American Journal of Emergency Medicine 37 (2019) 2125–2131

Contents lists available at ScienceDirect

American Journal of Emergency Medicine

journal homepage: www.elsevier.com/locate/ajem

The intensity of pain in the prehospital setting is most strongly reflected in the respiratory rate among physiological parameters

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ARTICLE INFO

Article history:
Received 11 September 2018
Received in revised form 7 January 2019
Accepted 21 January 2019

Keywords:
Pain
Vital parameters
Intensity
Prehospital setting

ABSTRACT

Background: In order to treat pain optimally, the Emergency Medical Service (EMS) clinician needs to be able to make a reasonable estimation of the severity of the pain. It is hypothesised that various physiological parameters will change as a response to pain.
Aim: In a cohort of patients who were seen by EMS clinicians, to relate the patients' estimated intensity of pain to various physiological parameters.
Methods: Patients who called for EMS due to pain in a part of western Sweden were included. The intensity of pain was assessed according to the visual analogue scale (VAS) or the Numerical Rating Scale (NRS). The following were assessed the same time as pain on EMS arrival: heart rate, systolic and diastolic blood pressure, respiratory rate, moist skin and paleness.
Results: In all, 19,908 patients (≥18 years), were studied (51% women). There were significant associations between intensity of pain and the respiratory rate ($r = 0.198$; $p < 0.0001$), heart rate ($r = 0.037$; $p < 0.0001$), systolic blood pressure ($r = -0.029$; $p < 0.0001$), moist skin ($r = 0.143$; $p < 0.0001$) and paleness ($r = 0.171$; $p < 0.0001$). The strongest association was found with respiratory rate among patients aged 18–64 years ($r = 0.258$; $p < 0.0001$).
Conclusion: In the prehospital setting, there were significant but weak correlations between intensity of pain and physiological parameters.

The most clinically relevant association was found with an increased respiratory rate and presence of pale and moist skin among patients aged < 65 years. Among younger patients, respiratory rate may support in the clinical evaluation of pain.

1. Introduction

International research since the beginning of the 1990s has shown that about half of patients who call for the EMS have pain as part of their symptoms [1-3]. About one third of these patients have moderate to severe pain. Patients who call for the EMS because of pain have been reported to have a median pain intensity of 5–6 on an 11-grade scale, where 0 means no pain at all and 10 means the most severe pain the patient could imagine [5,6]. The gender distribution among patients with pain in the prehospital setting is relatively similar, with a slight female predominance (51%–53%) [2,3,5]. The median age among patients who use the EMS due to pain varies between 51 and 61 years [3,5,7].

In order to understand the variety of perceptions that are experienced in pain, it must be regarded as a multidimensional phenomenon rather than as a separate symptom.

Before making a decision on pain relief, the care-giver needs to make a professional judgement of the patient's experience of the pain in order to choose the optimal level of pain relief. In the prehospital setting, as well as in other emergency care, it has been stated that various physiological parameters are reflected in the intensity of the pain. It is often stated that the patient exaggerates

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https://doi.org/10.1016/j.ajem.2019.01.032
0735-6757/

his/her pain intensity since the vital parameters are within the normal range. However, in recent years, the association between the intensity of the pain and various physiological parameters has been questioned increasingly. In the prehospital setting, there is a great deal of uncertainty regarding these issues.

Within prehospital emergency care and in emergency departments, observational studies comprising between 1000 and up to 150,000 patients have been performed. Both retrospective registry studies and prospective observational studies in emergency departments demonstrate a weak correlation between patients' own evaluation of pain and heart rate [8,9]. Other researchers did not find any individual correlation between the estimated intensity of pain and heart rate, but, on the other hand, they found that a reduction in the intensity of pain was accompanied by a decrease in heart rate [10]. No correlation between pain and blood pressure or respiratory rate respectively was reported [8,10].

Retrospective register studies within prehospital emergency care demonstrate a weak yet significant association between patients' reported intensity of pain and respiratory rate [6,7]. A respiratory rate above 25 breaths/min is a predictor of more severe pain [7]. Other researchers were unable to demonstrate a significant association between pain and heart rate and blood pressure respectively. However, in a very large study comprising >50,000 patients, it was found that, among younger patients, a heart rate of >100 beats/min and, in older patients, systolic blood pressure of >140 mm Hg were predictors of a more severe pain [7].

