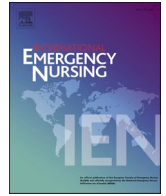


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## The relationship between acute pain and other types of suffering in pre-hospital trauma victims: An observational study

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## ABSTRACT

**Background:** Acute pain is an important complaint reported by trauma victims, however, the relationship between it and other types of discomfort, such as discomfort caused by cold, discomfort caused by immobilization, and psychological distress such as fear, anxiety, and sadness is limitedly studied and documented.

**Aim:** To assess the relationship between acute trauma pain and other types of suffering in pre-hospital trauma victims.

**Methods:** This is a prospective multicentre cohort study conducted in Immediate Life Support Ambulances in Portugal. All adult trauma victims with a mechanism of blunt and penetrating injuries, falls, road accidents and explosions, were included.

**Results:** 605 trauma victims were included, mainly male, with a mean age of 53.4 years. Before the intervention of the rescue teams, 90.5 % of the victims reported some level of pain, 39.0 % reported discomfort caused by cold, while 15.7 % felt fear, 8.4 % sadness, 49.8 % anxiety and 4.5 % apathy. Victims with high discomfort caused by cold tend to have higher pain levels. Significantly higher pain intensity were observed in victims with fear and anxiety. Univariate and multivariate analysis indicates that immobilization is associated with increased pain levels.

**Conclusions:** There is a statistically significant relationship between acute trauma pain, anxiety, fear, cold and immobilization.

### 1. Background

Pain is a subjective, complex, and multidimensional concept, defined as an unpleasant sensory experience associated with actual or potential

tissue damage [1]. Acute trauma pain is a major complaint experienced by trauma patients and is reported by up to 70 % of patients in pre-hospital settings and 91 % in emergency departments [2]. Approximately 50 % of trauma victims report a pain intensity greater than or

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equal to 7/10 (high pain intensity) [3,4]. In addition to pain, trauma victims may experience suffering from other causes, such as discomfort caused by cold [5], discomfort caused by immobilization [6], and psychological distress such as fear [7], anxiety [8], and sadness [9].

Hypothermia is common in trauma victims and, in addition to being a major risk factor for increased mortality, it is also a clinical condition that has a significant influence on the comfort of these patients [10]. The comfort of the trauma victim is also influenced by the whole event preceding the accident or any other traumatic event and is manifested by different types of psychological distress [11].

It has been pointed out that the discomfort caused by immobilization may have a major impact on pain management and overall quality of care [12]. Immobilization is an intervention aimed at reducing the movements of the victim, ensuring the alignment of the anatomical structures with the structures suspected of injury, thus minimizing the risk of injuries secondary to the primary trauma mechanism [13]. Immobilization of fractured bones is also necessary to reduce pain and the possibility of further injury, as movement of the sharp edges of the fractured bone can injure blood vessels, causing bleeding [14]. Nevertheless, it also contributes to the incidence of some level of discomfort [15].

Pre-hospital medical teams rescue injured people and perform a wide range of life-saving interventions while ensuring patient comfort. Pre-hospital care focuses on the critically ill patient, without neglecting pain control and the promotion of comfort [16].

The link between acute pain and other types of suffering resulting from traumatic events is bidirectional, and both act as risk factors and/or enhancers for each other and these types of suffering are associated with an increased perception of the severity of pain [17].

We propose that if pain and the other discomforts are related, treating each of them in isolation may not be enough to reduce the overall suffering of trauma victims rescued in the pre-hospital setting. Thus, to treat all types of suffering, including pain, it is necessary to understand how they relate to each other.

The aim of this study is to assess the relationship between acute traumatic pain and other types of suffering in pre-hospital trauma victims.

## 2. Methods

This study was conducted in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines [18].

### 2.1. Study designs, setting, and procedures

This is a prospective multicenter Portuguese cohort study conducted in Immediate Life Support Ambulances (ASIV) in mainland Portugal and the Azores from 1 March 2019 to 30 April 2020. Structured observation questionnaires were provided to 172 Registered Nurses (RN) who act as team leaders at ASIV and who have agreed to participate in the study and have regular clinical practice with assessment, treatment, and management of trauma patients in pre-hospital setting. The ASIV nurses recorded the entire clinical evolution of the victim, from the first assessment at the accident site, during transport and at the host hospital. All these data were recorded in the data collection tool. Prior to the start of the data collection period and to ensure data consistency, the principal investigator conducted specific training for registered nurses to complete the questionnaire.

