Evaluating Pain Assessment and Management in Acute Pancreatitis

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Acute pancreatitis is a prevalent gastrointestinal disease characterized by significant abdominal pain, frequently managed with opioids. However, the inherent subjective nature of pain makes it difficult for clinicians to objectively determine when opioid prescription is truly appropriate. This ambiguity can also contribute to biases in pain data collection, assessment, and response across race, gender, and age groups. Thus, an analysis of pain score documentation and opioid prescription from the MIMIC IV-ED dataset can highlight potential disparities in pain management in acute pancreatitis. These insights can drive more equitable and comprehensive approaches to pain assessment and treatment.

Additional Key Words and Phrases: Acute Pancreatitis, Pain Management, Opioids, Disparities, MIMIC IV-ED Dataset

ACM Reference Format:
Sammy Mustafa, Hara Moraitaki, Leo A. Celi, Sicheng Hao, Deirdre Goode, and Tamara Kahan. 2024. Evaluating Pain Assessment and Management in Acute Pancreatitis.

1 Introduction

Acute pancreatitis (AP) is a prevalent gastrointestinal disease characterized by sudden inflammation of the pancreas and severe abdominal pain, often necessitating hospitalization and intensive pain management strategies.[1] Emergency Departments (ED) are crucial for the initial management of AP patients, where timely and appropriate pain management is essential to prevent complications and reduce the likelihood of Intensive Care Unit (ICU) admissions.[9] While 80% of acute pancreatitis (AP) patients are initially prescribed parenteral opioids to alleviate discomfort,[14] non-opioids have been shown to provide sufficient pain relief without adverse events.[6] Given that 9.6% of AP patients continue using opioids persistently six months post-discharge,[14] critically examining how clinicians prescribe opioids, especially with concerns of an opioid epidemic, is essential. While there are growing efforts to standardize the prescription of opioids for acute pain management,[2] there are no clear opioid prescription guidelines to manage AP pain.[11]

This can be attributed to the subjective nature of pain measurement. The complex, multidimensional nature of pain involves sensory, emotional, cognitive and social components.[13] In clinical settings, the most common method for pain data collection is the 0-10 numeric pain rating scale (NPRS). However, this scale's limited ability to capture the multifaceted experience of pain across patients presents significant challenges for clinicians in

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ACM 2476-1249/2024/8-ART111
https://doi.org/10.1145/nnnnnnn.nnnnnnn

determining the necessity of opioid prescriptions in AP. This ambiguity not only impacts individual patient care but can also lead to biases in pain data collection, assessment, and response across different demographic groups, including race, gender, and age. These biases can result in disparities in treatment, affecting patient outcomes and exacerbating health inequities.[10] Additionally, the opioid crisis has shifted patient satisfaction metrics from focusing on pain relief to prioritizing quality of communication about pain, further complicating the collection of accurate data on opioid usage.[7]

Despite the critical role of accurate pain assessment, current research is limited in its examination of how pain scores are documented and influence analgesic prescribing patterns for AP in the ED. To address these concerns, this study analyzes data from the MIMIC-IV ED database, a comprehensive, publicly available dataset containing de-identified health records from over 40,000 ED admissions.[3] With this, the study aims to investigate the consistency and potential biases in the documentation of pain scores and pain management responses (medication prescriptions, average response time, etc.) across different demographic groups. The study will also explore the relative effectiveness of opioid and non-opioid medications for managing pain in acute pancreatitis patients, examining changes in pain scores by medication order and race. By highlighting these patterns, this study aims to uncover potential inequities in pain management for acute pancreatitis patients in the ED. Understanding these disparities is a critical step toward developing more equitable and effective pain assessment protocols, which could improve patient outcomes and inform best practices beyond acute pancreatitis care.[4]

2 Methods

2.1 Data Cleaning

The pain and medication-related data were extracted from the publicly available MIMIC-IV ED database, which contains de-identified health records from emergency department admissions. The dataset was filtered to include patients with ICD-9 and ICD-10 codes corresponding to a diagnosis of acute pancreatitis (AP). Key demographic and clinical variables—such as subject ID, stay ID, intake time, discharge time, gender, race, age, and disposition—were collected for analysis.

Pain scores, recorded on a 0–10 numeric scale, were extracted along with their timestamps. Data cleaning involved removing entries with invalid characters or trailing non-numeric values, ensuring a consistent dataset of valid scores. Racial categories with insufficient sample sizes—specifically Asian, American Indian or Alaska Native, Two or More Races, and Native Hawaiian or Other Pacific Islander—were excluded from the analysis. This process, visualized in Figure 1, resulted in a dataset encompassing 1,223 unique patients across 5,535 emergency department stays.

