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Analysis of the effectiveness of pain relief for wounded with combat surgical trauma of the extremities during medical evacuation to early care facilities

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Abstracts

Objective. To analyze the effectiveness of pain relief for wounded with combat surgical trauma of the extremities during medical evacuation to early medical care facilities.

Materials and Methods. We analyzed the effectiveness of pain relief for 100 wounded with combat surgical limb trauma at the beginning of interhospital transportation and at the end of it.

Results. An increase in the level of pain in the dynamics with a statistically significant ($p < 0.05$) difference between their values at the beginning of medical evacuation and at the end of it was revealed**.**

Conclusions. Regardless of the type of surgery performed and the type of anesthetic support, the dynamics of pain levels during interhospital transportation of wounded was negative. Thus, optimization of pain relief for the wounded during medical evacuation is extremely important.

Key words: combat surgical trauma; gunshot wounds of the extremities; anesthesia.

Medical evacuation is an important element of the staged treatment system that is inextricably linked to the provision of medical care to the wounded [1]. Thanks to medical evacuation in combat conditions, such basic principles of medical care as timeliness and sequence of medical care for the wounded are realized [2].

Effective analgesia during medical evacuation is considered one of the most urgent tasks to improve the condition of wounded with combat surgical trauma [3]. However, the issue of high–quality analgesia for wounded with combat surgical trauma during medical evacuation remains to be fully resolved. This is especially true for analgesia during the medical evacuation of wounded from frontline hospitals to further hospital levels of care. After all, in a frontline hospital, wounded with combat surgical trauma do not always have time to recover from the injury, surgery and anesthesia before evacuation [4]. Unfortunately, the control and correction of the level of analgesia of the wounded during medical evacuation to hospital–level medical care facilities is not always given the necessary attention. A retrospective analysis of the accompanying medical documentation during the medical evacuation of 963 wounded and injured people from African countries during 2008–2018 showed that the control of the level of intensity of pain syndrome was documented in only 202 (21.0%) of them [5]. In the period 2007–2016, during interhospital transportation of 869 patients injured during hostilities in Iraq and Afghanistan, only 382 (44.0%) had their analgesia level controlled and adjusted [6]. I. L. Kuchin and co–authors [7] studied the results of pain treatment in 280 wounded with combat surgical limb injuries. When the wounded were delivered to medical and nursing teams for treatment, the intensity of pain ranged from 8 to 9 points on the visual analog scale (VAS), and when the wounded were delivered to a military mobile hospital for treatment, it ranged from 6 to 7 points. The level of pain was not controlled, and the effectiveness of pain management tactics was low during medical evacuation. Thus, there are many questions about the quality of pain management for wounded with combat surgical trauma who need medical evacuation [8].

The aim of the study is to analyze the effectiveness of pain relief for wounded with combat surgical trauma of the extremities during medical evacuation to early hospital levels of care.

Materials and methods

A retrospective analysis of the results of pain relief for 100 wounded with isolated combat surgical trauma of one limb during medical evacuation from frontline hospitals to further hospital levels of care was conducted. During the period 2023–2024, in the medical institutions of the cities of Izyum (Kharkiv region), Kharkiv, Mykolaiv, and Odesa, during the delivery of wounded from frontline medical institutions of the second level of medical care, they were interviewed and their accompanying medical documentation was analyzed.

According to the localization of the gunshot wound, two groups of patients were formed. Group 1 included 50 wounded with isolated combat surgical trauma to the upper ex-

tremity who received different schemes of perioperative pain relief during medical evacuation, and Group 2 included 50 wounded with isolated combat surgical trauma to the lower extremity who also received different schemes of perioperative pain relief during medical evacuation.

The criteria for inclusion of patients in the study groups were their consent to be interviewed and the location of the gunshot wound in only one limb (upper limb – no higher than the upper third of the shoulder, lower limb – no higher than the knee joint).

Gunshot wounds of the shoulder were sustained by 18 patients, forearm – 26, hand – 6, shin – 31, foot – 19.

