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ULTRASOUND DIAGNOSIS OF PNEUMOTHORAX - PITFAILES AND HOW TO PREVENT THEM

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ABSTRACT

Introduction: Pneumothorax is a life-threatening condition resulting from the entry of air into the pleural cavity. The most popular imaging test used in its diagnosis is classical X-ray, and in doubtful cases, also computed tomography (CT). However, ultrasound (US) is becoming increasingly popular. Thanks to the development of diagnostic criteria, it is possible to quickly, safely, and extremely effectively detect pneumothorax using lung ultrasound. Despite its many advantages, this method has certain limitations, including conditions and diseases whose images may falsely suggest pneumothorax.
Methods: The following paper is based on a compilation of our own experiences from approximately 350 lung ultrasound examinations and a literature review to identify as many clinical conditions as possible that may falsely suggest an ultrasound image of pneumothorax, along with potential causes of error, taking into account the sonomorphology and pathophysiology of the lesions. Additionally, criteria have been developed to differentiate specific conditions from pneumothorax, and a classification has been prepared based on the difficulty of differentiation, with particular emphasis on situations requiring conclusive additional testing.
Conclusions: Ultrasound diagnosis of pneumothorax must be closely correlated with the clinical presentation to avoid errors. Adherence to diagnostic criteria will prevent errors in most cases. Less experienced examiners should pay particular attention to subtle differences in pleural sliding.

KEYWORDS

Pneumothorax, Lung Ultrasound, Ultrasonography, POCUS

CITATION

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Introduction:

A pneumothorax is a condition in which air is detected in the pleural cavity, the space bounded by membranes: the parietal pleura, which lines the inner chest wall, and the pulmonary pleura, which is adjacent to the lung surface. Furthermore, a small amount of fluid (a few milliliters) is physiologically present in the pleural cavity, ensuring the proper movement of the pleural membranes relative to each other during respiration. Pneumothorax can be classified differently depending on its cause (spontaneous, post-traumatic, iatrogenic), mechanism of development (closed, open, tension), or size (width of the pneumothorax greater or less than 2 cm). Possible causes of pneumothorax include, among others[2-4]:

- Primary idiopathic
- No clearly identified causes
- Primary secondary
- Exacerbation of chronic respiratory diseases (asthma, chronic obstructive pulmonary disease)
- Chronic interstitial lung diseases (sarcoidosis, idiopathic fibrosis, etc.)
- Infectious lung diseases (tuberculosis, parasitoses, fungal infections)
- Systemic connective tissue diseases (Ehlers-Danlos syndrome, ankylosing spondylitis, polymyositis, etc.)
- Primary and secondary lung tumors
- Traumatic and iatrogenic
- Traffic accidents or other high-energy injuries
- Stab, blast, or gunshot wounds to the chest
- Complication of cardiothoracic surgery
- Complication of subclavian vessel catheterization
- Complication of intercostal nerve blocks or brachial plexus
- Complication of aggressive ventilator therapy.

A particularly dangerous form of pneumothorax is the so-called tension pneumothorax, considered a direct threat to life and rapidly leading to sudden cardiac arrest. Its general mechanism involves the development of a valve mechanism within the pleural cavity. Air then inflows during inhalation and is blocked during exhalation. This phenomenon rapidly fills the pleural cavity with air, leading to a significant increase in pressure within the chest, leading to lung collapse and damage, displacement of chest structures to the opposite side, compression of the large venous and arterial trunks, and subsequent compression of the other lung. This leads to a dramatic disruption of ventilation and cardiac impairment, significantly reducing blood output. Therefore, the most important factor in determining the patient's prognosis is the promptest possible intervention to relieve the tension pneumothorax.[5]

The diagnosis of pneumothorax is based on a medical history, physical examination, and imaging studies. The most common complaints reported during the medical history are shortness of breath, chest pain, and cough. The interview should also address any previous trauma to the chest and a medical history of chronic respiratory diseases, connective tissue diseases, infectious diseases, or oncological conditions. In the case of medical procedures involving the chest or adjacent areas, deterioration of the patient's condition accompanied by the above-mentioned symptoms may suggest iatrogenic pneumothorax.[6]

During the physical examination, symptoms such as a reduced vesicular murmur on the side of the pneumothorax and an ipsilateral tympanic percussion may be observed. Additionally, tachycardia, hypotension, rapidly worsening dyspnea leading to cyanosis, tachypnea, and, in rapidly progressing pneumothorax, even cardiac arrest may be observed.[6]

