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PREHOSPITAL PAIN MANAGEMENT: DISPARITY BY AGE AND RACE

Hilary A. Hewes, MD, Mengtao Dai, N. Clay Mann, Tanya Baca, Peter Taillac

ABSTRACT

Importance: Historically, pain management in the prehospital setting, specifically pediatric pain management, has been inadequate despite many EMS (emergency medical services) transports related to traumatic injury with pain noted as a symptom. The National Emergency Services Information System (NEMSIS) database offers the largest national repository of prehospital data, and can be used to assess current patterns of EMS pain management across the country. **Objectives:** To analyze prehospital management of pain using NEMSIS data, and to assess if variables such as patient age and/or race/ethnicity are associated with disparity in pain treatment. **Design/Setting/Participants:** A retrospective descriptive study over a three-year period (2012–2014) of the NEMSIS database for patients evaluated for three potentially painful medical impressions (fracture, burn, penetrating injury) to assess the presence of documented pain as a symptom, and if patients received treatment with analgesic medications. Results were analyzed according to type of pain medication given, age categories, and race/ethnicity of the patients. **Main outcomes:** Percentage of EMS transports documenting the three painful impressions that had pain documented as a symptom, received any of the six pain medications, and the disparity in documentation and treatment by age and race/ethnicity. **Results:** There were 276,925 EMS records in the NEMSIS database that met inclusion criteria. Pain was listed as a primary or associated symptom for 29.5% of patients, and the youngest children (0–3 years) were least likely to have pain documented as a symptom (14.6%). Only 15.6% of all activations documented the receipt of prehospital pain medications. Children (<15 years) received pain medication 14.8% [95% CI 14.33, 15.34] of the time versus adults (≥15 years) 15.6% [95% CI 15.48, 15.76, $p = 0.004$]. Morphine and fentanyl were the most commonly administered medications to all age groups. Black patients were less likely to receive pain medication than other racial groups. **Conclusions:** Documentation of pain as a symptom and pain treatment continue to be infrequent in the prehospital setting in all age groups, especially young children. There appears to

be a racial disparity with Black patients less often treated with analgesics. The broad incorporation of national NEMSIS data suggests that these inadequacies are a widespread challenge deserving further attention. **Key words:** Pain; pediatrics; race; pain assessment

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BACKGROUND/INTRODUCTION

Pediatric transports comprise approximately 13% of total EMS transports/year across the United States.¹ Many of these children require transport because of an injury, and 20–26% of transported patients of all ages have been noted to have moderate to severe pain or list pain as their primary symptom.^{2,3} Previous literature suggests that despite known painful injuries, treatment, and assessment of pediatric pain in the prehospital setting is inadequate and leads to delayed time to adequate analgesia.^{2,4–8}

The Emergency Medical Services Outcome Project I (EMSOP) prioritized pain management for future prehospital care effectiveness studies, and EMS providers identified relief of discomfort as the outcome having the highest potential impact for both pediatric and adult patients.⁹ Other committees of experts, including the Pediatric Emergency Care Applied Research Network (PECARN),^{10,11} have initiated efforts to perform high quality research on prehospital care of the pediatric population. When configuring these research agendas, prehospital management of pain fell within the top 10 list of priorities, and the PECARN group further defined study objectives related to evaluation of prehospital pain management. In part because of these important research prioritization consensus statements, national prehospital evidence-based guidelines have been published that address pain assessment and management, including the recent National Association of State EMS Officials (NASEMSO) National Model EMS Clinical Guidelines.¹²

Analyses of pain management in the emergency department (ED) setting have revealed disparities related to race and ethnicity,^{13–15} however, these studies have examined smaller populations of patients receiving narcotics in an emergency department for specific conditions such as appendicitis or blunt trauma. Other research has focused on pain management in the prehospital setting, including evaluating how demographic factors such as age, sex, race, and ethnicity of the patient influence pain management.^{15,16}

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Browne's recent evaluation of the effect of new pediatric EMS protocol updates encouraging pediatric pain assessment and treatment in the prehospital setting found that opioid use for analgesia remained largely unchanged and suboptimal despite education specific to updates of pain protocols in three large urban EMS systems.¹⁶ These studies provide important regional information concerning pain management with specific types of medications, such as morphine, and/or evaluating specific age populations.

