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Original Research Article

Pain Management in the Emergency Chain: The Use and Effectiveness of Pain Management in Patients with Acute Musculoskeletal Pain

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Abstract

Objective. While acute musculoskeletal pain is a frequent complaint in emergency care, its management is often neglected, placing patients at risk for insufficient pain relief. Our aim is to investigate how often pain management is provided in the prehospital phase and emergency department (ED) and how this affects pain relief. A secondary goal is to identify prognostic factors for clinically relevant pain relief.

Design. This prospective study (PROTACT) includes 697 patients admitted to ED with musculoskeletal extremity injury. Data regarding pain, injury, and pain management were collected using questionnaires and registries.

Results. Although 39.9% of the patients used analgesics in the prehospital phase, most patients arrived at the ED with severe pain. Despite the high pain prevalence in the ED, only 35.7% of the patients received analgesics and 12.5% received adequate analgesic pain management. More than two-third of the patients still had moderate to severe pain at discharge. Clinically relevant pain relief was achieved in only 19.7% of the patients. Pain relief in the ED was higher in patients who received analgesics compared with those who did not. Besides analgesics, the type of injury and pain intensity on admission were associated with pain relief.

Conclusions. There is still room for improvement of musculoskeletal pain management in the chain of emergency care. A high percentage of patients were discharged with unacceptable pain levels. The use of multimodal pain management or the implementation of a pain management protocol might be useful methods to optimize pain relief. Additional research in these areas is needed.

Key Words. Acute Musculoskeletal Pain; Chain of Emergency Care; Emergency Department; Clinically Relevant Pain Relief; Analgesics; Ambulance

Background

Acute pain is a frequent complaint of patients requiring emergency medical care. In many patients, pain is the primary motive for visiting the emergency department (ED). Previous studies have shown that 61 to 91% of patients visiting the ED have a chief complaint related to pain [1–6].

Although pain is acknowledged as a major public health issue, the gap between the increasing knowledge of pain,

treatment and the effective application of it is large [7]. The term "oligoanalgesia," introduced in 1989, has been used to describe the phenomenon of poor pain management in the ED through the underuse of analgesics [8]. Acute pain in EDs appears undertreated worldwide which is reflected by the high prevalence of severe pain at discharge and the low percentage of patients receiving analgesics while in pain [1–3,5,6,8–15]. Previous studies have found that the proportion of adults receiving analgesics for painful conditions, such as musculoskeletal trauma, ranged between 11 and 64% [1,8–11,13,14]. Moreover, the percentage of patients discharged with severe pain ranged from 11 to 29% [1,5,6]. Despite substantial advances in pain research over the last decades acute pain management is still often neglected, placing patients at risk for oligoanalgesia [1,13,15].

In the Netherlands, musculoskeletal injury has a high incidence of approximately 20% each year, and more than one-quarter of these patients visits the ED [16]. Patients presenting with acute musculoskeletal pain to the ED are usually triaged to a low triage category which typically results in an extended waiting time for pain relief or oligoanalgesia [17]. A review shows that patient's pain experience is often underestimated [18]; for example, nurses underestimate the pain intensity of musculoskeletal pain in 95% of the patients [19]. As a result, insufficient pain relief occurs frequently [1,8], especially in patients with fractures [1,9,10,20].

Early and effective pain treatment is important to reduce both short-term and long-term consequences of acute pain. Patients become increasingly more sensitive to painful stimuli if the pain is uncontrolled for a longer period of time [21]. Therefore, treatment of moderate to severe pain should be a priority when a patient came to the ED. Moreover, adequate pain management leads to earlier mobilization, faster rehabilitation and possibly earlier discharge from the hospital [22]. Inadequate pain management is likely to result in decreased productivity and diminished patients' quality of life [22]. In addition, oligoanalgesia is a risk factor for the development of chronic pain [23,24].

Although the importance of timely pain management is acknowledged, it is also recognized that there are barriers to effective pain relief in emergency patients [25]. The right type of analgesic at an adequate dose at the right moment is necessary to successfully reduce pain. In addition, it is relevant to know if any and which type of pain management was provided in the prehospital phase to provide sufficient pain management in the ED and to optimize pain management in the chain of emergency care.

The aims of this study are to investigate how often and which type of pain management is used in patients with musculoskeletal extremity injury presented in emergency care including the prehospital phase and ED. The second objective is to explore the effectiveness and adequacy of pain management in the ED with an emphasis on a clinically relevant reduction in pain. Finally, prognostic factors for clinically relevant pain relief will be identified. Knowledge of these prognostic factors may help physicians explore ways to overcome barriers to properly provide analgesia in patients with musculoskeletal extremity injury.

Patients and Methods

Study Design and Setting

This study is part of a 1-year prospective follow-up study; the "PROgnostic factors for the Transition from Acute to Chronic pain in Trauma patients" (PROTACT). Adult patients with musculoskeletal extremity injury attending the ED of the level one trauma centre Medisch Spectrum Twente in Enschede, The Netherlands, were invited to participate. The ED of Medisch Spectrum Twente is a 24 hours a day, 7 days a week ED (24/7 ED). The catchment area for ED is about 264,000 individuals and the ED service treats approximately 27,000 patients annually. Ethical approval for this study was obtained from the regional Medical Research Ethics Committee on Research Involving Human Subjects (CCMO no. NL368.38044.11). All participants provided written informed consent.

Study Population

Eligible patients were consecutively recruited for the study when admitted to the ED during a 22 month period from September 2011 until July 2013. Inclusion criteria for participation were: i) patients who had musculoskeletal extremity injury caused by blunt trauma; ii) patients who had sufficient communication skills and a basic knowledge of the Dutch language; and iii) patients aged between 18 and 70 years. Exclusion criteria were: i) patients with life or limb threatening conditions; ii) patients with multiple trauma; iii) patients with documented cognitive disability; iv) patients suffering from hallucinations, delusions or suicidal ideation; v) patients with alcohol or drugs intoxication; and vi) patients who were living outside the "catchment area" served by the hospital. For the purpose of this study, we excluded patients who did not provide pain scores both on admission and at discharge.

Procedures and Data Sources

Patients admitted to the ED who met the study criteria were informed by a (triage) nurse about the purpose of the study. Those who agreed to participate were asked to provide informed consent and to complete a questionnaire. The questionnaire and informed consent sheet were returned to either a mailbox in the waiting room or sent by ordinary mail. Eligible patients who were not invited by the nurse to participate received an invitation and questionnaire by mail within 1 week of the ED visit.

