UDC 616.34-007.43:616.681:616.14-089-009.7

**Ya. Semkovych[1], D. Dmytriiev[2], P. Rusak[3], S. Zaporozhan[4], O. Nazarchuk[2]**

# Prevalence of chronic pain after herniorrhaphy, orchiopexy, and bernardi procedure in children. A retrospective-prospective study

*[1]Ivano-Frankivsk National Medical University, Ukraine*
*[2]National Pirogov Memorial Medical University, Vinnitsa, Ukraine*
*[3]Shupyk National Healthcare University of Ukraine, Kyiv*
*[4]I. Horbachevsky Ternopil National Medical University, Ukraine*

Paediatric Surgery(Ukraine).2022.3(76):8-18; doi 10.15574/PS.2022.76.8

**For citation:** Semkovych Ya, Dmytriiev D, Rusak P, Zaporozhan S, Nazarchuk O. (2022). Prevalence of chronic pain after herniorrhaphy, orchiopexy, and bernardi procedure in children. A retrospective-prospective study. Paediatric Surgery (Ukraine). 3 (76): 8-18. doi: 10.15574/PS.2022.76.8.

Chronic postsurgical pain (CPSP) is defined as pain that develops or increases in intensity after a surgical procedure and persists for at least three months. Its prevalence rate ranges from 5% to 54%.

**Aim** – to assess the prevalence of CPSP among children at the age of 7–18 years residing in the Precarpathian region at three and six months after herniorrhaphy, orchiopexy and Bernardi procedure.

**Materials and methods**. There were observed 92 children at the age of 7–18 years, who underwent treatment for abdominal wall hernia, cryptorchidism, varicocele, and hydrocele at the surgical department. Children were divided into the following groups: Group 1a included children at the age of 7–12 years with acute pain syndrome in the postoperative period; Group 1b comprised children at the age of 13–18 years with acute pain syndrome in the postoperative period; Group 2a included children at the age of 7–12 years with chronic pain syndrome; Group 2b included children at the age of 13–18 years with chronic pain syndrome.

**Results**. The prevalence of CPSP following surgery among children of the Precarpathian region was found to be 33.7%, with a male predominance ($p<0.05$). There was an increased need for postoperative pain management with paracetamol in children of Group 2a ($p<0.05$). The mean scores of the Face, Legs, Activity, Cry, Consolability (FLACC) scale were significantly higher in children of Group 2a, 2b as compared to Group 1a, 1b ($p<0.05$). The Visual Analogue Scale (VAS) confirmed greater pain intensity in children of Group 2a on the second and third days of treatment ($p<0.05$).

**Conclusions**. The high prevalence of chronic pain in children after herniorrhaphy, orchiopexy by Petrivalsky / Schoemaker technique, Ross and Bernardi procedures is due to ineffective perioperative pain management that requires the use of additional analgesia techniques, including regional ones.

The research was carried out in accordance with the principles of the Helsinki Declaration. The study protocol was approved by the Local Ethics Committee of the participating institution. The informed consent of the patient was obtained for conducting the studies.

No conflict of interests was declared by the authors.

***Keywords:*** children, acute pain, chronic pain, herniotomy.

## Поширеність хронічного болю у дітей Прикарпаття після герніорафії, орхопексії та операції Бернарді. Ретроспективно-проспективне дослідження

***Я. В. Семкович[1], Д. В. Дмитрієв[2], П. С. Русак[3], С. Й. Запорожан[4], О. А. Назарчук[2]***

*[1]Івано-Франківський національний медичний університет, Україна*
*[2]Вінницький національний медичний університет імені М. І. Пирогова, Україна*
*[3]Національний медичний університет охорони здоров'я України імені П. Л. Шупика, м. Київ*
*[4]Тернопільський національний медичний університет імені І. Я. Горбачевського, Україна*

Хронічний післяопераційний біль (CPSP – chronic postsurgical pain) – це біль, що розвивається або посилюється і зберігається щонайменше протягом трьох місяців після хірургічної процедури. Його поширеність коливається від 5% до 54%.

**Мета** – оцінити поширеність хронічного післяопераційного болю у дітей Прикарпаття віком 7–18 років через 3 та 6 місяців після операцій герніорафії, орхопексії та операції Бернарді.

**Матеріали та методи**. Спостерігалось 92 дітей віком від 7 до 18 років, які знаходились на лікуванні у хірургічному відділенні з приводу гриж черевної стінки, крипторхізму, варикоцеле та гідроцеле. Діти були розподілені на групи: 1а – діти 7–12 років із гострим больовим синдромом в післяопераційному періоді, 1б – діти 13–18 років із гострим больовим синдромом; 2а група – діти 7–12 років із хронічним больовим синдромом, 2б група – діти 13–18 років із хронічним больовим синдромом.

**Результати**. Поширеність хронічного больового синдрому після перенесених операцій у дітей Прикарпаття становить 33,7%, і він переважає у хлопчиків (p<0,05). Зростає необхідність знеболення парацетамолом у дітей 2а групи в післяопераційному періоді (p<0,05). У 2а та 2б групах середні значення шкали FLACC (Face, Legs, Activity, Cry, Consolability – обличчя, ноги, активність, плач, втішність) достовірно вищі порівняно із 1а та 1б групами (p<0,05). Візуальна аналогова шкала (ВАШ) підтверджує зростання інтенсивності болю у дітей 2а групи на другу і третю доби (p<0,05).

**Висновки.** Висока поширеність хронічного болю у дітей після перенесених операцій з приводу герніорафії, орхопексії та операції Бернарді формується через неефективне періопераційне знеболення, що вимагає використання додаткових методів анальгезії, в тому числі регіонарних.

Дослідження виконано відповідно до принципів Гельсінської декларації. Протокол дослідження ухвалено Локальним етичним комітетом зазначеної в роботі установи. На проведення досліджень отримано інформовану згоду батьків, дітей.

Автори заявляють про відсутність конфлікту інтересів.

***Ключові слова:*** діти, гострий біль, хронічний біль, герніотомія.

## Introduction

The lack of an adequate assessment of childhood-onset acute pain and its proper management can result in negative consequences that continue into adulthood, including chronic pain and suffering [7,17,22,25]. Every year, nearly 5 million children and adolescents in the USA undergo surgery. Approximately 20% of children report moderate or severe postsurgical pain three months after major surgery [9,18].

Chronic postsurgical pain (CPSP) is a public health problem recognized in the pediatric population [32]. CPSP is defined as pain that develops or increases in intensity after a surgical procedure and persists for at least three months [21]. The reported prevalence of CPSP varies in different studies, some studies have reported its prevalence as varying between 11% and 38% [4,19], while, according to other studies, it has been reported to range from 5% to 54% [12,18]. The risk of CPSP increases after inguinal hernia surgery as compared to other pediatric surgeries of the same complexity [15].

Such prevalence range of CPSP is due to the assessment of pain and surgical procedures of different types performed at various times after surgery. Data are scarce on chronic right lower quadrant pain in children, they are limited to inguinal hernia repair only. In one study, the prevalence of CPSP in the lower right abdomen after inguinal hernia surgery in children was 7.1% and 5.1% at twelve and three months after surgery, respectively [12].

