XXV Национальный Конгресс
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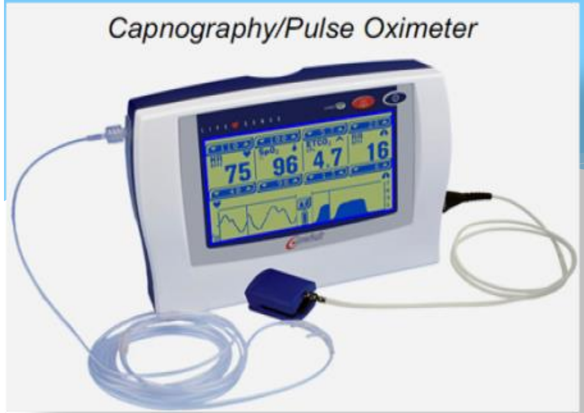
МОНИТОРИНГ $P_{ET}CO_2$ У БОЛЬНЫХ ХОБЛ ПРИ ВЫПОЛНЕНИИ ТЕСТА 6-МИНУТНОЙ ХОДЬБЫ

Агеева К.А., Абросимов В.Н.



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ERS TASK FORCE

Recommendations on the use of exercise testing in clinical practice

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ABSTRACT: Evidence-based recommendations on the clinical use of cardiopulmonary exercise testing (CPET) in lung and heart disease are presented, with reference to the assessment of exercise intolerance, prognostic assessment and the evaluation of therapeutic interventions (*e.g.* drugs, supplemental oxygen, exercise training). A commonly used grading system for recommendations in evidence-based guidelines was applied, with the grade of recommendation ranging from A, the highest, to D, the lowest.

For symptom-limited incremental exercise, CPET indices, such as peak O_2 uptake ($V'O_2$), $V'O_2$ at lactate threshold, the slope of the ventilation–CO_2 output relationship and the presence of arterial O_2 desaturation, have all been shown to have power in prognostic evaluation. In addition, for assessment of interventions, the tolerable duration of symptom-limited high-intensity constant-load exercise often provides greater sensitivity to discriminate change than the classical incremental test. Field-testing paradigms (*e.g.* timed and shuttle walking tests) also prove valuable.

In turn, these considerations allow the resolution of practical questions that often confront the clinician, such as: 1) "When should an evaluation of exercise intolerance be sought?"; 2) "Which particular form of test should be asked for?"; and 3) "What cluster of variables should be selected when evaluating prognosis for a particular disease or the effect of a particular intervention?"

KEYWORDS: Cardiopulmonary exercise testing, evaluation of interventions, exercise testing, prognosis, walking tests

The purpose of this document is to present recommendations on the clinical use of exercise testing in patients with cardiopulmonary disease, with particular emphasis on the evidence base for the functional evaluation, prognosis and assessment of interventions. While the scope of the document is broad, consideration will focus only on those indices that have demonstrable predictive power. Supplemental references will therefore be included, where appropriate.

Exercise intolerance can be defined as an inability to complete a required physical task successfully. In one sense, therefore, everyone who exercises has, at some level(s), "exercise intolerance". From a clinical perspective, the issue is whether a patient demonstrates intolerance to a task that normal subjects would find tolerable. However, exercise intolerance (often considered in terms of peak oxygen uptake ($V'O_{2,peak}$)) in pulmonary and cardiac disease patients cannot be confidently predicted from physiological variables, determined at rest, such as forced expiratory volume in one second (FEV_1), pulmonary diffusing capacity for carbon monoxide ($D_{L,CO}$), ejection fraction (EF) or body mass index (BMI). It is necessary, therefore, to actually assess an individual's exercise intolerance and, where possible, establish its cause(s). This task-specificity imposes technical challenges: the requirement to be able to impose particular work-rate protocols in an accurate and reproducible fashion largely confines assessment to ergometric devices, such as cycle ergometers and treadmills. While these represent a less-than-ideal approximation to the realities of daily exercise, they provide a precise and controlled focus for assessing the

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GLOBAL STRATEGY FOR THE DIAGNOSIS, MANAGEMENT, AND PREVENTION OF CHRONIC OBSTRUCTIVE PULMONARY DISEASE

2006

n once a year. Spirometry should be performed if there substantial increase in symptoms or a complication.

er pulmonary function tests, such as flow-volume loops, using capacity (D_{LCO}) measurements, inspiratory pacity, and measurement of lung volumes are not eded in a routine assessment but can provide informa- about the overall impact of the disease and can valuable in resolving diagnostic uncertainties and essing patients for surgery.

erial blood gas measurement. The development espiratory failure is indicated by a PaO_2 < 8.0 kPa mm Hg) with or without $PaCO_2$ > 6.7 kPa (50 mm Hg) arterial blood gas measurements made while breathing at sea level. Screening patients by pulse oximetry and essing arterial blood gases in those with an oxygen saturation (SaO_2) < 92% is a useful way of selecting patients for arterial blood gas measurement[42]. However, pulse oximetry gives no information about CO_2 tensions.

Clinical signs of respiratory failure or right heart failure include central cyanosis, ankle swelling, and an increase in the jugular venous pressure. Clinical signs of hypercapnia are extremely nonspecific outside of exacerbations.

Assessment of pulmonary hemodynamics. Mild to moderate pulmonary hypertension (mean pulmonary artery pressure ≥ 30 mm Hg) is only likely to be important in patients who have developed respiratory failure. Measurement of pulmonary arterial pressure is not recommended in clinical practice as it does not add practical information beyond that obtained from a knowledge of PaO_2.

Diagnosis of right heart failure or cor pulmonale.

more precisely.

Hematocrit. Polycythemia can develop in the presence of arterial hypoxemia, especially in continuing smokers[43], and can be identified by hematocrit > 55%. Anemia is more prevalent than previously thought, affecting almost a quarter of COPD patients in one hospital series[44]. A low hematocrit indicates a poor prognosis in COPD patients receiving long-term oxygen treatment[45].

Respiratory muscle function. Respiratory muscle function is usually measured by recording the maximum inspiratory and expiratory mouth pressures. More complex measurements are confined to research laboratories. Measurement of inspiratory muscle force is useful in assessing patients when dyspnea or hypercapnia is not readily explained by lung function testing or when peripheral muscle weakness is suspected. This measurement may improve in COPD patients when other measurements of lung mechanics do not (e.g., after pulmonary rehabilitation)[46,47].

Sleep studies. Sleep studies may be indicated when hypoxemia or right heart failure develops in the presence of relatively mild airflow limitation or when the patient has symptoms suggesting the presence of sleep apnea.

Exercise testing. Several types of tests are available to measure exercise capacity, e.g., treadmill and cycle ergometry in the laboratory – or six-minute and shuttle walking tests , but these are primarily used in conjunction with pulmonary rehabilitation programs.

Monitor Pharmacotherapy and Other Medical Treatment

In order to adjust therapy appropriately as the disease

American Thoracic Society

ATS Statement: Guidelines for the Six-Minute Walk Test

THIS OFFICIAL STATEMENT OF THE AMERICAN THORACIC SOCIETY WAS APPROVED BY THE ATS BOARD OF DIRECTORS MARCH 2002

CONTENTS

PURPOSE AND SCOPE

This statement provides practical guidelines for the 6-minute walk test (6MWT). Specifically, it reviews indications, details factors that influence results, presents a brief step-by-step protocol, outlines safety measures, describes proper patient preparation and procedures, and offers guidelines for clinical interpretation of results. These recommendations are not intended to limit the use of alternative protocols for research studies. We do not discuss the general topic of clinical exercise testing.

