

Socioeconomic status does not change decision-making in the treatment of distal radius fractures at a level 1 trauma center

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Abstract

Objectives: To compare operative rates, total hospital charges, and length of stay between different socioeconomic cohorts in treating distal radius fractures (DRFs).

Design: A retrospective cohort study.

Setting: Large public level 1 trauma center.

Patients: A retrospective search of all trauma activations over a 7-year period (2013–2020) yielded 816 adult patients diagnosed with DRF. Patients were separated into cohorts of socioeconomic status based on 2010 US Census data and insurance status.

Intervention: DRFs were treated either nonoperatively using closed reduction and splinting or operatively using open reduction and internal fixation, closed reduction percutaneous pinning, or external fixator application.

Main Outcome Measurements: Operative rates of DRF, total hospital charges, and length of stay.

Results: Patients who were uninsured or in the low-income socioeconomic cohort had no significant difference in operative rates, total hospital costs, or length of stay when compared with their respective insured or standard income groups. Younger patients and those with OTA/AO type C, bilateral, or open DRFs were more likely to undergo operative intervention.

Conclusions: This study demonstrates that low socioeconomic status based on annual household income and insurance status was not associated with differences in operative rates on DRFs, length of stay, or total hospital charges. These results suggest that outcome disparities between groups may be caused by postoperative differences rather than treatment decision-making. Although this study investigates access to surgical care at a publicly funded level 1 trauma center, disparities may still exist in other models of care.

Level of Evidence: Prognostic Level III.

Keywords: cost, distal radius, fracture, insurance, open reduction internal fixation, socioeconomic

1. Introduction

Distal radius fractures (DRF) are an exceedingly common fracture pattern, with more than 643,000 cases annually in the United States alone.^[1,2] These fractures lead to a significant financial burden on patients and the health care system.^[3] DRFs can be treated either operatively or nonoperatively. However, the preferred management method remains debatable and depends heavily on the clinical situation and provider choice.

Socioeconomic status (SES) is an all-encompassing term that includes a variety of factors, including income, race, ethnicity, sex, education level, insurance status, and geographic location.^[4] Research indicates that SES plays a significant role in postoperative

outcomes, morbidity, and complication rates in orthopaedic trauma.^[5] A systematic review of the effects of socioeconomic factors on DRF outcomes suggests that patient SES influences outcomes; however, many of the included studies were limited by small sample sizes.^[6] By contrast, a large retrospective review of DRFs by Clement et al demonstrated that SES did not significantly correlate with differences in outcomes or surgical rates. When investigating the operative management of DRFs with volar locking plate systems, Chung et al^[7] demonstrated that income was a significant predictor of improved outcome. The current literature lacks a clear consensus on the effects of socioeconomic factors on postoperative outcomes, and even less data exists on the effects of SES on the rates of surgical intervention.

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When examining the US health care system, it is clear that there is an exorbitant amount of cost associated with receiving care, with 170 million US dollars (USD) in DRF-attributable Medicare payments alone in 2007.^[8] The cause of this problem is multifaceted, exacerbated by a lack of price transparency between institutions, payers, and patients. In the treatment of DRFs in the Medicare population, the mean reimbursement per beneficiary for the closed reduction of isolated DRFs in 2007 was 1459 USD. With the use of internal fixation, the mean reimbursement was 3832 USD.^[8] The trauma population is often younger and sustains a higher number of concomitant injuries, inpatient admissions, and overall medical costs.^[9] These data bring to light the question as to whether insured and uninsured populations receive equitable care. A 2014 meta-analysis investigating the relation of SES and outcomes in trauma patients demonstrated that uninsured status is an independent predictor of higher mortality.^[10] When considering other orthopaedic injuries, Schairer et al found that clavicle fractures were managed surgically more often in White, privately insured, and high-income patients. In addition, delay of fixation longer than 3 weeks from initial presentation was associated with patients of lower incomes.^[11]

Owing to lack of consensus regarding the impact of SES on preoperative decision-making in the management of DRFs, the authors of this study chose to conduct a retrospective review of operative rates on DRFs at a large level 1 trauma center. This center is in a region that has a diverse population, including economically disadvantaged and immigrant communities. Previous research has shown that open reduction and internal fixation of DRFs leads to quicker return to function, less loss of motion, and decreased pain than other management methods, including nonoperative modalities.^[12] Therefore, this study considers whether estimated household income and insurance status significantly affect surgical intervention rates in DRFs, total cost of care, and length of stay.

