Original Contribution

Clinically meaningful reduction in pain severity in children treated by paramedics: a retrospective cohort study

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A R T I C L E   I N F O

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A B S T R A C T

Introduction: Pediatric pain is a common presenting symptom in the prehospital setting; however, there is a lack of data identifying factors associated with effective pain management in this population. We sought to identify the factors associated with clinically meaningful pain reduction in children.

Methods: An analysis of electronic patient care records of all patients younger than 15 years presenting with pain to the emergency medical service of Victoria, Australia, over a 4-year period (2008-2011). Data were analyzed using descriptive statistics and multivariate regression to assess predictors of clinically meaningful pain reduction. Clinically meaningful pain reduction was defined as a reduction of 2 or more points on an 11-point scale.

Results: A total of 92,378 children were transported, of whom 15,016 (16.3%) met the inclusion criteria. The median age was 11 (interquartile range, 9-13) years, and 59.2% were male. Patients older than 9 years were less likely (adjusted odds ratio [AOR], 0.5; 95% confidence interval [CI], 0.4-0.6) and boys were more likely (adjusted odds ratio, 1.1; 95% CI, 1.0-1.3) to have a clinically meaningful reduction in pain. Patients with pain classified as musculoskeletal were more likely to achieve a reduction in pain score of 2 or more when compared with pain due to other medical causes (AOR, 1.7; 95% CI, 1.5-1.9).

Conclusions: Factors other than the type of analgesia are important determinants of prehospital pain relief and are likely to impact on clinical care and research. Clinical audit and research projects should stratify patients according to patient as well as management factors to maximize service improvement.

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1. Introduction

Exposure to children with pain is very common in the prehospital and emergency setting. Despite being a frequent presentation, there is limited evidence regarding factors associated with the likelihood of a clinically meaningful reduction in pain severity in the paramedic practice setting. Early, effective pain management in both the emergency medical service (EMS) and emergency department settings is an important component of care and may play a role in reducing the likelihood of chronic pain syndromes and pain-related anxiety and posttraumatic stress after the acute phase [1-6].

Paramedics generally have a range of pharmacologic and nonpharmacologic pain management strategies available. An ability to identify demographic, injury, and management factors that are associated with the likelihood of successfully achieving clinically important pain reduction is important to clinicians. Knowledge of factors which improve or inhibit the likelihood of clinically important pain reduction in children allows the clinician to focus their attention on strategies to optimize their pain management plan.

Barriers to adequate analgesia administration have been previously reported in the provision of analgesia to both adults and children [7,8]. Qualitative studies have suggested that paramedics decision making around the provision and type of analgesia to be administered can be influenced by the patients’ age [8], concern of adverse effects, organizational norms and beliefs about opioids, and provider knowledge of pediatric parenteral analgesia options [7]. This study aims to identify the factors associated with the clinically meaningful reduction in pain severity in children who were treated by paramedics in a busy EMS.

2. Methods

2.1. Study design

This retrospective cohort study analyzed pediatric patients 14 years or younger who were treated and transported by paramedics in Victoria, Australia, between January 1, 2008, and December 31, 2011.
Ethics Committee approval was received by the Monash University Human Research Ethics Committee (A12/383), and access to de-identified patient data was approved by Ambulance Victoria.

2.2. Study population and setting

Ambulance Victoria is the sole statewide provider of emergency ambulance services for a population of approximately 5.5 million people in a region that covers more than 227,000 km², with more than 4.3 million residing in metropolitan Melbourne [9]. Paramedics responded to approximately 80,000 incidents in 2001 [10], resulting in 360,766 patients being transported. Pediatric patients represented 7.1% (n = 25,563) of this caseload.

The scope of practice for paramedics used in this jurisdiction includes inhaled methoxyflurane, parenteral morphine sulphate or fentanyl according to clinical practice guidelines. There are no age restrictions placed on the administration of opioids, the drugs are indicated for pain of any cause, and medical consultation is not required. Fentanyl via the intranasal route was added to the pain management guideline for children in 2009. All patient-level data are collected via an in-field electronic patient care record (ePCR) system (VACIS, VACIS Collaboration, Melbourne). Paramedics enter scene findings, patient demographic data, clinical observations, and treatment data directly into the ePCR both during and after the episode of care. Clinical, administrative, and operational data are then maintained in a data warehouse [11].