However, there are no large analyses to determine how pediatric pain is managed by EMS providers, to examine the types of medications used to treat pediatric versus adult pain, or to assess if factors such as age and race affect the prehospital approach to pain management on a national level. The National Emergency Medical Services Information System (NEMSIS) database offers a unique opportunity to explore management of prehospital pain medication administration on a large scale, and to determine if the goal of routine assessment and treatment of pain in the prehospital setting has been accomplished.

OBJECTIVES

1. To utilize the NEMSIS database to determine the percentage of pediatric and adult patients evaluated by EMS personnel with a potentially painful presenting complaint (fracture, burn, penetrating injury) that received any type of pain medication in the prehospital setting.
2. To determine if prehospital pain management varies according to age of the patient.
3. To determine what types of pain medications are administered in the prehospital setting.
4. To assess if there is a potential ethnic/racial disparity for pain management.

METHODS

We utilized the NEMSIS Public-Release Research Dataset from 2012–2014. The NEMSIS project was designed to standardize out-of-hospital information collected by EMS providers across the United States, and has been described in further detail previously.^{3,17,18} The NEMSIS Research Dataset is a national compilation of standardized emergency medical services patient care reports (PCRs), submitted by state repositories, from local EMS agencies providing service to the reporting state. In 2014, 48 states and territories contributed data to the registry; on average 77% (range of 18–100%) of all EMS agencies within a contributing state report EMS activation data to NEMSIS (Figure 1). The NEMSIS dataset consists of EMS activations and it is not a registry of patients receiving care. Multiple emergency resources can respond to the same 9-1-1 call

and each one may submit a PCR to its respective state data repository, which is then passed on to the NEMSIS repository. Methods are currently not in place, at the state or national level, to link different PCRs to the same patient or emergency event. Patients included in our analysis were those for whom EMS was activated as a result of a 9-1-1 response and who had a primary impression of a fracture, burn, or penetrating injury. This study was reviewed by the Institutional Review Board at the University of Utah.

Sample selection required that 9-1-1 initiated EMS activations resulted in a patient treated and transported, with the provider reporting, as an initial impression of the patient's condition, a fracture, burn, or penetrating injury. Specific primary impressions chosen for analysis included Center for Medicare and Medicaid Services (CMS) condition codes; Other Trauma (fracture/dislocation), Other Trauma (amputation digits) (BLS-886.0), Other Trauma (amputation other) (ALS-887.4), Burns-Major, Burns-Minor, and Other Trauma (penetrating extremity). To determine whether a patient was experiencing pain in the prehospital setting, we relied on a NEMSIS element reporting the documentation of pain as a symptom the patient was experiencing. The National NEMSIS dataset does not include a specific pain assessment, and, thus, we relied on the documentation of pain as a symptom as a proxy for a provider initiated pain assessment. For the evaluation of pain treatment, we searched the appropriate NEMSIS database elements for the six most commonly administered pain medications (morphine, fentanyl, ibuprofen, acetaminophen, hydromorphone, and nitrous oxide). We divided the patients into age categories (0–3, 4–10, 11–14, 15–18, >18 years of age). These age ranges were selected because they divide patients into similar developmental categories and patient weight/size groups (i.e., infant/toddler, early childhood, early adolescent, late adolescent, and adult), with the idea that children within these groups would likely be approached in a similar manner by prehospital providers. Specific analyses conducted by age category included:

1. If pain was recorded as a primary or associated symptom.
2. If the patient received any type of pain medication per each age category.
3. The percentage of patients in each age category receiving opiate analgesics, acetaminophen, ibuprofen, or nitrous oxide.
4. For patients with pain as a noted symptom, the percentage who received any pain medication.
5. A repeat of analysis #4, assessing variation in race and ethnicity of patients <15 or ≥15 years of age.

