Brief Report

Epidemiology of intravenous fluid use for headache treatment: Findings from the National Hospital Ambulatory Medical Care Survey

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ABSTRACT

Background: Headache is one of the most common reasons for patients to seek care in emergency departments. While the administration of intravenous fluids is frequently recommended for emergency department patients with migraine, the epidemiology of the use of this intervention is unknown.

Objectives: To describe the epidemiology of intravenous fluid use in emergency department patients with headache.

Methods: This retrospective study utilized the 2011 US National Hospital Ambulatory Medical Survey, a multi-stage weighted survey providing nationally representative estimates of ED visits. Patients with chief complaints of non-traumatic headache or migraine headache were included. We determined the frequency of intravenous fluid administration among patients presenting with headache, and among specific subgroups including those with migraine headache.

Results: There were 1251 sample cases representing 5,981,000 visits for a chief complaint of headache. Intravenous fluids were administered at 40% (95% CI 35–44%) of these visits. Among the 222 migraine cases, 47% (95% CI 39–56%) received fluids. Fluids were commonly administered regardless of pain severity, and fluid administration was not significantly associated with pain severity among patients diagnosed with migraine (p = 0.39). After adjusting for patient characteristics, ED visit duration remained greater for patients receiving fluids than for those who did not among both patients with a headache complaint and among those with a diagnosis of migraine headache.

Conclusions: Despite a lack of efficacy data, patients treated in United States EDs for headache frequently receive IV fluids. Studies are needed to determine the efficacy of this basic treatment intervention.

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1. Introduction

Headache is a substantial global public health problem [1], and the fourth most common reason that patients visit an emergency department (ED) in the United States (US) [2]. Numerous studies have evaluated the efficacy of medications for the treatment of acute headache in the ED setting, including serotonin agonists, dopamine receptor antagonists, and steroids [3–7]. In contrast, adjunctive non-pharmacologic therapies have received less study. In particular, the efficacy of intravenous (IV) fluids for the treatment of acute headache in the ED is unknown. Despite this lack of efficacy data, experts often recommend IV fluid administration for patients with migraine headache, and clinical experience suggests that IV fluids are commonly used in the ED for this indication. However, the epidemiology of IV fluid use for the ED treatment of headache has not been well defined.

We used the most recent data available from the National Hospital Ambulatory Medical Care Survey (NHAMCS) to define the epidemiology of IV fluid administration in US emergency departments for the treatment of acute headache. We hypothesized that IV fluid administration for headache would be common across all patients. In addition, we hypothesized that IV fluid administration would be associated with headache pain severity and medication use.

2. Methods

2.1. Study design and setting

This is a retrospective study of data collected through the National Hospital Ambulatory Medical Care Survey (NHAMCS). The NHAMCS is an annual multi-stage survey study which is conducted by the Centers for Disease Control and Prevention and the National Center of Health Statistics in order to study the utilization of ambulatory care services...
within a nationally representative sample of US hospitals [8]. All data from the NHAMCS are publicly available and de-identified, so this study did not require IRB approval. Survey methods have previously been described in detail [8]. While the survey includes information from visits to both emergency departments and outpatient clinics, this analysis utilizes only data from visits to hospital emergency departments. At selected hospitals, hospital staff members or Census Bureau representatives who have been trained in data collection procedures complete comprehensive patient record forms for a random sample of patient visits during a randomly selected four week sampling block.

2.2. Measurements

Data collected through the survey process include information on patient demographics, reasons for the ED visit, diagnostic tests performed, interventions, diagnoses, and patient disposition. We utilized data from 2011, during which 322 non-federal hospitals with emergency departments participated in the survey. Up to three reasons for the ED visit can be recorded. We included records in this analysis if one of these reasons for visit was “headache” or “migraine.” Records were excluded if the visit was due to injury, poisoning, or adverse effect of a medical treatment. Additional data fields included in this analysis were age, sex, race, pain severity, arrival by EMS, arrival at night (9 p.m. to 6 a.m.), diagnosis, length of stay, and disposition. Pain scores from 1 to 3 on a 1–10 scale were classified as mild, scores of 4–6 as moderate, and 7–10 as severe. Administration of IV fluids was assessed using the IV fluids (IVF) field, which is a dichotomous variable indicating whether or not intravenous fluids were administered during the ED visit. We performed a sensitivity analysis including those cases for which patients received a diagnosis of migraine headache or any migraine variant (ICD-9 code 346.*) during the index visit.