Based on the above findings, the aim of the present study was to evaluate whether there is a clinically meaningful association between the patients' estimated intensity of pain and vital parameters (heart rate, systolic blood pressure and respiratory rate) and vegetative symptoms (cold sweat and paleness).

2. Methods

2.1. Design

This was a retrospective, non-experimental, observational (register) study.

2.2. Study population

Patients were recruited from the following parts of western Sweden: Skaraborg, southern Älvsborg and northern Älvsborg. The area from which patients were recruited had 40 municipalities, an area of 21,688 km^2 and 852,000 inhabitants (2015) of which 49.7% were women. The area is a mixture of rural areas, small and large cities and is situated not far from the second largest city in Sweden. The population density in the municipalities varies between 6.6 and 155 inhabitants/km^2.

The mean population density in the whole area is 39.3 inhabitants/km^2. The mean age is 43.6 years (44.5 years for women and 42.7 years for men) [11].

2.3. Organisation

The EMS system within the catchment area takes care of around 100,000 patients a year. There is always at least one registered nurse on board each ambulance. The majority of them complete a one-year specialist course in prehospital emergency care for one year, following a three-year baseline course in medicine and health care.

Primary missions are dispatched according to three levels: 1) acute life threatening (50%), 2) acute but not life threatening (45%) and 3) other EMS missions.

Table 1
Final study cohort.

Categories	Study population	Study cohort	%
Chest discomfort	16,946	6008	35,5
Headache	2008	460	22,9
Fracture/damage	22,234	5269	23,7
Orthopaedics	8442	2351	27,8
Abdomen	15,242	5344	35,1
Gynaecology	1839	387	21,0
Other pain	465	89	19,1
Total	67,176	19,908	29,6

This table shows the selected diagnosis categories with the highest VAS mean value that became the final study cohort.

2.4. Patients

All EMS missions in the catchment area from 1 January 2013 to 28 February 2015 (n = 281,082) were exported from the EMS journal system in western Sweden (Ambu-Link). Missions without patient contact and cases which were not a primary patient evaluation (n = 116,705) were excluded. Since the vital parameters in children differ from those in adults, patients below the age of 18 years (n = 13,867) were also excluded. The study population thus consisted of 53% of the original population (n = 149,199).

Furthermore, all patients without an initial recording of the pain intensity with the visual analogue scale (value 0–10) were also excluded (n = 107,259). The remaining 41,940 patients were divided into 24 diagnosis groups. Among them, the seven with the highest mean pain intensity score were finally chosen as the study cohort for the present manuscript (n = 19,908) since the diagnosis groups of patients with pain according to visual analogue scale had a mean score above 5.80, which was the overall mean score for the total study group (Table 1). This was done in order to select the diagnosis groups where pain is a relatively frequent symptom. These seven groups included 77% (n = 47,605) of all patients with pain and 83% (n = 16,005) of all patients with pain who had the pain intensity reported.

2.5. Data reporting

The following variables were used in the analyses: respiratory rate, heart rate, systolic blood pressure, skin status (pale, moist), the patients' own estimated pain intensity, triage colour according to the Rapid Emergency Treatment and Triage System (RETTS), priority given to the patient (by the dispatch centre) and to the hospital (by the EMS clinician), the patients' gender and age.

The dispatch-initiated degree of urgency (time to further evaluation) in prehospital care includes four levels: 1) the highest level (acute life-threatening symptom or accident); 2) acute but not life threatening; 3) other EMS missions and 4) missions which do not require supervision and medical care.

The RETTS is a systematised instrument for triage in emergency care by the ambulance clinician. The instrument is used to estimate the risk of death or complications. It is specified in four different colours, each of which suggests a specific severity for need of emergency care. Red is the most urgent and indicates life threat and that urgent emergency care is required. Orange means potential life threat. Yellow means need for emergency medical care within a reasonable period of time. Green means need for care, but no requirement for emergency care.

