Thoracoscopy and Video-Assisted Thoracoscopy in Diagnostics of Pneumothoraxes, Traumatic Defeats of Thorax with Pneumothoraxes

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Abstract. In modern conditions, it is necessary to carry out interdisciplinary clinical and pharmacological, organizational and pharmaceutical researches on the correctness of diagnosis, treatment, pharmacotherapy and the appointment of life-necessary, effective, safe and high-quality medicines. This is due to the fact that the system of legal relations "doctor-patient-pharmacist" during the pandemic of COVID-19 and associated diseases (cardiovascular, oncological, tuberculosis, type I and II diabetes, asthma, HIV/AIDS, drug addiction, alcoholism, psychoneurological, injuries resulting from traffic accidents and combat operations, pain of various genesis and others) showed the need to improve the health care sector in each country, in general, and the work of a separate health care institution, doctor, nurse and pharmacist , in particular, that is, access to medical services and provision of medicines to patients.

The analysis of the anonymous results of diagnostics among 1368 patients and in 160 victims with closed chest trauma was carried out. There were 425 patients with spontaneous pneumothorax. Thoracoscopy or video thoracoscopy was used to verify nosologies. During the thoracoscopic examination, bullous emphysema of the lungs was found among 336 patients (79%) with pneumothorax, tuberculosis was diagnosed among 47 people (11%), lung cancer in 6.8% – 29 people; silicosis – 2.4% (10 people); sarcoid – 0.7% (3 people). According to the results of histopathological examination of biopsies obtained during thoracoscopy, tuberculous exudative pleurisy was found in 563 patients, lung cancer was the cause of the exudate in 133 cases, pleural mesothelioma was diagnosed in 98 cases, exudative pleurisy was caused by a nonspecific inflammatory process of the lungs in 149 patients. Video-Assisted Thoracoscopy is recommended to be used in patients with closed chest trauma with multiple rib fractures, complicated by small hemothorax, pneumothorax, to diagnose possible damage to the diaphragm, lungs, and pericardium.

Keywords: sternum injuries, pneumothorax, thoracoscopy, video-assisted thoracoscopy, diagnostics, pharmacotherapy, medicinal products, system of legal relations "doctor-patient-pharmacist", COVID-19.

Introduction. In modern conditions, the relevance of interdisciplinary clinical and pharmacological, organizational and pharmaceutical, pharmacoeconomic studies regarding the correctness of diagnosis, treatment, pharmacotherapy and the prescription of vital, effective, safe and high-quality medicines is increasing. The system of legal relations "doctor-patient-pharmacist" during the pandemic of COVID-19 and related diseases (cardiovascular, oncological, tuberculosis, type I and II diabetes, asthma, HIV/AIDS, smoking, drug addiction, alcoholism, psychoneurological, injuries as a result of traffic accidents and hostilities, pain of various genesis and others) showed the need to improve the field of health care in each country, medical and pharmaceutical care and pharmaceutical support for patients of different contingents and age groups [1-7].

Specialists from the US Centers for Disease Control and Prevention have discovered a new variant of COVID-19, called EG.5, or eris. Became the dominant strain, causing about 17% of cases of COVID-19 in the population throughout the country. According to the New York State Department of Health (as of August 2, 2023) [8]:

- 55% of the number of detected cases of COVID-19 among the population of the state;
- 22% of the number of hospitalizations of patients due to COVID-19.

On the 1st stages of the pandemic, the level of clinical and pharmacological, organizational and pharmaceutical provision of vaccination with the appropriate vaccines against COVID-19 was increased in the system of "doctor-patient-pharmacist" legal relations. This contributed to the prevention of morbidity and complications of lung lesions in patients [9-14].

