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*O. I. Panyuta https://orcid.org/0000-0003-4710-8441*
*O. M. Ignatyev https://orcid.org/0000-0002-7538-2854*
*L. I. Zahorodnia https://orcid.org/0000-0003-1908-0461*
*T. M. Yamilova https://orcid.org/0000-0001-9609-1688*

# VENTRICULAR BIGEMINY AS A COMPLICATION OF SPIROMETRY PERFORMED IN A PATIENT WITH A HISTORY OF WORK IN HARMFUL WORKING CONDITIONS – A CLINICAL CASE

Odesa National Medical University, Odesa, Ukraine

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*Odesa National Medical University, Odesa, Ukraine*

**Introduction.** The study of the external respiratory function (spirometry) is a generally recognized gold standard for the study of the respiratory system, mandatory for many pulmonary diseases. Global standards for the management of patients with bronchial asthma (GINA) and chronic obstructive lung disease define spirometry as the main method for assessing the effectiveness of treatment and determining the prognosis of these diseases. At the same time, the stress nature of the study and the tests performed during the study with inhaled adrenomimetics as bronchodilators can have a significant effect on the cardiovascular system of the patients being examined. Adrenomimetics are expected to cause an increase in heart rate and tachycardia-related arrhythmias – atrial fibrillation and similar conditions.

**Objective:** present a case of the "atypical" side effect of bronchodilator test during spirometry.

**Results.** The article presents a case of bigeminy, which developed as a side effect of a test with bronchodilators (salbutamol) during the study of the external respiratory function. This response to adrenergic drugs may be considered as atypical, since there is general agreement that tachycardia should prevent the development of ventricular bigeminy. The study was conducted on a patient with pneumofibrosis (pneumoconiosis), which developed as a result of long-term work in conditions of increased dustiness.

**Conclusions.** Cardiovascular pathology associated with pneumoconiosis may be considered a possible explanation for the development of bigeminy following salbutamol administration.

**Keywords:** functional diagnostics, spirometry, bronchodilator test, arrhythmia.

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**О. І. Панюта, О. М. Ігнатьєв, Л. І. Загородня, Т. М. Ямілова**

**АЛОРИТМІЧНА АРИТМІЯ ЯК УСКЛАДНЕННЯ ДОСЛІДЖЕННЯ ФУНКЦІЇ ЗОВНІШНЬОГО ДИХАННЯ У ПАЦІЄНТА З АНАМНЕЗОМ РОБОТИ ЗІ ШКІДЛИВИМИ УМОВАМИ ПРАЦІ – КЛІНІЧНИЙ ВИПАДОК**

*Одеський національний медичний університет, Одеса, Україна*

Спірометрія – загальновизнаний золотий стандарт дослідження дихальної системи, обов'язковий за наявності багатьох пульмонологічних захворювань. Разом із тим навантажувальний характер дослідження та виконувані під час дослідження проби з інгаляційними адреноміметиками як бронхолітиками можуть істотно впливати на серцево-судинну систему обстежуваних пацієнтів. У статті подано випадок бігемінії, яка розвинулася як побічний ефект проведення проби з бронхолітиками (сальбутамол) під час дослідження функції зовнішнього дихання. Дослідження проводилося пацієнту з пневмоконіозом, який розвинувся внаслідок тривалої роботи в умовах підвищеної запиленості.

**Ключові слова:** функціональна діагностика, спірометрія, проба з бронхолітиками, аритмія.

## Introduction

Spirometry is used to assess the condition and reactivity of the respiratory tract, the impact of diseases on lung function, and determine the results of using certain medications. Spirometry also allows assessment of the preoperative risk associated with inhalation anesthesia during elective surgeries, to assess the functional reserves of the lungs and the rehabilitation prognosis in patients with chronic diseases complicated by respiratory failure of various origins [1].

Assessment of pulmonary function consists of a series of sequential maneuvers designed to determine the maximum values of pulmonary ventilation. The procedure involves the patient performing a maximum inhalation, forced exhalation, and a maximum inhalation after forced exhalation. The cycle can be repeated several times until the test is performed correctly and a uniform closed flow-volume curve is obtained, allowing accurate assessment of the parameters [2].

There are known difficulties in obtaining reproducible results when performing the test on patients with restrictive breathing disorders. Restriction may be the result of a congenital disorder of the elasticity of the lung tissue, acquired pneumofibrosis in pneumoconiosis, etc. Such a

condition may require repeated forced breathing cycles up to 6–8 times and may be difficult for patients with significant impairment. [3].

Modern guidelines note that, despite the stressful nature of the study, significant side effects (fainting, arrhythmia) occur no more often than 5 out of 10,000 studies [4].

Spirometric testing may include assessment of reversibility of broncho-obstruction when using bronchodilators, which helps clarify the diagnosis and determine the appropriateness of their use as a drug [5]. Depending on the clinical indication, inhaled adrenergic agonists or anticholinergics can be used as a bronchodilator. Most often, short-acting inhaled adrenergic agonists (salbutamol or albuterol) are used.

