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Factors Influencing Quality of Pain Management in a Physician Staffed Helicopter Emergency Medical Service

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BACKGROUND: Pain is frequently encountered in the prehospital setting and needs to be treated quickly and sufficiently. However, incidences of insufficient analgesia after prehospital treatment by emergency medical services are reported to be as high as 43%. The purpose of this analysis was to identify modifiable factors in a specific emergency patient cohort that influence the pain suffered by patients when admitted to the hospital.

METHODS: For that purpose, this retrospective observational study included all patients with significant pain treated by a Swiss physician-staffed helicopter emergency service between April and October 2011 with the following characteristics to limit selection bias: Age > 15 years, numerical rating scale (NRS) for pain documented at the scene and at hospital admission, NRS > 3 at the scene, initial Glasgow coma scale > 12, and National Advisory Committee for Aeronautics score < VI. Univariate and multivariable logistic regression analyses were performed to evaluate patient and mission characteristics of helicopter emergency service associated with insufficient pain management.

RESULTS: A total of 778 patients were included in the analysis. Insufficient pain management (NRS > 3 at hospital admission) was identified in 298 patients (38%). Factors associated with insufficient pain management were higher National Advisory Committee for Aeronautics scores, high NRS at the scene, nontrauma patients, no analgesic administration, and treatment by a female physician. In 16% (128 patients), despite ongoing pain, no analgesics were administered. Factors associated with this untreated persisting pain were short time at the scene (below 10 minutes), secondary missions of helicopter emergency service, moderate pain at the scene, and nontrauma patients. Sufficient management of severe pain is significantly better if ketamine is combined with an opioid (65%), compared to a ketamine or opioid monotherapy (46%, $P = .007$).

CONCLUSIONS: In the studied specific Swiss cohort, nontrauma patients, patients on secondary missions, patients treated only for a short time at the scene before transport, patients who receive no analgesic, and treatment by a female physician may be risk factors for insufficient pain management. Patients suffering pain at the scene (NRS > 3) should receive an analgesic whenever possible. Patients with severe pain at the scene (NRS ≥ 8) may benefit from the combination of ketamine with an opioid. The finding about sex differences concerning analgesic administration is intriguing and possibly worthy of further study. (Anesth Analg 2017;125:200–9)

Pain in prehospital emergency medicine is a common symptom frequently experienced by both trauma and nontrauma patients.[1] Relieving pain as soon as possible should be a priority because the treatment minimizes the physiological pain reactions such as anxiety and cardiac effects caused by the adrenergic state.[2] Recent studies have shown that the prevalence of insufficient prehospital pain management (numerical rating scale [NRS] > 3 at hospital admission) can be as high as 43%,[3] emphasizing that this is an underestimated issue in prehospital care. This insufficient prehospital pain management is generally caused by a complete lack of analgesics[3–5] or an insufficient treatment such as underdosage, unavailability, or inadequate choice of analgesics.[6] Several predicting factors for an insufficient pain management have been identified including high initial pain scores, inexperienced emergency physician, and physician sex.[1,3,7] Some limitations may also be present in paramedic emergency medicine services omitting an emergency physician.[8] To evaluate treatable patient, physician, and mission characteristics that may account for insufficient prehospital pain management (NRS > 3 at hospital admission), we reviewed prehospital data of all patients who were treated by physician-staffed Swiss helicopter emergency medical service (HEMS) during a 6-month period. Second, we tried to identify factors that are associated with patients not receiving any analgesic treatment during HEMS treatment/transport despite ongoing pain. Third, we tried to identify an analgesic treatment regimen that may lead to improved pain management in the prehospital setting.

METHODS

After obtaining approval of the local ethics committee (Kantonale Ethikkommission Zurich, Switzerland, KEK-ZH-2015–193), data collection and analysis were started.

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Study Design and Participants

This is a retrospective observational study including all patients treated by HEMS crew of the Swiss Air-Ambulance (Rega) from April to October 2011, who met the following inclusion criteria: Age > 15 years, NRS for pain documented at both at the scene and at hospital admission, NRS > 3 at the scene, initial Glasgow coma scale (GCS) > 12 and National Advisory Committee for Aeronautics (NACA) score < VI. The study period was chosen because NRS scores at the scene and at hospital admission had been prospectively collected for internal quality control and board recertification purposes during that timeframe.

Setting

Rega is a nonprofit HEMS performing over 11,000 emergency missions from 12 bases (and one partner-base) in Switzerland per year. The Rega HEMS crew consists of a helicopter pilot, a paramedic, and a specially trained emergency physician. These physicians require at least 4 years of clinical training after graduation from medical school, including at least 1 year of clinical anesthesia, and must be experienced in emergency medicine. The physicians are required to attend an emergency medicine, advanced cardiovascular, and trauma life support course before they begin their assignment in the HEMS organization. In addition, experience in pediatric anesthesia is required. Mission profiles include primary missions (scene to hospital) and secondary missions (hospital to hospital) with all types of emergency situations (evacuations, trauma, and nontrauma) as described before.[9]

Equipment is standardized throughout the organization. Analgesics include fentanyl 0.1 mg/mL (Janssen-Cilag AG, Zug, Switzerland), ketamine 50 mg/mL (Ratiopharm AG, Ulm, Germany), and morphine 10 mg/mL (Sintetica SA, Mendrisio, Switzerland). All patients included in this study received the analgesic medication intravenously. No patient received intramuscular or intranasal application of analgesia. The choice of the analgesic regimen was at the discretion of the treating emergency physician.