In the world, there is an increase in injuries due to traffic accidents, household injuries, medical errors, and armed conflict [15]. According to statistics, more than 170,000 traffic accidents with consequences were registered in the last 5 years [16-18]:

- 43% of injured citizens, pedestrians, cyclists, etc.;
- losses amount to more than 2% of GDP;
- material losses from road accidents amount to UAH 40 billion. for a year;
- quarter of injured and injured citizens develop traumatic shock with a total mortality rate of up to 7.4%;
- almost all citizens have traumatic lesions of the chest of various degrees of severity.

Spontaneous pneumothorax as a kind of dangerous complication in patients with COVID-19 against the background of non-specific pneumonia is an infrequent, but dangerous complication against the background of COVID-19 pandemic, which can occur among 5.9% of patients [19]:

- pleural effusion, formation of lung atelectasis and pneumomediastinum should also be added to bronchopulmonary complications. Although the named complications are late and infrequent, they all require prompt decision-making to eliminate the existing pathology;
- this especially applies to the formation of an acute pneumothorax, which usually requires urgent surgical intervention. Usually, pneumothorax develops as a late complication of the disease, mainly due to the use of mechanical ventilation and the need to maintain increased pressure in the airways (barotrauma) to improve oxygenation.

Pneumothorax is the most common pathology with which patients are admitted to thoracic departments for treatment. Determining the cause of pneumothorax is an important clinical task, as further treatment tactics depend on it, the frequency of spontaneous pneumothorax is 10 cases per 100,000 population.

Modern diseases require the need for multidisciplinary research to develop new effective, safe, and economically available medicines [20-24].

It is worthy of attention to study the experience of UK scientists [25], who in modern conditions are working on the creation of innovative medicines and vaccines against four types of threats to the health care sector. It is noted [26]:

- potential threats that could cause problems, including bird flu and new variants of Covid;
- known infections that are becoming increasingly difficult to combat with modern medicine, such as antibiotic-resistant superbugs;
- crimean-congo hemorrhagic fever, which is spread by ticks, about a third of infected citizens;
- modern diseases common in Africa, the Balkans, the Middle East, and Asia. which may spread to other regions with climate change;
- "Disease X", which is unpredictable, like the Omicron variant of COVID-19, can bypass some of the protection provided by the Covid vaccines developed and implemented in industrial production and medical practice.

The purpose of the study is to establish the effectiveness of thoracoscopy and videothoracoscopy in determining the genesis of pneumothoraxes, as well as conducting multidisciplinary clinical-pharmacological and organizational-pharmaceutical studies on the correctness of diagnosis, treatment, pharmacotherapy, and the appointment of vital, effective, safe, and high-quality medicines.

Materials and methods. A retrospective anonymous analysis of the results of treatment among 1,368 patients who were treated at the clinical bases of the Danylo Halytsky Lviv National Medical University, thoracic departments of the Lung Health Center (Lviv) and the 8th City Clinical Hospital of Lviv (https://lviv.vgorode.ua/reference/bolnytsy/265911-komunalna-8-ma-miska-klinichna-likarnia). The communal non-profit enterprise "8th City Clinical Hospital" in Lviv is a powerful clinical and diagnostic complex equipped with modern equipment, where specialized medical care is provided around the clock in the following areas: urgent and planned cardiology care; orthopedics and traumatology; neurology and neurosurgery; combined and combined trauma surgery, hand surgery, emergency and planned abdominal surgery; treatment of thermal injury, plastic and reconstructive surgery; eye microsurgery; intensive therapy and anesthesia care.

To ensure the work of clinical departments, a 24-hour clinical and biochemical laboratory is deployed, ultrasound and endoscopic diagnostics are performed, an X-ray room, 9 operating rooms, an intensive care unit are in operation, and a trauma center is open around the clock. The bed fund of the hospital is 390 beds, about 10,000 residents of Lviv and the region receive inpatient medical care every year.