Medications administered during these ED stays were classified into three categories for analysis: acetaminophen, nonsteroidal anti-inflammatory drugs (NSAIDs), and opioids. The NSAID group included Ketorolac, Ibuprofen, and Naproxen, while the opioid group comprised Morphine, Hydromorphone, Fentanyl, Oxycodone, and Codeine. To maintain uniformity, only medications administered via non-oral routes were included for the NSAID and opioid groups. This selection resulted in 10,600 timestamped prescription data for the patients previously identified.

2.2 Pain Documentation

To assess patterns in pain documentation, the average number of pain scores recorded was analyzed across different demographic groups. Data were stratified by medication type to account for variability in pain score collection associated with the specific analgesic administered. In addition, the average time between scores were identified for each race and stratified by the first three instances reporting to the ED to compare changes in documentation with additional ED stays related to AP.

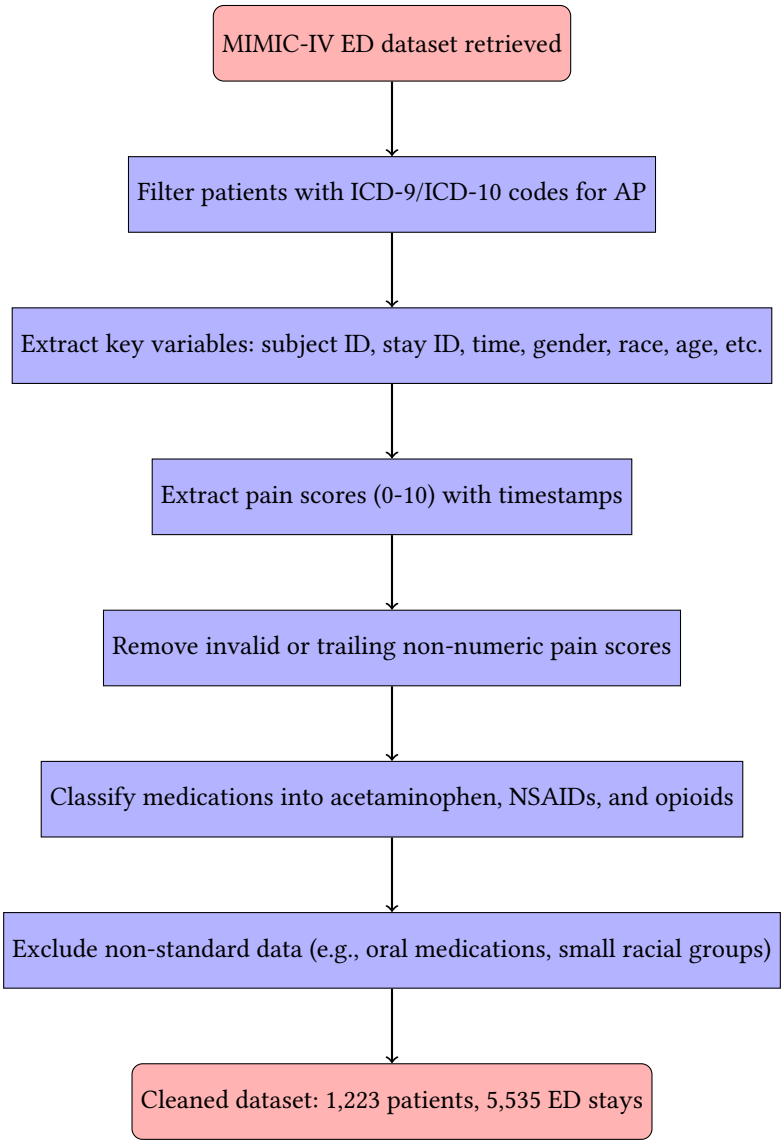

Fig. 1. Flowchart of the data cleaning process.

2.3 Response Time for Analgesic Prescription

Response times, defined as the interval between a recorded pain score and the administration of an analgesic, were calculated. These intervals were analyzed across demographic groups and initial pain score levels to identify potential disparities in response patterns.

2.4 Predictive Modeling of Medication Response

A logistic regression model was constructed to predict the likelihood of opioid prescription. Predictor variables included the reported pain score, age, gender, and race, as well as key vitals data such as temperature, heart rate, respiratory rate, and oxygen saturation. The binary outcome variable indicated whether opioids were prescribed during the ED stay.