As with other American Thoracic Society statements on pulmonary function testing, these guidelines come out of a consensus conference. Drafts were prepared by two members (P.L.E. and R.J.Z.) and were based on a comprehensive Medline literature search from 1970 through 2001, augmented by suggestions from other committee members. Each draft responded to comments from the working committee. The guidelines follow previously published methods as closely as possible and provide a rationale for each specific recommendation. The final recommendations represent a consensus of the committee. The committee recommends that these guidelines be reviewed in five years and in the meantime encourages further research in areas of controversy.

BACKGROUND

There are several modalities available for the objective evaluation of functional exercise capacity. Some provide a very complete assessment of all systems involved in exercise performance (high tech), whereas others provide basic information but are low tech and are simpler to perform. The modality used should be chosen based on the clinical question to be addressed and on available resources. The most popular clinical exercise tests in order of increasing complexity are stair climbing, a 6MWT, a shuttle-walk test, detection of exercise-induced asthma, a cardiac stress test (e.g., Bruce protocol), and a cardiopulmonary exercise test (1, 2). Other professional organizations have published standards for cardiac stress testing (3, 4).

Assessment of functional capacity has traditionally been done by merely asking patients the following: "How many flights of stairs can you climb or how many blocks can you walk?" However, patients vary in their recollection and may report overestimations or underestimations of their true functional capacity. Objective measurements are usually better than self-reports. In the early 1960s, Balke developed a simple test to evaluate the functional capacity by measuring the distance walked during a defined period of time (5). A 12-minute field performance test was then developed to evaluate the level of physical fitness of healthy individuals (6). The walking test was also adapted to assess disability in patients with chronic bronchitis (7). In an attempt to accommodate patients with respiratory disease for whom walking 12 minutes was too exhausting, a 6-minute walk was found to perform as well as the 12-minute walk (8). A recent review of functional walking tests concluded that "the 6MWT is easy to administer, better tolerated, and more reflective of activities of daily living than the other walk tests" (9).

The 6MWT is a practical simple test that requires a 100-ft hallway but no exercise equipment or advanced training for technicians. Walking is an activity performed daily by all but the most severely impaired patients. This test measures the distance that a patient can quickly walk on a flat, hard surface in a period of 6 minutes (the 6MWD). It evaluates the global and integrated responses of all the systems involved during exercise, including the pulmonary and cardiovascular systems, systemic circulation, peripheral circulation, blood, neuromuscular units, and muscle metabolism. It does not provide specific information on the function of each of the different organs and systems involved in exercise or the mechanism of exercise limitation, as is possible with maximal cardiopulmonary exercise testing. The self-paced 6MWT assesses the submaximal level of functional capacity. Most patients do not achieve maximal exercise capacity during the 6MWT; instead, they choose their own intensity of exercise and are allowed to stop and rest during the test. However, because most activities of daily living are performed at submaximal levels of exertion, the 6MWD may better reflect the functional exercise level for daily physical activities.

INDICATIONS AND LIMITATIONS

The strongest indication for the 6MWT is for measuring the response to medical interventions in patients with moderate to severe heart or lung disease. The 6MWT has also been used as a one-time measure of functional status of patients, as well as a predictor of morbidity and mortality (*see* Table 1 for a list of these indications). The fact that investigators have used the 6MWT in these settings does not prove that the test is clinically useful (or the best test) for determining functional capacity or changes in functional capacity due to an intervention in patients with these diseases. Further studies are necessary to determine the utility of the 6MWT in various clinical situations.

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DOI: 10.1164/rccm.166/1/111
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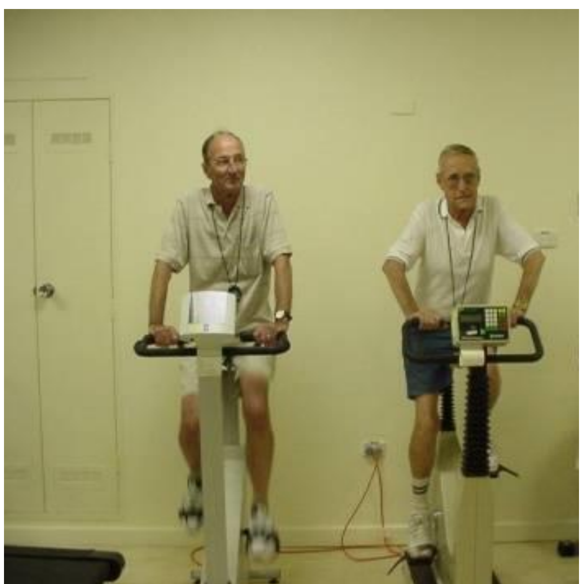
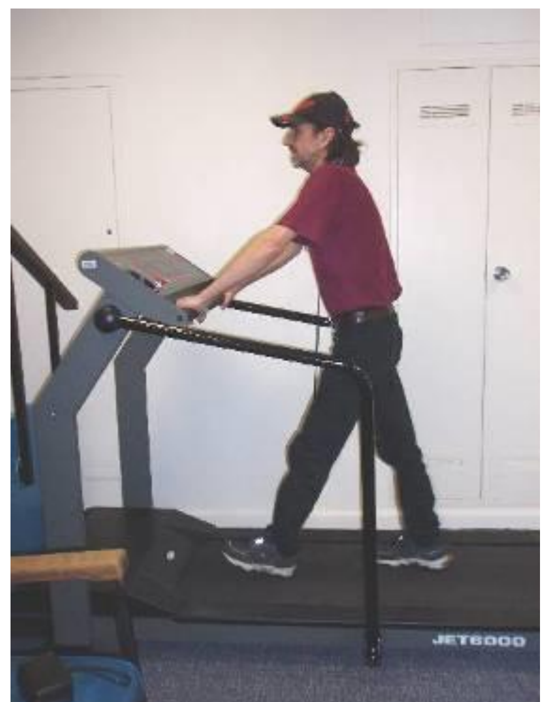
Виды нагрузочных тестов