A standard comprehensive examination of patients was carried out: clinical and radiological, laboratory, using invasive methods, pleural puncture, and cytological examination of punctate. To verify the above nosologies, thoracoscopy or video thoracoscopy was used. Thoracoscopy was performed with a rigid thoracoscope manufactured by the Berlin Medical Equipment Factory according to the generally accepted method. The examination of the pleural cavity was carried out sequentially by sector (pleural dome, costosternal, costal, costovertebral surfaces, lungs by segments, diaphragm, pericardium, areas of the upper, front, lower, and back interstitium) [27]. During thoracoscopy, attention was paid to the color, thickness of the visceral and parietal pleura mucosa, presence of moorings and adhesions, fibrin layering, presence of rashes and their nature on the pleura, presence of tumors. Before carrying out this invasive intervention, if the patient had a hydrothorax, an artificial pneumothorax was not applied.

Video thoracoscopy was performed under general anesthesia using Olympus YEC-40. It should be noted that video thoracoscopy is a modern high-tech method of direct examination of the organs of the chest cavity, which allows [28]: to carry out clarifying and differential diagnosis of diseases of the pleura, interstitium, lungs; perform the necessary medical endoscopic manipulations; low number of intraoperative and postoperative complications; short recovery period after surgery; high efficiency of diagnosis of intrathoracic pathology, reduction of surgical trauma, shortening of postoperative rehabilitation period.

Non-narcotic analgesics were used to provide pain relief. In some cases, due to the patient's characteristics, narcotic analgesics were used, but no more than 1-2 times, only on the first day after surgery.

The study of the article is a fragment of the research works of the department of phthisiology and pulmonology of Danylo Halytsky Lviv National Medical University and Lviv Medical Institute LLC on the topic "Improving the system of drug circulation during pharmacotherapy on the basis of evidence-based forensic pharmacy, organization, technology, biopharmacy and pharmaceutical law» (state registration number 0120U105348, implementation period 2021-2026).

Results and discussion. The provision of medical and pharmaceutical care during damage (trauma) to the human chest as a result of traffic accidents is important [29]. Pneumothorax is an accumulation of air outside the lungs, but in the pleural cavity of the sternum. A build-up of air can put pressure on the lungs and cause them to collapse. Pneumothoraxes are classified [30]:

- ✓ simple, that is, it does not displace the structures of the mediastinum;
- ✓ tense, that is, a life-threatening condition; includes the constant flow of air into the pleural cavity, compresses the lungs, does not allow them to expand properly; in the absence of timely assistance, the pathology progresses rapidly, causing cardiovascular collapse and, as a result, cardiac arrest; damage to the pleura in the form of a unilateral valve; air can enter the pleural space during inhalation, but cannot leave during exhalation [31];
- ✓ open, i.e., known as a "sucking" chest wound;
- ✓ closed – when air from the pleural cavity does not enter the external environment.

Lesions of the chest wall in closed injuries are the most common thoracic injuries, which make up 50-70%, and in combined injuries – 90.8% [27, 32]. Thoracic trauma with multiple and floating rib fractures in 80-90% of cases is accompanied by intrapleural complications due to damage to intercostal vessels and injury to the lung by a rib fragment. Need to note that this type of injury is one of the most severe, and every third victim with combined injuries leads to fatal consequences. With fragmented rib fractures, the mortality rate reaches 50%. Diagnosis of this pathology is difficult. Up to 25% of serious diagnostic errors are noted only in hospitalized patients with this pathology [27, 32, 33].

In the presence of long-term pneumothorax, the pleural cavity is filled with exudate. That is, primary pneumothorax is accompanied by secondary exudative pleurisy. This phenomenon is widely observed as a stage after pulmonectomy. Phthisiothoracic surgeons often have to deal with the presence of secondary exudative pleurisy after therapeutic artificial pneumothoraxes in patients with certain forms of pulmonary tuberculosis. Therefore, in certain cases, for the diagnosis of primary pneumothorax, video thoracoscopic and thoracoscopic methods should be used for exudative pleurisy. To verify the above-mentioned nosologies, it is advisable to use thoracoscopy or video thoracoscopy. These diagnostic methods allow to clearly visualize the pathologically changed tissue area, to take material for histological examination.

