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Ankle fracture surgery in patients experiencing homelessness: a national evaluation of one-year rates of reoperation

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Abstract

Objectives: To evaluate the impact of homelessness on surgical outcomes following ankle fracture surgery.

Design: Retrospective cohort study.

Setting: Mariner claims database.

Patients/Participants: Patients older than 18 years who underwent open reduction and internal fixation (ORIF) of ankle fractures between 2010 and 2021. A total of 345,759 patients were included in the study.

Intervention: Study patients were divided into two cohorts (homeless and nonhomeless) based on whether their patient record contained International Classification of Disease (ICD)-9 or ICD-10 codes for homelessness/inadequate housing.

Main Outcome Measures: One-year rates of reoperation for amputation, irrigation and debridement, repeat ORIF, repair of nonunion/malunion, and implant removal in isolation.

Results: Homeless patients had significantly higher odds of undergoing amputation (adjusted odds ratio [aOR] 1.59, 95% confidence interval [CI] 1.08–2.27, $P = 0.014$), irrigation and debridement (aOR 1.22, 95% CI 1.08–1.37, $P < 0.001$), and repeat ORIF (aOR 1.16, 95% CI 1.00–1.35, $P = 0.045$). Implant removal was less common in homeless patients (aOR 0.65, 95% CI 0.59–0.72, $P < 0.001$). There was no significant difference between homeless and nonhomeless patients in the rate of nonunion/malunion repair (aOR 0.87, 95% CI 0.63–1.18, $P = 0.41$).

Conclusions: Homelessness is a significant risk factor for worse surgical outcomes following ankle fracture surgery. The findings of this study warrant future research to identify gaps in surgical fracture care for patients with housing insecurity and underscore the importance of developing interventions to advance health equity for this vulnerable patient population.

Level of Evidence: Prognostic Level III.

Keywords: ankle fracture, homelessness, outcomes, health equity

1. Introduction

Homelessness is a growing public health crisis in the United States that impacts more than half a million people.[1] Compared with the general population, persons experiencing homelessness have higher rates of chronic medical conditions, infectious diseases, mental illness, substance and alcohol use disorders, and unintentional injury.[2] Furthermore, persons experiencing homelessness often have worse access to adequate primary and preventive care, and face barriers to obtaining health insurance.[3–5] These health disparities contribute to higher rates of hospitalization, emergency department usage, and mortality in this population.[2] Therefore, homeless patients constitute a vulnerable population for which it is challenging to deliver high-value patient-centered care.

Despite the increased incidence of musculoskeletal injuries among homeless patients,[6] the impact of homelessness on surgical fracture care remains understudied. Recent findings highlight the considerable impact of social determinants of health disparities on orthopedic trauma surgery.[7–13] However, to our knowledge, only one study has directly explored surgical outcomes in homeless

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patients with orthopedic trauma.[14] Given that musculoskeletal injury is a substantial cause of disability, understanding disparities in outcomes for homeless patients following surgical fracture care may help develop interventions that promote health equity.

The purpose of this study was to compare one-year rates of reoperation between homeless and nonhomeless patients undergoing open reduction and internal fixation (ORIF) of ankle fractures. We hypothesized that homeless patients would be more likely to return to the operating room for procedures indicative of complications following ankle fracture surgery, including amputation, irrigation and debridement, and repeat ORIF.

2. Methods

A retrospective review was performed using the Mariner database (PearlDiver Technologies, Colorado Springs, CO). This national all-payer database contains patient records from January 2010 to October 2021. All records are deidentified and are compliant with Health Insurance Portability and Accountability Act (HIPAA). Patient records can be searched using International Classification of Diseases, 9th Revision (ICD-9), ICD, 10th Revision (ICD-10), and Current Procedural Terminology (CPT) codes. Furthermore, claims data are subject to audit policies and internal review to ensure data validity and reliability. Institutional review board approval was waived for this public database study.

