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SPONTANEOUS HEMOPNEUMOTHORAX: 23-YEAR PATH TO NON-INTUBATED SURGICAL TREATMENT

Vasyl V. Tkalich[1], Valentyna I. Borysova[2], Sergii I. Savoliuk[3], Yurii V. Nedilia[1], Oleksandr V. Galiiev[2]

[1]Kyiv City Hospital No. 12, Kyiv, Ukraine
[2]Kyiv City Hospital No. 10, Kyiv, Ukraine
[3]Shupyk National Healthcare University of Ukraine, Kyiv, Ukraine

Abstract

Introduction. Spontaneous hemopneumothorax is a rare but potentially fatal complication of spontaneous pneumothorax, with a reported incidence of 0.5%–12%. It is characterized by the rapid accumulation of blood and air in the pleural cavity, most often due to rupture of fragile vascularized adhesions. SHP may cause acute respiratory compromise and hemodynamic instability, and if not promptly treated, can progress to shock or death. Although tube thoracostomy is frequently used as an initial intervention, its limitations in preventing clot retention, recurrence, and secondary infection are well documented. Despite decades of clinical experience, standardized guidelines regarding anesthetic strategy and timing of surgical intervention remain lacking, and the role of minimally invasive approaches is still under evaluation.
Aim. The objective of this study was to analyze 23 years of single-center experience in SHP management, to describe patient characteristics, perioperative approaches, and outcomes, and to propose a rational treatment algorithm with emphasis on surgical timing, and the feasibility of non-intubated anesthesia within enhanced recovery after surgery protocols.
Materials and methods. A registry of all patients treated for Spontaneous hemopneumothorax at Kyiv City Hospital No. 17 from January 2000 to December 2023 was reviewed. Data included demographics, clinical presentation, imaging, perioperative findings, surgical techniques, anesthetic management, and long-term follow-up.
Results. Thirty patients were surgically treated: thoracotomy (n=18), video-assisted thoracic surgery (n=10), and non-intubated video-assisted thoracic surgery (n=2). Active bleeding was confirmed in 20 cases, all from torn vascular adhesions. Surgery was performed within the first 24 h in 20 patients (66.7%), on days 2-3 in 8 patients (26.7%), and after day 10 in 2 patients (6.7%) with clotted hemothorax.
Conclusions. SHP remains a grave thoracic emergency in which early surgery provides the best chance of survival and avoidance of complications. VATS and NIVATS are feasible and safe alternatives to open thoracotomy in appropriately selected patients, especially when integrated into ERAS protocols that emphasize early mobilization, reduced analgesic use, and shortened hospital stay. Broader implementation of minimally invasive and non-intubated techniques may further optimize outcomes in this high-risk population.

Keywords: **spontaneous hemopneumothorax, thoracic emergency, video-assisted thoracic surgery, non-intubated thoracic surgery, ERAS, vascular adhesion rupture, intrathoracic bleeding**

INTRODUCTION

Spontaneous hemopneumothorax (SHP) is an uncommon but potentially life-threatening complication of spontaneous pneumothorax, with a reported incidence ranging from 0.5% to 12% of cases [1-3]. The condition was first described by Laennec in 1828 during an autopsy, while Whitaker in 1876 reported the first successful treatment by repeated pleural aspirations [4]. The first surgical intervention was performed by Elrod and Murphy in 1948 via open thoracotomy, and subsequent advances in thoracic surgery have markedly reduced mortality, which in early reports reached approximately 33% [5].

According to the Ohmori criteria, SHP is defined as the accumulation of more than 400 mL of blood in the pleural cavity in the absence of trauma or pre-existing pulmonary disease [7-10]. The clinical presentation is typically abrupt and includes acute chest pain, severe dyspnea, cough, and progressive anemia; in advanced cases, hypovolemic shock may occur, depending on the rate and volume of intrapleural hemorrhage.

Diagnosis is established through clinical evaluation combined with imaging and direct procedural confirmation. Upright chest radiography usually demonstrates hydropneumothorax, whereas in hemodynamically unstable patients examined in the supine position, unilateral opacification is often observed. Computed tomography may provide additional detail regarding pleural fluid levels and associated lung pathology. Thoracocentesis or thoracoscopy allows definitive confirmation and assessment of the bleeding source.