### 2.2. Participants and data collection

During the 14 months of data collection, all trauma victims, aged over 17 years, with a mechanism of injury from blunt and penetrating injuries, falls, road traffic accidents and explosions, rescued by ASIV were included. Patients under the influence of alcohol or other

psychoactive substances or with altered state of consciousness were not eligible for the study. A data collection tool was specifically designed for this study. Prior to its application and to ensure data consistency, the principal investigator conducted specific training for registered nurses to complete the questionnaire on the level of pain, the level of discomfort caused by cold, the presence of other types of suffering and whether immobilization of any anatomical structure was performed. This training was important to obtain data normalization and reduce the risk of bias. The nurses included in the study were not involved in data management and analysis.

### 2.3. Variables

The studied variables were as follows: patients' age and gender, level of pain, level of discomfort caused by the cold, and other types of psychological distress such as anxiety, fear, sadness, and apathy, in pre-hospital trauma victims. To assess acute trauma pain, we used an 10-point Numerical Rating Scale (NRS), a valid and reliable one-dimensional assessment method [19]. Pain was stratified into 3 classes on a 0–10 pain scale: mild pain, described as a severity of less than 4; moderate pain, described as a severity between 4 and 6; and severe pain, described as a severity of more than 6. The level of discomfort caused by the cold was assessed using the Cold Discomfort Scale (CDS), which is a scale from 0 to 10, where 0 means not feeling cold in any way and 10 means feeling unbearably cold [20]. Cold refers to body temperature and the CDS was stratified into 3 classes: mild cold discomfort, described as a severity of less than 4 on a scale of 0–10; moderate cold discomfort, described as a severity between 4 and 6; and severe cold discomfort, described as a severity of more than 6.

The other types of psychological distress were monitored for their presence or absence and no quantitative scale was applied. For this study we considered transient fear or anxiety that emerge around periods of life stressors [21]. Fear happens as a result of perceived imminent threat whereas anxiety is a state of anticipation about perceived future threats [22]. Sadness is a basic human emotion triggered in response to negative life events and stems from negative emotions [23]. Sadness is classically illustrated by raised inner eyebrows, lowered corners of the mouth, and slumped posture [24]. Emotional apathy refers to a reduction in empathy, spontaneous emotion, emotional responsiveness, or emotional intensity [25]. The present study assessed the intensity of pain and discomfort caused by cold and all other types of discomfort through patients' self-reported discomfort. Assessments were made at three moments: before (T1), during (T2) and after (T3) nurses' interventions. The RNs get information about the pain and discomfort caused by the cold through the verbal response of the victims, while for the variables of psychological distress in addition to the verbal manifestation, the signs that define them were considered.

Another study variable was the presence of immobilization. Since there is no scale to monitor the discomfort of this intervention, for this study only whether this intervention was or was not performed was considered. Trauma severity was assessed with the Mechanism, GCS, and Age and Arterial Pressure (MGAP) score. MGAP incorporates the Glasgow Coma Scale, systolic blood pressure, age, and injury mechanism, ranging from 3 to 29 [26].

### 2.4. Data analysis

Numerical variables are described with means, medians and inter-quartile ranges. Categorical variables are described with absolute frequencies and percentages. A scatter plot is used to illustrate the relationship between pain levels and cold discomfort. Scatter plots are commonly used to illustrate the relationship between two numeric variables, as each point represents the values of the two variables under study for a sampling unit, with the abscissa being the value of one of the variables and the ordinate being the value of the other variable. However, scatter plots of discrete data naturally have many overlapping

points, which obscure each other. In these situations, a possible approach is to randomly jitter the points, which was done in the scatter plot of pain (Y-axis) versus cold discomfort (X-axis) [27].

Significant differences between groups in pain level were assessed by the Mann-Whitney test, and Spearman’s correlation coefficient was used to evaluate the association between pain and cold reported levels.