2. Methods

A retrospective database search was conducted at a large level 1 trauma center over 7 years (2013–2020) for DRFs in adult patients. The institutional review board approved the use of patient data for research purposes before reviewing data, and this study was deemed exempt from continued review. With more than 4000 trauma activations per year and a 26,770 square mile, 22 county catchment area, this institution serves a diverse population of more than 2.4 million. A significant proportion of the patients are from underserved communities, including border cities and economically underdeveloped regions. The trauma department at this institution receives state funding to assist with trauma care. Historically, the region's average earnings per employee remain around 85 percent of the state average, with lower levels of educational achievement in the workforce than the national average^[13].

All trauma activations in a trauma database between 2013 and 2020 were reviewed for DRF-associated *ICD-9* and *ICD-10* codes. All patients older than 18 years were included. Eight hundred sixteen cases met the inclusion criteria. These charts were reviewed for age, sex, race, injury severity score (ISS), mechanism of injury, home zip code, insurance status, DRF Orthopaedic Trauma Association/AO Foundation (OTA/AO) classification, fracture management, length of stay, and total hospital charges. OTA/AO classifications were determined radiographically by 2 board-certified hand surgeons, who were blinded to demographic data.

Median household income data per zip code was calculated from the 2010 Census American Community Survey and a computational model created by the University of Michigan Population Studies Center.^[14] Based on the US Department of Housing and Urban development, patients with a median income below 50% of the state median were classified as very low income. Income data were retrieved from the 2015 Department of Housing and Urban Development Office of Policy and Research Briefing, with the very low-income group in this region being those with household incomes less than 31,700 USD annually. This very low-income group is categorized as the low socioeconomic cohort in this study.

Categorical variables are summarized as percentages. Continuous variables are summarized as mean and standard deviation. Chi-square tests were used for comparing groups for categorical variables. *t* tests were used for comparison of groups for continuous variables. When examining operative intervention rates, additional analyses were performed when comparing insurance status and median household income. Multiple logistic regressions were performed that included age, OTA/AO classification, open versus closed injuries, and laterality as confounding variables.

Total hospital charges and length of stay were compared for income cohorts using the *t* test with patients divided into low versus normal income groups. In addition, linear regression models were used to include income as a continuous measure rather than the low versus normal cohorts. This was performed for predicting both hospital charges and length of stay. In the comparison of hospital charges between insured and uninsured groups, an additional multiple linear regression was performed with baseline differences in age, sex, and ISS included as covariates to further examine differences in hospital charges between insurance cohorts.

3. Results

44.2% of DRFs were managed with closed reduction alone, while 55.8% received surgical intervention (Table 1). Most surgical cases used open reduction with internal fixation. The mean patient age was 50.7 years in nonoperative cases and 45.9 years in operative cases ($P = 0.0002$). There was a statistically significant difference in the rates of surgical interventions for the different OTA/AO types. A DRF classified as an OTA/AO type C was more likely to undergo surgical intervention than its type A or B counterparts. Patients with open injuries and patients sustaining bilateral fractures were also more likely to be treated surgically ($P < 0.0001$; $P = 0.0147$). There was a marginally significant difference in operative rates between insured and noninsured patients ($P = 0.0515$). However, after controlling for patient age, OTA/AO classification, open/closed injury status, and laterality, the difference in operative rates for insurance status was nonsignificant ($P = 0.9347$). There were no significant differences in operative rates for patients in the low-income socioeconomic cohort when compared with the normal income group both without ($P = 0.6574$) and with adjustment for confounding variables ($P = 0.4306$; Table 2).

