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Glittre-Activities Daily Living Test: physiological response in heart failure patients

Dissertação submetida à Escola Superior de Saúde – Instituto Politécnico do Porto para cumprimento dos requisitos necessários à obtenção do grau de Mestre em Fisioterapia – Opção Cardiorrespiratória, realizada sob a orientação científica do Professor Doutor Mário Santos, Médico Cardiologista no Centro de Reabilitação do Norte, e sob coorientação do Mestre Pedro Matos Silva e Doutora Sofia Viamonte.

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Glittre-Activities Daily Living Test: physiological response in heart failure patients

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Resumo

Introdução: A capacidade funcional e a qualidade de vida são medidas do estado de saúde do doente com insuficiência cardíaca (IC) e podem demonstrar o impacto da doença na capacidade de realizar atividades da vida diária (AVD´s). O teste *Glittre-ADL* (*TGlittre*) foi criado para avaliar a capacidade funcional em doentes, baseando-se nas atividades da vida diária. As respostas fisiológicas deste teste em doentes com IC ainda são desconhecidas. **Objectivo(s):** Analisar e comparar o desempenho cardíaco, ventilatório e metabólico no *TGlittre*, na prova de marcha de 6 minutos (PM6M) e na prova de esforço cardiopulmonar (PECP) em doentes com IC. **Métodos:** Estudo prospectivo e transversal com 11 doentes de ambos os sexos, com uma mediana 65 anos, com IC (mediana da fração de ejeção do ventriculo esquerdo de 40%) submetidos a avaliações antropométricas, função pulmonar e realizaram uma PECP, o *TGlittre* e PM6M. **Resultados:** As variáveis cardiopulmonares basais foram semelhantes entre o *TGlittre* e a PM6M ($p>0,05$). O *TGlittre* induziu um VE, VE/VO_2, RER, FC e VE/MVV significativamente superior em relação à PM6M ($p<0,05$). As outras variáveis fisiológicas obtidas foram semelhantes em ambos os testes. O *TGlittre* apresentou uma correlação significativa com a distância na PM6M ($r=-0,64$; $p=0,04$). No consumo final de oxigénio (VO_2), o *TGlittre* apresentou uma correlação significativa com a PECP ($r=0,72$; $p=0,01$) e com a PM6M ($r=0,67$; $p=0,02$). O *TGlittre* apresenta caracteristicas submáximas quando comparado com a PECP. **Conclusão:** O *TGlittre* induziu respostas ventilatórias e cardiovasculares superiores comparativamente com a PM6M, com perfil metabólico semelhante.

Palavras-chave: insuficiência Cardíaca, TGlittre, actividades de vida diária, capacidade funcional

Abstract

Background: Functional capacity and quality of life are measures of the heart failure (HF) patient's health status and can demonstrate the impact of the disease on the ability to perform activities of daily living (ADL´s). The Glittre-ADL (TGlittre) test is supposed to evaluate patient´s functional capacity and their ability to perform activities of daily life. The physiological requirements of this test in HF patients are still unknown.

Aim(s): Analyze and compare the cardiac, ventilatory and metabolic performance of the TGlittre, 6 minute walk test (6MWT) and cardiopulmonary exercise test (CPET) in patients with HF. **Methods:** A prospective cross-sectional study with 11 patients of both genders (median age of 65) with HF (median left ventricle ejection fraction of 40%) underwent anthropometric and lung function assessments and were submitted to a CPET. In separate day, with a maximum of 10 days apart, patients performed the TGlittre and 6MWT. **Results:** Baseline cardiopulmonary variables were similar between TGlittre and 6MWT (p>0,05). TGlittre induce significantly higher VE, VE/VO_2, RER, HR and VE/MVV (p<0,05) compared to 6MWT. The other physiological variables were similar at the end of both tests. TGlittre showed a significant correlation with 6MWT distance (r=-0,64; p=0,04). In the final oxygen consumption (VO_2), TGlittre showed a significant correlation with CPET (r=0,72; p=0,01) and 6MWT (r=0,67; p=0,02). TGlittre showed submaximal characteristics when compared with the CPET. **Conclusion:** TGlittre induce higher ventilatory and cardiovascular responses than the 6MWT, with similar metabolic adjustments.

Key words: heart failure, TGlittre, activities of daily living, functional capacity

1. Introduction

Cardiovascular diseases (CVDs) are a group of disorders of the heart and blood vessels, caused by the interaction of genetic and environmental factors. They are considered a public health problem and have a negative impact on patient’s quality of life. The most prevalent CVDs are hypertension, coronary artery disease and heart failure (HF) (Greenland et al., 2010; Smith et al., 2013).