2.3. Data analysis

We analyzed survey data using the visit weights provided by NHAMCS, which have been calculated for each visit according to sampling fractions corresponding to each stage of the survey and adjusted for non-response according to time of year, geographic region, urban/rural setting, and hospital ownership in order to allow for the calculation of an unbiased national estimate of ED visit characteristics and proportions. Point estimates and 95% confidence intervals are provided for categorical characteristics of headache patients. We assessed associations between categorical variables using the Rao-Scott Chi-square test, and considered p values <0.05 to be significant. We used multivariable linear regression to determine the relationship between IV fluid administration and ED length of stay when controlling for potential confounding variables: patient age, sex, pain score, and mode of arrival. This regression was performed after rank transformation of the length of stay data because of the nonparametric distribution of untransformed data. The regression analysis was not affected by multicollinearity. No imputation was performed for missing data. National estimates have been rounded to the nearest 1000 per NHAMCS recommendations. Estimates which are not based on at least 30 unweighted records are noted, as these may not be reliable. Analyses were performed using SAS v 9.4 (SAS Institute, Cary, NC).

3. Results

The 2011 NHAMCS involved the analysis of 31,084 visits, yielding an estimate of 136,296,000 ED visits nationwide. Of these 1251 visits for non-traumatic headache met inclusion criteria, corresponding to 5,981,000 visits across the US, or 4.4% of total ED visits (Fig. 1). The great majority of these individuals (91%, 95% CI 93–99%) were discharged to home after the ED visit. Adults between the ages of 18 and 64 accounted for 77% (95% CI 75–80%) of total visits for headache, and visits by women (68%, 95% CI 66–71%) outnumbered those by men (32%, 95% CI 29–34%) (Table 1). Most patients presented with severe pain (67%, 95% CI 63–72%), and 25% presented with moderate pain (95% CI 21–29%).

Among all visits for non-traumatic headache, 40% (95% CI 35–44%) received intravenous fluids, representing an estimated 2,375,000 visits. Patients with severe pain on arrival were more likely to receive IVF (47%) than were patients with moderate pain (35%) or mild pain (35%), p = 0.03, though fluids were commonly administered regardless of pain rating. Rates of fluid administration were not significantly different across geographic regions (p = 0.06) or among patients with a presenting complaint of migraine (47%) as compared to a complaint of non-specific headache (38%, p = 0.10). Patients receiving a diagnosis of migraine headache were not significantly more likely to receive IV fluids than those with other diagnoses (47% vs 38%, p = 0.10).

An estimated 4,512,000 of the patients with a chief complaint of headache (75%) received medications while in the ED. IV fluids were more commonly administered in patients who received antiemetic medications, opiates, and non-steroid anti-inflammatory (NSAID) medications as compared to those not receiving these drugs (Table 2).

The ED length of stay was substantially greater for patients who received IVF (median 202 min, IQR 148–307) than for patients who did not receive IVF (median 131 min, IQR 80–198). This effect remained significant (p < 0.001) after adjusting for initial pain score, sex, age, and mode of arrival.

There were 222 visits in which patients received a diagnosis of migraine headache, representing an estimated 958,000 visits nationwide in 2011. The majority of these patients were also adults between ages 18 and 64 (92%, 95% CI 88–96%), and most reported severe pain (76%, 95% CI 68–85%). IVF was administered during 97 of the 222 migraine visits (47%, 95% CI 39–56%), representing 453,000 national visits which received fluids and 504,000 visits which did not. After controlling for pain score, sex, age, and mode of arrival, ED length of stay for patients diagnosed with migraine was longer for those receiving fluids (median 190 min, mean 212 min (95% CI 183–240 min)) than for those receiving no fluids (median 105 min, mean 149 min (95% CI 122–177 min)) (p < 0.001).