The questionnaire included a validated tool to measure pain intensity and questions about sociodemographic data, pain management, and time between injury and ED admission. In addition to the data obtained from the questionnaire, data from the ED electronic patient registration system were used. The registry is a fully electronic

emergency medical record registry where each entry, order, or activity is automatically time-stamped for prespecified ED events. The registry includes patient demographics (date of birth, sex), referrer, triage urgency level, triage pain score, type of analgesics, medical diagnoses (e.g., injury type and location), type of nonpharmacological pain management, time of providing pain management, and refusal to use analgesics.

If patients arrived by ambulance, additional data regarding the use and type of analgesics in the ambulance were retrieved from the registry of the regional emergency medical services (EMS).

Measures and Definitions

Pain Intensity

Pain intensity was measured in the questionnaire using the numerical rating scale (NRS). The NRS of acute pain was validated for use in the ED [26–29] and retrospective 1-week recall of pain intensity was reliable and valid [30,31]. Patients were asked to fill in a number from 0 to 10 to represent their pain severity, where 0 is "no pain" and 10 "the worst pain imaginable" in response to the questions: "How severe was your pain on ED admission?" and "How severe was your pain at ED discharge?". NRS scores were converted to the categorical groups of i) no pain (NRS 0); ii) minimal pain (NRS 1-2); iii) mild pain (NRS 3-4); iv) moderate pain (NRS 5-6); v) severe pain (NRS 7-8); and vi) very severe pain (NRS 9-10).

Analgesics Administered or Self-Initiated Intake in Prehospital Phase

Data regarding the use and type of analgesics in prehospital phase were collected by questionnaires and retrieved from the registry of the regional EMS. In the questionnaire, the patient could indicate if any type of analgesics was taken on his or her own initiative or was given by a health professional such as a general practitioner (GP), before attending the ED.

Analgesics Administered in the ED

The type of analgesic administered in the ED was obtained directly from the ED patient registry. Analgesics administered (if any) were categorized as follows: i) no analgesics; ii) nonopioids such as paracetamol (acetaminophen) or nonsteriodal antiinflammatory drug (NSAID); iii) mild opioids such as codeine and tramadol; and iv) major opioids such as morphine and fentanyl.

Adequate Analgesic Pain Management in ED

The pain management index (PMI) combines an analgesics score and a pain intensity score to determine adequacy of pain management. The PMI is based on the WHO guidelines and orginally designed for cancer pain management and has been used in other pain studies, including acute pain in patients visiting the ED [15,32–34]. The PMI is considered a valid and reliable measure for pain management [35]. The analgesics score was calculated based on the analgesics provided in the ED. No pain medication was scored as "0," nonopioids as "1," mild opioids as "2," and major opioids as "3." For patients who received more than one type of analgesic, the most potent analgesic as per PMI definition was used. The pain intensity score for PMI was calculated using NRS on ED admission as reported by the patient. A pain intensity score of "0" was defined as no pain (NRS 0), "1" minimal and mild pain (NRS 1–4), "2" moderate pain (NRS 5-6) and "3" severe and very severe pain (NRS 7–10). The PMI was calculated by substracting the pain intensity score from the analgesic score. Possible scores ranged from -3 to $+3$. Patients with negative PMI scores were classified as receiving inadequate analgesics management.

Duration of ED Stay

The duration patients were in the ED was obtained from the ED patient registry. Time in the ED represents the time recorded from ED admission to ED discharge and was reported in minutes.

Nonpharmacological Treatment in ED

Data regarding type of nonpharmacological treatment were obtained from the ED patient registry and were categorized as follows: i) no pain treatment; ii) immobilization; iii) reposition; iv) compression; v) coldpack; and vi) others.

Clinically Relevant Pain Relief

Clinically relevant pain relief for acute pain was defined as 33% or more decrease in pain intensity [36]. The relation between demographic factors (sex and age), pain characteristics (pain intensity on admission), pain management characteristics (analgesics or nonpharmacological pain management in the ED, analgesic use in prehospital phase and the duration of ED stay) and injury related characteristics (type of injury, urgency level), were investigated to identify their association with clinically relevant pain relief.

Data Analysis

Descriptive data are presented as means with standard deviations (SD) or 95% confidence intervals (CIs) for differences in continuous variables as medians with interquartile ranges (IQR, 25th–75th percentile) for time variables and as frequencies for categorical variables. Pain intensity differences were calculated by subtracting the pain score at discharge from the pain score on admission. In addition, to determine the percentage of reduction this pain intensity

Table 1 Characteristics of 697 patients with acute musculoskeletal trauma

Age, median (IQR)	47.2 (30.7–58.1)
Gender, women, *N* (%)	391 (56.1%)
Time in ED, median (IQR)	100 min (72–143)
Pain on admission, *N* (%)	689 (98.9%)
Pain intensity score on admission, mean (SD)	6.5 (2.4)
Pain at discharge, *N* (%)	682 (97.7%)
Pain intensity score at discharge, mean (SD)	5.6 (2.5)
Documented pain intensity score at triage, mean (SD)	4.0 (1.4)*
Injury type, *N* (%)	
Fracture	489 (70.2%)
Dislocation	33 (4.7%)
Sprains & strains	89 (12.8%)
Contusion	69 (9.9%)
Muscle rupture	17 (2.4%)

*= 9 missings

difference was divided by the pain score on admission. Pain intensity differences between the different approaches to pain management were analysed using two-tailed Student's *t* test and mean differences with corresponding 95% CIs were calculated. A *P* value <0.05 is considered statistically significant. Boxplots were used to give a graphical representation of the association between the type of pain management and the type of analgesics, and the pain intensity difference between admission and discharge.

Univariate and multivariate analyses were performed to identify prognostic factors for the dichotomous outcome variable clinically relevant pain relief. Associations between categorical variables and the outcome variable were investigated using chi-squared tests. Odds ratios (ORs) and corresponding 95% CIs were calculated and interpreted as the relative risk of the presence of a potential risk prognostic factor for clinical relevant pain relief compared with the absence of risk prognostic factor (reference group). Because preselection of prognostic factor based on *P* values estimated from univariate analyses may result in unstable prediction models [37], all candidate prognostic factors were considered in the multivariate analysis. Backward stepwise selection of all candidate variables was applied using the likelihood ratio test with a *P* value of 0.157 according to Akaike's Information Criterion. Adjusted Odds Ratios (ORadj) and corresponding 95% CIs were calculated. All data were analysed using SPSS version 21.0 (IBM Corporation, Armonk, NY).

