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Graduate Studies

TRANSLATION OF TALK TEST RESPONSES TO EXERCISE TRAINING IN A CLINICAL POPULATION

A Manuscript Style Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Science in Clinical Exercise Physiology

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TRANSLATION OF TALK TEST RESPONSES TO EXERCISE TRAINING IN A CLINICAL POPULATION

By Ellen J. Lyon

We recommend acceptance of this thesis in partial fulfillment of the candidate's requirements for the degree of Master of Science, Clinical Exercise Physiology.

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ABSTRACT

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The Talk Test (TT) is a submaximal, incremental exercise test that has been shown to be useful in prescribing exercise. It is based on a subject's ability to speak comfortably during exercise. This study defined the amount of reduction in absolute workload intensity determined from an incremental exercise test appropriate for cardiac rehabilitation patients. Patients (N=16) performed an incremental exercise test, with the TT given every 2-minute stage. Patients rated their speech comfort after reciting a standardized paragraph. Anything other than a "yes" response was considered the "equivocal" stage, while all preceding stages being "positive" stages. Subsequently, three 20-minute steady-state training bouts were performed in random order at the absolute workload associated with the Last Positive (LP), LP-1, and LP-2 stages of the incremental test. Speech comfort, heart rate (HR), and Rating of Perceived Exertion (RPE) were recorded every 5 minutes. The 20-minute exercise training bout was completed fully by: LP (N=11), LP-1 (N=15), LP-2 (N=16). The results were based on the most appropriate speech comfort responses, HRs, and RPEs seen in each steady-state bout. It was determined that prescribing exercise at intensity associated with the LP-1 stage of the TT is most suitable for a clinical population.

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INTRODUCTION

Currently, exercise prescriptions for cardiac rehabilitation patients are made using the results from maximal exercise testing. Foster et al. (1986) observed that absolute exercise intensity during exercise training could be determined from the heart rate (HR) response during an incremental maximal exercise test. Consequently, measurements such as heart rate reserve (HRR), and oxygen consumption reserve (VO_2R) during maximal exercise tests are used in established exercise prescription guidelines set by the American College of Sports Medicine (ACSM) in 2010.

There are multiple limitations to using a maximal exercise tests as the basis of an exercise prescription. In many fitness settings, a physician is not available for supervision, which according to ACSM's Guidelines in 2010, is necessary in moderate and high risk cases. Patients using handrail support on the treadmill and/or taking specific medications can obscure the results of the test, and symptoms can limit the patient from reaching their true maximal level of intensity (ACSM, 2010; Berling, Foster, Gibson, Doberstein, & Porcari, 2006).

With these limitations in mind, it seems desirable that there be an alternative method to translate exercise test results to an exercise prescription. Within the past few decades, many studies have been conducted presenting the validity of the Talk Test (TT) as a means of prescribing exercise (Dehart-Beverly, Foster, Porcari Fater, & Mikat, 2000; Foster et al., 2008; Foster et al., 2012; Foster et al., 2009; Jeans, Foster, Porcari, Gibson, & Doberstein, 2011; Persinger, Foster, Gibson, Fater, & Porcari, 2004; Zanettini et al., 2012).

The TT is usually derived from an incremental, submaximal exercise test. After each stage of the selected protocol, the subject is instructed to read a standard paragraph. Usually the 'Pledge of Allegiance' is chosen, as it is a passage well-known to most Americans. After the statement is read, the subject is then asked by the tester, "Can you speak comfortably?" A "yes" answer is considered the positive stage, any answer other than "yes" is considered the equivocal stage, and a "no" answer is considered the negative stage.

The concept of the TT was thought of as early as 1937 by Professor Grayson. While mountain climbing in Scotland, he instructed his climbers to "climb no faster than you can talk" (Goode, Mertens, Shaiman, & Mertens, 1998). An early study conducted by Goode et al. (1998) suggested that once a person exercising can "hear their breathing", they are working at appropriate levels for training effects at an intensity of 60-90% of maximum heart rate. The TT was also included in the Fourth Edition of ACSM's Guidelines for Exercise and Training in 1991, as well as set as an exercise guideline by the American Council of Exercise in 1997. However, the TT has not gained the acceptance like that of the Karvonen Method, percent of maximal oxygen consumption, ventilatory threshold (VT), or techniques based on analysis of blood lactate (ACE Sponsored Research, 2012; Zanettini et al., 2012).