HF is a clinical syndrome characterized by typical symptoms, (e.g. exertional dyspnea) caused by a structural and/or functional cardiac abnormality, resulting in a reduced cardiac output and/ or elevated intracardiac pressures at rest or during stress (Ponikowski et al., 2016).

The assessment of functional capacity in patients with HF is important for clinical practice because it helps to understand patient’s limitations and their impact on quality of life to prognosticate and to tailor treatment (Fernandes-Andrade, Britto, Soares, Velloso, & Pereira, 2017).

Although cardiopulmonary exercise testing (CPET) is considered the gold standard for evaluation of functional capacity, it is not feasible or adequate in many frail and functionally impaired patients referred to cardio-respiratory rehabilitation programs (Forman et al., 2017). Therefore, submaximal tests, such as the 6-minute walk test (6MWT), have been widely used to assess functional capacity and to target intervention outcomes.

On the other hand, it is well known that patients with HF experience impairment in the ability to carry out activities of daily living (ADLs). The capacity to perform ADLs will be the most important factor on patient's functional independence, ability to work or to be safe on a day-to-day basis than maximal exercise tolerance (Forman et al., 2017; Kaminsky & Tuttle, 2014). Even knowing that 6MWT is a functional test used to evaluate the ability of patients perform ADLs, it´s an exclusive gait test, not being specific to evaluate activities that use the upper and lower limbs simultaneously (Skumlien, Hagelund, Bjørtuft, & Ryg, 2006). It´s well known that the use of the upper limbs is an important component in the execution of ADLs, which are guided reaching, grip and object handling (Rosamond et al., 2008).

Thus, considering that assessment of the functional capacity of CVDs patients should include the upper and lower limbs, there is a need for a comprehensive test that captures the patients' limitations to perform daily lives tasks (Fernandes-Andrade et al., 2017).

The Glittre–Activities of Daily Living Test (TGlittre) is a field test developed and validated to measure the functional capacity of patients with chronic obstructive pulmonary disease (COPD), through the most relevant issues of the pulmonary functional status and dyspnea questionnaire, which include day-to-day activities such as walking, sitting and standing, climbing stairs and moving objects with upper limbs (Skumlien et al., 2006).

It is still necessary to prove TGlittre validity in the evaluation and rehabilitation treatment response in individuals with HF, taking into account that little data is available of this stress testing, as well as on its utility as efficacy benchmark for cardio-respiratory rehabilitation programs. Despite of the physiological demands by the TGlittre on patients with HF is still unknown, we hypothesized that might be different from that induce by the 6MWT.

Therefore, the purpose of this study is to compare the cardiac, ventilatory and metabolic performance of the TGlittre and 6MWT of patients with HF who also underwent a CPET.

2. Methods

2.1. Study Design

This study is characterized as a prospective cross-sectional study.

2.2. Subjects

The target population included patients with a diagnosis of HF with age equal to or greater than 18 years, referred to cardiorespiratory rehabilitation program in Centro Reabilitação do Norte – Dr. Ferreira Alves, Vila Nova de Gaia.

Patients with unstable angina, decompensated heart failure or complex ventricular arrhythmias, with inability to perform physical exercise (eg. osteoarticular pathology) and with chronic obstructive pulmonary disease (COPD) defined by FEV1 / FVC ratio <0.7 were excluded from the study.

A convenience sample was used and 14 HF patients attending the Centro de Reabilitação do Norte agreed to participate in our study. Of these, 2 were excluded because technical problems with evaluation instruments and 1 due to withdrawal during collection. Finally, the final sample consisted of 11 patients (Figure 1).

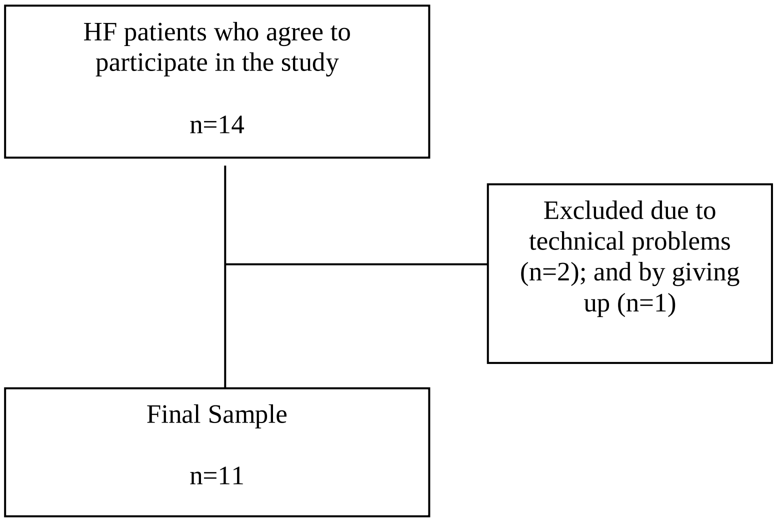

Figure 1 - Sample constitution diagram.

