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Factors Associated With 30-Day Readmission in Hand Surgery Patients

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Abstract

Background: Surgical patient hospital readmissions are costly to the health care system. The Affordable Care Act Hospital Readmissions Reduction Program introduced penalties for high hospital readmission rates. We performed a retrospective study evaluating factors associated with readmission in hand surgical inpatients. **Methods:** We performed a retrospective chart review on 566 patients admitted to a level 1 trauma center for hand trauma or infection from January 1, 2016, to December 31, 2019. Data included demographics, social history, medical problems, comorbidities, procedure details, and admission and readmission details. A multivariable regression analysis was performed to identify factors associated with hospital readmission within 30 days. **Results:** Cigarette smoking ($P = .048$), bite wound ($P = .038$), laceration wound ($P = .028$), laceration repair ($P < .01$), open reduction internal fixation ($P = .041$), and disposition to a skilled nursing facility ($P = .017$) were significantly associated with readmission to the hospital within 30 days. For patients who underwent emergency department interventions, alcohol use ($P = .034$), houselessness ($P = .046$), and malnutrition ($P = .036$) were additional factors associated with readmission. **Conclusions:** Immediately irremediable factors such as tobacco and alcohol abuse, malnutrition, and houselessness should be considered as exemptions for penalties levied on health care systems for readmissions. Initiating targeted interventions, such as detoxification, smoking cessation, housing assistance, and improved nutrition, may reduce readmission risk and could improve patient outcomes.

Keywords: trauma, diagnosis, research & health outcomes, health policy, outcomes, psychosocial, surgery, specialty

Introduction

Surgical patient hospital readmissions are costly to the health care system.[1] Factors associated with readmission include age, diabetes, heart disease, ASA class, discharge location, length of hospital stay, intensive care unit admission, insurance payer status, and strength of hospital-discharge facility linkage.[2-4] In efforts to improve patient safety and reduce this cost, the Hospital Readmissions Reduction Program (HRPP) was established in 2012.[5] Under this policy, hospitals with higher readmission rates, compared with neighboring centers, face financial penalties.[1,6] Medical conditions with increased readmission risk, such as heart failure or chronic obstructive pulmonary disease, can be exemptions.[5] However, exemptions for medical conditions do not take into account the psychosocial and socioeconomic variables that can contribute to poor patient outcomes and hospital readmissions.

Hand surgeons often care for underserved and underresourced patients. Multiple studies have demonstrated a connection between lower socioeconomic status and higher incidence and severity of hand and upper limb injuries.[7-10] These patients are often treated at safety net hospitals, whose maintenance is critical to providing these patients with access to care.[11,12]

However, safety net hospitals are often understaffed, pressuring the system to expeditiously discharge patients when they are medically stable. Under-resourced patients may not have stable housing, may have poor home support, may live remotely, may not have reliable transportation, and may have psychosocial factors that interfere with aftercare compliance such as wound management, follow-up, or therapy.[13] Poor

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aftercare follow through could adversely influence outcome and readmission, and could be a disproportionate financial burden on safety net hospitals.[14,15]

Our purpose was to identify factors that contribute to 30-day hospital readmissions in patients undergoing bedside and operative hand procedures as emergency department (ED) or inpatient admissions. We hope that by identifying uncorrectable psychosocial and demographic factors and medical comorbidities, we can suggest possible penalty exemptions to protect hospitals caring for these vulnerable patients.

Materials and Methods

After institutional review board approval, a retrospective review was conducted of all patients who received care at a single level 1 trauma center and safety net hospital in San Diego, CA, between January 1, 2016, and December 31, 2019, who were seen for upper extremity infection, fracture, or traumatic injury treated by our hand surgery service in the ED or operating room (OR) as an inpatient.