According to V. Mossetti et al [15], the prevalence of CPSP at one, three and six months after inguinal hernia surgery was 35.6%, 14.9%, and 9.2%, respectively. Another study on children under 5 years of age reported the prevalence of CPSP as 13.5%, although moderate or severe pain was observed in 2% of children only [1]. Worldwide, more than 20 million people undergo inguinal hernia repair annually. The many various approaches, treatment indications and techniques for inguinal hernia repair require guidelines for standardization of care, minimization of complications, and result improvement. The main goal of these guidelines is to improve patient outcomes, specifically to decrease recurrence rates and reduce chronic pain [10].

CPSP, also known as post-herniorrhaphy neuralgia, is a common complication following inguinal hernia repair [2]. Post-herniorrhaphy neuralgia is defined as nerve-related pain that persists for more than three months and is unrelated to any other cause. In some cases, the pain can be so severe that it interferes with walking, sitting, or even sleeping. After hernia repair, CPSP may last for months or years [10].

Risk factors for the development of CPSP following hernia repair include:

- young age;
- female gender;
- severe preoperative pain;
- patient's anxiety and fear before surgery;
- genetic predisposition;
- high level of pain at the beginning of surgery;
- surgery performed in nonspecialized centers by low-skilled surgeons;
- infection or other postoperative complications.

The risk factor for postsurgical pain is preoperative pain, while early intensive postsurgical pain may also serve as a risk factor for chronic pain [29].

The pain typically results from nerve damage (neuropathy) or when a nerve is trapped in sutures, staples, or surgical mesh.

Common symptoms of postsurgical neuropathy include:
- shooting, sharp, or radiating pain;
- burning sensation;
- foreign body sensation;
- testicular pain;
- painful walking.

The pain may also be somatic. Somatic pain results from injury to skin, muscles, or soft tissues and is characterized by unpleasant sensations of tension or aching, usually during movement, due to shortening the anatomical structures during surgery. Hernia may be the cause of severe CPSP that interferes with daily activities, impairs sleep [11] and leads to adolescent depression [5,30].

The prevalence of persistent postsurgical pain after major surgeries in children is over 20% [28]; however, data are scarce on the prevalence of CPSP among children of Ukraine, including the Precarpathian region, who underwent surgery for abdominal wall hernia, cryptorchidism, varicocele, and hydrocele.

***The aim*** of this study – to assess the prevalence of CPSP among children at the age of 7–18 years residing in the Precarpathian region at three and six months after herniorrhaphy, orchiopexy by Petrivalsky / Schoemaker technique, Ross and Bernardi procedures, as well as to assess the nature of pain and the consequences of persistent postsurgical pain.

## Materials and methods of the study

The study was conducted at the Communal Non-Profit Enterprise «Ivano-Frankivsk Regional Children's Clinical Hospital of Ivano-Frankivsk Regional Council». There were observed 92 children at the age of 7–18 years, who underwent treatment for abdominal wall hernia, cryptorchidism, varicocele, and hydrocele at the surgical department during 2020–02.2022. Abdominal wall hernia, cryptorchidism, varicocele, and hydrocele were diagnosed and treated according to the local clinical protocols of medical care and clinical pathways for children with hydrocele (Q43), varicocele (I 86.1), and cryptorchidism (Q53). A retrospective examination was made to work out 26 inpatient records; the remaining 70 patients were observed in a prospective phase.

Inclusion criteria were children at the age of 7–18 years with inguinal hernia, American Society of Anaesthesiologists' (ASA) classification of Physical Health grades I–II, with the mandatory parental consent to involve their child in clinical research. Exclusion criteria were children less than 7 years of age; those with ASA grade III or higher, mental disorders, neoplasms or tumors, acute or inflammatory processes of any etiology and localization, sepsis, shock; those who previously underwent surgery on the lower abdomen; those who experienced pain for 6 months prior to surgery; those who refused to participate in the research; children whose parents refused to give consent and children who gave no consent.

All patients were divided into 2 groups: Group 1 included children with acute pain syndrome in the postoperative period; Group 2 comprised children with chronic pain syndrome. Each of these groups was divided into subgroups depending on the patient's age: Group 1a included children at the age of 7–12 years with acute pain syndrome in the postoperative period; Group 1b comprised children at the age of 13–18 years with acute pain syndrome in the postoperative period; Group 2a included children at the age of 7–12 years with chronic pain syndrome; Group 2b included children at the age of 13–18 years with chronic pain syndrome.

All patients underwent anterior abdominal wall surgery under general anesthesia. Postoperative pain management included opioids and nonsteroidal anti-inflammatory drugs, if needed. The assessment of acute pain and the quality of pain management was carried out by means of the Visual Analogue Scale (VAS), the Face, Legs, Activity, Cry, Consolability (FLACC) scale, the Behavioral Pain Scale (BPS) (facial expression, upper limb movements, compliance with mechanical ventilation). The indicators of the VAS, BPS, FLACC scale were determined on the 1$^{st}$, 2$^{nd}$, and 3$^{rd}$ days after surgery, respectively, in all children. The Douleur Neuropathique 4 Questions (DN4) neuropathic pain diagnostic questionnaire and the Leeds Assessment of Neuropathic Symptoms and Signs (LANSS) Pain Scale (Bennett M, 2001) were used to assess the presence of chronic or neuropathic pain.

After a telephone survey with patients under study or their parents / guardians on the presence of pain at surgery sites at three and six months after surgery, children accompanied by their parents / guardians were invited for a clinical examination at the hospital. First, patients were informed about the purpose of the study once again, then children, adolescents, their parents / guardians signed the informed consent form and the DN4 and LANSS questionnaires were applied to all the participants.

During treatment, vital signs, including heart rate (HR), breathing rate (BR), oxygen saturation ($SpO_2$), blood pressure (BP), were monitored. Laboratory parameters, including leukocyte count, blood glucose level, erythrocyte sedimentation rate (ESR), were determined as well. In addition, the length of stay in the intensive care unit, the surgical department and the overall length of hospital stay were determined.

All clinical and laboratory studies were carried out in accordance with the World Medical Association Declaration of Helsinki «Ethical Principles for Medical Research Involving Human Subjects». Prior to a subject's participation in the study, the written informed consent form was signed by each subject (parents / guardians). The manuscript was approved by the Ethics Committee of the Communal Non-Profit Enterprise «Ivano-Frankivsk Regional

**Table 1**
Distribution of patients by age, gender, and body weight

| Indicator | Group 1a (7–12 years) n=44 | Group 1b (13–18 years) n=17 | Group 2a (7–12 years) n=24 | Group 2b (13–18 years) n=6 |
|---|---|---|---|---|
| | M±m | M±m | M±m | M±m |
| Age, years | 8.92±0.38 | 15.23±0.43 | 8.82±0.35 | 13.59±0.42* |
| Body weight, kg | 28.43±1.37 | 57.38±3.29 | 29.95±1.84 | 59.17±3.39 |
| Boys,% | 52.27±7.53 | 88.24±7.81* | 58.33±10.06 | 66.67±19.25 |
| Girls,% | 47.73±7.53 | 11.76±7.81 | 41.67±9.86 | 33.33±19.25 |

*Note*: * – a significant difference in the corresponding age groups (p<0.05).

