Racial, Ethnic, and Socioeconomic Disparities in Out-of-Hospital Pain Management for Patients With Long Bone Fractures

Remle P. Crowe, PhD, NREMT*; Jamie Kennel, PhD, NRP; Antonio R. Fernandez, PhD, NRP; Brooke A. Burton, NRP; Henry E. Wang, MD, MS; Lee Van Vleet, MHS, NRP; Scott S. Bourn, PhD, RN; J. Brent Myers, MD, MPH

*Corresponding Author. E-mail: Remle.Crowe@eso.com.

Study objective: To evaluate racial and ethnic disparities in out-of-hospital analgesic administration, accounting for the influence of clinical characteristics and community socioeconomic vulnerability, among a national cohort of patients with long bone fractures.

Methods: Using the 2019-2020 ESO Data Collaborative, we retrospectively analyzed emergency medical services (EMS) records for 9-1-1 advanced life support transport of adult patients diagnosed with long bone fractures at the emergency department. We calculated adjusted odds ratios (aOR) and 95% confidence intervals (CI) for out-of-hospital analgesic administration by race and ethnicity, accounting for age, sex, insurance, fracture location, transport time, pain severity, and scene Social Vulnerability Index. We reviewed a random sample of EMS narratives without analgesic administration to identify whether other clinical factors or patient preferences could explain differences in analgesic administration by race and ethnicity.

Results: Among 35,711 patients transported by 400 EMS agencies, 81% were White, non-Hispanic, 10% were Black, non-Hispanic, and 7% were Hispanic. In crude analyses, Black, non-Hispanic patients with severe pain were less likely to receive analgesics compared with White, non-Hispanic patients (59% versus 72%; Risk Difference: -12.5%, 95% CI: -15.8% to -9.9%). After adjustment, Black, non-Hispanic patients remained less likely to receive analgesics compared with White, non-Hispanic patients (aOR:0.65, 95% CI:0.53 to 0.79). Narrative review identified similar rates of patients declining analgesics offered by EMS and analgesic contraindications across racial and ethnic groups.

Conclusions: Among EMS patients with long bone fractures, Black, non-Hispanic patients were substantially less likely to receive out-of-hospital analgesics compared with White, non-Hispanic patients. These disparities were not explained by differences in clinical presentations, patient preferences, or community socioeconomic conditions. [Ann Emerg Med. 2023;■:1-12.]

Please see page XX for the Editor's Capsule Summary of this article.

0196-0644/$-see front matter

https://doi.org/10.1016/j.annemergmed.2023.03.035

INTRODUCTION

Background

Inadequate pain management in emergency care remains common, especially for patients belonging to racial and ethnic minority groups.[1] In the emergency department (ED), Black patients are 40% less likely, and Hispanic patients are 25% less likely to receive analgesics compared with White patients with similar conditions.[2] For many acutely ill or injured patients with pain, the first medical contact and the first opportunity for pain relief comes in the out-of-hospital setting with emergency medical services (EMS) clinicians. Out-of-hospital analgesic administration is associated with greater pain reduction and a greater likelihood of pain treatment after arrival at the ED.[3] Nevertheless, pain is largely undertreated in the out-of-hospital setting, and this burden is experienced disproportionately by racial and ethnic minority patients.[4,5]

Importance

Prior studies have described racial and ethnic disparities in pain management but have not adequately explored potential explanatory factors, such as differences in socioeconomic resources, patients' treatment preferences, and the severity of injury or medical condition. The decision to administer analgesics in the out-of-hospital setting is complex and multifactorial. Under some circumstances, such as when the patient declines the medication or when medical contraindications are present, withholding analgesics may be appropriate. Beyond clinical considerations, social and physical environments may also

Editor's Capsule Summary

What is already known on this topic

Pain is undertreated in the out-of-hospital setting, especially among racial and ethnic minority patients.

What question this study addressed

Can inequities in out-of-hospital analgesic administration for long bone fractures be explained by patient treatment preferences, severity of illness, or socioeconomic differences?

What this study adds to our knowledge

In this retrospective observational national study of >35,000 adults with long bone fractures, Black, non-Hispanic patients had 35% lower odds of receiving out-of-hospital analgesics compared to White, non-Hispanic patients. This treatment disparity was not explained by differences in demographic characteristics, pain severity, clinical appropriateness, patient preference, or community socioeconomic vulnerability.

How this is relevant to clinical practice

Future efforts to improve out-of-hospital pain management should focus on racial equity and will need to address underlying structural contributors to the observed inequities.

influence health and health equity. For example, higher income has been linked with increased out-of-hospital analgesic administration.[6] Limited data have distinguished the effects of socioeconomic status from systematic and/or interpersonal racism; however, this disentanglement is essential to effectively identify and address the root causes of persistent observed racial and ethnic disparities.

Goals of This Investigation

We sought to evaluate racial and ethnic disparities in out-of-hospital analgesic administration while accounting for the influence of clinical characteristics and community socioeconomic resources among a national cohort of patients with confirmed long bone fractures on ED diagnosis.

MATERIALS AND METHODS

Study Design and Data Source

We conducted a retrospective observational analysis of EMS-transported adult patients with long bone fractures using the 2019 and 2020 ESO Data Collaborative research datasets. The ESO is a large provider of out-of-hospital electronic health record software in the United States. In compliance with the National EMS Information System (NEMSIS) version 3.4 standard, the electronic health record facilitates the collection of dispatch, demographic, and clinical characteristics of the EMS encounter.[7] A separate health data exchange software allows for bi-directional data sharing and linkage of ED and hospital information, including International Classification of Diseases (*ICD*-10) diagnoses, with the electronic health record.