Historically, management often relied on tube thoracostomy alone. However, accumulated evidence has demonstrated significant limitations of conservative drainage, including recurrent bleeding, retained clots, and the need for delayed surgical decortication. Current literature increasingly supports early surgical intervention to prevent severe complications such as persistent atelectasis, restrictive ventilatory impairment, and secondary infection of the residual hematoma [9, 12]. Despite these observations, the optimal therapeutic strategy – conservative versus surgical management, and the choice between open thoracotomy and minimally invasive approaches – remains a subject of debate [11-15].

In recent years, attention has shifted toward minimally invasive modalities, particularly video-assisted thoracic surgery (VATS) and its non-intubated variant (NIVATS). These approaches aim to reduce the adverse consequences of intubation, one-lung ventilation, and systemic opioid use [16-23]. Although early results are promising, their role in emergency thoracic surgery is not yet fully established and requires further clinical validation.

AIM

The aim of this study was to comprehensively evaluate a 23-year single-center experience in the management of spontaneous hemopneumothorax, with particular attention to patient demographics, clinical presentation, and intraoperative findings, as well as to critically analyze the evolution of anesthetic and surgical strategies from conventional open thoracotomy to minimally invasive video-assisted and non-intubated approaches. The study further sought to assess both short-term and long-term outcomes, including postoperative recovery, length of stay, and recurrence rates, in order to formulate a rational treatment algorithm that integrates contemporary principles of enhanced recovery after surgery and may guide the choice of optimal timing and technique of intervention in this life-threatening condition.

MATERIALS AND METHODS

This single-center registry analysis was conducted at Kyiv City Hospital No. 17, a tertiary referral facility for thoracic emergencies, and covered the period from January 2000 to December 2023. During this time, 2,596 patients were admitted with spontaneous pneumothorax, of whom 30 (1.15%) were diagnosed with spontaneous hemopneumothorax (SHP) according to the Ohmori criteria, defined as the accumulation of more than 400 mL of blood in the pleural cavity in the absence of trauma or underlying pulmonary disease. The cohort included 28 men and 2 women, aged 21-44 years (mean age 27.7 years). In all cases, SHP represented the first episode of spontaneous pneumothorax; none of the patients had a history of thoracic trauma, prior surgery, or chronic pulmonary disease.

Diagnostic evaluation comprised clinical examination, chest radiography performed in upright or supine position depending on hemodynamic status, and, in selected cases, computed tomography. Thoracoscopy under local anesthesia was performed in 29 patients, allowing assessment of intrapleural blood volume, determination of bleeding activity, and identification of potential sources of hemorrhage. Following thoracoscopy, chest drains were inserted and connected to underwater seal systems. Patients were either referred for urgent surgery or admitted to the ward for observation depending on clinical stability and ongoing bleeding.

Surgical techniques evolved during the study period. Patients were divided into three groups: open thoracotomy (n=18), video-assisted thoracic surgery (VATS; n=10), and non-intubated VATS (NIVATS; n=2). Indications for surgical intervention included high or persistent chest tube output, clotted hemothorax, hemodynamic instability, and persistent air leakage. Thoracotomy was predominantly used in the pre-VATS era, while VATS became standard from 2010 onward, with a shift to the uniportal approach after 2017. NIVATS was introduced in 2017 for carefully selected hemodynamically stable patients.

Anesthetic management was tailored to the surgical technique. Thoracotomy was performed under general anesthesia with muscle relaxation and mechanical ventilation. VATS required intubated anesthesia with one-lung ventilation via double-lumen tube. NIVATS relied on intravenous sedation with dexmedetomidine, propofol, and fentanyl, combined with local infiltration of bupivacaine to attenuate vagal and phrenic reflexes. Standard intraoperative monitoring included ECG, non-invasive blood pressure, oxygen saturation, respiratory rate, capnography, and bispectral index. All patients received intravenous fluid resuscitation, and transfusion of blood products was performed when clinically indicated.

Ethical approval for the study was obtained from the Ethics Committee of Shupyk National Healthcare University of Ukraine (protocol No. 3/10, 31 January 2025). Written informed consent was obtained from all patients in accordance with the Helsinki Declaration, the Council of Europe Convention on Human Rights and Biomedicine, and the national legislation of Ukraine.

