Does current pre-hospital analgesia effectively reduce pain in children caused by trauma, within a UK ambulance service? A service evaluation

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Abstract

Introduction – Pain is one of the most common symptoms presented by patients of all ages to ambulance services, however very few children receive analgesia. Analgesic treatment of pre-hospital injured children is viewed as 'suboptimal'. The aim of this study was to explore current analgesia given to traumatically injured children in the pre-hospital setting and examine whether a clinically meaningful reduction in pain was achieved.

Methods – We evaluated electronic patient report forms over a two-year period (2013–2014) within a UK ambulance service NHS trust. All traumatically injured children within the age range 1–17 with a clinical impression of a fracture, dislocation, wound or burn were included. Patients with a Glasgow Coma Scale of < 15 were excluded. The outcome measure was a reduction in numeric pain rating scale or Wong and Baker faces of ≥ 2 out of 10.

Results – Of the evaluable patients (N = 11,317), 90.8% had a documented pain score, or a reason why a pain score could not be documented. For patients reporting pain (N = 7483), 51.6% (n = 3861) received analgesia, 9.6% (n = 717) received no analgesia but did receive alternative treatment and 38.8% (n = 2905) received no analgesia and no alternative treatment. Morphine sulphate IV, oral morphine, Entonox, paracetamol suspension and poly-analgesia all achieved a clinically meaningful median reduction in pain score; –3.0 (IQR, –5.0 to –2.0), –2.0 (–5.0 to –2.0), –2.0 (–4.0 to –1.0), –2.0 (–4.0 to 0.0) and –3.0 (–4.0 to –1.0), respectively.

Conclusions – Analgesia administered to traumatically injured children in the pre-hospital setting within this UK ambulance service NHS trust produces clinically meaningful reductions in pain for these patients. The concern is that a large number of patients received neither analgesia nor alternative treatment. There is a real need to identify barriers to analgesia administration in this patient group.

Keywords

emergency medical services; paediatrics; pain management

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Introduction

Pain is one of the most common symptoms presented by patients of all ages to ambulance services (Joint Royal Colleges Ambulance Liaison Committee (JRCALC), 2016). Three studies found that very few children in pain receive analgesia pre-hospitally (Hennes, Kim, & Pirrallo, 2005; Shaw, Fothergill, & Virdi, 2015; Swor, McEachin, Seguin, & Grail, 2005). Currently analgesic treatment of pre-hospital traumatically injured children is suboptimal (Samuel, Steiner, & Shavit, 2015).

When considering analgesic administration, the child's pain must first be assessed. A number of tools exist to assess pain, including but not limited to the numeric pain rating scale (NPRS), Wong and Baker faces and the Face Legs Activity Cry and Consolability (FLACC) scale (JRCALC, 2016).

Within the ambulance service that this evaluation was conducted in, paramedics carry four different analgesics: paracetamol (tablets, suspension and intravenous), ibuprofen (tablets), Entonox (inhaled) and morphine (oral and intravenous). Ambulance technicians can administer paracetamol (tablets and suspension), ibuprofen (tablets) and Entonox (inhaled).

Each of these analgesics has disadvantages. Oral medications are slow to act (Halbsguth, Rentsch, Eich-Höchli, Diterich, & Fattinger, 2008; JRCALC, 2016) and intravenous access is painful and difficult to achieve (Reigart et al., 2012). One study found that inhaled Entonox was effective in the majority of patients aged 2 to 16 (80.5%), leaving the remainder in pain (Heinrich, Menzel, Hoffmann, Berger, & Schweinitz, 2015). However, inhaled analgesics are difficult to administer to distressed and uncooperative children (Murphy et al., 2014). Intramuscular morphine sulphate is only recommended for patients with major trauma, cardiac conditions or shock, where the intravenous and oral routes are not optimal (JRCALC, 2016).

In order to better understand the effectiveness of pre-hospital analgesia administered to traumatically injured children within the UK a service evaluation was performed.

Methods

Aim

The aim of the service evaluation was to establish whether current analgesia can produce a clinically meaningful reduction in pain when treating traumatically injured children within a UK ambulance service NHS trust.