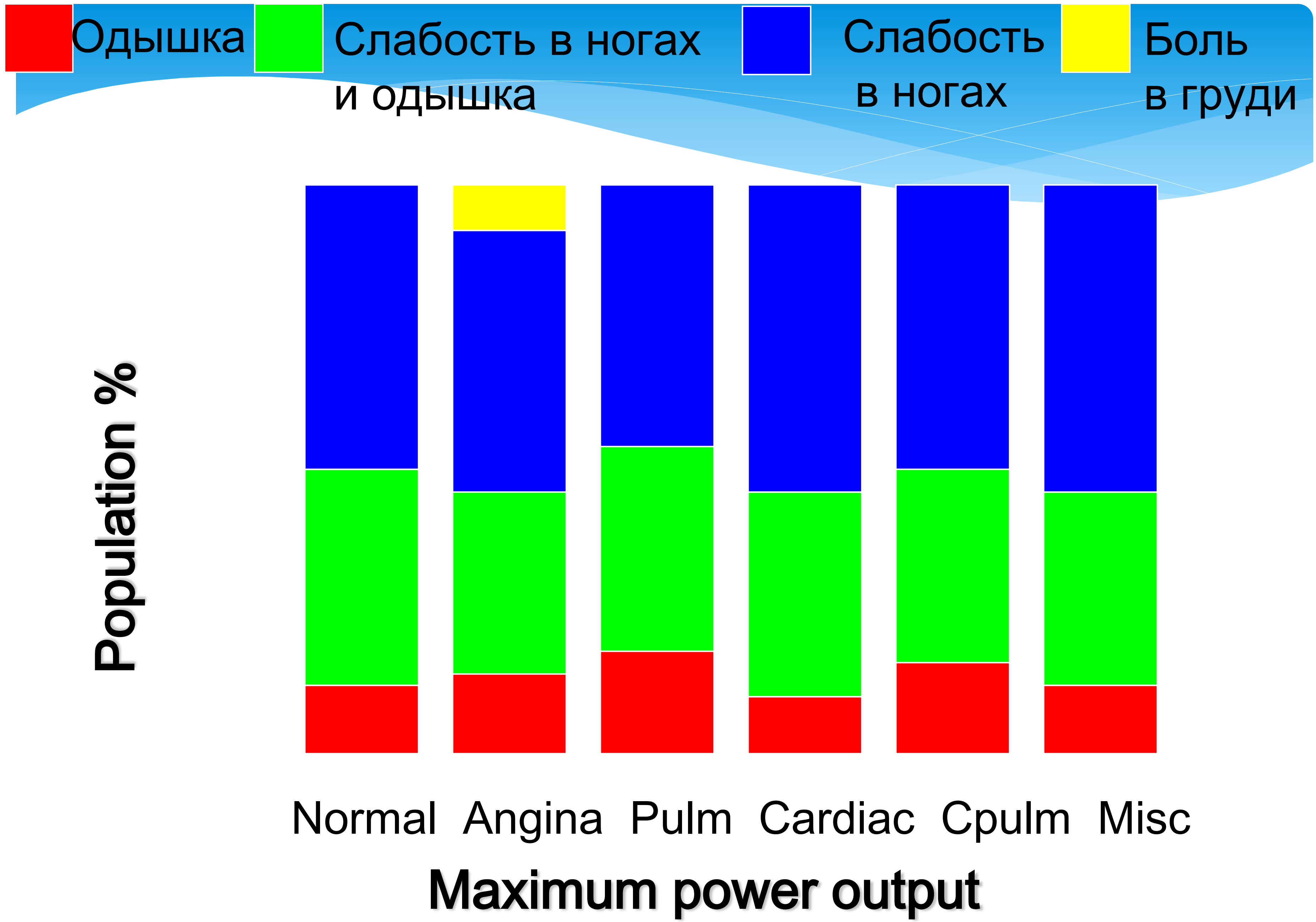


Преимущества 6MWT

- **6MWT прост в выполнении, не требует сложного оборудования и может проводиться как в стационарных, так и в амбулаторных условиях.**
- **Тест позволяет оценить уровень повседневной активности больных.**
- **Результаты 6MWT хорошо коррелируют с показателями качества жизни и могут быть использованы в качестве дополнительных критериев оценки эффективности лечения и реабилитации больных.**

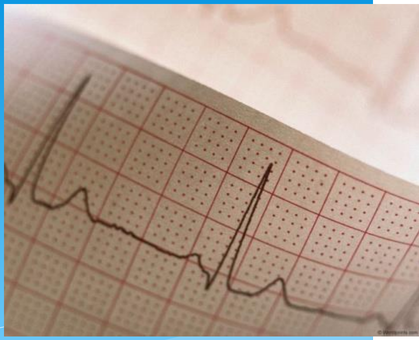
Недостатки 6MWT

- **Результаты проведения 6MWT в значительной мере определяются влиянием субъективных факторов, основным из которых является характер мотивации пациента, степень корректности проведения исследования инструктором.**

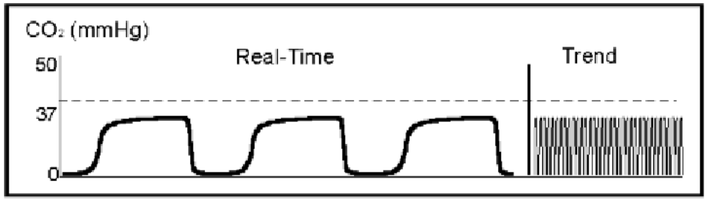


Killian KJ ERJ 2002

Капнограмма- как ЭКГ

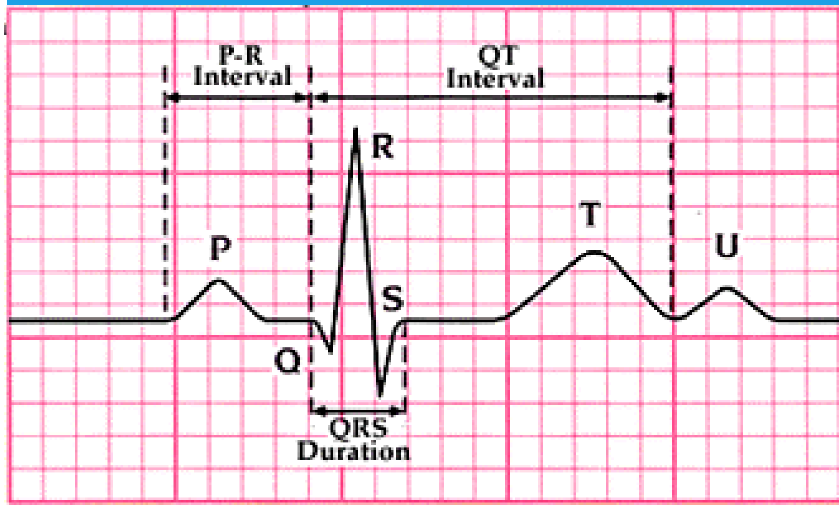


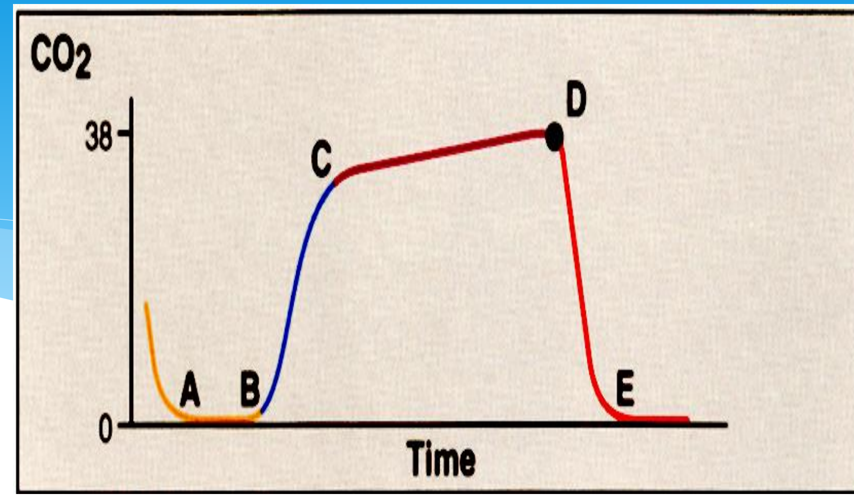
- Capnography is like the ECG, ...
- …provides an immediate picture of patient condition
- Капнограмма как ЭКГ…позволяет немедленно оценить картину состояния пациента



medicscribe.com/2012/05/5-**capnography**

Cardiac ECG Pulmonary ECG





Riding The Waves

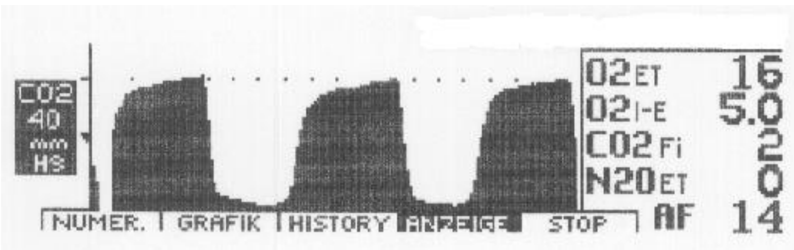
Street Wisdom: "End Tidal CO_2 reading without a waveform is like a heart rate without an ECG recording."

