Diagnosis and Treatment of Pleural Cavity Empyema

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Received: July 30, 2025
Published: August 20, 2025

Abstract. Pleural empyema remains a serious medical problem, accompanied by a high incidence, a complex clinical course and significant mortality. The article presents the results of a multi-year study of 556 patients who were treated at the Pulmonary Health Center of Lviv in 2017–2024. The clinical forms, etiology, radiological and ultrasound signs of empyema are analyzed, as well as the applied methods of diagnosis and treatment: pleural punctures, drainage, antibiotic therapy, thoracoplasty, decortication. Indications for surgical interventions and features of the course of pleural empyema are given. The importance of early diagnosis, a personalized approach to treatment and prevention of medical errors in the context of the development of telemedicine is emphasized. This large, single-center cohort reflects routine clinical practice in a high-volume referral facility, offering robust, generalizable evidence for settings with constrained resources and rising antimicrobial resistance. By integrating radiologic–sonographic criteria with procedural outcomes, the work clarifies triage, optimizes timing of intervention, and guides antibiotic stewardship, supporting standardized care pathways and telemedicine-enabled follow-up. The findings have immediate implications for guideline refinement, training of multidisciplinary teams, and reduction of complications and length of stay ultimately improving survival, preserving lung function, and enhancing patients' quality of life. The results obtained may be useful for improving the tactics of managing patients with pleural empyema and reducing the risk of chronicity of the disease.

Keywords: pleural empyema, diagnostics, drainage of the pleural cavity, pleural puncture, purulent-destructive processes, tuberculosis, telemedicine, antibiotic therapy.

Introduction. Pleural empyema is an important and urgent medical problem in both diagnostic and therapeutic aspects. The leading sign of this pathology is the presence of pus in the pleural cavity and purulent lesions of the costal and visceral pleura. In the UK, the annual hospitalization of patients with pleural empyema is 55,530 people. The incidence increased from 6.4 to 8.4 per 100,000 hospitalizations. Gender preference: men accounted for 67% of cases, among adults – 68% [1]. In hospital mortality is stable at about 13–14%, among younger age groups only 0.9%, among adults 15% [2].

In countries around the world, exudative pleurisy develops in 20 to 40% of patients hospitalized with pneumonia. At the same time, pleural empyema reaches 5-10% of patients with exudative pleurisy. Every year in the USA, 65,000 patients develop pleural empyema. Mortality in this pathology reaches 15%. The problem is especially growing against the background of covid, post-covid, long-covid diseases in accordance with ICD-11 [3-6].

Empyemas can be the consequences of several diseases and chronic lung injury because of combat service. Destructive purulent processes in the lungs such as: abscessing pneumonia, abscesses, purulent cysts, purulent bronchitis, bronchiectasis with suppuration, destructive forms of pulmonary tuberculosis. Suppuration of exudative pleurisy of various genesis can lead to the development of empyema. Malignant intrapulmonary neoplasms in the presence of a destructive process can also provoke the occurrence of empyema. Pulmonary infarction of various genesis can cause pleural empyema. Purulent processes of the abdominal cavity organs (purulent pancreatitis, subphrenic abscess, purulent intrahepatic processes) can be causative factors of pleural empyema. Septicopyemia can lead to the appearance of empyema. Traumatic lesions of the chest can provoke the occurrence of pleural empyema. We separately distinguish postoperative pleural empyema with the formation of bronchopleural fistulas. Mediastinitis can also be a causative factor of pleural empyema. The infectious agent enters the pleura by lympho-, hematogenous, contact route or in case of violation of the integrity of the pleural sheets, leading to the occurrence of infectious purulent

inflammation. In primary pleural empyema, the development of inflammation is observed directly on the pleural surface, in secondary - the pathological process is a consequence of purulent-septic damage to the lung parenchyma, mediastinal organs, and chest wall [7, 8].

Despite advances in diagnostics and pharmacotherapy, pleural empyema still remains an acute problem. This problem does not lose its relevance and practical significance due to the high morbidity, unpredictable and often severe course of the disease, and high mortality rate, reaching almost 25%.

The purpose of the study was to establish optimal methods for diagnosing and treating pleural empyema.

Materials and methods. The total number of patients with pleural empyema was 556 people. Patients were treated at the Center for Pulmonary Health in Lviv from 2017 to 2024. The majority of patients were aged 40-60 years – 61.9% of patients. The age distribution of patients is shown in Fig. 1.

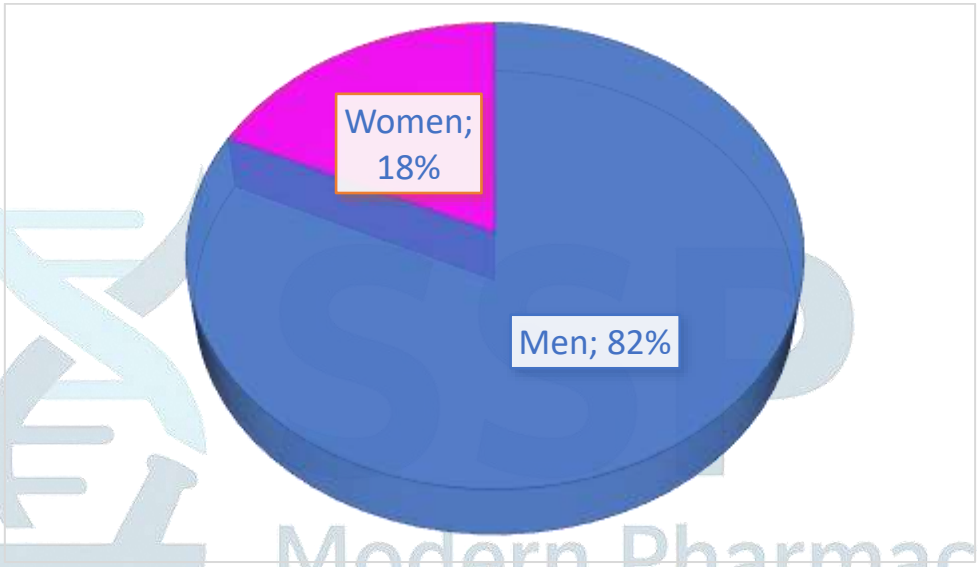

Fig. 1. Age distribution of patients with pleural empyema.