The final analysis examining race and ethnicity utilizes a < or > 15 years of age grouping to simplify the

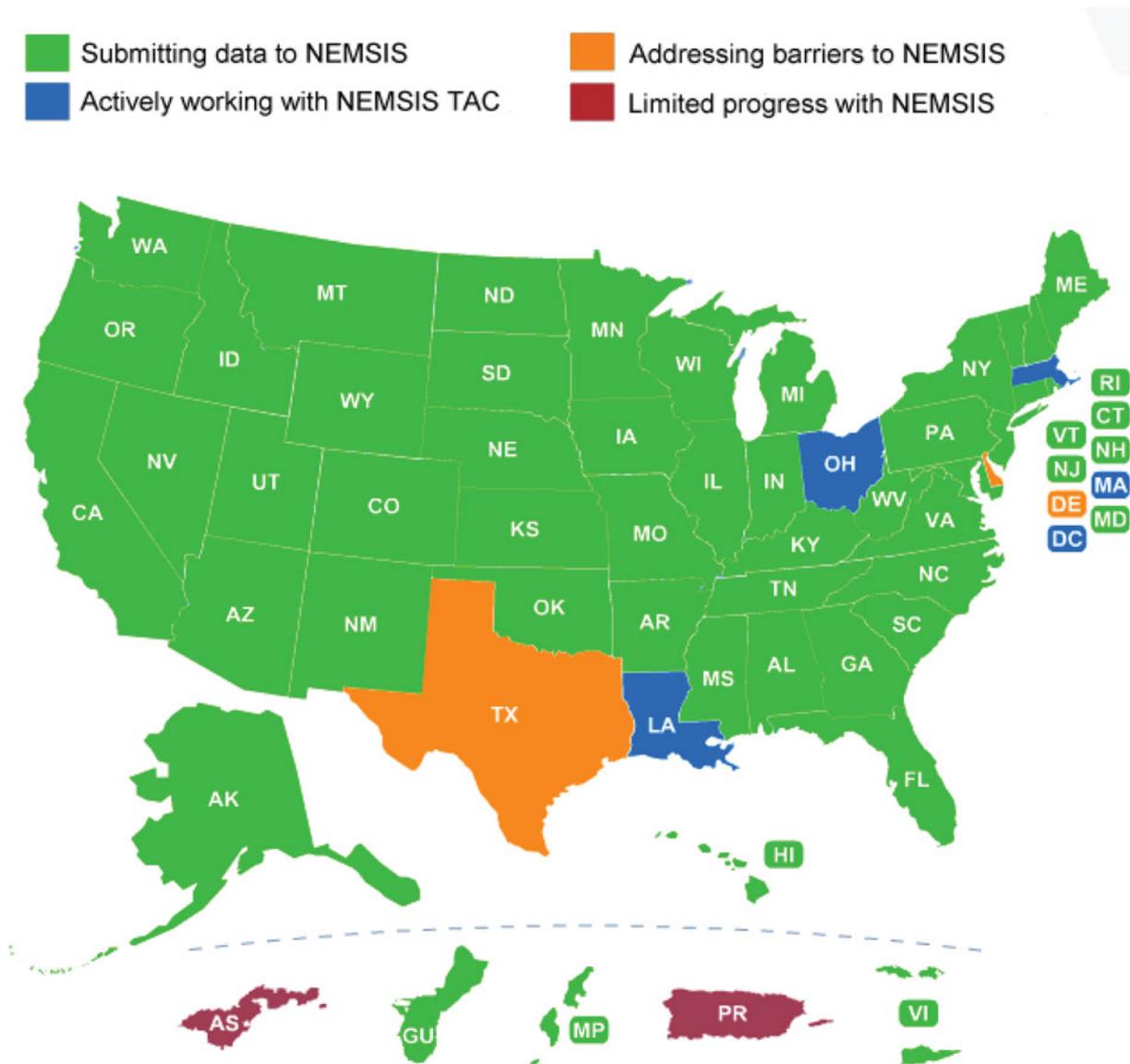


FIGURE 1. States and territories submitting EMS activations to the NEMSIS National database in 2014.

analysis and because many hospital and EMS guidelines use age 15 as a cut-off for patients considered a “pediatric” vs “adult” patient.