Data Collection, Variables, and Bias

As obliged by the Swiss aviation authorities, the Rega database contains every helicopter movement. These movements are distinctively linked to mandatory information on patient and mission characteristics, which limits the influence of selection bias. To narrow the effect of a recall bias, records were completed and filed in the database directly at the end of every mission by the emergency physician in charge.[9] Patient demographics and characteristics (age, sex, GCS, and cardiovascular/respiratory stability), data of the treating physician (age, sex, years of experience at the HEMS, and number of missions performed in the study period), mission characteristics (primary, secondary, time spent at the scene, flight time, and night flight), rescue in difficult terrain (hoist rescue or inability to land the helicopter at the scene), emergency specifications like NACA, type of emergency (trauma and nontrauma), administered intravenous analgesics (fentanyl, morphine, and ketamine), and sedation (benzodiazepines) were extracted from the Rega database. The patient selection excluded patients who were too unstable or too sedated to determine and verbalize 2 NRS scores (at the scene and at the hospital). The NRS score denoted by the patient lies on a scale from 0 to 10 with 0 representing no pain and 10 the worst pain imaginable.[10] An NRS > 3 corresponds reliably to the perceived need for additional analgesia in >90% of the patients.[11,12] To evaluate the effect of different analgesic regimen (combination of ketamine and opioid versus monotherapy), we defined an NRS ≥ 8 as severe pain. In the course of a quality investigation for recertification, the NRS scores at the scene and at hospital admission were collected prospectively for every HEMS mission during the study period and cross-checked by the attending physician. The physicians were instructed and repeatedly taught how to correctly determine NRS in a unified way. The Rega database was screened for the defined inclusion criteria. Data from relevant missions was extracted and transferred into a spreadsheet (Microsoft Excel: mac 2016, version 15.23.1, Microsoft Corporation, Redmond, WA).

Statistical Analysis

Categorical data are reported as frequency and percent and numerical data as mean ± SD and median with quartiles. The χ^2 and Fisher exact test were used to compare categorical data, and the Breslow-Day test was used to check for interactions. Wilcoxon-Mann-Whitney test was used to compare continuous data. Univariate and multivariable logistic regression analyses were performed for sufficient pain management. Explanatory variables were physician sex, NACA, night flight, difficult terrain, trauma, NRS at the scene, analgesic administration, time of prehospital care, and mission type (rationale: all variables with $P < .05$). Physician experience and patient sex were chosen as explanatory variables due to scientific rationale. Odds ratios (OR), 95% confidence intervals (CIs) and P values were calculated. The model fit was assessed using the Hosmer-Lemeshow test. A $P < .01$ was considered statistically significant due to the quantity of the statistical tests performed during this analysis. Statistical data were analyzed with IBM SPSS Statistics (version 22, IBM Corp, Armonk, NY).

RESULTS

Patient/Population Characteristics

During the study period in 2011 (April until October), 126 physicians performed 4028 HEMS missions of which 778 patients with moderate to severe pain levels at the scene met the inclusion criteria for this study (Figure 1), and 1159 patients with an NRS ≤ 3 at the scene were not included in the study analysis. A total of 80 male physicians treated 545 (70%) of the patients and 27 female physicians treated 233 (30%) of the patients, respectively.

The mean patient age was 48 ± 18 years, and the majority was male (70%) trauma patients (69%) on primary missions (83%). Over 65% of all rescue missions had a NACA score of IV or V. The mean NRS scores at the scene and later upon admission to the hospital were 6.5 ± 1.8 and 3.1 ± 1.9, respectively. The mean reduction in the NRS score was 3.4 ± 2.3 (Table 1; Supplemental Digital Content 1, Figure S1, http://links.lww.com/AA/B702). A summary of the mission, patient, and pain characteristics is depicted in Table 1.

