Complications During Transthoracic Lung Biopsies Under the Control of Computer Tomography (Diagnosis of Tumor-Like Formations)

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Abstract. Currently, there is a recognized causal link between infectious diseases such as influenza, acute respiratory viral infections, and COVID-19, and the onset or worsening of various chronic and concurrent health conditions. These include, but are not limited to, cardiac disorders, both type I and II diabetes, bronchial asthma, chronic obstructive pulmonary disease, and injuries affecting the brain, chest, and lungs. Notably, complications arising from transthoracic lung biopsies, such as tumor-like formations and pneumothorax, have been observed. An in-depth analysis was conducted on complications following transthoracic biopsies, particularly those monitored via computer tomography. This involved a comprehensive review of existing scientific literature on the subject matter. It is imperative to underscore the critical need for appropriate pharmacotherapy to manage these complications, emphasizing the necessity of essential medications within the framework of legal interactions among doctors, patients, pharmacists, and lawyers. This research is inherently multidisciplinary, bridging the fields of medical science, pharmacology, and legal studies. The technique of conducting transthoracic biopsies with the guidance of computer tomography is meticulously detailed within this study. The discussion extends to the method's benefits, inherent risks, and unique characteristics, highlighting its utility in diagnosing and managing lung-related pathologies. Despite the potential for complications, this method is portrayed as largely safe, minimally invasive, and without significant adverse outcomes. It stands out as a promising avenue for future investigations, especially in the accurate diagnosis and management of lung diseases. This conclusion not only reflects the efficacy and safety of the transthoracic biopsy method when performed under computed tomography but also calls for ongoing research to further optimize and understand its application in clinical practice. The interplay between advanced diagnostic techniques, effective pharmacotherapy, and the legal framework governing healthcare practices forms a crucial nexus for enhancing patient care and outcomes in the face of complex respiratory diseases and associated conditions.

Keywords: lungs, transthoracic biopsy, computed tomography, lung cancer, pneumothorax, drugs, chronic, comorbid disorders.

Introduction. Today, influenza, acute respiratory viral infections, and COVID-19 are causally related to the development and exacerbation of concomitant and chronic diseases. In particular, cardiac dysfunction, type I and II diabetes, bronchial asthma, chronic obstructive pulmonary disease, injuries of various types with damage to the brain and chest and lungs, complications during transthoracic lung biopsies (tumor-like formations), pneumothorax [1-7]. Pharmacotherapy requires urgent hospitalization of patients in health care institutions and provision of vitally necessary medicines in the system of legal relations "doctor-patient-pharmacist-lawyer" [8-14].

Thus, according to the data of the Ministry of Health of Ukraine, in general, health care institutions registered [15]:

- 1.9 ml. patients from October 2023 (the beginning of the epidemic season) became ill with acute respiratory viral infections, influenza, and COVID-19;
- 155,539 citizens (from December 4 to 10, 2023) fell ill with acute respiratory viral infections, influenza, and COVID-19;

- of them, 4,652 patients were hospitalized with a diagnosis of acute respiratory viral infections, 10,869 patients with COVID-19;
- of them, 2,083 patients were sent to inpatient treatment;
- 4,595 patients due to acute respiratory viral infections were admitted to hospitals during the week (from December 24 to 31, 2023), of which 2,417 were children under the age of 17:
- deaths of 3 citizens due to complications of influenza in health care facilities of the Ivano-Frankivsk region (from December 24 to 31, 2023);
- 6,746 citizens were diagnosed with influenza A and B viruses in 9 regions of Ukraine;
- 1,562 patients with COVID-19 were hospitalized;
- 39 deaths of citizens from complications of COVID-19 were recorded, including 2 children under the age of 14.

At the same time, since the beginning of 2024, vaccinations against COVID-19 in all regions of Ukraine will remain free of charge for every citizen:

- a person can get vaccinated by making an appointment with your family doctor or at a vaccination point in established health care institutions;
- family doctors use "Janssen" (manufacturer "Johnson&Johnson"), "Comirnaty" (manufacturer "Pfizer") vaccines for adult vaccinations, and for children from 5 years of age – the "Comirnaty" vaccine for children (manufacturer "Pfizer").