We used ICD and CPT codes to first identify the study population and then to characterize patients, their injuries, and outcomes (see Appendix, Supplemental Digital Content 1, http://links.lww.com/OTAI/A93 for all codes used to query the Mariner database). All patients older than 18 years who underwent ankle fracture surgery were identified using CPT codes for ankle ORIF. Patients were identified as homeless based on documentation of ICD-9 and ICD-10 diagnosis codes for homelessness and inadequate housing. In addition to evaluating the prevalence of specific comorbidities in the study population, we measured the overall burden of comorbidities using the Charlson Comorbidity Index (CCI).[15] Polytrauma was defined as presenting with one or more fractures elsewhere in the body in addition to the ankle fracture. Outcomes of interest included return to the operating room within one year of the index surgery for amputation, irrigation and debridement, repeat ORIF, repair of nonunion/malunion, and removal of implant in isolation (ie, excluding the other procedures listed).

Statistical analyses to compare patient and injury characteristics, as well as outcomes, between homeless and nonhomeless patients were performed using R software embedded within the PearlDiver database. Pearson's χ^2 test was used for categorical variables, and Student's t test was used for continuous variables. Multivariable logistic regression was used to determine the impact of homelessness on study outcomes after adjusting for age, sex, diabetes (uncomplicated and complicated), tobacco use, open fracture, and fracture dislocation. Adjusted odds ratios (aOR) are reported with 95% confidence intervals (CI). A $P < 0.05$ was considered significant.

3. Results

3.1. Patient and Injury Characteristics

We identified a total of 361,579 patients who underwent ankle fracture ORIF between 2010 and 2021. We excluded 15,820 patients who were younger than 18 years. Of the 345,759 eligible patients, we identified 4794 homeless patients and 340,965 nonhomeless patients who were included in the study.

Baseline patient characteristics are shown in Table 1. When compared with nonhomeless patients, those in the homeless cohort were more likely to be male (59% vs. 34%, $P < 0.001$), have Medicaid insurance (30% vs. 9%, $P < 0.001$), and be younger in age (mean [SD] = 48 [12] years vs. 57 [15] years, $P < 0.001$). Homeless patients also had significantly higher CCI scores ($P < 0.001$), with increased incidence of uncomplicated hypertension ($P < 0.001$), peripheral vascular disease ($P = 0.045$), HIV ($P < 0.001$), and hepatitis C ($P < 0.001$). Furthermore, homeless patients had markedly higher rates of disorders related to drug use (61% vs. 9%, $P < 0.001$), alcohol use (47% vs. 7%, $P < 0.001$), and tobacco use (61% vs. 21%, $P < 0.001$).

Injury characteristics also differed between the homeless and nonhomeless cohorts (Table 1). Although more than 50% of both groups underwent ORIF of bimalleolar or trimalleolar fractures, homeless patients were more likely to undergo ORIF of unimalleolar fractures compared with nonhomeless patients ($P < 0.001$). Of relevance, homeless patients more often presented with open fractures, fracture–dislocations, and polytrauma (all $P < 0.001$).

3.2. Outcomes

Implant removal was the most common reoperation for both homeless and nonhomeless patients, followed by irrigation and debridement, repeat ORIF, repair of nonunion/malunion, and amputation (Table 2). Bivariate analysis revealed increased rates of amputation, irrigation and debridement, and repeat ORIF among homeless patients within one year of ankle fracture surgery (all $P < 0.001$). Conversely, the rate of implant removal was higher in the nonhomeless cohort ($P < 0.001$). No significant difference was observed in the rate of nonunion/malunion repair ($P = 0.070$).

Multivariable logistic regression further elucidated the impact of homelessness on one-year reoperation following ankle ORIF (Table 3). After adjusting for confounding variables, homelessness was associated with higher odds of undergoing amputation (aOR 1.59, 95% CI 1.08–2.27, $P = 0.014$), irrigation and debridement (aOR 1.22, 95% CI 1.08–1.37, $P < 0.001$), and repeat ORIF (aOR 1.16, 95% CI 1.00–1.35, $P = 0.045$). Homeless patients were significantly less likely to have their implant removed (aOR 0.65, 95% CI 0.59–0.72, $P < 0.001$). There was no significant difference in the incidence of nonunion/malunion repair (aOR 0.87, 95% CI 0.63–1.18, $P = 0.41$).