As noted by Ludwig C., Koryllos A., trauma is the main cause of death [34]:

- approximately 2/3 of patients have a chest injury of varying degrees of severity, from a simple rib fracture to a penetrating wound of the heart or tracheobronchial rupture;
- the most common is a blunt chest injury with a frequency of 90%, of which less than 10% require any surgical intervention;
- mortality is the second only to head injury, which emphasizes the importance of initial treatment;
- many of these deaths are preventable through prompt diagnosis and treatment, so the question becomes:

What is the role of the thoracic surgeon in the management of chest trauma in seriously injured patients? When should a thoracic surgeon be involved?

The research of the authors of the article was carried out in the indicated health care institutions of the Lviv region during 2015-2023. Established that:

- primary spontaneous pneumothorax was more often detected in young men aged 21 to 30 years; was a consequence of rupture of subpleurally located pulmonary bullae;
- secondary spontaneous pneumothorax was more often observed in the older age group of patients; associated with chronic obstructive pulmonary disease or other pulmonary pathology;
- catamenial pneumothorax – a disease affecting women aged 27 to 48; pathology of the right hemithorax was observed in 92% of patients;
- spontaneous pneumothorax occurs in 5-8% of patients with cystic fibrosis, in 36% of patients with lymphangioleiomyomatosis.
- traumatic pneumothorax is the result of blunt or sharp penetrating trauma;
- iatrogenic pneumothorax can be caused by pleural puncture, insertion of a subclavian catheter. This complication is also observed during hyperbaric oxygenation – one case per 50,000 procedures, during artificial lung ventilation;
- the obtained data made it possible to predict that approximately 300 new patients with spontaneous pneumothorax will be detected annually in the Lviv region, not including patients with traumatic damage to the chest, with the consequences of bronchopulmonary pathology of non-specific and specific genesis.

There were 425 patients with spontaneous pneumothorax. Quantitatively, men significantly predominated in the ratio of 5:1. The age of these patients ranged from 16 to 80 years. Thoracoscopy for pneumothorax was performed on 300 patients, video thoracoscopy was performed on 125 patients. 943 patients with exudative pleurisy were examined. Among them are 635 men and 308 women, aged from 18 to 73 years. With this nosology, thoracoscopy was performed in 700 patients, video thoracoscopy – among 243 patients.

The results of diagnosis of 160 victims aged 17 to 84 with closed chest trauma were analyzed, among them: 131 (81.7%) were men; women – 29 (18.3%). The mentioned patients were in institutions of inpatient care, and later – for outpatient treatment. The treatment lasted for three years. Of them, 54 (33.75%) patients had a severe chest injury. According to the causes of injury, that is, according to the origin of the injury, the patients were distributed as follows (Fig. 1).