The basis for protection against a severe course of COVID-19 is a course of 3 vaccinations. Receiving two doses of the primary vaccination and the first booster vaccination, which is administered 5 months after the primary vaccination. All subsequent ones after the 3rd vaccination are called an additional booster. The need for additional booster vaccination is determined by the doctor based on the patient's medical history and the accepted recommendations of the Ministry of Health of Ukraine [16-18].

According to the experts of the State Institution "Lviv Regional Center for Disease Control and Prevention of the Ministry of Health of Ukraine" for the first week of 2024, it was recorded [19]:

- acute respiratory viral infections of more than 11,700 citizens (exceeding the epidural threshold by + 8%);
- 250 citizens were diagnosed with COVID-19, of which 37 patients were hospitalized due to a severe course of the disease, and deaths were recorded in 3 patients;
- 47 patients with a diagnosis of influenza, acute respiratory viral infections and COVID-19 are receiving inpatient treatment in the department of the Lviv Regional Infectious Clinical Hospital;
- there are 38 patients diagnosed with influenza and acute respiratory viral infections in the children's department;
- the 1st child who was admitted with severe pneumonia died from the flu;
- in the risk group – pregnant women, children under one year old, people of older retirement age and those who suffer from chronic, autoimmune diseases, problems with the cardiovascular, respiratory, and nervous systems.

In turn, the Director of the Department of Health Protection of the Kyiv City State Administration indicated on January 30, 2024 that the incidence of influenza, acute respiratory viral infections and COVID-19 is increasing in Kyiv. 17,666 patients were registered last week. Morbidity among children compared to the previous week increased by more than 50%. Among those who fell ill, there are patients who are in serious condition and need treatment in the inpatient conditions of a health care institution [20, 21].

Pharmacotherapy of infectious and comorbid disorders requires effective, high-quality, affordable vaccines and drugs [22-24]. The European Medicines Agency (EMA) in 2023 recommended for registration in the countries of the European Union [25]:

- 77 drugs for obtaining a circulation permit (issuance, sale, transportation, storage, etc.);
- 39 drugs in their composition contain an active substance that was not previously approved for circulation in the countries of the European Union;
- 2 vaccines to protect against diseases of the lower respiratory tract caused by respiratory syncytial virus (RSV);

➢ several drugs associated with the selection of new treatments that represent significant progress in their therapeutic areas.

Based on the recommendations of experts of the State Enterprise "State Expert Center of the Ministry of Health of Ukraine" [26]:

✓ 505 drugs are registered;
✓ 646 drugs were re-registered;
✓ changes were made to the registration materials of drugs (11,723).

So, doctors have at their disposal a certain list that is vital for the pharmacotherapy of influenza, COVID-19, and complications of transthoracic lung biopsies (tumor-like formations).

The purpose of the study was to analyze complications after transthoracic biopsy under the control of computer tomography. It was also planned to compare the results of the author's experiment with the relevant data presented in literary sources.

Materials and methods. Coagulogram, determination of clotting time and duration of bleeding, general blood analysis, detection of hematocrit level. Anonymous documentary case history analysis of the results of complications in CT-guided transthoracic biopsy of 195 patients treated between 2013 and 2023. Healthcare institutions:

○ communal non-commercial enterprise of the Lviv Regional Council "Lviv Regional Phthisiopulmonology Clinical Treatment and Diagnostic Center";
○ state organization (institution, facility) "Military Medical Clinical Center of the Western Region" in Lviv;
○ Lviv Military Medical Clinical Center (Clinical Hospital) of the State Border Service of Ukraine.

Transthoracic biopsy under the control of computer tomography was performed in the conditions of the computer tomography department according to the following method:

▪ local anesthesia was performed using 0.5% novocaine solution or 2% lidocaine solution.
▪ semi-automatic trocar needles, size 18 g, were used for biopsy;
▪ the place of the needle injection on the skin was determined after a preliminary scan on a computer tomography;
▪ depth, direction of needle injection was also determined according to the same scheme;
▪ after inserting the needle and passing it into the pleural cavity, the first one was fixed on the skin with the original fixator;
▪ after that, scanning and checking of the location of the distal end of the needle were again carried out;
▪ it was taken into account that when taking biotic material, the working part of the needle "shoots" by one centimeter.
▪ sampling of material for histological examination was carried out after the location of the distal end of the needle in the tumor-like formation was clearly determined.

