequently require follow-up care. This study aims to explore demographic characteristics of patients presenting to the emergency department for post-firearm injury care and to understand the reasons for their return visits. This was a retrospective chart review of all emergency department and readmission patient encounters for post-firearm injury care during the study period, January 1, 2019 to December 31, 2022, at an urban safety net hospital. Seventy-four patients with 84 corresponding emergency department encounters were included in the analysis. Key findings were that patients from racial and ethnic minorities, patients insured by Medicaid, and patients experiencing homelessness were overrepresented in the study cohort. Additionally, many repeat emergency department visits were potentially avoidable, stemming primarily from insufficient pain control, wound checks, postoperative complications, and infections. The authors proposed potential interventions to improve post-firearm injury care, including the provision of wound care kits and the optimization of the discharge medication pick-up process.

Keywords Firearms, Firearm injury, Violence prevention, Health disparities, Social determinants of health

Patients who survive gunshot wounds often face structural barriers to receiving post-discharge care and have injuries that lead to multiple follow-up visits and readmissions¹. This study explores demographic characteristics of those requiring post-firearm injury care and aims to understand reasons that patients return to the emergency department (ED) after a firearm injury.

Methods

This is a retrospective chart review of all patient encounters with firearm-related ICD-9/10 codes during the study period, January 1, 2019 to December 31, 2022, at a safety net hospital with a level one trauma center. Firearm-related patient encounters were queried using the Electronic Medical Record search criteria in Epic, using the provider-entered diagnoses “gunshot,” “gun shot,” or “firearm.” Patients of all ages were eligible for inclusion in the study, with no age-related restrictions applied. Direct transfers from outside hospitals were not included unless the patient was seen in the ED prior to admission. Only patients with at least one subsequent firearm-associated ED encounter within six months of their initial firearm injury were included in the analysis. Patient records were reviewed by one reviewer to confirm that the subsequent encounter(s) were related to the initial injury.

One reviewer participated in an initial chart review of the encounters that met inclusion criteria and identified the primary reason for the ED visit using the first two encounter diagnoses as well as the history of present illness (HPI) if the primary diagnoses were missing or inappropriate. Subsequently, a second chart reviewer independently reviewed each encounter and interrater reliability was calculated. Any discrepancies between the reviewers on the primary reason for ED visit categorization were resolved through discussion and consensus.

The encounters were categorized by the primary reason for ED visit: 1) pain control, 2) post-operative complications, 3) wound check, 4) wound infection, 5) suture/staple removal, or 6) other. Patient data were de-identified. The categories for ED visits were identified inductively during an initial review of the data by one reviewer, as the majority of encounters naturally aligned within these common reasons. When additional, more specific information (e.g. specific type of post-operative complication) relating to the reason for ED visit was

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available in the patient's primary diagnoses or HPI, this data was also collected to provide examples of specific ED visit reasons for each category.

Descriptive statistics were used to describe and summarize individual-level characteristics of the study cohort including age, sex, race, ethnicity, payor status, and housing status. The study protocol was reviewed and given a certificate of exemption by the Colorado Multiple Institutional Review Board. Informed consent was waived by the Colorado Multiple Institutional Review Board due to the retrospective nature of the study. The study was performed in accordance with relevant guidelines and regulations.

Results

Within the study period of January 1st, 2019 and December 31st, 2022, 1,086 patients had at least one ED encounter for a firearm-related injury. The individual-level characteristics for all patients presenting with a firearm injury are summarized in Table 1.

Of the 1,086 patients presenting with a firearm injury, 137 patients (12.6%) expired in-facility. Among the 949 survivors, 74 patients (7.8%) met inclusion criteria by having an additional ED encounter related to their initial firearm injury within six months of the injury. Individual-level characteristics of the study cohort of patients are summarized in Table 2.