The judgement in the RETTS is dependent on the vital parameters and the type of symptoms, both of which generate a colour.

The patients' own estimation of pain was registered on an 11-grade scale, where 0 meant no pain and 10 the most severe pain the patient could imagine. Most often the communication was mutual and, as a result, the scale should more correctly be named the Verbal Numerical Rating Scale (VNRS). However, visual scales have also been used.

2.6. Data processing

In a similar way as in previous studies of the association between pain and vital parameters, borderline values were constructed where values outside these borderlines were excluded as "not being reasonable" [7]. Values have therefore been accepted within the following ranges: heart rate (20–180 beats/min), systolic blood pressure (50–260 mm Hg), diastolic blood pressure (20–180 mm Hg) and respiratory rate (5–45 breaths/min).

In the analyses of age, the patients were divided into two groups, 18–64 years and above 65 years. The median age was 65 years and this is a natural divider, as it is the retirement age in Sweden. A similar division has been made by others [7,10].

The pain intensity according to the VAS and VNRS scale was divided up as follows 0 = no pain, 1–3 = mild pain, 4–7 = moderate pain and 8–10 = severe pain.

3. Statistical analysis

Descriptive statistics as the mean with standard deviations and/or the median with quartiles were presented for continuous variables. For categorical variables, frequencies and percentages were presented. To explore associations between vital parameters and the intensity of pain based on VAS and VNRS assessments that are regarded as ordinal data types, we used Spearman's correlations coefficient. To further explore associations between different vital parameters, such as explanatory factors and pain as an outcome variable, we performed a logistic regression analysis model; the pain scale was dichotomised into a binary variable with outcome no/mild pain or moderate/severe pain. To enable easier interpretation, vital parameters were also dichotomised and different cut-off values were tested when included in the multiple logistic regression models. A p value of <0.05 was considered statistically significant. All the data were analysed using SPSS version 22.0 (Inc., Chicago, IL).

4. Ethics

The present study has been approved by the head of the emergency medical service (EMS) system in Skaraborg, southern Älvsborg and northern Älvsborg. All the data have been treated confidentially according to the Helsinki Declaration's ethical guidelines. The present study was conducted as part of a master's degree and was assessed according to the university's ethical guidelines for master's theses (SFS 2003:460).

5. Results

Among 32.2% of patients with pain, a value on the intensity of pain was reported. The study cohort consists of patients above the age of 17 years from seven different diagnosis groups with a registered value on the intensity of pain. Among these patients, 80.4% had initially experienced pain (value > 0). Among the patients with pain, the mean score on the VNRS or VAS was 6.20 (95% CI 6.13–6.22) and the median score was 7.

In Table 2, data are compared between the original study population (n = 149,199), the study cohort (n = 19,908), all patients without pain (n = 64,513) and all patients with pain (n = 61,743). Compared with the original study population, the selected group for the study was younger, but it had a similar gender distribution. Compared with all patients with and without pain, the selected study cohort was younger, had a lower proportion of women than all patients with pain and a higher proportion of women than all patients without pain. With regard to the priority given by the EMS clinician, the study cohort had a similar proportion with an acute condition as compared with the total group with pain but a lower proportion compared with the total study population and the total group without pain. The proportion of patients who were transported to a hospital or corresponding unit in the study cohort was similar to the total group with pain but higher than

Table 2
Comparative data between study population, study cohort and between patients with and without pain.