Paramedics use several pain severity rating scales in this setting, most commonly the verbal numeric rating scale (VNRS), which is an 11-point scale whereby the patient is required to rate their pain severity between 0 and 10. Fentanyl is dosed in increments of 50 μg/kg to 1 mg/kg. Fentanyl intranasal is dosed in increments of 25 μg/kg to 1 mg/kg. Pain severity is subsequently converted to a numeric pain severity rating, where “none” represents 0; “mild,” “2; “moderate,” 5; and “severe,” 8. Clinically meaningful pain reduction was defined as a final pain severity score recorded on VACIS as ≥2 or more than the initial pain severity score. A reduction of 2 or more was selected, as a visual analog pain score reduction of 10 mm in children has been previously shown to be the minimum clinically significant difference whereby a patient is likely to report feeling “a bit better” or “a bit worse” [16]. Another study reported a reduction of 2 points was required for a child to recognize a difference in pain severity [17].

Cases were included if the patient was transported between January 1, 2008, December 31, 2011; the patient was younger than 15 years; “pain” was recorded in secondary survey, assessment, or patient complaint field; or a pain score higher than 0 was reported at any time during care. Cases were excluded if the initial or final pain score was missing, or the initial pain score was less than 3.

2.3. Statistical analysis

Descriptive statistics and logistic regression were used to test the association between clinically meaningful pain reduction and the independent variables. The χ² test was used to test associations between categorical variables and the Wilcoxon rank sum test for associates between continuous variables that were not normally distributed. The independent variables used in the multivariate regression analysis were age, sex, pain cause, initial pain score, administration of any analgesia, and case year and were selected as univariate analysis indicated that they were statistically associated with the dependent variable at the .05 significance level. Odds ratios and their associated 95% confidence intervals (CIs) were calculated. All statistical analyses were considered to be significant at the .05 level. Stata Statistical Version 12 (StataCorp, College Station, TX) was used for data analysis. The primary outcome measure was the proportion of patients with a clinically meaningful reduction in pain severity defined as a pain rating reduction of 2 or more points on an 11-point VNRS.

3. Results

During the study period, January 1, 2008, December 31, 2011, 92,378 children aged less than 15 years had an ambulance dispatched and AV paramedics attend, 38,167 (41.3%) of which reported pain at any time after ambulance arrival. Of the children presenting with pain, 23,151 (60.6%) were excluded based on study criteria (Figure). This left 15,016 children for inclusion in the analysis. The demographics of those who achieved and did not achieve clinically meaningful pain severity reduction are provided in Table 1.

Of the 15,016 children who were attended by paramedics with an initial pain score greater than 3 and available initial and final pain scores, 12,346 (82.2%) of 15,016 achieved clinically important pain reduction.

Most of the children presenting with a VNRS of 3 or greater were male (60.7%) and aged between 10 and 14 years (70.2%). The median time to first analgesia was 11 minutes (interquartile range [IQR], 9-13 minutes), and there was little difference between those who achieved clinically important pain reduction and those who did not.

The etiology of the children’s pain was assigned a category based on the paramedic’s assessment of case nature and is presented in Table 1, categorized by pain severity improvement. Musculoskeletal injury was the most common case nature encountered in this cohort (74.2%).

The group of children who achieved clinically important pain severity reduction presented with a higher median (IQR) initial pain score than the group who did not (7 [5-8] vs 5 [4-7]; P < .001; Table 1).

