Time of Exercise as Indicator of Quality Control in Ergometry Services

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Abstract

Background: The search for quality requires assessment tools in the various subdivisions of a health complex. In diagnostic medicine, they are scarce and in ergometry suggestions of indicators were not found.

Objective: To establish indicator for quality control on ergometry based on III Guidelines of the Brazilian Cardiology Society About Ergometric Test; to verify the percentage of tests that have presented the indicator within the compliance in two services of the same institution before and after the publication of the document.

Methods: A critical analysis of the guidelines in the search for indicator that would present: accuracy, reliability, simplicity, validity, sensitivity and ability to quantitatively measure the variations in the behavior of quality criteria and that would be applicable to all tests. The indicator was applied in tests of 2010 and 2011 prior to the publication, and after it was adopted by two services of the same institution.

Results: The indicator that has met the criteria was the percentage of ergometric tests with exercise duration between 8 and 12 minutes. In the years 2010 and 2011, respectively, the percentage of ergometric tests within compliance were 85.5% and 86.1% (p = 0.068) at the General Hospital, and 81.5% and 85.7% (p <0.001) the Service of Periodic Health Assessment.

Conclusion: The exercise time between 8 and 12 minutes can be used as a quality criterion in ergometric and services where it was applied, at least 80% of the ergometric tests were compliant.(Arq Bras Cardiol. 2014; 102(2):151-156)

Keywords: Ergometry; measures; exercise; quality indicators, health care.

Introduction

The implementation of quality programs[1] in public and private health services, as well as its increase in those that are already in course, is growing in Brazil. The adoption of indicators as tools for control of programs is necessary in this context, but the institutions, due to their complexities and multiple subdivisions, not always present specific indicators for each one of their areas. The search for quality requires that assessment tools should exist in each subdivision of a complex of health. Except for clinical laboratories and pathology anatomy that for years have indicators in their processes, there is a shortage of them to other areas of diagnostic medicine[2]. Particularly, in the context of the ergometric tests, it was not possible to find the proposition of indicators for this area in indexed publications. Whereas examination is noninvasive, but of risk, and it requires the informed consent form for its conduction, one deducts that tools of quality control can be useful and should be implemented.

In recent years, publications of Guidelines for medical practice, by specialty societies, have been increasing. The adoption of its recommendations has been strongly encouraged by representing the synthesis of reviews and analyzes of the available literature, according to the best scientific evidence.

The primary objective of this study was to establish a single indicator as a tool for quality control in ergometric testing, based on III Guidelines of the Brazilian Society of Cardiology about Ergometric Test[3], which guides the Brazilian practice in the area. Secondly, the research sought to record the measurement of the chosen indicator before and after the publication of the guidelines in order to verify their baseline and any changes determined by its adoption as a reference for medical practice in the area. For this evaluation, ergometric tests were analyzed in a General Hospital and Service of Periodic Health Assessment, the same private institution.

Methods

Characteristics and criterion of choice of the indicator

Initially, the characteristics of the indicators to be identified according to the criteria suggested by Saraceno and Levav[4] were

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established. They preconize that the indicator should measure quantitatively the variations in the behavior of the quality criteria previously established and describe a reality, there it must have the characteristics of a valid measure in statistical terms. In order to make these assumptions more objective, the criteria suggested by Kluck et al[5] were also incorporated into the present investigation, which are: accuracy, i.e., minimal chance of error, reliability, equal measures if they are made by other services with same methodology, simplicity, they may be collected by administrative staff; relevance, ability to measure the quality of the tests, validity, i.e., to effectively measure the phenomenon and sensitivity, the ability to detect variations in the behavior of the phenomenon that is examined.

The indicator chosen was the one that meet the highest number of characteristics considered: to be a quantitative measure able to indicate the quality of an ergometric test, to have accuracy, reliability, simplicity, relevance, validity and sensitivity, and to be applicable to all examinations.

Chartflow of the choice

Careful readings of the III Guidelines of the Brazilian Society of Cardiology for Ergometric Test[3] were made for the search of possible indicators of quality that would be derived from explicit and implicit recommendations. The indicators were analyzed according to the identified characteristics established beforehand and only one that would meet the highest number of criteria considered was chosen.