		Study population [*1] (n = 149,199)		Study cohort [*2] (n = 19,908)		All patients without pain [*3] (n = 64,513) Valid 51.1%		All patients with pain [*3] (n = 61,743) Valid 48.9%	
Age	Mean (SD)	64,0 (21,6)		60,5 (21,3)		66,7 (20,7)		61,6 (22,0)	
	Median (IQR)	69 (34)		65 (34)		72 (29)		66 (36)	
		Valid %	N [*4]	Valid %	n [*5]	Valid %	n [*6]	Valid %	n [*6]
Gender									
	Female	51,5%	76,209	51,1%	10,131	49,1%	31,505	54,5%	33,373
Triage vital signs	Red	9,2%	12,158	4,2%	810	10,8%	6112	6,2%	3619
	Orange	17,1%	22,615	14,5%	2791	18,6%	10,550	15,3%	8951
	Yellow	24,2%	31,979	24,1%	4645	23,7%	13,430	24,9%	14,551
	Green	49,4%	65,227	57,2%	11,033	46,9%	26,623	53,7%	31,428
	Missing		17,220		629		7798		3194
Prio out	1–Acute life threatening	42,0%	62,598	42,6%	8485	43,0%	27,719	38,8%	23,955
	2–Acute but not life threatening	58,0%	86,601	57,4%	11,423	57,0%	36,794	61,2%	37,778
Missions	To the care unit	85,2%	127,066	93,4%	18,591	81,6%	52,628	93,1%	57,497
	Care at the scene	14,8%	22,133	6,6%	1317	18,4%	11,885	6,9%	4246
Prio in	1–Acute life threatening	14,4%	18,308	12,5%	2319	14,2%	7449	12,6%	7257
	2–Acute but not life threatening	66,7%	84,778	75,4%	14,021	65,9%	34,663	71,1%	40,867
	3–Other EMS missions	18,3%	23,209	11,8%	2203	19,3%	10,150	16,0%	9190
	4–Transport	0,3%	794	0,3%	48	0,7%	370	0,3%	190
	Missing		22,110		1317		11,881		4239

[*1] All primary assessed patients over the age of 17 in the study area during the study period (study population), [*2] Patients from selected assessment groups who have a registered VAS value (0–10). [*3] Missing 22,943 patients (15.4%) without registered pain assessment. Without registered gender missing; [*4]: 1113; [*5]: 101; [*6] 859.
Triage vital signs = triage colour on the vital parameters according to the Rapid Emergency Treatment and Triage System (RETTS). Prio out = priority given to the patient by the dispatch centre. Prio in = priority given to the hospital by the EMS clinician.
This tabel shows comparative descriptive statistics between the study population, study cohort and between patients with and without pain.

Table 3
Correlation matrix for association between initial pain score (value 0–10) and physiological parameters.

		RR	HR	SBP	Moist	Pale
Study cohort (n = 19,908)	r_s	0,198	0,037	−0,029	0,143	0,171
	p	<0,001	<0,001	<0,001	<0,001	<0,001
	n	18,446	19,758	19,484	18,595	18,595
Females (n = 10,131)	r_s	0,205	0,048	−0,076	0,119	0,151
	p	<0,001	<0,001	<0,001	<0,001	<0,001
	n	9394	10,055	9916	9459	9459
Males (n = 9676)	r_s	0,189	0,019	0,027	0,173	0,195
	p	<0,001	0,065	0,007	<0,001	<0,001
	n	8963	9603	9471	9042	9042
Age 18–64 (n = 9949)	r_s	0,258	0,019	−0,033	0,151	0,199
	p	<0,001	0,054	0,001	<0,001	<0,001
	n	9136	9858	9682	9277	9277
Age ≥ 65 (n = 9959)	r_s	0,153	0,020	0,075	0,119	0,154
	p	<0,001	0,047	<0,001	<0,001	<0,001
	n	9310	9900	9802	9318	9318

r_s = Spearman's rank correlation coefficients, p = significance value, n = number of primary assessed patients. RR = respiratory rate, HR = heart rate, SBT = systolic blood pressure.
This table shows Spearman's rank correlation coefficients (r_s) with two-sided significance level between initial pain score (0–10), respiratory rate, heart rate, systolic blood pressure and skin status (pale or moist), stratified by age and gender.

the original study population and the total group without pain. From now on, only the study cohort will be included in the analyses (n = 19,908).

5.1. Correlation (Table 3)

There was a positive correlation between the intensity of pain and respiratory rate and heart rate respectively. There was also a positive association between pain intensity and paleness and moist skin respectively. There was, on the other hand, a negative correlation between pain intensity and systolic blood pressure.

The differences between women and men were small, but the correlation with systolic blood pressure was negative for women, whereas it was positive for men.

With regard to age, the strongest correlation between pain intensity and respiratory rate was found among the younger patients. The correlation between pain and systolic blood pressure was negative for the younger group and positive for the elderly one. Age did not influence the correlation between pain and heart rate.

