Multicenter Evaluation of Prehospital Opioid Pain Management in Injured Children

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**MULTICENTER EVALUATION OF PREHOSPITAL OPIOID PAIN MANAGEMENT IN INJURED CHILDREN**

Lorin R. Browne, DO, Manish I. Shah, MD, MS, Jonathan R. Studnek, PhD, Daniel G. Ostermayer, MD, Stacy Reynolds, MD, Clare E. Guse, MS, David C. Brousseau, MD, MS, E. Brooke Lerner, PhD

**ABSTRACT**

**Background:** The National Association of Emergency Medical Services Physicians’ (NAEMSP) Position Statement on Prehospital Pain Management and the joint National Highway Traffic Safety Administration (NHTSA) and Emergency Medical Services for Children (EMSC) Evidence-based Guideline for Prehospital Analgesia in Trauma aim to improve the recognition, assessment, and treatment of prehospital pain. The impact of implementation of these guidelines on pain management in children by emergency medical services (EMS) agencies has not been assessed. **Objective:** Determine the change in frequency of documented pain severity assessment and opiate administration among injured pediatric patients in three EMS agencies after adoption of best practice recommendations. **Methods:** This is a retrospective study of children <18 years of age with a prehospital injury-related primary impression from three EMS agencies. Each agency independently implemented pain protocol changes which included adding the use of age-appropriate pain scales, decreasing the minimum age for opiate administration, and updating fentanyl dosing. We abstracted data from prehospital electronic patient records before and after changes to the pain management protocols. The primary outcomes were the frequency of administration of opioid analgesia and documentation of pain severity assessment as recorded in the prehospital patient care record. **Results:** A total of 3,597 injured children were transported prior to pain protocol changes and 3,743 children after changes. Opiate administration to eligible patients across study sites regardless of documentation of pain severity was 156/3,089 (5%) before protocol changes and 175/3,509 (5%) after (p = 0.97). Prior to protocol changes, 580 (18%) children had documented pain assessments and 430 (74%) had moderate-to-severe pain. After protocol changes, 644 (18%) patients had pain severity documented with 464 (72%) in moderate-to-severe pain. For all study agencies, pain severity was documented in 13%, 19%, and 22% of patient records both before and after protocol changes. There was a difference in intranasal fentanyl administration rates before (27%) and after (17%) protocol changes (p = 0.02). **Conclusion:** The proportion of injured children who receive prehospital opioid analgesia remains suboptimal despite implementation of best practice recommendations. Frequency of pain severity assessment of injured children is low. Intranasal fentanyl administration may be an underutilized modality of prehospital opiate administration. **Key words:** prehospital; pain; pediatrics; analgesia

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**INTRODUCTION**

Prehospital care providers frequently encounter children in pain.1–3 Within the United States, approximately 20% of Emergency Medical Service (EMS) pediatric encounters involve a child in moderate-to-severe pain.1,4 It has been shown that children with untreated painful conditions may experience adverse effects such as increased anxiety, decreased pain tolerance, and fear of future medical encounters.5–7 Despite this, several studies have demonstrated that prehospital opioid analgesic administration is suboptimal, ranging from 2–32%.4,8–15

To optimize recognition, assessment and treatment of prehospital pain, stakeholder organizations have published consensus-based recommendations on pediatric prehospital pain management.16,17 This approach is in line with the Institute of Medicine recommendations that evidence-based guidelines (EBG)...
be further integrated intoprehospital care.\textsuperscript{18,19} Additionally, through the recently created Prehospital Guidelines Consortium, multiple national organizations support the facilitation of EBG implementation and outcomes assessment.\textsuperscript{19,20} In an effort to apply evidence-based practice toprehospital pain management, two publications describe best practices forprehospital pain management: the National Association of Emergency Medical Services Physicians’ (NAEMSP) Position Statement on Prehospital Pain Management and the joint National Highway Traffic Safety Administration (NHTSA) and Emergency Medical Services for Children (EMSC) EBG for Prehospital Analgesia in Trauma.\textsuperscript{16,17} Although these professional statements described similar components toprehospital pain management, the NAEMSP position statement is a general reference for allprehospital pain while the NHTSA/EMSC evidenced-based guideline is specific for injury-related pain. Although neither statement is specific to pediatric patients, the recommendations in both statements address principles to assess and manageprehospital pain and are relevant to children (see Table 1).