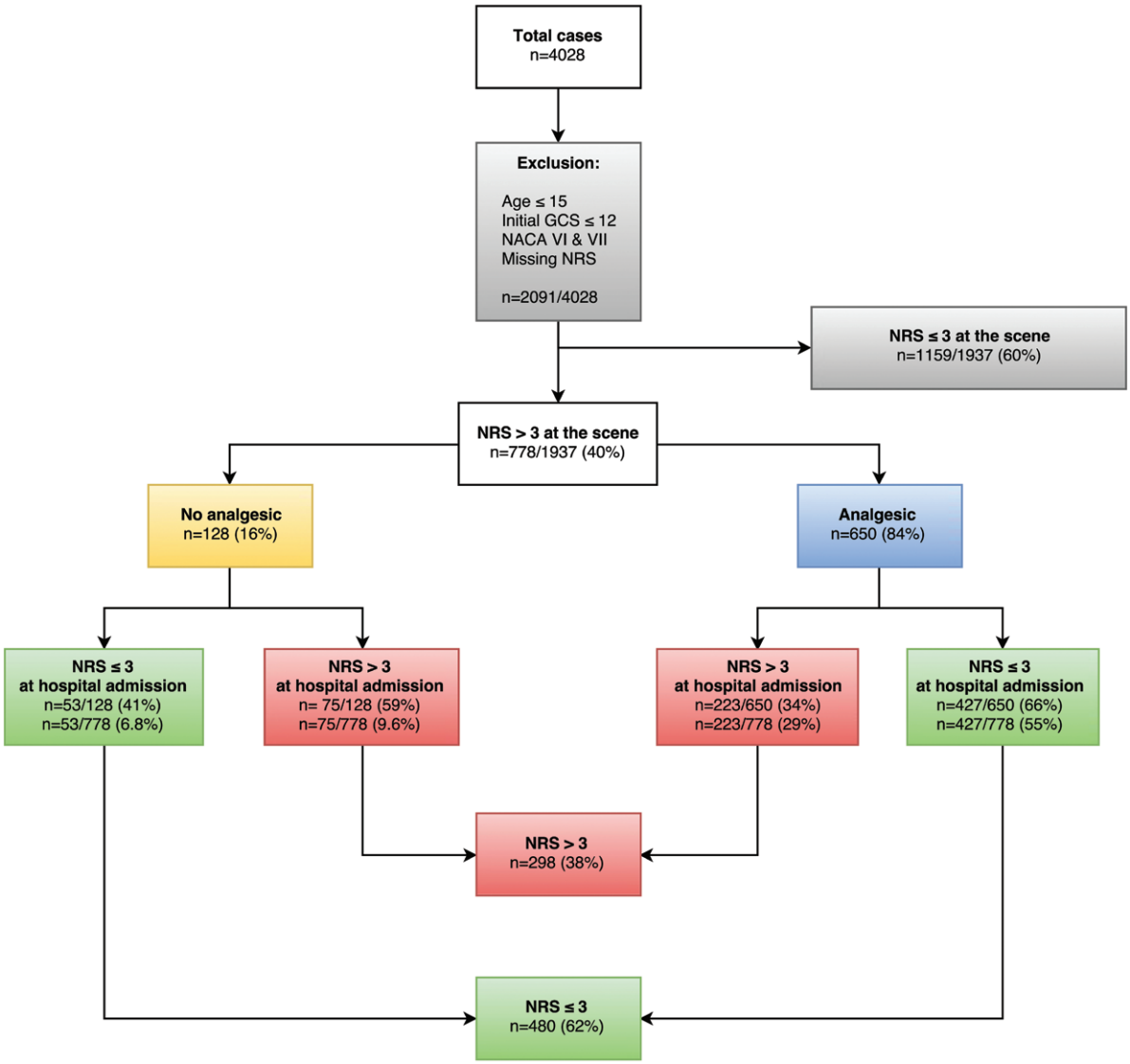

Figure 1. Flowchart: inclusion/exclusion of the patients. All patients transported and treated with the HEMS between April and October 2011 were screened for inclusion to the study. Exclusion criteria are shown in the flowchart. Patients experiencing moderate to severe pain at the scene (NRS > 3) were divided into 2 groups, depending on whether or not they received analgesics. Pain treatment sufficiency is illustrated separately for each group as well as the total for all included patients. GCS indicates Glasgow coma scale; HEMS, helicopter emergency medical service; NACA, National Advisory Committee for Aeronautics score; NRS, numerical rating scale.

Upon arrival at the hospital, a sufficient pain management (NRS ≤ 3 at hospital admission) was achieved in 480 patients (62%), thus leaving 298 patients (38%) with an NRS > 3 at hospital admission (Figure 1).

Of all patients analyzed, 128 patients (16%) did not receive any analgesic, resulting in 75 patients (59%) with insufficient pain management (NRS > 3 at hospital admission) in this group. Analgesics were administered to the remaining 650 patients (84%), leaving only 223 (34%) with insufficiently treated pain (Figure 1).

Insufficient Pain Management (NRS > 3 at Hospital Admission)

In patients with insufficient pain management, the data set revealed significantly higher NACA scores compared to patients with sufficient pain management (Table 1, $P = 0.008$). The NRS scores at the scene were significantly higher (6.8 ± 1.9 vs 6.2 ± 1.7, $P < .001$) and the NRS reduction during HEMS treatment was significantly lower (1.9 ± 1.9 vs 4.2 ± 2.1, $P < 0.001$). Nontrauma patients and patients who received no analgesics had a significantly higher incidence of insufficient pain management (Table 1). The frequency of fentanyl administration was significantly higher (72% vs 59%, $P < 0.001$), whereas the non–weight-adjusted dosage of the analgesics was not different in patients with sufficient pain management compared to patients with NRS > 3 at hospital admission. The equipotent non–weight-adjusted doses of fentanyl were twice the doses of morphine throughout all groups (Table 1).