Agencies voluntarily consent to participate in the ESO Data Collaborative, whereby all records are de-identified and included in annual research datasets. No data abstraction is performed as data elements are gathered directly from the electronic health record database. Annual research datasets are made available without cost following a proposal review process, institutional review board approval, and data use agreement.

In 2020, the ESO Data Collaborative research data set contained 9,854,576 records (84% 9-1-1 responses) from 2,000 consenting EMS agencies. Patient encounters were geographically distributed in the South (53%), Midwest (24%), West (16%), and Northeast (6%) Census regions. Most encounters (79%) occurred in urban areas per the Centers for Medicare and Medicaid Services classifications. A total of 516 (26%) agencies contributed EMS records linked with hospital data through the health data exchange, representing approximately 21% (1,001,809) of all 9-1-1 EMS transport in the data set. Of these linked encounters, 54% occurred in the South, 22% in the Midwest, 20% in the West, and 4% in the Northeast. Most (94%) occurred in urban settings. This study was considered exempt from review by the institutional review board at St. David's Health Care. We report findings in alignment with the STrengthening the Reporting of OBservational studies in Epidemiology (STROBE) guidelines.

Selection of Study Subjects

We included all 9-1-1 EMS responses involving adult patients (older than 18 years) with an ED *ICD*-10 diagnosis code indicating a fracture of one or more long bones (humerus, radius, ulna, femur, tibia, fibula) between January 1, 2019, and December 31, 2020. We excluded encounters not originating from a 9-1-1 call (eg, interfacility transports) and those that did not result in EMS transport to a hospital. We excluded patients with an initial Glasgow Coma Scale score less than 14 or an initial A-V-P-U (alert - verbal - pain - unresponsive) assessment of responsive to pain or unresponsive as these patients may have experienced more serious injuries that required prioritization of life-saving interventions over analgesic

administration. We also excluded encounters from EMS units providing solely basic life support (BLS) care to limit the influence of scope of practice restrictions on analgesic administration. Lastly, we excluded patients without documented race and ethnicity as this was the primary independent variable for this study.

Measures

Analgesic administration is an important process measure for alleviating pain associated with long bone fractures and is largely within the control and discretion of the attending EMS clinicians. Our primary outcome measure included any analgesic medication administered in the out-of-hospital setting by any route. Analgesic medications used by EMS include opioids (fentanyl, morphine, hydromorphone), ketamine, nonsteroidal anti-inflammatory drugs (ketorolac, ibuprofen), and acetaminophen. Secondarily, in alignment with existing out-of-hospital pain management research,[8] we describe clinically meaningful pain reduction as a decrease of 2 or more points on the 0 to 10 pain scale between the final and initial EMS pain assessments.

Our primary independent variable was EMS-documented patient race and ethnicity. As social rather than biological constructs, we used race and ethnicity as proxies for the effects of racism (structural and/or interpersonal). In the electronic health record, separate data elements existed for race and ethnicity. These items were not forced responses and could be omitted by the documenting clinician. For race, EMS clinicians selected from the following options: American Indian or Alaska Native, Asian, Black, non-Hispanic or African American, Hispanic or Latino, Native Hawaiian or Other Pacific Islander, or White. The race data element allowed a single selection from 2019 until August 2020, when the data element was revised to allow multiple selections. Ethnicity was a single select data element with Hispanic or Latino or Not Hispanic or Latino as drop-down selection options.

For analysis, we classified patients who were identified in the electronic health record as "White" in the race field and who either had "not Hispanic or Latino" or no selection for ethnicity as "White, non-Hispanic." Similarly, we classified those who were identified as "Black" in the race field and who either had "not Hispanic or Latino" or no selection for ethnicity as "Black, non-Hispanic." Because Hispanic or Latino was listed as a choice in both the ethnicity and race data elements, we categorized patients who had "Hispanic or Latino" selected for ethnicity and any one of the options for race "Hispanic or Latino." We also classified those who only had "Hispanic or Latino" selected for race as "Hispanic or Latino" (abbreviated as "Hispanic" throughout). Finally, because of small cell sizes precluding more granular stable analyses, we classified patients documented as any other race, as well as those documented as belonging to 2 or more races, into the "Other Race or Ethnicity" category (abbreviated as "Other" throughout).

To better understand and isolate racial and ethnic treatment inequities in the context of social determinants of health, we included socioeconomic status of the geographic area where the EMS encounter occurred as a proxy for patient access to financial resources. Socioeconomic status was measured using the Centers for Disease Control and Prevention's Social Vulnerability Index[9] for the EMS encounter scene location Census tract. Specifically, we used the socioeconomic status theme, which is computed using measures of the population below poverty, unemployment, income, and the proportion of the population without a high school diploma for each US Census tract.[10] Tract rankings are based on percentiles with values ranging from 0 to 1. Higher values indicate greater socioeconomic vulnerability. Previous work has linked higher values from the socioeconomic status theme to more health conditions and worse health outcomes for individual patients.[11,12] For analysis, we classified encounters in the 1 to 25th percentile as Q1 (least vulnerable), 26 to 50th percentile Q2, 51 to 75th percentile Q3, and >75th percentile as Q4 (most vulnerable).

We identified additional potentially confounding variables a priori: age in years, sex, fracture location, EMS transport time, and first pain score severity category. While sex and gender are distinct constructs, at the time of this work, the electronic health record included a field for gender only. The options within the gender data element included only "male," "female," and "unable to determine." Fracture location was categorized based on the linked hospital diagnoses as humerus, ulna/radius, femur, tibia/fibula/ankle, or multiple locations. As shorter EMS transport times are associated with clinician decisionmaking and choice to withhold analgesic administration in the out-of-hospital setting and are also associated with urban settings where racial and ethnic diversity is increased, we included EMS transport time as the difference in minutes from the time the ambulance departed the scene of the encounter until arrival at the hospital.[13] We classified pain scores documented by EMS on the 0 to 10 scale into severity categories: none (0), mild (1 to 3), moderate (4 to 6), or severe (7 to 10).