2.5 Reported Change in Pain Scores

Pain scores were identified before and after medication was administered and the proportion change of these pain scores were calculated to create a metric of analgesic effectiveness in terms of managing patient pain. This data was stratified by race in order to identify any differences between how groups respond to the treatment. Separate analyses were done for when opioid medications were administered compared to when non-opioid medications (defined as NSAIDs and Acetaminophen) were prescribed to compare their effectiveness on managing pain.

3 Results

3.1 Demographics of Pain Score Data

The demographic characteristics of patients diagnosed with acute pancreatitis (AP) and their associated pain score documentation are summarized in Table 1. The cohort included 8,825 White, 3,851 Black/African, and 1,289 Hispanic/Latino patient stays. The median age and gender distribution were comparable across racial groups, with a slightly higher proportion of female patients among White (55.5%) and Hispanic/Latino (54.0%) groups compared to Black/African patients (48.0%).

The median number of pain scores recorded per patient was consistent across groups (3.0 [Q1: 2.0, Q3: 5.0] for White patients; 3.0 [Q1: 2.0, Q3: 4.0] for Black/African and Hispanic/Latino patients), suggesting similar levels of pain documentation. However, the median time between pain score recordings was shorter for White patients (2.5 hours [Q1: 1.5, Q3: 4.0]) compared to Black/African (2.8 hours [Q1: 1.8, Q3: 4.7]) and Hispanic/Latino patients (2.8 hours [Q1: 1.8, Q3: 4.3]). This slight discrepancy could indicate differences in the frequency of clinical pain assessments.

Table 1. Distribution of Demographic Characteristics and Pain Scores by Race.

	White	**Black/African**	**Hispanic/Latino**
n	8,825	3,851	1,289
Age, median [Q1, Q3]	49.0 [38.0, 60.0]	49.0 [42.0, 58.0]	48.0 [38.0, 60.0]
Gender, n (%)			
F	4,895 (55.5)	1,850 (48.0)	696 (54.0)
M	3,930 (44.5)	2,001 (52.0)	593 (46.0)
Number of Pain Scores, median [Q1, Q3]	3.0 [2.0, 5.0]	3.0 [2.0, 4.0]	3.0 [2.0, 4.0]
Average Time Between Scores, median [Q1, Q3]	2.5 [1.5, 4.0]	2.8 [1.8, 4.7]	2.8 [1.8, 4.3]

3.2 Pain Score Documentation

The study sought to uncover whether pain documentation frequency could vary across different races. In the analysis, documentation across racial groups, the average number of pain scores was relatively consistent Figure 2. However, the results uncover that when opioids were prescribed, a notably higher number of pain scores were recorded compared to other medications, suggesting that opioid use may be associated with stricter

pain monitoring protocols. This trend appeared equitable across racial groups, with no substantial differences in the average number of pain scores documented.