Prior research on pediatricprehospital pain management has focused on single EMS systems and/or has been limited to specific injuries or mechanisms.\textsuperscript{10—15} Assessment of clinical outcomes after pain EBG implementation in one EMS system showed that only 11\% of injured children received opioid analgesia.\textsuperscript{10} Clinical outcomes in multiple EMS systems, however, have not been previously assessed after implementation of evidence-based pain management principles.

The objective of this study was to determine the change in frequency of pain severity assessment and documented opiate administration among injured pediatric patients in three emergency medical services agencies (EMSAs) after adoption of best practices recommendations. A secondary objective was to assess the use of the various routes of opiate administration after adoption of the recommendations.

### METHODS

**Study Design and Setting**

This is a retrospective study of patient care records from three EMSAs. Patients included in this analysis are children aged <18 years at the time of prehospital encounter who had aprehospital injury-related primary impression of blunt, penetrating, lacerating, and/or burn trauma.

Patients were transported by one of the EMSAs that comprise the Charlotte, Houston, and Milwaukee Prehospital (CHAmp) research node of the Pediatric Emergency Care Applied Research Network (PECARN). The CHAmp node includes Mecklenburg EMS Agency (Charlotte, NC), the City of Houston Fire Department EMS (Houston, TX) and Milwaukee County EMS (Milwaukee, WI). Collectively, CHAmp agencies serve nearly 1.7 million individuals <18 years of age.\textsuperscript{21}

Mecklenburg EMS is an Advanced Life Support (ALS) EMSA with at least one paramedic responding on all ambulances dispatched by emergency activation. All medical providers within the EMS system follow the same protocols and provide care under the same medical director. Pain management protocols in this agency are developed and maintained by local physicians with experience inemergency medicine (EM), EMS medicine, trauma, surgery, and orthopedics and were last updated in October 2014. Following the update of their pain management protocol, Mecklenburg EMS’ five full-time clinical educators provided essential protocol education and training in nine 4-hour sessions provided within a single calendar month. EMS providers were mandated to attend at least one of these in-service trainings. Access to video recording of the training was also made available to all providers.

The City of Houston Fire Department (HFD) EMS is a two-tiered EMS system with over 3,500 providers, all of whom are trained as firefighters and have at least Basic Life Support (BLS) training with

### TABLE 1. Specific recommendations of model prehospital analgesia protocols and guidelines

<table>
<thead>
<tr>
<th>NAEMSP\textsuperscript{*} Position Statement</th>
<th>NHTSA/EMSC\textsuperscript{\dagger} Evidence-Based Guideline</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Mandatory assessment of pain severity</td>
<td>1. Assess pain as part of general patient care</td>
</tr>
<tr>
<td>2. Use reliable tools for pain assessment</td>
<td>2. Consider all patients with acute traumatic pain as candidates for analgesia, regardless of transport interval</td>
</tr>
<tr>
<td>3. Note indications and contra-indications for pain management</td>
<td>3. Use an age-appropriate pain scale to assess pain</td>
</tr>
<tr>
<td>4. Use both nonpharmacologic and pharmacologic interventions to manage pain</td>
<td>4. Use narcotic analgesics for patients in moderate-to-severe pain</td>
</tr>
<tr>
<td>5. Mandatory patient monitoring and documentation</td>
<td>5. Absolute/relative contraindications should include Glasgow Coma Scale (GCS)&lt;15, hypotension, hypersensitivity, hypoxia, hyperventilation</td>
</tr>
<tr>
<td>6. Transfer of relevant patient care information to receiving medical personnel</td>
<td>6. Reassess all patients who have received analgesia every 5 minutes</td>
</tr>
<tr>
<td>7. Quality improvement and medical oversight to ensure appropriate use of prehospital pain management</td>
<td>7. Re-dose at half the initial dose if still in significant pain</td>
</tr>
</tbody>
</table>

\textsuperscript{*}National Association of Emergency Medical Services Physicians.