All patients underwent general clinical examination methods. Chest radiography in two projections was mandatory. The method of ultrasound diagnostics, previously published by the author [9], was also used according to indications.

Thoracoscopic and videothoracoscopic examination methods in patients with pleural empyema were practically not used, or were performed in isolated cases [10].

All patients with pleural empyema underwent pleural punctures according to the standard method. This manipulation was performed under local anesthesia in the 7th-8th intercostal space along the posterior axillary or scapular line.

The main treatment method for pleural empyema was drainage of the pleural cavity. In most cases, thoracocentesis was performed under local anesthesia in the 7-8th intercostal space along the posterior axillary or scapular line.

Passive and active removal of pus from the pleural cavity was used. In chronic pleural empyema with thickened costal and visceral pleura, surgical interventions were performed – decortication and pleurectomy.

In the presence of a rigid lung or a reticular lung as complications of pleural empyema, selective thoracoplasty was performed. The essence of this operation is to partially remove the ribs and fill the limited empyema pleural space with soft muscle tissue in their place.

Antibiotic therapy was performed taking into account the sensitivity of microflora. For this, it was necessary to culture the empyema contents on nutrient media.

The pleural empyema cavity was washed with antiseptic solutions (mediums with dioxidine, miramistin). In this case, from 20 to 50 ml of antiseptic solution was injected into the drainage tube.

After that, the drainage tube was clamped for 20-25 minutes. Patients constantly changed the position of the body, leaning in different directions. In limited pleural empyema, such an amount of antiseptic was injected to completely fill its cavity according to the authors' method [11].

The study of the article is a fragment of research works of Private Scientific Institution "Scientific and Research University of Medical and Pharmaceutical Law" and Danylo Halytsky Lviv National Medical University on the topic "Diagnosis, treatment, pharmacotherapy of inflammatory, traumatic and onco-thoracic pathology using instrumental methods" (state registration number 0125U000071, implementation period 2025-2031); "Multidisciplinary research of post-traumatic stress disorders during war among patients (primarily combatants)" (state registration number 0124U002540, implementation period 2024-2029) [12-21].

Results and discussion. In recent decades, the incidence of nonspecific pathological processes of the lungs and pleura has had a negative tendency to increase and is about 5% annually [5]. Of particular concern to doctors is the steady increase in the incidence of purulent-destructive pulmonary processes, which in 4% of patients are complicated by the development of secondary pleural empyema. The latter is one of the most frequent and severe complications of acute infectious destruction of the lungs [8]. There are different views on the pathogenesis of pleural empyema. According to some authors, pleural empyema in 85–90% of patients is a complication of acute and chronic diseases of the lungs and pleura. According to others, in 10–15% it is a consequence of chest injuries and extrapulmonary inflammatory or infectious processes [11].

It is noteworthy that with an increase in the number of intrathoracic interventions and their expansion, the number of postoperative pleural empyemas increases. Most often, such types of pleural empyema develop in patients operated on for purulent-inflammatory diseases of the lungs and tumors in the decay stage. In 50% of patients, infection of the pleural cavity during surgical interventions occurs because of damage to the abscess cavity or bronchiectasis formations during the separation of the lung from adhesions and treatment of the bronchial stump. After surgical interventions without lung trauma, acute pleural empyema occurs in 2–3% of patients [22]

It is generally believed that the development of acute pleural empyema is caused by untimely referral of patients to a doctor, and its spread is caused by the asocial behavior of patients, smoking, alcohol abuse, and psychoactive substances. In 4–20% of patients, acute pleural empyema, despite active treatment, becomes chronic, which leads to persistent loss of ability to work up to disability [23].

Fig. 2 shows the main causes of pleural empyema.

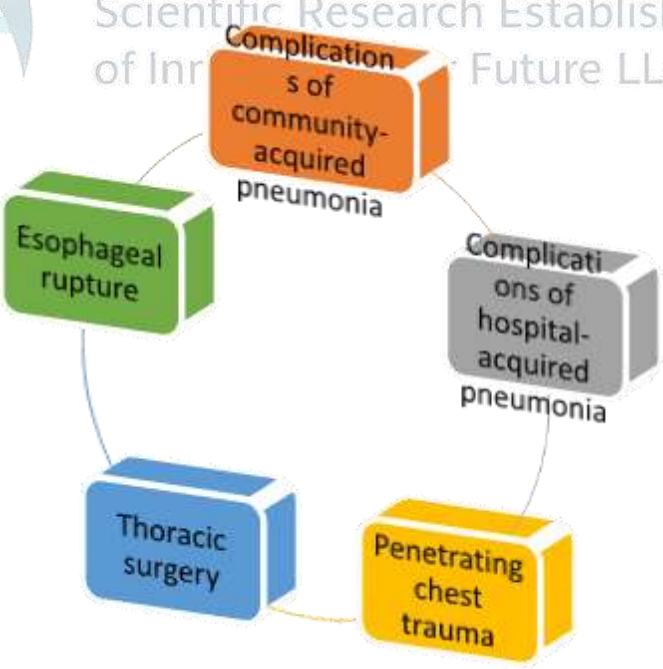

Fig. 2. The main causes of pleural empyema.