The 74 patients included in this study had a combined 84 follow-up ED encounters. The indications for subsequent firearm-associated ED encounters are shown in Fig. 1. There was strong interrater reliability with a Cohen's Kappa score of 0.914. There were six encounters where the two independent reviewers initially disagreed but then reached a consensus through discussion. While the primary visit reason for 32 of the ED encounters was categorized as "pain control," the medical records did not consistently include detailed explanations for the underlying causes of poor pain control. In the few cases where such information was available, specific reasons included patients running out of medication, forgetting to pick up their prescriptions, and feeling their pain wasn't adequately managed by prescribed medication. However, due to missing or insufficient documentation in many cases, we were unable to provide a detailed categorization within pain control for ED visit reasons. Similarly, missing or incomplete documentation prohibited further sub-categorizations of miscellaneous ("other") reasons. Examples of these included new onset paresthesias, headaches, respiratory symptoms, and gastrointestinal symptoms related to their initial injury. Lastly, examples of postoperative complications included postoperative ileus, abscesses, or drain and hardware malfunctions.

		N	%
Total number of patients		1086	100
Sex	Male	913	84.1
	Female	173	15.9
Race	White	543	50.0
	Black/African American	304	28.0
	Other	218	20.1
	American Indian/Alaskan Native	16	1.5
	Unknown	5	0.5
Hispanic/Latino	Yes	481	44.3
	No	539	49.6
	Null or declined to answer	66	6.1
Age (years)	0–11	8	0.74
	11–20	283	26.1
	21–25	192	17.8
	26–30	173	15.9
	31–40	131	12.1
	41–50	106	9.8
	51 and older	193	17.8
Housing status	Housed	949	87.4
	Currently unhoused	137	12.6
Payor	Medicaid	739	68.0
	Other (including private insurance and institutional financial assistance program)	223	20.5
	Uninsured	124	11.4
Discharge Department (for initial encounter)	Discharged from ED	540	49.7
	Admitted to Inpatient service	N/A	
	Admitted to ICU	N/A	
	Admitted to ED Observation	N/A	

Table 1. Individual-level characteristics for all patients with a firearm-related ED encounter.

		N	%
Total number of patients		74	100
Sex	Male	58	78.4
	Female	16	21.6
Race	White	40	54.1
	Black/African American	15	20.3
	Other	15	20.3
	American Indian/Alaskan Native	3	4.1
	Unknown	1	1.4
Hispanic/Latino	Yes	41	55.4
	No	33	44.6
Age (years)	0–11	0	0
	11–20	17	23.0
	21–25	10	13.5
	26–30	13	17.6
	31–40	21	28.4
	41–50	9	12.2
	51 and older	4	5.4
Housing status	Housed	55	74.3
	Currently unhoused	19	25.7
Payor	Medicaid	64	86.5
	Private insurance	7	9.5
	Uninsured	3	4.1
Discharge Department (for follow-up encounter)	Discharged from ED	49	58.3
	Admitted to Inpatient service	24	28.6
	Admitted to ICU	9	10.8
	Admitted to ED Observation	2	2.4

Table 2. Individual-level characteristics for patients with a subsequent ED encounter following a firearm injury.

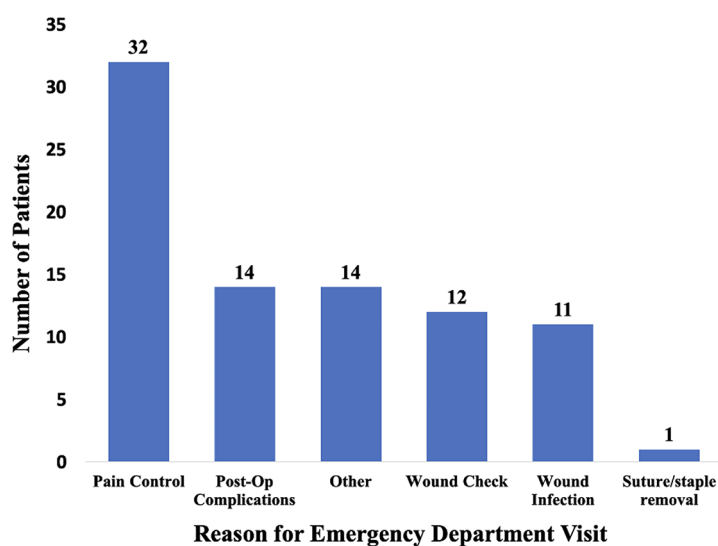


Fig. 1. Breakdown of ED return visit etiology.