2.3. Instruments

2.3.1. *Sample Characterization*

The characterization of the sample was performed based on an interview about sociodemographic data (age and gender). The clinical process was used to obtain the values of left ventricle ejection fraction (LVEF) and New York Heart Association Functional Classification (NYHA).

Anthropometric measures were evaluated through a SECA 220 stadiometer (SECA - Medical Scales and Measuring Systems®, Hamburg, Germany), with an accuracy of ± 5mm, and SECA 769 scale, with precision of 100 g (SECA - Medical Scales and Measuring Systems®, Hamburg, Germany), respectively.

2.3.2. *Cardiopulmonary Exercise Test (CPET)*

The CPET provides information on the response of the human body to exercise, through breath-by-breath gas exchange measures, during a progressive intensity exercise stimulus to provide an integrated analysis of physiological responses required by cardiovascular and respiratory systems to meet the metabolic demands of the skeletal muscle (Malhotra, Bakken, D'Elia, & Lewis, 2016).

2.3.3. *Glittre-ADL Test(TGlittre)*

TGlittre was developed with the objective of evaluate the functional status through daily activities, such as walking, getting up and sitting, going up and down stairs and moving objects at different heights in individuals with COPD (Skumlien et al., 2006).

2.3.4. *6 Minute Walk Test (6MWT)*

6MWT is a simple, low cost and practical measure of exercise capacity. It is a widely used and standardized evaluation in several scenarios, including people with cardiopulmonary diseases, with significant prognostic value (Holland et al., 2014; ATS, 2002).

2.3.5. *Physiological Responses*

In order to evaluate the physiological responses, patients were connected to a telemetric portable gas analyzer ($K4b^2$, Cosmed®, Rome, Italy). The $K4b^2$ is a light device with a face mask, heart rate chest strip, battery, a portable transmitting unit and was calibrated according to the manufacturer´s recommendations – volume calibration; room air calibration; reference gas calibration and delay calibration. The following variables were measured on a breath-by-breath mode: oxygen uptake (VO2), carbon dioxide output (VCO2), respiratory rate (RR), minute volume (VE), respiratory exchange rate (RER), heart rate (HR), oxygen pulse (VO2/HR), ventilatory demand (VE/MVV), and ventilatory equivalent for oxygen uptake and carbon dioxide output (VE/VO2 and VE/VCO2) (Tufanin et al., 2014). Maximum Voluntary Ventilation (MVV) was calculated based on the equation: FEV1 × 40.

2.4. Study Protocol

Evaluations were completed in two nonconsecutive days. On the first day, anthropometric and lung function assessments were carried out for all subjects. Then, patients performed a CPET on treadmill, fulfilling the Bruce protocol, whereby patients start exercising at 2.7 km/h on a 10% grade. Every 3 minutes the speed and grade increase to a maximum of 9,6 km/h and 22% grade (Bruce, Blackmon, Jones, & Strait, 2004). Subjects were encouraged to continue the exercise until exhaustion, but it could be interrupted in case of limiting symptoms. On the same day, patients underwent a familiarization trial for both 6MWT and TGlittre.

On the second day, within a ten days period, 6MWT and TGlittre were performed, randomly, with a minimum of 30 minutes resting time or the necessary time for all physiologic parameters return to basal values. During both functional capacity tests patients were connected to a telemetric portable gas analyzer to evaluate physiological responses.

In the 6MWT, performed according to the guidelines of American Thoracic Society, patients were asked to walk as far as possible, in 6 minutes, along a flat corridor of 30 meters demarcated every 3 meters. Standardized instructions and encouragement were given during the test. If the patient needed to stop walking during the test, the timer wasn´t stopped. Peripheral oxygen saturation (SpO_2), Heart Rate and Borg score for exertion, dyspnea and blood pressure were measured at the beginning and end of the test. The total distance walked by the patient, corresponds to the main outcome measure (Crapo et al., 2002; Holland et al., 2014).