DATA ANALYSIS

Demographic characteristics, documentation of pain as a symptom, pain medications administered, and race/ethnicity were expressed as frequencies or proportions with 95% confidence intervals. Chi-square analysis was performed to examine the differences in proportions of pain (as a symptom) and medications administered between different age and race/ethnicity categories. P-values less than 0.05 were considered statistically significant. Database management and analyses were conducted using SAS (v 9.4, SAS Institute, Cary, NC).

RESULTS

During the study period, a total of 69,564,130 EMS activations were submitted to the National NEMSIS Dataset (Figure 2). Among these, 276,925 9-1-1 initiated EMS activations involved patients evaluated and transported with a primary impression of a fracture, burn, and/or penetrating injury. Of these activations, 29.5% included documentation of “pain” as a symptom. Figure 3 indicates that infants and toddlers ages 0–3 had the lowest proportion of pain recorded as a symptom (14.6%, [95% CI 13.5, 15.6]) and 11–14 year olds had the highest proportion (32.9%, [95% CI 31.8, 33.9, $p < 0.001$]).

If we ignore documentation of “pain” as a symptom, only 15.6% of all EMS activations with potentially painful medical impressions received any of the

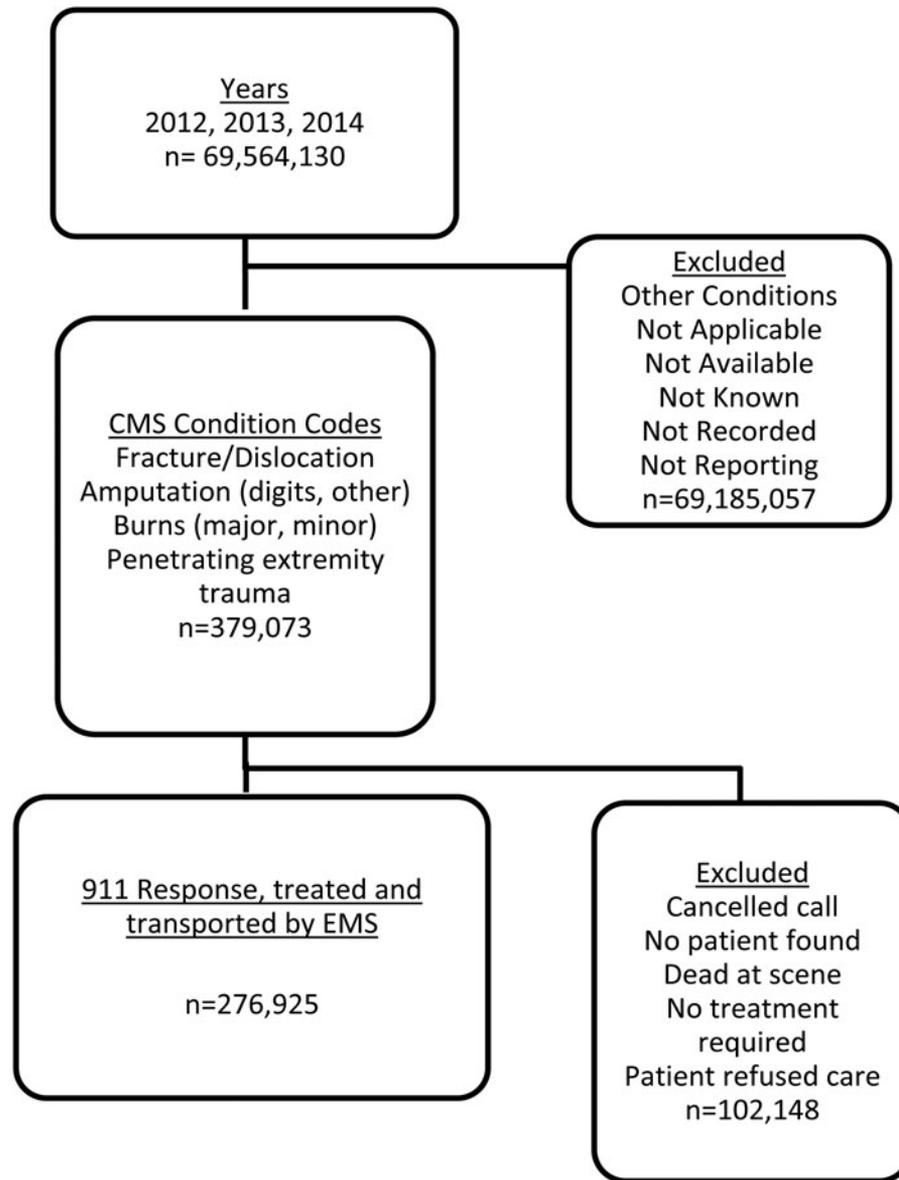


FIGURE 2. Selection of pain-related EMS activations from the NEMSIS registry.