A one-time collection of histological material was carried out. In 36 cases, repeated punctures of the studied formation were performed. In order to detect possible complications (pneumothorax, hemothorax), computer tomography of the chest must be performed under control after transthoracic biopsy [27].

The research has a multidisciplinary context.

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; 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); Kharkiv Medical Academy of Postgraduate Education on the topics "Improvement of the organizational and legal procedure of providing drugs to patients from the position of forensic pharmacy, organization and management of pharmacy" (state registration No. 0116U003137, implementation period 2016-2020) and "Pharmaceutical and medical law: integrated approaches to the drug circulation system from the standpoint of forensic pharmacy and the organization of the pharmaceutical case" (state registration

No. 0121U000031, implementation period 2021-2026); Luhansk State Medical University "Conceptual interdisciplinary approaches to pharmaceutical provision and availability of drugs, taking into account organizational and legal, technological, analytical, pharmacognostic, forensic and pharmaceutical, clinical and pharmacological, pharmacoeconomic, marketing, social and economic competencies" (state registration number 0123U101632, terms 2023-2027); Petro Mohyla Black Sea National University on the topic "Conceptual interdisciplinary approaches to the drug circulation system, taking into account organizational and legal, technological, biopharmaceutical, analytical, pharmacognostic, forensic and pharmaceutical, clinical and pharmacological, pharmacoeconomic, pharmacotherapeutic aspects" (state registration No. 0123U100468, implementation period 2023-2028).

Results and discussion. In 2021, an international multidisciplinary group of 217 expert authors and editors of the WHO published the "Classification of Chest Tumors", one of the sections of which is the classification of lung tumors, which was included in the 5th edition of the "Blue Book on Chest Tumors" [28- 30]. Experts in research first propose the use of the principles of morphology for a more accurate classification, and then – molecular methods, based on the achievements in the molecular pathology of all types of tumors.

Continuing our research, for the purpose of verifying tumor-like formations of the lungs, transthoracic biopsy under the control of computer tomography is widely used. This method is sufficiently informative regarding the diagnosis of malignant and benign neoplasms of the lungs, limited non-specific inflammatory processes, some types of disseminated lesions. It is this method that allows for histological verification of tumor-like formations of the lungs with their peripheral localization. This method is quite common in the verification of interstitial tumor formations.

Transthoracic biopsy under the control of computed tomography has a number of advantages compared to other minimally invasive methods. Advantages:

firstly, it is less traumatic compared to mediastinoscopy and thoracoscopy;

secondly, with the specified techniques, although small, but still cuts of soft tissues of the neck or chest wall are used;

thirdly, transthoracic biopsy under the control of computer tomography is performed under local anesthesia and does not require preoperative preparation;

fourthly, video mediastinoscopy and video thoracoscopy are performed only under anesthesia, which requires full preoperative preparation;

fifthly, radiation exposure during a one-time use of computer tomography is insignificant and does not significantly affect the patient's condition.

As for the needles that are used for transthoracic biopsy under the control of computer tomography, they are basically of two types: aspiration and trocar.

Transthoracic biopsy was performed by us for the diagnosis of tumor-like formations of the lungs, interstitium, differential diagnosis, limited inflammatory processes and some disseminated processes of the lungs. Note that Sinner W.N., Berquist T.H., Zajicek J. indicate possible complications [31-34].

First of all, there are complications related to technically correct manipulation, namely, choosing the type of needle for transthoracic biopsy. A number of authors pointed to the possibility of the development of implantation metastases during puncture of intrapulmonary malignant neoplasms.

Even a small percentage of this pathology, as noted by Sinner W.N., Zajicek J., is an extremely serious complication; calls into question the effectiveness of the subsequent radical surgical intervention [35]. The authors noted the possibility of implantation metastases along the entire course of the puncture channel, including in the soft tissues of the chest wall.

After analyzing data from literary sources, the authors came to the conclusion that all cases of implantation of metastases are associated with a specific type of needles, namely, aspiration needles.