The TGlittre test started with the patient rising from a seated position. Then, patients had to walk along a 10 meters flat course, going up and down 2 steps (17cm high and 27cm wide) located in the middle of the course, face two shelves upon arrival at the end of the course adjusted to patients' shoulder and waist height. Three jars of 1kg each, were positioned on the top shelf and the patient had to move them, one at a time, to the bottom shelf, and then to the floor. Afterwards, the patients returned the pots to the bottom shelf and then back to the top shelf. The patients then turned and walk back over the stairs to the chair, sat down, and immediately started the next lap. The test ends after five laps. The entire course was made wearing a schoolbag weighing 2.5kg (women) or 5.0kg (men).

Prior to the test, patients were oriented to perform it the fastest they could without running and no verbal incentive was given during the test. Patients are allowed to rest, if necessary, but their goal is to perform the test as quick as possible. If the patient stopped to rest, the chronometer went on counting the time. The test´s outcome was the total time taken to complete all the five laps (Tufanin et al., 2014). Before and at the end of the test, SpO_2, HR, Borg score for exertion and dyspnea and blood pressure were measured. The criteria for interruption were SpO_2 below 80%, HR above 85% of maximum HR predicted by Astrand formula (220-age), chest pain, dizziness, nausea, and headache (Tufanin et al., 2014).

2.5. Ethic

The study was approved by the Board of Administration and the Ethics Committee of the Santa Casa da Misericórdia do Porto.

Participants were informed of the study objectives, principles and possible implications of data collection methods and procedures for the analysis and treatment of collected information. They were also given the opportunity to ask any questions that they deemed necessary, as well as to refuse to participate in the study or to interrupt it at any time.

Participants agreed to join the study by signing the Helsinki Declaration, and the anonymity and confidentiality of the data were maintained throughout the study.

2.6. Statistical analysis

We opted for using non-parametric inferential statistics due to the reduced sample number (Marôco, 2010).

The measures of central tendency and dispersion were used to the descriptive statistics regarding the characterization of the sample.

The Wilcoxon signed-rank test was used to compare physiological data between 6MWT and TGlittre. Correlations between hemodynamic and metabolic variables were determined using Spearman´s correlation test. The existence of weak linear correlation was considered for a correlation coefficient between 0 and 0.3, moderate between 0.3 and 0.6, strong between 0.6 and 0.9 and very strong between 0.9 and 1. Statistical significance was determined by $p < 0,05$ (Marôco, 2010). Statistical analysis was performed using SPSS Statistics 25.0 (Statistical Package for the Social Sciences®).

2.7. Results

The final study sample consisted of 11 patients (2 females), with NYHA between class I (18%), II (73%) and III (9%). All 11 patients were able to finish the CPET, 6MWT and TGlittre without any intercurrence. The anthropometric parameters, pulmonary and cardiac function data are demonstrated in Table 1.

Table 1: Characteristics of the study group

Characteristics	Median	IQR 25/75	Minimum	Maximum
Age (years)	65,00	55,00 / 75,00	37,00	81,00
Weight (kg)	78,00	69,00 / 80,00	62,00	101,00
Height (m)	1,69	1,60 / 1,71	1,46	1,75
BMI (kg/m^2)	28,07	26,36 / 30,85	20,24	32,98
LVEF (%)	40,00	35,00 / 42,00	26,00	60,00
FVC (L)	3,30	2,65 / 3,66	1,90	4,76
FEV1 (L)	2,58	2,2 / 2,73	1,53	3,95

IQR: interquartile range; BMI: body mass index; LVEF: left ventricle ejection fraction; FVC: forced vital capacity; FEV1: forced expiratory volume in 1 second.

All the physiological variables measured at CPET are shown in Table 2.

Table 2 – Cardiopulmonary exercise test results of the study group

	Median	IQR 25/75
SBP, mmHg	140	140 / 160
DBP, mmHg	70	70 / 90
RR, bpm	34	28 / 35
VE, L	50	45 / 70
VO_2, ml/min	1290	1050 / 1790
VO_2/Kg, ml/min/kg	17	14 / 20,1
VCO_2, ml/min	1250	990 / 2040
VE/VO_2	42,8	3,5 / 45,9
VE/VCO_2	37,4	33,9 / 39,2
RER	1,12	1 / 1,14
HR, bpm	112	105 / 123
O_2 pulse, VO_2/HR	11,8	9 / 13,6
VE/MVV	0,56	0,48 / 0,64

IQR: interquartile range; SBP: systolic blood pressure; DBP: diastolic blood pressure; RR: respiratory rate; VT: tidal volume; VE: minute ventilation; VO_2: oxygen uptake; VCO_2: carbon dioxide output; VE/VO_2: ventilatory equivalent for oxygen; VE/VCO_2: ventilatory equivalent for carbon dioxide; RER: respiratory exchange ratio; HR: hear rate; MVV: maximal voluntary ventilation.