4. Discussion

We report that in 2011, there were an estimated 5.9 million visits to US emergency departments for non-traumatic headaches. Approximately 40% of these patients receive IV fluids as part of their ED treatment. Patients with more severe pain were more likely to receive IV fluid, but IV fluid use was common regardless of the initial pain score. The ED length of stay was substantially longer for patients who received IV fluids than for those who did not. The lack of efficacy data guiding practice, together with the substantial proportion of headache patients who received IV fluid, suggest that considerable practice variation exists between providers with respect to the administration of IV fluids for the ED treatment of non-traumatic headache.

A recent secondary analysis of data from four ED-based trials evaluating the use of IV metoclopramide demonstrated no association between IV fluid administration and improved pain outcomes [9]. However, several laboratory-based studies of healthy volunteers support the hypothesis that IV fluid may reduce pain in general. In one study, dehydrated subjects were found to have lower pain thresholds and increased pain-related brain activity involving the anterior cingulate cortex, insula, and thalamus, as compared to well hydrated subjects [10]. Another laboratory-based study found that mild dehydration increased pain response to a standardized noxious stimulus [11]. In addition, the rapid ingestion of 1500 ml of water was found in another study to reduce pain perception [12]. Consistent with these experimental data, a case series of individuals with migraine headaches reported dehydration as a trigger [13]. These data suggest that oral or IV fluids may be useful to administer to patients not only with headache, but perhaps to individuals presenting with pain complaints to the ED more
generally. If so, then perhaps fluids are currently underutilized as an ED treatment.

However, the need to prospectively study the potential utility of oral or IV fluid in pain populations such as non-traumatic headache is suggested by the fact that, in ED clinical populations with other acute pain conditions, the effect of IV fluids on pain outcomes has been mixed. For example, several randomized controlled trials of IV fluids for acute ureteral colic due to kidney stone failed to show that fluids improved pain scores [14]. In addition, trials of aggressive perioperative fluid administration to decrease post-operative pain have not yielded consistent results [15,16]. If IV fluids do not benefit individuals with non-traumatic headache, then patients are burdened by additional costs. In addition, while generally safe, risks associated with IV placement and/or fluid administration include infection [17] and thrombophlebitis [18]. While these outcomes are rare, the common use of IV fluids (versus no fluids or oral fluids) in millions of ED patients each year make them relevant to risk/benefit calculations. IV fluid use also pulls ED staff away from the care of other ED patients, when such staff time is often critical to ensuring patient safety.

Further studies are needed to determine the efficacy of IV fluid use in patients with non-traumatic headache. If efficacious, studies are needed to determine if this benefit is limited to the IV route of administration, or whether IV fluid can be reserved for those with substantial nausea or those who fail a trial of oral hydration. A better understanding of the utility of fluids for pain and other patient-oriented outcomes is important in order to optimize the management of those with non-traumatic headaches and other pain complaints. In the era of evidence-based

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**Table 1**
The epidemiology of intravenous (IV) fluid administration among patients visiting United States emergency departments (EDs) for non-traumatic headache based on the 2011 National Hospital Ambulatory Medicine Survey.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Encounters sampled</th>
<th>National estimate Visits × 10^7 (95% CI)</th>
<th>Percent receiving IV fluid p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>1251</td>
<td>5981 (3711–6252)</td>
<td>39.7%</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 18</td>
<td>163</td>
<td>848 (691–1005)</td>
<td>26.1% 0.01</td>
</tr>
<tr>
<td>18–64</td>
<td>982</td>
<td>4635 (4361–4909)</td>
<td>42.0%</td>
</tr>
<tr>
<td>&gt; 64</td>
<td>106</td>
<td>498 (378–619)</td>
<td>41.6%</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>845</td>
<td>4095 (3821–4269)</td>
<td>39.9% 0.89</td>
</tr>
<tr>
<td>Male</td>
<td>406</td>
<td>1886 (1672–2100)</td>
<td>39.3%</td>
</tr>
<tr>
<td>Race</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>862</td>
<td>3754 (3508–4000)</td>
<td>40.0% 0.60</td>
</tr>
<tr>
<td>Black</td>
<td>323</td>
<td>1949 (1704–2194)</td>
<td>40.4%</td>
</tr>
<tr>
<td>Other</td>
<td>66</td>
<td>279 (192–366)</td>
<td>31.8%</td>
</tr>
<tr>
<td>Pain</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mild (1–3)</td>
<td>70</td>
<td>371 (267–475)</td>
<td>35.3% 0.03</td>
</tr>
<tr>
<td>Moderate (4–6)</td>
<td>231</td>
<td>1130 (960–1301)</td>
<td>34.5%</td>
</tr>
<tr>
<td>Severe (7–10)</td>
<td>643</td>
<td>3099 (2855–3344)</td>
<td>46.5%</td>
</tr>
<tr>
<td>Disposition</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discharged</td>
<td>1134</td>
<td>5445 (5169–5721)</td>
<td>36.5% &lt;0.001</td>
</tr>
<tr>
<td>Not discharged</td>
<td>117</td>
<td>536 (414–659)</td>
<td>72.5%</td>
</tr>
</tbody>
</table>