Statistical Analysis

To evaluate for potential systematic differences in patient and encounter characteristics, we first described patients with and without documented race and ethnicity.

Next, we performed crude comparisons of out-of-hospital analgesic administration by patient race and ethnicity by calculating risk differences (RD) with 95% confidence intervals (CI), applying a Bonferroni adjustment for multiple comparisons. As EMS clinicians may be more likely to provide analgesics for patients presenting with severe pain, compared with moderate or mild pain, we further performed subgroup analysis of analgesic administration to patients with severe pain. Additionally, for patients with 2 or more EMS-documented pain scores and severe pain on initial EMS assessment, we compared the crude differences in pain reduction (of at least 2 points on a 0 to 10 scale) using RD and 95% CI with a Bonferroni adjustment.

We then used a multivariable generalized estimating equation model with a logit link and a robust Huber-White sandwich variance estimator to calculate adjusted odds ratios (aOR) and 95% CI for out-of-hospital analgesic administration by race and ethnicity, accounting for potential correlations arising from clustering because of agency-level protocols and training. In this multivariable model, we adjusted for confounding variables selected a priori based on existing literature and expert determination: patient age, gender, scene socioeconomic status, insurance status, fracture location, transport time, and first pain score severity category. We modeled categoric covariates using dummy coding and omitting the reference category. We assessed for statistical interactions between race and ethnicity with gender and scene socioeconomic status using postestimation Wald tests of the interaction terms. We planned to include interaction terms with $P<.05$ in the final model. We excluded patients with missing data in a casewise fashion from the multivariable analyses. As a sensitivity analysis, we performed multiple imputations by chained equations using 10 imputations, including race and ethnicity, age, gender, insurance status, scene socioeconomic status, fracture location, transport time, pain severity category, and region in the model. We used Stata v15.1 (College Station, TX) for all analyses.

Review of Free-Text EMS Clinician Narratives

To explore possible reasonable exceptions for analgesic administration, we reviewed a random sample of the free-text EMS clinician narratives. All records for patients with documented severe pain on initial EMS assessment and no documentation indicating out-of-hospital analgesic administration in the drop-down medication fields were eligible for further review. We obtained a random sample from each racial and ethnic group based on estimates from a sample-size calculator, assuming a 5% sampling error. Four reviewers with EMS clinician credentials (ARF, JK, RPC, SSB) conducted reviews. Two reviewers were randomly assigned to each narrative. Reviewers were blinded to the race and ethnicity of the patient.

We used an inductive approach to generate themes that could potentially explain why out-of-hospital analgesics were not administered by examining a subset of randomly selected records to identify themes. Final themes included: patient declined the analgesic medication, patient reported pain relief without medication, analgesic administration was documented in the free-text, nonpharmacologic pain management interventions were applied, analgesic administration occurred before arrival of the attending EMS unit, a contraindication for analgesic administration was noted, and/or a language barrier was present.

Reviewers then independently read their assigned narratives and marked themes for each record. More than one theme could be present within the free-text note of a single patient. For analysis, if either reviewer marked a theme as present, the theme was deemed present. We used descriptive statistics to summarize the frequencies of each theme stratified by race and ethnicity.

RESULTS

Patient Characteristics

We analyzed EMS records for 37,801 patients with ED-diagnosed long bone fractures who were transported by an advanced life support unit. Race and ethnicity were not documented by EMS for 2,090 (5.5%) patients. Pain scores were recorded less frequently, and analgesics were administered less frequently for patients without EMS-documented race and ethnicity (Table E1, available at http://www.annemergmed.com).

After excluding patients for whom race and ethnicity were not documented, the analysis sample consisted of 35,711 patients transported by 400 EMS agencies. Most EMS encounters (69%) occurred in a home/residence or assisted living facility. Most patients were White, non-Hispanic (81%), 10% were Black, non-Hispanic, 7% were Hispanic, and 1% were categorized as multi-racial or belonging to other races/ethnicities. In total, 41% of Black, non-Hispanic patients, 26% of Hispanic patients, and 13% of White, non-Hispanic patients were encountered in areas of high socioeconomic vulnerability (Table 1).

Out-of-Hospital Pain Assessment and Analgesic Administration

The proportion of patients with a documented out-of-hospital pain assessment was similar among White,

Table 1. Patient and encounter characteristics stratified by race and ethnicity groups (N=35,711).