Design

A service evaluation was undertaken including all children aged 1 to 17 years attended in the pre-hospital setting by ambulance service clinicians with a clinical impression of a fracture, dislocation, wound or burn. Patients up to 17 years were included because the UK legal age for adulthood is achieved at 18 years, and patients below this age may still be immature and naïve to traumatic pain. The lower age limit was selected as this was the minimum age for morphine administration (JRCALC, 2016). Patients with a Glasgow Coma Scale of < 15 at any time were excluded, as less conscious patients may not provide accurate pain reporting.

Data collection

Data were collected from the electronic database of patient report forms (PRFs) over a two-year period (1 January 2013 to 31 December 2014). Paper PRFs were not included due to the manual data extraction requirement being unfeasible given the resource and time constraints. Therefore, data included: age (years), sex, injury type, treatment administered (pharmacological and non-pharmacological), time of treatments, pain scores, pain score times, Glasgow Coma Scale and clinician level (paramedic/technician).

Outcomes

Primary outcome

The primary outcome was to establish which analgesics achieve a clinically meaningful reduction in pain using the NPRS (0–10) or Wong and Baker pain scale (0, 2, 4, 6, 8, 10). A reduction in pain of 2 or more on the NPRS or Wong and Baker was deemed clinically meaningful. This ambulance service does not routinely use a pre-verbal pain scoring tool such as FLACC.

Secondary outcomes

Secondary outcomes were to:

- determine the prevalence of pain scoring in traumatically injured children;
- determine the prevalence of analgesic use in traumatically injured children who report a pain score of 1–10 (NPRS) or 2–10 (Wong and Baker);
- establish which analgesics are most commonly used by paramedics and ambulance technicians;
- and establish which analgesics have the greatest pain score reduction per minute.

Analysis

The statistical analysis was performed using SPSS (versions 22 and 23). The primary outcome was assessed by calculating the average pain score reduction per analgesic and comparing it against the 'standard' (reduction in pain of ≥ 2 out of 10). We used the following definition to determine a clinically meaningful reduction in pain: reduction in pain of ≥ 2 out of 10 on the NPRS or Wong and Baker scale (Bulloch & Tenenbein, 2002; Farrar, Berlin, & Strom, 2003; Farrar, Young, LaMoreaux,

Werth, & Poole, 2001; Myrvik et al., 2013). Where patients received two or more analgesics, these were grouped and termed 'poly-analgesia'.

The first three secondary outcomes were determined by establishing the percentage difference. For the purpose of this service evaluation, data were split into mild (1–3), moderate (4–6) and severe (7–10) pain. The primary and secondary outcome data were skewed, therefore non-parametric testing was used. The significance level of the Kruskal-Wallis test was adjusted to 0.01 after the Bonferroni correction was made.

Ibuprofen (tablets) was not included in the analysis due to its limited usage. Forty-eight patients received ibuprofen, however 40 were excluded for the following reasons: duplicates (n = 3), no pain score (n = 2), pain score zero (n = 1), alternative treatment (n = 4), no pre- and post-analgesic pain score (n = 30). This left three patients who received ibuprofen only, and five patients who received ibuprofen along with other analgesics (poly-analgesia). Performing analysis on such small numbers

would not be ideal, therefore these have been excluded as 'no morphine, Entonox, oral morphine, paracetamol tablets or paracetamol suspension administered' (n = 3) and 'received alternative analgesia' (n = 5) (see Figure 1).

Approvals

Full NHS approval was obtained before the study was commenced. Full ethical approval was not required.