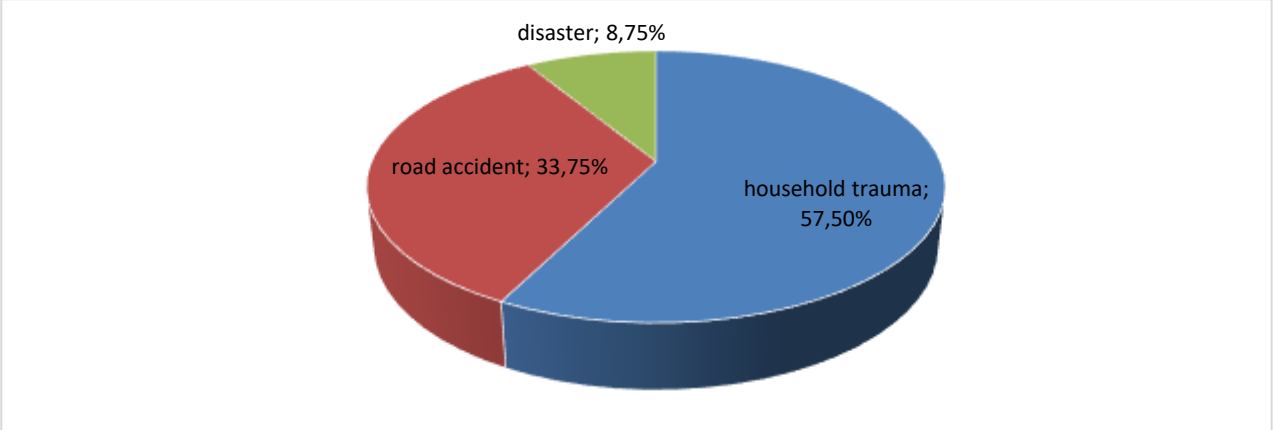

Fig. 1. Causes of chest injuries.

The authors' research showed that in:

- 44 patients (27.5%) were found to have multiple rib fractures;
- 13 patients (8.2%) were diagnosed with a fragmentary nature of rib damage with the formation of costal and sternocostal valves;
- 8 patients (5%) had a fracture of the body of the sternum with displacement of bone fragments of varying severity.

Preoperative treatment of patients with multiple and fragmentary rib fractures in the acute period of chest injuries included the following:

- ✓ pleural cavity puncture – 28 patients;
- ✓ drainage of the pleural cavity – 41 patients;
- ✓ thoracoscopy – 28 victims;
- ✓ rehabilitative tracheobronchoscopy was performed for 40 victims.

During the diagnostic videothoracoscopy, the visceral and costal pleura, the accessible areas of the pericardium, and the diaphragm were examined in detail. Diagnostic video thoracoscopy makes it possible to inspect the lungs, pericardium, and mediastinum. diaphragm, chest wall [35-37].

The obtained results indicate that:

- ❖ all patients with spontaneous pneumothorax had more than 20% lung collapse;
- ❖ clinical symptomatology was pronounced;
- ❖ the first symptoms in young people were acute pains in the chest, which often decreased in intensity over (after) 24 hours;
- ❖ dysentery was the leading symptom in patients with tense and bilateral pneumothorax (89 people);
- ❖ urgent drainage of the pleural cavity was carried out in case of tense pneumothorax. Thoracoscopy and video thoracoscopy were performed after stabilization of the patient's general condition.

During thoracoscopic examination of patients, the causes of spontaneous pneumothorax were revealed:

- 336 patients (79%) suffered from bullous emphysema of the lungs. This pathology is the leading cause of spontaneous pneumothorax [38]. A visual inspection of the visceral pleura revealed pulmonary nodules at the top of the lungs;
- tuberculosis, as the cause of spontaneous pneumothorax, was established in 47 people (11%).

Visually determined the presence of small, prosiform yellow blisters with a size of 2 to 5 mm, which affected the costal pleura. The diagnosis of tuberculosis was confirmed by histological verification of the material taken from the costal pleura. The costal pleura was stained bright red:

- 19 people were diagnosed with sail-like joints;
- patients with lung cancer accounted for 6.8% (29 people); silicosis – 2.4%, (10 people); sarcoidosis – 0.7% (3 persons).

Exudative pleurisy of tuberculous etiology was thoracoscopically characterized by sharp hyperemia of the pleural surfaces (visceral and costal). Rashes in the form of yellowish blisters, varying in size, on average from 0.5 to 5 mm, were very characteristic. These formations were round and oval in shape. With long-standing pleural effusion (215 cases) with this nosology, massive fibrin clots and moorings were found in the pleural cavity. Among 200 cases, they had a sail-like appearance, covered the pleural space between the costal and visceral surfaces, were quite "loose" and easily destroyed when the optical nozzle of the thoracoscope was moved. The volume of effusion in the pleural cavity was different, and in some patients (18 people) total unilateral pleurisy was observed. In such cases, a day before thoracoscopy, a pleural puncture was performed from the side of the lesion and up to 1.5-2 liters were removed. exudate, depending on the state of the cardiovascular system and the patient's age. The color of the exudate in tuberculous lesions was yellow (from light yellow to dark yellow).