Evaluation of indicator values before and after the publication of Guidelines

The indicator chosen was applied in ergometric tests carried out at two moments: from January to September 2010, period prior to the publication of the Guidelines, and January-December 2011, at which time the guidelines were adopted as a standard. Data were collected in the Ergometry Sector of the General Hospital and in the specific Service of Periodic Health Assessment, both at a sole institution. Finally, a comparison was made of the indicator values at the two periods considered. No specific instruction was given to the physicians who performed the tests, after the publication of the Guidelines, except for the information that they should have read, understood and applied. In both systems, the executors of the test have always had the freedom to choose the protocol they deemed pertinent.

Statistical Analysis

After the definition of the indicator for quality control in ergometric testing, it was evaluated the percentage of tests considered complaint performed in both services (Ergometry Sector of the General Hospital and Service of Periodic Health Assessment) in two periods: before the publication of guidelines (2010) and after standardization according to the Guidelines (2011). The results were summarized as absolute and relative frequencies (percentages). For comparison between the two periods for compliance examinations, we applied a Pearson's chi-square test with Yates correction for continuity under the assumption that the tests performed in the two periods within the same sector were independent. It was considered the usual significance level of 0.05. The statistical software was SPSS, version 19.0.

Results

Indicator chosen

Readings and analysis of III Guidelines of the Brazilian Society of Cardiology on Ergometric Test[3] enabled to identify only two possible indicators, considering the criteria previously chosen. They were: exercise time of 10 minutes, with acceptable variations between 8 and 12 minutes recommended for an ergometric test, according to the item "5.6 - Choose the ergometer and protocol" of the document, and others described in "Item" 6.3.1 - Heart Rate", where it is defined that normal behavior in the test is the patient achieve the recommended heart rate for its related age. The percentage of tests performed with treadmill exercise lasting 8 to 12 minutes was the one which met all criteria previously determined and was the chosen one[4,5].

Evaluation of indicator values before and after the publication of Guidelines.

The results of the retrospective analysis of tests conducted in 2010 and 2011 in the Ergometry Sector of the General Hospital are shown in table 1. Data were available for 4,255 sequential tests in 2010, and 2,698 in 2011. It can be seen that the indicator chosen was considered optimal in the range 84.55% to 86.1% of the ergometric tests performed in 2010 and 2011, respectively (figure 1). We observed a reduction in the percentage of tests outside the range of 15.5% in 2010 to 14.9% in 2011, this difference was not statistically significant ($p = 0.068$). Considering only the tests below, the minimum time of 8 minutes for the duration of the exercise, the percentage decreased from 11.5% in 2010 to 8.8% in 2011. However, there was an increase in the percentage of tests over 12 minutes long. The percentage of 4% observed in 2010 rose to 5.1% in 2011.

The results of the application, retrospective, of the chosen indicator in ergometric tests performed in the years 2010 and 2011, in the Service of Periodic Health Assessment, are shown in Table 2. Data were available for 3,763 sequential tests in 2010, and 6,458 in 2011.

The indicator in this service in 2010, was in the optimal range considered in 81.5% of the ergometric tests performed, increasing to 85.7% in 2011 (figure 1). After standardization according to the guidelines, there was a reduction in the percentage of tests out of range (18.5% in 2010 to 14.3% in 2011, $p < 0.001$). Considering only the tests below, the minimum time of 8 minutes for the duration of the test, the percentage decreased from 10.6% in 2010 to 7.1% in 2011. There was also a reduction of the percentage of tests lasting over 12 minutes between 2010 and 2011. The percentage of 7.9% in 2010 increased to 7.2% in 2011. It was observed in both periods and both services, the following protocols applied: Bruce modified, original Bruce, Ellestad and Naughton.