Most of the children with pain (78.8%) received an analgesic agent (either methoxyflurane or morphine sulphate or fentanyl). A small number (3.8%; 575/15016) of children (or their parents/guardians) were reported to have refused the offer of analgesia, and paramedics reported withholding analgesia when indicated in 1.0% (147/15016) of cases, which is most often due to contraindications. Inhaled methoxyflurane was the most common agent administered to children reporting pain (69.8%; 10,483/15016), followed by intranasal or intravenous fentanyl (16.5%; 2480/15016) and intravenous morphine (6.6%; 996/15016). More male than female children received an analgesic agent (79.8% vs 77.1%; P < .001). The odds of achieving clinically significant pain reduction was more than 6 times greater in children who received analgesia when compared with those who did not (adjusted odds ratio [AOR], 6.6; 95% CI, 5.9-7.3). Of all the analgesic agents, methoxyflurane was associated with the greatest odds of achieving clinically important pain reduction (AOR, 5.3; 95% CI, 4.8-5.9; Table 2).

Figure. Flowchart for included patients.
be at least “a little better.” Overall, the cohort presented with severe pain (median VNRS, 7; IQV, 5-8) from a range of causes, predominantly musculoskeletal injury. The majority achieved clinically important pain severity reduction (82.2%; 12346/15016), Those who achieved pain reduction reported quite a substantial reduction (median VNRS reduction, 6 (3-12); 4 (2-7); 4 (3-7); <.001). Pain relief was more likely for those children with higher initial pain severity (82.2%; 12346/15016).

4. Discussion

This study reports on more than 15000 children presenting to a single EMS over a 4-year period and identified 6 factors that were associated with the odds of children 14 years or younger achieving a pain score reduction of 2 or more points during their prehospital care. A pain score reduction of 2 or more was considered clinically important and was likely to be associated with the patient experiencing the pain to be at least “a little better.” Overall, the cohort presented with severe pain (median VNRS, 7; IQV, 5-8) from a range of causes, predominantly musculoskeletal injury. The majority achieved clinically important pain severity reduction (82.2%; 12346/15016), Those who achieved pain reduction reported quite a substantial reduction (median VNRS reduction, 6 (3-12); 4 (2-7); 4 (3-7); <.001). Pain relief was more likely for those children with higher initial pain severity (82.2%; 12346/15016).

Table 1
Characteristics of children by pain improvement

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>No clinically meaningful improvement (n = 2670)</th>
<th>Clinically meaningful improvement (n = 12346)</th>
<th>Total (n = 15016)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (y) median (IQR)</td>
<td>12 (10-13)</td>
<td>11 (9-13)</td>
<td>11 (9-13)</td>
</tr>
<tr>
<td>Case year</td>
<td>2009 1.3 (1.2-1.5)</td>
<td>2010 1.1 (0.9-1.3)</td>
<td>2011 1.09 (0.8-1.3)</td>
</tr>
<tr>
<td>Case nature</td>
<td>Medical 1</td>
<td>Musculoskeletal 1</td>
<td>Burns 1.6 (1.1-2.5)</td>
</tr>
<tr>
<td>Cardiac 1.7 (1.5-1.9)</td>
<td>Cardiac 1</td>
<td>1.7 (0.9-3.1)</td>
<td>.001</td>
</tr>
<tr>
<td>Poisoning 0.4 (0.2-0.8)</td>
<td>1.7 (0.9-3.1)</td>
<td>.002</td>
<td></td>
</tr>
<tr>
<td>Trauma other 3 (3-12)</td>
<td>1.0 (1.5-1.9)</td>
<td>.106</td>
<td></td>
</tr>
<tr>
<td>Moderate (4-7)</td>
<td>1.7 (0.9-3.1)</td>
<td>.002</td>
<td></td>
</tr>
<tr>
<td>Severe (8-10)</td>
<td>1.7 (0.9-3.1)</td>
<td>.002</td>
<td></td>
</tr>
<tr>
<td>Initial pain score category</td>
<td>Mild (3)</td>
<td>Moderate (4-7)</td>
<td>Severe (8-10)</td>
</tr>
<tr>
<td>Pain score (median (IQR))</td>
<td>Pain score (median (IQR))</td>
<td>Pain score (median (IQR))</td>
<td>Pain score (median (IQR))</td>
</tr>
</tbody>
</table>