The average median household income for the low-income group was 26,534 USD. The average hospital charges for this group were 93,836 USD. The average median household income for the normal income group was 52,606 USD, with an average hospital charge of 87,722 USD. There were no significant differences between income groups in total hospital charges, hospital length of stay, and ISS score (Table 3). When income was treated as a continuous variable and not categorized into low versus normal income groups, the 2 linear regressions of hospital

TABLE 1
Patient Descriptives.

Patient descriptives	Total (n = 816)
Mean age (SD), years	48.0 (18.0)
Male sex	59.7
Average annual median household income (SD), USD	48,105 (20,555)
≤\$31,700	17.3
≥\$31,700	82.7
Insured	62.5
Mechanism of injury	
Fall from < 3 m	29.4
Fall from height > 3 m	21.7
Car accident	26.6
Motorcycle accident	12.3
Pedestrian hit by car	5.0
Gunshot wound	1.1
Crush injury	1.4
Blast injury	0.3
Assault	0.7
Laceration	0.4
Bilateral injuries	6.3
Open injury	12.6
Mean ISS, (SD)	10.6 (7.9)
Distal radius OTA/AO classification	
A	13.1
B	17.4
C	69.5
Surgical management	55.8

All numbers are in percent unless otherwise specified.

charges to income and length of stay to income did not show any significant associations.

When comparing insured and uninsured patients, there were significant differences in age, ISS, and sex (data not shown). Insured patients were older, more likely to be female, and had higher ISS scores. There was no significant difference in hospital length of stay between insured and uninsured patients ($P = 0.3147$). Total hospital charges were significantly different by insurance status where insured patients averaged \$96,584 in total hospital charges compared with \$75,969 for uninsured patients

TABLE 2
Operative and Nonoperative Columns Describe Distal Radius Fracture Management.

	Operative	Nonoperative	P
Mean age (SD), years	45.9 (16.3)	50.7 (19.7)	0.0002
Distal radius OTA/AO classification			<0.0001
A	46.7	53.3	
B	26.8	73.4	
C	64.7	35.3	
Injury			<0.0001
Open	92.2	7.8	
Closed	50.5	49.5	
Laterality			0.0147
Bilateral injuries	72.6	27.5	
Unilateral injury	54.6	45.4	
Insurance Status			0.0515/0.9347*
Insured	53.1	46.9	
Uninsured	60.1	39.9	
Annual median household income			0.6574/0.4306*
≤31,700 USD	57.4	42.6	
≥31,700 USD	55.4	44.6	

All numbers are in percent unless otherwise specified.

* P-value after adjusting for age, OTA/AO, open/closed injury, and laterality.

($P = 0.0092$). However, after adjusting for age, sex, and ISS, there was no difference in total hospital charges between insurance cohorts ($P = 0.1808$; Table 4).

4. Discussion

DRFs are prevalent injuries that significantly affect many patients, causing pain, loss of occupation, loss of mobility, and financial strain.^[2,3,15] SES has been shown to be a factor in the outcomes of both orthopaedic and nonorthopaedic medical problems. However, it is difficult to determine the root cause of the effects of SES in the management of injury, whether it influences preintervention decision making or postoperative recovery success. Previous literature has described the benefits of operative fixation of DRFs, including quicker return to function, less loss of motion, and decreased pain.^[12]

In this study, the authors demonstrate that low SES based on annual household income and insurance status was not associated with differences in operative rates on DRFs, length of stay, or total hospital charges.

Although low SES did not significantly affect operative rates, DRF OTA/AO classification type C, younger age, open fractures, and bilateral fracture were all independent predictors of operative management. This is consistent with current practice principles because severe fractures, open fractures, and patients with better healing potential all make for better surgical candidates. Prior research conducted in mainly outpatient orthopaedic settings has concluded that insurance status is an independent predictor of access to care and surgical rates.^[16–18] Low SES has also been shown to lead to poorer DRF outcomes.^[6] Despite the literature, this study demonstrates that lack of insurance or low SES based on median household income was not associated with differences in the surgical treatment of DRFs in the trauma setting.