X-ray examinations are most often performed in the posterior-anterior (PA) projection; a lateral projection is generally unnecessary. Radiological features supporting the diagnosis of pneumothorax include: a linear pleural shadow parallel to the chest wall, mediastinal displacement to the healthy side and, as a result, abnormalities in the lung resulting from this displacement (on the healthy side), widening of the intercostal spaces, and a reduction in the height of the diaphragm (on the side of the pneumothorax). The size of a pneumothorax is estimated by measuring the distance from the chest wall to the lung (ideally at the level of the lung hilum). A distance of 2 cm has been calculated to correspond to a pneumothorax occupying approximately 50% of the chest.[5-6]

Computed tomography (CT) allows for a very accurate assessment of pneumothorax, but it is not recommended for routine use. It is particularly indicated when it is necessary to differentiate pneumothorax from bullae and other conditions causing destruction of the lung parenchyma. It is also preferred in trauma patients with polytrauma requiring a”trauma-scan" sequence. Furthermore, CT should be used when X-ray is inconclusive.[6]

It is a highly effective and non-invasive technique for diagnosing pneumothorax. Current research even indicates the superiority of ultrasound over traditional X-ray.

The examination technique depends on several factors, which are determined by the patient's clinical condition, the location of the examination, available equipment (probes), and the personal preferences of the person performing the examination. Without a doubt, the basic method for diagnosing pneumothorax is to place the patient in a supine position and place the ultrasound probe (preferably convex or linear) near the first or second intercostal space, in the midclavicular line (these are only approximate coordinates, as in practice the probe should be placed at the highest point of the chest). In emergency medicine, including in the Emergency Department, as well as in mobile emergency medical teams, or even in tactical situations where one is not dependent on one's own strength, the use of dedicated emergency protocols (especially e-FAST or BLUE) becomes particularly useful. They constitute a special examination protocol that allows for the diagnosis of potentially life-threatening conditions (including pneumothorax) in a highly effective manner with a relatively low probability of missing potential pathology. A key element determining their effectiveness is methodical training in their use, which allows for correct and rapid implementation even under stressful conditions. Another method for performing a pneumothorax examination is the increasingly popular POCUS (Point of Care Ultrasound). This is a so-called”bedside" examination of the patient, focused on a specific area or pathology. The POCUS method does not require the examiner to adhere to a protocol, but allows for a certain degree of freedom in performing the examination, meaning that it allows for limiting the examination to, for example, applying the head to only one area. The line between POCUS and ultrasound protocols is very fluid, and both concepts are often treated synonymously. Therefore, the proposed division should be considered purely informative. The most complex form of examination is performing a full assessment of the chest according to accepted standards. This is undoubtedly the most time-consuming form of examination, but it allows for scanning the largest possible area of the lungs and pleura. It is worth remembering this option in the case of a patient with an unknown cause of

shortness of breath and in a stable condition, as in addition to information about a potential pneumothorax, it will allow for the diagnosis of other coexisting lung diseases.[7-9]

According to international guidelines and expert consensus, the criteria for diagnosing pneumothorax include:

- Absence of the sliding sign, described in M-mode as the barcode sign
- Presence of A-line artifacts (reverberation artifact, indicating the presence of air)
- Absence of vertical artifacts (lines: B, Z, I, C)
- Absence of lung pulsation/cardiac pulse (a sign of lung pulsation resulting from the transmission of heartbeats)
- Presence of a lung point (the point at which the ventricle ends; in M-mode, a visible transition between the barcode sign and the normal image, the so-called seashore sign)

The presence of all criteria allows for a very high probability of diagnosing pneumothorax. Attention should be paid to the criterion related to the presence of a lung point, which will not be visible in cases of very large pneumothorax, due to the lack of contact between the parietal and pulmonary pleural laminae.

In such a case, if the patient's clinical picture is most consistent with pneumothorax and the other criteria are met, searching for a lung point is not necessary.[7-8, 10-11]

Methods:

This original work is based on the analysis of 350 lung ultrasound examinations and a literature review. Its primary goal was to collect data on the ultrasound diagnosis of pneumothorax, the diagnostic criteria, and the clinical conditions leading to false-positive or false-negative diagnoses. The data were collected from scientific publications selected using the Pubmed search engine. The examinations were performed using a Philips Affinity 50 system.