Baseline cardiopulmonary variables were similar between the 6MWT and TGlittre ($p>0,05$). The variables VE, VE/VO_2, RER, HR and VE/MVV were significantly higher in the end of TGlittre. On the contrary, the variable VO_2/HR was significantly higher on

6MWT. All the physiological variables measured at 6MWT and TGlittre are shown in Table 3.

Table 3: Comparison between functional capacity tests

	Rest			Final[a]		
	6MWT	TGlittre		6MWT (6min)	TGlittre (5ºlap)	
	Median [IQR]	Median [IQR]	p-value	Median [IQR]	Median [IQR]	p-value
SBP, mmHg	119 [115-135]	121 [114-133]	0,61	133 [131- 153]	138 [131- 153]	0,16
DBP, mmHg	73 [70/ 77]	71 [71-76]	0,95	75 [70-93]	76 [70-85]	0,79
RR, bpm	17,92 [15,35-20,62]	18,03 [16,80-23,03]	0,92	26,35 [22,81-36,35]	29,42 [26,50-38,92]	0,21
VT, L	0,76 [0,54-0,86]	0,67 [0,57-0,83]	0,09	1,56 [1,28-1,65]	1,56 [1,07-1,84]	0,62
VE, L/min	14,95 [10,74-15,99]	11,92 [10,91-14,85]	0,12	40,49 [35,92-44,15]	45,82 [43,36-50,75]	0,03
VO_2, ml/min	351,81 [323,35-455,46]	317,56 [234,08-357,03]	0,11	1239,84 [1044,32-1448,45]	1104,96 [876,42-1356,55]	0,42
VO_2/kg, ml/min/kg	4,84 [4,09-5,62]	4,15 [3,77-4,57]	0,11	16,10 [14,04-17,43]	15,57 [11,43-17,82]	0,31
VCO_2, ml/min	281,39 [253,43-362,39]	271,78 [231,82-320,15]	0,24	1011,27 [894,01-1155,22]	1083,72 [1028,07-1258,41]	0,09
VE/VO_2	35,28 [30,99-48,70]	39,80 [36,70-46,60]	0,42	34,39 [27,46-39,88]	36,93 [32,19-49,05]	0,01
VE/VCO_2	47,33 [41,48-50,88]	45,43 [44,23-49,56]	0,68	38,24 [34,19-46,31]	38,28 [34,48-43,63]	0,47
RER	0,83 (0,73/ 0,98)	0,91 (0,82/0,92)	0,59	0,82 (0,73/ 0,89)	0,97 (0,86/1,17)	0,04
HR, bpm	63,66 (56/72,71)	58,50 (55,29/ 77,14)	0,24	94 (87,31/ 110,23)	101 (94,42/119,71)	0,01
O_2 pulse, VO2/HR	5,77 (4,58/ 6,54)	5,75 (3,66/ 6,14)	0.21	12,28 (10,52/ 14,25)	11,23 (8,08/ 13,98)	0,04
VE/MVV	0,14 (0,09/0,17)	0,14(0,09/0,16)	0,26	0,41 (0,34/0,48)	0,45 (0,38/0,58)	0,03

[a]Final values refer to the average of the last 15 seconds of both the last minute of 6MWT (6[th] minute) and the last lap of TGlittre (5[th] lap).
6MWT: 6-minute walk test; TGlittre: Glittre-ADL test; IQR: interquartile range; SBP: systolic blood pressure; DBP: diastolic blood pressure; RR: respiratory rate; VT: tidal volume; VE: minute ventilation; VO_2: oxygen uptake; VCO_2: carbon dioxide output; VE/VO_2: ventilatory equivalent for oxygen; VE/VCO_2: ventilatory equivalent for carbon dioxide; RER: respiratory exchange ratio; HR: hear rate; MVV: maximal voluntary ventilation. p: significance level between tests (6MWT and TGlittre).

The median time required to complete the TGlittre was 3.19 min (IQR [2,55-4,25]) and the median distance walked in the 6MWT was 492 m (IQR [440-561]). No correlation was found between LVEF and the time spent in TGlittre (r=0,42; p=0,19). There was a positive correlation between the time spent in TGlittre and the age of study population (r=0,89; p<0,01). We also find that the time spent in TGlittre was negatively correlated with distance walked in the 6MWT (r=-0,64, p=0,04) (Figure 2).