\textsuperscript{\dagger}National Highway Traffic Safety Administration/EMS for Children.
Emergency Medical Technician (EMT) certification. Nearly 15% of the firefighters are trained paramedics and provide ALS-level care. Physicians board-certified in EM or pediatric emergency medicine (PEM) and/or EMS medicine develop and maintain the agency’s pain management protocol. This protocol was last updated in September 2014. HFD EMS providers were trained in the updated pain management protocol through a mandatory 3.5-hour in-person training taught by pediatric emergency medicine physicians.

Milwaukee County EMS is fire department-based and provides a tiered response with first response units composed of at least two private or municipal EMT providers. Simultaneously, ALS ambulances staffed by at least two ALS providers are dispatched with the first response units. All ALS providers within the EMS system follow the same protocols and provide care under the same Medical Director. Milwaukee’s EMS pain management protocol is developed and maintained by physicians board-certified in EM or PEM and/or EMS medicine and was last updated in October 2014. Upon updating the pain management protocol, all Milwaukee prehospital providers were notified of the change by email. Formal training on the protocol changes was then provided during mandatory quarterly video conferenced continuing education sessions.

Each study EMSA independently maintains their own pain management protocol development, training, implementation and monitoring, but each independent protocol is generally in-line with the same national best practice recommendations. In addition to maintaining competency in opioid analgesia administration, each agency also trains providers in non-pharmacologic pain management techniques (e.g. splinting, wound care, elevation, ice application), though these techniques are not specifically included in each agency’s pain protocols.

In order to maintain EMS agency confidentiality, each study site has been coded and individual study agencies will be hereto forth designated as Agency A, Agency B, or Agency C. Table 2 describes the specifics of the three agencies’ pain management protocols both before and after their most recent protocol revisions and how they align with currently accepted best practice recommendations. New recommendations that were updated with the most recent protocol revisions include instituting the use of age-
appropriate pain scales (Agencies B and C), decreasing the minimum patient age for protocol administration of opiates (Agency B), updating the dosing of fentanyl (Agency B), and the protocol use of non-pharmacologic pain interventions (Agency C). Within all three agencies, opioid analgesia administration is restricted to ALS providers’ scope of practice and can be provided only when an ALS provider is available at the scene or during transport.

We reviewed EMS patient encounters for two time periods: before and after the most recent changes to the study agencies’ pain management protocols. Based on each agency’s ability to maximize available records before a change in protocol, we analyzed records from November 1, 2013 to August 31, 2014. All three study agencies revised their pain management protocols between September 1, 2014 and October 31, 2014. Our study period after protocol change included the dates between November 1, 2014 and August 21, 2015. Ethics approval with a waiver of informed consent was received from institutional review boards of Baylor College of Medicine, Carolinas Healthcare System, and Medical College of Wisconsin.

**Study Procedures**

The primary outcomes for this study were the frequency of pain severity assessments and the documented administration of opioid analgesia in the prehospital patient care record. Prehospital encounters with injured children <18 years of age at the time of prehospital care were abstracted from each EMSA’s electronic patient records for the study time period before and after the agencies’ most recent protocol revision.

Analysis of the data was primarily descriptive. Proportions were calculated for the frequency of prehospital opioid analgesia administration for two patient groups. First, we assessed all children eligible for protocol prehospital opiate administration regardless of documentation of a prehospital pain assessment. Then we assessed eligible children with a pain assessment documented to be ≥4 (moderate-to-severe pain). Our secondary outcome was the proportion of the time fentanyl was administered intranasally (IN) as opposed to intravenously (IV) or intramuscularly (IM). Analysis between and within groups was performed to assess for differences in analgesia administration before and after protocol revision using Chi square analysis with a p-value of <0.05 considered significant.

**Results**

Collectively, 3,597 injured children were transported by the study agencies prior to pain protocol changes and 3,743 children after the changes. Table 3 describes the number of injured children transported, the frequency of pain assessment, the number of children who met minimum age of inclusion for protocol opiate administration, and the number of children eligible for protocol opiate administration by each agency before and after protocol changes.