Results:

There are numerous clinical conditions that can lead to a false-positive diagnosis of pneumothorax. Based on the literature review, a list of diseases and clinical conditions that can mimic pneumothorax was developed, along with symptoms that support its diagnosis. Furthermore, specific features were developed for each condition to prevent a false-positive result. Situations that lead to a false-negative diagnosis are particularly dangerous, as they pose a serious threat to life. Therefore, such situations are also described below. The main cause of errors was found to be basing the diagnosis solely on the absence of the sliding symptom, without considering additional criteria.[12]

This is a very rare complication of chronic pneumonia, most often bacterial in origin, in which both pleural plaques fuse together or numerous fibrinous connections develop, leading to disturbances in pleural sliding, most often segmental in nature. An additional contributing factor is the presence of high-protein fluid located locally and peribasally. Excluding features may include visible elements of fibroma between the plaques, a present lung pulse on M-mode, and the potential presence of vertical artifacts or consolidation. An increased amount of fluid in the peribasal pleural cavities may be observed. Furthermore, it is worth considering a patient's history suggesting chronic pneumonia.[13]

Emphysema is a progressive disease affecting the respiratory bronchioles and alveolar sacs, leading to impaired gas exchange. Characteristically, the formation of enlarged air-filled structures called emphysematous bullae or, in the case of large ones, bullae is observed.

When the transducer is placed over an emphysematous bulla, the image will be very similar to a pneumothorax, often indistinguishable from large lesions. Therefore, differentiating the two conditions requires considerable experience.

It may be helpful to pay attention to the pleural line, as its features, such as fragmentation, thickening, and the presence of Am lines (lines similar to A lines, but significantly increasing in number from mid-length, i.e., lying one beneath the other), strongly suggest the diagnosis of chronic lung destruction. The presence of B line artifacts, which will rule out the presence of pneumothorax, may be helpful. A lung pulse may be helpful in excluding a pneumothorax, but in the case of large bullae, it may be difficult to visualize or even absent. The patient's medical history, if available, may be decisive, as well as signs of advanced emphysema, such as a barrel chest. Additional imaging tests, such as a chest X-ray or computed tomography, may often be necessary. Dyspnea should not be a symptom differentiating emphysema from a pneumothorax, as its nature is not specific enough.

It should be remembered that the presence of an emphysematous bulla does not exclude the presence of a pneumothorax resulting from its perforation. However, puncture of an unruptured bulla may lead to the development of iatrogenic pneumothorax. Differentiating between pneumothorax and emphysema is a significant challenge even for an experienced sonographer, therefore any therapeutic interventions should be preceded by other tests [14-15]

Interstitial lung diseases are a very complex and heterogeneous group encompassing approximately 300 diseases. Causes are divided into:

- Known
- Irritants, e.g., dust, smog
- Certain medications, e.g., methotrexate
- Coexisting connective tissue diseases
- Certain genes predisposing to the disease
- Unknown
- Idiopathic

The clinical picture is initially very nonspecific, and symptoms develop gradually, often over many months or years. Most of these diseases are rare and extremely rare, hence the diagnostic time and the path leading to diagnosis are extremely long. Idiopathic pulmonary fibrosis is particularly important in this group, as one of the ultrasound signs in advanced disease is pleural sliding abnormalities, which may even take the form of local abolition. Furthermore, the possible presence of an Am line may be interpreted by an inexperienced sonographer as an image of multiple A lines. Features that militate against the diagnosis of pneumothorax include the presence of a lung pulse, visible changes in the pleural line (fragmentation, retraction, disruption, blurring, thickening), and the frequent B lines, often present in this disease and numerous, which constitute a very strong criterion for excluding pneumothorax in the examined area. The aforementioned pleural line abnormalities are presented in Table 3.[11, 15-16]

Pleurodesis is a procedure involving the induction of adhesion between the pulmonary pleura and the parietal pleura by inducing local inflammation using irritants (most often talc and iodopivene, less frequently bleomycin or tetracycline).

Pleurectomy involves the surgical removal of the parietal pleura and mechanical irritation of the parietal pleura. This procedure results in adhesion between the lung and the chest wall.

Pleurodesis is performed in cases of repeatedly recurrent pneumothorax or rapid accumulation of fluid in the pleural cavities. Both procedures are performed relatively rarely and most often in patients receiving palliative care and with poor baseline health. In cases of recurrent spontaneous pneumothorax, both procedures may be recommended for patients exposed to high atmospheric pressure differences.