Demographic data we collected included age, sex, body mass index (BMI), race, and ethnicity. We collected data regarding smoking status, diabetes, intravenous drug use (IVDU), hypertension, coronary artery disease, chronic obstructive pulmonary disease, peripheral vascular disease, anemia, history of immunodeficiency, human immunodeficiency virus (HIV) status, and history of hepatitis C infection. We also gathered houselessness status, diagnosis, procedure, laboratory results, admission and readmission dates, disposition, antibiotic history, and insurance status. Patients who were incarcerated, pregnant, or under the age of 18 were not included in the study.

Identifying houselessness is difficult in a retrospective study.[16] Social work and hospital discharge planning notes were reviewed. Patients with any mention of being houseless or having housing instability either during the specified admission or within the 30 days prior or following their admission were deemed houseless. Disposition planning notes were used to identify to which facility type patients were discharged (eg, street, skilled nursing facility [SNF], or to a shelter/home).

Statistical Analyses

Descriptive statistical analyses were performed on the demographic data for our cohort, including frequencies for categorical variables such as sex and mean and standard deviation for linear variables such as age. A multivariable logistic regression analysis was performed to identify which medical comorbidities and demographic factors were associated with hospital readmission within 30 days. These analyses were conducted in 2 cohorts: those who underwent bedside interventions in the ED and those who underwent OR intervention. All statistics were performed using SPSS Version 29 (IBM Corp., Armonk, New York).

Results

A total of 566 patients were identified. Most were white (64%), non-Hispanic (71%) males (74%), and the average age was 44.1 years ($SD = 17.9$ years). Most had Medicare or Medicaid insurance (60%), and approximately 1 out of every 5 patients was uninsured (18%). Demographics of all patients included in our study are summarized in Table 1.

The most common medical comorbidities were psychiatric diagnoses (26%), hypertension (25%), diabetes (12%), anemia (11%), and coronary artery disease (6%). Most patients were housed (71%), and 39% were employed. About half of the patients smoked cigarettes (46%) and used alcohol (48%). About a tenth documented IVDU (8%). All of the houseless patients (29%) were discharged without stable accommodations.

Of the 566 patients, 129 had OR procedures. Demographics of these patients are summarized in Table 2. The most common diagnoses were distal radius fractures (40%), other fractures (30%), lacerations (16%), and infection (abscess, 6%; bite wound, 3%; flexor tenosynovitis, 4%). Common procedures included open reduction and internal fixation (ORIF, 27%), laceration repair (16%), or incision and drainage (13%). Average admission was 2.1 days ($SD = 1.4$ days) and patients received approximately 1 week of postoperative antibiotics for soft tissue infection.

Of the 566 patients identified, a total of 75 patients were readmitted (13%). Forty-two of these were patients who underwent intervention in the ED such as closed reduction and splinting or bedside laceration repair. When looking solely at our operative cohort, 23 of these patients returned to our ED within 30 days of discharge. Seven were readmitted to the hospital, a 5.4% readmission rate. The most common reasons for re-presentation were wound care (52%), postoperative pain (22%), and surgical site infections (13%) (Figure 1). Almost all readmissions were due to infections, including 1 abscess, 2 surgical site infections, 1 patient with osteomyelitis, and 1 patient with sepsis. Two patients out of the 7 were readmitted for management of postoperative pain. Average length of stay after readmission was 5.7 days ($SD = 3.6$ days).

Multivariable analyses were performed to evaluate factors contributing to elevated readmission risk in both our operative and full cohorts. In the operative patient cohort, cigarette smoking ($P = .048$), animal bite ($P = .038$), laceration ($P = .028$), undergoing laceration repair ($P < .01$), ORIF ($P = .041$), and disposition to a SNF significantly increased the risk of hospital readmission ($P = .017$) (Table 3). Houselessness ($P = .065$) trended toward significance for readmission risk. Additional analyses were conducted to assess the risk of hospital readmission for patients

Table 1. Cohort Characteristics of All Patients (n = 566).