**Table 2**
Results of studying the indicators of vital signs in patients

| Indicator | | Group 1a (7–12 years) n=46 | Group 1b (13–18 years) n=15 | Group 2a (7–12 years) n=25 | Group 2b (13–18 years) n=6 |
|---|---|---|---|---|---|
| | | M±m | M±m | M±m | M±m |
| HR, beats per minute | Day 1 | 90.93±3.67 | 81.93±2.39* | 90.24±1.86 | 84.67±4.6 |
| | Day 3 | 89.08±3.98 | 83.08±2.94 | 86.92±1.7 | 84.5±3.96 |
| BR, beats per minute | Day 1 | 21.67±0.58 | 19.4±0.43 | 20.76±0.33 | 19.67±0.66 |
| | Day 3 | 21.0±0.53 | 19.33±0.51 | 20.48±0.46 | 20.17±0.79 |
| $SpO_2$,% | Day 1 | 97.65±0.2 | 97.73±0.18 | 98.04±0.11 | 97.67±0.45 |
| | Day 3 | 98.2±0.17 | 98.08±0.22 | 98.28±0.14 | 98±0.25 |
| BP, mm Hg | Day 1 | 100.13±2.01/ 63.11±2.02 | 115.73±2.57/* 73.6±1.71* | 106.6±1.64/ 68.56±1.25 | 115.5±3.67/ 69.83±3.18 |
| | Day 3 | 103.79±2.05/ 65.79±1.95 | 111.67±2.48/ 72.5±2.43* | 107.68±1.36/ 68.72±1.33 | 114.17±2.39/ 72.67±2.6 |

*Note*: * – a significant difference between Group 1b and Group 1a (p<0.05).

Children's Clinical Hospital of Ivano-Frankivsk Regional Council» as evidenced by an Excerpt from the Minute of the Committee Meeting No. 2 dated February 24, 2022.

The results obtained were statistically processed using statistical measures of variation, correlation analysis, Student's t-test. Differences were considered statistically significant at p<0.05. The proportions were statistically compared by using a z-test.

## Results and discussion of the study

A total of 96 children were treated. Four patients refused to participate in a trial, therefore, they were excluded from the study sample. A total of 92 children were included in our study design.

The prevalence of CPSP after herniorrhaphy, orchiopexy by Petrivalsky / Schoemaker technique, Ross and Bernardi procedures among children of the Precarpathian region was found to be 33.7%, with a male predominance (61.54±6.5% versus 38.46±8.22%). Chronic pain was found to dominate in younger children (Group 2a) – 80.65% as compared to older children (Group 2b) – 19.35% (p<0.05).

The assessment of age, gender, and body weight in children with acute (Group 1a, 1b) and chronic pain (Group 2a, 2b) found the following: acute pain in children at the age of 7–12 years (Group 1a) did not depend on gender; however, in Group 1b, there was observed an overwhelming male predominance (88.24±7.81% versus 11.76±7.81%, p<0.05). There was a difference in age between Group 1b and Group 2b (15.23±0.43 versus 13.59±0.42, p<0.05); however, there was no difference in body weight (57.38±3.29 versus 59.17±3.39), which indicated the representativeness of the sample (Table 1).

According to the assessment of vital signs (HR, BR, $SpO_2$, BP), in children of Group 1b, HR was 81.93±2.39 that was lower as compared to children of Group 1a – 90.93±3.67, p<0.05; however, it corresponded to a physiological age norm, therefore, it had no effect on result assessment. The difference in BD among children of Group 1b, 2b and Group 1a, 2a was clinically insignificant due to the age-related aspect of these patients. As there were no differences that would be statistically significant both within the group itself and when comparing groups of children with acute and chronic pain, the use of the indicators given for predicting chronic pain syndrome in children at the age of 7–18 years is unreasonable (Table 2).

**Table 3**
Results of laboratory parameter study

| Parameter | | Group 1a (7–12 years) n=46 | Group 1b (13–18 years) n=15 | Group 2a (7–12 years) n=25 | Group 2b (13–18 years) n=6 |
|---|---|---|---|---|---|
| | | M±m | M±m | M±m | M±m |
| Leukocytes, $10^9$/l | Day 1 | 7.53±0.66 | 6.87±0.79 | 7.58±0.53 | 6.96±0.86 |
| | Day 3 | 7.27±0.5 | 6.87±0.79 | 7.06±0.44 | 7.05±0.79 |
| ESR, mm/hr | Day 1 | 5.39±0.72 | 4.73±0.66 | 5.2±0.49 | 4.66±0.56 |
| | Day 3 | 5.7±0.78 | 5.16±0.57 | 5.04±0.24 | 5.66±0.66 |
| Glucose, mmol/L | Day 1 | 4.86±0.18 | 4.67±0.21 | 4.71±0.11 | 5.23±0.36 |
| | Day 3 | 4.7±0.15 | 4.58±0.15 | 4.55±0.08 | 5.0±0.32 |

**Table 4**
Results of studying patient pain management

| Indicator | Group 1a (7–12 years) n=46 | Group 1b (13–18 years) n=15 | Group 2a (7–12 years) n=25 | Group 2b (13–18 years) n=6 |
|---|---|---|---|---|
| | M±m | M±m | M±m | M±m |
| Fentanyl, ml | 2.89±0.27 | 3.0±0.32 | 2.84±0.24 | 2.5±0.34 |
| Analgene, ml | 2.24±0.41 | 5.83±0.3* | 3.14±0.5 | 1.82±0.22* |
| Paracetamol, ml | 101.0±47.13 | 42.0±11.02* | 119.62±38.97 | 83.25±17.38*,** |

*Notes*: *p<0.05 – a significant difference between children within the group; **p<0.05 – a significant difference between children of Group 1 and Group 2.

**Table 5**
Results of studying acute pain levels in children (points)

| Indicator | | Group 1a (7–12 years) n=46 | Group 1b (13–18 years) n=15 | Group 2a (7–12 years) n=25 | Group 2b (13–18 years) n=6 |
|---|---|---|---|---|---|
| | | M±m | M±m | M±m | M±m |
| FLACC scale | Day 1 | 4.78±0.32 | 4.7±0.17 | 5.48±0.13** | 5.5±0.22** |
| | Day 2 | 3.91±0.28 | 3.93±0.15 | 4.52±0.14** | 4.1±0.11 |
| | Day 3 | 3.45±0.40 | 3.22±0.22 | 4.0±0.16 | 4.01±0.01** |
| BPS | Day 1 | 4.86±0.26 | 5.0±0.19 | 5.48±0.14** | 5.33±0.21 |
| | Day 2 | 3.91±0.25 | 3.93±0.15 | 4.6±0.18** | 4.16±0.16 |
| | Day 3 | 3.58±0.24 | 3.33±0.16 | 3.85±0.1 | 4.11±0.29** |
| VAS | Day 1 | 4.76±0.28 | 4.93±0.24 | 5.36±0.18 | 5.16±0.16 |
| | Day 2 | 3.58±0.28 | 3.8±0.2 | 4.48±0.16** | 4.16±0.16 |
| | Day 3 | 3.2±0.36 | 3.44±0.17 | 3.95±0.11** | 4.0±0 |

*Note*: **p<0.05 – a significant difference between children of Group 1 and Group 2.

