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D. O. Tymchyshyn[1,2] https://orcid.org/0000-0001-8407-8849
O. O. Budniuk[1] https://orcid.org/0000-0002-0477-5036

EFFECTIVENESS OF ANALGESIA FOR THE WOUNDED WITH COMBAT TRAUMA OF THE EXTREMITIES AT THE EARLY HOSPITAL LEVELS OF PROVIDING MEDICAL CARE

[1] Odesa National Medical University, Odesa, Ukraine
[2] Military Medical Clinical Center of the Southern Region, Odesa, Ukraine

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D. O. Tymchyshyn[1,2], O. O. Budniuk[1]

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At the moment, issues regarding the organization of high-quality analgesia during medical evacuation between hospital levels of medical care remain unresolved.

The purpose of the study is to analyze the results of analgesia of the wounded with combat surgical trauma to the extremities during treatment at the early levels of providing medical care.

Materials and methods. The results of analgesia of 100 patients with combat surgical trauma of the extremities were analyzed. Indicators of the intensity level of pain syndrome were registered at the time of admission to the frontline hospitals (VAS1), at the time of the beginning of interhospital transportation (VAS2), at the end of interhospital transportation (VAS3).

Results. The indicators of VAS1 were 7 points (5; 8), VAS2 – 4 points (3; 5), VAS3 – 6 points (4; 7). Analyzing the dynamics of pain intensity level indicators, a decrease in pain level was found with a statistically significant difference between VAS1 and VAS2 ($p < 0.05$), as well as an increase in pain level with a statistically significant difference between VAS2 and VAS3 ($p < 0.05$).

Conclusions. Regardless of the localization of the gunshot wound of the extremity and the type of perioperative analgesia, negative dynamics of indicators of the intensity level of pain syndrome during interhospital transportation were observed. We consider the issue of optimizing analgesia during interhospital transportation of wounded with combat surgical trauma of the extremities extremely relevant.

Keywords: combat surgical trauma, gunshot wounds to the extremities, pain.

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Д. О. Тимчишин [1,2], О. О. Буднюк[1]

ЕФЕКТИВНІСТЬ ЗНЕБОЛЕННЯ ПОРАНЕНИХ З БОЙОВОЮ ТРАВМОЮ КІНЦІВОК НА РАННІХ ГОСПІТАЛЬНИХ РІВНЯХ НАДАННЯ МЕДИЧНОЇ ДОПОМОГИ

[1] Одеський національний медичний університет, Одеса, Україна
[2] Військово-медичний клінічний центр Південного регіону, Одеса, Україна

Мета дослідження – аналіз ефективності знеболення поранених з бойовою хірургічною травмою кінцівок під час лікування на ранніх госпітальних рівнях надання медичної допомоги. Проаналізовано ефективність знеболення 100 поранених на момент надходження до прифронтового медичного закладу (ВАШ1), на початку міжгоспітального транспортування (ВАШ2) та на момент закінчення міжгоспітального транспортування (ВАШ3). Показники ВАШ1 – 7 балів (5; 8), ВАШ2 – 4 бали (3; 5), ВАШ3 – 6 балів (4; 7). Виявлено зниження рівня болю в динаміці між значеннями ВАШ1 та ВАШ2 ($p < 0,05$), а також підвищення рівня болю між значеннями ВАШ2 та ВАШ3 ($p < 0,05$). Незалежно від локалізації вогнепального поранення кінцівки та виду періопераційного знеболення, спостерігалась негативна динаміка показників рівня болю під час міжгоспітального транспортування. Актуальним питанням є оптимізація знеболення поранених під час міжгоспітального транспортування.

Ключові слова: бойова хірургічна травма, вогнепальні поранення кінцівок, біль.

Introduction. Today in Ukraine, combat surgical trauma is a significant issue among both military personnel and civilians [1]. According to many studies, during the military conflicts of the early 21st century, gunshot wounds to the extremities accounted for more than 55% of the wounded in the structure of combat surgical trauma [2]. Thus, the issue of treating gunshot wounds to the extremities occupies a central place in military surgery [3].