According to standard protocols, initial diagnostic spirometry requires the first diagnostic spirometry (without additional instructions) requires the use of inhalation of two or more therapeutic doses of a bronchodilator. Such an excess of dosage is due to the difference between the time of the direct bronchodilatory effect of drugs and the time during which bronchodilators prevent bronchospasm. The second effect is significantly longer, while maximum bronchodilation when using therapeutic doses can last for minutes.

The following side effects of bronchodilators are most often observed: muscle tremor, tachycardia, headache, irritation of the mucous membrane, increased pressure, nausea, which typically resolve spontaneously [6].

Since spirometry is generally considered safe, performing a test with bronchodilators, although not mandatory, is recommended to be carried out immediately, so as not to require the patient to undergo spirometry again.

Potential side effects are not taken into account, and prior additional examinations for the presence of comorbid pathology are the responsibility of the physician who prescribed spirometry. This attitude is significantly different from other pharmacological stress tests, for example in cardiology and cardiac surgery [7; 8]. That may lead to unexpected results.

**Objective:** present a case of "atypical" side effect of bronchodilator test during spirometry.

## Materials and Methods

We present the case of patient B., a man born in 1970, who worked as a tallyman for over 25 years. The patient's written consent to the processing of his personal data has been obtained. In May 2024, the patient due to a long-term lung disease underwent spirometry that provoked an atypical complication. The patient was consulted and examined by the staff of the Department of Occupational Pathology at the Odesa Regional Clinical Center regarding the possible association between his underlying disease, the spirometry-related complication, and occupational exposure. The article was discussed at the meeting of the department and proposed to be submitted for publication in the Odesa Medical Journal, Protocol No. 7/1 dated 02/28/2025.

The research was carried out with the provision of safety measures for life and health, with respect for human rights and moral and ethical standards, which corresponds to the principles of the Helsinki Declaration of Human Rights and the order of the Ministry of Health of Ukraine No. 693 dated 01.10.2015, the Council of Europe Convention on Human Rights and of biomedicine (ETS-164) dated 04.04.1997, the Status of the Ukrainian Association for Bioethics and GCP norms (1992).

## Research results and their discussion

We present the case of patient B., a man born in 1970 (53 years old at the time of the 1st consultation), who worked as a tallyman for over 25 years handling bulk cargo at the port. The tallyman's work is classified as hazardous work with dust levels in the air of the working area significantly exceeding the MAC.

During the consultation, the patient complained of a cough with the release of a small amount of viscous sputum, shortness of breath during physical exertion, and chest pain.

From the anamnesis, it is known that the patient considers himself ill since 2017, which led to early retirement. He associates a significant deterioration in his condition with a forced move to Odessa in early 2024 due to military action in eastern Ukraine. After examination by the family doctor, the patient underwent a number of studies, including CT of the lungs on 04.2024, which revealed multiple pulmonary nodules measuring 2–5 mm in diameter, and a study of the function of external respiration, which was performed on 05.2024. Spirometry revealed a moderate mixed ventilatory impairment with predominant obstruction (VC – 67%, $FEV_1$ – 66%). A bronchodilator test with two puffs of salbutamol demonstrated a positive response, with $FEV_1$ increasing by 280 ml.

After the test with salbutamol, the patient complained of a sharp deterioration in health, dizziness, a sensation of palpitations or irregular heartbeats, and extreme weakness. The patient urgently underwent an ECG, which demonstrated ventricular bigeminy (Fig. 1).

Bigeminy persisted for an hour with progression to trigeminy and subsequent restoration of the rhythm.

During a detailed cardiological examination, it was found that the patient had previously reported cardiac-related symptoms – palpitations with a sensation of cardiac pauses, an increase in blood pressure to 160/100 mm Hg, which were associated with an exacerbation of pulmonary pathology. The patient had not previously been examined for heart disease and did not receive treatment. Resting ECG showed signs of cardiac hypertrophy (P-pulmonale, impaired intraventricular conduction) (Fig. 2), ECG monitoring revealed single ventricular extrasystoles, ultrasound of the heart – moderate myocardial hypertrophy with concentric remodeling, EF – 53%, cardiac chambers were not dilated, signs of pulmonary hypertension were not detected. During subsequent observation, no significant rhythm disturbances or other cardiac disorders were observed.

Ventricular bigeminy is a form of heart rhythm disorder consisting of alternation of normal and extrasystolic contractions with a certain sequence 1:1, 2:1, etc. The empirically derived "law of bigeminy" is known, according to which this arrhythmia more often develops with bradycardia, but tachycardia prevents it [9]. Therefore, the occurrence of bigeminy against the background of taking