In regard to physicians involved during the study period, there were no significant differences in age, number of performed missions during the study period, or overall length of employment in the HEMS organization (experience)

Table 1. Sufficient Versus Insufficient Pain Management

		Total (n = 778)			Sufficient Pain Management (n = 480)			Insufficient Pain Management (n = 298)			
		n (%)	Mean (±SD)	Median [Q1;Q3]	n (%)	Mean (±SD)	Median [Q1;Q3]	n (%)	Mean (±SD)	Median [Q1;Q3]	*P* Value
Mission type	Primary	647 (83%)			408 (85%)			239 (80%)			.08
	Secondary	131 (17%)			72 (15%)			59 (20%)			
NACA	II	16 (2.1%)			12 (2.5%)			4 (1.3%)			
	III	255 (33%)			173 (36%)			82 (28%)			
	IV	390 (50%)			236 (49%)			154 (52%)			**.008**
	V	117(15%)			59 (12%)			58 (20%)			
GCS	13	11 (1.4%)			7 (1.5%)			4 (1.3%)			
	14	77 (9.9%)			48 (10%)			29 (9.7%)			.98
	15	690 (89%)			425 (89%)			265 (89%)			
Age patients (y)			48 (±18)	48 [32;61]		48 (±18)	48 [31;62]		47(±18)	48 [32;59]	.75
Patient sex	Male	545 (70%)			336 (70%)			209 (70%)			.97
Physician sex	Male	546 (70%)			362 (76%)			184 (62%)			**<.001**
Experience physician (y)			1.8 (±3.1)	1.8 [0.5;1.8]		1.9 (±3.3)	0.5 [0.3;1.8]		1.7 (±2.8)	0.4 [0.1;2.1]	.11
Age physician (y)			38 (±6)	36 [34;41]		38 (±6)	36 [34;40]		38 (±6)	37 [34;41]	.61
Missions per physician (n)			68 (±48)	55 [26;107]		69 (±48)	55 [26;107]		66 (±46)	49 [26;93]	.56
Difficult terrain		152 (20%)			106 (22%)			46 (15%)			.02
Circulation insufficient		13 (1.7%)			5 (1.0%)			8 (2.7%)			.09
Breathing insufficient		6 (0.8%)			5 (1.0%)			1 (0.3%)			.42
Time on scene (min)			25 (±13)	23 [18;29]		26 (±133)	23 [18;30]		24 (±12)	22 [17;28]	.04
Flight time (min)			11 (±6)	10 [7;13]		10 (±6)	9 [6;13]		11 (±6)	10 [7;14]	.11
Time of prehospital care (min)			36 (±15)	34 [27;41]		37 (±15)	34 [27;42]		35 (±14)	33 [26;40]	.22
Night flight		115 (15%)			61 (13%)			54 (18%)			.04
Trauma		538 (69%)			353 (74%)			185 (62%)			**.001**
NRS at scene (0–10)			6.5 (±1.8)	6 [5;8]		6.2 (±1.7)	6 [5;8]		6.8 (±1.9)	7 [5;8]	**<.001**
NRS at hospital admission (0–10)			3.1 (±1.9)	3 [2;4]		2 (±1.0)	2 [2;3]		4.9 (±1.3)	4 [4;5]	**<.001**
NRS reduction (0–10)			3.4 (±2.3)	3 [2;5]		4.2 (±2.1)	4 [3;6]		1.9 (±1.9)	2 [0;3]	**<.001**
Administered analgesic		650 (84%)			427 (89%)			223 (75%)			**<.001**
	Fentanyl	521 (67%)			346 (72%)			175 (59%)			**<.001**
	Fentanyl (µg)		140 (±109)	100 [100;200]		134 (±98)	100 [100;200]		151 (±127)	100 [100;200]	.19
	Morphine	107 (14%)			65 (14%)			42 (14%)			.83
	Morphine (mg)		7.0 (±4.6)	6 [4;10]		6.4 (±4.0)	5 [3;10]		7.9 (±5.4)	8 [4;10]	.11
	Ketamine	137 (18%)			93 (19%)			44 (15%)			.1
	Ketamine (mg)		58 (±37)	50 [50;79]		59 (±39)	50 [38;75]		54 (±30)	50 [25;79]	.57

Patient, physician, operational, and mission characteristics are presented for all included patients. Characteristics of patients with sufficient pain management (NRS ≤ 3 at hospital admission) were compared with patients with insufficient pain management (NRS > 3 at hospital admission). Data are shown as frequency with percentage or mean value and standard deviation (SD) and median with quartiles ([Q1;Q3]). A *P* value of .01 between sufficient and insufficient pain management was considered statistically significant (χ^2 test, Fisher exact test, Wilcoxon-Mann-Whitney test).