The correlation between pain and diastolic blood pressure and pulse pressure respectively did not add any further information.

5.2. Visual control (Table 4)

The mean value for respiratory rate and heart rate increased with increasing severity of pain (mild, moderate, severe). The same thing was found for pale and moist skin. However, for systolic blood pressure, the mean value increased from mild to moderate pain ($p = 0.034$), whereas it decreased from moderate to severe pain ($p < 0.0001$).

The differences between no and mild pain were generally minor and were not significant.

5.3. Logistic regression (Table 5)

The three vital parameters were all dichotomised by creating stepwise increasing borderline values. Binary logistic regression analyses were shown with the outcome variables of no/mild pain versus moderate/severe pain.

There was no significant odds ratio for heart rate in any of the models. Among the elderly, a significant odds ratio was found for systolic blood pressure, which decreased with increasing borderline values. The most marked odds ratio was found for respiratory rate, which was highest among younger patients. The difference between age groups increased with increasing borderline values. Significant odds ratios were also found for skin status, with higher values for the younger patients.

Association between increase in respiratory rate and increase in pain (Fig. 1).

In the figure is shown how the mean intensity of pain increases with increasing respiratory rate (the respiratory rate was increased with up to 5 breaths/min). When there were <15 breaths/min the mean pain score was 5.5. When the respiratory rate increased to 15–19 breaths/min the mean pain score increased to 5.8. The corresponding figure for 20–24 was 6.6, for 25–29 it was 7.4 and if the respiratory rate was more or equal to 30 breaths/min the mean pain score was 7.8.

5.4. Types of pain that gave the highest respiratory rate (Table 6)

As shown in the table was abdominal pain and gynaecological pain associated with the highest respiratory rate.

5.5. Missing data and its consequences (supplemental Tables 1 and 2)

The proportion of patients with missing information were for respiratory rate 7.3%, for pale and moist skin 6.6%, for systolic blood pressure 2.1% and for heart rate 0.8%.

In supplemental Table 1 is the total study cohort compared with patients without information on respiratory rate. The patients who had missing information were younger, had a more intensive pain and more often an acute condition according to the triage colour and according to the prioritisation made by the EMS clinician. The distribution of sex was similar in the two groups.

In supplemental Table 2 are patients with information on VAS compared with patients without information on VAS. The patients who had missing information on VAS were older, included more women and they had a lower proportion of patients with an acute condition according to the triage colour and according to the prioritisation made by the EMS clinician.

6. Discussion

The main message from this study is that the most marked association between the intensity of pain and different physiological parameters was found for respiratory rate. Furthermore, this association was strongest among younger patients.

Table 4
Comparative data between physiological parameters stratified by pain categories in study cohort.

	Pain	N	Valid %	$\bar{x}$	Md	sd	$q_1 - q_3$
RR	VAS 0–10	18,446	92,7%	18,6	18	4,3	16–20
	None	3636	93,2%	17,9	17	3,7	16–20
	Mild	2984	93,2%	17,4	17	3,5	15–20
	Moderate	6264	93,5%	18,5	18	4,3	16–20
	Severe	5562	91,2%	19,8	20	4,9	16–22
HR	VAS 0–10	19,758	99,2%	83,4	81	17,3	71–94
	None	3880	99,4%	82,9	80	16,7	71–93
	Mild	3192	99,7%	82,2	80	16,5	70–91
	Moderate	6662	99,4%	83,2	81	17,5	71–94
	Severe	6024	98,7%	84,1	82	17,3	72–95
SBP	VAS 0–10	19,487	97,9%	147,2	145	25,7	130–165
	None	3799	97,3%	146,8	145	25,4	130–164
	Mild	3153	98,5%	148,0	145	25,2	130–165
	Moderate	6621	98,8%	149,4	148	25,6	130–166
	Severe	5911	96,9%	145,8	142	25,3	129–160
	Pain	**N**	**Valid %**	**Yes**	**%**	**No**	**%**
Pale	VAS 0–10	18,595	93,4%				
	None	3595	92,1%	529	14,7%	3066	85,3%
	Mild	2983	93,2%	430	14,4%	2553	85,6%
	Moderate	6302	94,0%	1482	23,5%	4820	76,5%
	Severe	5715	93,7%	1802	31,5%	3913	68,5%
Moist	VAS 0–10	18,595	93,4%				
	None	3595	92,1%	82	2,3%	3513	97,7%
	Mild	2983	93,2%	65	2,2%	2918	97,8%
	Moderate	6302	94,0%	378	6,0%	5924	94,0%
	Severe	5715	93,7%	569	10,0%	5146	90,0%