Linear mixed-effects models for longitudinal data were considered to study the relationship between pain and other types of discomfort and psychological distress. The three repeated measurements on each patient are used to model pain as a function of the other distress/discomfort variables with a random intercept that is allowed to vary over individuals and reflects the natural heterogeneity among patients. Moment T1 (before nurses’ interventions) is taken as the reference time instant. MGAP was included in the model to control for injury severity. Thus, the effect of other suffering variables can be evaluated as if the patients were at the same level of severity. The non-significant variables were removed from the model. IBM SPSS Statistics (Version 28) and R software were used to undertake the statistical analysis. The R package “nlme” was used to estimate the linear mixed-effects models. A 2-sided  $p < 0.05$  was considered statistically significant.

2.5. Ethical considerations

The study was approved by the National Institute of Medical Emergency of Portugal and the Azores Regional Civil Protection and Fire Service. This study is part of the project “Evidências para Não Arriscar MaisVidas: do pré-hospitalar ao serviço de urgência e a alta (MaisVidas),” with reference PROJ/UniCISE/2017/0001 and obtained favorable ethical approvals from the Tondela Viseu Hospital Centre Ethics Committees. The questionnaire contained information about the research, how to contact the researchers for questions, and the voluntary nature of the respondents’ participation. Due to the study design, the Ethics Committee has waived the requirement for informed consent from patients. The data collection procedures align with applicable Portuguese relevant laws and regulations, as well as the ethical guidelines of the institution. The research demonstrates respect for privacy and data security. Only the principal investigator had access to the data who promptly encoded them using a unique code.

3. Results

The number of victims involved in this study was 605, mainly male (66 %) and aged between 18 and 96 years old, with an average age of 53.4 years. A summary of the sample being examined for the relevant variables can be found in Table 1. The most frequent mechanisms of injury were road traffic accidents (40.7 %) and falls (37 %). Most patients had blunt trauma only (79.3 %), 15.7 % had penetrating trauma only, and 5 % both (Table 1). The median value of the MGAP score was 25 with an interquartile range of 23 to 29. In the first assessment performed by nurses, the mean value of acute trauma pain was 5.6, with 90.5 % of victims reporting some level of pain and 47.1 % of victims a high level of pain (>6). In addition, 39 % of the victims reported cold discomfort, while 15.7 % showed signs of fear, 8.4 % of sadness, 49.8 % of anxiety and 4.5 % of apathy (Table 1).

Fig. 1 shows the relationship between acute pain and discomfort caused by cold at moment T1. The almost total absence of points in the lower right quadrant of Fig. 1 indicates a low prevalence of cases with low acute pain (<4) and at the same time high discomfort caused by cold (>6). In fact, according to Spearman’s correlation coefficient, there is a significant positive association between cold discomfort and pain (Spearman rho = 0.224,  $p < 0.001$ , 95 %, IC: 0.136–0.308), which means that patients reporting higher levels of cold discomfort also tend to report higher levels of pain.

Significantly higher levels of pain were observed in patients reporting fear as compared with those who did not (median pain level of 8 vs 6,  $p < 0.001$ ), and in patients reporting anxiety (median pain level of 7 vs

Table 1  
Victims’ characteristics.

Age, years (mean; median IQR)	53.4	54 (37–69)
MGAP score (mean; median IQR)	25.1	25 (23–29)
Pain (before the intervention of the rescue teams)		
(mean; median IQR)	5.6	6 (3–8)
Mild pain (n, %)	109	18.9 %
Moderate pain (n, %)	141	24.4 %
Severe pain (n, %)	272	47.1 %
Cold Discomfort Scale (CDS) - before the intervention of the rescue teams		
(mean; median IQR)	1,7	0 (0–3)
Mild cold discomfort (n, %)	86	16.9 %
Moderate cold discomfort (n, %)	72	14.2 %
Severe cold discomfort (n, %)	40	7.9 %
Gender, male (n, %)	401	66.3 %
Mechanism of injury		
Aggression (n, %)	25	4.1 %
Fall (n, %)	224	37.0 %
Road traffic accidents (n,%)	246	40.7 %
Tramplng (n, %)	44	7.3 %
Other (n, %)	66	10.9 %
Type of trauma		
Blunt (only) (n, %)	480	79.3 %
Blunt and penetrating (n, %)	30	5.0 %
Penetrating (only) (n, %)	95	15.7 %
Psychological distress - before the intervention of the rescue teams		
Presence of fear (n, %)	95	15.7 %
Presence of anxiety (n, %)	301	49.8 %
Presence of sadness (n, %)	51	8.4 %
Presence of apathy (n, %)	27	4.5 %
Immobilization (n, %)	474	78.3 %

IQR – interquartile range.