Bold indicates statistical significance.

Abbreviations: GCS, Glasgow coma scale; NACA, National Advisory Committee for Aeronautics score; NRS, numerical rating scale.

between the groups of patients with sufficient and insufficient pain management (Table 1).

However, patients with sufficient pain management were treated significantly more often by a male physician (76%) compared to patients with insufficient pain management (62%, $P < .001$, Table 1). If patients did not receive any analgesic, physician sex did not differ between patients with sufficient or insufficient pain management ($P = .57$). If an analgesic was administered, male physicians achieved sufficient analgesia in 71%, whereas female physicians achieved sufficient analgesia in only 52% ($P < .001$). Male physicians applied significantly higher doses of fentanyl (146 ± 111 µg) compared to female physicians (126 ± 103 µg, $P = .002$). Mean doses of ketamine ($P = .86$) and morphine ($P = .49$) were not different between physician sexes. There was no interaction between physician and patient sex concerning sufficient or insufficient pain management ($P = .38$).

A multivariable logistic regression analysis with correction for possible confounders attributed a significant adjusted OR of 1.63 (95 % CI, 1.15–2.31, $P = .006$) for insufficient pain management if a female physician treated the patient. NACA and trauma were dependent and thus lost significance in the multivariate analysis (Table 2). Patients who do not receive an analgesic have an adjusted OR of 4.25 (95 % CI, 2.67–6.76, $P < .001$) for insufficient pain management. This represents the largest treatable independent factor for insufficient pain management.

Persisting Untreated Pain

Mission characteristics of patients who suffered persisting untreated pain (no analgesia during HEMS transport and NRS > 3 at hospital admission) differ from mission characteristics where analgesics were administered. The time at the scene was significantly shorter in patients who suffered persisting untreated pain (22 vs 26 minutes, $P = .001$, Table 3). Factors that were significantly associated with patients suffering persisting untreated pain were transfers from hospital to hospital (secondary missions) (31% vs 14%, $P = .001$), patients with only moderate pain at the scene (mean NRS 5.2 ± 1.4) compared to more severe pain (mean NRS 6.7 ±1.8, $P < .001$) and nontrauma patients (52% vs 28%, $P < .001$) (Table 3).

Successful Treatment of Severe Pain

Patients with severe pain at the scene (NRS ≥ 8) had a significantly higher incidence of sufficient analgesia if they had been treated with a combination of opioid and ketamine (65%) compared to ketamine or opioid monoanalgesic therapy (47%, $P = .007$, Figure 2A). Opioid monotherapy was significantly less effective in achieving sufficient analgesia in patients with severe pain (44%) compared to patients with moderate to severe pain (NRS 4–7) at the scene (75%, $P < .001$, Table 4). Mean NRS reduction in patients with an NRS ≥ 8 at the scene was significantly higher if an opioid and ketamine were combined (6.0 ± 2.5), compared to ketamine or opioid monoanalgesic therapy (4.7 ± 2.1, $P < .001$, Figure 2B). Ketamine was combined with a sedative (most commonly midazolam) in 66% of the treated patients to limit psychomimetic effects, regardless of combination with an opioid or monotherapy.

Mean doses of ketamine did not differ significantly between monotherapy or in combination with an opioid (Table 4).

DISCUSSION

Key Results

At the scene, 40% of patients suffered moderate to severe pain (NRS > 3), affirming the fact that pain is a frequently encountered symptom in prehospital medicine.[13–15] On admission to the hospital, 38% of those 778 patients still had insufficient pain management (NRS scores > 3).

Table 2. Factors for Insufficient Pain Management, Multivariate Analysis

		Multivariate Logistic Regression for Insufficient Pain Management			
		Raw OR (95% CI)	***P* Value**	**Adjusted OR (95% CI)**	***P* Value**
Physician sex	Female	1.92 (1.40–2.62)	**<.001**	1.63 (1.15–2.31)	**.006**
NACA			**.009**		.17
	II	Reference		Reference	
	III	0.70 (0.22–2.25)	.55	0.52 (1.45–1.82)	.31
	IV	0.51 (0.16–1.61)	.25	0.44 (0.12–1.57)	.21
	V	0.34 (0.10–1.11)	.07	0.31 (0.08–1.16)	.08
Day-time flight		0.66 (0.44–0.98)	.04	0.67 (0.41–1.07)	.09
No difficult terrain		1.55 (1.06–2.27)	.02	1.23 (0.76–2.01)	.40
Nontrauma		1.70 (1.25–2.31)	**.001**	1.41 (0.96–2.06)	.08
NRS at scene		0.83 (0.77–0.90)	**<.001**	0.72 (0.66–0.79)	**<.001**
No analgesic administration		2.71 (1.84–3.99)	**<.001**	4.25 (2.67–6.76)	**<.001**
Time of prehospital care (min)		1.02 (1.00–1.03)	.02	1.02 (1.00–1.03)	.05
Mission type		0.71 (0.49–1.04)	.08	1.05 (0.65–1.70)	.84
Experience physician (y)			.61		.66
	≦0.5	Reference		Reference	
	0.6–1.0	1.23 (0.72–2.12)	.45	1.15 (0.64–2.07)	.65
	1.1–2.0	1.14 (0.74–1.75)	.56	1.03 (0.63–1.70)	.91
	2.1–5.0	0.75 (0.46–1.22)	.25	0.75 (0.44–1.28)	.29
	≧5.1	0.96 (0.61–1.52)	.87	0.78 (0.47–1.30)	.34
Patient sex	Female	0.99 (0.73–1.36)	.97	0.97 (0.68–1.37)	.86