The initial pain score (0–10) was categorised into none (0), mild (1–3), moderate (4–7) and severe (8–10). Valid % calculated on total number of primary assessed patients within the study cohort (VAS 0–10) and pain categories: VAS 0–10 = 19,908; none = 3903; mild = 3201; moderate = 6702; severe = 6102. $\bar{x}$ = arithmetic mean, Md = median, sd = standard deviation, q = quartile.
This table shows the change in numerals, mean, median, standard deviation and quartile with the physiological parameters of respiratory rate (RR), heart rate (HR), systolic blood pressure (SBP) and skin status (pale or moist), stratified by pain categories of none, mild, moderate and severe pain.

The study cohort represents a wide variety of conditions which are associated with pain in different settings and situations. The results can probably be generalised to other prehospital organisations with similar populations. The median age was 65 years which is in agreement with previous experiences that patients who call for EMS is a relatively old group of patients [12].

The study population was recruited from areas outside the largest cities, including rural areas, small and large cities and the areas close to the largest cities. Within the catchment areas, 14% were born outside Sweden, as compared with 18% for the total country. Previous studies have revealed cultural differences with regard to experiences of pain [13]. Since the proportion of people

Table 5
Results of binary logistic regression between physiological parameters in three different models and pain categories with the outcome of none-mild vs moderate-severe pain, stratified by age.

Age	OR (95% CI)				
	Model - A				
	RR ≤20/>20	HR ≤80/>80	SBP ≤120/>120	Skin: Pale	Skin: Moist
18–64	2,78[a] (2,39–3,24)	0,99 (0,90–1,10)	1,04 (0,92–1,18)	2,33[a] (2,01–2,69)	3,38[a] (2,47–4,63)
≥65	1,63[a] (1,46–1,83)	1,07 (0,98–1,17)	1,56[a] (1,36–1,79)	1,78[a] (1,59–1,99)	2,38[a] (1,85–3,06)
	Model - B				
	RR ≤25/>25	HR ≤100/>100	SBP ≤140/>140	Skin Pale	Moist
18–64	3,58[a] (2,57–5,00)	0,99 (0,87–1,14)	1,07 (0,97–1,18)	2,40[a] (2,08–2,77)	3,53[a] (2,58–4,83)
≥65	1,69[a] (1,39–2,07)	1,07 (0,93–1,22)	1,41[a] (1,29–1,55)	1,81[a] (1,62–2,02)	2,39[a] (1,86–3,07)
	Model - C				
	RR ≤30/>30	HR ≤120/>120	SBP ≤160/>160	Skin Pale	Moist
18–64	4,87[a] (2,25–10,56)	1,09 (0,78–1,52)	1,06 (0,93–1,21)	2,48[a] (2,15–2,87)	3,73[a] (2,73–5,10)
≥65	1,88[a] (1,28–2,76)	1,32 (0,98–1,76)	1,37[a] (1,25–1,50)	1,82[a] (1,63–2,03)	2,39[a] (1,86–3,07)

[a] Significant < 0.05. OR, odds ratio. 95% CI, confidence interval with 95% confidence level.