Results

All child electronic PRFs from 1 January 2013 to 31 December 2014 were gathered initially (N = 46,281). These were filtered by clinical impression to include fractures, dislocations, wounds and burns. This produced 12,809 patients for data extraction. A further 1492 patients were excluded for having either no initial GCS or a GCS < 15 at any time. Thus, 11,317 patients were analysed. Patient demographics can be seen in Table 1.
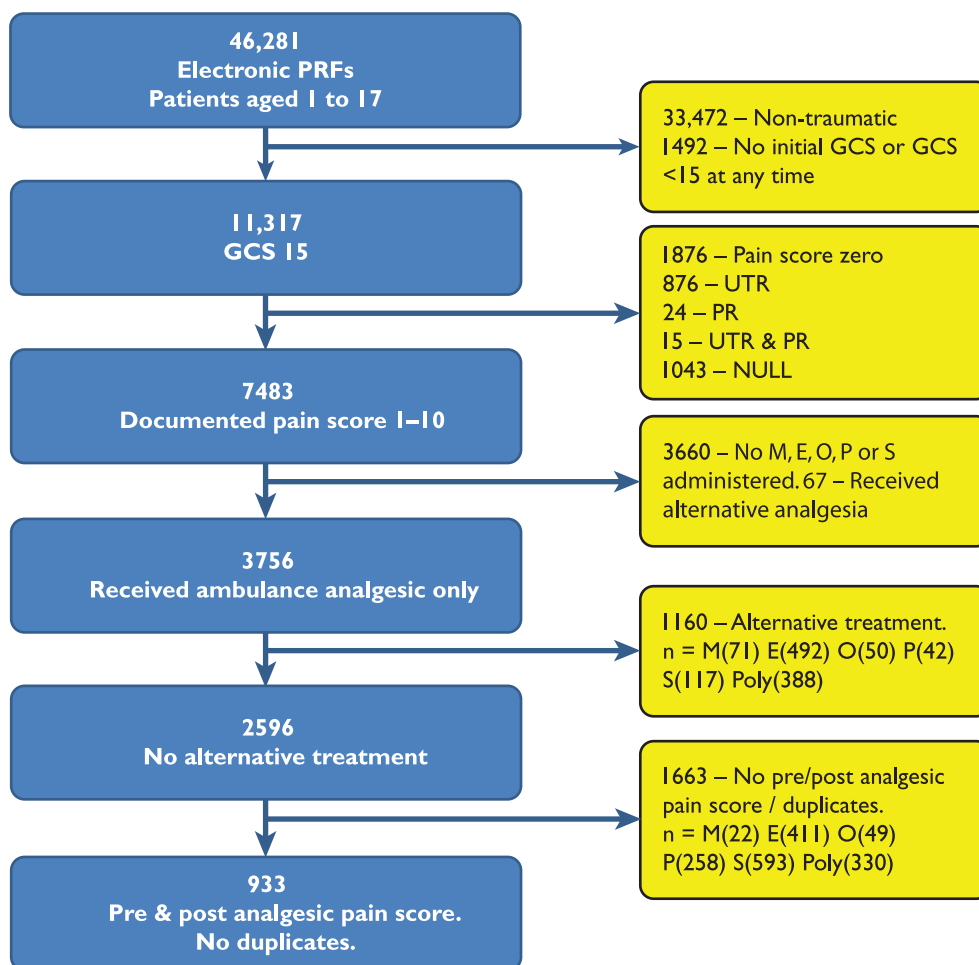

Figure 1. Patient flow diagram illustrating all the patients excluded from the primary outcome.

Abbreviations: GCS = Glasgow Coma Scale; NULL = no data entered; UTR = unable to record; PR = patient refused; M = morphine sulphate intravenous; E = Entonox; O = oral morphine; P = paracetamol tablets; S = paracetamol suspension; Poly = poly-analgesia.

Table 1. Demographics of patient population.

Age (years)	n	% of total*	Sex	n	% of total**
1	918	8.1	Male	513	55.9
			Female	373	40.6
2	826	7.3	Male	490	59.3
			Female	313	37.9
3	669	5.9	Male	382	57.1
			Female	268	40.1
4	531	4.7	Male	347	65.3
			Female	170	32.0
5	471	4.2	Male	273	58.0
			Female	188	39.9
6	379	3.3	Male	231	60.9
			Female	135	35.6
7	385	3.4	Male	240	62.3
			Female	132	34.3
8	359	3.2	Male	202	56.3
			Female	149	41.5
9	429	3.8	Male	252	58.7
			Female	167	38.9
10	456	4.0	Male	286	62.7
			Female	161	35.3
11	583	5.2	Male	354	60.7
			Female	208	35.7
12	670	5.9	Male	407	60.7
			Female	246	36.7
13	705	6.2	Male	414	58.7
			Female	274	38.9
14	842	7.4	Male	496	58.9
			Female	328	39.0
15	864	7.4	Male	480	55.6
			Female	362	41.9
16	1032	9.1	Male	594	57.6
			Female	404	39.1
17	1198	10.6	Male	693	57.8
			Female	472	39.4
TOTAL	**11,317**	**99.7%***	**Male**	**6654**	**58.8****
			Female	**4350**	**38.4****

*Total not 100% due to rounding.
**Where % does not equal 100%, the data were 'unknown' or missing.