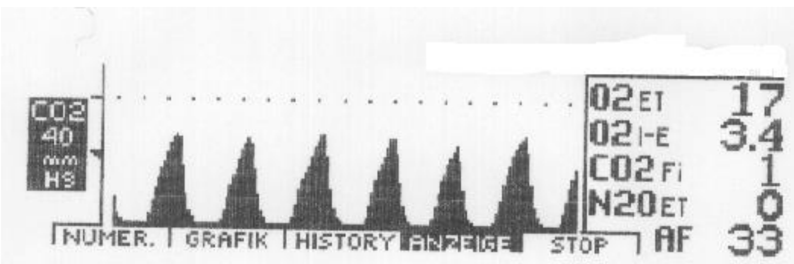
Street Wisdom: “Анализ $EtCO_2$ без оценки формы капнографической кривой как ЧСС без регистрации ЭКГ”

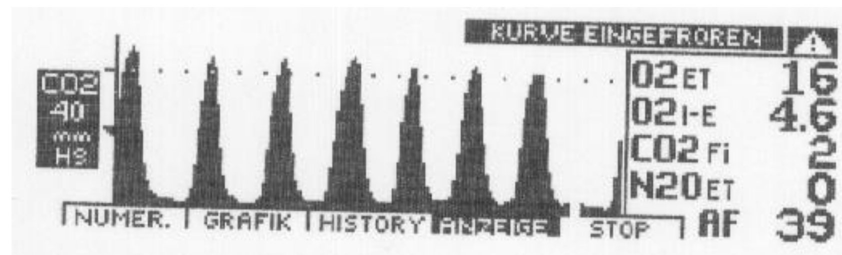
The Role of Capnography in EMS
By Bob Page, AAS, NREMT-P, CCEMT-P, I/C

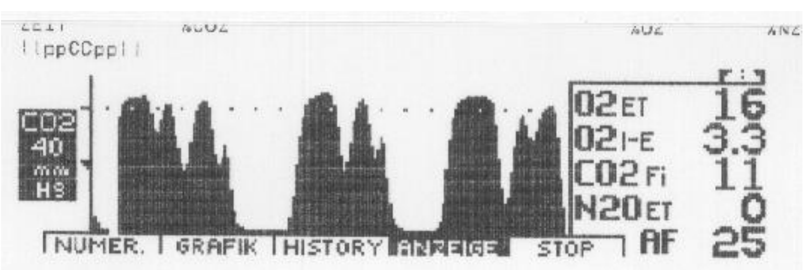
Капнограммы

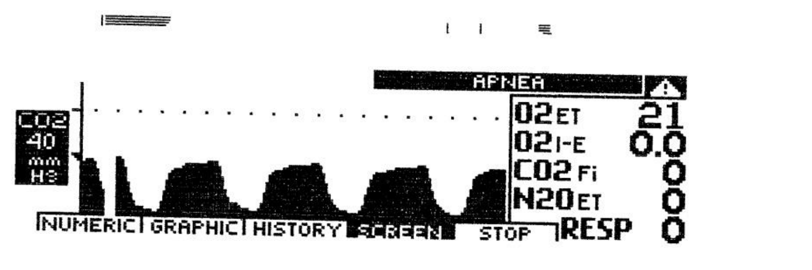
(Datex NORMOCAP® 200 oxy)











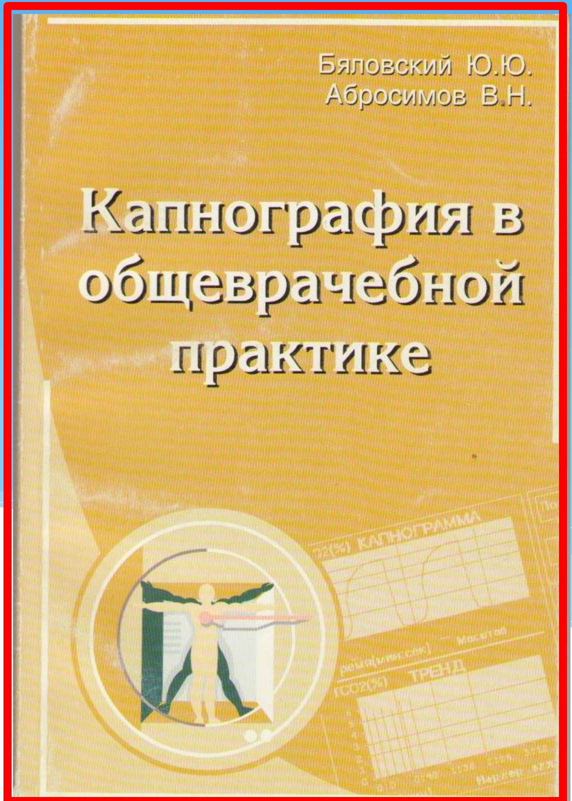
Капнограф регистрирует показатели

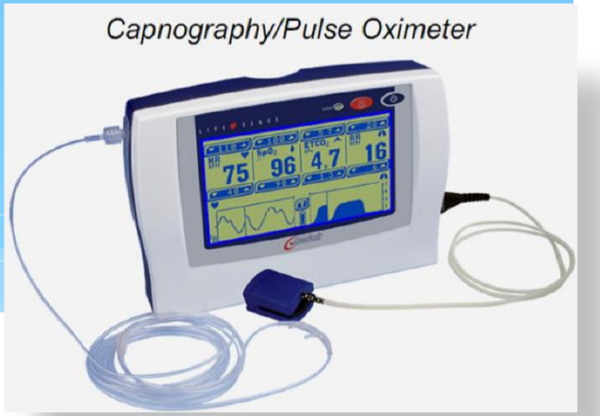
* Парциальное давление или объемную концентрацию СО2
* Частоту дыхания
* Форму капнограммы.
* Паттерн дыхания

<u>Цель:</u>

Оценить диагностические возможности динамической капнографии при выполнении 6MWT у больных с ХОБЛ