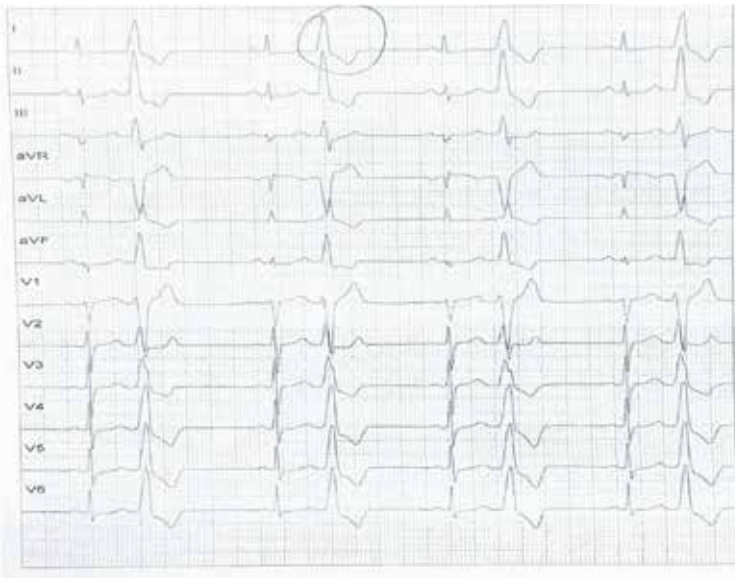


**Fig. 1. Patient B., 53 years old, ECG after taking two doses of salbutamol**

inhaled adrenergic agonists, which cause tachycardia, requires additional explanation [10].

According to the ESC Guidelines for the management of patients with ventricular arrhythmias (2022) all patients with documented non-sustained or sustained ventricular arrhythmias should undergo a 12-lead electrocardiogram (ECG) at rest and a transthoracic echocardiogram to identify underlying heart disease, including hereditary and acquired cardiomyopathies [11].

This was performed on the patient, but no significant changes were found that would allow a definitive diagnosis of the corresponding cardiac pathology. The detected "non-specific" changes can be interpreted in a wide range from signs of arterial hypertension to "age-related" changes. However, if we take into account the history of many years working in harmful conditions and the clinical and instrumental picture of pneumoconiosis, we can assume that the detected changes were provoked by long-term pulmonary pathology and their manifestations are aggravated by exacerbations/ decompensation of lung disease.

The severity of clinical manifestations of cardiac pathology directly depends on the degree of pneumoconiosis (in fact, the prevalence of pneumofibrosis) and the duration of the disease. In patients with pneumoconiosis, unstable blood pressure is observed with the subsequent development of arterial hypertension; hypertrophy of the heart with subsequent dilatation; pulmonary hypertension with subsequent decompensation and the progression to heart failure; the development of arrhythmias. Arrhythmias, which were provoked by pneumoconiosis, are usually associated with overstrain, hypertrophy and dilatation of the myocardium.

That is, the patient experienced metabolic shifts in the ventricular myocardium against the background of

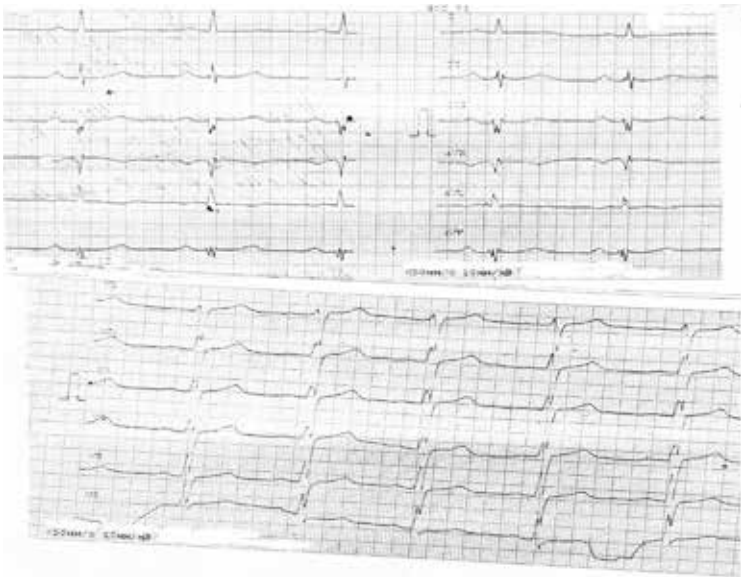

**Fig. 2. Patient B., 53 years old, resting ECG**

an exacerbation of the pulmonary disease, but the cells of the sinus node remained intact. Therefore, when the use of salbutamol enhanced excitability of ventricular myocardium, this did not lead to sinus tachycardia, but contributed to a sharp increase in trigger activity in the ventricular conduction system and the resulting in a transient episode of ventricular bigeminy for the duration of high salbutamol concentration in the blood (up to 90 minutes).

## Conclusions

Pneumofibrosis, as a result of harmful production factors, develops over decades and is typically accompanied by characteristic “non-specific” myocardial changes. These changes in the practice of occupational pathology are additional evidence of long-standing disease and allow us to distinguish pneumoconiosis from post-inflammatory pneumofibrosis.

Since a patient with pneumoconiosis will seek medical help during an exacerbation/decompensation of the process in the lungs, it can be assumed that the heart at this time will be more sensitive to provoking agents, such as inhaled adrenergic agonists, than would be expected based on the results of standard studies.

Underestimation of the clinical picture of pneumoconiosis and occupational history (25 years of work in dusty conditions) and CT results (signs of nodular pneumofibrosis) contributed to an unexpected adverse reaction with the manifestation of an "atypical" form of arrhythmia.

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