six pain medications (Figure 3). Infants and toddlers were least likely to receive pain medication (6.4% [95% CI 5.7, 7.2, $p < 0.001$]). Morphine and fentanyl were the most commonly administered medications to all age groups, but less than 7% of children age <11 received either medication. Oral medications (ibuprofen/acetaminophen) were almost never given (highest use of ibuprofen is 0.04% of EMS activations in the 4–10 year age group; highest use of acetaminophen is 0.07% in 11–14 years old age category).

If we account for an EMS provider's documentation of pain as a symptom ($n = 81,617$), only 19.9% ($n = 16,207$) of patients received pain medication. Of these, only 6.8% (95% CI 4.8, 8.7) of infants and toddlers received any pain medication versus 26.4% (95%

CI 22.4, 28.2) of children 11–14 years of age ($p < 0.001$, Figure 3). Interestingly, if age groups are collapsed, the percentage of EMS activations involving adults (≥ 15 years) who had documented pain and received pain medication (19.9%) is similar the percentage among the pediatric age group (< 15 years, $p > 0.956$).

We conducted a secondary analysis of the data, assessing pain documentation by race and ethnicity (Table 1). We then assessed actual pain treatment, among those with documented pain, by race for two age categories (< 15 or ≥ 15 years of age, Tables 2 and 3). The frequency with which pain was recorded as a symptom for all patients varied by race ($p < 0.001$, Table 1). The largest discrepancy existed between American Indian/Native Alaskans who were least

