

Value of functional capacity assessment of patients undergoing noncardiac surgery

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Abstract

Introduction. Functional capacity is important parameter of activity of a person. It can be assessed with different methods, including interviewing, walk tests, cardiopulmonary exercise testing. According to the recommendations of the European Society of Cardiology, the assessment of functional capacity is an important step in the perioperative management of a patient with concomitant cardiovascular pathology during non-cardiac surgery. Purpose of our study was to implement assessing of functional capacity in clinical practice, including perioperative management of patients. And also, to compare the practical value of self-reported methods of assessing functional capacity and exercise testing. **Materials and methods.** 15 healthy men aged 33 ± 5.4 years and 172 patients with documented pathology of the cardiovascular system aged 65 ± 2.8 years were included in the study, among them 51% were male. We compared the value of different methods and the expediency of assessing the functional capacity of a patient with concomitant pathology of the cardiovascular system before planned non-cardiac surgery. **Results.** All healthy individuals gave a positive answer to the question about ability to climb two flights of stairs. The average Duke Activity Status Index score was 52.47 ± 5.96 , which corresponded to the calculated value of METs 9.19 ± 0.73 . During cardiopulmonary exercise testing, the average value of $VO_2\max$ in these individuals was 47.56 ± 11.34 mL/(kg·min). A direct strong correlation between Duke Activity Status Index values and $VO_2\max$ was established ($r=0.91$, $p<0.01$). 36 patients (21%) reported inability to climb two flights of stairs added. The average DASI in these persons was 12.84 ± 4.38 and the level of NTproBNP was 1116 ± 75 . On the contrary in the rest of the patients the DASI was 28.18 ± 7.72 and NTproBNP 302 ± 42 with statistically significant difference ($p<0.01$). The dynamics of troponins in the examined subjects did not show any increase in the postoperative period. The values of the EF in patients reported inability to climb two flights were lower by 9.78% compared with others ($56.57 \pm 12.34\%$ and $62.71 \pm 6.35\%$, $p<0.01$). The average number of days spent in the hospital was 22 in patients with inability to climb two flights and 12 in the rest. 32 patients (19%) died, 28 deceased belonged to the group with inability to climb two flights of stairs. The average time of death was 29.86 days. Correlation analysis revealed a direct relationship of average strength between the Duke Activity Status Index and EF (0.42, $p=0.007$), an inverse relationship of average strength between the Duke Activity Status Index and NTproBNP (-0.42 , $p=0.01$) and the number of days spent in a hospital (-0.39 ,

$p=0.005$). In conclusion we found that healthy men with an active lifestyle have higher average $VO_2\text{max}$ parameters and confirmed that the $VO_2\text{max}$ obtained during the cardiopulmonary exercise testing was comparable to questionnaire methods for assessing functional capacity. One fifth of patients with confirmed cardiovascular pathology self-reported inability to climb two flights of stairs. These individuals had a lower EF, a higher concentration of NTproBNP, a longer stay in the hospital, and significantly higher mortality. the Duke Activity Status Index correlates with left ventricular systolic function and NTproBNP level.

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Introduction

Capacity is important parameter of activity of a person. It can be assessed with different methods, including interviewing, walk tests, cardiopulmonary exercise testing (CPET). The last method consists in the computerized determination of the maximum oxygen consumption by the organism ($VO_2\text{max}$) during physical exertion. It depends on two factors - the supply of O_2 to the cell (pulmonary system function and respiration, cardiovascular system and blood circulation, musculoskeletal system,) and the utilization of O_2 by mitochondria. Therefore, it decreases in pathological conditions, as well as physiologically with age.

The level of $VO_2\text{max}$ is used to examine athletes in order to determine the degree of their training and endurance, although it is also important in clinical practice. In 2016, the American Heart Association published a document recommending the determination of $VO_2\text{max}$ as a routine clinical sign among other "vital" measures, as lower $VO_2\text{max}$ levels have been found to be associated with a higher risk of cardiovascular disease, overall mortality, and cancer mortality [1-7]. In addition, the American Heart Association recommends using $VO_2\text{max}$ levels to determine the level of physical activity and recommended loads in order to optimize the treatment of the patient and improve his health.

When conducting CPET for both clinical and sports examination, one principle is used - a gradual increase in the level of load on a treadmill or bicycle ergometer. During this, the concentration of oxygen and carbon dioxide in both inhaled and exhaled air is measured. $VO_2\text{max}$ is reached when oxygen consumption reaches a steady level (plateau) despite increasing workload [2-4]. In an untrained man, the value is in the range of 35–40 mL/(kg·min), in women - 27–31 mL/(kg·min), it can be improved by physical training. $VO_2\text{max}$ is highest in those sports where endurance plays a role - cyclists, rowers, skiers, swimmers, runners. Thus, male "elite runners" can reach a level of up to 85 mL/(kg·min),

women - up to 77 mL/(kg·min). Five-time Tour de France champion Miguel Indurain had a documented $VO_2\text{max}$ value of 88.0 mL/(kg·min). Alpine skier Bjørn Dæhlie – 96 mL/(kg·min). The record value of $VO_2\text{max}$ was documented in Oskar Svendsen at the age of 18 - 97.5 mL/(kg·min). In thoroughbred horses, $VO_2\text{max}$ is 180 mL/(kg·min). Siberian dogs at the Iditarod Trail Sled Dog Race $VO_2\text{max}$ reaches 240 mL/(kg·min).