Discussion

Medical progress, improving diagnostic and therapeutic arsenal has increased, so expressively, the health care costs in the world[1], including our country. In Brazil, most evidently in the Unified Health System (SUS) and the suppletive, available resources are limited, which leads to the requirement for full optimization of assistance to assist as many people as possible. The implementation of quality programs in health, started in our country, since the 1990s, it can be an important weapon, so this optimization is pursued without deterioration of assistance[1]. On the other hand, the consumer of private services of the complementary system and SUS system have an increasingly desire for a good health assistance. This causes health services to more and more seek for quality. As the process moves forward, searching quality of care, there is a tendency that tools for quality assessment in health care are not restricted to the general aspects of an institution, rather that such quality is pursued in its various sectors, according to their particularities and constructing indicators of structure, process and results[6]. Clinical laboratories and pathology anatomy were the first to seek quality improvement, standardizing their processes and obtaining certifications. In other areas, in medical diagnosis, there is still a lack of tools capable of performing quality control in its various subdivisions[2]. Particularly in the area of ergometric tests, it was found no indexed publication to suggest specific indicators for quality control. Therefore, this research seems to have a pioneering nature.

The choice of the document III Guidelines of the Brazilian Society of Cardiology on Ergometric Test, published in September 2010, happened due to the fact that they have based on the analysis of the available literature so far. Considering that this document represents an important guide to the implementation and interpretation of ergometric tests, it was considered an ideal source to search for indicators for ergometric tests. The choice of an indicator can always deserve criticism and biases. The percentage of tests performed with

Table 1- Absolute and percentage values of the ergometric tests in 2010 and 2011, classified according to the time of exercise, total of examinations and absolute number and percentage of tests out of the ideal range in the Ergonometry Service of the General Hospital

	Period of Assessment	
Stress Time	2010	2011
Under 8 minutes	491 (11.5%)	237 (8.8%)
Above 12 minutes	168 (4%)	137 (5.1%)
Between 8-12 minutes	3596 (84.5%)	2324 (86.1%)
Total of examinations	4255 (100%)	2698 (100%)
Tests out of range	659 (15.5%)	374 (14.9%)

Table 2 - Absolute and percentages values of the ergometric tests in 2010 and 2011, classified according to the time of exercise, total of examinations and absolute number and percentage of tests out of the ideal range in the Service of Periodic Health Assessment

	Period of Assessment	
Stress Time	2010	2011
Under 8 minutes	401 (10.6%)	458 (7.1%)
Above 12 minutes	296 (7.9%)	468 (7.2%)
Between 8-12 minutes	3066 (81.5%)	5532 (85.7%)
Total of examinations	3763 (100%)	6458 (100%)
Tests out of range	697 (18.5%)	926 (14.3%)