Raw and adjusted odds ratios (OR) for insufficient pain management (NRS > 3 at hospital admission) with 95% confidence intervals (CI). *P* values of .01 are considered statistically significant. NACA and trauma are associated variables.

Bold indicates statistical significance.

Abbreviations: NACA, National Advisory Committee for Aeronautics score; NRS, numerical rating scale.

Table 3. Persisting Untreated Pain

		Administered Analgesic (n = 650)			No Analgesia and Persisting Pain (NRS >3) (n = 75)			
		n (%)	Mean (±SD)	Median [Q1;Q3]	n (%)	Mean (±SD)	Median [Q1;Q3]	*P* Value
Mission	Primary	557 (86%)			52 (69%)			**.001**
	Secondary	93 (14%)			23 (31%)			
NACA	II	11 (1.7%)			1 (1.3%)			
	III	216 (33%)			24 (32%)			
	IV	328 (51%)			34 (45%)			.49
	V	95 (15%)			16 (21%)			
GCS	13	8 (1.2%)			1 (1.3%)			
	14	66 (10%)			8 (11%)			.99
	15	576 (87%)			66 (88%)			
Age patients (y)			47 (±18)	48 [32;61]		48 (±18)	47 [32;62]	.74
Sex patients	Male	462 (71%)			50 (67%)			.42
Sex physician	Male	465 (72%)			49 (65%)			.28
Experience physician (y)			1.8 (±3.1)	0.4 [0.3;1.5]		2.1 (±3.4)	0.7 [0.1;2.7]	.7
Age physician (y)			38 (±6)	36 [34;40]		39 (±6)	37 [34;42]	.16
Missions per physician (n)			68 (±48)	55 [27;107]		64 (±45)	46 [25;93]	.43
Difficult terrain		123 (19%)			11 (15%)			.43
Circulation insufficient		9 (1.4%)			3 (4.0%)			.12
Breathing insufficient		6 (0.9%)			0 (0%)			1
Time on scene (min)			26 (±13)	23 [18;30]		22 (±12)	19 [16:25]	**.001**
Flight time (min)			10 (±6)	10 [6;13]		11 (±8)	9 [6;14]	.93
Time of prehospital care (min)			36 (±15)	34 [27;42]		33 (±16)	31 [23;38]	.02
Night flight		87 (13%)			17 (23%)			.04
Trauma		469 (72%)			36 (48%)			**<.001**
NRS at scene (0–10)			6.7 (±1.8)	7 [5;8]		5.2 (±1.4)	5 [4;6]	**<.001**
NRS at hospital admission (0–10)			3.0 (±1.8)	3 [2;4]		4.8 (±1.1)	4 [4;5]	**<.001**
NRS reduction (0–10)			3.7 (±2.2)	4 [2;5]		0.4 (±0.9)	0 [0;1]	**<.001**

Patient, physician, operational, and mission characteristics for patients who suffered persisting untreated pain (no analgesic and persisting pain NRS > 3 at hospital admission) were compared with characteristics of patients who received an analgesic. Data are shown as frequency with percentage or mean and SD and median with quartiles ([Q1;Q3]). A *P* value of .01 was considered statistically significant (χ^2 test, Fisher exact test, and Wilcoxon-Mann-Whitney test).

Bold indicates statistical significance.

Abbreviations: GCS, Glasgow coma scale; NACA, National Advisory Committee for Aeronautics score; NRS, numerical rating scale.

This study revealed the following factors that may be associated with insufficient pain management during HEMS treatment: higher NACA scores, high pain at the scene, nontrauma patients, no administration of analgesics, and treatment by a female physician. Not administering an analgesic agent to patients with moderate to severe pain may predispose for a high likelihood of persisting pain.[3] In the investigated setting, the following causal and potentially treatable factors may account for untreated pain: patients on secondary missions, very short mission times (<10 minutes), patients with only moderate pain, and pain of nontrauma origin.

Interpretation

Patients with higher NACA scores have a higher incidence of insufficient pain management during HEMS treatment, which has already been shown by Albrecht et al.[3] The NACA score uses 8 categories (NACA 0 to VII) to describe the urgency of a patient's condition and shows a good association with morbidity and mortality.[16] Treatment priorities in critical emergencies may not focus primarily on analgesia, although in this analysis there was no evidence that circulatory or respiratory unstable patients received inferior analgesic treatment.