Characteristic	Mean	Standard deviation
Age	47.1 years	18.1 years
BMI	26.8	5.5
Length of stay	3.44 days	7.9 days
Length of antibiotics	7.33 days	7.74 days
Length of stay at readmission	3.59 days	4.68 days
Characteristic	**Frequency (%)**	
Sex		
Female	164 (27.4)	
Male	435 (72.6)	
Race		
American Indian or Alaska Native	1 (0.2)	
Asian	18 (3)	
Black	48 (8)	
White	372 (62.1)	
Other	160 (26.7)	
Ethnicity		
Hispanic	177 (29.5)	
Non-Hispanic	422 (70.5)	
Insurance status		
Medicare/Medicaid	362 (60.4)	
Private	129 (21.5)	
Uninsured	108 (18.0)	
Current or former smoker		
No	324 (54.1)	
Yes	275 (45.9)	
Alcohol use		
No	313 (52.3)	
Yes	286 (47.7)	
Intravenous drug use		
No	552 (92.2)	
Yes	47 (7.8)	
Homeless		
No	425 (71.0)	
Yes	174 (29.0)	
Chronic obstructive pulmonary disease		
No	563 (94)	
Yes	36 (6)	
Diabetes		
No	527 (88)	
Yes	72 (12)	
Hypertension		
No	451 (75.3)	
Yes	148 (24.7)	
Coronary artery disease		
No	564 (94.2)	
Yes	35 (5.8)	
Steroid use		
No	585 (97.7)	
Yes	14 (2.3)	
Dialysis		
No	588 (98.2)	
Yes	11 (1.8)	
Bleeding disorder		
No	597 (99.7)	
Yes	2 (0.3)	
Anemia		
No	536 (89.50)	
Yes	63 (10.5)	
Congestive heart failure		
No	576 (96.2)	
Yes	23 (3.8)	
Human immunodeficiency virus		
No	584 (97.5)	
Yes	15 (2.5)	
Hepatitis C		
No	562 (93.8)	
Yes	37 (6.2)	
Malnutrition		
No	582 (97.2)	
Yes	17 (2.8)	
Employment		
Employed	235 (39.2)	
Unemployed	138 (23)	
Other	144 (24)	
Not specified	82 (13.7)	
Psychiatric diagnosis		
No	445 (74.3)	
Yes	154 (25.7)	
Treating specialty		
Orthopedic surgery	574 (95.8)	
Plastic surgery	25 (4.2)	
Preoperative diagnosis		
Abscess	36 (6)	
Bite (human or animal)	21 (3.5)	
Compartment syndrome	7 (1.2)	
Distal radius fracture	51 (8.5)	
All other fractures	146 (24.4)	
Flexor tenosynovitis	10 (1.7)	
Laceration	93 (15.5)	
Cellulitis	103 (17.2)	
Emergency department intervention		
Closed reduction and splinting	123 (20.5)	
Laceration repair	77 (12.9)	
Incision and drainage	120 (20.1)	
Other	38 (6.3)	
None	241 (40.2)	
Operating room intervention		
Closed reduction and percutaneous pinning	11 (1.8)	
Fasciotomy	3 (0.5)	
Incision and drainage	67 (11.2)	
Laceration repair	34 (5.7)	
Open reduction, internal fixation	14 (2.3)	
Dispo		
Home	382 (63.8)	
Nursing facility	46 (7.7)	
Street	171 (528.5)	

Note. BMI = body mass index.

Table 2. Cohort Characteristics of Patients Who Underwent Surgical Intervention in the Operating Room (n = 129).