Results

Patient Characteristics and Pain Intensity

Overall, 1994 adult patients with musculoskeletal extremity injury caused by blunt trauma met the inclusion criteria. Written informed consent and questionnaires were obtained from 803 patients of whom 697 patients filled in both pain scores on admission and at discharge. Distribution of age and sex among the nonresponders was not significantly different from the participating patients.

Median age of the 697 patients was 47.2 years (IQR 30.7–58.1) and 56.1% were women (Table 1). A fracture was the most common reason for admission (70.2%). Patients reported a high frequency of pain, both on admission (98.9%) and at discharge (97.7%). Overall, the mean self-reported pain intensity score changed from 6.50 on admission to 5.64 at discharge (difference 0.86; 95% CI 0.71–0.99). Figure 1 shows the percentage of patients with pain

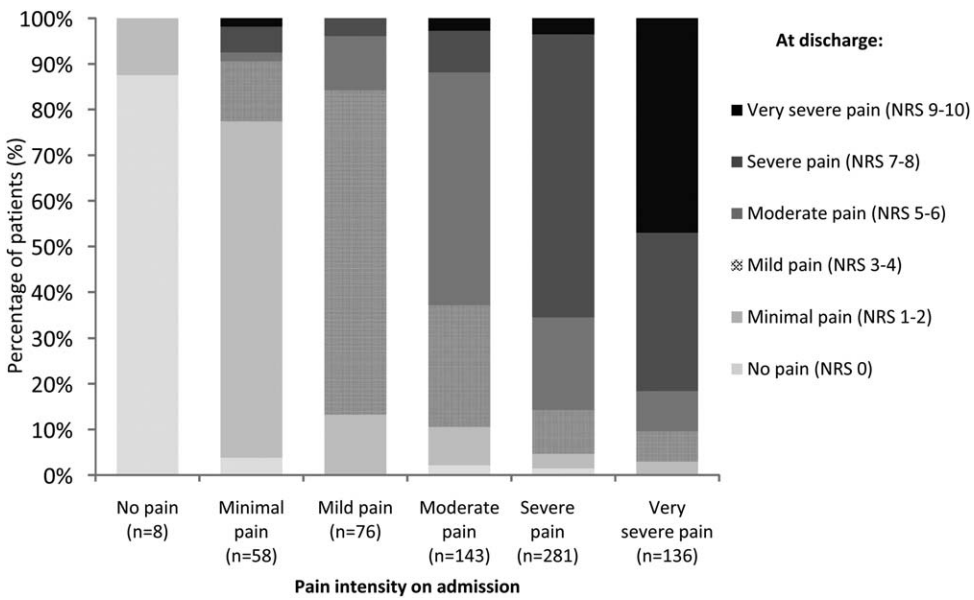

Figure 1 The percentages of patients with reported pain levels at discharge by pain intensity on admission.

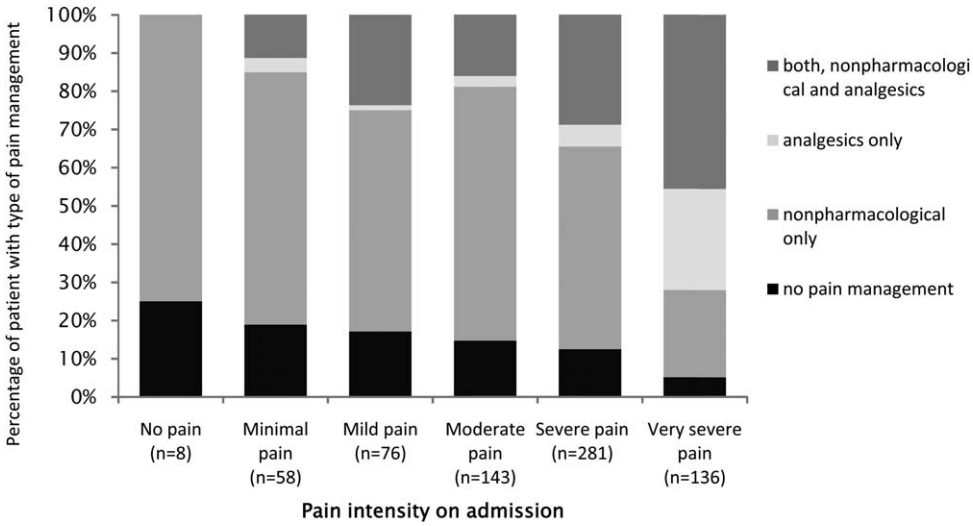

Figure 2 Percentage of patients with type of pain management provided in the ED by pain intensity on admission.

levels at discharge within pain intensity categories on admission. Overall, 560 out of 697 (80.3%) patients had moderate to severe pain on admission and, more than two-third of the patients (67.6%) had moderate to severe pain at discharge.

Type of Pain Management in ED

Overall, 609 out of the 697 patients (87.4%) received pain management in ED. Most patients (n = 360) received nonpharmacological treatment only, 59 patients received analgesics only, and 190 patients a combination of both nonpharmacological treatment and analgesics. Figure 2 shows the percentage and type of pain management that was provided to patients in the ED according to their pain intensity on admission. The percentage of patients who received analgesics, with or without nonpharmacological treatment, increased when pain was more severe from 0% (no pain) to 72% (very severe pain).

Analgesics Use in the Chain of Emergency Care

Figure 3 gives an overview of the analgesic use in the chain of emergency care. Patients came to the ED by four different routes. Overall, 278 out of the 697 patients (39.9%) used one or more analgesics in the prehospital phase. A high percentage of patients (41.6%) was self-referred and 20.7% of these self-referrals did use analgesics before attending the ED. This percentage is somewhat lower than the overall of 25.1% of patients who self-initiated the intake of analgesics, mostly the nonopioid paracetamol. Of the 337 patients who visited a GP or other health professional before attending the ED, 58 patients (17.2%) received analgesics, mostly the nonopioid paracetamol. Out of the 279 patients who did not receive analgesics, 102 patients (32.6%) had already taken analgesics themselves. For 50 out of the 337 patients (14.8%) the GP was the first link in the chain where they received analgesics. In the ambulance, 48 out of the 77 patients (62.3%) received analgesics, mostly the short-acting major opioid Fentanyl. For 45 out of the 77 patients (58.4%) the ambulance was the first link in the chain where they received analgesics. Yet, the patients who used analgesics in prehospital phase (n = 278) had a higher mean pain score of 7.00 on admission compared with 6.17 for those patients not taking analgesics (difference of 0.82; 95%CI 0.47–1.18).