In-depth analysis of laboratory parameters revealed no difference in leukocyte count, ESR, and blood glucose level in children of all groups during the entire period of hospital treatment (Table 3).

During the perioperative period, all patients received anesthesia using opioid and non-opioid analgesics. The amount of intraoperatively administered fentanyl did not differ in patients with acute and chronic pain syndrome. For non-opioid pain management, intravenous administrations of analgene (metamizole sodium) and paracetamol were used. There was an increased need for postoperative pain management with analgene in children of Group 1b (5.83±0.3 ml) as compared to children of Group 1a (2.24±0.41 ml, p<0.05). Paracetamol, as a component of a multimodal analgesic regimen, was administered in significantly greater amounts in children of Group 2a as compared to children of Group 2b (119.62±38.97 ml versus 83.25±17.38 ml, respectively, p<0.05). Paracetamol was predominantly used in older children with chronic pain as compared to older children with acute pain (83.25±17.38 ml and 42.0±11.02 ml in Group 2b and Group 1b, respectively, p<0.05). This may be due to gene-

**Table 6**
Results of assessing chronic pain level in children (points)

| Indicator | | Group 2a (7–12 years) n=25 | Group 2b (13–18 years) n=6 |
|---|---|---|---|
| | | M±m | M±m |
| DN-4 | 3 months after treatment | 5.4±0.18 | 4.16±0.16* |
| | 6 months after treatment | 4.08±0.05 | 3.83±0.16 |
| LANSS | 3 months after treatment | 13.52±0.19 | 13.5±0.67 |
| | 6 months after treatment | 12.92±0.14 | 12.3±0.33 |

*Note*: *p<0.05 – a significant difference between Group 2b and Group 2a.

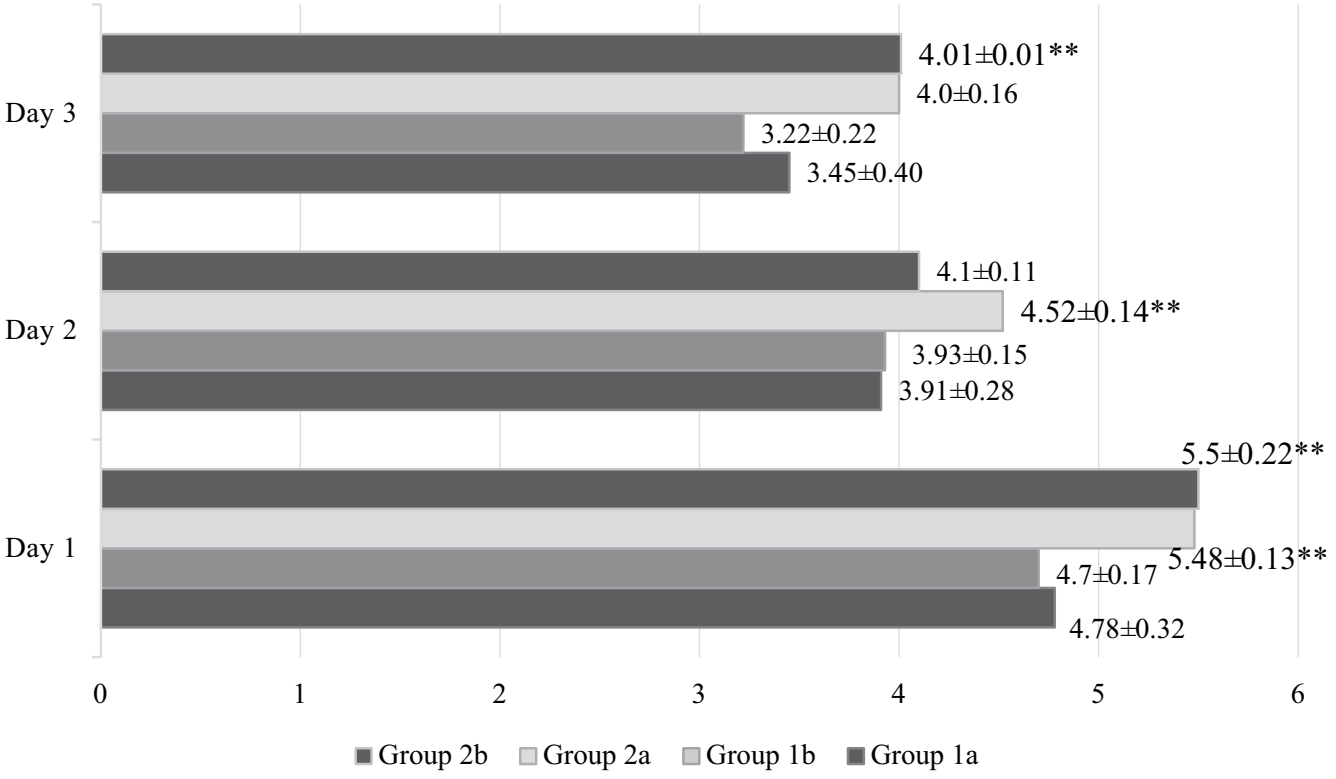
tic elements involved with non-opioid drug tolerance in children with chronic pain syndrome, which may have a prognostic effect (Table 4).

Table 5 presents the results of analyzing the indicators of acute pain assessment in children.

In Group I, the mean FLACC scores were the same (p>0.05) from the 1st to the third day of treatment in all age categories: they decreased from 4.78±0.32 and 4.7±0.17 to 3.45±0.4 and 3.22±0.22 in Group 1a and Group 1b, respectively. However, in Group 2a and Group 2b, the mean FLACC scores were significantly higher as compared to Group 1a and Group 1b: on the first day of treatment, they were 5.48±0.13 and 5.5±0.22 and, on the third day of treatment, they decreased to 4.0±0.16 and 4.01±0.01 (p<0.05) (Fig. 1).