Even though the TT has not yet achieved a highly accepted status in the exercise physiology field, the TT has been highly correlated with objective physiological markers. In early studies first involving the TT done by Brawner, Vanzant, and Ehrman (1995), Czaplicki, Keteyian, Brawner, and Weingarten, (1997), and Porcari, Kelso, and Foster (2002), it was found that HR responses from different strategies used with the TT

achieved training intensities of 60-90% HRR or VO_2max, correlating with ACSM exercise guidelines.

Studies by Dehart-Beverly et al. (2000), Foster et al. (2008), Goode et al. (1998), Persinger et al. (2004), and Recalde et al. (2002) have shown that results from the TT correspond with a subject's VT and respiratory compensation threshold (RCT). These studies have concluded that subjects could speak comfortably when exercising at intensities below their VT, and correlate with ASCM exercise intensity guidelines. Conversely, once subjects could no longer speak comfortably, they were found to be at their RCT. Foster and Cotter (2005) suggested that markers of sustainable exercise capacity may be the changes that occur in VT. Accordingly, since the TT is closely related to VT, using results from TT to prescribe exercise would be logical.

Also, studies were conducted showing a correlation between the TT and myocardial ischemia by Cannon et al. (2004). It was found that when a cardiac patient is able to speak comfortably, they are unlikely to have exertional ischemia. This research has helped support the idea that the TT can be used to prescribe exercise in individuals with cardiovascular disease (Voelker et al., 2002; Zanettini et al., 2012).

Amongst all the studies relating the TT to exercise prescription to various populations, there is still a need for studies that focus on how absolute exercise intensity translates when TT responses are applied to a steady-state exercise bout. Earlier studies have noted that due to cardiac drift, the response of HR found from a maximal exercise test is delayed, resulting in higher than desirable HR during a steady state exercise bout (Foster et al., 1986; Foster & Thompson, 1991). This concept can also be applied to the TT responses suggesting that due to the delay in physiological responses during an

exercise test, applying a desired workload to a steady-state exercise bout must be reduced (Foster et al., 2008).

Foster et al. (2009) found that for healthy, sedentary individuals, a reduction of 10-12% in absolute workload from the exercise test using the TT was needed to achieve desirable results during exercise training. The amount of reduction was based on the exercise responses seen during the workload intensity of the stage before the LP stage (LP-1). Another study by Jeans et al. (2011), found that in more active populations, only a 5% reduction in workload established from the TT (equivalent with the LP stage) was needed for a steady-state bout of exercise. This same finding was observed in a study by Foster et al. (2012) using well-trained athletes as the subjects.

As previously stated, prior studies have found that the desired exercise intensity to meet training recommendations for a steady state exercise bout is below the intensity experienced during an incremental exercise test which allows for comfortable speech (Brawner et al., 2006; Dehart-Beverly et al., 2000; Goode et al., 1998; Foster et al., 2008; Foster et al., 2012; Foster et al., 2009; Jeans et al., 2011; Persinger et al., 2004; Recalde et al., 2002). However, there is an absence of data justifying application of these findings to clinical populations. In 2012, Menke, Foster, Porcari, Gibson, and Bubbers performed a study which defined the absolute training intensity in a clinical population using the results from an incremental TT. In order to support the study conducted by Menke et al. (2012), the purpose of this study was the same; to find the amount of workload reduction needed in a clinical population to sustain a 20-minute exercise bout from data collected from a submaximal, incremental exercise test and still have appropriate exercise responses. It was hypothesized that cardiac rehabilitation patients would have the

appropriate exercise responses for a 20-minute steady-state exercise bout in workloads associated with the Last Positive-1 (LP-1) and Last Positive-2 (LP-2) stages of Talk Test incremental exercise testing.

METHODS

Subjects

Written informed consent was provided by the subjects, which consisted of 16 Phase II Gundersen Lutheran Medical Center (GLMC) cardiac rehabilitation participants. Phase II participants had to have completed at least 3 weeks of cardiac rehabilitation before partaking in this study. Approval from the University of Wisconsin-La Crosse Institutional Review Board for the Protection of Human Subjects, as well as from the GLMC Human Subjects Committee was received before carrying out the testing of subjects. Descriptive characteristics of the subjects in both the current study and Menke (2012) studies are seen in Table 1.