Pain management and effectiveness control of analgesia during wartime are integral parts of the treatment and care provided to the wounded [4]. Reducing pain is one of the key tasks to improve the quality of life of those who survive gunshot wounds [5]. However, as noted in the study by scientists from United Kingdom (2011), throughout the armed conflicts of the 20th century, the primary goal of military medicine was to ensure effective triage of the wounded, and pain management was not given significant attention [6]. Although early treatment of pain has been well established to improve post-injury outcomes, inadequate analgesia leads to increased rates of post-traumatic stress disorder [7].

Providing medical assistance to those wounded with combat surgical trauma in front-line medical facilities requires action in combat conditions and readiness for the potential mass influx of injured individuals, as it is known that sanitary losses are distributed unevenly both territorially and temporally [8]. In this regard, the most questions about organizing anesthesiological care arise at the second level of medical care provision and during subsequent medical evacuation between hospital levels of medical care. Anesthesiologists face strict time constraints, requiring optimization of emergency measures algorithms in accordance with the actual capabilities of the anesthesiology management [9].

The choice of anesthesia method during primary surgical debridement of gunshot wounds and options for postoperative analgesia, directly depend on the strategy for providing surgical care, as the timing, scope, and sequence of surgical interventions can be particularly challenging in cases of mass casualties [10]. Effective analgesia during medical evacuation is considered one of the critical tasks for improving the condition of patients with combat surgical trauma [11]. However, the specifics of pain management for those wounded with combat surgical trauma during transportation from the second level of medical care to subsequent hospital levels are sparsely covered in scientific literature. In a study of Kuchyn YuL et al. (2022), the results of pain management in 280 the wounded with combat surgical trauma to the extremities were analyzed, which showed that during admission to the second level of medical care, pain intensity ranged from 8 to 9 points on the VAS (Visual Analog Scale), while upon arrival at a military mobile hospital, pain intensity ranged from 6 to 7 points on the VAS. Thus, there was an observed lack of pain control and low effectiveness in pain treatment strategies during medical evacuation [12].

The Aim of the Study. Analysis of the effectiveness of analgesia for the wounded with combat surgical trauma of the extremities, during treatment in the conditions of front-line hospitals and during interhospital medical evacuation.

Materials and methods. The study was conducted in compliance with the principles and guidelines of the Helsinki Declaration on research involving human subjects. The research protocol was approved by the Bioethics Committee of Odesa National Medical University (Protocol No. 18; December 6, 2023). The study was performed as part of the research work by the Department of Anesthesiology, Intensive Care and Emergency Medicine "Improvement of methods of anesthetic management and intensive therapy during surgical interventions and critical conditions" (No. 0124U002183).

It is a retrospective study. The results of analgesia for 100 patients with isolated combat surgical trauma to one extremity were analyzed during treatment in frontline hospitals of the secondary care and during medical evacuation to medical facilities of subsequent levels of hospital care. In the period from July 2023 to January 2024, in different medical institutions (Izyum, Kharkiv, Mykolaiv, Odesa), examinations were conducted and accompanying medical documentation was analysed for the wounded with combat surgical trauma of the extremities, admitted from frontline hospitals.

According to the location of the gunshot wound to the extremity, two patient groups were formed. Group 1 included 50 patients with isolated combat surgical trauma to the upper extremity (n = 50), who received various perioperative pain relief schemes during the stages of medical evacuation. Group 2 included 50 patients with isolated combat surgical trauma to the lower extremity (n = 50), who also received various perioperative pain relief schemes during the stages of medical evacuation. Inclusion criteria for the study groups were: the patient's consent to participate in the investigation and a gunshot wound localized to only one extremity (upper extremity – no higher than the upper third of the arm, lower extremity – no higher than the knee joint). Gunshot wounds to the shoulder were observed in 18 patients, to the forearm – in 26 patients, to the hand – in 6 patients, to the lower leg – in 31 patients, and to the foot – in 19 patients.

Taking into account that the "Primary Medical Record" (Form No. 100) lacks a section for pain level assessment, there was no documented information on pain levels at previous stages of medical care. Thus, pain intensity assessment was conducted through a patient survey. After explaining the purpose of the survey, patients were asked to retrospectively self-assess their pain intensity level at previous stages of medical care and during medical evacuation. A ten-point Visual Analog Scale (VAS) was used for self-assessment of pain intensity.