Statistical analysis. Owing to the small and unbalanced sample – particularly the NIVATS subgroup (n=2) – formal three-group hypothesis testing was not pursued. Continuous variables are presented as mean±SD and median (IQR); categorical variables as counts and percentages. The NIVATS subgroup is summarized descriptively. Effect sizes with 95% confidence intervals were estimated using non-parametric bootstrap. In a sensitivity analysis, minimally invasive procedures (VATS+NIVATS) were contrasted with thoracotomy using Mann–Whitney tests and permutation-based confidence intervals. All analyses were considered exploratory and hypothesis-generating; no multiplicity adjustments were applied.

RESULTS

During the 23-year observation period, 30 patients with spontaneous hemopneumothorax (SHP) underwent surgical treatment: thoracotomy in 18 cases, video-assisted thoracic surgery (VATS) in 10 cases, and non-intubated VATS (NIVATS) in 2 cases. Intraoperative active bleeding was identified in 20 patients (66.7%), invariably originating from ruptured vascularized pleural adhesions. There was no laterality predominance (right-sided in 16, left-sided in 14). The mean age of the cohort was 27.7 years (range 21-44), and all patients presented with their first episode of spontaneous pneumothorax.

The timing of surgical intervention varied according to clinical severity and diagnostic findings. Twenty patients (66.7%) required surgery within the first 24 h of admission, reflecting acute hemodynamic compromise or uncontrolled intrapleural hemorrhage. Eight patients (26.7%) underwent surgery on days 2-3, primarily due to continued chest tube output or delayed stabilization. Two patients (6.7%) were operated after day 10 for clotted hemothorax, confirmed by imaging and thoracoscopy.

Thoracoscopy under local anesthesia was performed in 29 patients before definitive surgery, enabling estimation of intrapleural blood volume and visualization of bleeding sites. In 59% of cases, the source of hemorrhage could be clearly identified at thoracoscopy. Following this assessment, chest drains (18 Fr) were inserted and connected to underwater seal systems, either serving as a bridge to surgery or as initial stabilization.

Baseline characteristics and perioperative findings are summarized in Table 1.

Table 1

Baseline Characteristics and Perioperative Parameters in SHP (Median [IQR])

Parameter	Open (n=18)	VATS (n=10)	NIVATS (n=2)
Age, years	28 (24-32)	26 (24-29)	31 (29-32)
Laterality (R: L)	10:8	5:5	1:1
Symptom duration, days	2 (1-4)	3 (2-5)	1.5 (1-2)
Time to surgery, days	2 (1-4)	2 (1-3)	1 (1-1)
Initial chest drainage, mL	900 (600-1,400)	800 (500-1,200)	1,400 (1,100-1,700)
Intraoperative blood loss, mL	600 (400-900)	450 (250-700)	575 (500-650)
Length of stay, days	11 (9-15)	10 (8-12)	8 (7-9)
Follow-up, months	120	72	60

Table 2

Indications for Surgical Intervention in SHP

Indication	Open (n=18)	VATS (n=10)	NIVATS (n=2)
High/persistent chest-tube output	16	8	2
Clotted hemothorax	2	2	–

In the thoracotomy group, the median intraoperative blood loss was 600 mL (IQR 400-900). Sixteen patients were hemodynamically stable at admission, whereas two presented with a massive hemothorax (2,000 and 2,500 mL) and severe hypotension, necessitating emergency thoracotomy with transfusion of crystalloids, fresh frozen plasma, and red blood cells. Postoperatively, these patients required opioid analgesia and prolonged drainage. The median length of stay (LOS) after thoracotomy was 11 days (IQR 9-15).

The VATS group demonstrated lower intraoperative blood loss, with a median of 450 mL (IQR 250-700). Patients were extubated in the operating room and monitored in the intensive care unit for 2-4 h before being transferred to the ward. Postoperative analgesia was adequately achieved with NSAIDs alone. Drain management was simplified to a single tube in most cases, and criteria for removal were met earlier, facilitating mobilization. The median LOS in this group was 10 days (IQR 8-12).

The NIVATS subgroup, although small (n=2), provided valuable insights. Both patients were hemodynamically stable, with baseline oxygen saturations of 92% and 94%. Sedation with dexmedetomidine, propofol, and fentanyl combined with regional infiltration provided satisfactory operative conditions. Intraoperative blood loss was moderate (575 mL median). Both patients tolerated the procedure well, with only transient hypercapnia ($EtCO_2$ 57-65 mmHg) resolving upon lung re-expansion. Postoperative recovery was uneventful, with early mobilization initiated within hours. LOS was 8 days (IQR 7-9), the shortest among all groups.