Primary outcome

From the dataset of 11,317 patients, a large number were excluded (n = 10,384) for having no documented pre- and post-analgesic pain score or where alternative analgesics or treatments were given, leaving 933 patients (Figure 1). Alternative analgesics were medicines not available to ambulance clinicians but either prescribed or administered by a third party (e.g. ketamine, diclofenac and co-codamol), while alternative treatments included immobilisation equipment such as splints, slings, bandages and dressings.

Average pain score reductions were established and compared against the standard (≥ 2 out 10). Analgesics which achieved a clinically meaningful reduction in pain can be seen in Figure 2, along with descriptive statistics in Table 2.

It was found that morphine sulphate IV, oral morphine, Entonox, paracetamol suspension and poly-analgesia all achieved a clinically meaningful reduction in pain when treating traumatically injured children in the pre-hospital setting. Paracetamol tablets did not achieve a clinically meaningful reduction in pain.

The median time taken between analgesic administration and final pain score varied between groups, with the shortest time being paracetamol tablets (10.5 minutes) and the longest being poly-analgesia (28 minutes).

Secondary outcomes

From 11,317 patients, 90.8% were assessed for pain. This included cases where the pain score was documented as 'unable to record' and 'patient refused'.

For patients who reported pain (N = 7483), 51.6% (n = 3861) were administered analgesia, 9.6% (n = 717) received no analgesia but did receive alternative treatment and 38.8% (n = 2905) received no analgesia and no
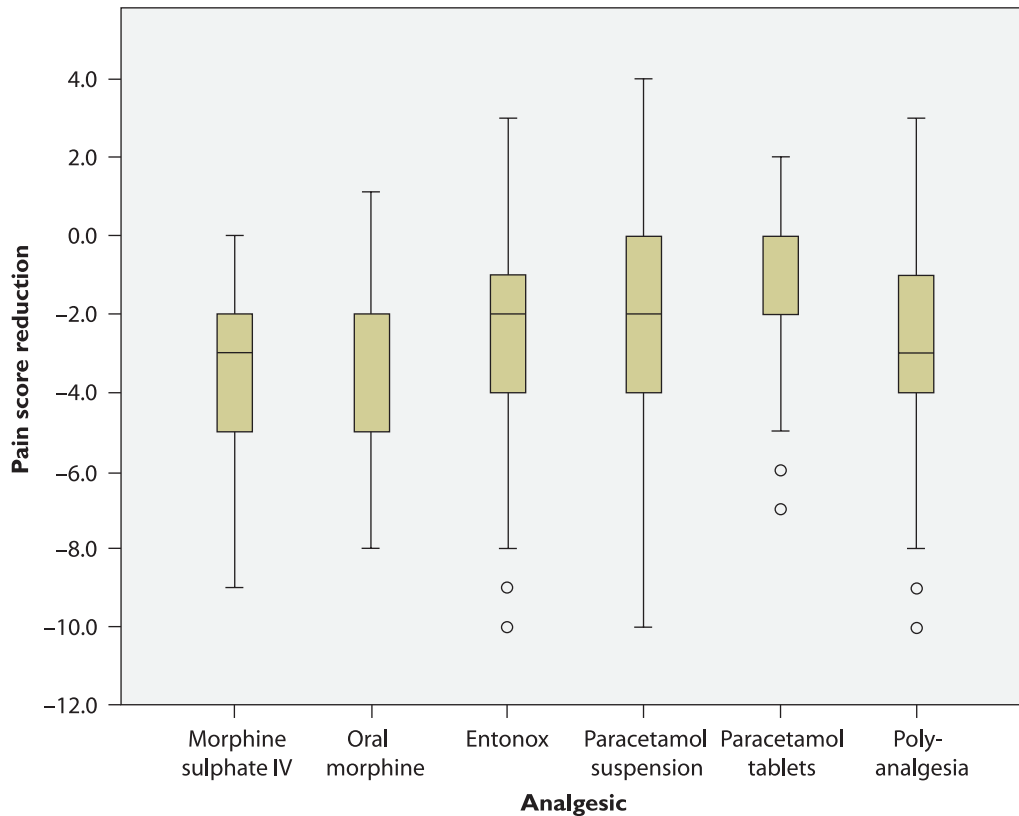
Figure 2. Median pain score reductions per analgesic.