Pain intensity levels were recorded at three stages: Stage 1 – upon admission to the frontline medical institution (VAS1); Stage 2 – at the beginning of interhospital transportation (VAS2); Stage 3 – at the end of interhospital transportation (VAS3).

Pursuant to the accompanying medical documentation, the following parameters were recorded: patient's age, location of the gunshot wound on the extremity, list of analgesic medications used at pre-hospital care stages, type of surgical intervention, type of perioperative pain management, and hemoglobin level (HGB) during the stay at the frontline medical facility.

Patient characteristics by anthropometric indicators and hemoglobin levels is presented in Table 1.

Table 1

Characteristics of patients according to anthropometric parameters and hemoglobin level

Parameter	Group 1 (n=50)	Group 2 (n=50)	p
Age (years) M ± σ	35.3 ± 9.5	37.4 ± 8.7	0.26*
Height (m) M ± σ	1.78 ± 0.07	1.77 ± 0.07	0.46*
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**
HGB (g/L) Me (Q_{25}-Q_{75})	138 (132; 145)	130 (116; 142)	0.08**

Note: * – the Student's t-test was used to determine the significance level of differences between groups; ** – the Mann-Whitney U-test was used to determine the significance level of differences between groups; BMI – Body Mass Index.

Patients in the study groups did not statistically differ by age (p = 0.26), height (p = 0.46), weight (p = 0.83), BMI (p = 0.19) and HGB (p = 0.08).

A characterization of the patients by type of pre-hospital analgesia, surgical interventions, anesthetic support and postoperative analgesia (including during interhospital transportation) is presented in Table 2.

Table 2

General characteristics of patients by type of pre-hospital analgesia, surgical interventions, anesthetic support and postoperative analgesia (including during interhospital transportation)

Parameter	Group 1	Group 2	Total, n=100 (%):	p
Type of pre-hospital analgesia:				0.54
Opiate + NSAID	23	20	43 (43%)	
NSAID	27	30	57 (57%)	
Type of surgical interventions:				0.24
Extremity amputation	6	8	15 (15%)	
External fixation of the fracture	4	9	13 (13%)	
Surgical debridement	40	33	73 (73%)	
Type of anesthetic support:				0.06
General anesthesia + MV	17	9	26 (26%)	
General anesthesia without MV	24	23	47 (47%)	
Local infiltration anesthesia	9	18	27 (27%)	
Postoperative analgesia:				0.23
Opiates + NSAID	20	26	46 (46%)	
NSAID	30	24	54 (54%)	
Analgesia during interhospital transportation:				0.75
Opiates + NSAID	7	7	14 (14%)	
NSAID	12	9	21 (21%)	
Without analgesia	31	34	65 (65%)	

Note: Pearson's χ^2-test was used to assess the incidence of events between groups; NSAID – non-steroidal anti-inflammatory drugs; MV – mechanical ventilation.

Statistical analysis was conducted using Statistica for Windows, version 12.6. The normality of data distribution was checked using the Shapiro-Wilk test. In cases of normal distribution, results are presented as arithmetic mean ± standard deviation (M ± σ), and the Student's t-test was used to determine the significance level of differences between groups. When the null hypothesis of normal distribution was rejected, results are presented as the median (Me) with 25th and 75th percentiles (Q25-Q75), and the Mann-Whitney U-test was used to determine the significance level of differences between groups. For assessing the significance of changes in dependent variables over time, the Wilcoxon W-test was used. Pearson's χ^2-test was used to assess the incidence of events between groups. A significance level of $p < 0.05$ was considered statistically significant.

Results and their Discussion. A comparative analysis of pain intensity levels between patients in Group 1 and Group 2 is presented in Table 3.

Table 3

Comparative analysis of pain intensity levels between patients in Group 1 and Group 2

Parameter	Group 1 (n=50)	Group 2 (n=50)	p
VAS1 (points) Me (Q_{25}-Q_{75})	7 (5; 8)	7 (5; 8)	0.54
VAS2 (points) Me (Q_{25}-Q_{75})	4 (3; 5)	4 (3; 5)	0.33
VAS3 (points) Me (Q_{25}-Q_{75})	6 (4; 7)	5 (4; 7)	0.60

Note: the Mann-Whitney U-test was used to determine the significance level of differences between groups.