Fig. 3 shows the main risk factors for the development of pleural empyema.

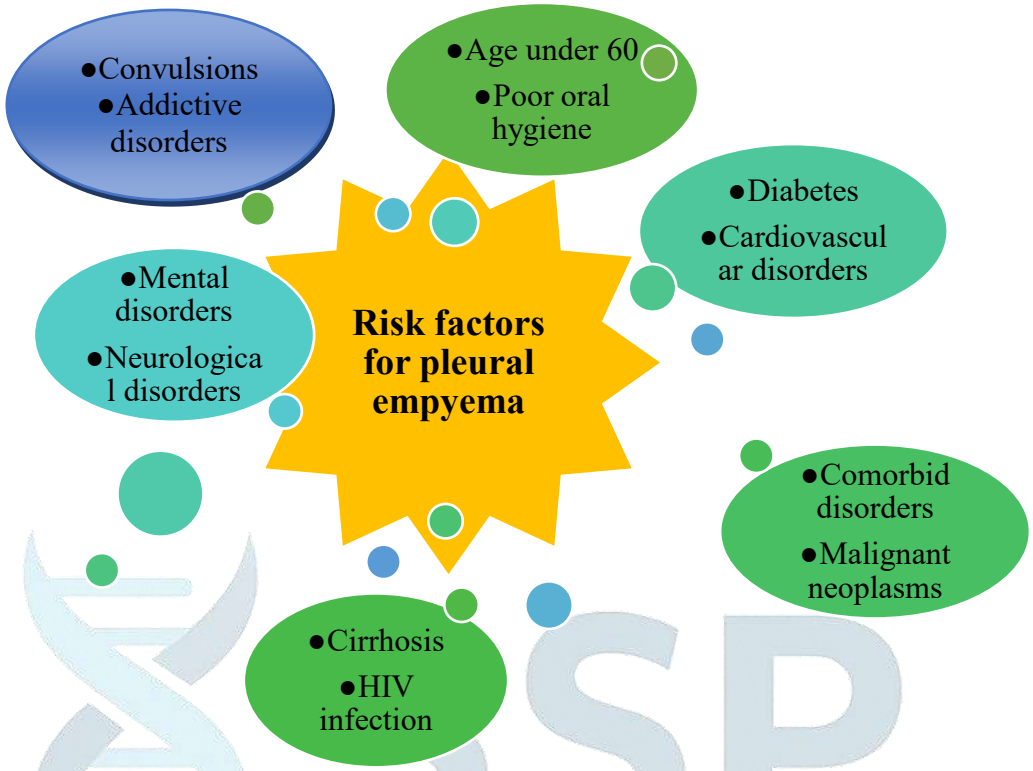

Fig. 3. The main risk factors for pleural empyema.

The author of the article, out of 556 patients with pleural empyema, found nonspecific genesis in 271 cases, tuberculous – in 285 (Fig. 4).

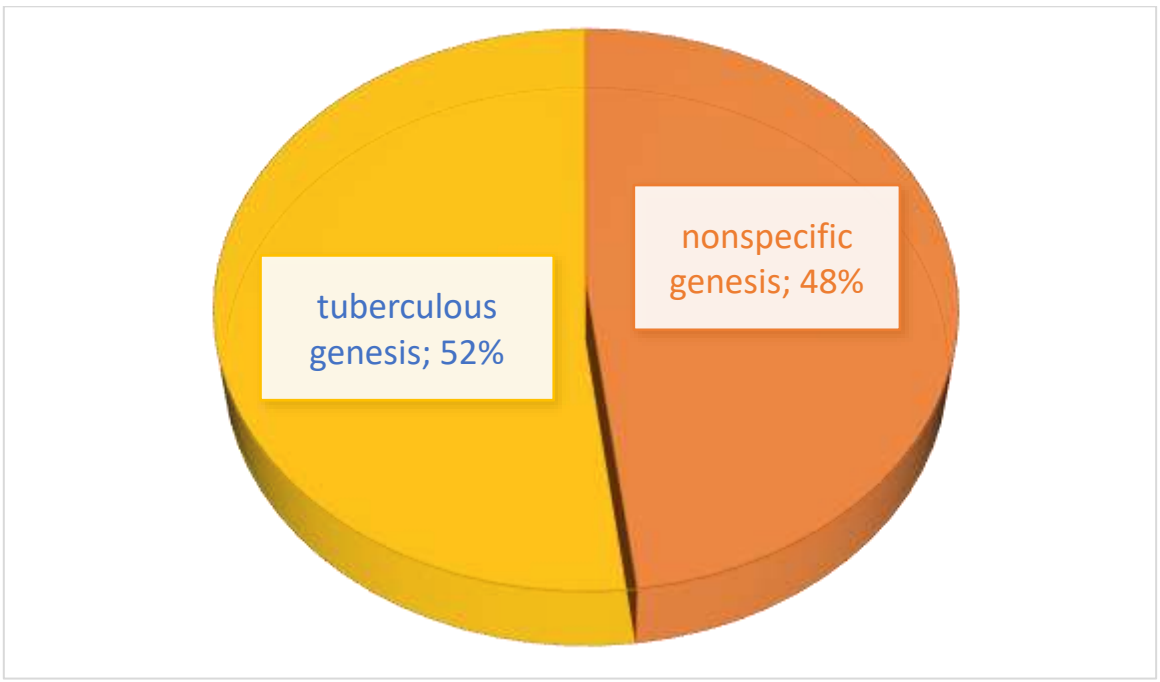

Fig. 4. Distribution of the studied patients according to the genesis of empyema of the pleural cavity.

Extensive empyema was diagnosed in 472 patients, limited in 84 (Fig. 5).