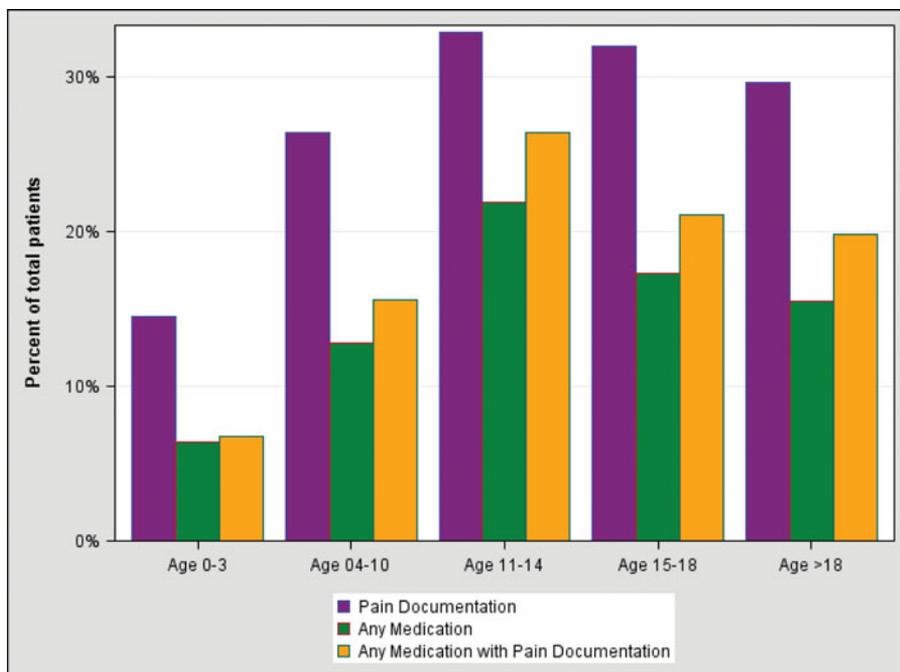


FIGURE 3. Percentage of pain documentation and treatment by age group.** Patients presenting with one of three potentially painful medical impressions (i.e., fracture, burn, penetrating injury). Medications assessed include; morphine, fentanyl, ibuprophen, acetaminophen, hydromorphone, and nitrous oxide. Pain Documentation, $p < 0.001$; Any Medication, $p < 0.001$, Any Medication with Pain Documentation, $p < 0.001$.

likely to have pain documented as a symptom (18.9%, 95%CI (17.4, 20.4)) and Hawaiian/Pacific Islanders who were most likely to have pain documented (60.5%, 95% CI 56.6, 64.4, Table 1). In regards to ethnicity, EMS activations involving Hispanic patients were more likely to have pain recorded as a symptom compared to non-Hispanic patients (44%, 95% CI (43.6, 45.1) vs. 31% [95% CI 30.8, 31.2], $p < 0.001$).

Administration of pain medication to patients >15 years of age with documented pain also varied by racial groups ($p < 0.001$). EMS activations involving

black patients with documented pain were least likely to be administered pain medication (8.7% [95%CI 8.1, 9.3]), while white patients were most likely (22.4% [95%CI 22, - 22.8]), $p < 0.001$, Table 2). When analyzing the administration of pain medication to pediatric patients (<15 years of age) with documented pain, similar variation is present ($p < 0.001$) with American Indian or Alaska Native and black pediatric patients less likely to receive pain medications (8.8% [95% CI 1.2, 21]) vs. white pediatric patients (25% [95% CI 23.2, 26.9], $p = 0.02$).

TABLE 1. Frequency of pain documentation by race/ethnicity categories*

Race/Ethnicity [§]	Pain Documentation [†]			
	No		Yes	
	Frequency	%	Frequency	%
American Indian or Alaska Native	2,099	81.1	488	18.9
Asian	993	41.6	1,392	58.4
Black or African American	23,259	71.6	9,223	28.4
Native Hawaiian/Other Pacific Islander	235	39.5	360	60.5
White	118,663	69.8	51,326	30.2
Other Race	7,651	45.2	9,258	54.8
All Race	152,900	68.0	72,047	32.0
Hispanic or Latino	9,510	55.7	7,571	44.3
Not Hispanic or Latino	143,390	69.0	64,476	31.0
All Ethnicity	152,900	68.0	72,047	32.0

*Patients presenting with one of three painful medical impressions (i.e., fracture, burn, penetrating injury).

[†] $p < 0.001$.

[§]Race/ethnicity may be self-reported or assumed by EMS providers.

TABLE 2. Frequency of pain medication administration for patients ≥15 years of age by race categories*

Race [‡]	Any Medication [†]			
	No		Yes	
	Frequency	%	Frequency	%
American Indian or Alaska Native	400	87.3	58	12.7
Asian	1,153	89.5	135	10.5
Black or African American	7,553	91.3	721	8.7
Native Hawaiian or Other Pacific Islander	298	89.8	34	10.2
White	38,204	77.6	11,015	22.4
Other Race	6,733	82.9	1,392	17.1
All	53,341	78.8	13,355	22.2

*Patients presenting with one of three painful medical impressions (i.e., fracture, burn, penetrating injury) and pain as a documented symptom.

[†]p < 0.001.

[‡]Race may be self-reported or assumed by EMS providers.