Characteristic	Mean	Standard deviation
Age	44.1 years	17.9 years
BMI	26.5	5.4
Length of stay	2.1 days	1.4 days
Length of antibiotics	7.5 days	7.8 days
Length of stay at readmission	5.7 days	3.6 days
Characteristic	**Frequency (%)**	
Sex		
Female	34 (26.4)	
Male	95 (73.6)	
Race		
Asian	4 (3.1)	
Black	10 (7.8)	
White	82 (63.6)	
Other	33 (25.6)	
Ethnicity		
Hispanic	37 (28.7)	
Non-Hispanic	92 (71.3)	
Insurance status		
Medicare/Medicaid	72 (55.8)	
Private	30 (23.3)	
Uninsured	27 (20.9)	
Current or former smoker		
No	78 (60.5)	
Yes	51 (39.5)	
Alcohol use		
No	66 (51.2)	
Yes	63 (48.8)	
Homeless		
No	105 (81.4)	
Yes	24 (18.6)	
Intravenous drug use		
No	119 (92.2)	
Yes	10 (7.8)	
Chronic obstructive pulmonary disease		
No	120 (93)	
Yes	9 (7)	
Diabetes		
No	113 (87.6)	
Yes	16 (12.4)	
Hypertension		
No	93 (72.1)	
Yes	36 (27.9)	
Coronary artery disease		
No	115 (89.1)	
Yes	14 (10.9)	
Steroid use		
No	128 (99.2)	
Yes	1 (0.8)	
Dialysis		
No	128 (99.2)	
Yes	1 (0.8)	
Bleeding disorder		
No	129 (100)	
Yes	0 (0)	
Anemia		
No	116 (89.9)	
Yes	13 (10.1)	
Congestive heart failure		
No	127 (98.4)	
Yes	2 (1.6)	
Human immunodeficiency virus		
No	129 (100)	
Yes	0 (0)	
Hepatitis C		
No	129 (100)	
Yes	0 (0)	
Malnutrition		
No	126 (97.7)	
Yes	3 (2.3)	
Employment		
Employed	82 (63.6)	
Unemployed	47 (36.4)	
Psychiatric diagnosis		
No	89 (69)	
Yes	40 (31)	
Treating specialty		
Orthopedic surgery	107 (82.9)	
Plastic surgery	22 (17.1)	
Preoperative diagnosis		
Abscess	8 (6.3)	
Bite (human or animal)	4 (3.2)	
Compartment syndrome	1 (0.8)	
Distal radius fracture	52 (40.3)	
All other fractures	38 (29.5)	
Flexor tenosynovitis	5 (3.9)	
Laceration	21 (16.3)	
Operating room intervention		
Closed reduction and percutaneous pinning	55 (69.7)	
Fasciotomy	1 (0.8)	
Incision and drainage	17 (13.2)	
Laceration repair	21 (16.3)	
Open reduction, internal fixation	35 (27.1)	
Dispo		
Home	96 (74.4)	
Nursing facility	9 (7.0)	
Street	24 (18.6)	

Note. BMI = body mass index.