	Patient Race and Ethnicity*			
Characteristic	**Black, Non-Hispanic 10.4% (3,723) Col % (n)**	**Hispanic 7.0% (2,490) Col % (n)**	**Other 1.4% (498) Col % (n)**	**White, Non-Hispanic 81.2% (29,000) Col % (n)**
Age, y				
Median (IQR)	53 (32–68)	53 (35–73)	63 (42–79)	73 (59–84)
Gender				
Female	49.4 (1,838)	51.1 (1,273)	61.0 (304)	66.5 (19,268)
Male	50.6 (1,885)	48.9 (1,217)	39.0 (194)	33.6 (9,729)
Census Region				
Northeast	0.3 (12)	1.7 (41)	0.8 (4)	1.6 (456)
Midwest	16.8 (624)	6.0 (147)	11.1 (55)	16.5 (4,731)
South	75.5 (2,801)	66.1 (1,632)	56.1 (278)	63.3 (18,197)
West	7.4 (274)	26.3 (650)	32.1 (159)	18.7 (5,383)
Urbanicity				
Urban	97.3 (3,615)	95.8 (2,384)	98.2 (489)	91.7 (26,553)
Rural	2.7 (101)	4.2 (104)	1.8 (9)	8.3 (2,408)
Scene Socioeconomic Quartile				
Q1 (Least vulnerable)	15.6 (578)	22.2 (553)	44.0 (218)	35.3 (10,228)
Q2	16.8 (624)	21.6 (537)	24.6 (122)	27.1 (7,839)
Q3	26.7 (991)	30.6 (760)	18.8 (93)	24.2 (7,011)
Q4 (Most vulnerable)	40.9 (1,520)	25.6 (636)	12.7 (63)	13.4 (3,881)
Insurance				
Yes	92.2 (3,432)	93.3 (2,322)	94.6 (471)	96.9 (28,086)
No/Unknown	7.8 (291)	6.7 (168)	5.4 (27)	3.2 (914)
Long Bone Fracture Location				
Humerus	10.5 (389)	12.3 (305)	12.1 (60)	14.7 (4,251)
Ulna/Radius	13.1 (489)	19.1 (475)	14.3 (71)	11.0 (3,203)
Femur	27.4 (1,021)	26.1 (650)	37.4 (186)	44.0 (12,758)
Tibia/Fibula/Ankle	43.6 (1,624)	36.3 (904)	31.1 (155)	25.6 (7,437)
Multiple	5.4 (200)	6.3 (156)	5.2 (26)	4.7 (1,351)
EMS Transport Time, min				
Median (IQR)	11.9 (8.2–16.8)	12.9 (8.8–18.3)	14.0 (9.4–20.6)	14.2 (9.7–20.8)
Number of EMS Pain Scores Recorded				
0	14.3 (534)	15.7 (391)	14.9 (74)	12.7 (3,685)
1	27.0 (1,004)	21.5 (535)	28.7 (143)	23.0 (6,683)
2+	58.7 (2,185)	62.8 (1,564)	56.4 (281)	64.3 (18,632)
First Pain Score Category				
None (0)	8.3 (263)	5.6 (118)	6.6 (28)	8.1 (2,042)
Mild (1-3)	6.7 (214)	6.4 (134)	8.0 (34)	10.1 (2,562)
Moderate (4-6)	26.4 (843)	27.2 (570)	33.0 (140)	29.3 (7,427)
Severe (7-10)	58.6 (1,869)	60.8 (1,277)	52.4 (222)	52.5 (13,284)

*Race and ethnicity categories were defined as: Hispanic = Hispanic or Latino and any other single race, Other = American Indian or Alaska Native, Asian, Native Hawaiian or Other Pacific Islander, or those with 2 or more races selected. *IQR*, interquartile range.

non-Hispanic patients (87%), Black, non-Hispanic, non-Hispanic patients (86%), and Hispanic patients (84%). Pain was re-assessed by EMS for 64% of White, non-Hispanic patients, 59% of Black, non-Hispanic patients, and 63% of Hispanic patients. On initial EMS assessment, a pain score indicating severe pain (more than 6) was

Table 2. Patient and encounter characteristics by out-of-hospital analgesic administration.

	Out-of-Hospital Analgesic Administration		
Characteristic	**Yes 45.7% (16,310) Row % (n)**	**No 54.3% (19,401) Row % (n)**	**RD (95% CI)**
Patient Race and Ethnicity*			
Black, non-Hispanic	39.5 (1,469)	60.5 (2,254)	-6.5 (-8.8 to -4.3)
Hispanic	50.7 (1,263)	49.3 (1,227)	4.7 (1.2 to 7.5)
Other	47.6 (237)	52.4 (261)	1.6 (-4.3 to 7.5)
White, non-Hispanic	46.0 (13,341)	54.0 (15,659)	Reference
Age, y			
Median (IQR)	68 (49–81)	72 (58–84)	
Gender			
Female	47.3 (10,726)	52.7 (11,957)	Reference
Male	42.9 (5,583)	57.1 (7,442)	-4.4 (-5.5 to -3.4)
Census Region			
Northeast	42.9 (220)	57.1 (293)	Reference
Midwest	45.8 (2,547)	54.2 (3,010)	2.9 (-3.1 to 9.0)
South	46.1 (10,556)	53.9 (12,352)	3.2 (-2.7 to 9.1)
West	44.3 (2,866)	55.7 (3,600)	1.4 (-4.6 to 7.5)
Urbanicity			
Urban	45.4 (14,990)	54.6 (18,051)	Reference
Rural	49.7 (1,302)	50.3 (1,320)	4.3 (2.3 to 6.3)
Scene Socioeconomic Quartile			
Q1 (Least Vulnerable)	50.1 (5,794)	50.0 (5,783)	Reference
Q2	45.8 (4,176)	54.2 (4,946)	-4.3 (-6.1 to 2.4)
Q3	43.8 (3,875)	56.2 (4,980)	-6.3 (-8.1 to -4.4)
Q4 (Most Vulnerable)	39.9 (2,436)	60.1 (3,664)	-10.1 (-12.2 to -8.0)
Insurance			
Yes	45.8 (15,724)	54.2 (18,587)	4.0% (1.3 to 6.6)
No/Unknown	41.9 (586)	58.1 (814)	Reference
Long Bone Fracture Location			
Humerus	42.3 (2,118)	57.7 (2,887)	Reference
Ulna/Radius	39.2 (1,663)	60.8 (2,575)	-3.1 (-6.0 to -0.2)
Femur	47.8 (6,990)	52.2 (7,625)	5.5 (3.2 to 7.8)
Tibia/Fibula/Ankle	46.0 (4,657)	54.0 (5,463)	3.7 (1.3 to 6.1)
Multiple	50.9 (882)	49.1 (851)	8.6 (4.7 to 12.5)
EMS Scene Time, min			
Median (IQR)	22 (16.6-28.8)	16 (11.7-21.6)	
EMS Transport Time, min			
Median (IQR)	15.3 (10.6–22.0)	12.7 (8.5–18.5)	
Number of EMS Pain Scores			
0	29.3 (1,373)	70.7 (3,311)	Reference
1	30.5 (2,552)	69.5 (5,813)	1.2 (-0.9 to 3.3)
2+	54.7 (12,385)	45.4 (10,277)	25.3 (23.5 to 27.2)
First Pain Score Category			
None	8.2 (200)	91.8 (2,251)	Reference