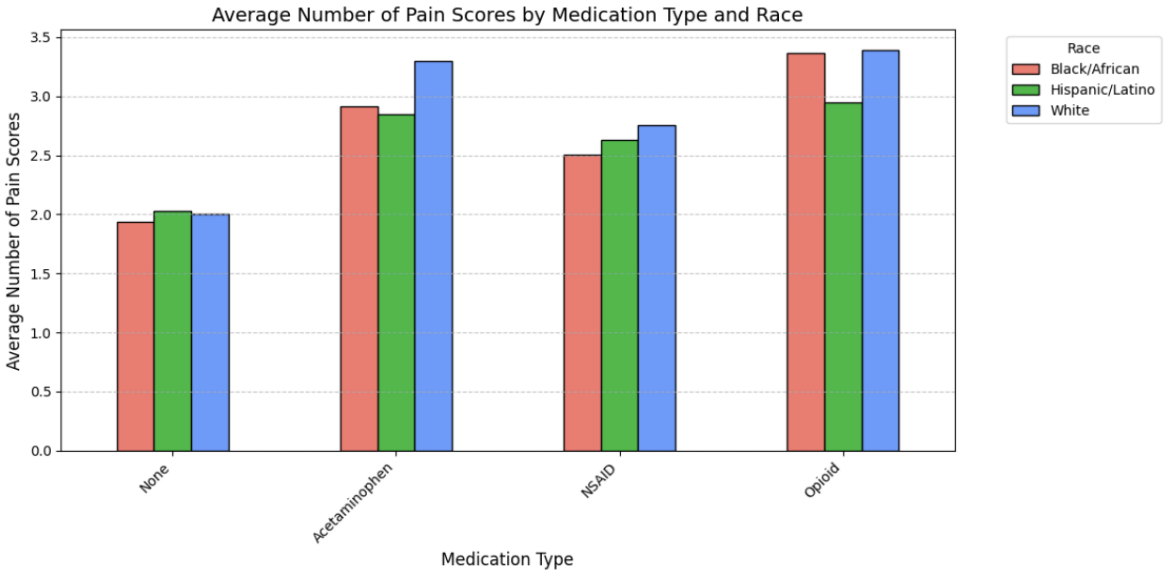

Fig. 2. Average Number of Pain Scores by Medication Type and Race. This figure illustrates the average number of pain scores documented across different medication types (None, Acetaminophen, NSAID, Opioid) for Black/African, Hispanic/Latino, and White patient groups. The results indicate a relatively homogeneous number of pain scores across racial groups for each medication type. Notably, when opioids are prescribed, a higher number of pain scores are recorded, regardless of race, suggesting equitable pain assessment practices associated with opioid administration.

Further analysis aimed to identify pain reporting across multiple stays for each patient. Figure 3 examines the average time between pain score recordings across multiple ED visits. During the initial ED visit (Instance 1), White and Hispanic/Latino patients exhibited longer average times between pain scores compared to Black/African patients. However, as patients had repeated ED visits (Instances 2 and 3), the time between pain scores increased for all groups. This trend suggests potential differences in care provided during recurrent visits, which could reflect changes in clinician familiarity with the patient or systemic biases in the management of patients with repeated admissions.

3.3 Pain Medication Prescription Patterns

Table 2 highlights the types and frequencies of pain medications prescribed to patients in the MIMIC-V ED Dataset. Opioid medications were the predominant analgesic used, with 67.5% of White patients receiving opioids compared to 57.0% of Black/African patients and 54.8% of Hispanic/Latino patients. Conversely, non-opioid medications, such as acetaminophen and NSAIDs, were more frequently prescribed to Black/African and Hispanic/Latino patients. Additionally, the median number of medications prescribed per patient was highest among White patients (3.0 [Q1: 2.0, Q3: 5.0]) compared to Black/African (2.0 [Q1: 1.0, Q3: 4.0]) and Hispanic/Latino patients (2.0 [Q1: 1.0, Q3: 4.0]).

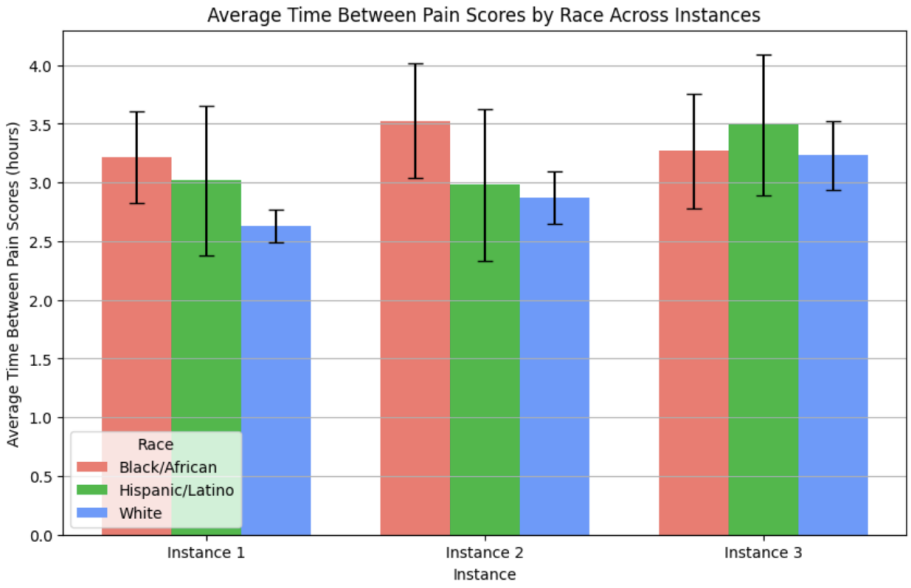

Fig. 3. Average Time Between Pain Scores by Race Across Multiple Emergency Department Visits. White and Hispanic/Latino patients had longer initial times between scores, while repeated visits showed increasing times for all groups.