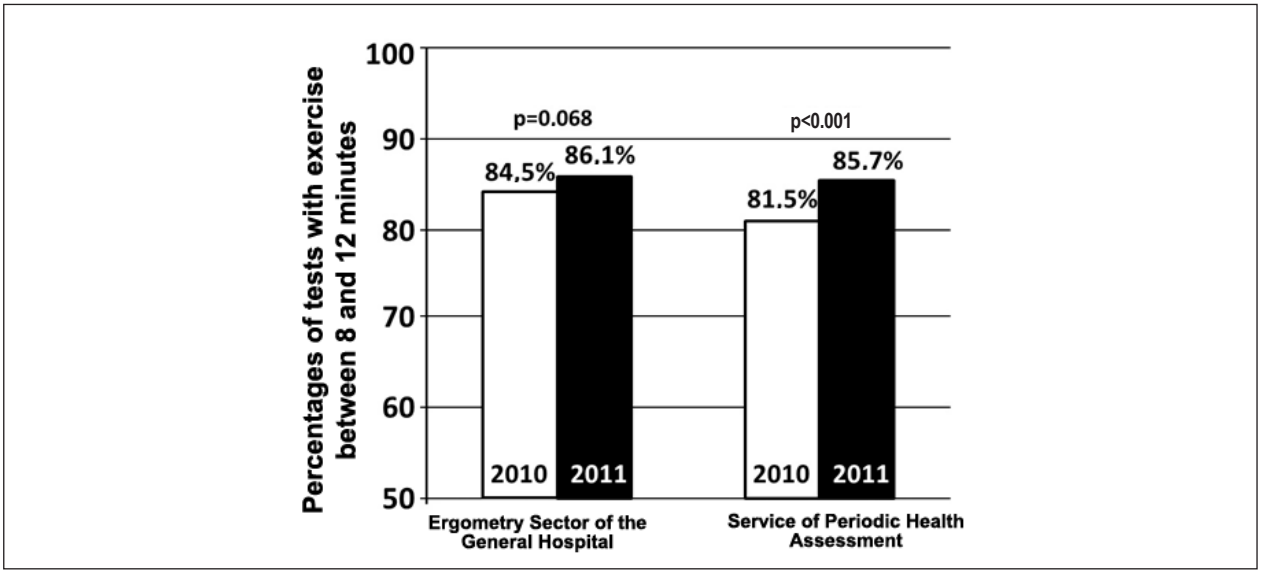

Figure 1 - *Percentages of tests considered in compliance, according to the chosen quality indicator (duration of ergometric test exercise between 8 and 12 minutes), at the two services researched in years of 2010 and 2011.*

treadmill exercise lasting 8 to 12 minutes, which meets all the criteria previously determined[4,5], represents the expertise of the physician performing the examination, after analyzing anamnesis data for assessing the functional capacity of an individual patient. It is a quantitative measurement able to indicate the quality of an ergometric test having accuracy, reliability, simplicity, relevance, validity and sensitivity.

The stress time execution, ideally of 10 minutes, with acceptable variations from 8 to 12 minutes have justifications in the literature that have not been thoroughly commented in the III Guidelines of the Brazilian Society of Cardiology, perhaps because it is synthetic document and easy to read to facilitate its intended full dissemination. Since 1973 it is already known that load exercise may trigger intense ST segment depression, compatible with myocardial ischemic response[7].

Barnard et al[7], applying a run of only 30 seconds, no heating, in 10 normal firefighters discovered slight depression of the ST segment in three of them, significant depression in three of them and four of them with normal electrocardiographic response. After heating, with normal ergometric test with of increasing load, the repetition of the experiment showed very slight depression in just two firefighters and normal response in eight firefighters. Since then it is known that ergometric tests with short duration mean an imposition of improper load to the patient in question, which can generate false positive results. Based on research that measured concomitantly intra-arterial pressure in the brachial artery, the rationale for the onset of ST segment depression was a reduction of the subendocardial coronary flow due to lack of adequate cardio-circulatory adjustments before a sudden and intense stress.

Also since 1991, it is known that prolonged ergometric tests can minimize possible ischemic electrocardiographic manifestations in patients with coronary artery disease[8]. Panza et al[8] have performed two tests on a treadmill in 70 patients with known coronary artery disease after discontinuation of medication in use, using the Bruce protocol and increment loads protocol, in a more attenuated manner, of the National Institutes of Health (NIH) in Bethesda, United States. The exercise time was 6.8 minutes (SD +2) in Bruce Protocol and 14.1 minutes (SD +5) in the NIH protocol. They have had positive ergometric tests of 82% of patients with the Bruce protocol and only 67 % with the protocol in a more attenuated manner and of longer duration. This publication assessed the findings of Bruchfuhrer et al[9] published in 1983, which tested 10 healthy subjects in different protocols on a treadmill and stationary bike, finding in both ergometers the time of 10 minutes as the optimal duration of stress to obtain the highest oxygen consumption for each individual. Tests lasting less than eight minutes led to an average reduction of higher oxygen consumption by 10%, and when lasting more than 17 minutes it has a reduction of 5%.

All these publications have guided the Guidelines[10,11] on ergometic tests and the Guideline from the American Heart Association recommends values between 6 and 12 minutes[10], and the Brazilian one recommends 8 to 12 minutes. As seen, the duration of stress during ergometric test is an important variable in the quality of the examination and it may generate false positive and negative diagnostic results, if not proper, therefore it measures the actual quality of the process of conducting an ergometric test.