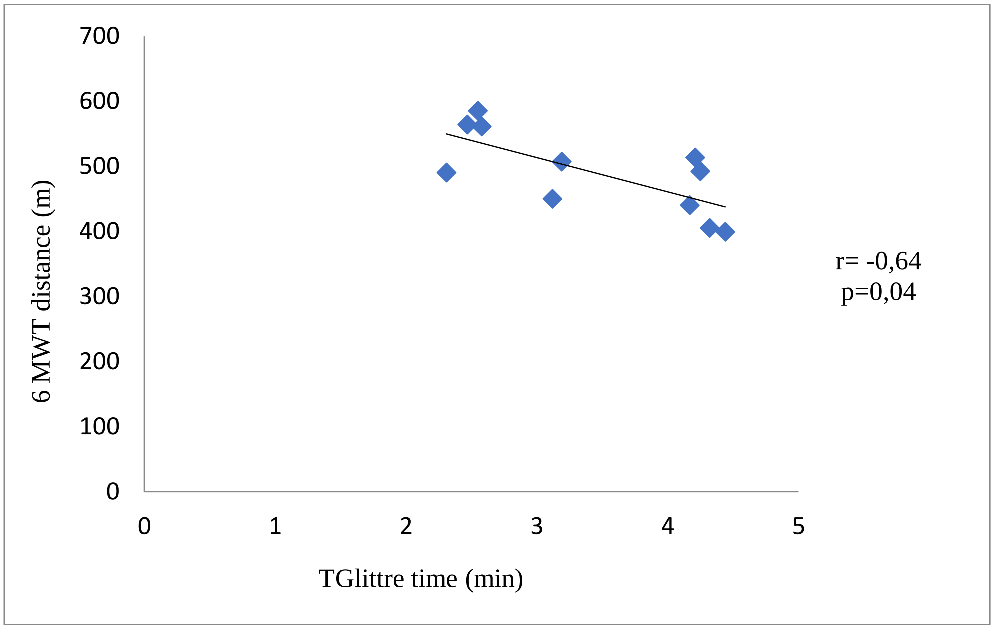

Figure 2 – Correlation plot of 6-minute walk test (6MWT) distance and Glittre-ADL test (TGlittre) time.

Analyzing the final VO_2, we find a strong and positive correlation between CPET and TGlittre (r=0,72, p=0,01) and between 6MWT and TGlittre (r=0,67, p=0,02) (Figure 3).

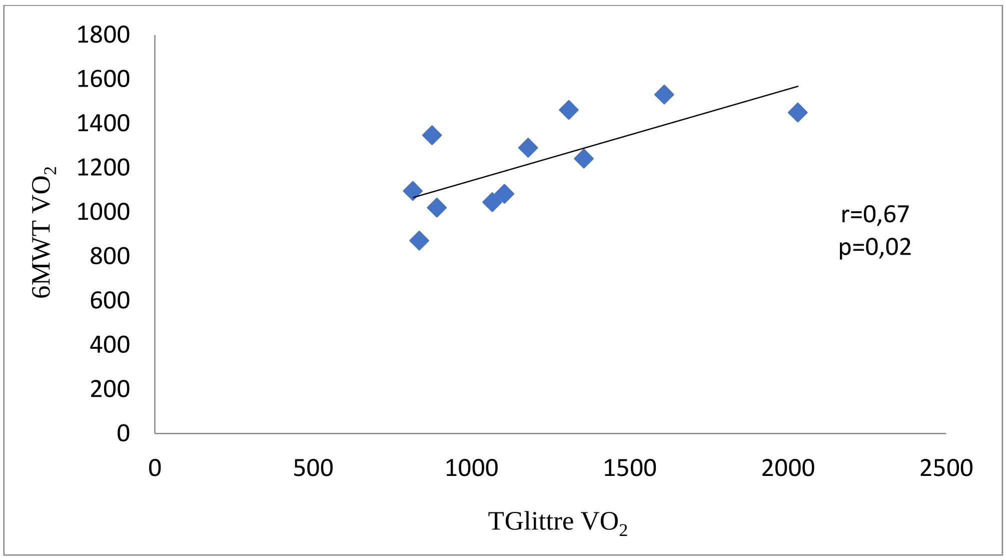

Figure 3 – Correlation plot of final VO_2 between the 6-minute walk test (6MWT) and Glittre-ADL test (TGlittre).