For nontrauma patients, the source of pain may not be as apparent as for trauma patients, which could lead to inferior evaluation and treatment of pain by the emergency physician.[17] Furthermore, an emergency physician's concern to administer analgesics to nontrauma patients may be the fear of obstructing or hindering further diagnostic processes in the hospital,[18] although this belief has been disproved (at least) for abdominal pain.[19,20]

In the investigated setting, higher levels of pain at the scene are associated with insufficient pain management during HEMS treatment. Physicians may be reluctant to administer high dosages in fear of causing respiratory depression or other adverse events, although in a 10-year retrospective study, Losvik et al[21] associated the administration of either an opioid or ketamine with better outcome in respiratory rate and systolic blood pressure in comparison to patients who did not receive analgesics. In a systematic review of 21 studies including 6212 patients, Park et al[22] reported that none of the 6212 patients on opioids required respiratory support and that cardiovascular instability was uncommon. The most frequent adverse events reported were nausea, vomiting, dizziness, and pruritus.

In our specific setting, female physicians administered lower doses of fentanyl compared to male physicians, which may in part explain why the incidence of sufficient pain management differs between physician sexes. Our data confirm the results from Albrecht et al,[3] who attributed an OR of 2 for insufficient pain management if the patient was treated by a female physician. Physician–patient sex differences in acute and chronic pain assessment and treatment have been described.[23–27]

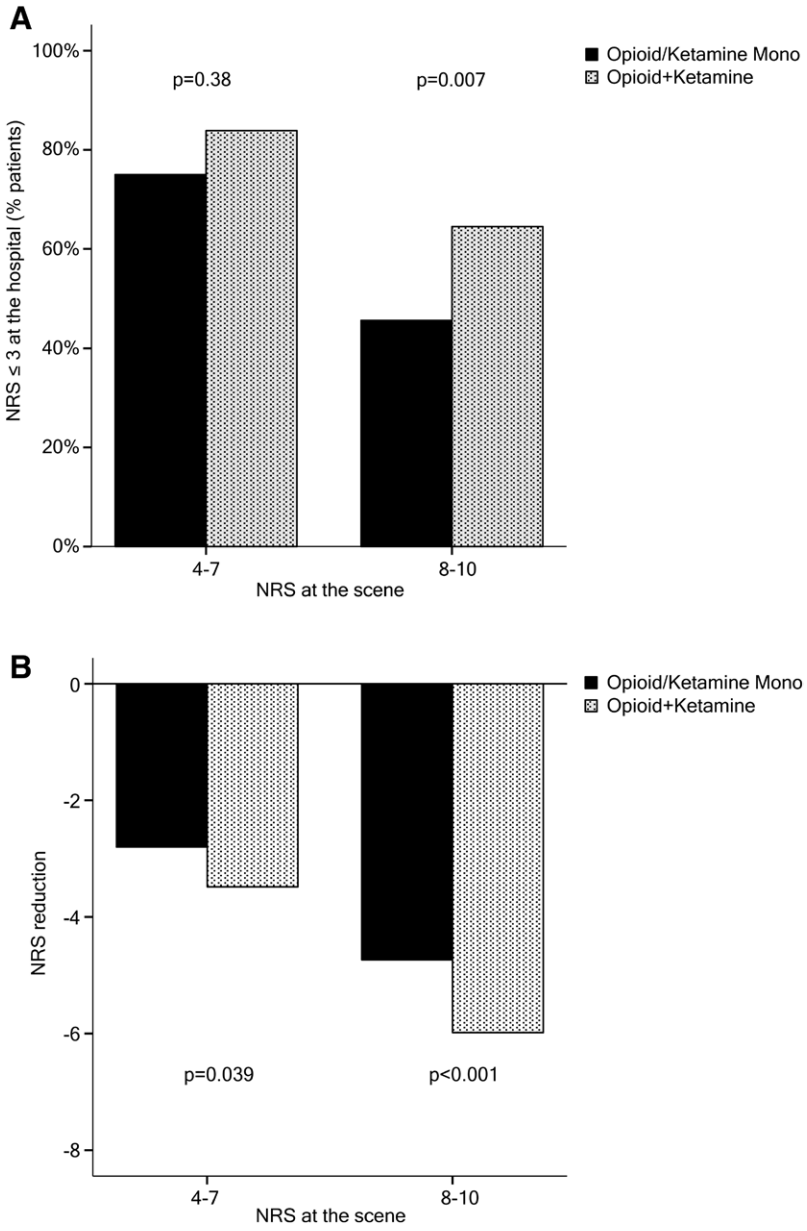

Figure 2. A, Successful pain management per used analgesic: Percentage of sufficient pain management (NRS ≤ 3 at hospital admission) was compared between ketamine or opioid monoanalgesic therapy and treatment with a combination of opioid and ketamine. The combination of opioid and ketamine led to a significantly higher percentage of sufficient pain management in patients experiencing severe pain (NRS 8–10, $P = .007$). For patients experiencing moderate pain (NRS 4–7) there was no significant difference between the treatment regimen ($P = .38$). B, Reduction in NRS per used analgesic: Differences in NRS reduction for opioid or ketamine monotreatment and their combination are visualized for patients with moderate (NRS 4–7) and severe (NRS 8–10) pain. Patients experiencing severe pain had a significantly higher NRS reduction if treated with the combination of opioid and ketamine ($P < .001$) compared to a monoanalgesic therapy. NRS indicates numerical rating scale.