Across the entire cohort, no cases of recurrence were documented during a mean follow-up of 5 years (range 60-120 months). Importantly, while the study sample was relatively small and the NIVATS subgroup particularly limited, the data consistently indicated that minimally invasive surgery (VATS and NIVATS) was associated with shorter hospital stays, reduced analgesic requirements, and smoother recovery compared with thoracotomy, without compromising hemostatic efficacy.

DISCUSSION

This 23-year single-center experience supports early surgical management as the cornerstone of care for spontaneous hemopneumothorax (SHP), aligning with the contemporary shift away from primary tube thoracostomy toward prompt operative control of bleeding, evacuation of clots, and treatment of the underlying pulmonary pathology. In our cohort, two thirds of patients underwent surgery within the first 24 h, and active bleeding – uniformly from ruptured vascularized adhesions – was identified in most cases. These observations are concordant with prior reports that implicate fragile aberrant vessels and adhesional bands as the principal source of hemorrhage in SHP and that emphasize the hazards of expectant management, particularly retained hemothorax, atelectasis, and secondary infection [7-12].

Our findings also corroborate the growing body of evidence favoring minimally invasive approaches, particularly video-assisted thoracic surgery (VATS), for hemostasis, evacuation of clots, bullectomy/adhesiolysis, and pleurodesis. Series by Hwong et al. and Tay et al. reported high rates of VATS feasibility and favorable convalescence compared with open surgery, including shorter drainage duration and hospital stay and fewer postoperative complications [14, 15]. In the present study, VATS was associated with a shorter postoperative length of stay (LOS) on a cohort level (median 10 days) compared with thoracotomy (median 11 days), with a further reduction observed in the two carefully selected non-intubated VATS (NIVATS) cases (median 8 days). While between-group statistical testing is underpowered in our dataset – especially for NIVATS – the directionality of effects is internally consistent and clinically meaningful, and it mirrors advantages reported elsewhere for minimally invasive techniques in thoracic emergencies [11, 13-15].

The role of NIVATS in the emergency thoracic domain merits particular attention. The physiological rationale – avoidance of endotracheal intubation, one-lung ventilation, neuromuscular blockade, and high-dose opioids – has been linked to reduced ventilator-induced lung injury, attenuation of the stress response, and expedited recovery [16-22]. In our limited NIVATS experience, intraoperative conditions were satisfactory with multimodal sedation (dexmedetomidine–propofol–fentanyl) and targeted local anesthetic infiltration, oxygenation remained acceptable under tight facemask delivery, and transient hypercapnia resolved promptly after re-expansion. These perioperative features, together with the shortest LOS in our series, suggest that NIVATS is a feasible option for hemodynamically stable SHP patients in expert hands, provided that strict selection criteria are respected and immediate conversion to intubated anesthesia remains available [15, 22, 23]. Notwithstanding, the very small sample precludes definitive efficacy claims and underscores the need for prospective multicenter evaluation.

Timing of surgery remains a recurrent theme in the SHP literature. Several authors have argued that early intervention reduces the risk of organized/clotted hemothorax and the subsequent need for decortication, while facilitating definitive control of both bleeding and air leak [9, 11, 12, 14, 15]. Our results are concordant: patients treated after day 10 did so precisely because of clotted hemothorax, and the intraoperative burden in delayed cases was greater. In practical terms, our data support a decision pathway in which hemodynamically unstable patients proceed directly to thoracotomy, whereas hemodynamically stable patients – with ongoing output, suspected active bleeding, or substantial pleural burden – are triaged to early VATS (or NIVATS in strictly selected cases), with low threshold for conversion when required.

Integration of enhanced recovery after surgery (ERAS) principles appears synergistic with minimally invasive management. In our practice, standardized warming, prophylaxis for nausea/vomiting, early mobilization, and protocolized drain removal (<200 mL/day) were well tolerated and were not associated with an increase in pleural complications. The observation that NSAIDs sufficed for postoperative analgesia after VATS/NIVATS, in contrast to the frequent opioid requirement after thoracotomy, dovetails with ERAS objectives and likely contributed to earlier ambulation and discharge. Similar benefits of ERAS-aligned care pathways have been reported for non-intubated thoracic surgery and may be particularly relevant in emergent settings where physiological reserve is threatened [17, 20-22].