The risk of tumor spread during aspiration biopsy of lung cancer per 1264 patients – only one case was recorded. In the retrospective analysis of transthoracic biopsy under the control of computer tomography, implantation metastases were ascertained in 3 cases during aspiration biopsy [36]. With

trocar needles, not a single case of implantation metastases was found in large randomized studies [37].

The next group of complications is postpuncture pneumothorax. According to Vachani A., Bae K., Lang D., the frequency ranges from 3% to 30% [38-40].

As can be seen from the literature, the vast majority of complicated pneumothoraxes were eliminated by performing pleural punctures. Drainage of the pleural cavity was used to eliminate the complicated pneumothorax. Subcutaneous emphysema can accompany the development of complicated pneumothorax, with the risk of progression to interstitial emphysema.

Hemoptysis and pulmonary bleeding are possible complications after a transthoracic biopsy under the control of computer tomography, and can reach up to 30.9% [41-45]. The first can be observed during the manipulation and after it. Cases of small hemoptysis and large pulmonary hemorrhages associated with this manipulation are described. Especially dangerous are the cases of injury to the main vessels during the puncture of centrally located tumor-like formations.

The next serious complication is the possible development of acute cardiovascular failure, which is associated with the performance of this procedure. Clinically, the course of this complication is very similar to the phenomena of acute bleeding. There is a sharp drop in blood pressure in patients, a colaptoid state, clouded consciousness. The development of allergic reactions to the administration of anesthetic with transthoracic biopsy is not noted.

Treatment of pneumothorax, as noted by Zarogoulidis P., Kioumis I., Pitsiou G., depends on the pulmonologist and a number of factors. It can vary from discharge with early observation to immediate needle decompression or insertion of a drainage tube [46].

✓ Performing thoracoscopy with one port, or video thoracoscopy with two or one port.

✓ In case of traumatic pneumothorax, drainage tubes are usually used; such patients are treated by thoracic surgeons, as other chest organs may be damaged.

✓ With artificial lung ventilation, the risk of tension pneumothorax increases significantly, so the introduction of a drainage tube is mandatory.

✓ Any open chest wound should be closed hermetically, as it carries a high risk of tension pneumothorax.

✓ Tension pneumothorax is urgently treated with a decompression needle. Needle decompression may be required prior to transport to the hospital at the scene of the accident. It can be performed by an emergency medical technician or other specialist. The needle or cannula is left in place until a drainage tube can be inserted. If a tension pneumothorax leads to cardiac arrest, needle decompression is performed as part of resuscitation because it can restore cardiac output.

Our research consisted in carrying out a transthoracic biopsy under the control of computer tomography. We divided the identified complications after this procedure into two groups:

1) develop during or immediately after a transthoracic biopsy;

2) may appear after 8 hours of transthoracic biopsy.

During the research it was established:

➔ iatrogenic pneumothorax – in 14% of cases after the specified manipulation;

➔ clinically, patients with iatrogenic pneumothorax in the vast majority of cases did not experience pain, shortness of breath, or respiratory failure;

➔ in most cases, the specified complication developed gradually after transthoracic biopsy and was detected by computed tomography.

In 70.4% of cases, delayed development of pneumothorax was determined, when the presence of free air in the pleural cavity was not determined on the control computer tomography during the procedure. Pneumothorax was diagnosed based on the data of physical examination (percussion, auscultation), according to the results of X-ray examination more than 8 hours after the procedure. In 74% of cases, the pneumothorax that developed after 8 hours of the procedure was eliminated by pleural puncture. Thoracentesis with drainage of the pleural cavity was used in 26% of total pneumothoraxes. In 56% of cases with pneumothorax that developed immediately after transthoracic biopsy, pain, and discomfort in the affected half of the chest were noted. In these situations, the diagnosis was not difficult, since the specified complication was detected during the control computer

tomography. In these cases, we performed drainage of the pleural cavity. In 46% of patients, pneumothorax that developed immediately after transthoracic biopsy was not accompanied by pain. In 9% of cases, minor subcutaneous emphysema after pneumothorax was diagnosed. This pathology did not require separate medical manipulations (incisions with drainage of soft tissues). In no case was the development of massive subcutaneous emphysema or interstitial emphysema noted.