Капнограф КП-01 ЕЛАМЕД





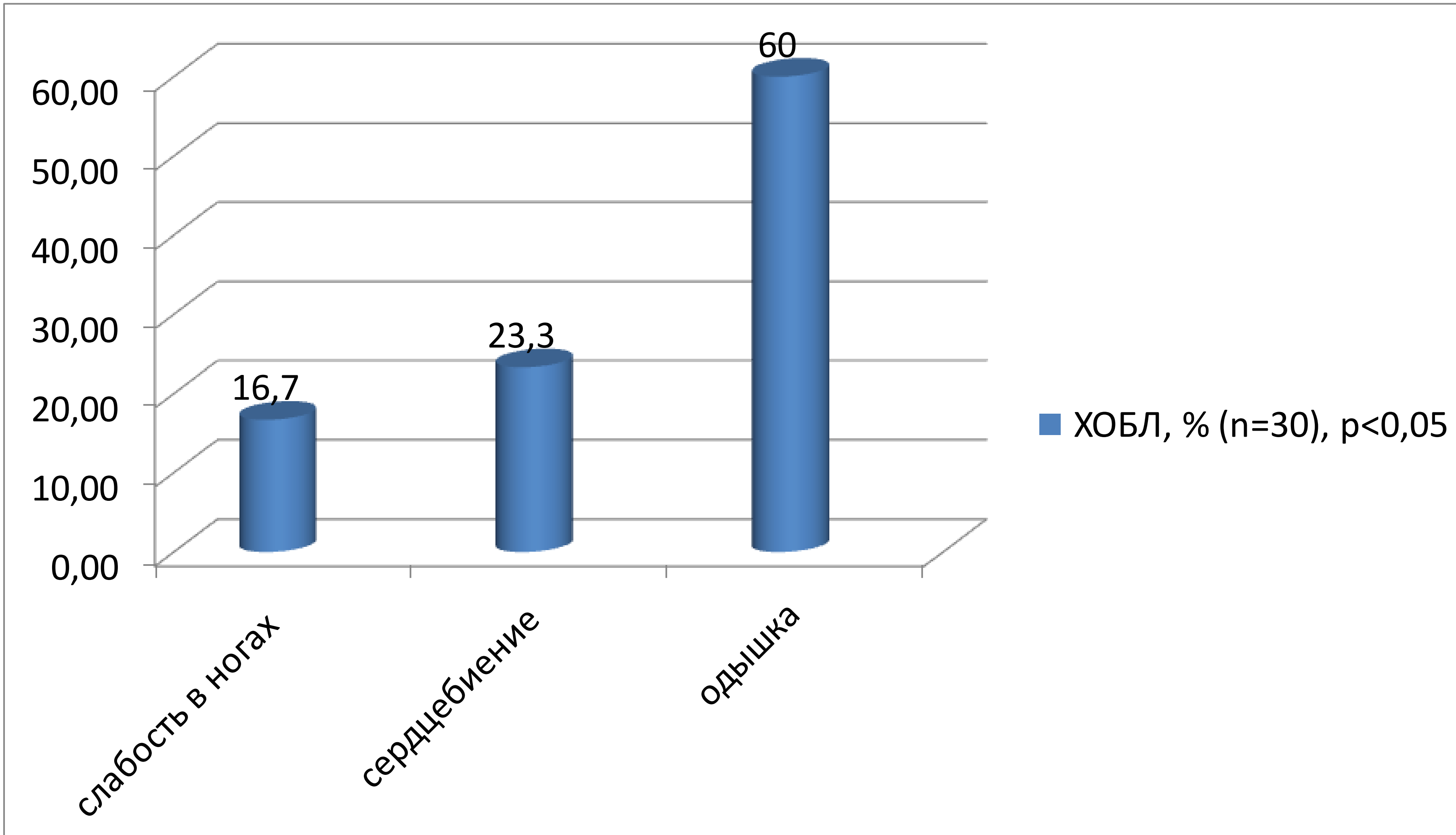
Материалы и методы:

* обследовано 30 пациентов с диагнозом ХОБЛ II-III ст, возраст 60±7,48 года.
* тест 6-минутной ходьбы в соответствии со стандартными процедурами.
* динамическая капнография и пульсоксимерия с помощью монитора LifeSense LS1-9R компании MedAir AB
* изучалась динамика жалоб больного (одышка (шкалы Borg, ВАШ), слабость в ногах, сердцебиение, и др.).
* Методы клинического шкалирования