Table 2. Continued.

Characteristic	Out-of-Hospital Analgesic Administration		
	Yes 45.7% (16,310) Row % (n)	No 54.3% (19,401) Row % (n)	RD (95% CI)
Mild	11.3 (333)	88.7 (2,611)	3.2 (0.03 to 6.2)
Moderate	29.5 (2,645)	70.6 (6,335)	21.3 (18.7 to 23.9)
Severe	70.6 (11,759)	29.4 (4,893)	62.5 (60.0 to 64.9)

*Race and ethnicity categories were defined as: Hispanic = Hispanic or Latino and any other single race, Other = American Indian or Alaska Native, Asian, Native Hawaiian or Other Pacific Islander, or those with 2 or more races selected. *IQR*, interquartile range.

documented for 53% of White, non-Hispanic patients, 59% of Black, non-Hispanic patients, and 61% of Hispanic patients (Table 1). Among those with at least 2 EMS-recorded pain scores and severe pain documented on initial EMS assessment (n=13,080), fewer Black, non-Hispanic patients experienced a pain reduction of at least 2 points compared with White, non-Hispanic patients (55% versus 69%; RD: -14.6, 95% CI: -18.1 to -11.1) (Table E2, available at http://www.annemergmed.com).

In crude analyses of patients with any or no recorded pain score, Black, non-Hispanic patients were 6.5% less likely to receive an out-of-hospital analgesic compared to White, non-Hispanic patients (40% versus 46%; RD: -6.5%, 95% CI: -8.8% to -4.3%) (Table 2). Among patients with severe pain on initial EMS assessment (n=16,652), Black, non-Hispanic patients were 12.5% less likely to receive analgesics compared to White, non-Hispanic patients (59% versus 72%; RD: -12.5%, 95% CI: -15.8% to -9.9%) (Table E3, available at http://www.annemergmed.com). Fentanyl was the most commonly administered out-of-hospital analgesic across all racial and ethnic groups, representing 86% of all first analgesic administrations. Few patients received acetaminophen or nonsteroidal anti-inflammatory drug medications (Table E4, available at http://www.annemergmed.com).

We identified no significant statistical interactions between race and ethnicity, gender, and scene socioeconomic status; however, each of these variables demonstrated significant main effects in the final multivariable model. In the final multivariable model, Black, non-Hispanic patients had 35% lower odds of receiving an out-of-hospital analgesic compared to their White, non-Hispanic counterparts (aOR: 0.65, 95% CI: 0.53 to 0.79) (Table 3). Adjusted odds of out-of-hospital analgesic administration did not differ for Hispanic patients or those of other races and ethnicities in comparison to White, non-Hispanic patients. Analysis of the imputed data set yielded similar results (Table E5, available at http://www.annemergmed.com).

Review of Free-Text Clinician Notes

Of the 4,893 patients with severe pain who did not receive an out-of-hospital analgesic treatment, we randomly selected 844 free-text clinician-patient care narratives for qualitative review. A total of 14% (47/349) of White, non-Hispanic patients had documentation indicating that the patient declined an analgesic compared with 10% (25/256) of Black, non-Hispanic patients, 7% (12/181) of Hispanic patients, and 5% (3/58) of patients classified as belonging to other racial and ethnic groups. Five percent (18/349) of White, non-Hispanic patients had documented pain relief in the free-text narrative compared with 2% (5/256) of Black, non-Hispanic patients and 1% (2/181) of Hispanic patients. Analgesic medication administration was uncommonly documented in the free-text narrative (4% [34/844] of reviewed records) and did not differ meaningfully by race and ethnicity. Meanwhile, 22% (182/844) had nonpharmacologic interventions documented without substantial differences across racial/ethnic groups. Contraindications for analgesic administration were documented similarly across racial/ethnic groups and affected 16% (137/844) of reviewed records (Table 4).

LIMITATIONS

As a retrospective data set of electronic patient care records, discrete clinical fields lack information regarding clinical decisionmaking. Pain is dynamic, and pain scores alone do not necessarily distinguish between patients who want pharmacologic pain management and those who do not. Further, there are challenges with measuring nonpharmacologic interventions such as positioning or distraction, as these techniques are not always consistently documented.

Patient race and ethnicity were categorized as documented by the EMS clinicians. It is unknown whether these values were self reported by the patient or selected by the EMS clinicians without consulting the patients. Previous research has demonstrated strong agreement

Table 3. Multivariable generalized estimating equation* odds ratios and 95% CI for of out-of-hospital analgesic administration (N=30,939).