The study results potentially suggest 2 things. Preoperative disparities in surgical care access potentially affect outpatient, elective, or private settings more than large academic trauma centers. Second, the differences in DRF-specific outcomes reported in the literature may be the result of postoperative differences or other factors that may be different between socioeconomic groups. Intrinsic factors such as smoking, comorbidities, psychosocial factors, and social support may play a significant role in surgical outcomes. Future studies should investigate the availability of postoperative resources in low socioeconomic cohorts, such as physical therapy, medical follow-up, or potential occupational hazards. Patients in low socioeconomic groups may have higher rates of manual labor-type occupations and be unable to immobilize their wrists for adequate times for bony healing because of the risk of potential job loss due to their injuries.

Regarding total hospital cost and length of stay, this study demonstrated no significant differences between socioeconomic cohorts after controlling for injury severity. However, the data highlight the exceedingly high costs that arise from trauma care, with the mean total hospital charge being 88,395 USD, regardless of insurance status or median household income. Many patients sustained significant polytrauma, which drives costs up because of prolonged hospitalizations, ICU stays, and increased number of procedures required. However, these figures call attention to the problem of rising health care costs in the United States. In stark contrast, an observational study conducted in the United Kingdom demonstrated that the average cost of admission at a tertiary referral center for patients with significant polytrauma and ISS >15 was merely 14,129 British Pound Sterling (GBP), which equates to approximately 17,000 USD at the time of

TABLE 3
Mean Annual Median Household Income, Mean Length of Stay, Mean Hospital Charges, and ISS Score by Income Group.

	Overall	Income ≤ \$31,700 n = 141	Income > \$31,700 n = 675	P
Annual median household income (SD), USD	48,105 (20,555)	26,560 (3374)	52,606 (19,777)	
Total hospital charges (SD), USD	88,395 (113,174)	93,836 (118,307)	87,722 (112,945)	0.5705
Length of stay (SD), days	5.9 (9.9)	6.0 (9.7)	5.9 (10.0)	0.8594
ISS score	10.6	10.7	10.6	0.8886

publication.^[19] The average incurred charge for the low socioeconomic cohort in this study equated to approximately 350% of their average median household income, a cost that would be staggering to any family. By contrast, the normal socioeconomic cohort in this study incurred charges equating to approximately 160% of their average median household income (Table 3). This cost study demonstrates the drastically increased burden that health care costs play on those from lower socioeconomic backgrounds. These staggering data bring light to the enormous economic gap between groups of different SES, with equitable medical care bringing varying levels of financial hardship on different peoples.

The cost burden of DRFs in patients with low SES varies drastically between operative and conservative management, with open reduction and internal fixation being twice as costly as closed reduction alone.^[8] Many of these patients inevitably will be unable to pay for their care, thereby incurring fiscal deficits to either hospitals or government assistance programs, in addition to themselves. In addition, patients with lower socioeconomic backgrounds are less likely to have private or employer-sponsored insurance to assist them in repaying hospital costs. All these barriers to access may cause patients to seek care that is less costly. It is essential to provide quality indicated care to patients. In addition, during the shared decision-making process, it is crucial to consider the long-term outcomes of medical or surgical treatment to a patient, whether it is the function of their wrist or their financial stability and socioeconomic situation.

Considering the increasingly evident burden of DRFs on patients with lower SES, surgeons must consider their approach to this problem. Many health plans, employers, and governments are investing in price transparency models to improve the accessibility of care for their patients,^[20] but this brings to light the difficulty of price transparency in the trauma or emergency setting. One potential area for improvement is the nature of the consent process for surgery. Current practice does not require cost to be a factor in the discussions of informed consent for surgery, and exorbitant hospital costs can surprise many patients brought in under emergency circumstances. In a patient with a moderately displaced fracture with less than clear indications for surgical management, it is potentially prudent to factor in the patient’s ability to sustain the financial burden of such a surgery. Bringing the cost of care into the preoperative consent discussion

can help improve collaborative care and allow patients to make better decisions for their overall long-term well-being both regarding surgical outcomes and economic burden.