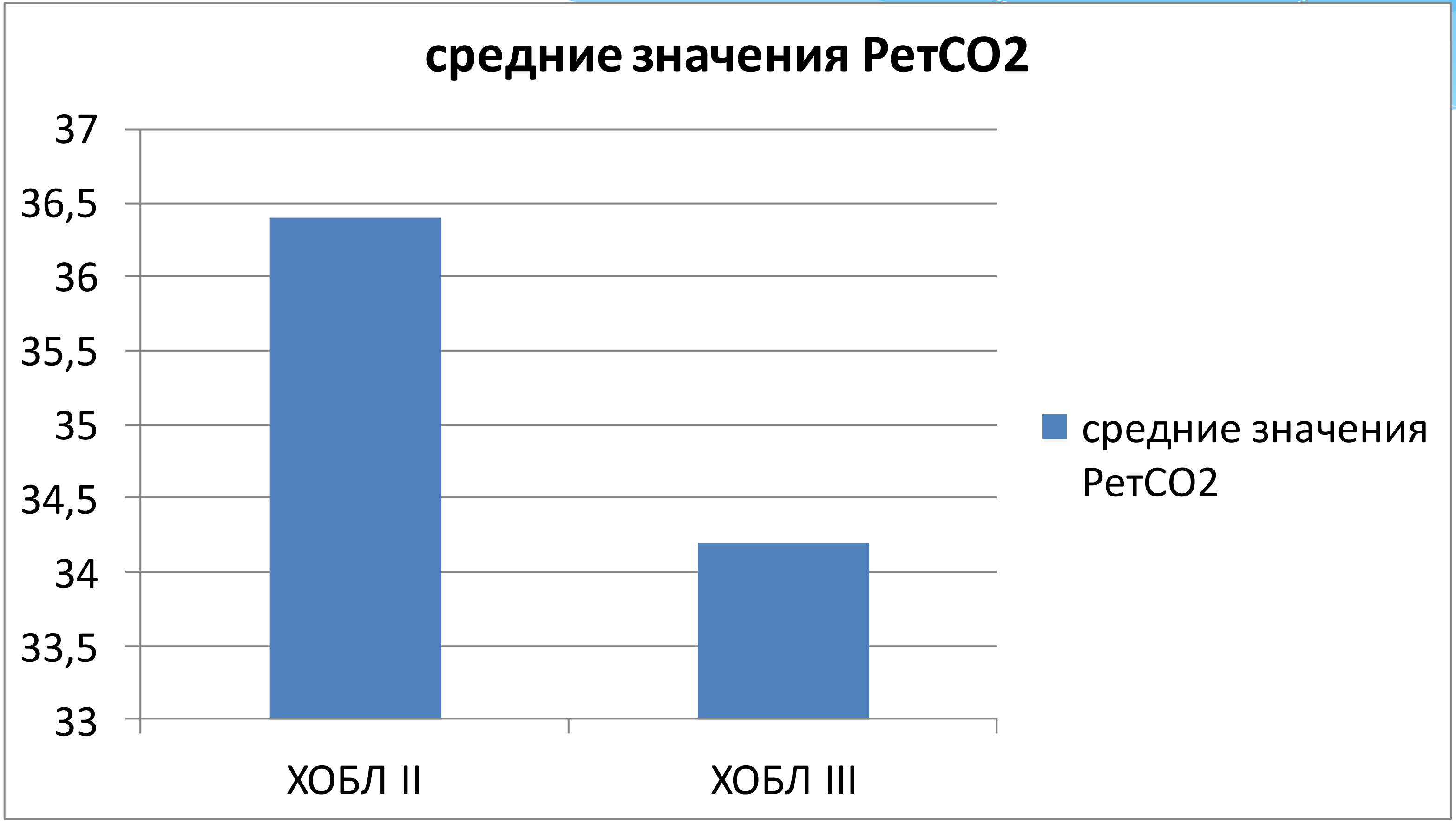
Capnography/Pulse Oximeter

LifeSense LS1-9R

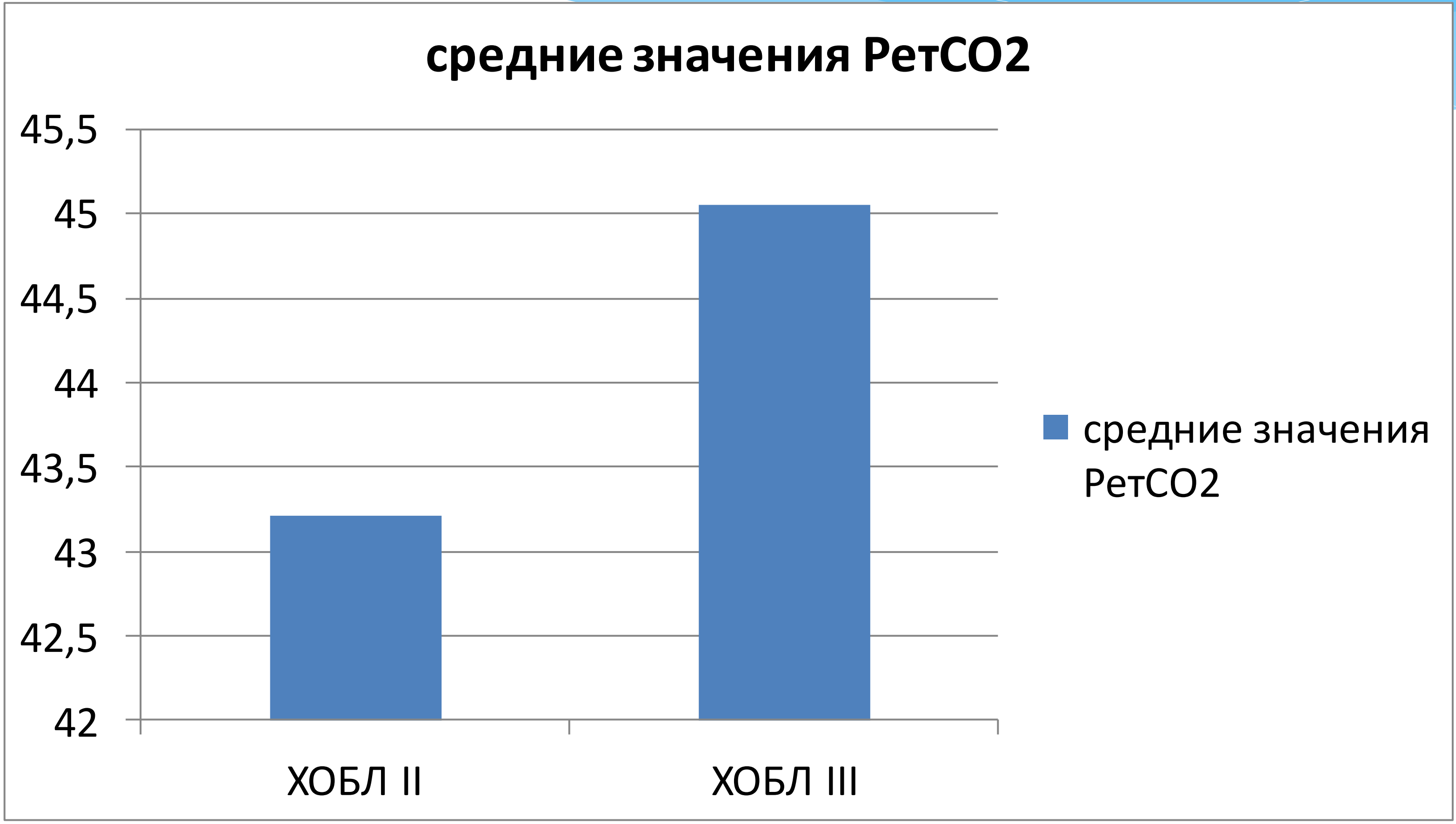
Жалобы больных после выполнения 6-минутного теста