In the ED, 249 out of the 697 (35.7%) patients received analgesics. Most common analgesics provided in the ED were the nonopioid paracetamol and major opioid morphine. Of all the patients, 100 patients (14.3%) were offered analgesics but refused to use any. Of those who refused, 21 patients already received analgesics before hospital admission. Yet, half of the patients in pain (n = 348) did not get analgesics offered.

In total, 420 out of the 697 patients (60.3%) used analgesics somewhere in the chain of emergency care. The ED was for 147 out of the 420 patients who used analgesics (35.0%) the first link in the chain where they received these analgesics. Most patients (65.4%) who received analgesics at more than one link in the chain received different types of analgesics. For example, most patients with mild or major opioid also received paracetamol or NSAID somewhere in the chain of emergency care (Appendix Table A1). A specific overview of generic names of provided analgesics is given in Appendix Table B1.

Adequate Analgesic Pain Management in ED

The PMI score, which was used to calculate the adequacy of pain management, showed that only 87 (12.5%) out of 697 patients received adequate pain management (Table 2). Of the remaining 610 patients, 440 (72.1%) received no analgesics and 170 (27.9%) were given inappropriate analgesics according to the PMI. Out of the 560 patients who had moderate to very severe pain on admission, 52 patients (9.3%) received adequate analgesic pain management. Although 87.5% of the patients received inadequate pain management, only 35 patients (5.0%) were not satisfied with their treatment at the ED.

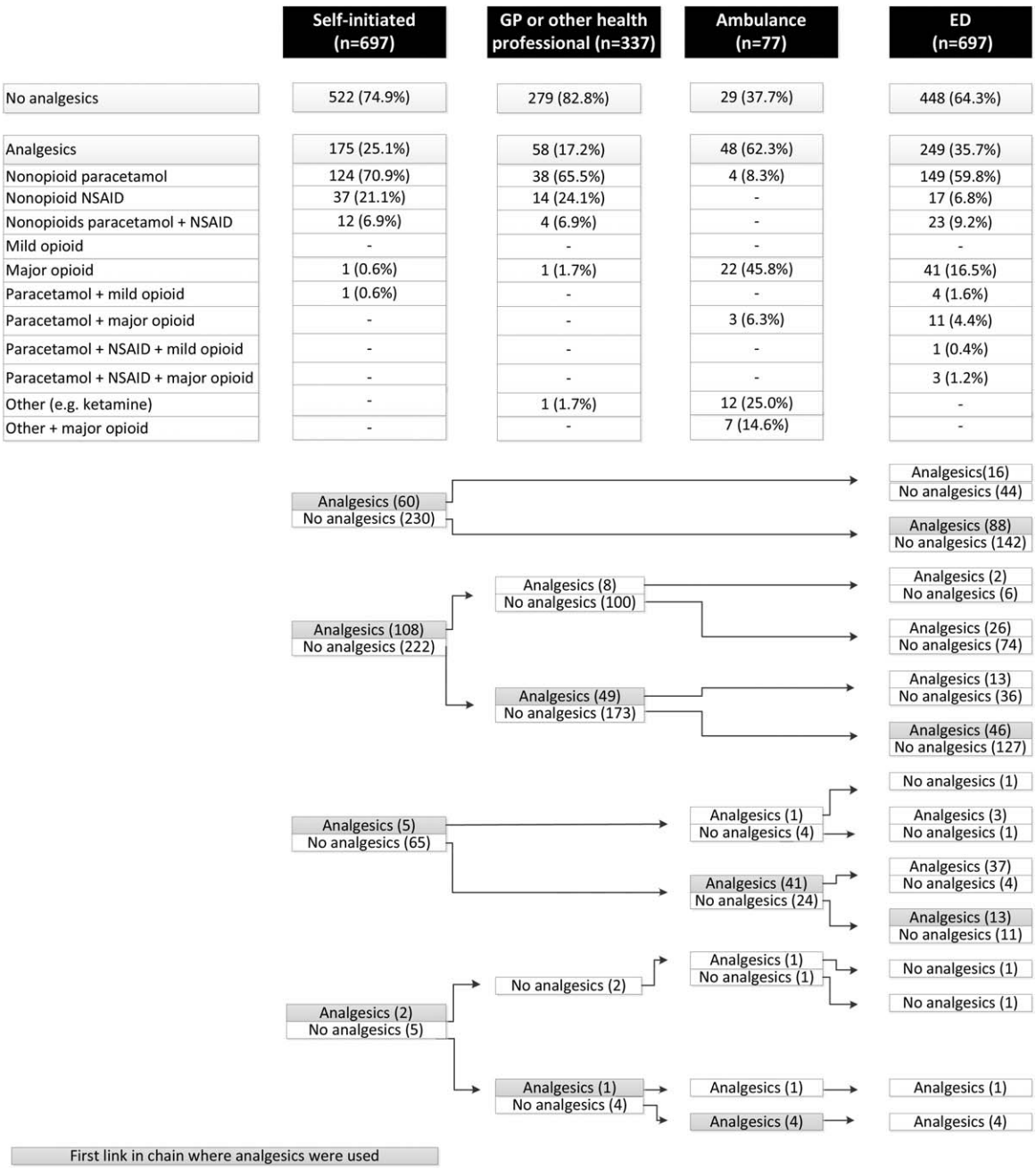

Figure 3 Analgesic use in the chain of emergency care.

Nonpharmacological Treatment

In total, 550 out of the 697 patients (78.9%) received nonpharmacological treatment in the ED. Of these, 446 patients (81.1%) underwent immobilization only or in combination with reposition, compression or cold pack (Appendix Table C1). Compression was used in 22.7% of the patients.