The data in this study are collected from every trauma activation over 7 years at a large level 1 trauma center with a vast catchment area, taking care of a patient population of more than 2.4 million. This lends to a broad patient mix that includes many demographics. However, a significant limitation arises from studying data constrained to a tertiary referral center in a large city. In addition, the DRFs in this study were retrieved from a trauma department database that excluded normal emergency department visits, including only those that resulted in a trauma activation. Owing to the nature of the data retrieved and the patient population at this center, there are higher proportions of severe fractures and fractures requiring surgical management because many trauma activations resulted from a transfer from smaller trauma centers in the community. Although this was the case, 35% of the OTA/AO type C fractures were managed nonoperatively, despite these typically being intra-articular, unstable, and displaced. A significant number of these patients sustained significant polytrauma and were too medically unstable to undergo definitive fixation, as well as many patients who were set up for outpatient surgery at discharge but failed to follow-up. In this study, the surgeons are compensated by salary with an additional production-based incentive, which may lead to selection bias and higher operative rates. Between 2010 and 2015, only 13% of Medicare beneficiaries who sustained DRFs were managed with open reduction and internal fixation.^[21] By contrast, 55.8% of the patients in this study were managed operatively, consistent with more severe injuries and a younger population. All these factors contribute to potential confounding variables in operative rates. Nonetheless, the data discussed in this study are an accurate representation of the operative trends at a busy level 1 trauma center in a large city, which can be used to extrapolate to other large urban trauma centers around the country.

Surgical decision-making may be different in private practice or smaller medical centers because lower-energy mechanisms may present at higher frequencies at these types of practices. Archdeacon et al^[22] demonstrated that community hospitals were more likely to definitively manage femur fractures in insured patients and transfer those who were not. Thus, tertiary medical centers are the end points of referral chains and definitively

TABLE 4
Mean Length of Stay and Hospital Charges by Insurance Status.

	Overall	Insured N = 510	Uninsured N = 306	P
Length of stay (SD), days	5.9 (9.9)	6.2 (7.9)	5.4 (12.6)	0.3147
Total hospital charges (SD), USD	88,395 (113,174)	96,584 (122,632)	75,969 (96,540)	0.0092/0.1808*

* P-value after adjusting for age, sex, and ISS.

manage injuries more often than other medical centers. For these reasons, the findings in this study should be constrained to large academic medical centers. Calfee et al.^[23] described that economically disadvantaged patients were less likely to access tertiary hand surgery referral centers. Because the patients in this study presented after trauma activation, many of them may have bypassed typical community referral patterns and may have had an increased access to care compared with those not near large level 1 trauma centers. Nevertheless, this study accurately reflects the practices of this institution because data were collected over a 7-year period, with more than 800 cases of DRF during this time and more than 4000 trauma activations per year. Further research into socioeconomic variables on DRF management in other medical settings such as the outpatient setting would be beneficial, especially because other medical practices may have different distributions of patient presentations.

SES plays a role in the morbidity and mortality of many orthopaedic injuries, including DRFs. However, this study shows that income and insurance status were not significant predictors of surgical management in a large tertiary medical center with level 1 trauma designation. This region remains one with a population that includes a significant number of underserved communities. The region's average earnings per employee remain significantly less than the state average, and the workforce remains less educated on average than the rest of the state.^[13] Many patients present from border cities and economically underdeveloped areas. These populations are some of the most vulnerable, and this study sheds light on how the standard of medical practice can be financially devastating to those who have less fiscal freedom and struggle with poverty. Regardless of SES, it is crucial that orthopaedic surgeons, practices, and hospital systems work to provide equitable care that considers holistic patient health, including not only extremity function but also socioeconomic health and stability.

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