Characteristic	aOR (95% CI)
Patient Race and Ethnicity**	
Black, non-Hispanic	0.65 (0.53–0.79)
Hispanic	1.02 (0.81–1.28)
Other	1.00 (0.66–1.51)
White, non-Hispanic	Reference
Scene Socioeconomic Quartile	
Q1 (Least Vulnerable)	Reference
Q2	0.74 (0.64–0.85)
Q3	0.64 (0.54–0.76)
Q4 (Most Vulnerable)	0.50 (0.40–0.63)
Insurance	
No/Unknown	Reference
Yes	1.39 (1.05–1.86)
Age (per 10-y increase)	0.90 (0.88–0.93)
Gender	
Female	Reference
Male	0.82 (0.76–0.88)
Long Bone Fracture Location	
Humerus	Reference
Ulna/Radius	0.82 (0.73–0.93)
Femur	1.49 (1.35–1.65)
Tibia/Fibula/Ankle	1.12 (1.00–1.25)
Multiple	1.21 (1.04–1.41)
EMS Transport Time (per 10-minute increase)	1.00 (1.00–1.00)
First Pain Score Category	
None	Reference
Mild	1.39 (1.10–1.74)
Moderate	4.62 (3.97–5.37)
Severe	26.9 (22.3–32.5)

*EMS agency used as clustering variable.
**Race and ethnicity categories were defined as: Hispanic = Hispanic or Latino and any other single race, Other = American Indian or Alaska Native, Asian, Native Hawaiian or Other Pacific Islander, or those with 2 or more races selected.

between race and ethnicity documented in hospital records with patient self reported race, though there is a tendency for undercounting individuals belonging to minority racial and ethnic groups.[14] For the research question at hand, the mechanism behind analgesic disparities is social rather than biological, and as such, the clinician-reported race and ethnicity carries value as this socially assigned category affects conscious and unconscious biases that influence behaviors.[15]

Small cell sizes precluded more granular analyses of patients identified as American Indian or Alaska Native, Asian, Native Hawaiian, or Other Pacific Islander, and further research is needed to understand the out-of-hospital experiences of patients belonging to these racial and ethnic groups. The inclusion of "Hispanic or Latino" as a list option in both the ethnicity and race data elements in the electronic health record prevented more granular analyses of patients who were Hispanic or Latino with other combinations of race. Similarly, the inability to select multiple races for patients in the electronic health record before August 2020 could have resulted in underreporting of patients who were bi-racial or multi-racial. Patients who were identified as bi-racial or multi-racial were also included in the other race and ethnicity group for analysis. The proportion of patients classified in the other race and ethnicity category before August 2020 and after August 2020 was similar (1.5% and 1.2%, respectively).

In classifying socioeconomic status, we used an area-based measure for the Census tract of EMS encounter location. As an ecologic measure, the socioeconomic quartiles reported may not reflect the true socioeconomic status of individual patients.

Our decision to exclude BLS unit responses has important implications. Although BLS units can provide pain-relieving interventions such as splinting, ice, positioning, distraction, or over-the-counter oral medications, our primary interest was quantifying disparities in provision of analgesic medications. We chose to limit the analysis to encounters where the opportunity to provide a wide variety of pharmacologic options was present. Thus, this study would not capture any systemic bias at the time of dispatch if BLS units were differentially assigned to encounters involving patients belonging to minority racial and ethnic groups.

Finally, although this study leveraged a large multiagency sample of EMS records, the analysis group remains a sample of convenience as the ESO Data Collaborative does not include every EMS encounter in the United States. The population of EMS agencies participating in the health data exchange tends to contain more encounters in urban populations, as reflected in the demographic distribution of this analysis (93% urban). Nevertheless, this is the largest known sample of EMS patients with confirmed ED diagnoses of long bone fractures. Further, the agencies included in this analysis represent a variety of geographic and practice settings on which future work may build.

DISCUSSION

In our study, EMS clinicians did not provide analgesic medications to Black, non-Hispanic patients as often as

Table 4. Qualitative review of the free-text EMS clinician notes for patients with severe pain and no documented EMS analgesic administration.

	Patient Race and Ethnicity*			
Potential Contributing Factor	**Black, Non-Hispanic N = 256 % (n)**	**Hispanic N = 181 % (n)**	**Other N = 58 % (n)**	**White, Non-Hispanic N = 349 % (n)**
Patient declined medication	9.8 (25)	6.6 (12)	5.2 (3)	13.5 (47)
Patient reported pain relief	2.0 (5)	1.1 (2)	5.2 (3)	5.2 (18)
Analgesic documented in free-text	4.7 (12)	2.8 (5)	3.5 (2)	4.3 (15)
Nonpharmacologic pain management	19.5 (50)	21.0 (38)	25.9 (15)	22.6 (79)
Analgesic given prior to arrival	4.7 (12)	2.2 (04)	6.9 (04)	4.6 (16)
Contraindication noted	18.4 (47)	15.5 (28)	17.2 (10)	14.9 (52)
Language barrier	0.4 (1)	12.7 (23)	12.1 (7)	0.9 (3)

*Race and ethnicity categories were defined as: Hispanic = Hispanic or Latino and any other single race, Other = American Indian or Alaska Native, Asian, Native Hawaiian or Other Pacific Islander, or those with 2 or more races selected.

they did to White, non-Hispanic patients experiencing pain because of long bone fractures. This treatment disparity was not explained by differences in pain severity, clinical appropriateness, patient preferences, or community socioeconomic resources. We did not identify pain treatment inequities among Hispanic patients or those belonging to other racial and or ethnic groups.

