

## ORIGINAL RESEARCH

## Emergency Medical Services

# Out-of-hospital assessment and treatment of adults with atraumatic headache

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## Abstract

**Objective:** Little is known about the presentation or management of patients with headache in the out-of-hospital setting. Our primary objective is to describe the out-of-hospital assessment and treatment of adults with benign headache. We also describe meaningful pain reduction stratified by commonly administered medications.

**Methods:** This retrospective evaluation was conducted using data from a large national cohort. We included all 911 responses by paramedics for patients 18 and older with headache. We excluded patients with trauma, fever, suspected alcohol/drug use, or who received medications suggestive of an alternate condition. We presented our findings with descriptive statistics.

**Results:** Of the 5,977,612 emergency responses, 1.1% (66,235) had a provider-documented primary impression of headache or migraine and 52.5% (34,763) met inclusion criteria. An initial pain score was recorded for 73.5% (25,544) of patients, and 58.5% (14,948) of these patients had multiple pain scores documented. Of the patients with multiple pain scores documented, 53.8% (8037) of patients had an initial pain score >5. Of these, 7.1% (573) were administered any medication. Among patients receiving a single medication, Fentanyl was the most commonly administered (32.1%, 126). As a group, opioids were the most commonly administered class of drugs (38.9%, 153) and were associated with the largest proportion of clinically significant pain reduction (69.3%, 106). Dopamine antagonists were given least frequently (9.9%, 39) but had the second largest proportion of pain reduction (43.6%, 17).

**Conclusion:** Out-of-hospital pain scores were documented infrequently and less than one in five patients with initial pain scores >5 received medication. Additionally, adherence to evidence-based guidelines was infrequent.

## 1 | INTRODUCTION

### 1.1 | Background

Severe atraumatic headaches often lead patients to seek emergency care. Headaches were the fifth leading cause of emergency department (ED) visits in 2016, accounting for 2.8% of encounters (4.1 million) that

year.<sup>1</sup> Some of these patients present to the ED by ambulance and early initiation of treatment could reduce the intensity and duration of pain. In 2012, <1% of all 911 calls for emergency medical services (EMS) were for headache.<sup>2</sup>

The main goals in treating the atraumatic headache are ruling out life-threatening conditions, treating pain, and preventing recurrence.<sup>3-5</sup> The treatment for atraumatic headaches in the ED

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varies and includes dopaminergic antagonists,<sup>6–18</sup> non-steroidal anti-inflammatory drugs (NSAIDs),<sup>19–23</sup> typical antipsychotics,<sup>24–28</sup> ketamine,<sup>18</sup> and acetaminophen.<sup>29</sup> Despite professional association guidelines recommending against the routine use of opioids for atraumatic headache,<sup>4,30,31</sup> opioids made up more than half of all medications given to treat this condition in one multicenter ED study in 2010.<sup>32</sup>

## 1.2 | Goals

Little is known about the assessment or treatment of patients with atraumatic headache encountered by EMS personnel. We aimed to describe the presentation, assessment, and treatment of adults with atraumatic headache encountered by EMS. We also described the comparative effectiveness of treatments administered.

## 2 | METHODS

### 2.1 | Study design and setting

We used data from ESO, Inc. (Austin, Texas) to perform a retrospective analysis of all EMS emergency calls for adult patients with atraumatic headache between January 1, 2018 and December 31, 2018. ESO is a software and data company that provides an electronic health record software platform for EMS agencies. The ESO electronic health record is compliant with the standards of version 3.0 of the National EMS Information System (NEMSIS).<sup>33</sup> The ESO electronic health record allows EMS providers to record patient demographics, clinical impressions, vital signs, and interventions at the time of care. ESO maintains a research database of patient care records from EMS agencies that have consented to contribute their data for the purposes of research and benchmarking. All records in this dataset are de-identified to remove any potential patient or agency identifying information. In 2018, there were >1200 EMS agencies across the United States that contributed records to this dataset. This dataset includes records from emergency responses occurring in 50 states and the District of Columbia, and includes agencies that are fire-based, third-service, governmental, and private. The dataset used for this study was limited to prehospital elements only. This study was reviewed and approved by the Institutional Review Board at Baylor Scott & White Hospital.