Prior to protocol changes, 580 (18%) children had a formal pain severity assessment documented by prehospital providers with 430 (74%) of those assessed with moderate-to-severe pain (pain score ≥4). Among all three agencies, pain was documented in 19% (Agency A), 13% (Agency B), and 22% (Agency C) of patients before protocol changes and 19% (Agency A), 13% (Agency B), and 22% (Agency C) of the time after protocol changes. 644 (18%) patients had pain severity documented after protocol changes with 464 (72%) patients in moderate-to-severe pain. The proportion of children with moderate-to-severe pain treated with prehospital opioid analgesia was 15% before and 14% after protocol changes, p = 0.62 (Table 4).

Overall, no change in opiate administration across study sites was detected before and after protocol changes. In children who met age and eligibility requirements, 156/3,089 (5%) received opioid analgesia before protocol changes and 175/3,509 (5%) received opioid analgesia after (p = 0.97). The observed frequency of opioid analgesia administration by study EMSA is described in Table 5. Across all agencies, 15% of children with documented moderate-to-severe pain received opioid analgesia; 66/430 (15%) prior to protocol changes and 70/464 (15%) after. No children with a documented pain score <4 received opioid analgesia prior to protocol changes, but 4/184 (4%) of children did after. Additionally, we observed a total of 11 patients across two of the study sites (three before protocol changes and eight after) who received opioid analgesia despite meeting at least one protocol exclusion criteria. Five patients had a Glasgow Coma Scale (GCS) score of <15, three patients had a pulse oximetry value <94%, one patient was hypotensive, one patient had both hypotension and GCS <15, and one patient had known opioid hypersensitivity. In these patients, it is unknown if opiates were administered with or without on-line medical direction.

In order to better understand prehospital opioid analgesia usage, we assessed the method of administration for each patient that received prehospital opioid analgesia. Each study EMSA approves, trains, and maintains competencies in several methods of opiate administration including IN, IV, and intramuscular (IM) routes. Overall, opioid analgesia was administered by the intranasal route in 22% of children who received prehospital opiates during our study periods. Table 6 describes the modes of fentanyl administration utilized during the study periods. There was a difference in IN administration rates before (27%) and after (17%) protocol changes (p = 0.02). One agency
TABLE 3. Children transported during study period

<table>
<thead>
<tr>
<th></th>
<th>Agency A</th>
<th></th>
<th>Agency B</th>
<th></th>
<th>Agency C</th>
<th></th>
<th>Total</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before</td>
<td>After</td>
<td>Before</td>
<td>After</td>
<td>Before</td>
<td>After</td>
<td>Before</td>
<td>After</td>
</tr>
<tr>
<td>Injury-related working assessments</td>
<td>1,738</td>
<td>1,693</td>
<td>948</td>
<td>1,000</td>
<td>911</td>
<td>1,050</td>
<td>3,597</td>
<td>3,743</td>
</tr>
<tr>
<td>Pain score ≥ 4 documented</td>
<td>235</td>
<td>234</td>
<td>71</td>
<td>107</td>
<td>129</td>
<td>122</td>
<td>435</td>
<td>463</td>
</tr>
<tr>
<td></td>
<td>(14%)</td>
<td>(14%)</td>
<td>(7%)</td>
<td>(11%)</td>
<td>(14%)</td>
<td>(12%)</td>
<td>(12%)</td>
<td>(12%)</td>
</tr>
<tr>
<td>Pain score not documented</td>
<td>1,412</td>
<td>1,373</td>
<td>864</td>
<td>871</td>
<td>732</td>
<td>849</td>
<td>3,008</td>
<td>3,093</td>
</tr>
<tr>
<td></td>
<td>(81%)</td>
<td>(81%)</td>
<td>(91%)</td>
<td>(87%)</td>
<td>(80%)</td>
<td>(81%)</td>
<td>(84%)</td>
<td>(83%)</td>
</tr>
<tr>
<td>Met age inclusion</td>
<td>1,738</td>
<td>1,693</td>
<td>617*</td>
<td>956*</td>
<td>786</td>
<td>920</td>
<td>3,141</td>
<td>3,569</td>
</tr>
<tr>
<td></td>
<td>(100%)</td>
<td>(100%)</td>
<td>(65%)</td>
<td>(96%)</td>
<td>(86%)</td>
<td>(88%)</td>
<td>(87%)</td>
<td>(95%)</td>
</tr>
<tr>
<td>Protocol eligible†</td>
<td>1,725†</td>
<td>1,685†</td>
<td>616†</td>
<td>955†</td>
<td>748†</td>
<td>869†</td>
<td>3,089†</td>
<td>3,509†</td>
</tr>
<tr>
<td></td>
<td>(99%)</td>
<td>(99%)</td>
<td>(99%)</td>
<td>(99%)</td>
<td>(82%)</td>
<td>(84%)</td>
<td>(86%)</td>
<td>(94%)</td>
</tr>
</tbody>
</table>