The Effects of Pain Treatment in the ED

Clinically relevant pain relief, a pain reduction of 33% or more during ED visit, was achieved in 137 out of the 697 patients (19.7%). The effects of analgesics and nonpharmacological treatment on change in pain intensity during the ED visit are depicted in Figure 4A. Most patients who did not receive any pain management did not experience pain relief, and 12.5% achieved clinically relevant pain relief. Patients who received only nonpharmacological treatment had a mean pain reduction of 0.68, and 17.5% achieved clinically relevant pain relief. Most patients who received only analgesics had a mean pain reduction of 1.54, and 22.0% achieved clinically relevant pain relief. Patients who received both

Table 2 Pain management Index Score of analgesic use in the ED (n = 697)

	Intensity of pain on admission			
Analgesic type	None (0)	Minimal and mild (1)	Moderate (2)	Severe and very severe (3)
No analgesic (0)	0 (n = 8)	−1 (n = 102)	−2 (n = 116)	−3 (n = 222)
Nonopioid (1)	1 (n = 0)	0 (n = 23)	−1 (n = 24)	−2 (n = 142)
Mild opioid (2)	2 (n = 0)	1 (n = 0)	0 (n = 1)	−1 (n = 4)
Major opioid (3)	3 (n = 0)	2 (n = 4)	1 (n = 2)	0 (n = 49)

* 87 out of 697 patients (12.5%) received adequate pain management during ED visit (zero's or positive scores); 440 out of 610 patients (72.1%) who received inadequate treatment (negative scores) received no analgesics; 70 out of 610 patients (27.9%)) who received inadequate treatment were given inappropriate analgesics according to their pain intensity.

analgesics and nonpharmacological treatment had a mean pain reduction of 1.34, and 26.3% achieved clinically relevant pain relief. Patients who were administered analgesics had a higher mean pain reduction, 1.39 compared with 0.56 of those who received no analgesic (difference of 0.83; 95% CI 0.53–1.11) and achieved also more clinically relevant pain relief, 25.3% vs 16.5% (difference of 8.8%; 95%CI 2.6–14.9). Similar results were found in a subgroup of patients with moderate to severe pain on admission. Patients who were administered analgesics had significantly higher mean pain reduction, 1.53 compared with 0.89 of those who received no analgesic (difference 0.64; 95%CI 0.34–0.95). Also clinical relevant pain relief was higher in patients who received analgesics, 25.7% vs 18.9% (difference of 6.7; 95% CI −0.2 to 13.7).

The effects of the type of analgesics administered in the ED on change in pain intensity of patients during the ED visit are graphed in Figure 4B. The 189 patients who received a nonopioid had a mean pain reduction of 1.37, and the 55 patients who received a major opioid had the highest pain reduction: 1.59.

Patients who received *adequate* analgesic pain management according to PMI had a mean pain reduction of 1.03 and patients with *inadequate* treatment a mean pain reduction of 0.83 (difference of 0.20; 95% CI −0.21 to 0.62). Clinically relevant pain relief was similar in both groups, around 20%. Of the patients who had moderate to very severe pain on admission, mean pain reduction was significantly higher in those who received adequate pain management (1.65) compared with those who received inadequate treatment (1.09) (difference of 0.56; 95% CI 0.04–1.08). Clinically relevant pain relief was achieved in 23.1% of moderate to severe pain patients who received adequate pain management compared with 21.5% of those who received inadequate treatment (difference of 1.6%; 95% CI −10.2 to 13.4%).

Of the patients who were not satisfied with their treatment (n = 35), 14.3% achieved clinically relevant pain relief compared with 21.3% who were satisfied with treatment (difference of 7.1%; 95% CI −6.0 to 21.9) Patients who were satisfied with their treatment had more pain relief during ED visit (difference of 0.53; 95% CI −0.11 to 1.17).

Factors Associated with Clinically Relevant Pain Relief

Overall, 19.7% of the patients had clinically relevant pain relief during ED visit. Table 3 shows the association between candidate prognostic factors for clinically relevant pain relief, sex, age, pain intensity on admission, analgesic use in the ED, nonpharmacological pain management in the ED, analgesic use in prehospital phase, duration of ED stay, type of injury and urgency level, and clinically relevant pain relief. All candidate prognostic factorswere to some extent associated with the prediction of relevant pain relief except for the duration of ED stay. Of all nine candidate-prognostic factors, only three prognostic factors independently contributed to the prediction of the outcome relevant pain relief. The final model (Table 3; ORadj) included three prognostic factors for clinically relevant pain relief, namely type of injury, pain intensity on admission and analgesic use in the ED were highly significant.

Patients who: a) received analgesics in the ED [ORadj1.72; 95% CI (1.12–2.65)]; b) had a dislocation [ORadj 2.67;95% CI (1.23–5.76)]; and c) had moderate [ORadj 3.98; 95% CI (1.57–10.13)] to severe pain [ORadj 2.44.; 95% CI (0.98–6.11)] on admission were more likely to achieve relevant pain relief. Patients with a sprain and strain [ORadj 0.56; 95% CI (0.28–1.11)] or contusion [ORadj 0.30; 95% CI (0.12–0.78)] were less likely to achieve relevant pain relief during ED visit.

Discussion

This part of the PROTACT study confirms oligoanalgesia to be a serious problem in patients with musculoskeletal extremity injury. Even though sixty percent of the patients used analgesics somewhere in the chain of emergency care, more than two-third of the patients still suffered moderate to very severe pain at discharge from the ED.

In the prehospital phase, almost 40% of the patients used one or more analgesics. They reported a mean pain score of 7.0 on ED admission suggesting that most of these patients suffer from severe pain. Despite the fact