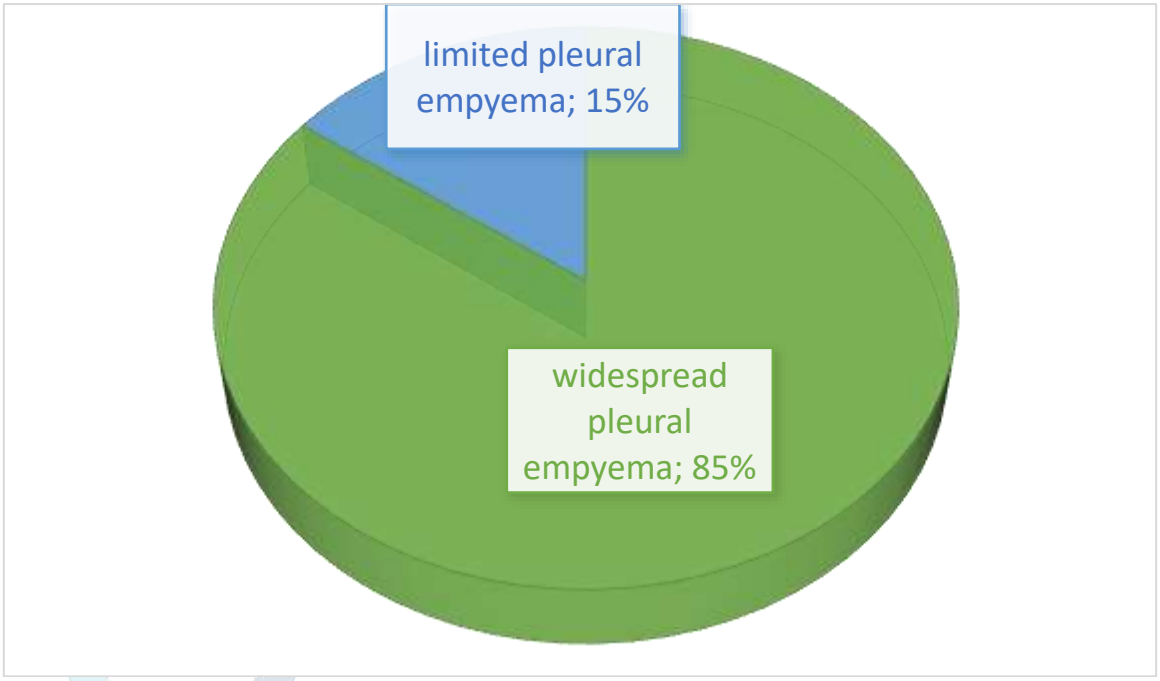

Fig. 5. Distribution of the studied patients by types of empyema of the pleural cavity.

With empyema of the pleura, patients complained of a hectic increase in body temperature to 39-40 C. Almost all patients noted the presence of cough, pain in the affected half of the chest, shortness of breath with an accelerated respiratory rate. The development of empyema of the pleura was characterized by an acute onset. At the same time, tuberculous empyema is characterized by a more torpid course compared to nonspecific ones. The septic state was more pronounced with a large amount of pus in the pleural cavity, but was observed in almost all patients.

According to the results of the study, the author of the article concluded that the X-ray method of diagnosis was very important for various pulmonary pathologies. A characteristic X-ray sign of empyema of the pleura was the horizontal level of shadowing, which extended to the diaphragm. It was the horizontal level of shadowing that indicated the presence of air in the pleural cavity.

The presented X-ray (Fig. 6) clearly shows the edge of the collapsed lung, the horizontal level of empyema fluid, and signs of pneumothorax from the level of the 4th rib upwards.

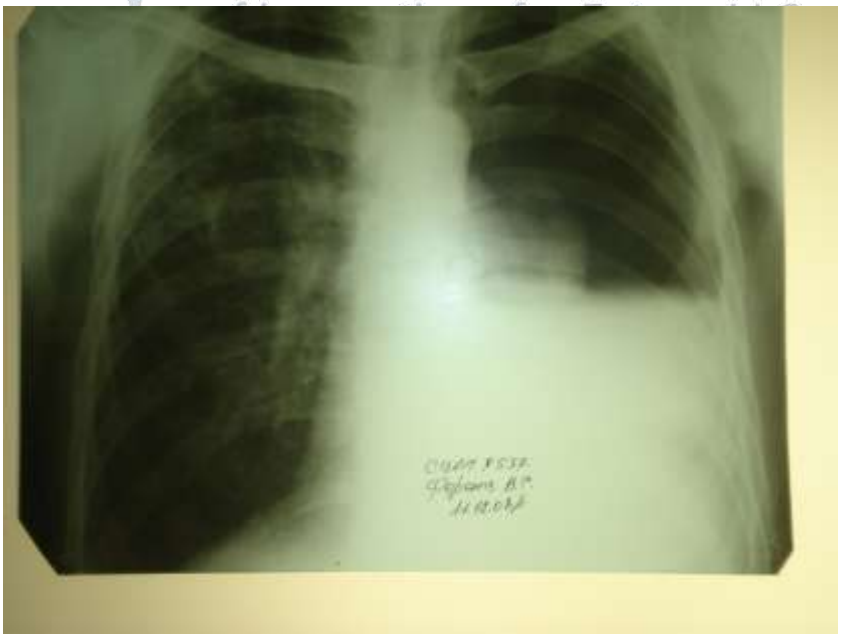

Fig. 6. X-ray of pleural empyema.

In all cases, pleural puncture was performed before drainage of the pleural cavity. It is used as an important diagnostic method. It must be remembered that in the presence of thick pus, especially with fibrin inclusions, a sufficiently coarse puncture needle should be used, since pus may not pass through a regular one in such cases.

Thoracoscopy as a diagnostic method was performed in 12 cases. After complete removal of pus, the pleural cavity was thoroughly washed with antiseptic agents according to protocols [23-27].