Discussion

Nearly 8% of all firearm injury survivors returned to the ED within six months, though the actual proportion is likely greater as our data did not include records from other nearby hospitals, community clinics, or urgent care centers. Many repeat ED visits were potentially avoidable, stemming primarily from insufficient pain control, wound checks, postoperative complications, and infections. While the reasons for returning to the ED following a firearm injury are multifaceted, this study helps clarify those factors, highlights the affected populations, and suggests ways to enhance care and reduce unnecessary ED visits.

In the United States, Black/African American and Hispanic patients constitute 20.7% and 15.4%, respectively, of all patients presenting to the ED. In this study, Black/African American and Hispanic patients were either similarly represented or overrepresented in both the overall firearm injury cohort (28.0% and 47.2%, respectively) and the follow-up ED encounter cohort (20.3% and 55.4%, respectively)². Patient demographics including sex, age, race and ethnicity in the follow-up ED encounter cohort was generally reflective of the overall cohort. Notably, the proportion of patients experiencing homelessness in the follow-up ED encounter cohort was double that of the overall firearm injury cohort (25.7% vs. 12.6%), suggesting that housing insecurity may impact post-firearm injury care.

This study's findings align with previous research indicating that the Social Vulnerability Index, which is a multifactorial measure that includes racial and ethnic minority status, socioeconomic status, and housing status, correlates with increased 30-, 60-, and 90-day readmission following firearm injury in adults aged 18–35³. Other studies have highlighted inadequate medication access and transportation as barriers to post-discharge firearm care^{4,5}. These insights suggest that social determinants of health influence the post-discharge trajectory of patients with a firearm injury.

The common reasons that patients returned to the ED in this study—pain control, post-operative complications, wound check, and wound infection—are consistent with a prior study that reported a 14% ED revisit rate for all cause trauma patients within 30 days, primarily due to similar issues (pain control and wound issues)⁶. Moreover, qualitative research highlights that poor communication between patients and providers, feelings of premature discharge by the patient, barriers to obtaining medication, and challenges with transportation for follow-up care adversely affect post-discharge care⁴. These findings emphasize the necessity for proactive measures that connect patients who survive firearm injuries with the appropriate resources after discharge as exemplified by many hospital violence intervention programs.

This single-center study is limited by its small sample size, retrospective design, and selection biases and only included patients who returned to this center within six months of injury. Additionally, the study's limited exploration of long-term patient outcomes and broader factors influencing healthcare disparities beyond immediate post-discharge care highlights the need for additional research with more comprehensive outcome measures. Lastly, limitations included reviewer bias and challenges in interpreting the specific reasons for return ED visits due to insufficient injury documentation, missing records from outside hospitals, and inaccurate ICD-10 codes.

Using this study's findings and previous studies' findings on post-firearm injury care, the authors propose several possible interventions to address some of the reasons why patients return to the ED following a firearm injury. A 2024 study that randomized firearm injury survivors to either a pilot Post Discharge Care Team (N = 44) consisting of a dedicated trauma nurse navigator and medical social worker to provide patient education regarding injuries, wound care, and outpatient follow-up or standard of care workflows (N = 47) found that the Post Discharge Care Team group had 9 fewer ED visits, 27.9 fewer hospital days, and cost the hospital \$34,542 less compared to the standard of care group⁷. A similar program could help address this study's findings that most patients return to the ED for inadequate pain control, wound checks, and new wound infections.

This intervention is resource intensive, however, and a less resource intensive option could be to focus on improving the process of getting patients their medications prior to discharge, increasing the probability that they have the appropriate pain medications and antibiotics. Currently, when patients are discharged from the ED, they typically pick up their medications at the discharge pharmacy within the hospital if it is within business hours and at an outside pharmacy of their choosing if it is outside business hours. One proposed intervention is to implement a “meds to bedside” system, where providers can request that patient discharge medications are brought to the patient's bedside from the discharge pharmacy prior to discharge. “Meds to bedside” is currently offered at our institution on inpatient services for patients who would not pick up or who would have difficulty picking up their medications at the discharge pharmacy. Implementing “meds to bedside” for patients being discharged, both from inpatient services and from the ED, for firearm injuries could increase medication adherence and decrease pain control and wound infection visits.