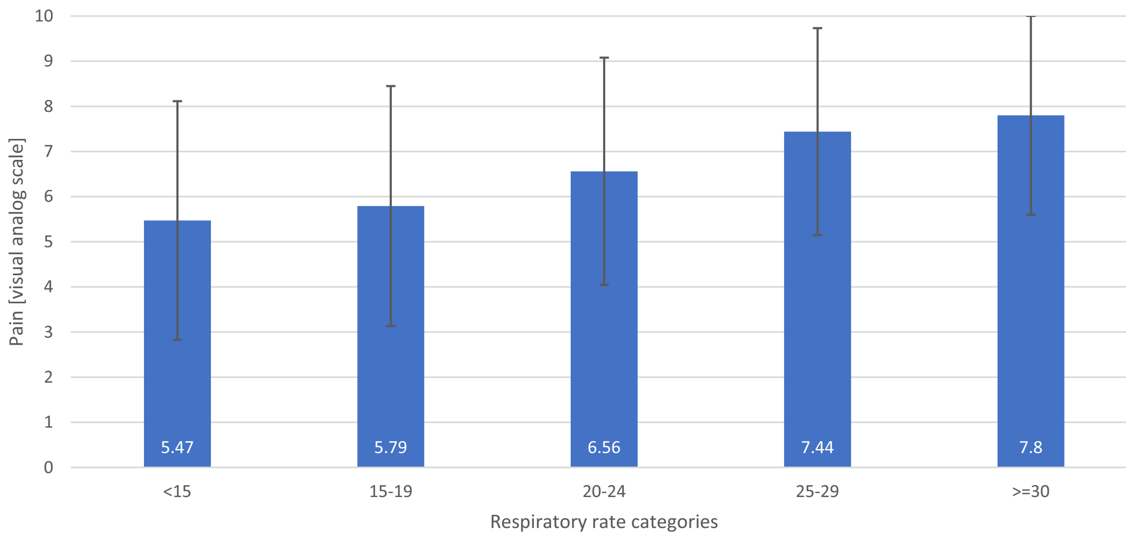

Fig. 1. Relationship between pain and respiratory rate.

born outside Sweden was four percentage points below the overall figures for Sweden, some caution is recommended when it comes to generalising the results to the whole country.

In the analyses of correlation, the respiratory rate showed the strongest association (r = 0.20) between the level of physiological parameters and the experienced intensity of pain at the first assessment by the EMS clinician. This is in agreement with a previous observation [7].

Even skin status, pale skin (r = 0.17) and moist skin (r = 0.14), showed a correlation that was almost as strong. This has not previously been studied in the prehospital setting. For heart rate, the association was very weak (r = 0.04), which is in agreement with previous findings [9,13]. For systolic blood pressure, there was a negative association (r = −0.03) indicating lower blood pressure with increasing pain. This information has not been published before.

The results from binary logistic regression with all parameters as binary showed that increasing respiratory rate is an important predictor of severe pain. This result is in agreement with previous findings. Even the finding that the likelihood of severe pain is higher among younger patients with a high respiratory rate as compared with the elderly is in agreement with previous findings [7]. The difference between age groups might be explained by age-related physiological changes among the elderly, with decreasing mobility in the muscles of the respiratory organs and a decreasing sensibility to stress hormones [14]. A high respiratory rate has been shown to identify critically ill patients who require active treatment and intensive care within 24 h [15]. It appears that the respiratory rate is a more sensitive marker than heart rate and systolic blood pressure when it comes to identifying critically ill patients [14]. This should be related to the observation that the respiratory rate was the least frequent vital parameter to be recorded in study population (82%). A lack of electronic measurement and difficulty measuring without the patients' knowledge are obstacles to the measurement of the respiratory rate. There are also difficulties involved in evaluating the results, since the respiratory rate is the vital parameter which is most influenced by psychological factors, in addition to the physiological factors.

The results for skin status also indicate a clear association between both pale and moist skin and more severe pain. Here, too, the odds ratio was higher for the younger patients. The likelihood of experiencing pain when the skin was pale or moist was similar, regardless of the values of the vital parameters.

For systolic blood pressure, there was a weak tendency among the elderly, indicating decreasing blood pressure with increasing pain. This information has not previously been reported in the clinical situation. However, experimental research has demonstrated a similar association [16-18]. The association might be explained by a limited capacity for the cardiovascular system in the elderly to react rapidly and normally to stress [14]. Others have reported a positive association between pain and systolic blood pressure among the elderly in the clinical situation [7].

It is obvious that small changes in the intensity of pain are difficult to follow with support from physiological changes. In the present study, a breakpoint was created between 0 and 3 (no/mild pain) and 4–10 (moderate to severe pain). It could now be demonstrated that an increased respiratory rate, as well as pale and moist skin, increased the likelihood of moderate to severe pain.