Fig. 7 shows a sharp hyperemia of the costal and visceral pleural surfaces. The color could vary from purple to greenish.

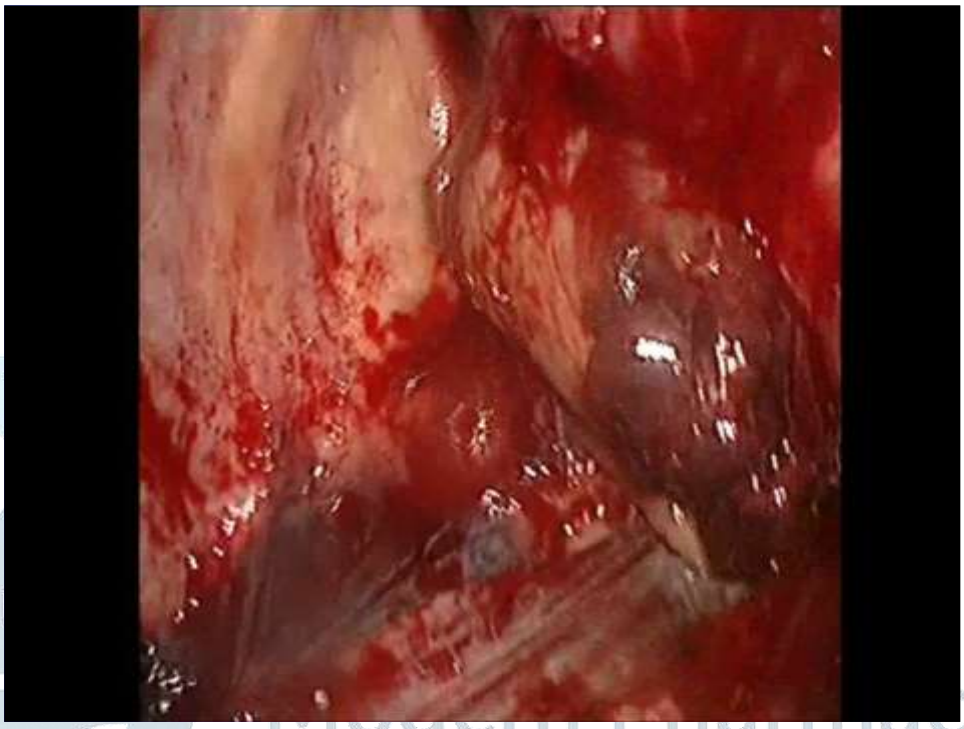

Fig. 7. Thoracoscopic view of empyema pleural cavity.

Fig. 8 illustrates a massive purulent process in pleural empyema. The smell of empyema contents is extremely unpleasant, pungent, especially in the presence of anaerobic flora.

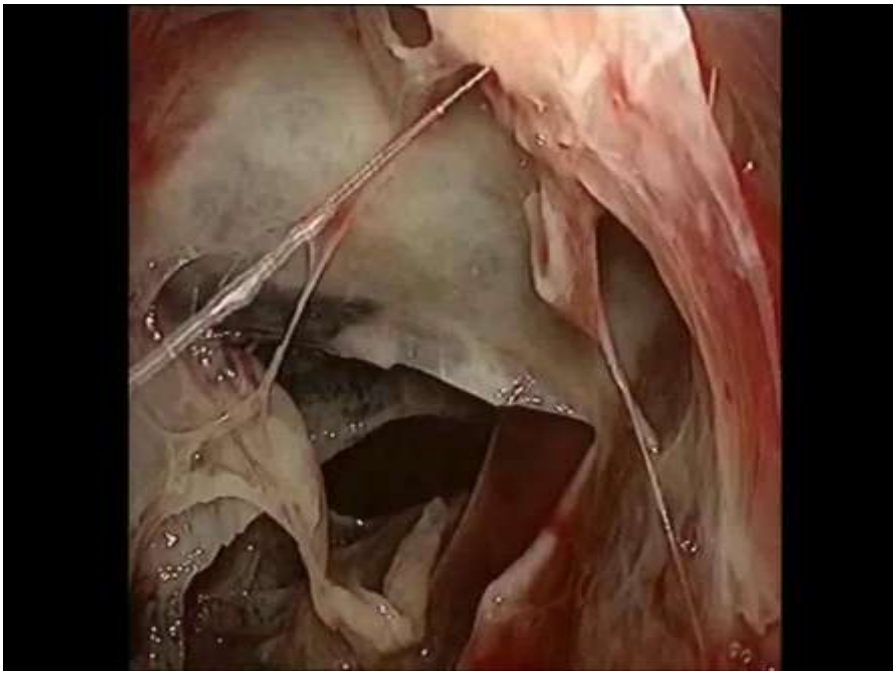

Fig. 8. Massive biliary process in pleural empyema.

As an independent method of treatment, only pleural puncture was used in 57 cases of limited pleural empyema and in 12 cases in the treatment of widespread pleural empyema with a small fluid content.

Thoracocentesis is the main method of treatment of patients with pleural empyema. It was performed in 487 cases. In 398 cases, active suction of purulent contents was used.

Indications for drainage of the pleural cavity are given in Fig. 9.