Table 2
AORs of achieving clinically important pain reduction by analgesic agent (compared with no analgesic agent)

<table>
<thead>
<tr>
<th>Analgesic agent</th>
<th>Eligible patients (n = 15016)</th>
<th>AOR (95% CI)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any analgesic</td>
<td>11882 (78.8)</td>
<td>6.6 (5.9-7.3)</td>
<td>&lt;0.001</td>
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<tr>
<td>Methoxyflurane</td>
<td>10483 (69.8)</td>
<td>5.3 (4.8-5.9)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Fentanyl</td>
<td>2480 (16.5)</td>
<td>2.8 (2.3-3.3)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Morphine</td>
<td>996 (6.6)</td>
<td>2.8 (2.2-3.6)</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Table 3
AORs of achieving clinically important pain reduction by demographic factor and case nature

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>AOR (95% CI)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (y)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-4</td>
<td>0.7 (0.6-0.95)</td>
<td>.020</td>
</tr>
<tr>
<td>5-9</td>
<td>0.5 (0.4-0.5)</td>
<td>&lt;0.001</td>
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<tr>
<td>Sex</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>1.1 (1.0-1.3)</td>
<td>007</td>
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<tr>
<td>Case Nature</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medical</td>
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<tr>
<td>Musculoskeletal</td>
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</tr>
<tr>
<td>Burns</td>
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<tr>
<td>Poisoning</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trauma other</td>
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<td></td>
</tr>
<tr>
<td>Cardiac</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unknown</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Adjusted model includes analgesic administered, analgesic agent, sex, case nature, case year, and initial pain score. Pseudo R² for the model = 0.22.
The more severe the initial report of pain, the greater the odds of achieving clinically important pain reduction. Those with an initial pain report of “severe” (VNRS 8–10) were 7.5 times more likely to achieve clinically important pain reduction than those reporting mild pain initially (VNRS 1–3). This is not a new phenomenon and has been previously reported in adults presenting to EMS with pain [23]. This may be related to the paramedics’ willingness to treat pain based on their initial assessment of pain severity (through pain report and observed discomfort). In this cohort, more than 9 of 10 children who reported their initial pain as severe received analgesia, whereas less than 4 of 10 received analgesia where their initial pain was rated as mild.

The type of pain categorized by case nature reported by the children was independently associated with the odds of achieving clinically important pain reduction. When compared with “other pain” which was predominantly of a medical etiology, children with musculoskeletal, burns, and other traumatic injuries had significantly greater odds of achieving clinically important pain reduction. Differences in the likelihood of achieving meaningful pain reduction in adults have also been reported, reporting that medical and “unknown” pain etiology has less odds of clinically meaningful pain reduction than pain of a traumatic nature [23]. It was clear in this population that the current treatment regime was not adequately managing pain of a medical etiology. One prehospital study reported that patients with traumatic injury were as likely to have their pain successfully managed as pain of other causes; however, the trauma group required larger doses of morphine [24].

Future research and audit should take these factors into account, targeting groups within the pediatric population which are at risk for inadequate analgesia. Older children and children with nontraumatic injury present a distinct risk of poor pain management, and the barriers to effective pain management and most appropriate analgesic agents for this population require further investigation.

5. Limitations

This retrospective study relies on ePCR data recorded by paramedics during or shortly after patient care. It is possible that errors of documentation or omission have occurred. Also, there was a large number (23.0%; 8779/38167) of cases that were missing either initial pain or final pain scores which were excluded prior to analysis. Finally, this study did not take into account the effect of any nonpharmacologic pain reduction strategies or the total doses of analgesic agents administered.

6. Conclusion

This study provides new knowledge regarding factors associated with the management of pain in children. Despite few of the factors that have been shown to be independently associated with clinically important pain reduction being modifiable, they serve as characteristics of which clinicians and educators should focus attention. These factors should also inform strategies that aim to reduce barriers to effective management of pain in this vulnerable population.

Acknowledgments

Removed to allow for blinded review.

References