### 2.2 | Selection of participants

For this study, we included all activations from a 911 request for adult patients (age >18) with a primary impression of “headache” or “migraine” between January 1, 2018 and December 31, 2018. We excluded any patient with documented injury, trauma, fever, or documented suspicion of alcohol or drug use. The presence of fever was based on documented temperature, an included data point in the

electronic health record, and excluded patients with a documented temperature >100°F.

We also excluded records that did not have a paramedic included in the EMS crew, as only providers certified at the paramedic level can administer most medications used in the treatment of the atraumatic headache. Because there were many patients who received medications that were not plausibly used for analgesia (eg, neuromuscular blockers), we concluded that patients who received any of these medications did not have an uncomplicated, afebrile, atraumatic headache and excluded them from the analysis. A list of what we determined by consensus to be non-plausible medications and the frequency of their use is given in Supplemental Table S1.

### 2.3 | Outcomes

Outcomes included the proportion of patients who had a documented prehospital pain assessment, reassessment, and received one or more medications. For patients with at least two recorded pain assessments, we also assessed the proportion with a clinically meaningful reduction in pain from first to last recorded pain score. We defined clinically meaningful for each patient as a reduction between the first and last pain score of two or more on a 0 to 10 scale. We used a reduction of two points on the pain scale based on work describing a decrease of 1.3 points on the numeric rating scale as clinically significant.<sup>34</sup> Because the electronic health record records pain scales as whole numbers, we round up and used a reduction of two in pain score rating.

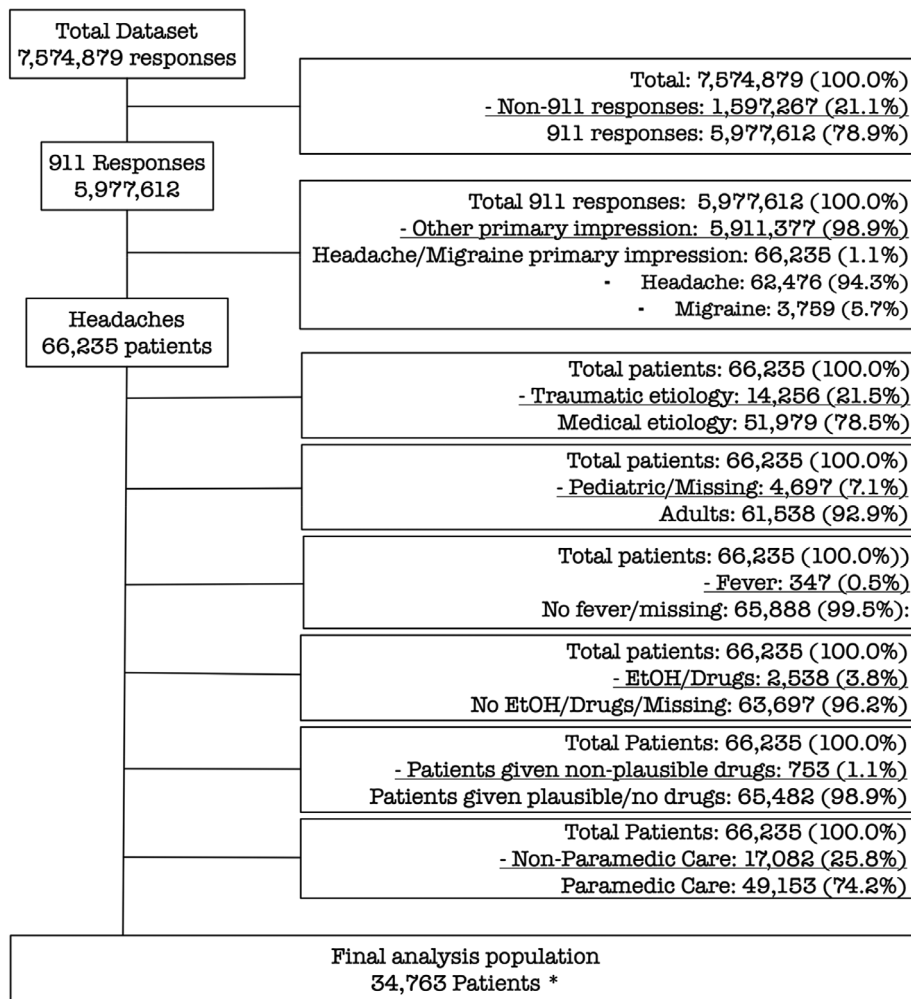
### 2.4 | Measurements

We described the demographics of this population in terms of age, gender, race, vital signs, change in vital signs from first to last, and treatments given. For the treatments given, we described their frequency as well as doses and routes of administration.