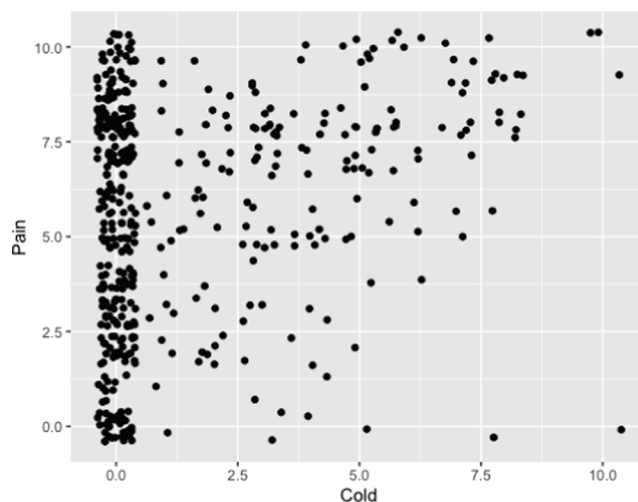


Fig. 1. Scatter plot illustrating the relationship between the numerical rating scale of acute pain and the cold discomfort scale assessed before the nurses’ intervention.

5,  $p < 0.001$ , respectively). When comparing the groups of patients with presence versus absence of other psychological distress, neither sadness nor apathy exhibited significant differences in pain levels (Table 2).

**Table 2**

The relationship between different types of psychological distress and pain (before the intervention of the rescue teams).

			Pain	
			Median (IQR)	p-value*
Fear	absence	475	6 (3–8)	<0.001
	presence	95	8 (5–9)	
anxiety	absence	269	5 (3–8)	<0.001
	presence	301	7 (4–8)	
apathy	absence	543	6 (3–8)	0.076
	presence	27	5 (1–8)	
sadness	absence	519	6 (3–8)	0.340
	presence	51	7.5 (3–8)	

\* Mann Whitney test.

Accordingly, considering three groups of patients defined by the level of pain intensity (mild, moderate and severe), Fig. 2 shows an increase in the percentage of cases reporting fear (7.8 %, 14.8 % and 24.2 %, for mild, moderate and severe pain, respectively) and anxiety (46.6 %, 54.1 % and 58.1 %, for mild, moderate and severe pain, respectively) and also an increase in the percentage of patients reporting severe cold discomfort (1.1 %, 2.6 %, and 11.2 %, for mild, moderate and severe pain, respectively). Hence, patients with anxiety, fear or severe cold discomfort are more likely to report higher levels of pain.

The number of victims immobilized was 474. For the three evaluation moments, pain levels were compared between the immobilized and non-immobilized groups of patients. Univariable analysis indicates that immobilization is associated with significantly higher pain levels reported at T2 and T3 (Table 3).

The parameter estimates of the linear mixed-effects model are presented in Table 4. The significant negative coefficients of T2 and T3 (−1.23,  $p < 0.0001$ ; −2.259,  $p < 0.0001$ ) reveal that there is a significant reduction in pain from T1 to T2 and T3. When adjusted for the severity of the injury (MGAP), the model supports the evidence given in the univariable statistical analysis that higher intensity of cold discomfort is associated with higher levels of pain (0.259,  $p < 0.0001$ ). In addition, the presence of emotional distress such as fear and anxiety is also associated with higher levels of pain (0.800,  $p < 0.0001$ ; 0.651,  $p < 0.0001$ ). Conversely, apathy is associated with lower levels of pain (−1.125,  $p = 0.0003$ ). Immobilization is also identified as being

**Table 3**

The intensity of pain between the immobilized group and the non-immobilized group at the three moments of assessment.