Table 2. Descriptive statistics of each analgesic's pain score reduction.

		Morphine sulphate IV	Oral morphine	Entonox	Paracetamol suspension	Paracetamol tablets	Poly-analgesia
N		48	39	245	236	168	197
Mean		−3.40	−3.074	−2.824	−2.015	−0.929	−3.048
Median		−3.00	−2.000	−2.000	−2.000	0.000	−3.000
Std. deviation		2.285	2.3373	2.6189	2.4363	1.3996	2.6369
Minimum		−9	−8.0	−10.0	−10.0	−7.0	−10.0
Maximum		0	1.1	3.0	4.0	2.0	3.0
IQR	25	−5.00	−5.000	−4.000	−4.000	−2.000	−4.000
	75	−2.00	−2.000	−1.000	0.000	0.000	−1.000

alternative treatment. Of the patients who received no analgesia and no alternative treatment (n = 2905), 45% (n = 1307), 36% (n = 1036) and 19% (n = 541) reported mild, moderate and severe pain, respectively. Twenty-one patients initially reported zero pain, therefore these were excluded.

The most commonly used analgesics were paracetamol (45%; n = 2438), Entonox (40%; n = 2141) and morphine (15%; n = 836) (Figure 3).

From 933 eligible patients (Figure 1), morphine sulphate IV provided the most significant reduction in pain score. The median (range; IQR) reduction in pain per minute for morphine sulphate IV was −0.189 (−2.5 to 0.0;

−0.294 and −0.085) with paracetamol tablets 0.000 (−2.0 to 0.500; −0.116 and 0.000) (Figure 4, Table 3).

Morphine sulphate IV was significantly more effective at reducing pain than paracetamol tablets (P < 0.001) and paracetamol suspension (P = 0.001). Entonox was significantly more effective at reducing pain than paracetamol tablets (P < 0.001) and paracetamol suspension (P = 0.003). Oral morphine was significantly more effective at reducing pain than paracetamol tablets (P < 0.001). Poly-analgesia was significantly more effective at reducing pain than paracetamol tablets (P < 0.001). Paracetamol suspension was significantly more effective at reducing pain than paracetamol tablets (P = 0.005).
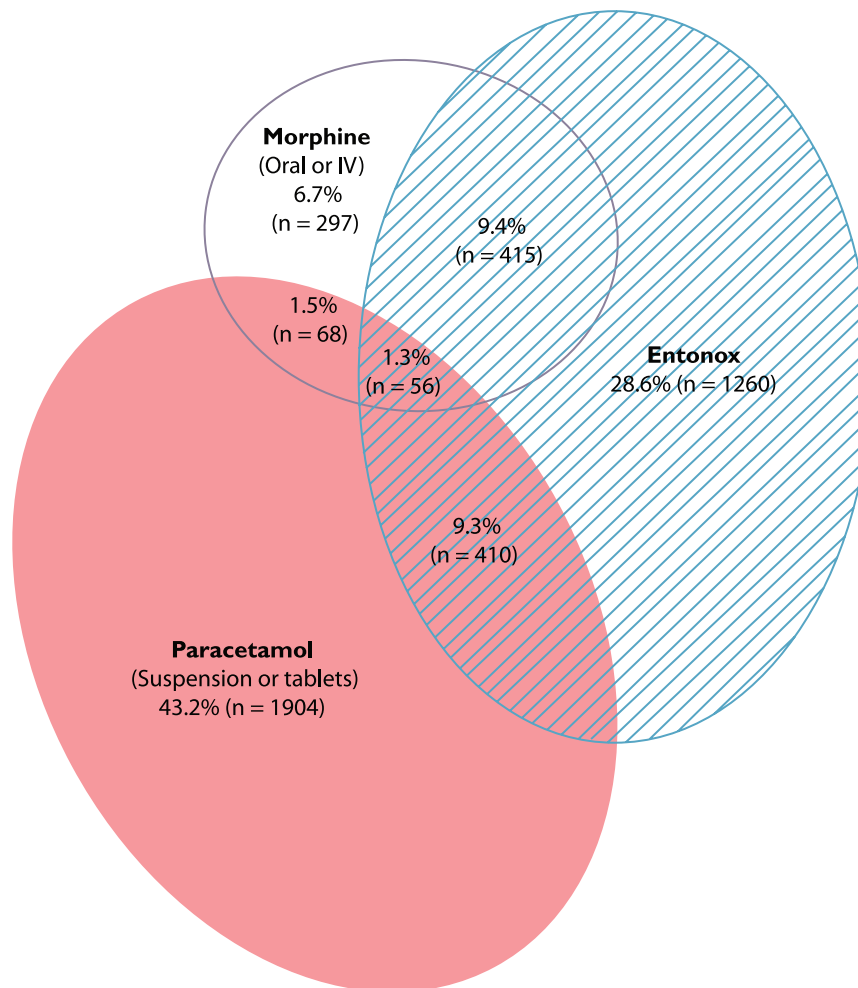
Figure 3. Venn diagram illustrating overall analgesic usage.