To describe the effectiveness of treatments, we limited the dataset to only those patients with at least two documented pain scores to evaluate for change. We further limited our analysis to only those patients with an initial pain score >5 to focus on patients with more severe pain. Finally, to avoid the confounding effect on pain reduction from patients receiving multiple medications, we restricted our analysis to only those patients who received only one distinct medication (patients who received multiple doses of a single medication were included).

### 2.5 | Analysis

We summarized continuous variables using median and interquartile range (IQR) and categorical variables with frequencies and proportions. Descriptive statistics were performed using R (Vienna, Austria).<sup>35</sup>



**FIGURE 1** Patient inclusion and exclusion criteria. Note: there were patients with multiple exclusion criteria. Because any given patient can only be excluded once, the number of patients included does not equal the number of patients with headache from 911 call minus exclusions

### 3 | RESULTS

#### 3.1 | Characteristics of study subjects

There were 7,574,879 records in the overall dataset. Of these, 78.9% (5,977,612) were emergency (911) responses. 1.1% (66,235) of emergency responses had a documented EMS primary impression of “headache” or “migraine.” After exclusions for trauma, fever, age, alcohol/drug use, non-paramedic care, and non-plausible medications, our analysis population consisted of 34,763 patients (Figure 1). The median age was 50 years (IQR 35, 65) and 66.8% (23,232) were female. 51.2% (17,816) of patients were non-Hispanic White and 29.9% (10,400) were non-Hispanic Black (Table 1).

#### 3.2 | Main results

26.5% (9219) of all patients had no pain scale documented and 1.4% (125) of these received analgesic treatment. 73.5% (25,544) of all patients had at least one pain scale documented and of these 3.9%

(998) received analgesia. The median initial pain score of patients with at least one pain score was 6 (IQR 2,8). There were 37.5% (13,031) of patients who had an initial pain score >5 and of these, 5.6% (733) received one or more analgesic medications.

Overall, regardless of presence or absence of an initial pain score, 3.2% (1123) of patients received one or more analgesic medications (Figure 2). The five most common analgesic medications were fentanyl (32.1%), acetaminophen (25.5%), ketorolac (12.7%), promethazine (6.9%), and morphine (5.6%). While not an analgesic, 703 patients received ondansetron, potentially for the treatment of headache-associated nausea. See Supplemental Table S2 for all medications given along with route and dosage.

We determined medication effectiveness in 8037 patients with at least two pain scores and an initial pain score >5. Of the 7464 patients who received no medications, 16.3% had a clinically significant reduction in pain. 573 patients received at least one medication and 55.1% (316) saw a meaningful reduction in pain. 393 were given only one medication and 48.6% (191) had a clinically significant reduction in pain. Of the 180 patients who received more than one medication, 69.4% (125) had a clinically significant reduction in pain (Figure 2, Table 2).

**TABLE 1** Patient characteristics

Characteristic	N (%) [IQR]		
Age (median [IQR])	50 [35,65]		
Female <sup>a</sup>	23,232 (66.8)		
Race/ethnicity <sup>a</sup>			
White, non-Hispanic	17,816 (51.2%)		
Black, non-Hispanic	10,400 (29.9%)		
Missing	3449 (9.9%)		
Hispanic	2782 (8.0%)		
Asian	244 (0.7%)		
Other	72 (0.2%)		
Primary impression			
Headache	29,979 (92.7%)		
Migraine	2367 (7.3%)		
Vital signs	First median [IQR]	Last median [IQR]	Difference <sup>b</sup> (last-first) median [IQR]
Pain score	6 [2,8]	5 [2,8]	0 [0,0]
Pulse rate	85 [75,96]	83 [73,94]	2 [-2,7]
Respiratory rate	18 [16,18]	18 [16,18]	0 [0,0]
Systolic blood pressure	145 [130,166]	141 [126,160]	4 [-4,14]
Diastolic blood pressure	87 [78,98]	84 [76,95]	2 [-4,10]
SpO <sub>2</sub>	98 [97,99]	98 [97,99]	0 [-1,1]
Glasgow coma score	15 [15,15]	15 [15,15]	0 [0,0]

IQR, interquartile range.