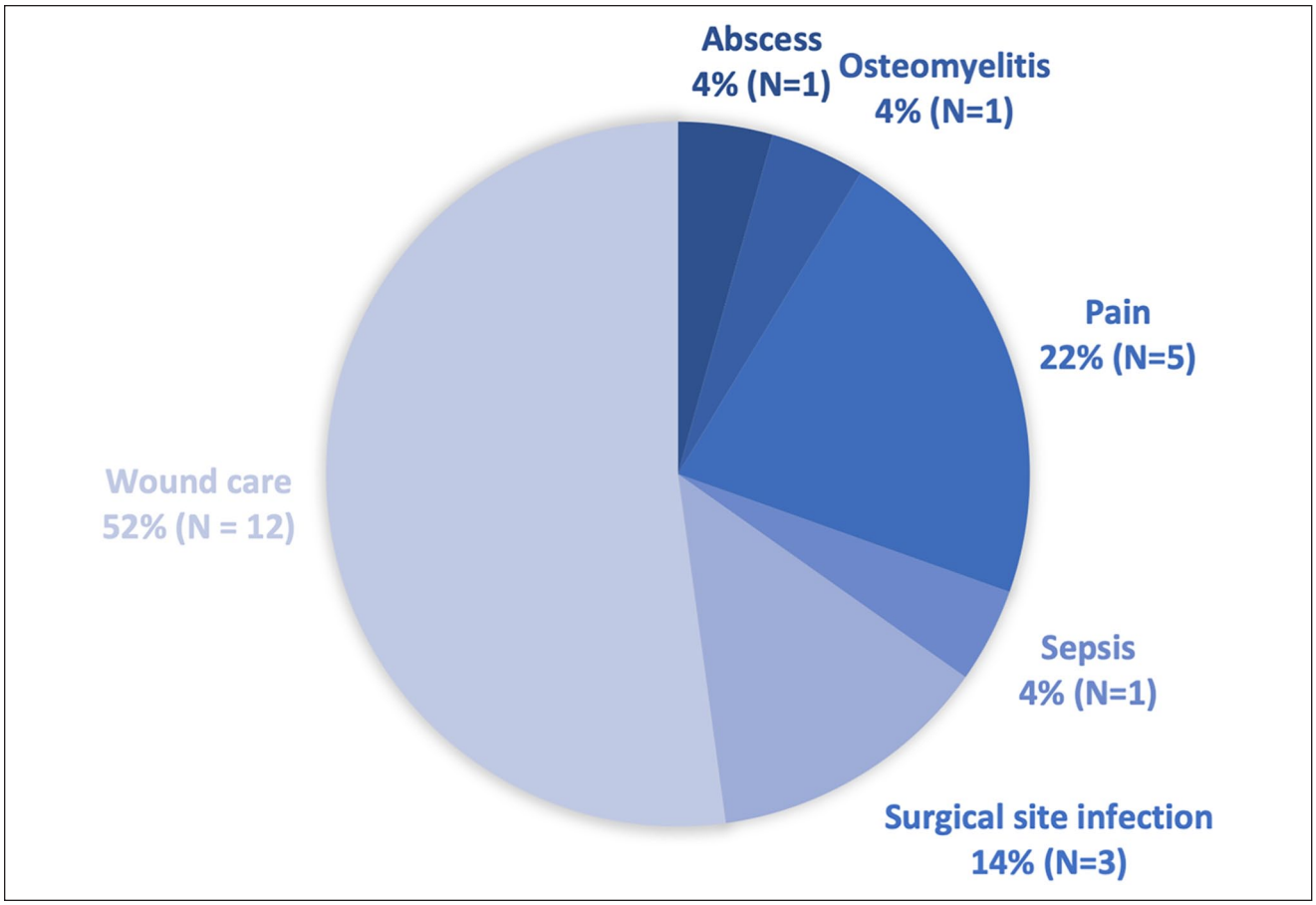

Figure 1. Reasons for re-presentation to the emergency department for patients who underwent surgical intervention in the operating room.

whose initial intervention was in the ED, such as bedside laceration repairs or incision and drainage. For these patients, alcohol use ($P = .034$), houselessness ($P = .046$), and malnutrition ($P = .036$) were associated with readmission. Findings are summarized in Table 4.

Discussion

Hand surgery has lower rates of unplanned hospital readmissions compared with other surgical fields, with best estimates in a large dataset of outpatient hand surgery patients close to 0.88%.[17] Hand surgery inpatient readmission has not been thoroughly studied. We had a 5.4% readmission rate in an academic level 1 trauma hospital. We presume that the high acuity and wound contamination typically found in the injuries necessitating inpatient surgical management contribute to a higher rate of hospital readmissions in an inpatient population, which is consistent with a 2022 study on pediatric hand surgery readmissions that found inpatient surgery to be a risk factor for hospital readmission when compared with outpatient surgeries.[18]

The most frequent reasons for hospital readmission in this cohort included infections (eg, abscess and surgical site infections) and uncontrolled postoperative pain, similar to other published studies in hand surgery.[17,19-21] We propose that interventions targeted at better understanding postoperative pain in hand surgery as well as patient education and outpatient facilitation of wound management may help reduce these readmissions. Multimodal approaches to pain treatment have been beneficial in a systematic review and may help reduce readmissions for pain control.[22] Close follow-up in the immediate postoperative period may help identify patients at additional risk of infection (eg, immunodeficient status, wound contamination).