Strategies to optimize prehospital pain treatment could include protocols that use the combination of fentanyl with at least low-dose ketamine, if the patient experiences severe pain at the scene (NRS ≥ 8). This successful opioid-sparing combination was shown to be successful perioperatively.[28,29] A combination of ketamine (median dose 35 mg) and morphine resulted in superior prehospital trauma analgesia compared to the monoadministration of morphine, but was associated with psychomimetic effects like tachycardia, disorientation, and increased systolic blood pressure.[30] Losvik et al[21] attributed significantly better effects on systolic blood pressure to the use of ketamine in patients with Injury Severity Score > 8 compared to the use of opioids only. Low-dose ketamine was safely used for sedation and postoperative analgesia without causing hallucinations or psychomimetic effects.[31,32] The safety profile and costs of ketamine may also predispose the use of this drug in lower income countries.[33,34] It may also fit to the prehospital setting because it was shown to prevent the development of redistribution hypothermia.[35]

Nasal application of ketamine and/or fentanyl or morphine has been described as equally effective as intravenous administration of analgesics and is accordingly a safe and less painful alternative to intravenous cannulation.[36–40] Therefore, to avoid patients not receiving analgesia, especially in situations where the patient treatment time is short or other reasons prohibit the use of intravenous agents, nasal application of either ketamine or fentanyl may be used to deliver analgesia.

A direct comparison of the effectiveness of fentanyl and morphine was not calculated in this study. Taking into account that the used fentanyl doses were twice the (equipotent) morphine doses, this could be an indicator that fentanyl onset of action was faster, was more predictable, or led to less sedation and thus allowed the application of twice the equipotent dose of morphine.

Table 4. Administration of Analgesics in Relation to NRS Score at Scene and the Respective Percentage of Sufficient Analgesia at Hospital Admission

		NRS at the Scene				
		4–7 (n = 395)		8–10 (n = 255)		
		Count	Group %	Count	Group %	*P* Value
Opioid mono	Sufficient analgesia	260/346	75%	74/167	44%	**<.001**
Ketamine mono	Sufficient analgesia	13/18	72%	14/26	54%	.35
	Ketamine mg, mean (SD)	73 (57)		61 (29)		
	Ketamine mg, median [Q1;Q3]	50 [34;100]		55 [39;79]		
Opioid+ketamine	Sufficient analgesia	26/31	84%	40/62	65%	.06
	Ketamine mg, mean (SD)	47 (30)		58 (34)		
	Ketamine mg, median [Q1;Q3]	50 [25;60]		50 [36;75]		

Analgesic treatment regimen and consecutive percentages of sufficient analgesia (NRS ≤ 3 at hospital admission) for patients experiencing moderate (NRS 4–7) and severe (NRS 8–10) pain. Data are shown as frequency with percentage or mean dose and SD and median with quartiles ([Q1;Q3]). A *P* value of .01 was considered statistically significant (χ^2 test, Fisher exact test, and Wilcoxon-Mann-Whitney test).

Bold indicates statistical significance.

Abbreviation: NRS, numerical rating scale.

Physicians should be aware of the possible treatment differences according to physician sex, and, whenever possible, the analgesic regimen and dosing must target on sufficient analgesia in all patient groups.

Limitations and Generalizability

The study has a retrospective design. Only patients who already experienced moderate to severe pain (NRS > 3) at the scene were included, which limits the generalizability of the overall percentages. Only weak conclusions can be drawn from self-reported quality-improvement data such as the pain scores. The results concerning treatment differences according to physician sex are significant for the investigated cohort of emergency physicians but may not apply to other physician collectives. Additionally, some HEMS organizations are paramedic systems only, omitting a physician on board, which limits the generalizability of our results. The study does not report adverse events of analgesic treatment. Data collection and the study plan were not designed to quantify adverse events attributed to analgesic treatment. In the group of patients who were severely injured and unstable, many arrived already intubated at the hospital, unable to report a pain score.[41] All patients included in this study verbally reported their pain score before and after analgesia, which implies a safe practice for the reported patient characteristics and analgesic dosages.

CONCLUSIONS

In the studied specific Swiss cohort, nontrauma patients, patients on secondary missions, patients treated only for a short time at the scene before transport, patients who receive no analgesic, and treatment by a female physician may be risk factors for insufficient pain management. Patients suffering pain at the scene (NRS > 3) should receive an analgesic whenever possible. Patients with severe pain at the scene (NRS ≥ 8) may benefit from the combination of ketamine with an opioid. The finding about sex differences concerning analgesic administration is intriguing, and possibly worthy of further study.

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