To make an ergometric test to be within compliance, according to the indicator implies that the performer has medical expertise to choose the appropriate protocol from among those recommended by the Guidelines, which are the original Bruce, modified Bruce or ramped, Ellestad, Balke and Naughton. These protocols have different intensities of work increase, enabling patients with very low physical ability until those well-conditioned, to perform exercise between 8 and 12 minutes. There is still the possibility of applying a ramp-type protocol, the principles advocate that the stress should be in the range of 8 to 12 minutes, whereas 10 minutes is the ideal time[12].

Questionnaires are available in the literature for the estimate of prior functional capacity and they can be of use in order to reach such objectives[13-15].

The indicator chosen meets the recommendations of Saraceno and Lavav[4] because, as it was seen, it quantitatively measures the variations in the behavior of the quality criteria and describes a reality, which can be considered as a valid measurement in statistical terms.

Considering the recommendations has as objective from Kluck et al[5] one may affirm that the indicator is accurate because it is a measure of time easily obtained in computerized systems for testing; it is reliable, enabling it to be measured by other services with the same methodology, it is simple, it can be collected by administrative staff only by observation of the report, without the use of subjectivity, without specific technical knowledge, it is relevant for measuring the quality of an ergometric test with broad support in the pertinent medical literature, it is valid because it measures effectively a *quality* of the test, and, finally, it is sensitive because it can detect the changes in the phenomenon behavior that is examined.

Another possible indicator identified to achieve maximal predicted heart rate, is based on the formula (220 - age in years) (SD = 11) and (208 to 0.7 x age in years) is also a quantitative measure capable of indicate the quality of an ergometric test; it has accuracy, reliability, simplicity, relevance, validity and sensitivity. However, several conditions can influence the behavior of heart rate in ergometric test: the patient's functional capacity, the presence of anxiety, neurovegetative dystonia, hypothyroidism, hyperthyroidism, Chagas disease, anemia, among others, and particularly the action of agents operating in chronotropism. Due to these influences, which cannot be applied to all tests, the indicator is deprecated. Although it might be considered simple and it can be applied by administrative staff, their use implies the application of formulas.

The adoption of such an indicator tool for quality control, once implemented, requires the establishment of limits to some degree of acceptability, particularly in the early stages of implementation. In the present investigation it was sought to establish with the chosen indicator, the actual world of the ergometric practice, the values obtained in diagnostic and in the service of periodic health assessment. There were differences in the indications of the ergometric tests between two selected services in most patients. At the General Hospital, it was

predominant the indications targeting diagnosis of coronary artery disease in patients with any suspicious symptoms to clarify or patients with risk factors for coronary artery disease.

Most of the patients in the service of periodic health assessment consisted of asymptomatic individuals belonging to companies that hired the service to assess the health of their employees. The selected services has the scope of pursuing quality and are composed by physicians experienced in the method and knowledge of literature. The results of 85% and 81% in 2010 may suggest that these may be possible goals for the indicator in services with the same characteristic.

The application of the indicator, after the publication of the III Guidelines of the Brazilian Society of Cardiology on Ergometric Test[3], adopted as a reference for the ergometric test in both services, demonstrated increased of tests within the range of 8 and 12 minutes of exercise in one of them, therefore one may speculate that this occurred under the influence of the document. The comparison, however, took place from January to September 2010, and throughout the year 2011. The exclusion of data from the last three months of 2010 was due to the fact that the Guidelines[3] were available on the Internet in October of that year, and their knowledge could contaminate the desired baseline.

Conclusions

The percentage of realization of the ergometric test with exercise time between 8 and 12 minutes may be used as a quality indicator in ergometry services. At places where it was applied, an incidence of at least 80% of ergometric tests were within compliance provided by the indicator. The adoption of the III Guidelines of the Brazilian Society of Cardiology on Ergometric Test may has had only a discrete influence in the increase of number of tests within compliance in one out of the two services researched.

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Author contributions

Conception and design of the research, Acquisition of data, Critical revision of the manuscript for intellectual content and Analysis and interpretation of the data: Meneghelo RS, Morhy SS, Zucchi P; Statistical analysis and Writing of the manuscript: Meneghelo RS, Zucchi P.

Potential Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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