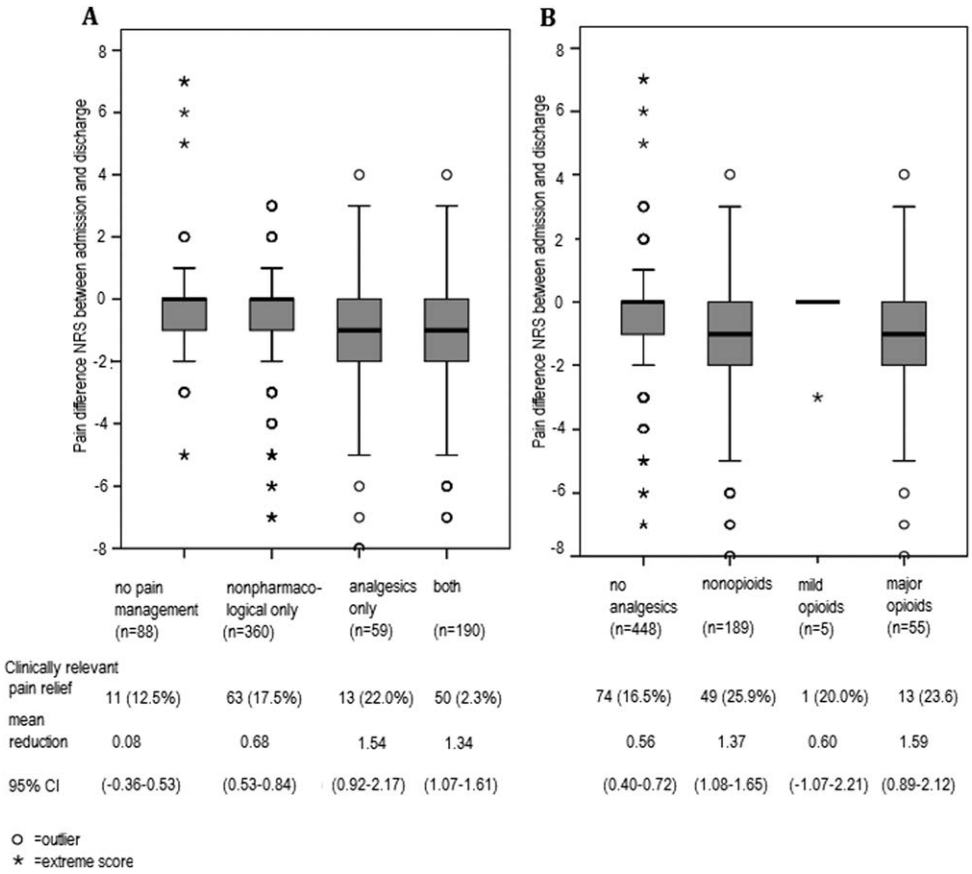

Figure 4 (A) A boxplot with the effects of the type of pain management on the pain intensity of patients between admission and discharge. Mean pain reduction is given with corresponding 95% CIs. (B) A boxplot with the effects of (if any) type of analgesics on pain intensity of patients between admission and discharge. Mean pain reduction with corresponding 95% CIs are given.

that pain prevalence and pain intensity on ED admission were both high, only few patients actually received analgesics during their stay at the ED even when pain intensity was moderate to very severe. Moreover, only one in eight patients had adequate analgesic treatment. Patients did not receive analgesics at all or did receive an inappropriate type of analgesics for their pain intensity at admission. However, the low number of patients receiving (adequate) analgesic pain management is partly explained by almost 15% patients refusing any analgesics. In contrast to the rather low percentage of patients that received analgesics, nonpharmacological treatment was provided to most patients in the ED.

A second objective of this study was to identify patients with clinically relevant pain relief at discharge. Because statistically significant difference in pain change is mostly a matter of sample size, it is more important to know whether this difference is clinically relevant. This clinically relevant pain relief was achieved in only one out of five patients. The administration of analgesics during ED visit, the type of injury and pain intensity on admission were associated with relevant pain relief.

The present study is the first attempt to provide more knowledge about pain management throughout the chain of emergency care. The study is to our knowledge the first study where analgesic use in patients with musculoskeletal injury is described in both prehospital phase and ED. Although a high percentage of patients used analgesics somewhere in the chain of emergency care, more than one-third of these patients received their first analgesic in the ED. As pain is a primary motive of patients to present themselves to the ED [1–6], pain relief should be one of the primary foci of emergency care provision. Adequate and effective pain management is important, it leads to early mobilization and recovery and may prevent long-term consequences like chronic pain [23]. The delayed provision of analgesics in the chain together with the high levels of severe pain reported on ED admission by patients who received analgesics in prehospital phase, shows that there is still room for improvement in pain management in the prehospital phase.

Pain management in the ED has been reported to be a serious problem in previous studies [1–3,5,6,8–15]. For instance, in a study in two Dutch EDs, 86% of a heterogeneous group of trauma patients still suffered pain at discharge, of which two-thirds reported moderate to severe pain [1]. In the present PROTACT study, almost every patient suffered pain at discharge and more than two-third of the patients had moderate to very severe pain although almost 9 out of 10 patients received some kind of pain management. This shows that there is room for improvement in pain management in the ED.

Table 3 Association between different factors with clinically relevant pain relief

			Clinical relevant pain relief			
		Mean pain reduction (SD)	No (n)	Yes (n)	OR (95% CI)	ORadj (95% CI)
Sex	Men	0.63 (1.84)	253	53	1.00 (referent)	–
	Women	1.03 (1.87)	307	84	1.31 (0.89–1.91)	
Age	18–29 years	0.69 (1.89)	139	29	1.00 (referent)	–
	30–39 years	0.35 (1.45)	72	10	0.67 (0.31–1.44)	
	40–49 years	0.75 (1.69)	113	25	1.06 (0.59–1.91)	
	50–59 years	0.97 (1.92)	128	32	1.20 (0.68–2.09)	
	60–69 years	1.30 (2.04)	108	41	1.82 (1.06–3.11)	
Injury type	Fracture	0.98 (1.77)	385	104	1.00 (referent)	1.00 (referent)
	Dislocation	1.78 (2.99)	20	13	2.41 (1.16–5.00)	2.67 (1.23–5.76)
	Sprains & strains	0.41 (1.57)	78	11	0.52 (0.27–1.02)	0.56 (0.28–1.11)
	Contusion	1.01 (1.74)	64	5	0.29 (0.11–0.74)	0.30 (0.12–0.78)
	Muscle rupture	0.94 (2.36)	13	4	1.14 (0.36–3.57)	1.31 (0.41–4.23)
Urgency Level	Standard	0.65 (1.74)	408	83	1.00 (referent)	–
	Urgent	1.29 (1.88)	136	46	1.66 (1.10–2.50)	
	Very Urgent	1.75 (3.15)	16	8	2.46 (1.02–5.93)	
Time in ED	<60 min	0.74 (1.73)	94	19	1.00 (referent)	–
	60 to <120 min	0.78 (1.79)	269	61	1.12 (0.64–1.98)	
	120 to ≤ 180 min	0.98 (2.03)	147	42	1.41 (0.78–2.58)	
	>180 min	1.08 (1.96)	50	15	1.48 (0.70–3.17)	
Pain intensity on admission	No and minimal pain	+0.61 (1.86)	55	6	1.00 (referent)	1.00 (referent)
	Mild pain	+0.09(1.22)	66	10	1.39 (0.48–4.06)	1.56 (0.52–4.67)
	Moderate pain	0.70(1.71)	103	40	3.56 (1.42–8.92)	3.98 (1.57–10.13)
	Severe pain	1.15 (1.78)	225	56	2.28 (0.94–5.57)	2.44 (0.98–6.11)
	Very severe pain	1.60 (1.92)	111	25	2.07 (0.80–5.33)	1.50 (0.55–4.09)
Analgesics in ED	No analgesic	0.56 (1.71)	374	74	1.00 (referent)	1.00 (referent)
	Analgesics	1.39 (2.02)	186	63	1.71 (1.17–2.50)	1.72 (1.12–2.65)
Specified per type	Nonopioid	1.37 (1.95)	140	49	1.79 (1.17–2.67)	1.75 (1.16–2.74)
	Mild opioid	0.60 (1.34)	4	1	1.26 (0.14–11.27)	1.60 (0.16–16.11)
	Major opioid	1.51 (2.27)	42	13	1.56 (0.80–3.06)	1.60 (0.74–3.44)
Nonpharmacological pain management in ED	No	0.67 (2.31)	123	24	1.00 (referent)	
	Yes	0.91 (1.73)	437	113	1.33 (0.82–2.15)	
Analgesic in prehospital phase	No	0.75 (1.89)	338	81	1.00 (referent)	
	Yes	1.02 (1.82)	222	56	1.05 (0.72–1.54)	