The authors of the article did not observe hemorrhagic effusion in case of a specific lesion of the pleura – in all cases the color of the exudate was yellowish.

The tumor process was accompanied by hemorrhagic exudate, the color of the exudate was red. The size of tumor formations in lung tissue was different (from 3 to 23 cm).

On instrumental palpation, these neoplasms were dense. Among 7 cases, tumor growth into the chest wall was detected. Eruptions on the costal pleura had a plaque-like character. The presence of a dense tumor mass in the lung tissue, and subsequent biopsy with histological examination of the material from this mass allowed to verify the diagnosis. Eruptions on the costal pleura detected in mesothelioma (among 7 cases) had the appearance of yellowish layers, different in size and shape.

Exudative pleurisy of non-specific genesis in most cases was manifested by cloak-like fibrinous layering. To perform a thoracoscopy in such patients, up to 300 ml of sterile dexasan solution was first injected into the corresponding pleural cavity by puncture. This manipulation was performed immediately before the thoracoscopy, while a pleural puncture was performed with exudate collection for cytological examination.

In all cases with non-specific genesis of pleurisy, the color of the exudate was yellow. Sharp hyperemia of the costal and visceral pleura was characteristic. Hyperemia of the pleura was much more intense than in the case of a tuberculous lesion.

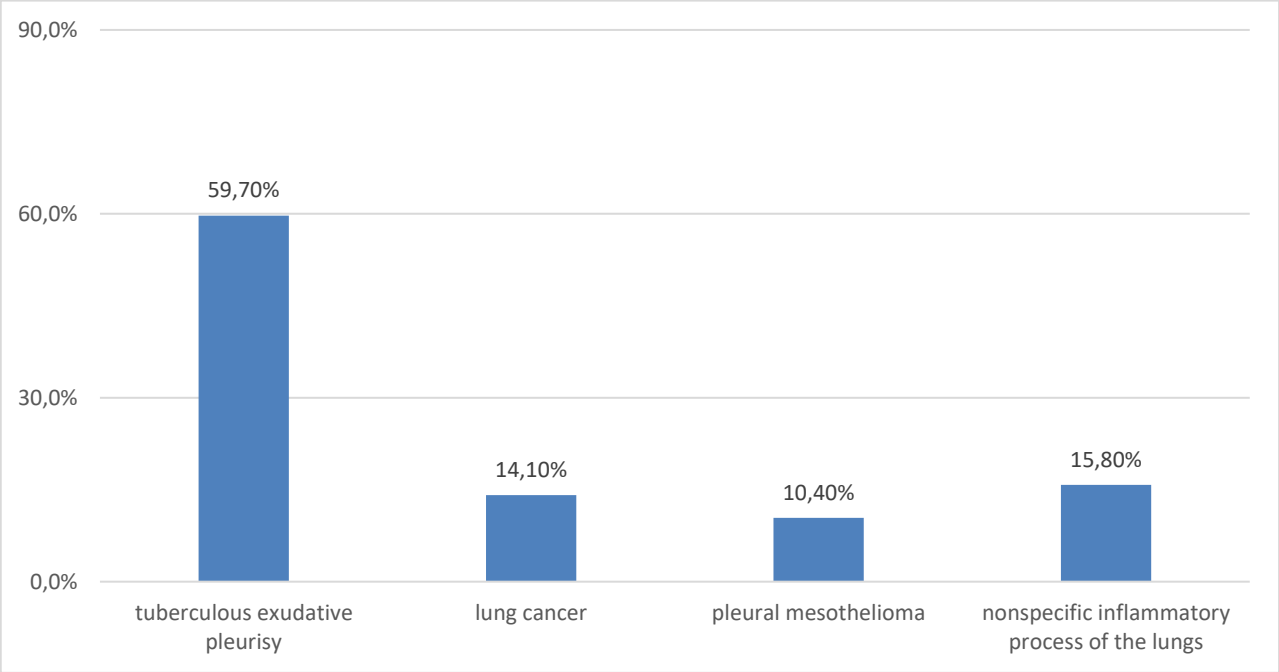

Fig. 2. Results of histopathological examination of biopsies.

With a long-standing pathological process (more than 2 months), fibrin layers were found in the pleural cavity, the color of which was from yellow to bluish-green. In not a single case of non-

specific pleural exudate, rashes in the form of yellowish blisters, which are characteristic of a tuberculous lesion, were found.

The results of histopathological examination of biopsies obtained during thoracoscopy are shown on the Fig. 2.

Diagnostic methods among patients with chest injuries were aimed at clarifying the nature of the damage itself and determining the state of vital organs and systems. In clinical observations, with multiple rib fractures, destruction of the chest frame was accompanied by severe damage to internal organs (Fig. 3).

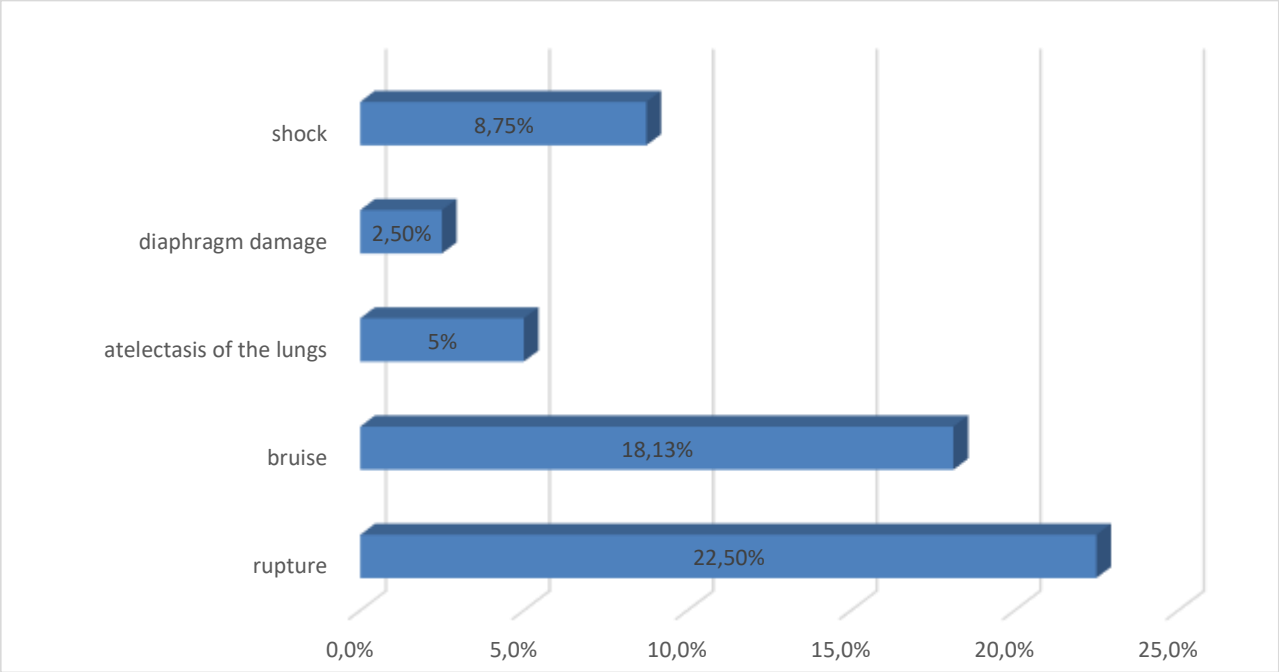

Fig. 3. Damage to internal organs with multiple rib fractures.