<sup>a</sup>Percentages are of those reporting gender or race/ethnicity.

<sup>b</sup>Difference is between only those patients with at least 2 of relevant vital signs.

**TABLE 2** Analgesic effectiveness by drug class<sup>a</sup>

Drug class	N (%)	PS median [IQR]	Clinically significant reduction n (%)
Opioids	153 (38.9%)	2 [1,4]	106 (69.3%)
NSAIDs	101 (25.7%)	0 [0,2]	38 (37.6%)
APAP	100 (25.5%)	0 [0,2]	30 (30.0%)
Anti-dopamine	39 (9.9%)	0 [0,2]	17 (43.6%)

APAP, acetaminophen

<sup>a</sup>Limited to only drug classes administered to patients with >1 pain score and an initial pain score >5.

Of the 393 patients with at least two pain scores and an initial pain score >5 who received only one medication, 38.9% (153) received an opioid and, of these, 69.3% (106) had a significant reduction in pain. 25.7% (101) of patients received an NSAID and 37.6% (38) had a significant reduction in pain. 25.5% (100) received acetaminophen and 30.0% (30) had a significant reduction in pain. Only 9.3% (39) received

a dopamine antagonist and, of these, 43.6% (17) had a clinically significant reduction in pain. See Supplemental Table S3 for median difference in pain score and proportion of patients with clinically meaningful reduction in pain score, by medication.