*Agency B lowered the eligible age for protocol administration from 3 years to 1 year of age between study periods.
†Patients are considered eligible for opioid analgesia if no protocol contraindications were documented.
‡Protocol contraindications include: opioid hypersensitivity, SpO2 < 90%, systolic blood pressure < 5th percentile for age.
§Protocol contraindications include: opioid hypersensitivity.
∥Protocol contraindications include: opioid hypersensitivity, SpO2 < 94%, systolic blood pressure < 5th percentile for age.

TABLE 4. Pain treatment pre- and post-protocol changes by site for children with a pain score ≥ 4

<table>
<thead>
<tr>
<th></th>
<th>Pre-Protocol Changes</th>
<th></th>
<th>Post-Protocol Changes</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Patients without documented contraindications, n</td>
<td>Treated with opioid analgesics, n (%)</td>
<td>Patients without documented contraindications, n</td>
<td>Treated with opioid analgesics, n (%)</td>
</tr>
<tr>
<td>Agency A</td>
<td>233</td>
<td>36 (15.5%)</td>
<td>232</td>
<td>33 (14.2%)</td>
</tr>
<tr>
<td>Agency B</td>
<td>66</td>
<td>2 (3.0%)</td>
<td>107</td>
<td>2 (1.9%)</td>
</tr>
<tr>
<td>Agency C</td>
<td>127</td>
<td>28 (22.1%)</td>
<td>116</td>
<td>30 (25.9%)</td>
</tr>
<tr>
<td>Total</td>
<td>426</td>
<td>66 (15.5%)</td>
<td>455</td>
<td>65 (14.3%)</td>
</tr>
</tbody>
</table>

TABLE 5. Pain treatment pre- and post-protocol changes by site for children without documented protocol exclusion

<table>
<thead>
<tr>
<th></th>
<th>Pre-Protocol Changes</th>
<th></th>
<th>Post-Protocol Changes</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Patients without documented contraindications, n</td>
<td>Treated with opioid analgesics, n (%)</td>
<td>Patients without documented contraindications, n</td>
<td>Treated with opioid analgesics, n (%)</td>
</tr>
<tr>
<td>Agency A</td>
<td>1,725</td>
<td>97 (5.6%)</td>
<td>1,685</td>
<td>92 (5.5%)</td>
</tr>
<tr>
<td>Agency B</td>
<td>616</td>
<td>3 (0.5%)</td>
<td>955</td>
<td>7 (0.7%)</td>
</tr>
<tr>
<td>Agency C</td>
<td>748</td>
<td>56 (7.5%)</td>
<td>869</td>
<td>76 (8.7%)</td>
</tr>
<tr>
<td>Total</td>
<td>3,089</td>
<td>156 (5.1%)</td>
<td>3,509</td>
<td>175 (5.0%)</td>
</tr>
</tbody>
</table>

accounted for 86% (67/78) of IN doses given during our study periods (Figure 1).

**DISCUSSION**

Our objective was to determine the change in frequency of pain severity assessment and documented opioid administration among injured pediatric patients in three EMSAs after adoption of best practices recommendations. Our results reveal that there was no significant difference in pain assessment and opioid administration rates across three large urban/suburban EMS agencies after adoption of best practice recommendations. Opiate treatment rates remained unchanged for all injured children regardless of pain severity as well as for injured children with documented moderate-to-severe pain. Our observed rates of prehospital opiate administration are consistent with previously published treatment rates of 2-32%, 4-13

All prehospital care is protocol-driven and national stakeholder organizations have strongly recommended that prehospital protocols be based on the best available evidence.16-19 Model evidence-based guidelines for the assessment and treatment of pain do exist to guide the development of appropriate agency protocols; however, as demonstrated by our results, recommended protocol changes did not immediately translate into changes in clinical practice. The guidelines recommend that reliable and age-appropriate pain assessment tools be used, that opioid analgesia be pro-