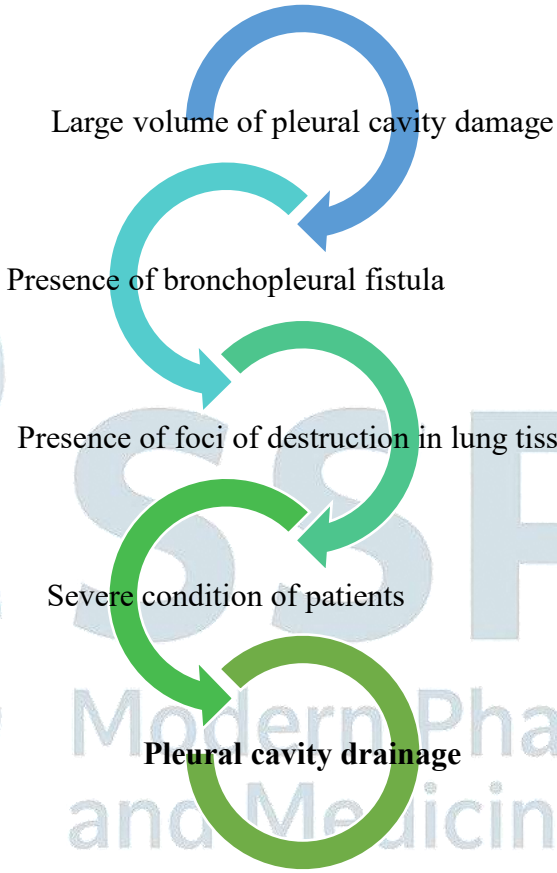

Fig. 9. Indications for drainage of the pleural cavity in empyema of the pleural cavity.

In the study of the author of the article, decortication with pleurectomy was performed for patients with chronic pleural empyema with the development of massive fibrotic and connective processes. At the same time, pleural thickening up to 1.5-2 cm was observed. The number of such operated patients was 41.

The most important stage of the operation in massive pleurofibrosis caused by purulent pleurisy is the separation of connective processes between the costal and parietal pleura.

Fig. 10 and Fig. 11 show images of the separation of massive pleural adhesions and adhesions during pleurectomy for chronic empyema.

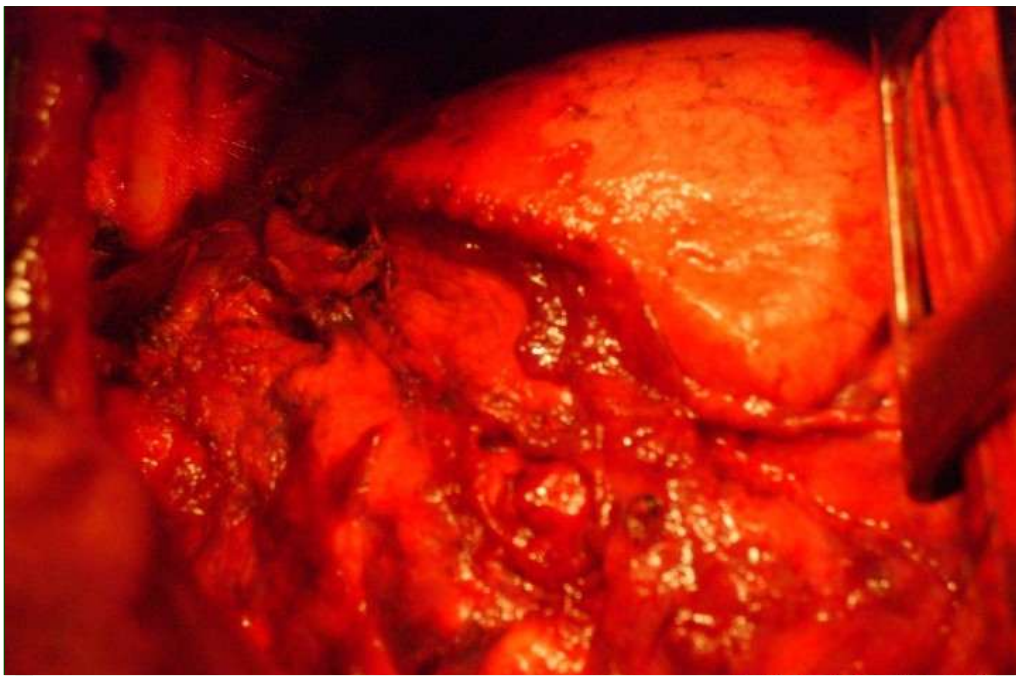

Fig. 10. Isolation of adhesions and adhesions in chronic empyema of the pleural cavity.