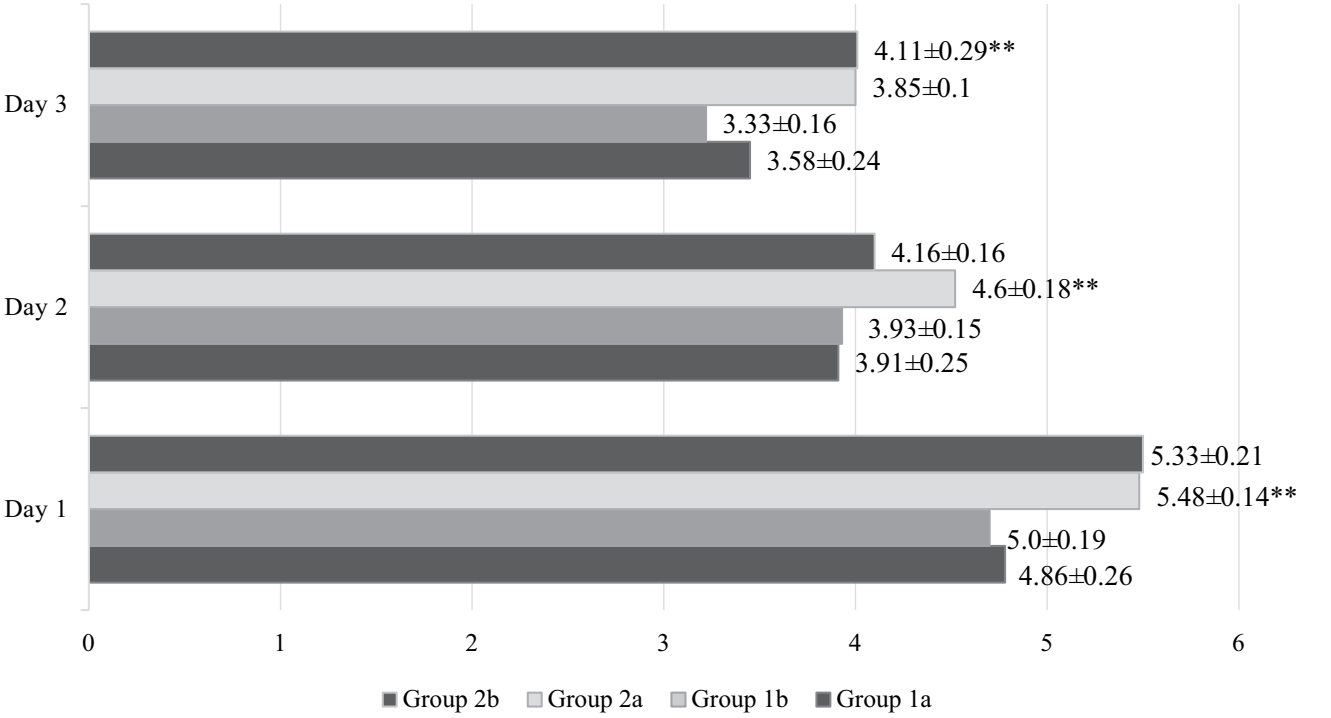
The same results were obtained when analyzing the other two scales. According to the BPS, on the first day of treatment, the indicators were significantly higher in children of Group 2a as compared to children of Group 1a – 5.48±0.14 versus 4.86±0.26, respectively, p<0.05. On the second and third days of treatment, the indicators given were higher in children of Group 2a and Group 2b as compared to those in children of Group 1a and Group 1b, respectively (p<0.05) (Fig. 2).

The VAS confirmed greater pain intensity in children of Group 2a on the 2nd and 3d days of treatment as compared to children of Group 1a (4.48±0.16 and 3.95±0.11 versus 3.58±0.28 and 3.2±0.36, respectively, p<0.05). The results of acute pain assessment in children may indicate central sensitization, hyperalgesia, and no adequate effect when using




*Note*: **p<0.05 – a significant difference between children of Group 1 and Group 2.

**Fig. 1.** Results of assessing acute pain levels in children according to the FLACC scale (points)




*Note*: **p<0.05 – a significant difference between children of Group 1 and Group 2.

**Fig. 2.** Results of assessing acute pain levels in children according to the BPS (points)

opioid and non-opioid analgesics, which demands their unjustified use in greater amounts in children with chronic pain syndrome (Fig. 3).

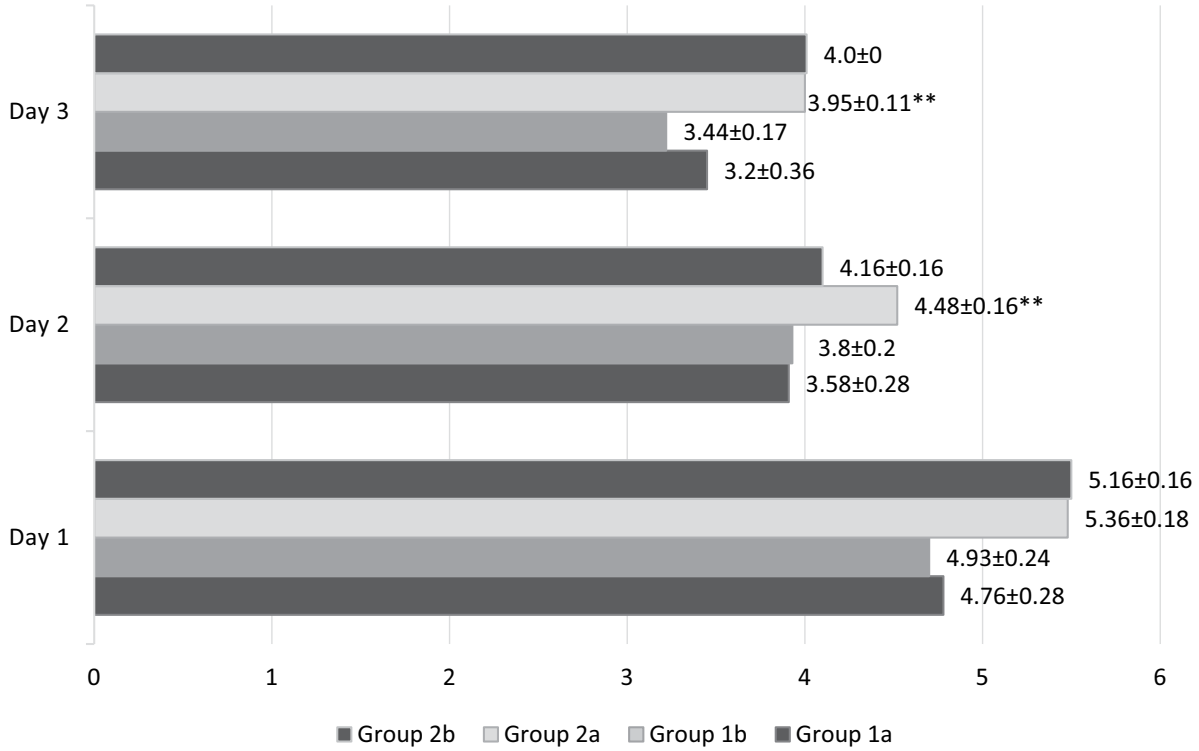
According to the results of assessing the indicators of chronic pain scales, in children of Group 2b, pain indicators decreased at three months after treatment only (4.16±0.16 versus 5.4±0.18 in children of Group 2a, p<0.05), remaining quite high at six months after surgical treatment (Table 6).

There was almost no difference in the length of stay in the surgical department between groups. Children of Group 2b were discharged from the hospital much faster as compared to children of other groups (day 2.1±0.16 versus day 3.28±0.24 in Group 2a, day 3.0±0.30 in Group 1b, and day 3.06±0.34 in Group 1a, respectively, p<0.05) (Fig. 4).

Thus, risk factors for CPSP are diagnosed throughout the entire perioperative period [20]. Perioperative pain management in children is often insufficient, and up to 50% of patients experience inadequate pain control and serious side effects of opioid analgesics [26]. According to R. McBain et al (2018), the prevalence of chronic pain correlates with a significant increase in opioid use [13]. There is evidence that morphine and other opioids induce neuroinflammation, partially mediated through glial Toll-like receptor 4 (TLR4) expression [8].