DISCUSSION

This study, utilizing the NEMSIS database, represents a unique effort to assess pain management in the pre-hospital setting across the United States. Because of the vast scope of the NEMSIS database, this study offers the most comprehensive national, rather than regional, examination of prehospital pain management, evaluating the use of multiple medication options, and the opportunity to validate previous literature on a national level. Despite the presence of pain management protocols in most EMS systems,² our data show that less than one third of all patients with an EMS reported fracture, burn, or penetrating injury, regardless of age, have pain recorded as a symptom. Furthermore, only 15% of patients with a potentially painful injury are receiving pain medications in the prehospital setting, regardless of whether or not pain was documented as a patient symptom. In particular, findings suggest that younger children rarely had pain documented as a symptom, and they infrequently received pain medication for the three traumatic and potentially painful injuries included in this analysis. We also documented a potential racial discrepancy in prehospi-

tal pain treatment. Our study confirms, on a national scale, prior work showing that patients of all ages and races suffer unnecessarily from oligoanalgesia in the field.^{2,4,5,19,20}

Our results also support previous studies, which have demonstrated that pediatric patients are less likely to receive prehospital pain management, including pain assessment and pain medication administration, compared to older individuals.^{2,8} Several reasons for this discrepancy have been cited, including discomfort with (or the inability of) the EMS provider to assess pain in young pediatric patients, preverbal age, difficult intravascular (IV) access, fear of complications, concerns about calculating drug doses, and IV access not otherwise needed.^{2,5,8,21} Lack of adequate pain management, especially for pediatric patients, is not unique to the prehospital arena. Previous literature also finds that health care providers in other settings do a poor job of appropriately managing pediatric pain, affirming that emergency pain management in general for pediatric patients is inadequate.^{4,5,19}

The existence of a pain assessment and documentation of pain scores improves the percentage of patients who receive analgesia.^{2,20,22} This is consistent with

TABLE 3. Frequency of pain medication administration for patients <15 years of age by race categories*

Race [‡]	Any Medication [†]			
	No		Yes	
	Frequency	%	Frequency	%
American Indian or Alaska Native	28	93.3	2	6.7
Asian	91	87.5	13	12.5
Black or African American	846	89.1	103	10.9
Native Hawaiian or Other Pacific Islander	24	85.7	4	14.3
White	1,579	75.0	528	25.0
Other Race	926	81.7	207	18.3
All	3,494	80.3	857	19.7

*Patients presenting with one of three painful medical impressions (i.e., fracture, burn, penetrating injury) and pain as a documented symptom.

[†]p < 0.001.

[‡]Race may be self-reported or assumed by EMS providers.

our findings, as even though we could not measure how many patients received a formal pain assessment, patients who had pain documented as a symptom were more frequently treated for pain. Nevertheless, several previous studies highlight that pain assessments are infrequently documented in pediatric patients.^{4,7,8} The mandatory assessment of the presence and severity of pain using a validated pain assessment tool has been previously recommended by the National Association of EMS Physicians and is included in the National Association of State EMS Officials (NASEMSO) National Model EMS Clinical Guidelines.¹² In addition, the use of a validated pain scale is recommended by the recently-published evidence-based guideline on the prehospital management of traumatic pain.²³

The use of intranasal (IN) fentanyl represents an easy, very effective method to treat pediatric pain which avoids many of the treatment barriers mentioned earlier. The nasal atomizer eliminates the need to obtain painful IV access, which can be challenging when dealing with young patients. IN fentanyl is as effective as IV fentanyl and IV morphine, and has an excellent safety record.^{4,24} Despite its known ease of use and efficacy, we found that any form of fentanyl was infrequently used in young children (2.99% of transported patients < four years of age and 6.49% among patients < 11 years of age). Limitations in the NEMSIS data set do not allow us to accurately analyze the percentage of fentanyl administered IV vs. IN. Regardless, the low percentage of fentanyl use suggests that IN fentanyl is not being utilized regularly, despite its demonstrated record as a simpler, rapid and painless way to manage pediatric pain.