According to the recommendations of the European Society of Cardiology, the assessment of functional capacity is an important step in the perioperative management of a patient with concomitant cardiovascular pathology during non-cardiac surgery (NCS) [3]. Reduced functional capacity is one of the prognostic markers of cardiac events and death in the postoperative period [4]. Self-reported inability to climb two flights of stairs added incremental value to the 30-day cardiac event rate [4, 5]. The Duke Activity Status Index (DASI) had a more precise estimation of cardiac risk than subjectively assessed functional capacity [6]. CPET which allows to assess value of maximal oxygen consumption reflects exercise capacity, is the most precise test amongst the exercise assessments is the cardiopulmonary exercise test but did not predict 30-day mortality, post-operative MI, or cardiac arrest [3, 5, 6].

Objective

The purpose of our study was to implement assessing of functional capacity in clinical practice, including perioperative management of patients. And also to compare the practical value of self-reported methods of assessing functional capacity and exercise testing.

Materials and methods

Functional capacity was assessed in three ways: self-reported inability to climb two flights of stairs, the Duke Activity Status Index, cardiopulmonary exercise testing.

The study consisted of two components:

1. Analysis of functional capacity of healthy persons with active lifestyle using Self-reported inability to climb two flights of stairs, the DASI and CPET;
2. Analysis of functional capacity of patients with documented pathology of the cardiovascular system in preparation for planned non-cardiac surgery using Self-reported inability to climb two flights of stairs and the DASI.

We compared the value of the methods and the expediency of assessing the functional capacity of a patient with concomitant pathology of the cardiovascular system before planned non-cardiac surgery.

15 healthy men aged 33 ± 5.4 years and 172 patients with documented pathology of the cardiovascular system aged 65 ± 2.8 years were included in the study, among them 51% were male. The level of natriuretic peptide (NTproBNP) was determined in patients before surgery, and if it was elevated, a highly sensitive troponin test was performed postoperatively in dynamics according to the European Society of Cardiology guidelines on perioperative management. All patients underwent echocardiography with determination of left ventricular ejection fraction (EF) using the Simpson method.

The duration of follow-up of patients was 6 months (inpatient visits or telephone visits).

Results

All healthy individuals gave a positive answer to the question about ability to climb two flights of stairs. The average DASI score was 52.47 ± 5.96 , which corresponded to the calculated value of METs 9.19 ± 0.73 . During CPET, the average value of $VO_2\max$ in these individuals was 47.56 ± 11.34 mL/(kg·min), and the performed load corresponded to 13.61 ± 3.24 METs. A direct strong correlation between DASI values and $VO_2\max$ was established ($r=0.91$, $p<0.01$). It is noteworthy that the values of METs calculated and obtained by CPET differed from each other (results were higher during exercise stress testing), but there is a direct correlation between them ($r=0.9$, $p<0.01$).

Upon admission to the hospital, 36 patients (21%) self-reported inability to climb two flights of stairs added. On the basis of this, we divided patients into two groups - the first with self-reported inability to climb two flights of stairs, the second included persons who can independently climb to with reduced functional capacity. Therefore, the assessment of functional capacity by means of questionnaires is a sufficiently effective tool for both cardiologists and anesthesiologists to single out patients who will need more

the 2nd floor. The average DASI in the first group was 12.84 ± 4.38 , the calculated number of METs was 4.32 ± 0.54 , in the second group 28.18 ± 7.72 and 6.25 ± 0.95 , respectively, the difference of both parameters between the groups was statistically significant ($p<0.01$). The level of NTproBNP was 1116 ± 75 in the first group and 302 ± 42 in the second group ($p=0.002$). The dynamics of troponins in the examined subjects did not show any increase in the postoperative period. As expected, the average values of the EF in the first group were lower by 9.78% compared to the second group ($56.57 \pm 12.34\%$ and $62.71 \pm 6.35\%$, $p<0.01$).

Among all the examined patients 32 (19%) died while 28 deceased belonged to the group of persons with reduced functional capacity. The average time of death was 29.86 days (minimum 11, maximum 67 days), four patients died in the interval between 90-120 days after the intervention. The average number of days spent in the hospital was 22 and 12 in patients of the first and second groups, respectively.

Correlation analysis revealed a direct relationship of average strength between DASI and EF (0.42 , $p=0.007$), an inverse relationship of average strength between DASI and NTproBNP (-0.42 , $p=0.01$) and the number of days spent in a hospital (-0.39 , $p=0.005$).

Discussion

Exercise stress testing is a computerized method of determining $VO_2\max$. Even though the validity of interview-based assessment of functional capacity has been questioned [3], our study confirmed the results of a cohort study of high-risk patients undergoing NCS, which confirmed self-reported inability to climb two flights of stairs added incremental value to the cardiac event ratio.

When assessing functional capacity using questionnaires, answers are self-reported they provide an estimate of functional capacity and may not be as accurate as objective measurements such as exercise stress testing. Criticism of CPET has been directed at both the difficulty of doing the test and the exorbitant cost [6]. Not all patients can undergo a stress test due to various reasons both from the patient's reasons, and from the medical system's side.

The correlation we proved between $VO_2\max$ as computerized breath-by-breath analysis and interview-based assessment confirms that these methods are comparable in terms of assessing functional capacity [7]. The questionnaire method made it possible to identify persons attention, a multidisciplinary consensus decision regarding preoperative preparation, and the type of anesthesiological support. The method does not require spending time, money, or special skills of the medical staff.

Conclusions

We found that healthy men with an active lifestyle have higher average VO_2max parameters. We confirmed that the VO_2max obtained during CPET was comparable to questionnaire methods for assessing functional capacity. One fifth of patients with confirmed cardiovascular pathology self-reported inability to climb two flights of stairs. Actually, these individuals had a lower EF, a higher concentration of NTproBNP, a longer stay in the hospital, and significantly higher mortality. DASI correlates with left ventricular systolic function and NTproBNP level.

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