Table 2. Distribution of Demographic Characteristics and Pain Medications by Race.

	White	Black/African	Hispanic/Latino
n	7,668	2,847	981
Age, median [Q1, Q3]	46.0 [36.0, 57.0]	48.0 [41.0, 57.0]	44.0 [32.0, 55.0]
Gender, n (%)			
F	4,390 (57.3)	1,355 (47.6)	488 (49.7)
M	3,278 (42.7)	1,492 (52.4)	493 (50.3)
Type of Pain Medication			
None	844 (11.0)	571 (20.1)	169 (17.2)
Acetaminophen	594 (7.7)	326 (11.5)	151 (15.4)
NSAID	277 (3.6)	118 (4.1)	67 (6.8)
Opioid	5,179 (67.5)	1,624 (57.0)	538 (54.8)
Number of Medications, median [Q1, Q3]	3.0 [2.0, 5.0]	2.0 [1.0, 4.0]	2.0 [1.0, 4.0]

3.4 Response Times to Analgesic Administration

The relationship between initial pain scores and response times to analgesic administration is presented in Figure 4. The figure illustrates the relationship between initial pain scores (categorized from 0 to 10) and the average response time (in minutes) to treatment, stratified by race. Black/African patients with lower pain scores (around 1-3) experienced significantly longer response times compared to other groups, suggesting potential delays in pain management prioritization. Conversely, White patients with higher pain scores had prolonged response times relative to Black/African and Hispanic/Latino patients, indicating possible inconsistencies in how pain

severity influences treatment urgency. These patterns suggest systemic differences in how pain is perceived and addressed across racial groups.

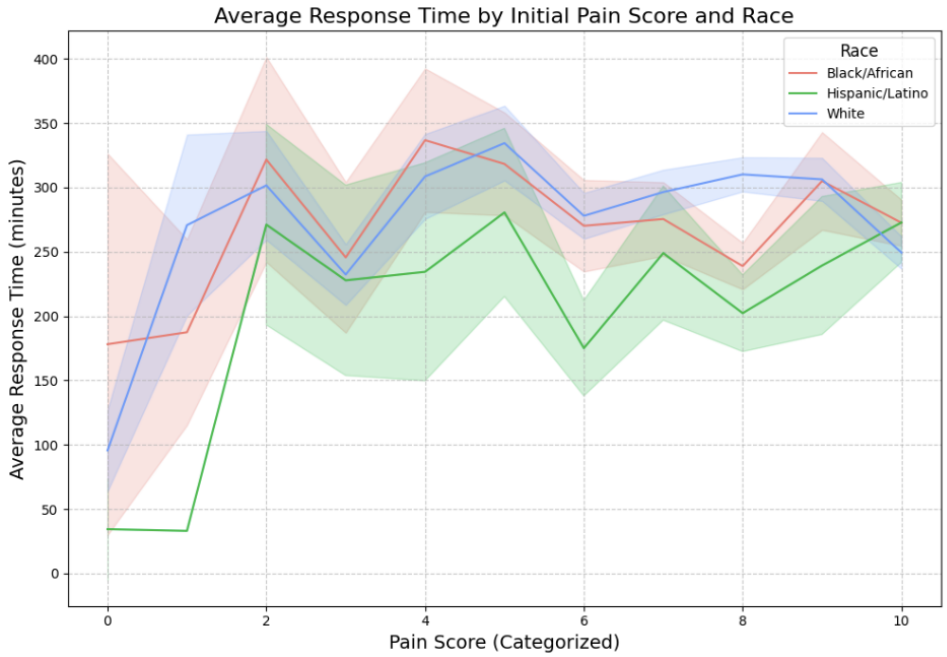

Fig. 4. Response times to analgesic administration by initial pain score and race. The figure highlights delays in pain management prioritization for Black/African patients with lower pain scores and inconsistencies in response for White patients with higher pain scores.

3.5 Predictors of Opioid Prescription

The logistic regression fed pain scores, demographics (gender, age, race), and vital data had a model accuracy of 83.37% in predicting opioid prescription. These key predictors are visualized in the forest plot in Figure 5. Black/African and Hispanic/Latino patients were significantly less likely to receive opioids compared to White patients, with adjusted odds ratios well below 1.0. Male patients were more likely to receive opioids than female patients. Notably, the numeric pain score had a relatively low positive odds ratio, indicating that higher pain scores are slightly associated with an increased likelihood of receiving opioids, but the effect is relatively small. Therefore, opioid prescription decisions are likely influenced by additional factors beyond the reported pain score and those studied, such as clinical judgment, patient history, or systemic biases. These observations align with the high constant which suggests that factors beyond those measured likely play a role in opioid prescription decisions.