Ibuprofen is another safe and effective choice for pain management in young children that avoids a need for an IV. It has been shown to be a reliable choice for pediatric pain management with equal efficacy to narcotics in management of such conditions as post-fracture care, post-operative tonsillectomy, and has no potential for respiratory depression.^{25,26,27} Our data indicate that Ibuprofen is rarely used in prehospital care, which may reflect the fact that many EMS agencies do not carry this medication on their ambulances or that EMS providers have concern about oral medications affecting a patient's NPO status. However, oral medications such as ibuprofen are included within the NASEMSO guidelines for pain management.¹²

Our study also revealed apparent racial/ethnic disparities in the prehospital documentation of pain as a symptom and in the prehospital treatment of pain, with black patients least likely to have either recorded in the NEMSIS database. In both the pediatric and adult age categories, black patients received pain medication less often than white patients. Asian and American Indian patients also received analgesia in the field less often than white or Hispanic patients. These results are con-

sistent with other studies describing racial differences in patients with blunt trauma who receive morphine,¹⁵ and a recent meta-analysis concluding that disparities in opioid administration for pain across multiple diagnoses and clinical settings continue to exist for black patients and subsets of other minorities.²⁸

In order to improve pain management in the field, we feel that EMS protocols, policies, and education must include elements addressing these issues. This could include a requirement of a pain assessment with education on the use of pain measurement tools for different ages as well as various options for pain management including oral and intranasal medications for ease of administration. Also, there should be training of providers in the dosing and indications of these medications to increase their comfort in their use. In addition, training must address racial, ethnic, and language disparities to ensure adequate management of pain for all transported patients.

LIMITATIONS

Although the NEMSIS database offers a national scope for evaluation of prehospital care systems, there are limitations inherent in its design. Importantly, the data quality of individual records are dependent on the due diligence of providers. This study assumes that if a provider failed to document a procedure, medication or assessment, it was not done. Although each field within the NEMSIS dataset is required to be completed, EMS providers can elect to complete fields with null values. Nevertheless, the sample size available for analysis, albeit potentially biased, was larger than any previously published reports.

Pain assessment scores were not collected in the National NEMSIS database during our study period. As a surrogate, we used reported primary and secondary symptoms, with a choice of "pain," as an indication that a provider documented a patient experiencing pain. A provider may have documented a pain assessment for the patient, but this information was not present in the national database. Also, if pain was present, but perceived as low, patients appropriately may not have received medication. The percentage of patients receiving pain medications is more reliable, as documentation of medications administered, especially narcotics, is more tightly regulated and assumed well documented in the database.³

Race/ethnicity is poorly documented by EMS with noted missing values. Data elements concerning race/ethnicity are subject to individual provider interpretation. In some cases, EMS may have designated a race/ethnicity assignment based on personal judgment rather than direct patient questioning. However, the patient's actual race and/or ethnicity may be less important than the perceived race/ethnicity by the

EMS provider when determining factors influencing pain management.

It is important to note that the national EMS repository is a collection of EMS activations for service, rather than a repository of patients receiving care. This is due to the fact that multiple emergency resources responding to the same 9-1-1 call may submit data to their state dataset for the same patient. Multiple activation records for the same patient encounter could result in inaccuracy of our analyses, perhaps underestimating the percentage of patients who received pain medications as likely only one EMS crew would administer medications although more than one may document the encounter. Nevertheless, each patient record that documents pain, and then, medication administration (or not) is a unique provider decision point and action taken while caring for a patient, and likely the majority of the activations do represent single agency responses.

Finally, the data submitted to NEMSIS also represents a very large convenience sample, as not all EMS responses are included.¹⁷ However, the proportion of EMS agencies and states contributing to the dataset continues to grow, and the database remains the best national estimate of EMS information, incorporating the majority of the United States, both rural and urban, EMS agencies.

CONCLUSION

The recognition of pain as a symptom is not consistently documented among patients in the prehospital setting, and the majority of patients with a painful traumatic injury do not receive pain medication prior to arrival to a hospital. Young pediatric patients are less likely to have pain documented and to receive pain medication than adult patients. Black patients are less likely than other racial/ethnic groups to have pain documented and to receive pain medication by EMS providers. This study, utilizing the largest national EMS database, suggests areas for improvement in the approach to pain management in the prehospital setting across the United States.

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