Consistent with previous literature, we found that cigarette smoking was associated with increased risk of readmission.[17,23] Readmission rates were also affected by injury mechanism, notably, lacerations and animal bites. Animal bites are a well-known cause for increased risk of infection.[24,25] Although associated with increased readmission rate, the "catch-all" diagnosis of a laceration requiring repair precluded analysis of the impact of the wound size, degree of

Table 3. Multivariable Regression Analysis for Patients Who Underwent Surgical Intervention in the Operating Room.

Dependent variable	Significance
Sex	.929
Race	
Asian	.115
Black	.401
White	.414
Other	.429
Ethnicity	.573
BMI	.119
Insurance status	
Uninsured	.135
Private insurance	.065†
Medicare/Medical	.735
Current or former smoker	.048*
Alcohol use	.846
Intravenous drug use	.401
Homeless	.065†
Chronic obstructive pulmonary disease	.530
Diabetes	.104
Hypertension	.153
Coronary artery disease	.878
Steroid use	.789
Dialysis	.789
Anemia	.332
Congestive heart failure	.717
Malnutrition	.757
Employment	
Employed	.768
Unemployed	.707
Psychiatric diagnosis	.214
Length of stay	.164
Treating specialty	.765
Diagnosis	
Abscess	.304
Bite (human or animal)	.038*
Compartment syndrome	.708
Distal radius fracture	.417
Fracture (other than radius)	.621
Flexor tenosynovitis	.144
Laceration	.028*
Operating room intervention	
Closed reduction and percutaneous pinning	.617
Fasciotomy	.759
Incision and drainage	.719
Laceration repair	<.01**
Open reduction and internal fixation	.041*
Disposition	
Home	.353
Skilled nursing facility	.017*
Street	.120
Length of antibiotics	.869

Note. BMI = body mass index.
†$P < .10$. *$P < .05$. **$P < .01$.

Table 4. Multivariable Regression Analysis of Patients Who Underwent Emergency Department Interventions.

Dependent variable	Significance
Sex	.823
Race	
Asian	.162
Black	.297
White	.135
Other	.244
Ethnicity	.827
BMI	.119
Insurance status	
Uninsured	.361
Private insurance	.417
Medicare/Medical	.889
Current or former smoker	.047*
Alcohol use	.034*
Intravenous drug use	.268
Homeless	.046*
Chronic obstructive pulmonary disease	.284
Diabetes	.104
Hypertension	.533
Coronary artery disease	.785
Steroid use	.430
Dialysis	.800
Bleeding disorder	.660
Anemia	.191
Congestive heart failure	.540
Human immunodeficiency virus	.745
Hepatitis C	.646
Malnutrition	.036*
Employment	
Employed	.768
Unemployed	.021*
Psychiatric diagnosis	.214
Length of stay	.164
Treating specialty	.233
Diagnosis	
Abscess	.744
Bite (human or animal)	.025*
Cellulitis	.462
Compartment syndrome	.233
Distal radius fracture	.601
Fracture (other than radius)	.441
Flexor tenosynovitis	.155
Laceration	.036*
Other	.517
ED intervention	
Closed reduction and splinting	.124
Laceration repair	.423
Incision and drainage	.016*
Disposition	
Home	.533
Skilled nursing facility	.017*
Street	<.01**
Length of antibiotics	.913

Note. BMI = body mass index; ED = emergency department.
*$P < .05$. **$P < .01$.

contamination, or the precipitating injury, in this retrospective study. An infection "scoring system," as described by Sharma et al, may allow clinicians to better prognosticate and identify higher risk patients, such as those with heavily contaminated wounds and animal bites, indicating the need for more aggressive interventions and antibiotic regimens.[26] Open reduction and internal fixation was another factor correlated with an increased risk of hospital readmission. Finally, discharge to a SNF was a predictor of increased risk of hospital readmission. Skilled nursing facilities are subject to a similar policy as the HRPP, with similar disproportionate financial burden on SNFs that treat underserved communities.[27] Interventions targeted at collaboration between hospitals and local SNFs have shown promise, with one study showing a significant decrease in 30-day readmissions following implementation of a targeted protocol to reduce acute care transfers.[28,29]