Исходные показатели PетCO2



Показатели PetCO2 после 6-минутного теста

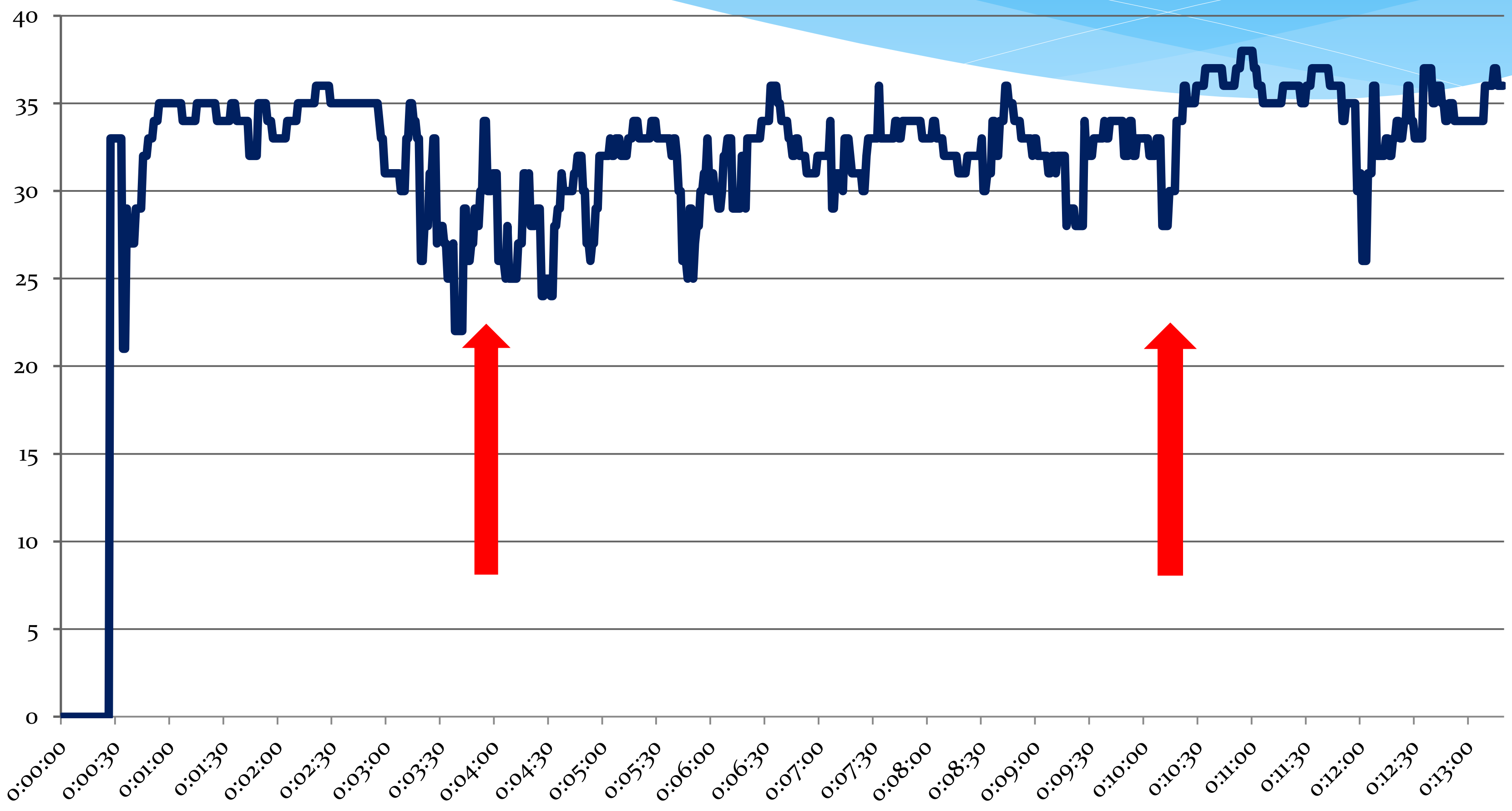


Результаты

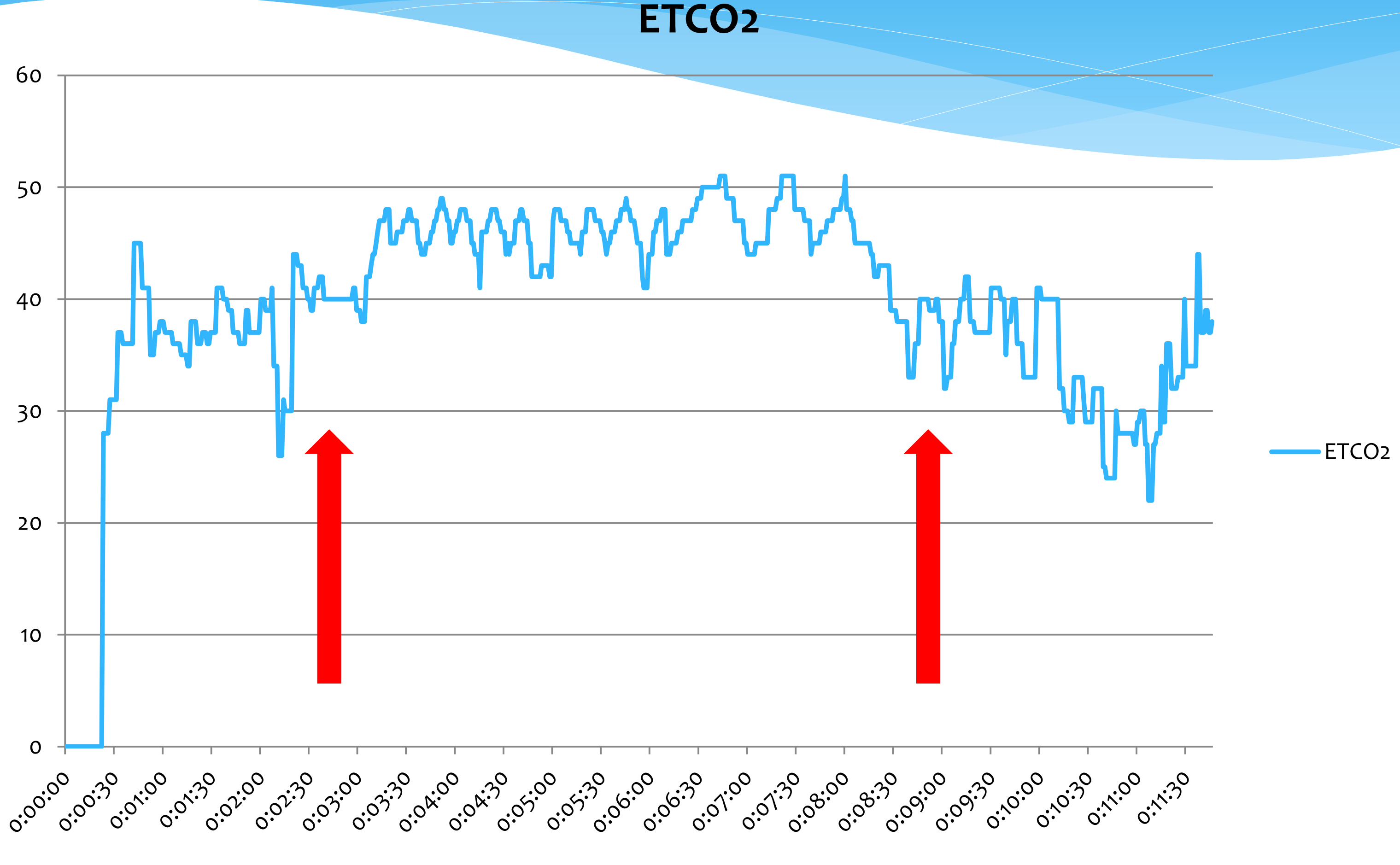
Показатели капнографии, дистанции 6MWT и одышки

	Данные капнографии (мм рт. ст.)		Расстояние 6MWT	Borg (баллы)		Визуально-аналоговая шкала	
	В покое	После 6MWT		В покое	После 6MWT	В покое	После 6MWT
ХОБЛ II	36,4 ± 2,53	43,21±2,81	450 ± 35,48	2,53±0,50	4,95±0,56	4,38±0,73	5,99±0,66
ХОБЛ III	34,2 ± 1,62	45,05±3,26	384 ± 35,42	2,95±0,43	5,53±0,65	4,98±0,46	6,78±0,48

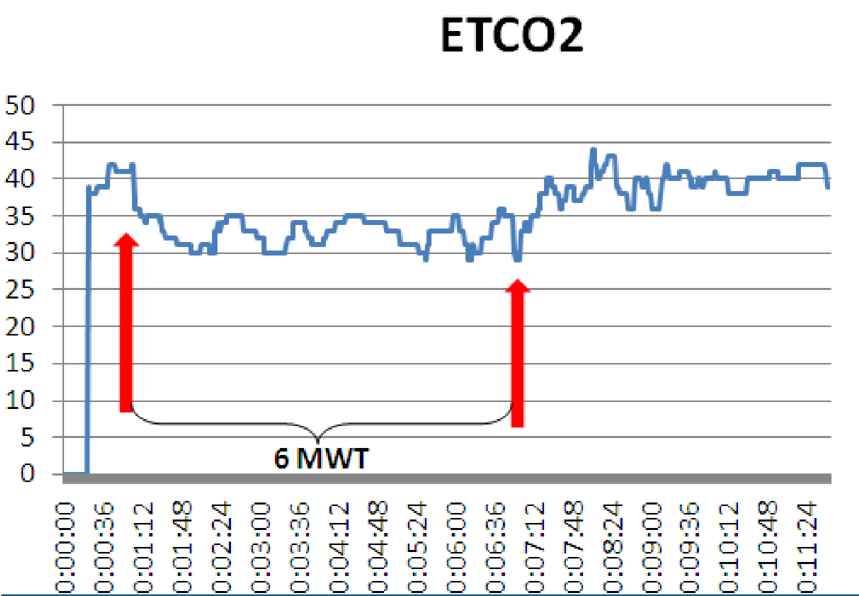
Показатель PETCO2 во время 6MWT ХОБЛ II



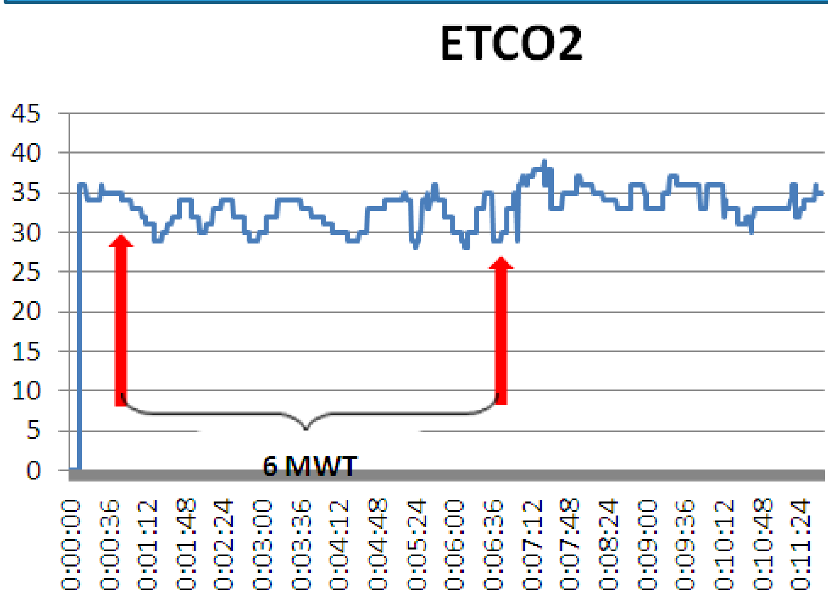
Показатель PETCO2 во время 6MWT ХОБЛ III