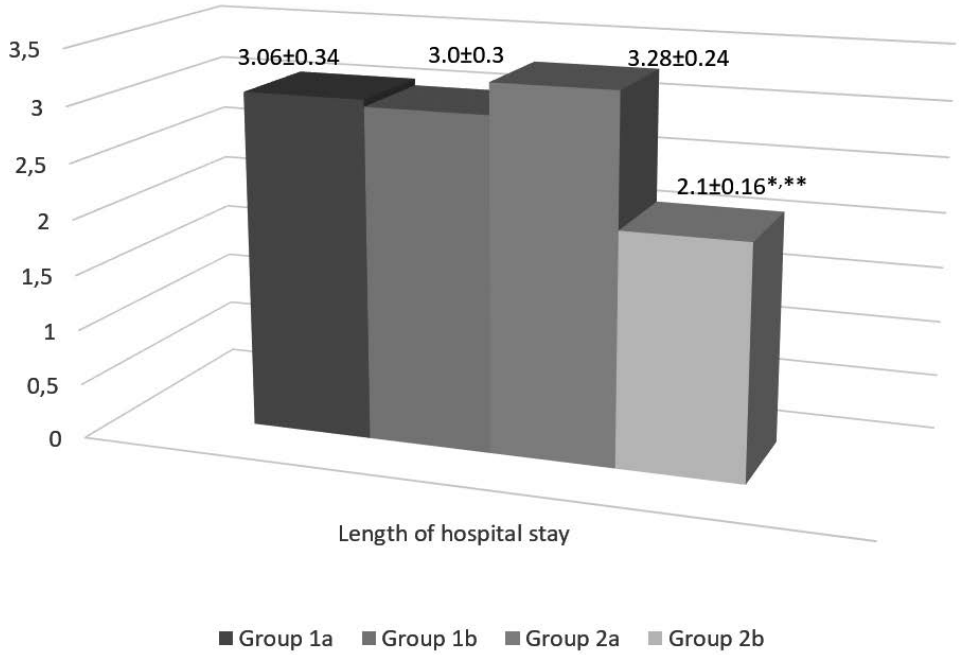
Inguinal hernia repair is a common surgical procedure performed in children worldwide [14]. Pain management after herniotomy is of great importance for functional restoration and subjective comfort of patients [26]. Pain management in abdominal wall surgery varies significantly and there is no consensus on its optimal strategy. Open herniorrhaphy in children is a day-case surgery and requires effective pain management for early discharge from hospital. There are a wide range of local and regional nerve blocks for effective control of postoperative pain in children with hernia, varicocele, hydrocele, that allows for reducing opioid use [23,24]. The use of ultrasound guidance in regional analgesia increased the safety and effectiveness of these blocks [31]. Inadequate pain management after anterior abdominal wall surgery may result in chronic pain [12]. In our study, it was confirmed that children experiencing chronic pain syndrome paradoxically reacted to opioid analgesics.

To date, there is no universal method of adequate pain control after herniorrhaphy [3]. The ESPA Pain Ladder approach to advanced pain management in herniotomy recommends intravenous paracetamol loading dose, rectal non-steroidal anti-inflammatory drugs (NSAIDs), and ultrasound-guided peripheral nerve blocks intraoperatively [24]. Therefore, in our study, pain assessment scales were used to determine the effectiveness of pain management when using paracetamol and analgene (metamizole sodium). Pain intensity on the BPS, VAS, and FLACC scale was independently assessed by patients or parents / guardians and physicians, and data were recorded in the




*Note:* **p<0.05 – a significant difference between children of Group 1 and Group 2.

**Fig. 3.** Results of assessing acute pain levels in children according to the VAS (points)




*Notes*: *p<0.05 – a significant difference between children within the group; **p<0.05 – a significant difference between children of Group 1 and Group 2.

**Fig. 4.** Overall length of hospital stay (days)

patient questionnaire and inpatient record. Pain monitoring was performed on the 1st, 2nd, and 3rd days, respectively, in all children. The FLACC scale was used for pain assessment in all age groups, although it is better suited for children under seven years of age. Children, who have high indicators of pain intensity in the postoperative period, have been known to require significantly greater amounts of analgesics. Later they develop chronic pain syndrome. The data available in the literature point to a phenomenon known as opioid-induced hyperalgesia. To

**Table 7**
Correlation between pain intensity and an opioid analgesic

| Indicator | | Fentanyl, r | | | |
|---|---|---|---|---|---|
| | | **Group 1a (7–12 years) n=46** | **Group 1b (13–18 years) n=15** | **Group 2a (7–12 years) n=25** | **Group 2b (13–18 years) n=6** |
| FLACC scale | Day 1 | 0.41 | 0.58 | 0.15 | -0.22 |
| | Day 2 | 0.21 | 0.56 | 0.19 | - |
| | Day 3 | -0.27 | -0.28 | 0.56 | - |
| VAS | Day 1 | 0.49 | 0.53 | -0.13 | 0.29 |
| | Day 2 | 0.28 | -0.22 | 0.12 | - |
| | Day 3 | -0.27 | -0.47 | 0.53 | - |

**Table 8**
Correlation between pain intensity and a non-opioid analgesic

| Indicator | | Analgene, r | | | |
|---|---|---|---|---|---|
| | | **Group 1a (7–12 years) n=46** | **Group 1b (13–18 years) n=15** | **Group 2a (7–12 years) n=25** | **Group 2b (13–18 years) n=6** |
| FLACC scale | Day 1 | 0.29 | 0.13 | 0.49 | 0.34 |
| | Day 2 | -0.01 | -0.08 | 0.54 | - |
| | Day 3 | 0.02 | 0.17 | 0.02 | - |
| VAS | Day 1 | 0.35 | 0.36 | 0.59 | 0.16 |
| | Day 2 | 0.02 | 0.22 | 0.42 | 0.59 |
| | Day 3 | -0.11 | -0.28 | 0.19 | - |

**Table 9**
Correlation between pain intensity and a non-opioid analgesic

| Indicator | | Paracetamol, r | | | |
|---|---|---|---|---|---|
| | | **Group 1a (7–12 years) n=46** | **Group 1b (13–18 years) n=15** | **Group 2a (7–12 years) n=25** | **Group 2b (13–18 years) n=6** |
| FLACC scale | Day 1 | 0.02 | - | -0.24 | 0.29 |
| | Day 2 | 0.09 | - | -0.24 | - |
| | Day 3 | 0.15 | - | 0.57 | - |
| VAS | Day 1 | 0.35 | - | -0.16 | 0.99 |
| | Day 2 | 0.43 | - | -0.35 | - |
| | Day 3 | 0.31 | - | -0.14 | - |

stop the pain signaling process, complete tissue healing is needed. However, if nociceptive stimuli persist, pathophysiological changes occurring at the peripheral, spinal, and supraspinal levels can cause chronic pain [16]. Increasing evidence suggests the involvement of the immune system, including TLR4 (Toll Like Receptors-4), in the development of chronic pain syndrome [6].