Patients were asked to self–assess the level of pain intensity during medical evacuation. A ten–point VAS was used for self–assessment of pain intensity. The pain intensity level was recorded at the beginning of interhospital transportation (VAS1) and at the end of it (VAS2).

The influence of the type of surgical intervention and the type of anesthetic support on the intensity of pain syndrome in the dynamics during interhospital transportation of patients was analyzed.

The data were statistically processed using Statistica for Windows, version 12.6. The normality of the distribution of indicators was checked using the Shapiro–Wilk test. In the case of normal distribution of indicators, the results are presented as the arithmetic mean ± standard deviation (M±σ), and the Student's t–test was used to determine the level of significance of the difference between the groups. In case of rejection of the null hypothesis of normal distribution of indicators, the results are presented as median (Me) and 25th and 75th percentiles (Q_{25} –Q_{75}). The Mann–Whitney U test was used to determine the level of statistical significance of the difference between the two groups, the Kruskal–Wallis H test between the three groups, and the Wilcoxon W test between the dependent indicators in the dynamics. To assess the incidence of events between groups, Pearson's consistency criterion χ^2 was used. The level of statistical significance was considered to be $p < 0.05$.

The study was approved by the Bioethics Committee of Odesa National Medical University (Protocol No. 18 of 06.12.2023), performed within the framework of the research work of the Department of Anesthesiology, Intensive Care and Emergency Medicine of Odesa National Medical University "Improvement of methods of anesthetic support and intensive care in surgical interventions and critical conditions" (No. 0124U002183). The study complied with the provisions and principles of the Declaration of Helsinki regarding research involving human subjects.

Results

The study groups of patients did not differ statistically significantly in age, height, body weight, body mass index (BMI), and hemoglobin level (*Table 1*).

The studied groups of patients also did not differ statistically significantly in the type of prehospital anesthesia, surgical intervention, anesthetic support, and postoperative analgesia, including during interhospital transportation (*Table 2*).

A comparative analysis of the dynamics of the intensity of pain in wounded patients showed an increase with a statistically significant difference ($p < 0.05$) between the values of VAS1 and VAS2 (*Table 3*). The obtained results give grounds to conclude that the effectiveness of the selected types of pain relief for wounded during interhospital transportation is low.

In order to determine the effect of the type of surgical intervention on the level of pain intensity in patients in the dynamics during interhospital transportation, a comparative analysis of the relevant VAS indicators was performed (*Table 4*).

In the studied patients, there was no statistically significant difference ($p = 0.15$) between the values of HAS1 depending on the type of surgical intervention performed, but a statistically significant difference ($p < 0.05$) was found between the values of HAS2. There was no statistically significant difference ($p = 0.56$) between the values of HAS2 in patients who underwent limb

Table 1. **Characteristics of patients by anthropometric parameters and hemoglobin level**

Indicator.	Patient group		p
	1st (n=50)	2nd (n=50)	
Age, years (M ± σ)	35,3 ± 9,5	37,4 ± 8,7	0,26*
Height, cm (M ± σ)	177,6 ± 7,2	176,5 ± 6,5	0,46*
Body weight, kg Me (Q_{25} - Q)$_{75}$	71,5 (69; 82)	74,5 (68; 83)	0,83**
BMI, kg/m ^{2} Me(Q_{25} - Q)$_{75}$	23,0 (22,0; 22,7)	23,3 (22,5; 26,1)	0,19**
Hemoglobin, g/l Me ($_{Q25}$ - Q)$_{75}$	138 (132; 145)	130 (116; 142)	0,08**

Note. To determine the level of statistical significance of differences between the groups, we used: * - Student's t-test; ** - Mann-Whitney U-test; hemoglobin level was determined during the patients' stay in a frontline hospital.