The severity of damage to the internal organs of the chest in patients with multiple and fragmented rib fractures is also confirmed by the significant frequency of hemo- and pneumothorax, i.e.:

- various types of hemothorax were detected in 29 patients (18.13%);
- pneumothorax – in 38 patients (23.75%).

The most important prerequisite for the use of restorative operations for multiple and fragmented rib fractures is an accurate diagnosis of post-traumatic morphofunctional changes detected by general clinical, radiological, instrumental and endoscopic methods of diagnosis – thoracoscopy and tracheobronchoscopy.

In the presence of intrapleural bleeding, diagnostic thoracoscopy made it possible to establish the cause of the hemorrhage. The most frequent cause of the latter was damage to the intercostal arteries [37, 39-41]. Traumatic ruptures of the lung tissue also led to bleeding and the occurrence of pneumothorax. Thoracoscopy was performed only with a small hemothorax (12 cases). According to generally accepted standard approaches, thoracotomy was immediately performed for medium and large hemothorax. Thoracoscopy was performed in patients with combined pneumothorax. The most frequent cause of this pathology in patients was a rupture of the lung tissue as a result of its injury by a fragment of a rib. The examination revealed damage to the lung tissue, irregular in shape with "torn" edges. Diagnostic thoracoscopy also revealed traumatic damage to the diaphragm in four cases. The cause of the appearance of pleural effusion was most often a tuberculous process of the respiratory system, less often pleural mesothelioma was established.

The authors continue further research in this direction [42, 43].

Conclusions. In modern conditions, it is necessary to conduct interdisciplinary clinical and pharmacological, organizational and pharmaceutical researches on the correctness of diagnosis,

treatment, pharmacotherapy and the appointment of vital, effective, safe and high-quality medicines. This is due to the fact that the system of legal relations "doctor-patient-pharmacist" during the pandemic of COVID-19 and associated diseases (cardiovascular, oncological, tuberculosis, type I and II diabetes, asthma, HIV/AIDS, drug addiction, alcoholism, psychoneurological, injuries resulting from traffic accidents and combat operations, pain of various genesis and others) showed the need to improve the health care sector in each country, in general, and the work of a separate health care institution, doctor, nurse and pharmacist , in particular, that is, access to medical services and provision of medicines to patients. The main surgical method in the diagnosis of spontaneous pneumothorax is thoracoscopy, which allows establishing the etiological factors of this nosology. Bullous emphysema of the lungs was found to be the most frequent cause of spontaneous pneumothoraxes in our study.

The effectiveness of thoracoscopic and videothoracoscopic examination in spontaneous pneumothorax reaches 98%. Thoracoscopy is recommended for patients with closed chest trauma with multiple rib fractures complicated by small hemothorax, pneumothorax, to diagnose possible damage to the diaphragm, lungs, and pericardium.

It requires separate pharmacoeconomic studies on the level of accessibility of patients to life-necessary medicinal products, dispensed by prescription or without a doctor's prescription and, separately, medicinal products dispensed by discounted prescriptions of a doctor on a free basis or a 50.0% discount.

Conflict of interests. The authors confirm that they are the authors of this work and have approved it for publication. The authors also certify that the obtained clinical data and research were conducted in compliance with the requirements of moral and ethical principles based on medical and pharmaceutical law, and in the absence of any commercial or financial relationships that could be interpreted as a potential conflict of interest.

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Ethical approval. Ethical clearance was obtained from the administration of the Danylo Halytsky Lviv National Medical University. Permission statement for conducting the experiments was received from the administration of the Danylo Halytsky Lviv National Medical University. Before any data collection, the main purpose of the study was clearly explained to each department (concerned personnel).

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