In accounting for our findings, the analgesic treatment disparities uncovered may simply represent a clinically convenient context through which to see the ways in which racism influences EMS treatment. There are unique aspects of medical care in the out-of-hospital environment which may contribute to racially biased treatment. First, EMS clinicians treating patients in out-of-hospital settings commonly work under time pressure with substantial clinical ambiguity, which often leads to increased cognitive loads. These situations are known to exacerbate the use of biases through stereotype activation.[16,17] Second, the rising prevalence of EMS patients with substance use disorders can further complicate analgesic administration decisions.[18] Attitudes toward substance abuse disorders may influence suspected misuse of pain medications, which may be incorrectly and disproportionately associated with people of color.[19,20] Next, EMS clinician disbelief in pain reporting, unfortunately, plays an important role in the decision to treat, and these perceptions are subject to racial biases.[20,21] Further, disproven beliefs in EMS clinicians that Black, non-Hispanic patients are physiologically distinct from White, non-Hispanic patients may still persist, as disturbingly reflected in a study of medical students, which may also partially account for our findings.[22] And finally, EMS organizations have important and nontrivial contributions to these disparities, either actively or complicitly, through selective structural neglect creating environments and organizational cultures in which discriminatory behaviors are not appropriately addressed through education, focused performance improvement activities, and clear prioritization from leadership.[23,24]

Our results also reveal important relationships between community socioeconomic vulnerability, race and ethnicity, and EMS treatment. Patients encountered by EMS in areas of lower socioeconomic status received out-of-hospital pain medications less often than patients in wealthier areas. Because of the historical and ongoing impacts of societal racism, this burden also disproportionately impacts Black, non-Hispanic patients, who are more likely to live and work in geographies of lower socioeconomic status.[25] However, socioeconomic conditions alone do not explain the observed racial and ethnic disparities. After adjusting for community socioeconomic conditions where the EMS encounter took place, Black, non-Hispanic patients remained less likely to receive out-of-hospital analgesics. Whereas racial and ethnic disparities in hospital-based health care have been noted to persist across categories of socioeconomic status,[26] this is the first time this relationship has been demonstrated in EMS.

Reasonable clinical explanations or appropriate exceptions to providing out-of-hospital analgesic medications do not appear to be the main drivers of the observed racial and ethnic disparities. In reviewing EMS clinician narratives, we found that Black, non-Hispanic patients refused pain medications at a similar rate compared with White, non-Hispanic patients and that the rate of documented contraindications was also similar. Pain relief achieved through nonpharmacologic interventions also did

not appear to be a contributing factor to the lower rate of analgesic administration to Black, non-Hispanic patients. Notably, nearly half of Black, non-Hispanic patients experiencing severe pain on initial EMS assessment did not experience a meaningful pain reduction on final EMS assessment, whereas this figure was far lower among White, non-Hispanic patients. Even among patients who received out-of-hospital analgesics, fewer Black, non-Hispanic patients experienced pain reduction compared with White, non-Hispanic patients. This difference did not appear to relate to the choice of analgesic as opioids were the front-line out-of-hospital analgesic in the overwhelming majority of cases. Future research is needed to understand clinical and interpersonal factors underlying these disparities in pain relief.

Looking forward, a critical question remains as to how best to improve pain management for Black, non-Hispanic patients in the out-of-hospital setting. Interventions that may effectively combat biases, including empathy training and cross-cultural training, are certainly insufficient and, if done in isolation, risk placing inappropriate levels of blame on the clinicians when the challenge is also likely to be systemic.[27] Additionally, increasing racial and ethnic diversity within the EMS workforce and leadership could serve as a powerful means to reducing communication barriers (both linguistic and cultural), reducing stereotype threat, providing culturally relevant patient care, and reducing resulting inequities.[28,29] Further research is needed to explore the factors associated with disparities, develop evidence-based interventions, and evaluate strategies to reduce racial and ethnic treatment disparities in out-of-hospital pain management.

Collectively, the findings presented here speak to the complexity of the racial and ethnic treatment inequities and further support the need to examine EMS treatment disparities within the context of social theories of race and racism. As efforts to improve out-of-hospital pain management increase, deliberate attention on equitable care through robust quality management processes using racism-informed methodological tools and recommendations are warranted to ensure that gaps in care for Black, non-Hispanic patients and the most socioeconomically vulnerable are eliminated.

Supervising editors: Hemal K. Kanzaria, MD and Richelle J. Cooper, MD, MSHS. Specific detailed information about possible conflicts of interest for individual editors is available at https://www.annemergmed.com/editors.

Author affiliations: From ESO (Crowe, Fernandez, Bourn, Myers), Austin, TX; Oregon Health and Science University (Kennel), Portland, OR; Oregon Institute of Technology (Kennel), Wilsonville, OR; Unified Fire Authority (Burton), Salt Lake City, UT; Department of Emergency Medicine, The Ohio State University (Wang), Columbus, OH; Durham County EMS (Van Vleet), Durham, NC.

Author contributions: Study conceptualization and design: RPC, JK, ARF, BAB, HEW, LVV, SSB, and JBM. Literature review: SSB, RPC, and JK. Data analysis and interpretation of results: RPC, JK, ARF, SSB, and JBM. Manuscript development: RPC, JK, ARF, BAB, HEW, LVV, SSB, and JBM. RPC takes responsibility for the paper as a whole.

All authors attest to meeting the four ICMJE.org authorship criteria: (1) Substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work; AND (2) Drafting the work or revising it critically for important intellectual content; AND (3) Final approval of the version to be published; AND (4) Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Funding and support: By *Annals* policy, all authors are required to disclose any and all commercial, financial, and other relationships in any way related to the subject of this article as per ICMJE conflict of interest guidelines (see www.icmje.org). The authors have declared that no competing interests exist.

Publication dates: Received for publication September 1, 2022. Revisions received January 18, 2023, and February 20, 2023. Accepted for publication March 30, 2023.

Presentation information: Accepted for oral presentation at the American College of Emergency Physicians *Scientific Assembly* October, 2022, San Francisco, CA.