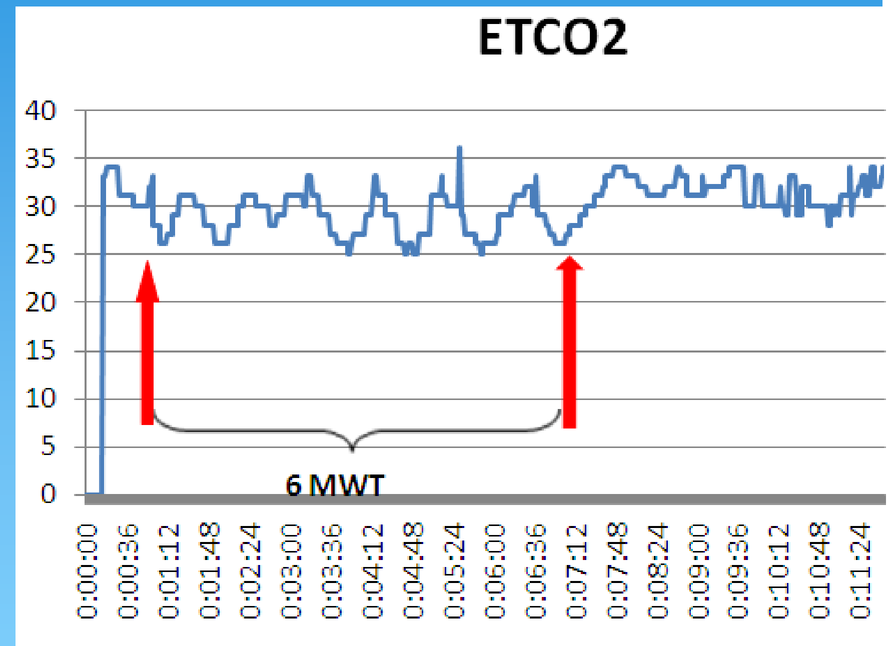
Показатель PETCO2 во время 6MWT



Пациент с ХСН II ФК



Пациент с ХСН III ФК



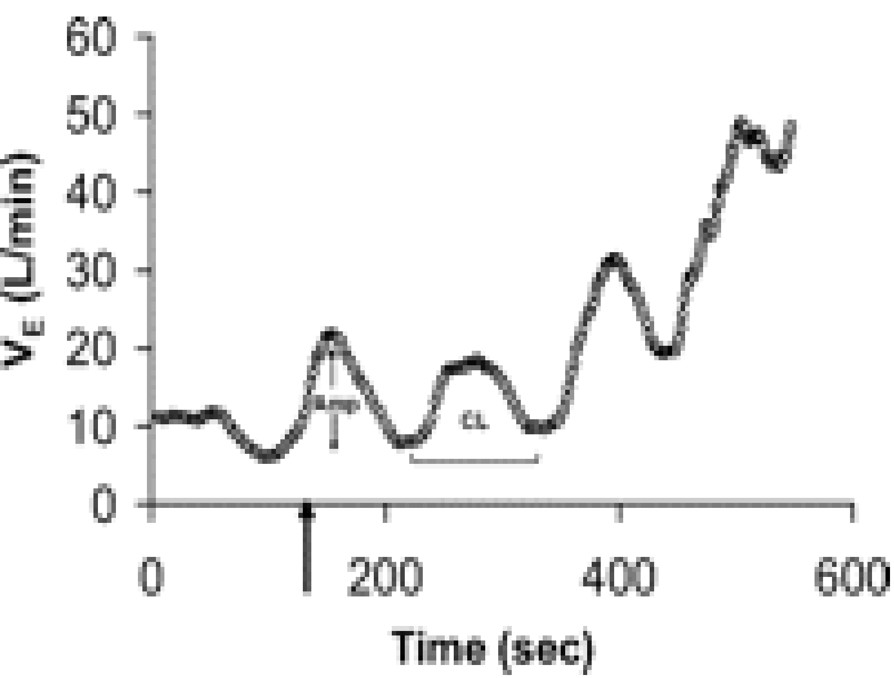
Пациент с ХСН IV ФК

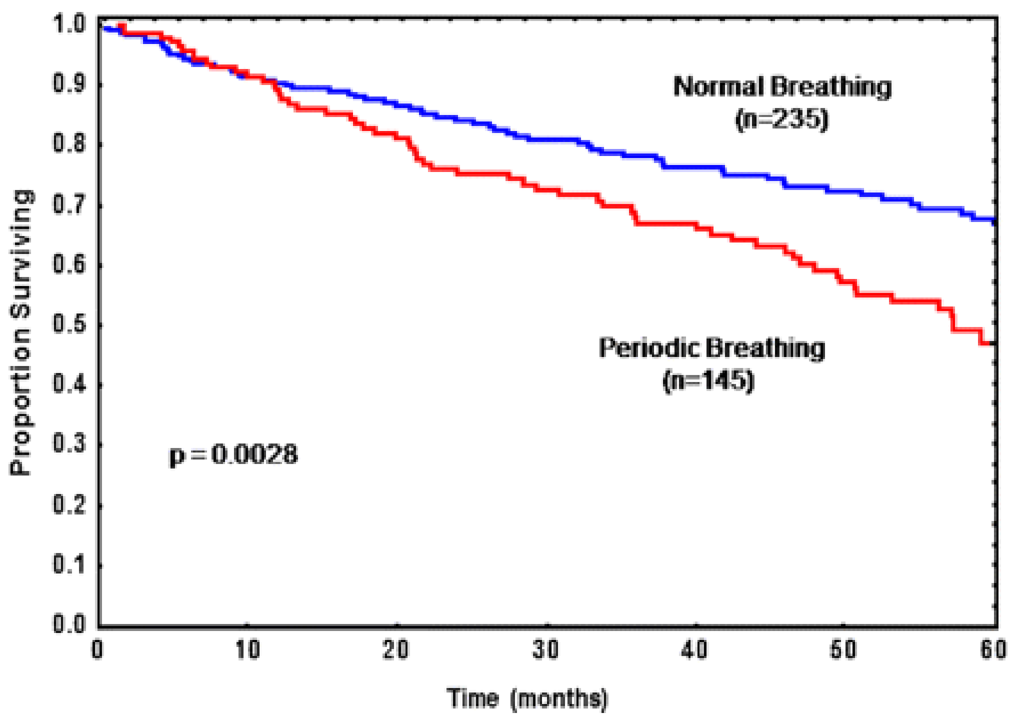
Exercise Oscillatory Ventilation in Systolic Heart Failure
An Indicator of Impaired Hemodynamic Response to Exercise

Ryan M. Murphy, et al.

Kaplan-Meier survival curves for the end-point of total cardiac mortality. Patients with periodic breathing during a short-term day-time recording had a significantly worse prognosis than patients with a normal breathing pattern

Eur J Heart Fail (2007) 9 (9): 949-954. .





Выводы:

- Капнография является простым, неинвазивным методом оценки легочной функции
- Динамическая капнография позволяет регистрировать изменение $P_{ET}CO_2$ во время проведения тестов с физической нагрузкой
- Капнография позволяет объективно оценить реакцию пациента на нагрузку во время 6MWT
- Применение капнографии дает более глубокую оценку легочных функций у больных ХОБЛ в процессе 6MWT

Спасибо за внимание