	Not Immobilized (n = 131)		Immobilized (n = 474)		p-value*
	Mean	Median (IQR)	Mean	Median (IQR)	
Level of pain Moment T1	5.1	5.0 (2–8)	5.7	6.0 (3–8)	0.089
Level of pain Moment T2	3.5	3.0 (2–5)	4.3	4.0 (3–6)	0.002
Level of pain Moment T3	2.8	3.0 (1–4)	3.2	3.0 (2–4)	0.027

\* Mann Whitney test, IQR – interquartile range.

**Table 4**

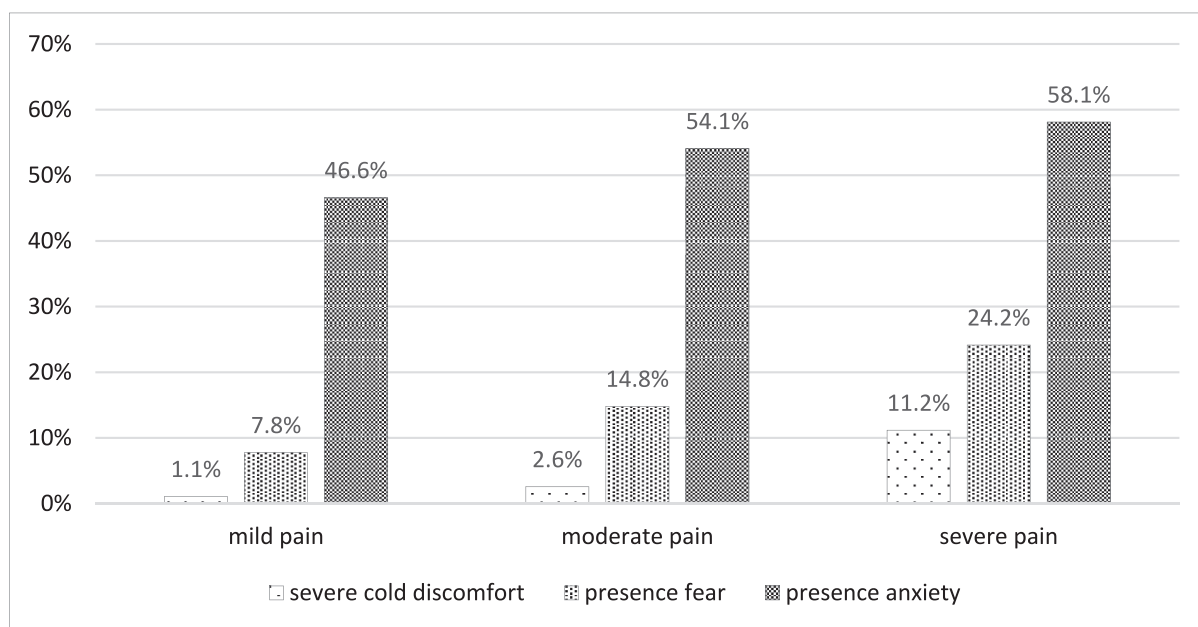
Linear mixed-effects regression model (with random intercept) to assess factors related to pain level.

	CoefficientEstimate (SE)	P-value
<b>Cold Discomfort</b>	0.259 (0.032)	<0.0001
<b>Fear</b>	0.800 (0.195)	<0.0001
<b>Anxiety</b>	0.651 (0.130)	<0.0001
<b>Apathy</b>	−1.125 (0.307)	0.0003
<b>Immobilization</b>	0.487 (0.246)	0.0481
<b>MGAP</b>	0.064 (0.033)	0.0486
<b>T2</b>	−1.230 (0.091)	<0.0001
<b>T3</b>	−2.259 (0.091)	<0.0001

positively associated with pain (0.487,  $p = 0.0481$ ). Age and gender were removed from the final model because they were not significantly associated with pain.

**4. Discussion**

To our knowledge, no previous study that has focused on the pre-hospital rescue of trauma victims has assessed the relationship between different types of suffering. We believe that knowing the relationship that exists between acute trauma pain and other types of



**Fig. 2.** The relationship between the discomfort caused by the cold, anxiety and fear and the three levels of pain.

discomfort, such as fear, anxiety, cold, and immobilization, will help to increase the ability of health professionals to improve the quality of pre-hospital care.