3.6 Difference in Pain Score Change in Response to Opioids vs. Non-Opioids

Figure 6 illustrates the proportional change in pain scores following sequential opioid administrations. Across all racial groups, the greatest reduction in pain scores occurred during the initial doses of opioids, indicating that early treatment was most effective. However, disparities emerged after the third to fifth opioid dose, where

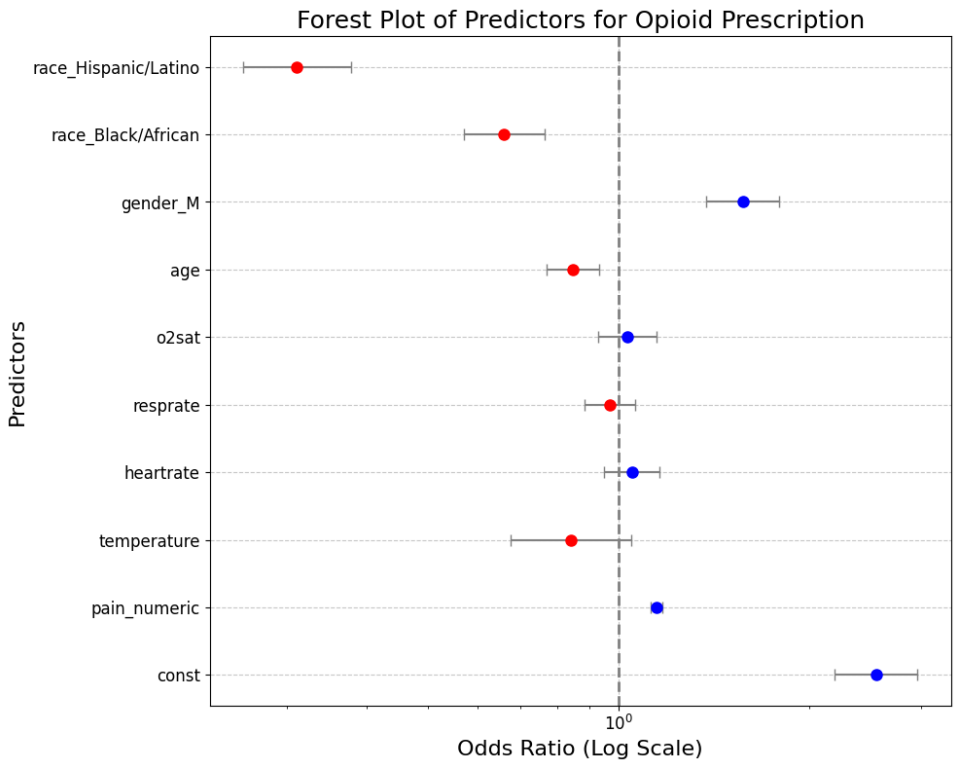

Fig. 5. Forest plot of predictors for opioid prescription. The plot shows significant disparities in opioid prescription likelihood across racial and gender groups, with numeric pain scores playing a relatively minor role.

Black/African patients demonstrated less improvement in pain scores compared to White and Hispanic/Latino patients. Interestingly, Black/African patients showed larger improvements after five or more doses compared to other groups, though this could reflect differences in subjective pain reporting, pharmacologic responses, or care practices.

Figure 7 illustrates the proportional change in pain scores following sequential non-opioid administrations. Similar findings were identified as the opioid data, in which relatively similar reductions in pain score were seen initially and race-dependent changes appeared after three doses. Interestingly, White patients demonstrated lower changes in pain scores in response to non-opioids compared to Black/African and Hispanic/Latino patients.

Comparing the data stratified by medication type provides insight in comparing the effectiveness of opioids vs non-opioids in managing pain in AP. The initial pain relief effects of non-opioids were higher in all races compared to opioids (more negative proportion change). Post-initial medication administration, the pain change between opioids and non-opioids appeared to be similar. It is observed that opioid administration in later stages decreased pain scores in White patients while it increased pain scores in Black/African patients. Interestingly, the opposite was seen in non-opioids in which Black/African patients reported a decrease in pain scores while White patients reported an increase in pain scores. These findings highlight potential inequities in pain relief and response to opioid treatment, underscoring the need to investigate whether these differences stem from biases in treatment protocols or variability in patient-provider interactions.