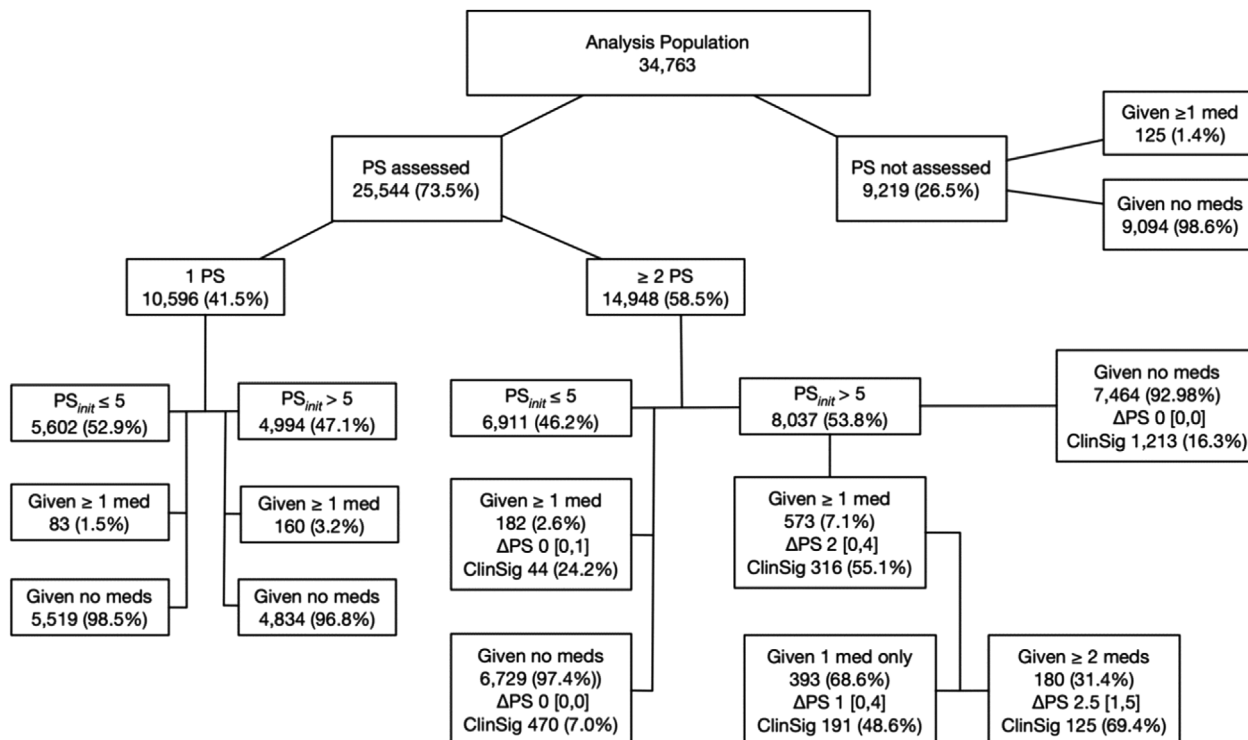
## 4 | LIMITATIONS

This was a retrospective electronic chart review of a widely used EMS electronic medical record. Although this dataset is national, the agencies included represent a convenience sample of EMS agencies and may not capture the regional variation in practice among all EMS agencies in the United States. Further, it is possible that patients presenting with atraumatic headache to agencies using this electronic health record may, in some way, be different than those presenting to other agencies using other electronic health record products. The dataset was limited to prehospital elements only, and no patient outcome or hospital process (eg, ED length of stay, return visits) was included in this study. We were unable to determine if patients had repeat EMS encounters because the data was de-identified, and the electronic health record did not contain a universal patient-specific identifier. Data were not specifically collected for research purposes, and there were no uniform documentation standards. Despite this, the following data points abstracted were likely to have been unambiguous: age, gender, treatments, and pain scores. Some data entry errors were also likely, which could explain non-feasible treatment methods (eg, the administration of acetaminophen or ondansetron endotracheally). It is possible that medications may have been administered, or pain scores assessed, that were not documented and the impact of this type of missing data on the results of our study is unknown.

We attempted to isolate patients who had a benign etiology of headache to exclude those with more critical diagnoses, such as stroke, intracranial hemorrhage, meningitis, or trauma. We did this by including adults with an impression of headache and excluding those with impressions of stroke, presence of fever, suspected alcohol/drug use, or trauma. We were unable to reliably determine pregnancy status for patients and were thus unable to exclude potential cases of eclampsia. We excluded patients with a documented fever. Because the majority of patients (>84%) had no documented temperature, it is possible that some febrile patients were inadvertently included in the analysis.

We also excluded patients who received a medication deemed more likely to be given for an alternative reason. For example, 0.5% of patients in our study received etomidate and/or succinylcholine suggesting these patients did not have a benign headache. It is possible that our criteria were imprecise and inadvertently included patients with more serious diagnoses, which may have impacted the decision to assess or treat pain. Indeed, there is some evidence that patients with headache who present to the ED by EMS have a more serious etiology than those who self-transport.<sup>36</sup>

Because specific treatment protocols are state- and agency-specific, and we do not have access to such information, we are unable to determine which medications were available to providers, if agencies had



**FIGURE 2** Distribution of patients with pain score assessment and analgesic medications given. ClinSig, number and proportion of patients with clinically significant reduction in pain score; PS, pain score;  $\Delta$ PS, difference in pain score (first–last).  $\Delta$ PS and ClinSig only calculated for those patients with two or more pain score assessments

specific protocols for headache, and the degree to which any protocols were complied with.

We provide information on medication effectiveness for descriptive purposes only. This is based on provider documentation that was not specifically collected for this purpose. Further, this study was solely descriptive; we did not make an attempt to control for potential differing characteristics of patients who received medications. These results should not be extrapolated to judge comparative effectiveness of the included medications.

## 5 | DISCUSSION

In this retrospective analysis of a large EMS dataset, we found that analgesic treatment was infrequent for adults with afebrile, atraumatic headaches. Over a quarter of patients in our analysis did not have a pain scale recorded. Of those who had an initial pain assessment, 42% did not have a documented repeat assessment. Less than 4% of patients received any treatment. Of those who did receive treatment, fentanyl was the most common analgesic medication given. Despite guidelines to the contrary, opioids were the most commonly given drug class.

The prevalence of patients with a primary impression of headache was 1% of all 911 EMS responses. This was slightly less common than the 3% of ED visits for headache.<sup>1</sup> Assuming 25 million EMS calls per year in the United States,<sup>37</sup> with 1% of these being for atraumatic

headache, there are many (~250,000/year) patients who could benefit from EMS treatment. Given the low proportion of patients who received any medication, this study highlights an important improvement opportunity for EMS agencies.

Opioids were the most commonly administered type of medication. This is a lower utilization than seen in the ED.<sup>32</sup> Although effective at treating an episode of acute headache, opioid treatment of headache has been associated with increased return ED visits, a longer ED length of stay, increased risk of developing chronic daily headaches, increased risk of opioid dependence, and more severe headache-related disability.<sup>38–41</sup> For these reasons, current guidelines for the treatment of headache in the emergency medicine setting recommend against using opioids as first-line therapy.<sup>4,30</sup> Introduction of an opioid-free protocol for EMS may decrease utilization of opioids for headache. Such a protocol was effective in the ED setting and was associated with 26% lower odds of a return ED visit.<sup>41</sup> Future research could determine if such a protocol using opioid alternatives may also have similar effects in EMS without impacting effective symptom management.