Our results showed that trauma victims who show signs of fear, or anxiety, or discomfort caused by cold also have higher levels of pain. These results were obtained both in univariate analysis and regression models.

Knowledge deficits are reported in the approach to acute pain in trauma, which results from little attention paid to pain assessment and management during initial training and lack of continuing education [28]. The pre-hospital environment is limited in resource availability and pre-hospital providers assess and treat patients based on presumptive outcomes as there are few diagnostic modalities available [29]. Added to this reality is the lack of strategies to assess and manage other types of suffering. The assessment of acute trauma pain remains the sole focus of attention for rescuers' attention and our findings show the importance of extending the assessment to other sources of discomfort such as fear, anxiety, sadness, and the effects of immobilization on the overall comfort of victims. Some authors point to the influence that these types of discomfort have on the victims' perception of pain [17], and in this sense, pain management should not exclude the management of the other types of discomfort. Some studies assess the discomfort caused by cold [5,30], but do not address the relationship it has with acute pain in trauma. Our research showed that victims with moderate or high discomfort caused by cold also tended to have higher pain levels, and rarely low pain levels. The same goes for fear and anxiety. Trauma events are triggered by critical, unexpected, sudden and overwhelming events, whereby the victim is left in a position of no control over the event, and with a perception of life-threatening danger to him/herself or another person [31]. The discomfort resulting from this phenomenon cannot be treated as if it were only pain, so the global management of comfort must contemplate equally relevant and common variables of unpredictable events of trauma. Our research showed that 49.8 % of the trauma victims showed signs of anxiety, 15.7 % signs of fear, and almost 39 % discomfort caused by the cold. It seems clear that in the same way that acute pain is a very frequent phenomenon in trauma victims, other nosologically etiologies are equally frequent and equally harmful, and therefore should not be ignored. Despite this, their relationship with pain, apart from existing, is not taken into account by rescue teams.

Injuries that result in instability require immobilization to reduce the likelihood of further damage and thus protect the tissues [32]. Despite these benefits, the discomfort inherent to this procedure has been pointed out in several studies [33–35]. Our data show that 78.3 % (n = 474) of trauma victims were immobilized and immobilization was associated with higher pain levels. There is clearly a relationship between pain and immobilization, however, it is not clear whether what patients report is only pain, or whether this discomfort caused by immobilization increases the perception of pain. Thus, it is possible that in order to treat the pain that the victim reports, it is necessary to improve the management of the discomfort caused by the immobilization and not just the focus of the trauma causing the pain.

Studies continue to report acute pre-hospital pain as a frequent but often poorly managed symptom [36,37]. Our results show a statistically significant relationship between pain and other types of discomfort, such as fear, anxiety, cold and immobilization, and in this sense, it is crucial to identify strategies to reduce all the sources that create discomfort. Thus, we believe that to improve effectiveness in the treatment of acute trauma pain it is necessary to identify other causes of discomfort and then define strategies and interventions to reduce them.

## 5. Strengths and limitations

The relationship between acute pain in trauma victims and other variables that also cause discomfort remains a topic little explored by the academic and clinical community and the present study, in addition to re-exploring this topic, introduces new relevant data, namely the

relationship that immobilization has with the evolution of acute pain itself. These findings will allow the approach to the trauma victim not to be limited only to pain, but also to other variables and, in this sense, we believe, it will be possible not only to reduce the sensation of pain, but also to increase the victims' overall comfort.

Although this study presents some important results, some limitations should be pointed out. First, the results do not allow the identification of cause-and-effect relationships and should therefore be read with inherent caution. Second, monitoring the variables fear, anxiety, sadness and apathy still has a lot of subjectivity associated with it, so even with the training developed with the nurses who collected the data, it is not possible to reduce all inherent biases.

## 6. Conclusions

The management of acute traumatic pain remains a huge challenge for pre-hospital rescue teams. Understanding the relationship it has with other variables that may, on the one hand, increase pain perception and, on the other hand, worsen victims' overall comfort is therefore a priority. Our study demonstrated that there is a statistically significant relationship between acute trauma pain and anxiety, fear, cold and immobilization. Thus, to improve the effectiveness of pain management, it is necessary to consider other types of discomforts that also cause suffering.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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