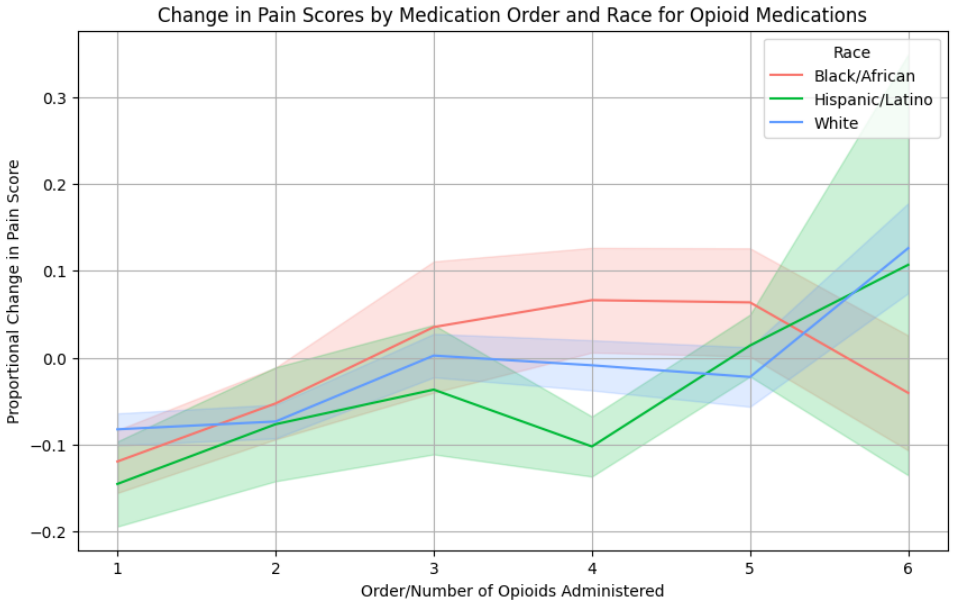

Fig. 6. Proportional Changes in Pain Scores Following Opioid Administration. This figure illustrates the proportional change in pain scores following sequential opioid administrations.

4 Discussion

This study offers a novel and comprehensive view into how acute pancreatitis (AP) pain is assessed and managed in the emergency department (ED), particularly with respect to potential disparities tied to race and gender. While this study observed general equality in the overall documentation of pain scores, our findings indicated that patients receiving opioids tended to have more frequent pain assessments. This pattern aligns with established nurse-driven protocols mandating closer monitoring of patients on opioid therapy, thereby increasing documentation frequency when higher-risk medications are used.[12]

Despite equitable documentation practices, our analysis revealed stark disparities in the likelihood of receiving opioids, notably by race and gender. This is the first reported instance showing wide racial and gender gaps in opioid prescribing for AP specifically, dovetailing with existing literature on analgesic disparities in acute pain management for other conditions. Black and Hispanic/Latino patients, as well as female patients, were systematically less likely to receive opioids despite similar pain documentation.[5] These findings suggest that while the front-end measures of pain assessment appear uniform, decisions on actual treatment modalities may still be influenced by implicit biases or systemic factors that disadvantage certain groups. Such disparities are particularly concerning given the subjective nature of pain and the reliance on clinician judgment, reinforcing how perceptions of patient pain and opioid-seeking risk may differ across demographic lines.

Biases in opioid prescription prompted an examination of the effectiveness of opioids vs. non-opioids for pain relief, in which racial disparities were also identified. Considering clinically meaningful improvement has been defined as as a 30% improvement in pain scores,[8] examination of the proportion change of scores due to medication administration allowed for a juxtaposition of potential opioid over-prescription considering, again, non-opioid have been shown to provide sufficient pain relief for AP.[6] Non-opioids, defined in this study as NSAIDs or Acetaminophen, demonstrated a greater negative change in the initial pain scores compared to opioids