The pathophysiological pattern observed – in which torn vascular adhesions constitute the bleeding focus – adds

mechanistic coherence to operative strategy. Magnified visualization during VATS facilitates targeted hemostasis and precise stapled resection of culprit bullae/adhesions under direct vision, while enabling thorough clot evacuation and mechanical pleurodesis through minimal access. These technical advantages plausibly explain the consistent trend toward shorter LOS and lower analgesic requirements in our minimally invasive cohorts and are in line with prior thoracoscopic series that documented decreased postoperative pain, shorter drainage duration, and accelerated functional recovery [14, 15].

Strengths of this work include a long observation window with uniform institutional practices, systematic use of preoperative thoracoscopy for diagnostic clarification in the majority of patients, and a coherent perioperative pathway that evolved in a traceable manner from thoracotomy to multiport and then uniportal VATS, with subsequent adoption of NIVATS and ERAS elements. The principal limitations are those inherent to a single-center registry: modest sample size, particularly in the NIVATS subgroup; absence of randomized allocation; and the potential for selection bias as techniques matured over time. Recognizing these constraints, we deliberately refrained from over-interpreting between-group statistics and instead emphasized descriptive distributions (medians and IQRs) and clinically interpretable effect direction. Future research should prioritize multicenter prospective registries or pragmatic trials comparing early VATS versus thoracotomy in SHP, with predefined criteria for NIVATS candidacy, standardized ERAS bundles, and patient-centered outcomes (pain, time to mobilization, quality of life), alongside hard endpoints (re-intervention, readmission, recurrence).

CONCLUSIONS

This long-term institutional analysis confirms that spontaneous hemopneumothorax, although infrequent, constitutes a life-threatening emergency that in most cases necessitates surgical intervention. The majority of patients presented with ongoing intrapleural hemorrhage arising from fragile vascularized adhesions, and conservative management alone proved insufficient to prevent complications. Early operative treatment, ideally within the first 24 hours, was associated with improved outcomes, particularly by avoiding the development of clotted hemothorax and reducing perioperative morbidity. The progressive shift from open thoracotomy toward video-assisted thoracic surgery and, more recently, to non-intubated approaches demonstrates a clear trend toward minimally invasive and physiology-preserving modalities. In this context, both VATS and NIVATS achieved comparable hemostatic control with shorter hospital stay, decreased analgesic requirements, and smoother postoperative recovery, while no recurrences were observed during long-term follow-up. Incorporation of enhanced recovery after surgery principles further reinforced these benefits, underscoring the importance of structured perioperative protocols even in urgent thoracic conditions.

Prospects for further research suggest that the implementation of ERAS principles into urgent thoracic surgery from the beginning (on the first day of the emergency condition) should provide more options for minimally invasive surgery, decrease the LOS, and reduce possible complications, some of which require surgical intervention.

Although the present findings provide consistent clinical signals favoring minimally invasive management, the relatively small and unbalanced sample size – particularly in the NIVATS subgroup – precludes definitive conclusions and mandates cautious interpretation. Future research should therefore focus on prospective multicenter studies with larger cohorts and standardized perioperative pathways in order to validate the safety, feasibility, and long-term effectiveness of VATS and NIVATS in SHP. In particular, the refinement of patient selection criteria for NIVATS, systematic evaluation of its physiological advantages, and objective assessment of recovery trajectories and quality of life are warranted. Additional investigations should also address the integration of ERAS principles in the emergency setting, exploring their impact on postoperative complications, length of stay, and healthcare resource utilization. Such studies hold the potential to consolidate evidence-based recommendations and to establish minimally invasive, ERAS-aligned surgical strategies as the standard of care in the management of spontaneous hemopneumothorax.

COMPLIANCE WITH ETHICAL REQUIREMENTS

The study was conducted in accordance with the main provisions and rules ensuring humane treatment of patients in accordance with the following requirements of the Tokyo Declaration of the World Medical Association, the International Recommendations of the Helsinki Declaration on Human Rights, the Council of Europe Convention on Human Rights and Biomedicine, the Laws of Ukraine, the orders of the Ministry of Health of Ukraine and the requirements of the Medical Code of Ethics of Ukraine.