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**Table 2**
Percentage of patients presenting with a complaint of headache or migraine receiving pharmacologic therapy who also received intravenous fluids.

<table>
<thead>
<tr>
<th>Medication class</th>
<th>Encounters sampled</th>
<th>Nationally estimated annual visits</th>
<th>Percent receiving IV fluid p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anti-emetic</td>
<td>549</td>
<td>2,374,681</td>
<td>60% &lt;0.001</td>
</tr>
<tr>
<td>No anti-emetic</td>
<td>702</td>
<td>3,276,000</td>
<td>22%</td>
</tr>
<tr>
<td>NSAIDa</td>
<td>368</td>
<td>1,760,000</td>
<td>52% &lt;0.001</td>
</tr>
<tr>
<td>No NSAID</td>
<td>883</td>
<td>4,221,000</td>
<td>33%</td>
</tr>
<tr>
<td>Opiate</td>
<td>386</td>
<td>1,819,000</td>
<td>54% &lt;0.001</td>
</tr>
<tr>
<td>No opiate</td>
<td>865</td>
<td>4,163,000</td>
<td>32%</td>
</tr>
<tr>
<td>Migraine-specific medicationb</td>
<td>39</td>
<td>134,000</td>
<td>53% 0.24</td>
</tr>
<tr>
<td>No migraine-specific medication</td>
<td>894</td>
<td>4,378,000</td>
<td>49%</td>
</tr>
</tbody>
</table>

a Nonsteroidal anti-inflammatory drug.
b Triptans and ergotamines.
c Estimates based on subgroups with fewer than 30 cases may not be reliable.
medicine. It is time that we better understood the utility of this most basic of ED interventions.

4.1. Limitations

This study has several important limitations. First, as with other retrospective chart reviews, NHAMCS data are susceptible to selection bias, as well as errors and omissions both at the time the medical record is created and during the data abstraction process. Additionally, the NHAMCS is intended to provide basic demographic and clinical information about a representative sample of US ED visits. This focus on general visit characteristics, however, means that details relevant to the investigation of any single clinical entity are often not available. For example, we did not have access to information about the timing of symptom onset or information about response to therapy. As a result, we are unable to control our results for potentially important clinical details. It is very likely, for example, that the observed relationship between fluid administration and ED length of stay is affected by the existence of confounding variables, and it is important to note that we have not demonstrated evidence of a causal relationship. NHAMCS also does not contain detailed information about the dose of IVF administered in each case. Finally, patients who present to the ED for treatment of atraumatic headache comprise a heterogeneous group, and it is likely that much of the observed treatment variation with respect to IVF administration reflects this heterogeneity. We addressed this concern by performing a sensitivity analysis involving data from patients diagnosed with migraine headache in the ED, as this group is likely to be less clinically heterogeneous. However, it is important to note that in clinical practice within the ED, providers often make a diagnosis of migraine headache without formally applying the migraine diagnostic criteria as defined by the International Classification of Headache Disorders [19].

5. Conclusions

In summary, we demonstrate that approximately 40% of patients treated in US EDs for non-traumatic headache are treated with IV fluids. Fluids administration is common regardless of pain severity, patient demographic characteristics, or medication administration. Given the frequency of headache encounters in the ED and the high degree of practice variation established by this analysis, a randomized trial assessing the effects of IV fluid on patients presenting to the ED with acute headache is warranted.

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Competing interests

Dr. Jones is an investigator on unrelated studies sponsored by AstraZeneca, Roche Diagnostics, Inc., and Janssen. The remaining authors declare no additional competing interests.

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