TABLE 6. Modes of fentanyl administration for all three study sites combined

<table>
<thead>
<tr>
<th></th>
<th>Pre-Protocol Changes</th>
<th></th>
<th>Post-Protocol Changes</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>IN</td>
<td>45 (27%)</td>
<td>32 (17%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>IV/IM</td>
<td>100 (60%)</td>
<td>137 (72%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Unknown</td>
<td>23 (13%)</td>
<td>21 (11%)</td>
<td></td>
</tr>
</tbody>
</table>
vided for all patients with moderate-to-severe pain regardless of transport duration, and that frequent reassessment of pain be performed throughout prehospital patient care.\textsuperscript{16,17} It had been anticipated that these recommendations would improve the appropriate treatment of prehospital pain. However, even among systems aligning protocols around evidence based guidelines there was little observed change in the frequency of pediatric pain assessment and analgesia administration.

Our findings demonstrate that pain severity assessments of injured children are infrequently documented by prehospital providers. Only 18\% of children transported with injury-related complaints had a documented pain assessment. In one of our study agencies, the documentation rate was as low as 12\%. Our retrospective study design may underestimate the frequency of pain assessments performed if providers formally assessed pain but did not document a pain score. Additionally, in the prehospital setting, frequent use of clinical judgment in lieu of a formal pain score has been shown by prior research and also may have impacted our observed frequency of pain score documentation.\textsuperscript{22} Nearly 75\% of children in our study who did have a documented pain score were assessed with moderate-to-severe pain, suggesting that prehospital providers may be more apt to document a pain score in children with obvious pain. Factors such as obviously painful injuries (e.g., visible extremity deformities, burns), mechanism of injury, and/or voiced or perceived discomfort may drive the decision to document a formal pain assessment. Our data agree with previous literature in showing that, when a formal pain assessment is documented, children are more likely to receive opioid analgesia, however, the rate of pain treatment was still extremely low and seems to indicate that simply assessing for pain is not sufficient to significantly increase the rate of analgesic administration in the prehospital setting.\textsuperscript{10,23}

Additionally, the under-assessment of pain severity may have been related to the age of the injured patients. It has been shown previously that children are less likely to receive a formal pain assessment when compared to adults.\textsuperscript{22} This may be due to lack of frequent exposure to pediatric patients, lack of comfort assessing pain in children, or lack of formal pediatric-specific pain assessment training. It should be noted that two of the three participating study agencies do not include a validated pain assessment tool for children less than 4 years of age. This may be in part due to the complexities of these pain scales, which are based on as many as five observational findings that must be assessed and scored individually.\textsuperscript{24} This is inherently more complex than the subjective assessment tools that have been validated in older ages.\textsuperscript{25,26}

The decision to administer opioid analgesia is complex and the explanation for the continued low rate of opiate use in injured children cannot be determined from our current analysis. It is possible that our observed frequency of suboptimal treatment rate may be due to ineffective application and translation of best practice recommendations to actual clinical care. Our study agencies, however, are independent entities and develop, maintain, and distribute their protocols to their providers in varying ways. We did not observe a change in the proportion of children receiving opioid analgesia in any of our sites, suggesting that either all agencies implemented current best practice recommendations poorly or that the current recommendations are insufficient to greatly improve the appropriate prehospital use of opioid analgesia in children.
Other agency and EMS-specific operational barriers may inhibit opiate administration despite effective best practice implementation. Previous authors have noted several barriers to the administration of opioid analgesia in the prehospital setting. Such barriers include training and medical oversight deficiencies, provider comfort levels and biases toward pain treatment, concerns for adverse effects, and perceived lack of importance of analgesia in the prehospital setting. Given the continued infrequent use of opioid analgesia, it is likely that there are unrecognized factors that influence a provider’s pain management decision.