The EMS clinicians are more convinced about the patients' need for pain relief if there are physiological changes as well [19].

Individual differences may be explained by physiological pain-modulating activities and by psychological, cognitive, cultural, sociological, emotional and existential perspectives. The time period from the onset of pain until the EMS clinician's observation of physiological changes can also be of importance. The great variety in prehospital emergency situations can explain the individual variability in the results and it can also create difficulties when it comes to generalising the association between experienced pain and different physiological parameters.

7. Strengths and limitations

The major strength of the study is that data are collected from a very large sample size in the prehospital setting and that the assessment was made on arrival of EMS to the scene before any medication was given.

In the present study, only 32% of the patients with pain had a recorded estimate of the intensity of the pain. This is a limitation which highlights the need for more user friendly instruments in the evaluation of pain than VAS. Cognitive impairment and difficulties in understanding the Swedish language are major contributors to the limited use of VAS when trying to estimate the severity of the pain.

Data were collected from routine prehospital care and all the observations were made by a large number of EMS clinicians. There is a risk of variability with regard to their carefulness and skilfulness. A number of factors may influence the association between the estimated intensity of pain and different vital parameters such as fear, previous experiences of pain and knowledge about the mechanisms behind the pain. Even the type of physical condition may influence the association. Previous studies have not shown that factors such as ongoing medication with beta blockers or the use of a pacemaker influence the association between pain and the vital parameters [20].

However, it is important to stress that the aim of this study was to assess the observed association between pain and vital parameters and not the true biologic association. To a large extent, the observation of skin status is a subjective assessment which can be influenced by skin colour and the clinical condition. This study did not consider the patients' previous experiences of health care, nor did it consider the patients' psychological well-being. According to the guidelines in the catchment area, the first blood pressure should be recorded manually. There are no instructions on how to measure heart rate or respiratory rate.

The use of the VAS to measure pain is a validated method. The most common method for pain assessment is the VNRS, which has been validated in prehospital emergency care [21]. Thus, a strong correlation has been demonstrated between VNRS and VAS at the scene (r = 0865). It has been shown that VNRS is more easy to use from a patient perspective [22]. It has been argued that a simple correlation is a limited method to explain an association between vital parameters and pain, where each vital parameter is separately compared with pain [7]. However, other vital parameters may influence the results at the same time. In order to approach this dilemma in a satisfactory manner, the use of multiple regression has been advocated. Binary logistic regression was therefor used in this study.

The categorization of patients intensity of pain into mild, moderate and severe pain may be argued. Thus, previous experiences suggest that a change in more than a unit according to VAS is required to become clinically meaningful [23,24]. However, these cut off points have been used in previous studies [3,5,7].

One concern may be that we are mixing visceral and non visceral pain categories. We have estimated that about 60% of the patients suffered from visceral pain. Furthermore, some of the patients may have suffered from pain which has been persistent for a very long time although being severe enough to call for EMS. Such pain may differ from pain with a more recent onset.

With regard to missing information 7% had a lack of information on the respiratory rate. The fact that these patients were younger, had more pain and more often an acute condition may be explained by the acute condition that did not allow the EMS clinician to count the breaths.

8. Conclusion

Pain is a common symptom in prehospital emergency care. In only 32% of the patients was the estimated intensity of pain recorded. There is an association between respiratory rate and the experience of pain. There is also an association between pale skin and moist skin and the experience of pain. The association was stronger among the younger patients (below 65 years) than among the elderly (above 65 years).

Results shown with a reference value (breakpoint) for the vital parameters create a general clinical knowledge which can be a support in the individual evaluation of pain.

The results indicate that there is large variability between the patients' experiences of pain and the level of physiological parameters as a rough reflection of the physiologic reaction to pain. These physiological parameters as a reflection of the reaction to pain should therefore be interpreted with caution. Using physiological parameters to exclude the presence of pain is not recommended. On the other hand, an increase in respiratory rate and the presence of pale and moist skin should support the suspicion of severe pain.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ajem.2019.01.032.

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Further Reading

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