All patients included in the study reported the presence of pain syndrome upon admission to the frontline medical facility at the second level of medical care. 37 patients (15 from Group 1 and 22 from Group 2) rated their pain intensity between 4 and 6 points on the VAS. 63 patients (35 from Group 1 and 28 from Group 2) reported a pain intensity level between 7 and 9 points on the VAS. The VAS1 values for all patients in the study were Me = 7 points (5; 8). For Group 1, VAS1 values were Me = 7 points (5; 8). For Group 2, VAS1 values were Me = 7 points (5; 8). No statistically significant difference in VAS1 values was found between patients in Group 1 and Group 2 (p = 0.54).

At the beginning of medical evacuation from the frontline medical facility to next-level medical facilities, all patients reported a decrease in pain intensity. 33 patients (15 from Group 1 and 18 from Group 2) rated their pain intensity between 1 and 3 points on the VAS. 67 patients (35 from Group 1 and 32 from Group 2) rated their pain intensity between 4 and 6 points on the VAS. VAS2 values for all patients in the study were Me = 4 points (3; 5). For Group 1, VAS2 values were Me = 4 points (3; 5). For Group 2, VAS2 values were Me = 4 points (3; 5). No statistically significant difference in VAS2 values was found between patients in Group 1 and Group 2 (p = 0.33).

At the end of interhospital transportation, patients from both groups reported an increase in pain compared to their pain levels at the beginning of transportation. 17 patients (11 from Group 1 and 6 from Group 2) rated their pain intensity between 1 and 3 points on the VAS. 54 patients

(23 from Group 1 and 31 from Group 2) rated their pain intensity between 4 and 6 points on the VAS. 29 patients (16 from Group 1 and 13 from Group 2) rated their pain intensity between 7 and 9 points on the VAS. VAS3 values for all patients in the study were Me = 6 points (4; 7). For Group 1, VAS3 values were Me = 6 points (4; 7). For Group 2, VAS3 values were Me = 5 points (4; 7). No statistically significant difference in VAS3 values was found between patients in Group 1 and Group 2 (p = 0.60).

A comparative analysis of dynamic pain intensity indicators among the study groups is presented in Table 4 and Figure 1.

Table 4

Comparative analysis of dynamic pain intensity indicators among the study groups

Parameter	Research group (n=100)	p
VAS1 (points) Me (Q_{25}-Q_{75})	7 (5; 8)	$p_{1-2} < 0.05$ $p_{1-3} < 0.05$ $p_{2-3} < 0.05$
VAS2 (points) Me (Q_{25}-Q_{75})	4 (3; 5)	
VAS3 (points) Me (Q_{25}-Q_{75})	6 (4; 7)	

Note: the Wilcoxon W-test was used to determine the significance of differences in dynamic indicators; p_{1-2} indicates significance between VAS1 and VAS2; p_{1-3} indicates significance between VAS1 and VAS3; p_{2-3} indicates significance between VAS2 and VAS3.

Analyzing the dynamics of pain intensity levels in the wounded, a statistically significant reduction in pain was observed between VAS1 and VAS2 values (p < 0.05). These findings may reflect the relative effectiveness of the selected pain management approaches in frontline hospitals at the second level of medical care. However, the main reason for improved condition, as reported by patients, was the transition from high-risk combat conditions to the relative calm of a medical facility. Nonetheless, there remains a need for pain management optimization, as 67% of patients reported a pain intensity level of more than 3 points on the VAS at the start of interhospital transportation.

A statistically significant increase in pain intensity was observed between VAS2 and VAS3 (p < 0.05). These findings may indicate low effectiveness of pain management during interhospital transportation, as 54% of patients rated their pain above 3 points on the VAS, and 29% rated it above 6 points. Patients reported that the main cause of worsening condition was increased pain during transport movement, especially due to maneuvers and travel over damaged roads. Optimization of pain management during interhospital transportation, considering these factors, is thus highly relevant.

Patients included in the study groups differed in terms of the location of gunshot wounds to the extremity, and they received various combinations of analgesic medications at pre-hospital levels of care, in the postoperative period, and during interhospital transportation. Accordingly, an analysis of pain intensity dynamics during transportation was conducted for each category of patients within the study groups.