IN administration of opioid analgesia is a relatively recent addition to prehospital pain treatment. It has been shown to be effective for pediatric pain management and safe to administer in the prehospital setting. IN opiate administration was available for use by all ALS providers in our study sites for both study periods. Because several studies have indicated that the perceived need for vascular access to administer opiates is a barrier to analgesia in children, we anticipated that IN administration would be utilized more frequently in the study agencies. IN administration constituted 22% of the opiate administration in our study. However, we observed disparate results between the study agencies. Agency A administered IN opiates ten times more frequently than the other agencies and accounted for 67 of the 78 doses given within the study. Contrary to what was anticipated, this increased use of IN administration did not translate into a greater proportion of children receiving opioid analgesia as Agency A provided opioid analgesia more frequently than Agency B, but slightly less than Agency C. We also observed a significant decrease in the use of IN administration after protocol changes. The explanation for this is not clear, but may be, in part, related to the fact that Agency A utilized IN administration much more frequently than the other two sites and a slight decrease in use in this agency will be magnified when cumulative frequencies are reported.

Although beyond the scope of this study, our results may also demonstrate the challenges of translating medical knowledge into actual clinical practice. There are many barriers to successful translation of evidence-based knowledge into prehospital practice and protocol changes and education alone may have limited effectiveness in changing clinical decisions in prehospital care. For example, Shah et al. showed that protocol change with passive education may not be sufficient to change provider practice in the management of pediatric prehospital seizures. There is a wealth of information and resources for effective translation of evidence-based medical knowledge into clinical practice. The Cochrane Review’s Effective Practice and Organization of Care (EPOC) is an international network working to improve decision-making in health care. Although they have not addressed implementation of best practice knowledge in the prehospital treatment of pain, EPOC is currently active in assessing prehospital care by evaluating the effectiveness of prehospital clinical pathways for triaging of potential stroke patients. The KT (Knowledge Translation) Clearinghouse is another resource for the development, dissemination and evaluation of evidence-based medicine that emphasizes strategies for successful implementation of scientific evidence into clinical practice.

Finally, there may be additional barriers in the prehospital administration of opiate analgesia that protocol changes alone do not eliminate. Some examples include infrastructure barriers regarding the documentation of administration of controlled substances, provider perceptions that short transport times obviate the need to administer prehospital opiates, or concerns over the potential harm that could be caused by opiate use in children.

**Limitations**

Our study is affected by the limitations of its retrospective design. While an efficient way to observe a large number of patients, retrospective review limits our data to the information that is documented in the medical record. Therefore, we are only able to report on what was documented and do not know if the low rates of assessment and treatment are due to poor documentation or to not providing the care. Further, we are only able to comment on treatments that are typically documented and cannot comment on non-pharmacologic pain management that, though not documented, may have been provided and obviated the need for opioid pain medication. Finally, because it is rarely documented, we were unable to comment on why providers made the decision to provide or withhold pain treatment.

During both study periods, there was one evidence-based recommendation that was not implemented by the study EMSAs: maintenance of pain-specific quality improvement (Table 2). Because this recommendation is lacking from our agencies’ protocols, we are unable to comment on the effect it may or may not have on prehospital pain management practices. We cannot discount that this recommendation, when put into clinical practice, may have greater influence on improving the appropriate use of opioid analgesia than those that are included in our protocols.

There are significant differences between our study agencies and the changes that were made to their pain management protocols. Also, the variability in ALS response between agencies means that some patients inherently had a higher chance of receiving opiates simply because there was higher likelihood that care would be provided by ALS providers. Although this
is a limitation in analyzing our results, given the significant variability in the delivery of prehospital care throughout the country, inclusion of agencies with different operational policies in prehospital research studies is important and our results show that one system's approach did not result in marked improvement over the other systems.

Finally, there is the possibility that the lack of improvement in opiate administration observed in our results was affected by larger influences in pain management trends. Although unlikely, if opiate administration for prehospital pain is declining, our protocol changes may have helped to stabilize this decline in our study agencies.

**CONCLUSION**

Children with potential traumatic injuries who are transported by prehospital providers infrequently receive opioid analgesia despite implementation of best practice recommendations into prehospital protocols. Opioid analgesia was infrequent even if children were documented to be in moderate-to-severe pain. This continued suboptimal use of appropriate prehospital opioid analgesia suggests that there remain significant barriers to its use. Further research to define barriers to prehospital analgesia is essential for the development of effective education, protocols, and system design that will facilitate the appropriate use of opiates in pediatric prehospital pain management.

**References**