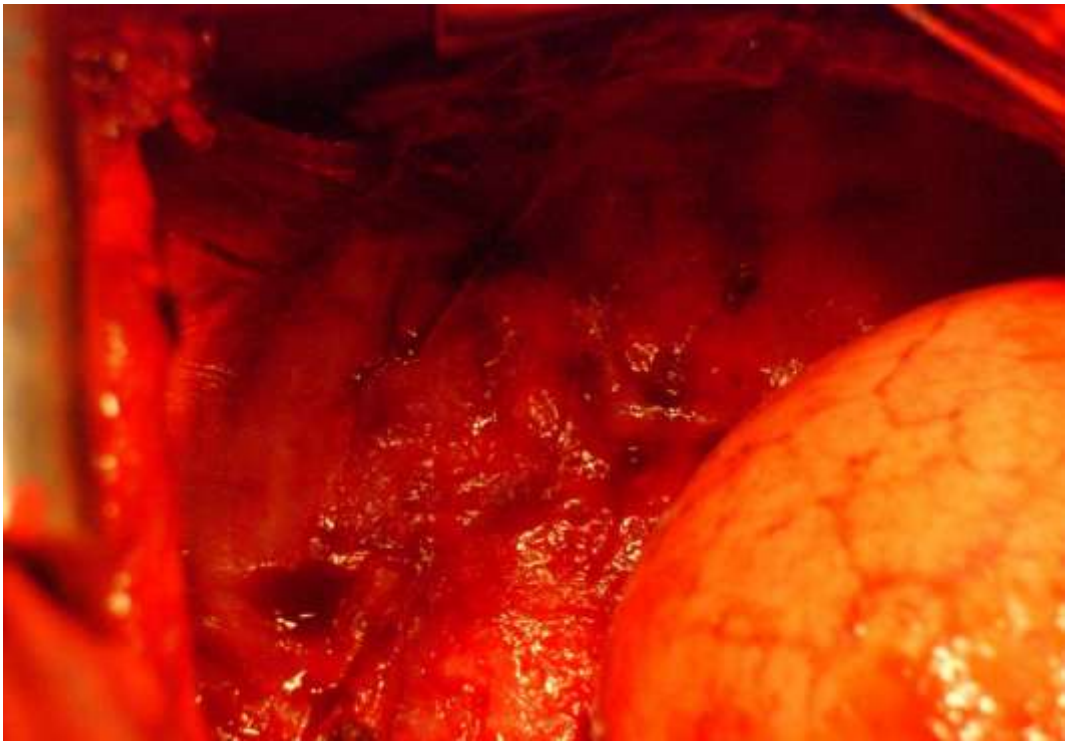

Fig. 11. Isolation of adhesions and adhesions in chronic empyema of the pleural cavity.

In 28 patients, after the sanitation of the residual pleural cavity, a two-stage selective thoracoplasty was performed. This type of operation consists in the fragmentary removal of the ribs above the cavity and filling the latter with muscle mass. Patients well tolerate the operation. There is no significant deformation of the shape of the chest and curvature of the spine. All patients were discharged from the hospital with the elimination of signs of empyema. No mortality was observed in two-stage selective thoracotomy.

Fig. 12, Fig. 13, and Fig. 14 present the stages of selective thoracoplasty in a patient with chronic pleural empyema.

Fig. 12. Drained left pleural cavity in chronic pleural empyema, rigid lung.

Fig. 13. The first stage of selective thoracoplasty.

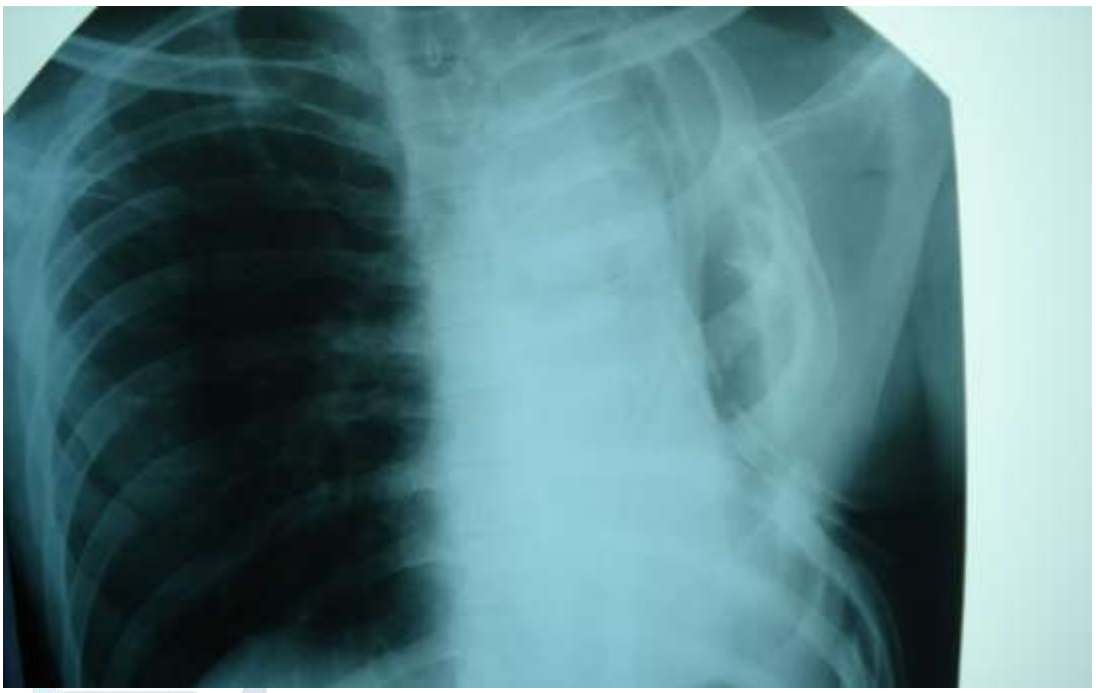

Fig. 14. The second stage of selective thoracoplasty.

In limited pleural empyemas, transthoracic biopsy under the control of computed tomography was widely used in differential diagnosis with lung tumors.

Treatment of pleural empyema consists of adequate and immediate sanitation of the purulent focus, elimination of inflammation in the pleural cavity, elimination of obliteration of residual pleural cavities and expansion of the lung.

Parenteral antibiotic therapy considering the sensitivity of microflora and local antibacterial therapy are very important [28-31].

Determination of the microflora of empyema fluid in the studied patients is shown in Fig. 15.