Among patients with gunshot wounds to the shoulder, VAS2 values were Me = 5 points (4; 5), and VAS3 values were Me = 6 points (6; 7). Among patients with gunshot wounds to the forearm, VAS2 values were Me = 4 points (4; 5) and VAS3 values were Me = 6 points (5; 7). Among patients with gunshot wounds to the hand, VAS2 values were Me = 2 points (2; 3) and VAS3 values were Me = 3 points (3; 3). Among patients with gunshot wounds to the lower leg, VAS2 values were Me = 4 points (3; 5) and VAS3 values were Me = 6 points (4; 7). Among patients with gunshot wounds to the foot, VAS2 values were Me = 3 points (3; 4) and VAS3 values were Me = 5 points (4; 6). A statistically significant difference between VAS2 and VAS3 values (p < 0.05) was found in all patients, regardless of the location of the extremity gunshot wound.

For patients receiving narcotic analgesics during the study stages, VAS2 values were Me = 4.5 points (4; 5), and VAS3 values were Me = 6 points (5; 7). For those who did not receive narcotic analgesics, VAS2 values were Me = 3 points (2; 4) and VAS3 values were Me = 4 points (3; 5). A statistically significant difference between VAS2 and VAS3 values (p < 0.05) was found in all patients, regardless of the type of analgesia administered during the study.

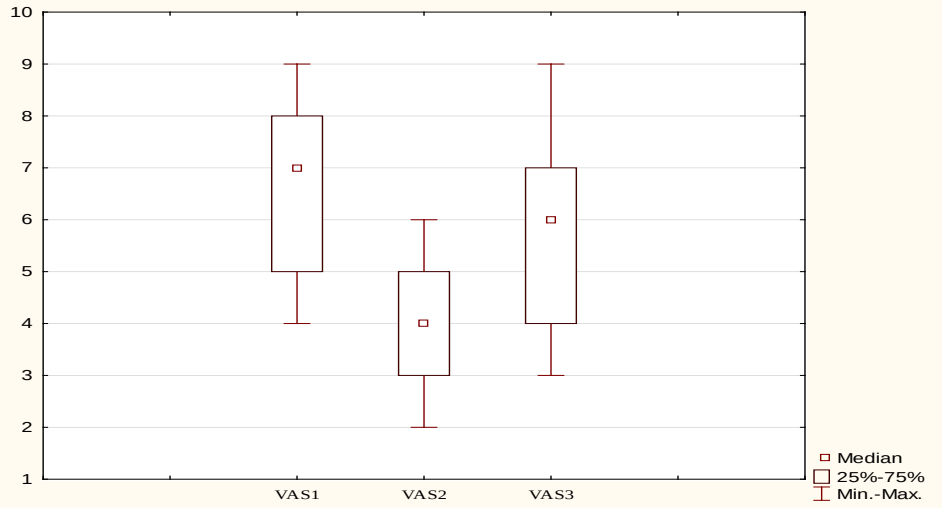

Fig. 1. Comparative analysis of dynamic pain intensity indicators among the study groups

These results may indicate that, regardless of the location of extremity gunshot wounds and types of perioperative analgesia, pain intensity levels showed a negative trend during interhospital transportation due to the low effectiveness of the chosen pain management methods. The need to optimize pain management during interhospital transportation for the wounded with combat surgical trauma of the extremities is thus highly relevant.

Conclusions

1. In the wounded with combat surgical trauma of the extremities, upon admission to front-line hospitals, a high level of pain intensity was observed with values of Me = 7 points (5; 8) according to VAS.

2. The wounded with combat surgical trauma of the extremities had a positive change in pain intensity levels, reaching Me = 4 points (3; 5) on the VAS, during their stay in frontline hospitals. Patients attributed this improvement to the transition from dangerous conditions to the relative calm of the medical facility.

3. During interhospital transportation, the wounded with combat surgical trauma of the extremities had negative changes in pain intensity levels, with values reaching Me = 6 points (4; 7) on the VAS. Patients reported that the main cause of worsening condition was increased pain during transport movement, especially due to maneuvers and travel over bad roads.

4. Regardless of the location of extremity gunshot wounds and types of perioperative analgesia, pain intensity levels showed a negative trend during interhospital transportation due to the low effectiveness of the chosen pain management methods.

5. We consider the issue of optimizing analgesia during interhospital transportation of the wounded with combat surgical trauma to the extremities to be extremely relevant.

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