These findings pose the intriguing question of how pain management can be improved. To improve pain management in the ED, a pain management protocol might increase the percentage of patients receiving analgesics. Studies have reported that a nurse-initiated protocol for pain management improves the amount of patient receiving analgesics and shortens the time to analgesic provision [38,39]. The importance of analgesic use is reflected by the significant and clinically relevant higher reduction of pain. Although the practice of prescribing analgesics, in particular opioids has been improved in recent years [40], only a low percentage (12.7%) of the patients with severe pain in the present study received an opioid-induced side effects and fear for addiction are clinical concerns that may prevent proper prescribing Yet, the reluctance of clinicians to use opioids could be partly explained by our study population, patients with musculoskeletal injury, who often will be discharged home. The use of more potent analgesics could result in longer ED stay and the inability to be discharged

home safely. Another reason may be that clinicians are too focused on "anatomical" injury treatment and do not always follow expert recommendations regarding the use of self-reported pain intensity [41]. Moreover, patients do not always desire opioids while in pain [42].

Extra attention could be paid to patients who suffered a sprain, strain or contusion. The PROTACT study showed that patients with a contusion, sprain or a strain are less likely to achieve clinically relevant pain relief than patients with fractures, while patients with a dislocation are more likely to achieve clinically relevant pain relief. This confirms earlier findings [1]. When a dislocated joint is successfully repositioned into its normal anatomical position, clinically relevant pain relief will be achieved relatively easy. Painful diagnostic procedures performed in the ED to patients with contusions, sprains or strains could be an explanation for the lower pain relief in these patients [1]. Furthermore, patients with nonfracture injury may be more liable to treatment disparities than patients with fractures [41]. When treating patients with musculoskeletal injury, one should pay extra attention to patients' pain, especially in patients who suffered a sprain, strain, or contusion. This might improve pain relief in these patients

In addition to a pain management protocol, multimodal therapy to improve pain management is worth considering. Given the high complexity of pain [43], it is clear that no single analgesic will provide optimal pain relief. Paracetamol, NSAIDs and opioids all have different mechanisms of actions. Studies examining the use of multiple analgesics with different mechanisms of action suggest that multimodal therapies may offer an improved efficacy/tolerability balance over the use of a single analgesic [25]. Fortunately, in more than half of the patients, analgesics were already given with a multimodal approach. Still there are patients who received only opioids and especially in patients with musculoskeletal extremity injury, who often have considerable tissue damage, the use of only opioids is not optimal. Pain management is expected to improve if different types of analgesics are combined to capitalize on their complementary mechanism of action [44].

The strength of the present study is the use of patients' self-reporting pain intensity instead of the documented pain scores assessed by clinicians such as physicians or nurses. Many studies are retrospective and therefore use available registry data. Because there is no objective measurement for the experience of pain, the measurement of pain relies primarily on patients' self-report. In the PROTACT study, mean pain scores documented during triage by clinicians were significantly lower than those self-reported by patients. This underestimation of pain is a common phenomenon in patients with musculoskeletal pain [18,19,45]. While patients self-reports were used for pain intensity, registry data were used for the provision of analgesics in the ambulance and the ED. Although patients were asked to write down the name of the analgesic they used, most patients did not know which analgesic they received. Therefore, we used registry data if available. Unfortunately, registry data from GP were not available in this study. Furthermore, the effectiveness of pain management in the prehospital phase could not be assessed due to a lack of prehospital initial pain scores which unfortunately were not documented in the registries. Additionally, data on nonpharmacological pain management in the prehospital phase were poorly documented and except for cooling not asked for in the questionnaire. To investigate the effect of analgesic treatment in the ED, analgesics were divided in classes according to WHO guidelines, even though the name, dose and frequency for the administered analgesics were collected. Most clinicians will start with an initial low dose according to body weight and carefully adjust the dose upwards to adequate levels (titration to effect) to reduce side effects.

Altogether, the addition of initial pain scores, availability of pain management registry from GPs, and nonpharmacological pain management in the prehospital phase in the questionnaire would have made the study even more complete.

The limitations of PMI as an index of adequate analgesic pain management must be acknowledged. The PMI reflects a relatively simple approach to assess the adequacy of analgesic pain management and does not address many of the complexities inherent in pain management such as side effects, contraindications to specific analgesics and does not take into account that some patients tolerate more pain than others. The PMI combines only the class of analgesics administered and the pain intensity at admission. Therefore, PMI only gives an indication of the adequacy of analgesic provision, not of the effect of treatment or adequate pain relief. Furthermore, most patients received in addition to analgesic treatment, also nonpharmacological treatment.

Moreover, the percentage of patients who used analgesics in the ED might be underestimated and found effects of analgesic use might be higher because of misclassification of patients. Even though medical staff was instructed to list all medications, including over-the-counter drugs, some may have neglected this, especially if the over-the-counter drugs (nonopioids like paracetamol) which were routinely administered by nurses during triage. These patients were classified as "received no analgesic." As the PROTACT study revealed that more than two-third of the patients discharged with severe pain, it is also required to monitor patients after discharge regarding analgesic use. Furthermore, to investigate whether the study participants were a selected group of patients, a substudy was performed in which several characteristics of the participants (type of injury, urgency level, documented triage pain score, pain management) were compared with a random group of hundred nonresponders. Characteristics were similar, indicating that the included participants were not a selected group of patients.

Finally, the PROTACT study was conducted in a single center ED and may not represent the practices of other EDs and ambulance services. However, problems of pain management in emergency care extend far beyond

a single ED; the high pain prevalence and low percentage of analgesic administration are comparable to other EDs [1,9]. In summary, pain management in both the prehospital phase and in the ED is clearly not optimal. A high percentage of patients was discharged with unacceptable levels of pain. The use of multimodal pain management or the implementation of a pain management protocol might be useful methods to optimize pain relief. Additional research regarding the best methods to manage pain in the chain of emergency care is necessary.