An analysis of the value of the correlation coefficient between pain intensity and an opioid analgesic allowed for suggestion that intraoperative fentanyl use had no effect on pain relief in patients of Group 2 (the FLACC scale (r=0.15 and r= –0.22) and the VAS (r= –0.13 and r=0.29) on the 1st day of treatment in Group 2a and Group 2b, respectively). In contrast, in the postoperative period, in patients of Group 2, the paradoxical effect of fentanyl on pain (increased pain intensity) was observed (the FLACC scale (r=0.56) and the VAS (r=0.53) on the third day of treatment in Group 2a, respectively). In patients of Group 2, there was a direct correlation, indicating pain increase with an increase in the dose of the drug.

The change in the value of the correlation coefficient in Group 1 is indicative (an inverse correlation was observed, indicating pain relief in case of administration of the preparation). Thus, on the first day of treatment, in Group 1a and Group 1b, the correlation coefficient value according to the FLACC scale was r=0.41 and r=0.58, and r=0.49 and r=0.53 according to the VAS, respectively. On the third day of treatment, the indicators given were as follows: ac-

cording to the FLACC scale – r= –0.27 and r= –0.28, and according to the VAS – r= –0.27 and r= –0.47 in Group 1a and Group 1b, respectively (Table 7).

An analysis of the correlation between pain intensity and non-opioid analgesic use did not confirm a significant difference between the groups of patients with acute and chronic pain syndrome (Table 8). Given that, we can affirm that there is no relationship between analgene dose and pain syndrome level, therefore, increasing the amount or dose of this preparation is unreasonable. In inpatient settings, where analgene is widely used for pain relief in the postoperative period, this strategy needs rethinking. If there is no reduction in pain intensity on the VAS and FLACC scale after analgene administration, the group of analgesics needs to be changed, or regional analgesia techniques should be used.

The assessment of the correlation coefficient indicated that there was a close positive correlation between paracetamol administration and pain syndrome in patients of Group 1. We can assume that intraoperative use of paracetamol had no effect on pain relief in patients of Group 2a (the FLACC scale – r= –0.24 and the VAS – r= –0.16 on the 1st day of treatment). In the postoperative period, there was no adequate effect of paracetamol on reducing pain intensity in patients of Group 2a (the FLACC scale – r= –0.16 and the VAS – r= –0.16 on the third day of treatment, respectively), (Table 9).

## Conclusions

The results of our study confirm the presence of pain of varying severity in children after anterior abdominal wall surgery.

– Chronic pain, which, in fact, occurs due to an ineffective intra- and postoperative analgesia, was found to affect 33.7% of children who underwent herniorrhaphy, orchiopexy by Petrivalsky / Schoemaker technique, Ross and Bernardi procedures.

– Ineffective perioperative pain management requires the use of additional analgesia techniques, including regional ones.

– Patients, who were diagnosed with chronic pain at six months after treatment, reported its presence even at 3 months after surgery.

– We recommend that physicians, who examine patients after surgery on the anterior abdominal wall, ask them about the presence of persistent pain and functional disorders.

– Prolonged pain is a bad and unpleasant experience, causing children and adolescents to wonder why the pain did not go away soon after surgery if it was done to help them. They may feel that surgery causes pain rather than eliminates it. In addition, both parents and teachers underestimate and neglect children's reports of pain, as well as biopsychosocial factors associated with persistent pain, including fear.

– Chronic pain syndrome isolates children socially, interferes with daily school activities and rest, as well as reduces their physical and mental development.

*No conflict of interests was declared by the authors.*

**References/Література**


1. Aasvang EK, Kehlet H. (2007). Chronic pain after childhood groin hernia repair. Journal of Pediatric Surgery. 42 (8): 1403–1408. doi: 10.1016/j.jpedsurg.2007.03.042.
2. Andresen K, Rosenberg J. (2018). Management of chronic pain after hernia repair. Journal of Pain Research. 11: 675–681. doi: 10.2147/JPR.S127820.
3. Baird R, Guilbault MP, Tessier R, Ansermino JM. (2013). A systematic review and meta-analysis of caudal blockade versus alternative analgesic strategies for pediatric inguinal hernia repair. Journal of Pediatric Surgery. 48: 1077–1085. doi: 10.1016/j.jpedsurg.2013.02.030.
4. Batoz H, Semjen F, Bordes–Demolis M, Bénard A, Nouette–Gaulain K. (2016). Chronic postsurgical pain in children: prevalence and risk factors. A prospective observational study. British Journal of Anaesthesia. 117: 489–496. doi: 10.1093/bja/aew260.
5. Chow CHT, Schmidt LA, Buckley DN. (2020). The role of anxiety and related states in pediatric postsurgical pain. Canadian Journal of Pain. 4 (4): 26–36. doi: 10.1080/24740527.2020.1847600.
6. Dmytriiev DV, Zaletskyi BV, Dmytriieva KYu. (2017). Substantiation of application of the multimodal analgesia schemes for postoperative anesthesia in children. Klinicheskaia khirurgiia. 11: 54–56. doi: 10.26779/2522-1396.2017.11.54.
7. Eccleston C, Fisher E, Howard RF, Slater R, Forgeron P et al. (2021). Delivering transformative action in paediatric pain: a Lancet Child & Adolescent Health Commission. The Lancet. Child & Adolescent Health. 5 (1): 47–87. doi: 10.1016/S2352-4642(20)30277–7.
8. Grace PM, Strand KA, Galer EL, Urban DJ, Wang X et al. (2016). Morphine paradoxically prolongs neuropathic pain in rats by amplifying spinal NLRP3 inflammasome activation. Proceedings of the National Academy of Sciences of the United States of America. 113 (24): E3441–E3450. doi: 10.1073/pnas.1602070113.
9. Groenewald CB, Rabbitts JA, Schroeder DR, Harrison TE. (2022). Prevalence of moderate-severe pain in hospitalized children. Paediatric Anaesthesia. 22: 661–668. doi: 10.1111/j.1460-9592.2012.03807.x.
10. Hernia Surge Group. (2018). International guidelines for groin hernia management. Hernia. 22 (1): 1–165. doi: 10.1007/s10029-017-1668-x.
11. Incledon E, O'Connor M, Giallo R, Chalkiadis GA, Palermo TM. (2016). Child and family antecedents of pain during the transition to adolescence: a longitudinal population-based study. The Journal of Pain. 17 (11): 1174–1182. doi: 10.1016/j.jpain.2016.07.005.
12. Kristensen AD, Ahlburg P, Lauridsen MC, Jensen TS, Nikolajsen L. (2012). Chronic pain after inguinal hernia repair in children. British Journal of Anaesthesia. 109 (4): 603–608. doi: 10.1093/bja/aes250.
13. McBain R, Rose AJ, LaRochelle MR. (2018). The U. S. opioid epidemic: one disease, diverging tales. Preventive Medicine. 112: 176–178. doi: 10.1016/j.ypmed.2018.04.023.
14. Morini F, Dreuning KMA, Lok MJH, Wester T, Derikx JPM et al. (2022). Surgical management of pediatric inguinal hernia: a systematic review and guideline from the European pediatric surgeons' association evidence and guideline Committee. European Journal of Pediatric Surgery. 32 (3): 219–232. doi: 10.1055/s-0040-1721420.