The condition following pleurodesis or pleurectomy may result in a very heterogeneous lung image, starting with the frequently described incomplete pleural atresia. In the case of complete fusion of the pulmonary pleura with the chest wall, the sliding sign will be completely eliminated. If areas of the surface remain unaffected by fusion, the sliding sign over them will be attenuated, and in very small areas, it may even be imperceptible.

To avoid misdiagnosis of pneumothorax, attention should be paid to the pleural line, whose appearance will differ significantly from the physiological image, as well as to the possibility of multiple B lines and consolidation. Furthermore, another sign that excludes pneumothorax is a visible lung pulse. Without a doubt, contact with a patient after the above procedures is rare, and it is most often possible to check the medical history in the documentation, especially since these patients are usually undergoing hospice care. It may be much more difficult to rule out pneumothorax in a patient after pleuredesis/pleurectomy due to recurrent spontaneous pneumothorax (we assume the patient loses consciousness during the examination). Although this potential clinical situation seems unlikely, understanding the sonomorphology of these changes will allow for effective discovery of important details that may occur in other, more common conditions, and will help protect the examiner from errors.[11, 17-19]

A lobectomy is a surgical procedure involving the removal of a single lobe of the lung, while a pneumonectomy involves the removal of the entire lung. The most common indication for this type of surgery is non-small cell lung cancer, which, according to the TNM scale, requires surgical resection. Post-traumatic lung injuries leading to a significant deterioration in the patient's clinical condition are significantly less common. Very rare indications include parasitic infections such as Echinococus granulosus and multilocularis that are resistant to pharmacological treatment, extensive lung abscesses, emphysema, or even pulmonary

infarction. The ultrasound image of the postoperative bed will be characterized by a lack of pleural sliding and numerous and clearly visible A-lines. In the case of a pneumonectomy, the image will be practically uniform across the entire chest, whereas in the image after a lobectomy, the lung adjacent to the bed will be characterized by numerous B-lines, which may form interstitial complexes. Small subpleural consolidations and attenuated sliding symptoms can also be expected. The patient's history and, in the case of unconsciousness, the presence of postoperative scars within the chest play a key role in this clinical situation. The ultrasound image may significantly resemble that of a pneumothorax (especially after pneumonectomy); therefore, additional imaging studies, especially computed tomography, are worth considering. [11, 20-21]

ARDS (acute respiratory distress syndrome)

Acute respiratory distress syndrome (ARDS) is a life-threatening condition resulting from capillary damage. Damage to the capillary-alveolar barrier results in the ingress of protein-rich fluid into the alveoli and lung parenchyma, leading to impaired ventilation and hypoxia. There are numerous causes of ARDS, including infections, mechanical injuries, trauma, and chemical damage. Ultrasound examination primarily demonstrates the presence of numerous B lines, which, as their number increases, create the image of interstitial syndrome, alveolar-interstitial syndrome, and white lung. In advanced disease, the sliding symptom may be reduced or eliminated, but the presence of numerous B lines allows for the rapid exclusion of pneumothorax. Cases of false interpretation of a”white lung" as a normal lung have been described in the literature, mainly due to incorrectly selected instrument settings and insufficient experience of the examiner.[7, 22]

Pneumonia is one of the basic pathologies diagnosed on lung ultrasound, therefore differentiating it from pneumothorax is not problematic. A situation that may lead to error is the weakening or disappearance of the sliding sign, which can be misinterpreted as pneumothorax, but is actually the result of an ongoing inflammatory process.

Features that speak against pneumothorax include the presence of consolidation with a characteristic vascular pattern on color Doppler and vertical artifacts.[23]

Lung cancer is the leading cause of cancer-related deaths in both men and women in Poland. In advanced disease and significant tumor growth, the tumor may invade the chest and surrounding tissues, resulting in local abolition of the sliding symptom. The characteristic echostructure of the tumor lesion suggests against the diagnosis of pneumothorax. Additional differentiating criteria include the patient's serious general condition (significant cachexia) and the usually available medical records.[24]