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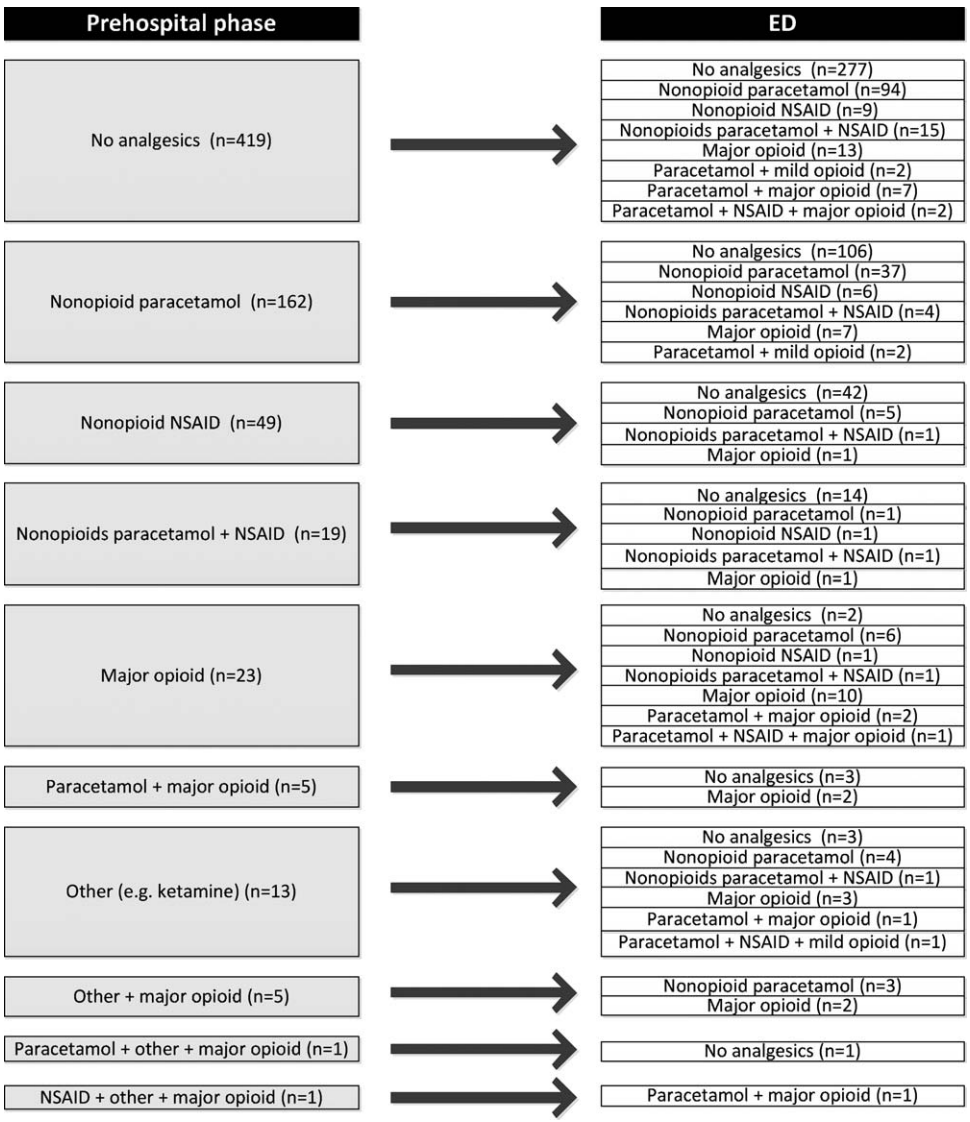
Appendix A

Table A1 Follow-up treatment of pain in the ED. Combination of analgesics used in the chain of emergency care



Appendix B

Table B1 Type and generic name of analgesics administered in prehospital phase and the ED

Ambulance medical emergency services (n = 77)		N (%)
No analgesics 29 (37.7%)		
Analgesics 48 (62.3%)		
	Nonopioids	4 (8.3%)
	Paracetamol IV	4
	Mild opioids	0 (0.0%)
	Major opioids	32 (66.7%)
	Fentanyl	22
	Fentanyl + paracetamol	2
	Morphine + paracetamol	1
	Fentanyl + esketamine	4
	Fentanyl + 50% N2/ 50% O2	3
	Other	12 (25%)
	Esketamine	11
	50% N2/ 50% O2	1
Self-initiated (n = 697)		N (%)
No analgesics 522 (74.9%)		
Analgesics 175 (25.1%)		
	Nonopioids	173 (98.9%)
	Paracetamol	124
	Paracetamol + ibuprofen	9
	Paracetamol + diclofenac	3
	Ibuprofen	27
	Diclofenac	5
	Aspirin	3
	Meloxicam	1
	Mild opioids	1(0.6%)
	Zaldiar	1
	Major opioids	1(0.6%)
	Oxycodone	1
General practitioner or other health professional (n = 337)		N (%)
No analgesics 279 (82.8%)		
Analgesics 58 (17.2%)		
	Nonopioids	56 (96.6%)
	Paracetamol	38
	Paracetamol+ibuprofen	1
	Paracetamol+diclofenac	3
	Ibuprofen	9
	Ibuprofen +diclofenac	1
	Diclofenac	3
	Naproxen	1
	Major opioids	1 (1.7%)
	Morphine	1
	Other	1 (1.7%)
	Prilocaïne hydrochloride	1
ED		N (%)
No analgesics 448 (64.3%)		
Analgesics 249 (35.7%)		
	Nonopioids	189 (75.9%)
	Paracetamol	149

Table B1: *Continued*

Ambulance medical emergency services (n = 77)	*N* (%)
Paracetamol + ibuprofen	1
Paracetamol + diclofenac	22
Diclofenac	17
Mild opioids	5 (2.0%)
Tramadol + paracetamol	4
Tramadol + paracetamol+dicofenac	1
Major opioids	55 (22.1%)
Morphine	40
Morphine + paracetamol	11
Morphine + paracetamol+diclofenac	3
Piritramide	1

Appendix C

Table C1 Nonpharmacological pain management in ED

Nonpharmacological pain management in ED		*N* (%)
No nonpharmacological 147 (21.1%)		
Nonpharmacological 550 (78.9%)		
	Immobilization	381 (69.3%)
	Immobilization + reposition	27 (4.9%)
	Immobilization + compression	28 (5.1%)
	Immobilization + cold pack	10 (1.8%)
	Reposition	1 (0.2%)
	Compression	95 (17.3%)
	Compression + cold pack	2 (0.4%)
	Coldpack	1 (0.2%)
	Others	5 (0.9%)

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