When we analyze different variables of the physiological responses in both functional tests, and compare with CPET, we can observe that all results are submaximal (figure 4).

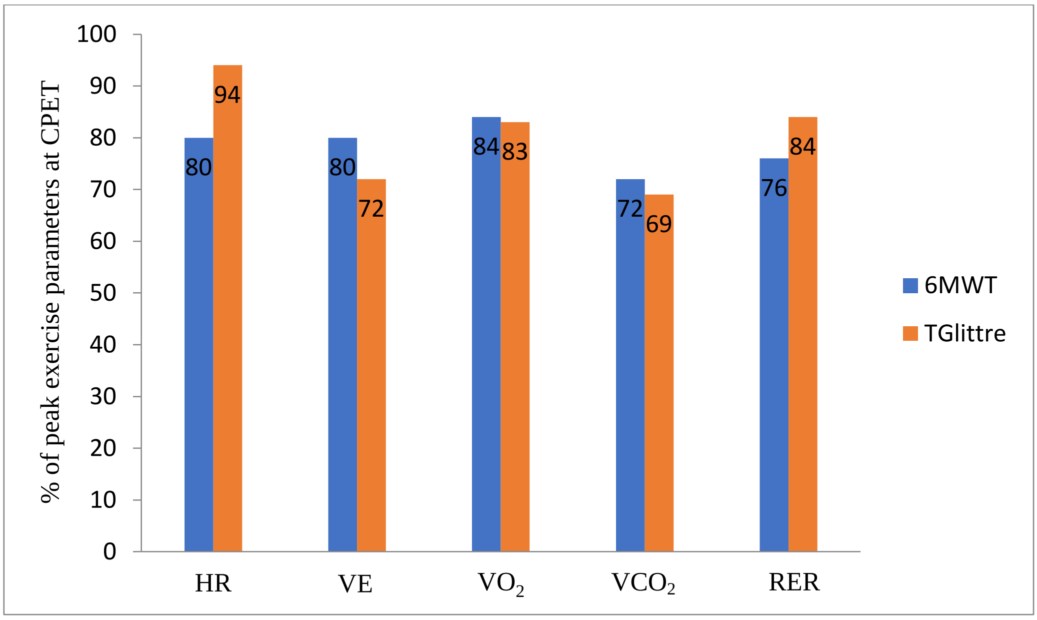

Figure 4 – Comparison between Heart Rate (HR), Minute Ventilation (VE), oxygen uptake (VO_2) and respiratory exchange ratio (RER) of both submaximal tests (6 minute walk test and Glittre-ADL test) expressed as percentage of peak values at cardiopulmonary exercise test (CPET) performed by each patient.

3. Discussion

To the best of our knowledge, this is the first study describing cardiac, ventilatory and metabolic performance of TGlittre in HF patients. The main finding of our study is that TGlittre led to higher ventilatory and cardiovascular responses, but similar oxygen uptake compared to 6MWT.

A previous study with COPD patients reported that TGlittre led to a slightly higher oxygen uptake, but similar ventilatory and cardiovascular responses when compared to a 6MWT (Karloh, Karsten, Pissaia, Araujo, & Mayer, 2014). This discordance might be explained by the different nature of each disease such as COPD and HF, as well as the different clinical severity of the patients in that study, which enrolled patients mostly (72%) with a GOLD 3 and 4 classifications.

In our study, we observed that TGlittre induced higher ventilatory and cardiac responses, probably due to the fact that involves a greater number of muscles groups and with different activities besides walking, such as climbing up and down stairs.

These findings may suggest that this functional test can be more specific when we aimed to evaluate different ADLs in HF patients.

Despite the significant difference in final RER between TGlittre and 6MWT, the RER remained below 1, indicating that both tests evaluated exercise capacity in aerobic conditions. This characteristic has already been reported in several studies regarding 6MWT (Deboeck, Muylem, Vachiéry, & Naeije, 2014; Kervio, Ville, Leclercq, Daubert, & Carre, 2004).

Heart failure patients are very heterogeneous. The name of this disease is an umbrella term that encompasses younger patients with severe left ventricle systolic dysfunction and elderly with preserved left ventricle systolic function. Comorbidities and the stage of the disease have significantly impact their functional capacity. The patients we studied, had predominantly reduced LVEF, but with mild functional capacity impairment, as 91% of them present NYHA I-II class.