Additionally, creating and distributing simple wound care kits consisting of sterile bandaging materials and providing education on how to utilize them may be an effective tool to reduce the number of repeat ED visits after firearm injuries related to wound infections and wound checks. One organization that has implemented a similar intervention since 2020 is The Bullet Related Injury Clinic (BRIC) founded in St Louis, MO, which designed a “BRIC Box,” containing wound care supplies and over the counter pain interventions with detailed instructions for every item included in the box available in English and Spanish⁸. Patients with firearm injuries who are discharged from a BRIC-partnering ED are referred to the BRIC and provided the “BRIC box” at no cost⁸. Following discharge, a member of the BRIC team reaches out within 72 h to invite them to visit the free BRIC to address patients' pain and additional physical, psychological, or social needs⁸. BRIC is expanding to additional sites and can serve as a valuable resource for patients following firearm injuries, providing an additional and more specific outpatient resource aside from primary care visits and urgent care. In locations without access to BRIC, distributing similar wound care kits with detailed instructions to all post-firearm injury patients could still provide a valuable post-discharge resource for patients and may prevent ED visits.

In conclusion, this study enhances our understanding of post-firearm injury care and identifies key populations at risk. Potential interventions including patient navigators, wound care kits, bullet injury-specific clinics, clearer and more concise discharge instructions, and bedside discharge medications could decrease repeat ED encounters and may improve health outcomes and reduce health disparities by ensuring that all patients receive equitable and complete care following firearm injuries.

Data availability

Data is provided within the manuscript.

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References

1. Rattan, R. et al. Hidden costs of hospitalization after firearm injury: National analysis of different hospital readmission. *Ann. Surg.* **267**(5), 810–815 (2018).
2. Tsai, J. W., Janke, A., Krumholz, H. M., Khidir, H. & Venkatesh, A. K. Race and ethnicity and emergency department discharge against medical advice. *JAMA Netw. Open* **6**(11), e2345437–e2345437 (2023).
3. Siu, M., Coulter, A. P., Knee, A. & Tirabassi, M. V. Association between social vulnerability index and hospital readmission following gunshot injuries. *J. Surg. Res.* **293**, 50–56 (2024).
4. 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* **34**(1), 135–155 (2019).
5. Song, Z., Zubizarreta, J. R., Giuriato, M., Paulos, E. & Koh, K. A. Changes in health care spending, use, and clinical outcomes after nonfatal firearm injuries among survivors and family members: A cohort study. *Ann. Intern. Med.* **175**(6), 795–803 (2022).
6. Abou-Hanna, J., Kugler, N. W., Rein, L., Szabo, A. & Carver, T. W. Back so soon? Characterizing emergency department use after trauma. *Am. J. Surg.* **220**(1), 217–221 (2020).
7. Biesboer, E. A., Brandolino, A., Servi, A., Laskiewicz, R., Herbst, L., Cronn, S., Cronn, S., Cadman, J., Trevino, C., Deroon-Cassini, T. & Schroeder, M. E. A pilot project of a post discharge care team for firearm injury survivors decreases emergency department utilization, hospital readmission days, and cost. *J. Trauma Acute Care Surg.* 10–1097 (2023).
8. Hayes, J. M., Hann, I. & Punch, L. J. The bullet related injury clinic—healing the deep wounds of gun violence. *JAMA Surg.* **157**(2), 167–168 (2022).

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Author contributions

C.J., A.D., C.W., and B.A. contributed to study design. C.J., A.B., R.C. completed data collection. C.J., A.B., R.C., and A.M. contributed to data analysis. C.J., A.B., R.C., B.A., C.W., A.D., A.M. all contributed towards drafting and finalizing the final manuscript.

Declarations

Competing interests

The authors declare no competing interests.

Additional information

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