15. Mossetti V, Boretsky K, Astuto M, Locatelli BG, Zurakowski D et al. (2018). Persistent pain following common outpatient surgeries in children: a multicenter study in Italy. Paediatric Anaesthesia. 28 (3): 231–236. doi: 10.1111/pan.13321.
16. Nicotra L, Loram LC, Watkins LR, Hutchinson MR. (2012). Toll-like receptors in chronic pain. Experimental Neurology. 234 (2): 316–329. doi: 10.1016/j.expneurol.2011.09.038.
17. Perova–Sharonova. (2020). Comparison of different methods of postoperative analgesia in children with peritonitis complicated with intra-abdominal hypertension. Paediatric Surgery. Ukraine. 1 (66): 41–50. [Перова–Шаронова ВМ. (2020). Порівняння різних методів післяопераційного знеболення у дітей з перитонітом, ускладненим інтраабдомінальною гіпертензією. Хірургія дитячого віку. 1 (66): 41–50]. doi: 10.15574/PS.2020.66.41.
18. Rabbitts JA, Fisher E, Rosenbloom BN, Palermo TM. (2017). Prevalence and predictors of chronic postsurgical pain in children: a systematic review and meta-analysis. The Journal of Pain. 18 (6): 605–614. doi: 10.1016/j.jpain.2017.03.007.
19. Rosenbloom BN, Pagé MG, Isaac L, Campbell F, Stinson JN, Wright JG, Katz J. (2019). Pediatric chronic postsurgical pain and functional disability: a prospective study of risk factors up to one year after major surgery. Journal of Pain Research. 12: 3079–3098. doi: 10.2147/JPR.S210594.
20. Schug S, Bruce J. (2017). Risk stratification for development of chronic post-surgical pain. Pain Reports. 2 (6): e627. doi: 10.1097/PR9.0000000000000627.
21. Schug SA, Lavand'homme P, Barke A, Korwisi B, Rief W, Treede R, IASP Taskforce for the Classification of Chronic Pain. (2019). The IASP classification of chronic pain for ICD-11: chronic postsurgical or posttraumatic pain. Pain. 160 (1): 45–52. doi: 10.1097/j.pain.0000000000001413.
22. Skyba VV, Ivanko AV, Voytyuk NV, Lysytsia VV, Kosiuk MA, Korchemnyi IO. (2021). Postoperative condition of patients as a result of treatment of inguinal hernias by laparoscopic and open methods. Paediatric Surgery. Ukraine. 3 (72): 30–35. [Скиба ВВ, Іванько ОВ, Войтюк НВ, Лисиця ВВ та ін. (2021). Післяопераційний стан пацієнтів у результаті лікування пахових гриж лапароскопічним та відкритим методами. Хірургія дитячого віку. 3 (72): 30–35]. doi: 10.15574/PS.2021.72.30.
23. Visoiu M. (2015). Paediatric regional anaesthesia: a current perspective. Current Opinion in Anaesthesiology. 28: 577–582. doi: 10.1097/ACO.0000000000000238.
24. Vittinghoff M, Lönnqvist PA, Mossetti V, Heschl S, Simic D et al. (2018). Postoperative pain management in children: guidance from the pain Committee of the European Society for paediatric Anaesthesiology (EspA pain management ladder initiative). Paediatric Anaesthesia. 28: 493–506. doi: 10.1111/pan.13373.
25. Vlasov OO. (2020). Modern solution to the problem of pain relief in newborns with necrotizing enterocolitis. Modern Pediatrics. Ukraine. 7 (111): 47–52. [Власов ОО. (2020). Сучасне вирішення проблеми знеболювання в новонароджених із некротизуючим ентероколітом. Сучасна педіатрія. Україна. 7 (111): 47–52]. doi: 10.15574/SP.2020.111.47.
26. Walco GA, Cassidy RC, Schechter NL. (1994). Pain, hurt, and harm. The ethics of pain control in infants and children. The New England Journal of Medicine. 331 (8): 541–544. doi: 10.1056/NEJM199408253310812.
27. Walker SM. (2015). Pain after surgery in children: clinical recommendations. Current Opinion in Anaesthesiology. 28: 570–576. doi: 10.1097/ACO.0000000000000227.
28. Walters CB, Kynes JM, Sobey J, Chimhundu-Sithole T, McQueen KAK. (2018). Chronic Pediatric Pain in Low- and Middle-Income Countries. Children (Basel). 5 (9): 113. doi: 10.3390/children5090113.
29. Werner MU, Kongsgaard UE. (2014). I Defining persistent post-surgical pain: is an update required? British Journal of Anaesthesia. 113 (1): 1–4. doi: 10.1093/bja/aeu012.
30. Wicksell RK, Kanstrup M, Kemani MK, Holmström L. (2016). Pain interference mediates the relationship between pain and functioning in pediatric chronic pain. Frontiers in Psychology. 7: 1978. doi: 10.3389/fpsyg.2016.01978.
31. Wiegele M, Marhofer P, Lönnqvist PA. (2019). Caudal epidural blocks in paediatric patients: a review and practical considerations. British Journal of Anaesthesia. 122: 509–517. doi: 10.1016/j.bja.2018.11.030.
32. Williams G, Howard RF, Liossi C. (2017). Persistent postsurgical pain in children and young people: prediction, prevention, and management. Pain Reports. 2 (5): e616. doi: 10.1097/PR9.0000000000000616.



**Відомості про авторів:**

***Семкович Ярослав Васильович*** *– к.мед.н., доц. каф. анестезіології та інтенсивної терапії Івано-Франківського НМУ. Адреса: м. Івано-Франківськ, вул. Галицька, 2. https://orcid.org/0000–0002–8319–022X.*

***Дмитрієв Дмитро Валерійович*** *– д.мед.н., проф. каф. анестезіології Вінницького НМУ імені М. І. Пирогова. Адреса: м. Вінниця, вул. Пирогова, 56. https://orcid.org/0000–0001–6067–681X.*

***Русак Петро Степанович*** *– д.мед.н., проф. каф. дитячої хірургії НМУОЗ України імені П. Л. Шупика, зав. хірургічного відділення №1 КНП «Житомирська обласна дитяча клінічна лікарня» Житомирської обласної ради. Адреса: Житомирський район, с. Станишівка, Сквирське шосе, 6. https://orcid.org/0000–0002–1267–0816.*

***Запорожан Степан Йосипович*** *– д.мед.н., проф., проректор з науково-педагогічної та лікувальної роботи Тернопільського НМУ імені І. Я. Горбачевського, засл. працівник охорони здоров'я України. Адреса: м. Тернопіль, майдан Волі, 1. https://orcid.org/0000–0002–4038–2010.*

***Назарчук Олександр Адамович*** *– д.мед.н., доц. каф. мікробіології Вінницького НМУ імені М. І. Пирогова. Адреса: м. Вінниця, вул. Пирогова, 56. https://orcid.org/0000–0001–7581–0938.*


Стаття надійшла до редакції 23.05.2022 р., прийнята до друку 19.09.2022 р.