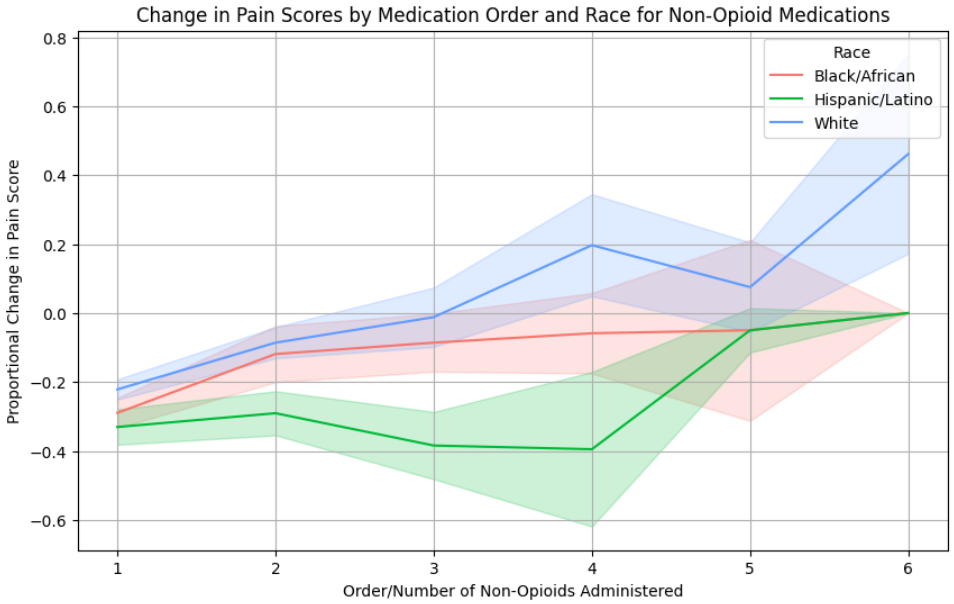

Fig. 7. Proportional Changes in Pain Scores Following Non-Opioid Administration. This figure illustrates the proportional change in pain scores following sequential non-opioid administrations.

across all races, indicating a better option for first-line pain management approaches. Interestingly, White patients reported lower pain scores from later opioid prescriptions higher pain scores from later non-opioid prescriptions. The opposite was observed in Black/African patients, which may point to stratified treatment approaches but also may be due to lower opioid prescription rates in these patients. Considerations of these findings include the overall lower sample size of non-opioid prescriptions as well as, the expected lower proportion changes in pain score as treatment proceeds. Generally, further examination of this data should further stratify and specify instances without opioid and non-opioid overlap as combinatorial treatment is common and may skew findings. However, these findings bring to light the debate surrounding whether opioids are necessary considering potential adverse effects and abuse; future studies should examine the isolated effectiveness of opioids vs. non-opioids in AP, potentially stratified by race, to better inform more standardized AP pain management protocols.

Another key contribution of this work lies in the introduction of novel pain management response metrics. Going beyond simple rates of prescription or documentation frequency, this study examined measures such as average response times to analgesic administration and changes in pain management patterns over multiple ED visits. By incorporating temporal dimensions, this study demonstrates that disparities may emerge not only in the initial decision to prescribe but also in the timeliness of pain relief. For instance, Black/African patients often experienced longer delays in receiving pain medications, especially at lower reported pain levels, while White patients sometimes faced longer waits despite higher pain scores. Such patterns hint at nuanced and complex biases in how clinicians interpret and prioritize patients' reported pain over time.

Despite its contributions, the study has several limitations. First, the relatively small sample size for Hispanic/Latino patients and the exclusion of certain racial groups due to limited data restricts the generalizability of our findings. Furthermore, this study lacked dosage-level data, hindering our ability to assess whether disparities persist at the level of medication intensity or regimen complexity. Without dosing information, it remains unclear

if certain groups receive lower doses or less potent opioid regimens, further complicating our understanding of pain management fairness.

Future directions include validating these results in larger, more diverse datasets and exploring how these disparities impact clinical outcomes, such as persistent opioid use, patient-reported pain relief, and long-term complications. Expanding the scope of inquiry to other conditions or chronic pain scenarios could help determine whether these inequities are pervasive or limited to AP. Additionally, investigating strategies to mitigate implicit biases—such as standardized prescribing guidelines, provider education, or decision-support systems—may lead to more equitable and evidence-based approaches to pain management.

Overall, our findings underscore that the complexity of pain assessment, intertwined with patient and provider factors, can perpetuate disparities in care in addition to the potential differential impact of opioid vs. non-opioid treatment. By highlighting these patterns, this study aims to inform more standardized opioid prescribing approaches and encourage interventions that address the subjective and potentially biased elements of pain management. Such efforts are essential to ensure that all patients, regardless of demographic background, receive timely, effective, and equitable relief from AP-associated pain.

Acknowledgments

We would like to thank the teaching staff of 6.8850 - Clinical Data Learning for their ongoing support for this project.

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