Venn diagram produced using eulerAPE software (Micallef & Rodgers, 2014) to illustrate overall usage of analgesics. Analgesics were grouped.
One patient received both oral and intravenous morphine.

Discussion

The UK Ambulance Services Clinical Practice Guidelines state that assessment should be undertaken for all children in pain, with regards to the severity, location, duration and nature (JRCALC, 2016). Based on the results of this service evaluation, this UK ambulance service NHS trust performed well, with pain scoring documented in 90.8% of cases which compared favourably against the London Ambulance Service NHS Trust (64%) (Shaw et al., 2015).

The most concerning result was that only 51.6% (n = 3861) of children reporting a pain score of 1–10 were administered analgesia. It was acknowledged that other forms of non-pharmacological pain relief could be used, such as splinting, dressings or slings, for example. However, 38.8% (n = 2905) of children reporting a pain score of 1–10 received no analgesia and no alternative treatment, when indeed these patients had moderate (4–6; n = 1036) and severe (7–10; n = 541) pain.

Comparing initial and final/destination pain scores may not take into consideration the time taken to achieve the reduction, therefore faster acting analgesics may not receive appropriate credit for reducing pain more quickly. It was also noted that a large number of patients (n = 1663) were excluded for not having a pre- and post-analgesic pain score documented. Pain management cannot be effectively evaluated without a pre- and post-analgesic pain score and therefore this should be a standard requirement.

All of the analgesics produced a clinically meaningful reduction in pain, except for paracetamol tablets. The time taken between analgesic administration and final pain score could not be controlled and there were significant differences between the groups. Calculating the pain score reductions per minute (Figure 4, Table 3) was a valuable consideration when determining the overall clinical significance of the analgesics. It was useful to compare Figure 2 and Figure 4, showing a similar pattern with morphine sulphate IV as the most effective analgesic and paracetamol tablets as the least effective. The most effective way to accurately measure pain score reduction would be regular pain scoring at short intervals post-analgesia, capturing rapid acting analgesics and distinguishing them from slower acting analgesics. Therefore,
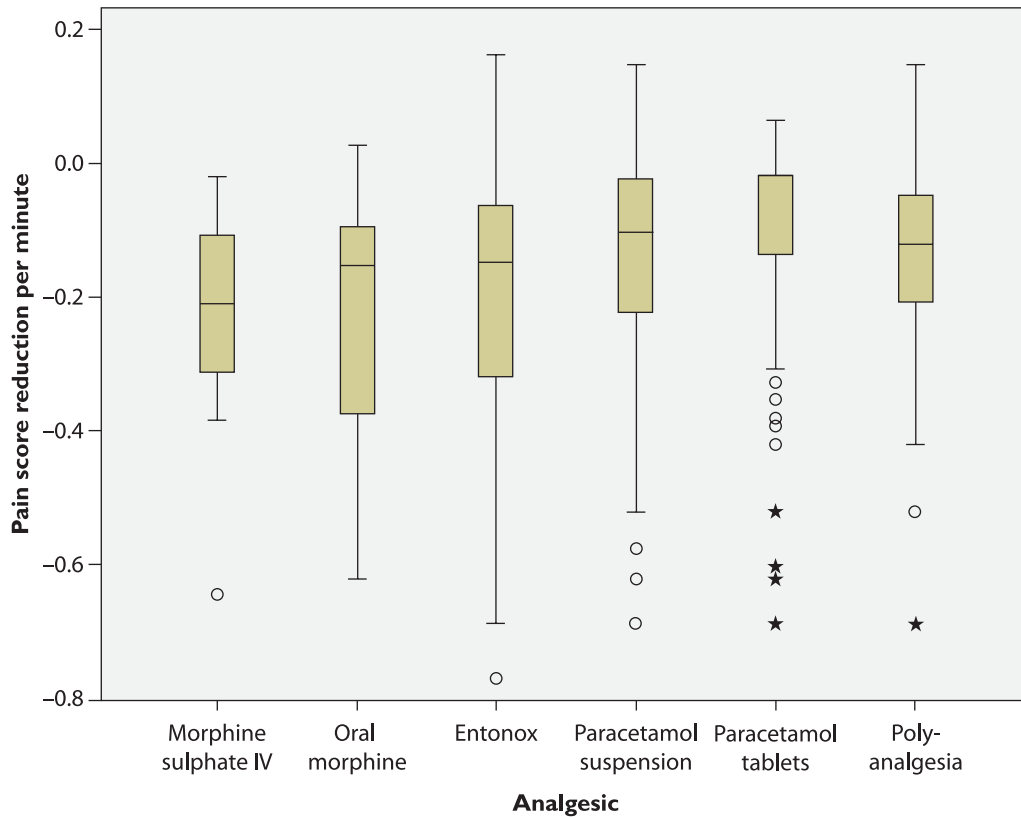
Figure 4. Median pain score reductions per minute per analgesic.