During the research, we did not establish a correlation between the size, depth of location of tumor-like formations and complications of pneumothorax. No reliable cause-and-effect relationship was found between the size and depth of the location of the tumor-like formation and the presence of iatrogenic pneumothorax after transthoracic biopsy.

According to the research results, it was also established that:

- when the formations are located at a depth of more than 3 cm, pneumothorax was detected in 15 patients;
- at the location of tumor-like formations with a depth of up to 3 cm, iatrogenic pneumothorax after transthoracic biopsy was ascertained in 12 patients;
- iatrogenic pneumothorax was diagnosed after puncture of formations from 1.5 cm to 3 cm in size in 14 patients and after puncture of formations over 3 cm in 13 cases.

No statistically significant difference was found.

Tension iatrogenic pneumothorax [47-49] is accompanied by signs of respiratory failure, dyspnoea. Also, we did not ascertain a single case of tension iatrogenic pneumothorax after transthoracic biopsy. Thus, after the transthoracic biopsy we performed, there were no severe pneumothoraxes that would require urgent medical measures.

One of the rather serious complications after a transthoracic biopsy is the presence of intrapulmonary bleeding. But we did not establish a single case of medium or large pulmonary hemorrhages.

In our opinion, this is the merit of the radiologists who performed the computed tomography of the lungs, and who clearly indicated the presence of large vessels. These issues were very relevant in the case of central location of tumor-like formations, or when the latter were localized in the interstitium.

Hemoptysis after transthoracic biopsy was observed in 9% of cases. Patients complained of minor repeated hemoptysis the day after the transthoracic biopsy. Such patients were prescribed standard methods of examination: coagulogram, determination of clotting time and duration of bleeding, general blood analysis. Hemostatic therapy was continued for two days. We found no correlation between the frequency of hemoptysis and the size or depth of the location of the tumor-like formation. In our study, the development of acute cardiovascular insufficiency was noted in the 1st case.

An example from clinical practice. Patient S., 28 years old, complained of a dry cough, periodic general weakness, an increase in body temperature to subfebrile numbers. A radiographic examination revealed a paramediastinally located tumor-like formation up to 3 cm in diameter. No pathology was detected during fibrobronchoscopic examination. For diagnostic purposes, it was decided to conduct a transthoracic biopsy under the control of computer tomography. The puncture was performed relatively close to the main vessels and to the root of the left lung. Intrapulmonary placement of the trocar needle was evaluated using computed tomography. Material was taken from the lesion for histological examination. The trocar needle was removed from the pleural cavity. Control computed tomography of the lungs was performed for the presence of pneumothorax or hemothorax. These complications were not detected during this study. A few minutes later, the patient began to complain of dizziness, "darkening" in front of her eyes, and sudden general weakness. When measuring blood pressure, the indicators were 70/40 mm of mercury column, pulse rate – 120 beats per minute. The development of acute iatrogenic hemorrhage from the main vessel was suspected. A control computed tomography of the lungs was performed urgently. No free fluid or air was detected in the left pleural cavity. To stabilize blood pressure, the patient underwent intensive therapy measures: intravenous administration of dexamethasone, strophanthin, and panangin. Despite this,

low blood pressure, dizziness, and general weakness persisted for 3 hours. After this period, blood pressure indicators normalized (pulse – 82 beats per minute, blood pressure – 115/80 mm Hg).

During the entire specified period, not a single fatal case related to transthoracic biopsy was ascertained.

Conclusions. Complications after transthoracic biopsy under the control of computer tomography were analyzed. A review of scientific literature data on the topic of the work is summarized. It is noted that the pharmacotherapy of complications needs to be provided with essential medicines in the system of legal relations "doctor-patient-pharmacist-lawyer". The statistics of the Ministry of Health of Ukraine regarding influenza, acute respiratory viral infections, and COVID-19 have been systematized. Cause-and-effect relationships with the development and aggravation of concomitant and chronic diseases have been proven. Attention is focused on the multidisciplinary context of research. The method of transthoracic biopsy under the control of computer tomography is described. The advantages, risks, and features of transthoracic lung biopsy under the control of computer tomography are indicated. An example from clinical practice is given. It was concluded that the method of transthoracic biopsy under the control of computed tomography of the lungs is safe, is not accompanied by significant complications and is promising for further research.

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

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