4. Discussion

Homeless patients face unique challenges throughout the surgical care continuum.[16,17] The few studies that have explored surgery in the homeless population highlight higher rates of postoperative emergency department usage and hospital readmission,[14,18,19] increased length of stay and costs of admission,[20,21] and lower rates of follow-up.[14] However, the impact of homelessness on surgical outcomes, including for patients with orthopedic trauma, remains largely understudied. Therefore, understanding disparities in surgical outcomes among homeless patients may contribute to the development of strategies that improve surgical care and advance health equity for this patient population. This study evaluated a large national administrative data set and identified significant disparities in preoperative risk factors and one-year rates of reoperation in homeless patients undergoing ankle fracture surgery.

TABLE 1.

Characteristics of Homeless and Nonhomeless Patients

Characteristic	Homeless (n = 4794)	Nonhomeless (n = 340,965)	P
Age, y; mean (SD)	47.6 (12.0)	56.7 (15.0)	<0.001
Sex			
Female	1987 (41.4)	223,641 (65.6)	
Male	2807 (58.6)	117,324 (34.4)	<0.001
Insurance			
Commerical	2309 (48.2)	227,272 (66.7)	
Medicare	414 (8.6)	61,106 (17.9)	
Medicaid	1435 (29.9)	30,118 (8.8)	
Other	636 (13.3)	22,469 (6.6)	<0.001
Fracture			
Unimalleolar	2093 (43.6)	135,286 (39.7)	<0.001
Bimalleolar or trimalleolar	2518 (52.5)	195,060 (57.2)	<0.001
Fracture dislocation	511 (10.7)	30,188 (8.9)	<0.001
Open fracture	407 (8.5)	23,523 (6.9)	<0.001
Polytrauma	2986 (62.3)	147,168 (43.2)	<0.001
CCI score; mean (SD)	2.43 (2.7)	2.34 (2.8)	<0.001
Hypertension			
Uncomplicated	2220 (45.9)	141,438 (41.5)	<0.001
Complicated	287 (6.0)	23,294 (6.8)	0.021
Diabetes			
Uncomplicated	1118 (23.3)	79,125 (23.2)	0.85
Complicated	658 (13.7)	45,392 (13.3)	0.40
Peripheral vascular disease	579 (12.1)	38,045 (11.2)	0.045
HIV	154 (3.2)	1801 (0.53)	<0.001
Hepatitis C	728 (15.2)	6517 (1.9)	<0.001
Drug use	2909 (60.7)	30,968 (9.1)	<0.001
Alcohol use	2269 (47.3)	24,884 (7.3)	<0.001
Tobacco use	2898 (60.5)	71,166 (20.9)	<0.001

Unless otherwise indicated, data are reported as number of patients (%).
CCI, Charlson Comorbidity Index.

Although it is well-known that health disparities exist among homeless people,[2] no study has characterized the prevalence of preoperative risk factors in homeless patients undergoing orthopedic trauma surgery. In this study, homeless patients had higher rates of several established risk factors for complications following ankle fracture surgery, including comorbidities that impede wound healing (ie, peripheral vascular disease and hypertension),[22–25] psychological disorders (ie, substance, tobacco, and alcohol use),[24,26–29] and injury characteristics indicative of soft tissue compromise (ie, open fracture and fracture–dislocation).[22,25,30,31] Other factors associated with reoperation following ankle fracture surgery that were more prevalent among homeless patients were male sex, younger age, and having Medicaid insurance.[23,25,32] The incidences of HIV and hepatitis C, both of which can increase the risk of complications following major orthopedic surgery,[24,33,34] were also markedly higher in the homeless cohort. It is relevant to note that this is not a comprehensive list; future studies should focus on better defining the medical and social factors that affect surgical fracture care in this vulnerable patient population.

This study also demonstrates that homeless patients who underwent ankle ORIF had worse surgical outcomes relative to their nonhomeless counterparts. Homeless patients were significantly more likely to return to the operating room for procedures indicative of complications, including amputation, irrigation and debridement, and repeat ORIF. The substantial impact of homelessness on outcomes following ankle ORIF was further highlighted by its association with these worse one-year outcomes after adjusting for established confounding variables. Conversely, homeless patients were significantly less likely to have their hardware removed in isolation, potentially resulting from unequal provision of care at the patient level or a lack of follow-up.[14,25] These findings contribute to the growing body of evidence that demonstrates the significant impact of social determinants of health disparities on ankle fracture surgery,[7,8] and surgical fracture care more broadly.[9–14] However, it should

TABLE 2.