REFERENCES

1. Owens A, Holroyd BR, McLane P. Patient race, ethnicity, and care in the emergency department: a scoping review. *CJEM*. 2020;22:245-253.
2. Lee P, Le Saux M, Siegel R, et al. Racial and ethnic disparities in the management of acute pain in US emergency departments: meta-analysis and systematic review. *Am J Emerg Med*. 2019;37:1770-1777.
3. Harris MI, Adelgais KM, Linakis SW, et al. Impact of prehospital pain management on emergency department management of injured children. *Prehosp Emerg Care*. 2021:1-12.
4. Hewes HA, Dai M, Mann NC, et al. Prehospital pain management: disparity by age and race. *Prehosp Emerg Care*. 2018;22:189-197.
5. Kennel J, Withers E, Parsons N, et al. Racial/ethnic disparities in pain treatment: evidence from oregon emergency medical services agencies. *Med Care*. Dec 2019;57:924-929.
6. Michael GE, Sporer KA, Youngblood GM. Women are less likely than men to receive prehospital analgesia for isolated extremity injuries. *Am J Emerg Med*. 2007;25:901-906.
7. National EMS Information System. NEMSIS Data Dictionary NHTSA v3.4.0 Build 200910 EMS Data Standard. Accessed February 16, 2023. https://nemsis.org/media/nemsis_v3/release-3.4.0/DataDictionary/PDFHTML/DEMEMS/index.html
8. Jarvis JL, Johnson B, Crowe RP. Out-of-hospital assessment and treatment of adults with atraumatic headache. *J Am Coll Emerg Physicians Open*. Feb 2020;1:17-23.

9. Agency for Toxic Substances and Disease Registry. CDC/ATSDR Social Vulnerability Index. Accessed December 3, 2022. https://www.atsdr.cdc.gov/placeandhealth/svi/index.html
10. Flanagan BE, Gregory EW, Hallisey EJ, et al. A social vulnerability index for disaster management. *JHSEM*. 2011;8.
11. Bevan G, Pandey A, Griggs S, et al. Neighborhood-level social vulnerability and prevalence of cardiovascular risk factors and coronary heart disease. *Curr Probl Cardiol*. 2022:101182.
12. Herrera-Escobar JP, Uribe-Leitz T, Wang J, et al. The social vulnerability index and long-term outcomes after traumatic injury. *Ann Surg*. 2022;276:22-29.
13. Browne LR, Studnek JR, Shah MI, et al. Prehospital opioid administration in the emergency care of injured children. *Prehosp Emerg Care*. 2016;20:59-65.
14. Klinger EV, Carlini SV, Gonzalez I, et al. Accuracy of race, ethnicity, and language preference in an electronic health record. *J Gen Intern Med*. 2015;30(6):719-723.
15. Macintosh T, Desai MM, Lewis TT, et al. Socially-assigned race, healthcare discrimination and preventive healthcare services. *PLoS One*. 2013;8:e64522.
16. Hirsh AT, Hollingshead NA, Ashburn-Nardo L, et al. The interaction of patient race, provider bias, and clinical ambiguity on pain management decisions. *J Pain*. 2015;16:558-568.
17. Burgess DJ. Are providers more likely to contribute to healthcare disparities under high levels of cognitive load? How features of the healthcare setting may lead to biases in medical decision making. *Med Decis Making*. 2010;30:246-257.
18. Turner HN, Oliver J, Compton P, et al. Pain management and risks associated with substance use: practice recommendations. *Pain Manag Nurs*. 2022;23:91-108.
19. Tait RC, Chibnall JT. Racial/ethnic disparities in the assessment and treatment of pain: psychosocial perspectives. *American Psychol*. 2014;69:131.
20. Rupp T, Delaney KA. Inadequate analgesia in emergency medicine. *Ann Emerg Med*. 2004;43:494-503.
21. Mende-Siedlecki P, Lin J, Ferron S, et al. Seeing no pain: assessing the generalizability of racial bias in pain perception. *Emotion*. 2021;21:932-950.
22. Hoffman KM, Trawalter S, Axt JR, et al. Racial bias in pain assessment and treatment recommendations, and false beliefs about biological differences between blacks and whites. *Proc Natl Acad Sci U S A*. 2016;113:4296-4301.
23. Cash RE, White-Mills K, Crowe RP, et al. Workplace incivility among nationally certified EMS professionals and associations with workforce-reducing factors and organizational culture. *Prehosp Emerg Care*. 2019;23:346-355.
24. Ventura CAI, Denton EE, Asack BR. Implications of systemic racism in emergency medical services: on prehospital bias and complicity. *EClinicalMedicine*. 2022;50:101525.
25. Clouston SAP, Natale G, Link BG. Socioeconomic inequalities in the spread of coronavirus-19 in the United States: a examination of the emergence of social inequalities. *Soc Sci Med*. 2021;268:113554.
26. Williams DR, Priest N, Anderson NB. Understanding associations among race, socioeconomic status, and health: patterns and prospects. *Health Psychol*. 2016;35(4):407-411.
27. Ogunyemi D. A practical approach to implicit bias training. *J Grad Med Educ*. 2021;13:583-584.
28. Crowe RP, Krebs W, Cash RE, et al. Females and minority racial/ethnic groups remain underrepresented in emergency medical services: a ten-year assessment, 2008-2017. *Prehosp Emerg Care*. 2020;24:180-187.
29. Marrast LM, Zallman L, Woolhandler S, et al. Minority physicians' role in the care of underserved patients: diversifying the physician workforce may be key in addressing health disparities. *JAMA Intern Med*. 2014;174:289-291.