The phrenic nerve is the longest pair of nerves arising from the cervical plexus, formed from spinal fibers C3-C5. It is extremely important to the body because it is the only motor nerve of the diaphragm and also innervates sensory sensations to the pleura, the peritoneum below the diaphragm, and the pericardium. The main causes of phrenic nerve palsy include trauma, usually multi-organ trauma, damaging the peripheral parts of the nerve, or trauma involving the cervical spine, causing spinal cord damage and, consequently, central nerve damage. Iatrogenic injuries include inadvertent severing of the nerve during cardiac and thoracic surgery. Such damage is usually unilateral and causes paralysis of one of the nerve branches. Rare causes of damage include neuroinfections, motor neuron diseases, polyneuropathy, complications of liver transplant surgery, and tumor infiltration. Cases of transient phrenic nerve damage resulting from rehabilitation procedures involving the cervical spine have also been described in the literature; this type of damage was described as unilateral. Peripheral damage to the phrenic nerve leads to ipsilateral diaphragmatic dysfunction, which leads to increased respiratory effort in the patient, with possible involvement of accessory respiratory muscles, dyspnea, and deterioration of ventilation parameters. Damage at the cervical plexus level also leads to, among other things, ipsilateral paralysis of the upper limb, while damage at the spinal cord level can lead to tetraparesis or tetraplegia, complete diaphragmatic paralysis, impaired physiological function, etc. Impaired diaphragmatic function leads to impaired thoracic movement and, consequently, to the disappearance of the slipping symptom on the affected side. The presence of a lung pulse will primarily militate against the diagnosis of pneumothorax, as the presence of B lines or consolidation will depend on the patient's clinical condition, and therefore their presence is optional. It is worth considering an ultrasound examination of the diaphragm, using a linear transducer to assess muscle thickness, as well as a convex transducer to assess diaphragmatic movement in M-mode (normal movement is described as the so-called”sinusoidal sign"). Diaphragmatic paralysis is described on ultrasound as abnormal dome movements during spontaneous breathing, which include complete lack of movement, paradoxical movements, or a reduction in movement to <5 mm. Depending on the location, a high position of the liver or spleen can be distinguished, as well as absent or residual muscle thickening during inspiration. The presence of the above-mentioned symptoms will not only

allow for the exclusion of pneumothorax, but will also allow for the rapid diagnosis of diaphragmatic paralysis and the referral of diagnostics to determine this condition.[25-28]

Subcutaneous emphysema (formerly called subcutaneous emphysema) is the presence of air in the subcutaneous tissue, most often in the neck, less frequently in the chest or abdomen. Causes of its development include trauma, air leakage from the chest (e.g., pneumothorax escaping into the subcutaneous tissue), or, much less frequently, perforation of the gastrointestinal tract. The ultrasound appearance of subcutaneous emphysema is characteristic and allows for easy diagnosis of a cervical or abdominal location. In the case of a location on the surface of the chest, the image can be highly misleading due to the formation of artifacts, which are also observed in the air-filled lung. Reverberation artifacts physiologically arise below the pleura, therefore, in cases of suspected subcutaneous emphysema, it is crucial to determine the correct anatomical relationships. If reverberations are observed starting at a relatively shallow depth, one should aim to find landmarks such as the ribs and the pleural line. For an inexperienced examiner, the image can be highly misleading, so whenever possible, additional symptoms and other imaging tests should be used. The presence of subcutaneous crepitus is a very specific symptom of subcutaneous emphysema, strongly suggestive of the diagnosis. Among the imaging tests, computed tomography is the most useful.[29-30]

Long-term tobacco smoking is a very strong predisposing factor to diseases of the circulatory, respiratory, and digestive systems, and is a potent carcinogen. In lung ultrasound examinations of long-term smokers, the obtained image is nonspecific and results from the coexistence of other respiratory diseases. A feature leading to errors is the local attenuation (advanced interstitial disease) or significant attenuation of the sliding sign. Pneumothorax is ruled out by features such as the presence of B lines (more common in smokers) and subpleural consolidations (due to a greater predisposition to infection and slower resolution of post-infectious lesions).[31]

In the geriatric population, a physiological attenuation of the pleural sliding symptom is observed, resulting from systemic aging processes. As frailty develops, the patient may experience a significant reduction in sliding, which may be incorrectly interpreted as its elimination. In the described situation, the ultrasound image most often coexists with B lines and subpleural consolidations, which help rule out pneumothorax. It may be helpful to assess the pleural lines, which may show signs of degradation, e.g., thickening or blurring.[11, 32]