Anti-dopaminergic agents were used less frequently than opioids in this population. They were, however, the second most effective agent. Of patients treated with an anti-dopaminergic agent, 44% experienced clinically significant pain reduction compared with 69% of patients receiving an opioid. This is contrary to much of the literature regarding adult patients with headache in the ED. Several studies have demonstrated either similar or superior reduction in symptoms with various anti-dopaminergic agents when compared with opioids.<sup>7,12,13</sup>

The most commonly studied anti-dopaminergic agents used to treat headaches are prochlorperazine and metoclopramide with substantial evidence supporting their efficacy.<sup>6,8,10,14,16–18</sup> These two agents were also the most commonly used anti-dopaminergic agents in our study. One potential explanation for the seemingly lower efficacy of anti-dopaminergic agents seen in our study is that these agents have a longer onset of action than do opioids and may not have had time for their effects to be noted. Promethazine was the most commonly administered anti-dopamine antagonist in our study. Although we cannot determine rationale from our dataset, one possible explanation for giving promethazine is that it may have been given more for the nausea associated with headache than for the headache itself. This explanation is supported by the number of patients in our study who were given ondansetron, a medication, unlike promethazine, without a theoretic analgesic benefit.

One of the most effective agents for the treatment of headache in the emergency setting is droperidol, another anti-dopaminergic agent.<sup>26–28</sup> Droperidol was not used at all in our patient population, possibly because of a “black box” warning placed on this agent by the US Federal Drug Administration which, combined with drug shortages in the United States, made the drug essentially unobtainable.<sup>42</sup> Haloperidol, also an anti-dopaminergic agent similar to droperidol, does have some evidence supporting its use for headache,<sup>24,25</sup> but was used infrequently in our study.

We are unaware of many EMS education programs that focus effort on distinguishing different types of headaches. If it were feasible for paramedics to accurately diagnosis cluster headaches, the administration of oxygen would likely be effective and is certainly within the scope of paramedics.

Current evidence and guidelines suggest first line treatment of acute headache should include acetaminophen, NSAIDs, or anti-dopaminergic agents while avoiding opioid usage.<sup>4,30,31</sup> Our results suggest these guidelines are often not followed by EMS. There are several potential explanations for this. Patients may avoid calling for EMS until their headache is severe and until oral medications, such as acetaminophen and ibuprofen, have already failed. Patients may also present with associated nausea making EMS administration of oral medications problematic. Still, parenteral ketorolac or acetaminophen both remain reasonable options. When given in our population, NSAIDs and acetaminophen were the least effective analgesic medications given, although this could be an indication that such agents take longer to have an effect than is reflected in the time with EMS. EMS medical directors may be unaware of treatment guidelines for headache or, more likely, did not include a specific protocol utilizing evidenced-based care for headache in their protocols. It is also possible that paramedics may have a bias that, because headaches are not perceived to be life-threatening or because there is no outwardly visible indication of pain with headache, there was less motivation for treatment or concern that the patient might be “faking it.” Regardless of the reason, our results indicate that evidence-based treatment for headache is an area for improvement in EMS. Future investigations are warranted to evaluate the effects of specific EMS headache protocols on compliance with treatment guidelines, their impact on

patient-oriented outcomes such as pain relief, return ED visits, and process outcomes such as ED length of stay.

## 6 | CONCLUSIONS

In summary, we provide a description of EMS patients presenting with benign atraumatic headache in a large, national cohort. Overall, patients with headache were rarely given any medication. Of those receiving analgesic therapy, opioids were given most commonly, a practice not in accordance with evidence-based guidelines for the treatment of headache. These results provide an opportunity for improvement in EMS management of benign headache.

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## AUTHOR CONTRIBUTIONS

JLJ and BJ conceived of the study. JLJ performed the analysis. JLJ, BJ, and RC wrote the first draft. All authors contributed edits to the paper and revisions. JLJ takes responsibility for the paper as a whole.

## CONFLICTS OF INTEREST

The authors have no conflicts of interest to disclose.

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#### SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

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