One-Year Rates of Reoperation in Homeless and Nonhomeless Patients

Outcome	Homeless (n = 4794)	Nonhomeless (n = 340,965)	P
Amputation	31 (0.65)	1001 (0.29)	<0.001
Irrigation and debridement	335 (7.0)	17,222 (5.1)	<0.001
Repeat ORIF	191 (4.0)	10,110 (3.0)	<0.001
Repair of nonunion/malunion	40 (0.83)	2134 (0.63)	0.070
Implant removal	413 (8.6)	37,437 (11.0)	<0.001

Data are reported as number of patients (%).
ORIF, open reduction and internal fixation.

TABLE 3.

Impact of Homelessness on One-Year Reoperation Following Ankle ORIF

Outcome	aOR (95% CI)	*P*
Amputation	1.59 (1.08–2.27)	0.014
Irrigation and debridement	1.22 (1.08–1.37)	<0.001
Repeat ORIF	1.16 (1.00–1.35)	0.045
Repair of nonunion/malunion	0.87 (0.63–1.18)	0.41
Implant removal	0.65 (0.59–0.72)	<0.001

aOR, adjusted odds ratios; CI, confidence interval; ORIF, open reduction and internal fixation.

be noted that rates of amputation, irrigation and debridement, and repeat ORIF were still quite low even in the homeless cohort. Therefore, until there is convincing evidence to support alternate treatment options for ankle fracture in this population, concerns regarding the risk of reoperation should not preclude surgical management in patients experiencing homelessness.

The disparities in surgical outcomes highlighted in this study underscore the need for strategies to improve care for homeless patients following ankle fracture. Notably, there is a need for research to explore the efficacy of nonoperative treatment of ankle fractures in this population. Consideration of nonsurgical management might be especially relevant for homeless patients with Weber B ankle fractures to mitigate the risk of complication associated with surgery.[35,36] This study's finding that homelessness was associated with higher odds of worse surgical outcomes when controlling for well-established risk factors (ie, age, sex, diabetes, open fracture, fracture–dislocation, and tobacco use) also emphasizes the importance of addressing the social needs of patients to optimize surgical care. In this light, homeless patients may benefit from an integrated multidisciplinary approach to care, which targets patients with increased psychosocial needs. Efficient care coordination and increased utilization of social workers, behavioral health specialists, and relevant community stakeholders could have an important impact.[37,38] Ultimately, strategies to reduce complications and rates of reoperation in homeless patients may improve health-related quality of life and functional outcomes among these patients, and increase the value of care by reducing readmissions, length of stay, and costs to the healthcare system.

This study had limitations. Large administrative data sets, including the one used in this study, are subject to inaccuracies due to miscoding or undercoding, inherently lack granularity, and may find statistically significant associations that are not clinically significant.[39] Notably, although ICD-10 codes for social determinants of health are reflective of variations in social problems, their underutilization in medical records likely reduced the generalizability of our findings by limiting the number of homeless patients included in the study.[40] Although we tracked patients for one year following the first documented instance of ankle ORIF, it is unclear whether all subsequent procedures in this time frame were related to the index ankle fracture. We were also unable to capture complexities related to patient and injury characteristics beyond what was assessed and documented with ICD codes, including race/ethnicity. Complications that did not result in reoperation, but which may have influenced patients' quality of life or functional outcomes, were also beyond the scope of this study. Given our large sample size, future research is warranted to validate associations found in this study that reached statistical significance but may not be clinically relevant.

5. Conclusion

This study is the first to evaluate surgical outcomes in homeless patients undergoing ankle fracture surgery. Homeless patients were more likely to present with preoperative risk factors and more often returned to the operating room for procedures indicative of complications within the year following their index surgery. Furthermore, the associations between homelessness and one-year rates of amputation, irrigation and debridement, and repeat ORIF remained significant after adjusting for established risk factors. However, given that rates of reoperation were still quite low in the homeless cohort, there is insufficient evidence at this time to preclude operative treatment of ankle fractures in homeless patients. Future research should focus on understanding the factors that perpetuate worse outcomes in homeless patients with the ultimate goal of improving surgical fracture care in this vulnerable patient population.

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