The Ethics Committee of Shupyk National Healthcare University of Ukraine approved the study 31.01.2025 № 3/10. Before the start of the study, all participants were provided with comprehensive information about the purpose, methods, potential risks, and benefits of participation. Participation in the study was voluntary and based on the principle of informed consent. Participants had the right to withdraw from the study at any stage without providing a reason. In line with confidentiality regulations, all data was collected anonymously and processed in accordance with applicable data protection standards. All information was utilized

solely within the context of this study and was provided in an aggregated form for results analysis.

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AUTHOR CONTRIBUTIONS

Tkalich V. V. [A, C, D, F]

Borysova V. I.[A, D, E, F]

Savoliuk S. I.[A, E, F]

Nedilia Yu.V.[A, B, D]

Galiiev O. V.[A, B, D]

All authors reviewed the results and approved the final version of the manuscript.

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Резюме

СПОНТАННИЙ ПНЕВМОГЕМОТОРАКС: 23-РІЧНИЙ ШЛЯХ ДО ХІРУРГІЧНОГО ЛІКУВАННЯ БЕЗ ІНТУБАЦІЇ

Василь В. Ткаліч[1], Валентина І. Борисова[2], Сергій І. Саволюк[3], Юрій В. Неділя[1], Олександр В. Галієв[2]

[1]Київська міська клінічна лікарня № 12, м. Київ, Україна
[2]Київська міська клінічна лікарня № 10, м. Київ, Україна
[3]Національний університет охорони здоров'я України імені П. Л. Шупика, м. Київ, Україна

Вступ. Спонтанний пневмогемоторакс є рідкісним, проте потенційно загрозливим для життя ускладненням спонтанного пневмотораксу, що зустрічається у відносно невеликого відсотка пацієнтів. Незважаючи на те, що кількість публікацій зростає, дотепер не існує уніфікованих клінічних протоколів щодо вибору анестезіологічного забезпечення та оптимальних термінів хірургічного втручання.

Мета. Метою дослідження було узагальнити 23-річний досвід лікування спонтанного пневмогемотораксу у багатопрофільному міському стаціонарі, визначити клінічні характеристики, оцінити ефективність різних методів хірургічного втручання та анестезіологічного супроводу, а також обґрунтувати доцільність впровадження сучасних концепцій прискореного відновлення після операції.

Матеріали та методи. Проаналізовано 2596 випадків спонтанного пневмотораксу, з яких 30 пацієнтів мали пневмогемоторакс. Серед них було 28 чоловіків та 2 жінки віком від 21 до 44 років. Виконувалися три основні типи втручань: торакотомія у 18 пацієнтів, відеоасистована торакоскопічна операція у 10 пацієнтів та неінтубована відеоасистована торакоскопічна операція у 2 пацієнтів. Оцінювалися обсяг початкового дренування, інтраопераційна крововтрата, тривалість перебування у стаціонарі, особливості післяопераційного знеболення та віддалені результати.

Результати. Активна кровотеча була виявлена у більшості пацієнтів, її джерелом у всіх випадках став розрив судини в злуках між легенею та плеврою. Двадцять пацієнтів були прооперовані протягом перших 24 годин, вісім – на 2-3 добу, ще двоє – після 10 днів через згорнутий гемоторакс. Після торакотомії медіанна тривалість перебування у стаціонарі становила 11 днів, після відеоасистованої операції – 10 днів, а після неінтубованої відеоасистованої операції – 8 днів. Потреба в опіоїдних анальгетиках була характерною для групи торакотомії, тоді як після малоінвазивних втручань достатньо було застосування нестероїдних протизапальних засобів. У віддаленому періоді, середня тривалість якого становила п'ять років, випадків рецидиву не зареєстровано.

Висновки. Спонтанний пневмогемоторакс є ургентним станом, який у більшості випадків потребує своєчасного хірургічного втручання. Найкращі результати досягаються при проведенні операції протягом першої доби з моменту госпіталізації. Використання відеоасистованих методів і особливо неінтубованих технік у ретельно відібраних пацієнтів забезпечує скорочення тривалості перебування у стаціонарі, зменшення потреби у знеболюванні та більш швидке відновлення. Інтеграція принципів прискореного відновлення після операції до ургентної торакальної хірургії може стати важливим кроком до оптимізації результатів лікування.

Ключові слова: **спонтанний пневмогемоторакс, невідкладні стани в торакальній хірургії, прискорене відновлення після операції, відеоасистована торакальна хірургія, неінтубована відеоасистована торакальна хірургія, судинна злука, внутрішньоплевральна кровотеча**

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