Table 2. **General characteristics of patients by the type of prehospital anesthesia, surgical intervention, anesthetic support and postoperative analgesia (including during interhospital transportation)**

Indicator.	Patient group		Total (n=100)		p
	1st (n=50)	2nd (n=50)	abs.	%	
Pre-hospital anesthesia					0,54
opiates + NSAIDs	23	20	43	43	
NSAIDS	27	30	57	57	
Surgical interventions					0,24
amputation of a limb	6	8	14	14	
PKDO OF THE AZOV SEA PORT	4	9	13	13	
PCH, wound care center	40	33	73	73	
Anesthesia					0,06
intravenous + ventilator	17	9	26	26	
intravenous without ventilator	24	23	47	47	
local infiltration	9	18	27	27	
Postoperative analgesia					0,23
opiates + NSAIDs	20	26	46	46	
NSAIDS	30	24	54	54	
Analgesia during inter-hospital transportation					0,75
opiates + NSAIDs	7	7	14	14	
NSAIDS	12	9	21	21	
there was no anesthesia	31	34	65	65	

Note. To assess the incidence of events between the groups, Pearson's χ^2 consistency criterion was used; NSAIDs - non-steroidal anti-inflammatory pain medications; FCDO - non-focal compression-distraction osteosynthesis (the same in Table 4); ADF - external fixation device *(same as in Table 4)*; PSO - primary surgical treatment (same as in Table 4); ALV - artificial lung ventilation (*same as in Table 5)*.

amputation and in patients who underwent PCDO of ASF. Also, there was no statistically significant difference (p = 0.09) between the values of HAS2 in patients who underwent PCDO of ACS and in patients who underwent PCI of gunshot wounds. On the contrary, we observed higher values of WAS2 in patients who underwent limb amputation than in patients who underwent PCI of gunshot wounds, and they differed statistically significantly (p < 0.05).

At the same time, when analyzing the dynamics of pain intensity in all patients who underwent various types of surgical interventions during interhospital transportation, their increase was found with a statistically significant difference (p < 0.05) between the values of VAS1 and VAS2, regardless of the type of surgical intervention performed.

In order to determine the effect of the type of anesthetic support for surgical interventions on the level of intensity of pain in patients in the dynamics during interhospital transportation, a comparative analysis of the relevant VAS indicators was performed (*Table 5)*.

There was no statistically significant difference (p = 0.05) between the values of WAS1 in patients undergoing general anesthesia + mechanical ventilation and patients undergoing general intravenous anesthesia. Instead, higher values of WAS1

Table 3. **Dynamics of indicators of the level of intensity of pain syndrome in patients of the study groups**

Patient group	Indicator, points		p <
	YOUR1 Me (Q_{25} -Q)$_{75}$	YOUR2 Me (Q_{25} -Q)$_{75}$	
1st (n=50)	4 (3; 5)	6 (4; 7)	0,05
2nd (n=50)	4 (3; 5)	5 (4; 7)	0,05
Total (n=100)	4 (3; 5)	6 (4; 7)	0,05

Note. To determine the level of statistical significance of differences between the indicators in the dynamics, the Wilcoxon W-criterion was used (the same in *Tables 4.5)*.

Table 4. **Indicators of the level of intensity of pain syndrome in patients undergoing various types of surgical interventions in the dynamics**

Type of surgical intervention	Indicator, points		P <
	YOUR1 Me (Q_{25} -Q)$_{75}$	YOUR2 Me (Q_{25} -Q)$_{75}$	
Amputation of a limb or its distal parts (n=14)	4,5 (3; 5)	6 (5; 8)	0,05
PKDO of the Azov Sea Port (n=13)	5 (4; 5)	6 (5; 7)	0,05
PCO, gunshot wound toilet (n=73)	4 (3; 5)	5 (4; 6)	0,05

Table 5. **Indicators of the level of intensity of pain syndrome in patients who received different types of anesthetic support for surgical interventions, in the dynamics**