Intubation is an invasive form of ventilation with a high risk of failure and complications. After insertion of the endotracheal tube, its position in the trachea must be confirmed using chest auscultation, capnometry, capnography, bronchofiberoscopy, or ultrasound. Confirmation using ultrasound is performed by examining the slipping sign in both lungs, which indicates correct tube placement. Esophageal intubation will manifest as the absence of the slipping sign in both lungs, whereas in the case of single-bronchial intubation, it will not be visible in the contralateral lung. On ultrasound, the diagnosis of pneumothorax is contradicted by rapidly increasing lung atelectasis and the possible presence of vertical artifacts. Without a doubt, pneumothorax is a condition that can be ruled out very quickly in hospital settings. The situation seems to be much less obvious in the case of out-of-hospital intubation, in the emergency medical team setting, especially in the case of a trauma patient.[34]

Discussion

Pneumothorax, its classic clinical symptoms, and the basic criteria for radiological diagnosis constitute basic medical knowledge, particularly important from the perspective of emergency medicine, according to which it is classified (especially tension pneumothorax) as one of the reversible causes of sudden cardiac arrest. The use of ultrasonography has significantly improved diagnostics on many levels, both in hospital and pre-hospital care.[1] Based on extensive literature, diagnostic criteria have been developed that allow for high sensitivity and specificity for ultrasound confirmation or exclusion of pneumothorax. Without a doubt, the basic criterion is the presence of a sliding sign, occurring between the laminae of the pulmonary pleura and the parietal pleura. Despite the absence of this sign, the diagnosis of pneumothorax can only be made after considering the remaining criteria, namely the presence of an A-line, the absence of vertical artifacts, the absence of a lung pulse, and the presence of a lung point.[7] A significant change was made in the latest guidelines on lung ultrasound, according to which the presence of a lung point has been recognized as an optional criterion.[10-11] The expert commentary highlighted the issue of complete separation of pleural plaques by air in the pleural cavity, which can occur in the case of a mantle pneumothorax and also a tension pneumothorax. Especially in the case of the latter, persistently searching for a lung point may not only be pointless but also delay diagnosis and appropriate intervention, which can significantly affect the patient's

prognosis. Various causes of a false-positive pneumothorax have been described in the literature, often emphasizing the cause of such an error and proposing tips on how to avoid it. According to the literature, the effectiveness of ultrasound diagnostics for pneumothorax is approximately 93.5%, while for classical X-ray, the authors estimated the effectiveness at 50%.[36] The significant differences in the values between the two techniques result, among other things, from the sensitivity of the above methods, as using ultrasound allows the examiner to detect even small ventricles that do not yet produce clinical symptoms and are too subtle to be detected on X-ray. Therefore, a prompt diagnosis allows for planning further treatment of the patient, including taking measures to prevent respiratory and hemodynamic destabilization.[37]

An additional advantage of ultrasonography is the short examination time, which, according to literature, allows for a diagnosis within a minute.[36, 38] This is due both to the wide availability of ultrasound machines and their high mobility, which eliminates the need to transport the patient to an imaging facility for radiological examinations. In the case of mobile X-ray machines and bedside examinations, it is essential to ensure radiation protection for staff and other patients, which involves additional logistical efforts.

A milestone in POCUS diagnostics is the development and introduction of portable ultrasound transducers, wired or wireless, paired with a phone, tablet, etc., whose ergonomic design allows them to be stored in the proverbial”coat pocket."[39] This offers a valuable opportunity to use ultrasound in pre-hospital settings, e.g., in mobile emergency medical teams, in health clinics, during home visits, or in combat situations. Additionally, using emergency protocols or performing a POCUS examination makes it possible to quickly recognize many life-threatening conditions and make appropriate therapeutic decisions. It should be noted that, for purely technical reasons, the quality and sensitivity of imaging with stationary devices will be higher than with portable transducers. Therefore, after ruling out basic pathologies, it may be necessary to perform a detailed examination in a hospital or ultrasound laboratory to look for more subtle changes.[40]

Conclusions:

Ultrasonography is an extremely sensitive, widely available, and easy-to-implement tool that allows for the rapid diagnosis of pneumothorax. Its widespread use has enabled early detection of pneumothorax and, depending on the patient's clinical condition, immediate intervention or additional testing such as computed tomography with subsequent planning of a surgical procedure. Many conditions that can mask the appearance of pneumothorax can be quickly ruled out in most cases through history, physical examination, or other additional tests. Many of these clinical situations are relatively rare, so they should only be differentiated from pneumothorax in selected patients.

Disclosure

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