Table 3. Descriptive statistics of each analgesic's median pain score reduction per minute.

		Morphine sulphate IV	Oral morphine	Entonox	Paracetamol suspension	Paracetamol tablets	Poly-analgesia
N		48	39	245	236	168	197
Median		−0.189	−0.133	−0.128	−0.083	0.000	−0.100
Minimum		−2.500	−1.200	−4.000	−4.000	−2.000	−5.000
Maximum		0.000	0.048	0.182	0.400	0.500	0.667
IQR	25	−0.294	−0.300	−0.400	−0.200	−0.116	−0.189
	75	−0.085	−0.042	−0.075	0.000	0.000	−0.027

a study taking pain score measurements at regular intervals would be useful.

Limitations

There were several limitations to the service evaluation. The 'free text' section of each PRF was not examined due to time and resource constraints. Therefore, if clinicians documented their analgesia or pain scores in the 'free text' section and not in the 'treatments' or 'observations' sections then these would not have been found. Data were not extracted from paper PRFs as this was not feasible for this study and therefore it is possible that we have missed some children. It was not possible to determine the number of excluded paper PRFs due to the scanning and verification process.

Another limitation was the sample size. Although there were 11,317 traumatically injured GCS 15 children, only 933 were used for comparing each analgesic, with the smallest group being oral morphine (n = 39).

Implications for clinical practice

The results of the evaluation have significant implications for clinical practice within this UK ambulance service NHS trust and should be implemented into practice through change. A service improvement plan should be developed to improve child pain scoring from 90.8% to 100%. Treatment, either pharmacological or non-pharmacological, should be administered to all children who report pain, particularly moderate to severe pain. Furthermore, it should be made clear that a pre- and

post-analgesic pain score should be obtained when administering analgesia in order to measure its effectiveness. These goals could be achieved by releasing clinical bulletins in the weekly newsletter that is sent to all front line clinicians across the service. Also, during the mandatory yearly training sessions, these issues should be reinforced.

Implications for future research

Recommendations for future research include performing a qualitative study to highlight the barriers and facilitators of analgesia administration in children. This would inform an educational intervention for paramedics around analgesia and pain assessment.

Conclusion

Analgesia currently available to ambulance clinicians working within this UK ambulance service NHS trust does produce a clinically meaningful reduction in pain when treating traumatically injured children. However, a large number of patients go untreated and it would be useful to explore reasons for this in further research.

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Author contributions

GAW: Responsible for conception, approvals, study design, data management, data analysis, interpretation and conclusions.

FB-H: Responsible for approvals, study design, interpretation and conclusions.

Both authors contributed to the development of the manuscript and agreed on the final version.

Conflict of interest

None declared.

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