Type of anesthetic support	Indicator, points		p <
	YOUR1 Me (Q_{25} -Q)$_{75}$	YOUR2 Me (Q_{25} -Q)$_{75}$	
Intravenous anesthesia + ventilator (n=26)	5 (4; 5)	6 (6; 7)	0,05
Intravenous anesthesia without mechanical ventilation (n=47)	4 (3; 5)	5 (4; 7)	0,05
Local infiltration anesthesia (n=27)	3 (2; 4)	4 (3; 6)	0,05

were observed in patients undergoing general anesthesia + mechanical ventilation than in patients undergoing local infiltration anesthesia, and they differed statistically significantly ($p < 0.05$). We also observed higher values of WAS1 in patients undergoing general intravenous anesthesia than in patients undergoing local infiltration anesthesia, and they also differed statistically significantly ($p < 0.05$). There was no statistically significant difference ($p = 0.09$) between the values of WAS2 in patients undergoing general intravenous anesthesia and patients undergoing local infiltration anesthesia. Instead, higher values of WAS2 were observed in patients undergoing general anesthesia + mechanical ventilation than in patients undergoing general intravenous anesthesia, and the difference between them was statistically significant ($p < 0.05$). We also observed higher values of WAS2 in patients undergoing general anesthesia + mechanical ventilation than in patients undergoing local infiltration anesthesia, also with a statistically significant difference ($p < 0.05$).

At the same time, an analysis of the dynamics of pain intensity in all patients who received different types of anesthetic support for surgical interventions during interhospital transportation showed an increase in pain level with a statistically significant difference ($p < 0.05$) between VAS1 and VAS2 values, regardless of the type of anesthetic support for surgery.

Discussion

The main reason for the deterioration of pain relief at the stage of medical evacuation, the patients who participated in the study indicated an increase in the level of pain intensity during the movement of medical transport, especially in the conditions of maneuvers and driving on roads with damaged road surfaces. The obtained results demonstrate that regardless of the type of surgical intervention performed and the type of anesthetic support during interhospital transportation, there is a negative dynamics of pain intensity in patients of the study groups due to the low effectiveness of the selected types of pain relief. Thus, optimization of pain relief during interhospital transportation of wounded with combat surgical trauma of the extremities is extremely important.

As one of the possible solutions to this issue, the current medical literature suggests the use of regional analgesic techniques in wounded with combat surgical trauma at the initial levels of medical care, in particular, it is reported that regional analgesic blockades were included in the pain treatment regimen in 88% of wounded with combat surgical trauma of the extremities in one of the hospitals in Baghdad [9]. However, there is great uncertainty about the efficacy and safety of regional analgesic blockades at the early levels of medical care for wounded with combat surgical trauma to the extremities. In this regard, the use of regional analgesic blockades cannot be considered a widespread technique in the emergency treatment of wounded and injured. Scientists from Canada conducted a survey among 1435 doctors of emergency departments of medical centers in the country to determine the frequency of use of regional analgesic block-

ades in the provision of emergency care to victims. According to the survey results, only 149 (10.4%) doctors regularly used regional analgesic blockades in their practice. Among the problematic issues, the surveyed doctors indicated the following: the regional blockade procedure is time–consuming and technically complex; lack of knowledge and skills of the staff, special equipment in the medical facility; imperfect existing anesthesia protocols that do not contain clear algorithms for regional anesthesia [10]. Moshkivsky and co–authors [11] analyzed the accompanying medical records of 46 wounded with combat surgical trauma of the upper extremity who sustained gunshot wounds in 2022, the share of regional anesthesia methods was only 8%. 2/3 of patients had combined injuries, which suggests that the time required to infiltrate nerves and nerve plexuses with a local anesthetic solution is sometimes inappropriate for mass delivery of wounded. Instead, at the next level of medical care, regional analgesic blocks were the method of choice for anesthesia in 21% of wounded.

Conclusions

1. During the period of interhospital transportation, there is a negative dynamics of pain intensity in wounded with combat surgical trauma of the extremities who underwent amputation, PCDO of APF and PCO of gunshot wounds, and general anesthesia + ventilator, general intravenous anesthesia and local infiltration anesthesia were used as anesthetic support for surgical interventions.

2. Optimization of pain relief during interhospital transportation of wounded with combat surgical trauma to the extremities is extremely important.

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Consent for publication. Both authors have read and approved the final version of the manuscript and agreed to its publication.

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