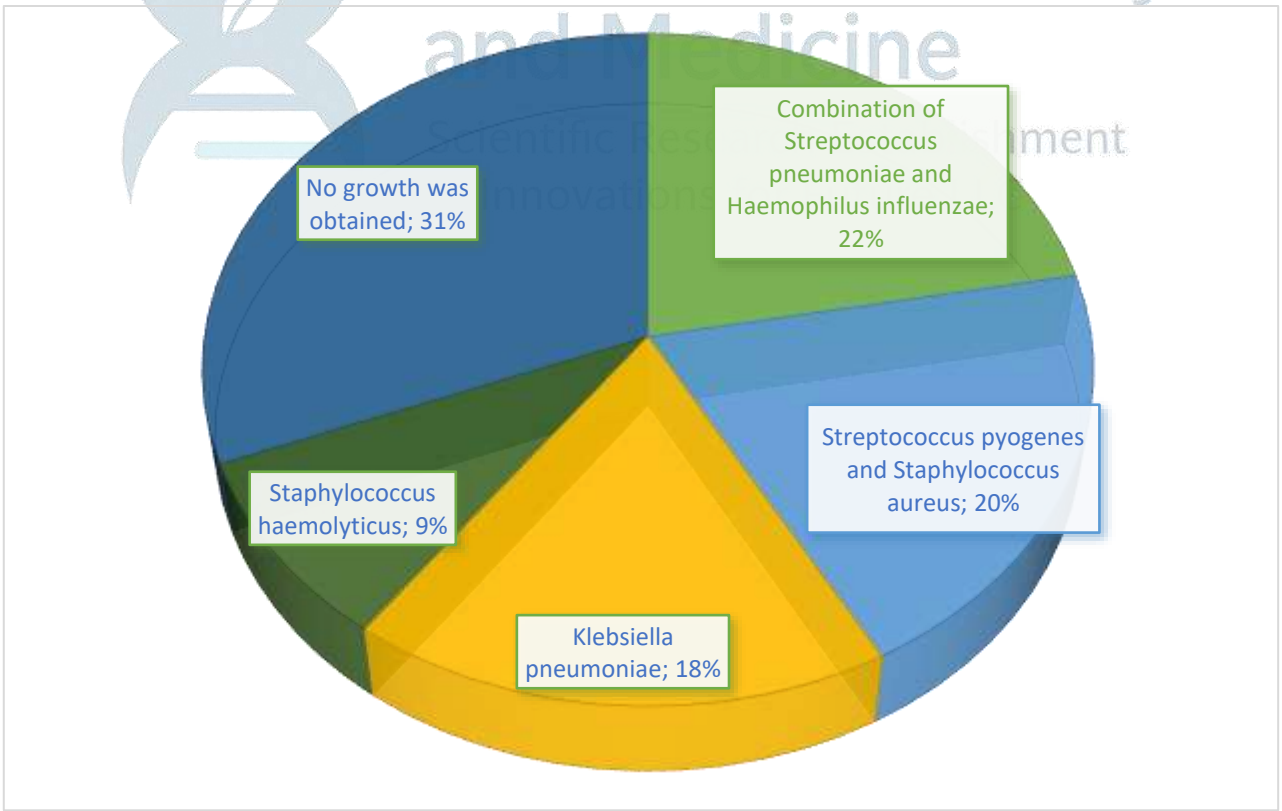

Fig. 15. Types of microflorae of empyema fluid in the studied patients.

In the context of the development of telemedicine and telepharmacy, it is important to prevent medical errors in the diagnosis and treatment of pleural empyema [32, 33].

The results obtained indicate the high effectiveness of a comprehensive approach to the diagnosis and treatment of pleural empyema. The use of modern instrumental examination methods, in particular radiography and ultrasound, allows for timely detection of pathological changes and determination of the scope of therapeutic interventions. Pleural puncture, active drainage, as well as surgical methods (decortication, pleurectomy, selective thoracoplasty) provides high clinical effectiveness even in cases of chronic course of the disease.

In the context of the development of telemedicine and digital medical technologies, it is especially relevant to increase the awareness of doctors about the standards of diagnosis and treatment of pleural empyema, prevention of complications and reduction of the risks of medical errors. Further research should be aimed at developing personalized antibiotic therapy regimens and implementing algorithms for pharmacoeconomic assessment of treatment effectiveness, considering the global problem of antimicrobial resistance.

Conclusions. Pleural empyema is a complex clinical condition that occurs as a complication of several inflammatory, infectious, traumatic, or oncological processes. Despite the achievements of modern medicine, this pathology is still associated with a high mortality rate, especially in patients with delayed medical care or with chronic underlying diseases. The data of the study confirm that timely diagnosis and active treatment tactics can significantly reduce the risk of complications and chronicity of the disease.

The gold standard for diagnosis remains radiography and ultrasound of the chest, which allow verifying the presence of empyema content, determining its location and volume. Pleural puncture, as a diagnostic and at the same time therapeutic procedure, is an important component in the algorithm for managing such patients. In cases of thick pus with fibrinous layers, the use of wider diameter needles or catheters is required for effective removal of the contents.

Treatment of pleural empyema should be individualized and include both conservative and surgical methods. Drainage of the pleural cavity, active removal of pus, local and systemic antibiotic therapy are the basis of initial treatment. In the case of chronic course or the formation of massive adhesions and pleural thickening, decortication, pleurectomy or selective thoracoplasty is advisable. Surgical treatment ensures the restoration of lung ventilation function and prevents re-accumulation of exudate.

In modern conditions of the development of telemedicine and digital clinical tools, it is important to focus the attention of the medical community on the prevention of diagnostic and treatment errors that can lead to chronicity of the process or ineffective antibiotic therapy. The dissemination of clinical protocols, advanced training of doctors, and the formation of interdisciplinary teams will improve the treatment outcomes of patients with pleural empyema and reduce the social consequences of this pathology.

Declaration of conflict interest. The author declared no potential conflicts of interest with respect to the research, authorship, and publication of this article. The author confirm that they are the authors of this work and have approved it for publication. The author 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 conflict and/or potential conflict of interest.

Funding. The author state that this research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

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) in accordance with the Law of Ukraine "On the Protection of Personal Data", which regulates legal relations related to the protection and processing of personal data, and is aimed

at protecting the fundamental rights and freedoms of a person and a citizen, in particular the right to non-interference in personal life, in connection with processing of personal data. This Law applies to the processing of personal data, which is carried out in whole or in part using automated means, as well as to the processing of personal data contained in the card file or intended to be entered in the card file, using non-automated means.

Data availability statement. The datasets analyzed during the current study are available from the corresponding author on reasonable request.

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