Looking into LVEF, our study found no correlation with TGlittre time spent. However, a previous study showed a negative correlation between TGlittre and LVEF (r =-0.66) (YD Valadares, KS Corrêa, BO Silva et al., 2011). One of the reasons that may explain the difference is that the patients, who spent more time in TGlittre, were those with a LVEF lower than 25%. In our study, all patients had a LVEF higher than 25%.

In the present study our sample completed the TGlittre in 3.19 minutes, in agreement with a recent study that reports 3.24 minutes in individuals with cardiovascular diseases (Fernandes-Andrade et al., 2017). However, different results were presented in a study with HF patients, who took 6.30 minutes to complete TGlittre (YD Valadares, KS Corrêa, BO Silva et al., 2011). These results can be explained by the substantial difference in functional class, since that patients had NYHA III and IV class.

6MWT is a functional test widely used in patients with HF, which has been shown to be reproducible, sensitive to rehabilitation programs and valid in the functional evaluation (Adnan, Mckellar, Appukutty, Sulaiman, & Hassan, 2011). TGlittre is more recent, it includes exercises such as sit and stand, walk, climb up-and-down stairs and move objects with unsupported upper limbs. Therefore, the functional tests that include different activities with the upper and lower limbs allow to measure with more precision the limitations of the ADLs when compared with tests that include exclusively walking, such as 6MWT (Karloh et al., 2014; YD Valadares, KS Corrêa, BO Silva et al., 2011).

Evaluation of ADLs is not a simple task, and patients are typically asked to fill out questionnaires about their daily activities, which do not always reflect their limitations (Forman et al., 2017). TGlittre tries to overcome this by bringing together a group of activities that integrate any ADLs.

In our view, taking into account the differences in physiological responses and the design of the test, we suggest that TGlittre adds additional information to 6MWT and can be potentially used in clinical practice, helping to identify the limitations in ADLs of patients with HF. However, it is still necessary to prove TGlittre sensitivity to changes induced by interventions in rehabilitation programs.

One of the major advantages in our study was that all patients performed a CPET to evaluate at which proportion of maximal physiological responses the both submaximal test were performed.

A previous study with HF patients reported that 6MWT was a submaximal test, with a maximal VO2 between 80% and 90% of peak VO_2, similar to what we had observed in our study (Kervio et al., 2004). Comparing the TGlittre with CPET, we did observe that the variables VE, VO_2, VCO_2 and RER in TGlittre are below 85%. These results prove the submaximal characteristics of TGlittre.

Aged society is accelerating rapidly and is associated with a decline of motor function and ability to perform ADLs. A frequent consideration in the assessment of functional capacity is whether to perform maximal or submaximal testing in elderly people. Whereas functional capacity measured by maximal exercise test is the gold standard, it is not always readily available and often limited by orthopedic, neurological or excessive cardiovascular risks in older adults (Arena et al., 2007). In turn, submaximal tests are more accessible and with lower risks, and also represent important measures of functional capacity that in many cases strongly determine an elderly person ability to remain independent (Forman, et al., 2017).

The importance of using submaximal tests that evaluate and determine objectives for the accomplishment of ADLs in patients with HF should be emphasized, since such goals are more tangible and motivating for the patient than an abstract measure such as peak VO_2. For that reason, rehabilitation programs should seek not only to increase maximal functional capacity but also the ability to perform ADLs, promoting independence and improvement in the quality of life (Forman, et al., 2017).

In our opinion, physical therapists and physicians, together, need to assume a leadership role in developing new tests and measures, with the aimed of increasing the sensitivity as assessment and treatment outcome tools in different contexts. For instance, we consider that TGlittre has a great potential to provide valid indexes of a person's capacity to perform ADLs.

The following limitations of our study should be considered. The analysis of the comparison of CPET with submaximal tests should take into account the use of different indirect oximetry devices. Furthermore, the limited sample size should preclude the extrapolation of our results to other HF patients, particularly those with more severe functional impairment. Therefore, our results suggest that future studies aiming to look at TGlittre in HF should prioritize patients with more severe functional class impairment.

4. Conclusion

We describe for the first time the cardiac, ventilatory and metabolic performance of HF patients using TGlittre. In our sample, we observed difference ventilatory and cardiac responses compared to the widely used and validated 6MWT, despite similar metabolic profile.

It seems plausible that this test opens a new perspective of global evaluation of individuals with HF and with the potential to become a valid and reliable method to portray functional performance in daily activities in this population.

Our limited sample size, predominantly composed of HF patients with mild functional impairment, precludes a definite conclusion about the advantages of this new and promising submaximal test.

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