In the ED setting, practitioners must use their clinical judgment to determine the severity of disease when deciding whether patients require operative intervention in the OR versus the bedside. Often, minor wounds or infections can be treated at bedside with local anesthetic and then monitored in the hospital for a short stay. However, the potential for incomplete debridement of infection is higher in this scenario. While a retrospective study in 2015 found no significant association between treatment setting and number of procedures needed to effectively manage acute suppurative finger infection, they determined that patients with methicillin-resistant *Staphylococcus aureus* (MRSA) infections were at increased risk of persistent infections requiring multiple procedures.[30] When we assessed readmission risk for patients who underwent bedside procedures in the ED, alcohol use, houselessness, and malnutrition were significant risk factors for unplanned 30-day readmissions. We suspect this relationship is multifactorial, stemming from social and physiologic factors. Alcohol use and malnutrition have been independently studied and shown to be associated with higher risk of infection and surgical complications.[31-33] Furthermore, the lack of stable housing, close living quarters in shelters, and absence of consistent access to personal hygiene measures put houseless individuals at higher risk of soft tissue infections, particularly MRSA.[34]

Houselessness merits special consideration when addressing readmission rates in hand surgery. Multiple studies have demonstrated an increased risk of hospital readmissions in patients with housing instability.[35] Patients experiencing houselessness face increased risk of soft tissue infection and traumatic injuries of the hand, likely due to a combination of unsafe living conditions as well as a higher prevalence of concomitant substance use disorder and injection drug use.[36-38] Hand surgeons, particularly those who work at safety net hospitals, are uniquely poised to care for these populations, and an understanding of the unique barriers to care in these patients is crucial. In our study, houselessness was associated with an increased risk of hospital readmission in the Emergency Department intervention group, but our findings were not significant in the OR intervention cohort. It is possible that this elevated risk may be due to undertreating hand problems in patients experiencing houselessness, particularly soft tissue infections. While the lack of statistically significant results in the OR cohort may be due to more complete treatment in the sterile and controlled environment of the OR, we suspect that we also may simply have not operated on enough patients experiencing houselessness to power that statistic adequately. Lack of stable housing and access to sanitary living conditions can further contribute to poor postintervention wound management. Previous studies have investigated a transitional housing for houseless patients who are "too ill to be on the street, but not sick enough to require hospital care," termed respite care.[39] While studies have shown improvements in readmission rates when these policies are implemented, the lack of a stable funding source has precluded their expansion.[40]

There are several limitations to this study. The imprecise nature of the use of the Epic Slicer Dicer tool, along with inconsistencies in medical coding, likely resulted in an imperfect sampling of the department's hand surgery inpatients. Furthermore, the inconsistent medical documentation related to housing status, particularly when describing patients discharged to the "street" versus to unstable housing, likely contributes to some uncertainty in the findings. Finally, we acknowledge that the relatively small sample size and analysis of a single center preclude generalizability of this study. Although these data are not enough to provide ample evidence for sweeping policy change, we hope that our data will encourage further study and prompt the federal government to consider social factors and irremediable comorbidities as readmission penalty exclusions to minimize the financial burden to already overburdened hospital systems.

In a quality and outcome measure-focused health care system, unplanned hospital readmissions are a costly burden to hospital systems. It is in the hand surgeon's best interest to identify and account for social and demographic factors that may contribute to unplanned readmission, particularly in safety net hospitals. The authors suggest that social and demographic factors which may contribute to elevated risk of hospital readmission be factored into penalties incurred against hospital systems to reduce disproportionate financial burden on safety net hospitals that treat at-risk populations.

Ethical Approval

This study was approved by our institutional review board.

Statement of Human and Animal Rights

All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008 (5). A waiver of informed consent was obtained from our university institutional review board for this study.

Statement of Informed Consent

A waiver of informed consent was obtained from our university institutional review board for this study.

Declaration of Conflicting Interests

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