Table 1. Descriptive characteristics of subjects (mean $\pm$ SD) from Menke and Lyon studies

	Male (N=27)	**Female (N=3)**	**Total (N=30)**
Age	65.8 $\pm$ 9.3	66.3 $\pm$ 14.6	65.7 $\pm$ 9.0
Height (cm)	179.5 $\pm$ 7.8	160.0 $\pm$ 6.7	177.6 $\pm$ 9.6
Weight (kg)	95.3 $\pm$ 19.3	83.0 $\pm$ 7.9	94.1 $\pm$ 18.8
BMI	29.5 $\pm$ 5.3	32.7 $\pm$ 5.6	29.8 $\pm$ 5.3

A list of medication subjects in both the Menke (2012) study and the current study are shown in Table 2.

Table 2. List of medications subjects were taking at time of testing from Menke and Lyon studies

Type of Medication	Percentage of Subjects Prescribed
Statin	97%
Beta Blocker	93%
ASA	77%
ACE Inhibitor	70%
Anticoagulant	70%
Nitroglycerin	50%
Ca+ Channel Blocker	10%
Digitalis	7%
Diuretic	7%
Angiotensin II Receptor Blocker	7%

Procedure

The first test completed by the subjects was a submaximal incremental TT trial. It followed the Modified Balke Protocol or Cycle Ergometer Protocol, depending on the subject's preferred mode of exercise. Handrail support was discouraged. The trial began with the subject exercising at a workload of ~2 metabolic equivalents (METS), and increased by 0.5 METS every 2-minute stage until the test was terminated. During the last 30 seconds of each stage, the subject was asked to recite the 'Pledge of Allegiance' and once they completed the paragraph, were asked if they could "speak comfortably". Possible answers were "yes", or an equivocal response such as "yes, but". The workload at the last stage a "yes" answer was given by the subject was noted and used as a reference point (LP) for later exercise training bouts. HR and Rating of Perceived Exertion (RPE) using the Borg 6-20 scale was also recorded at the end of each 2-minute

stage (Borg, 1998). The test was terminated at the point at which the subject's response to the question "Can you speak comfortably" was not unequivocally "yes".

Subsequently, three exercise training bouts were performed in random order, with a period of at least 48 hours between them. Each test entailed a steady-state exercise bout with 20-minute duration of the workload levels found from the first incremental TT Trial at LP, LP-1 stage, and LP-2 stages. Handrail support was discouraged. Every 5 minutes, the subjects were asked to recite the 'Pledge of Allegiance' and were then asked if they could "speak comfortably". A yes, equivocal, or no answer was recorded along with their RPE, HR, and the minutes completed. If a subject was unable to complete the 20-minute duration at the respective workload, the test was terminated early.

Determining whether or not the appropriate responses were seen at LP-1 and LP-2 stages of the TT, was based on the subject's ability to complete the 20-minute steady-state exercise bout, speak comfortably, and maintain adequate RPE and HR responses.

Statistical Analysis

Descriptive statistics were used to distinguish the HR, RPE and TT responses amongst the Talk Test trials.

RESULTS

The study conducted by Menke in 2012, acted as a pilot for the current study. The study by Menke and colleagues was also designed to test the hypothesis that responses observed during the TT could be translated and used to define absolute training intensity in clinical populations. The protocols between the two studies were essentially identical. In the pilot study, 14 patients performed an incremental exercise test, with the TT implemented every 2-minute stage. Subsequently, the subjects completed randomly ordered 20-minute steady-state bouts at the absolute exercise intensity associated with the EQ, LP, LP-1, and LP-2 TT stages determined from the incremental test.

The 20-minute exercise training bout was fully completed by: EQ (N=1), LP (N=8), LP-1 (N=13), LP-2 (N=14) patients as seen in Figure 1. At LP-1, speech was comfortable for 13/14 patients through 15 minutes. From these results, it was determined that the LP-1stage of the TT appeared to be an appropriate absolute exercise training intensity for Phase II and III cardiac rehabilitation patients.

Since the pilot study had favorable results, it seemed reasonable that the study be repeated in order to find more supporting evidence. However, due to the lack of ability among the subjects to complete the EQ stage of the steady state bouts, the EQ was removed from the current study. The data from the two studies were combined.

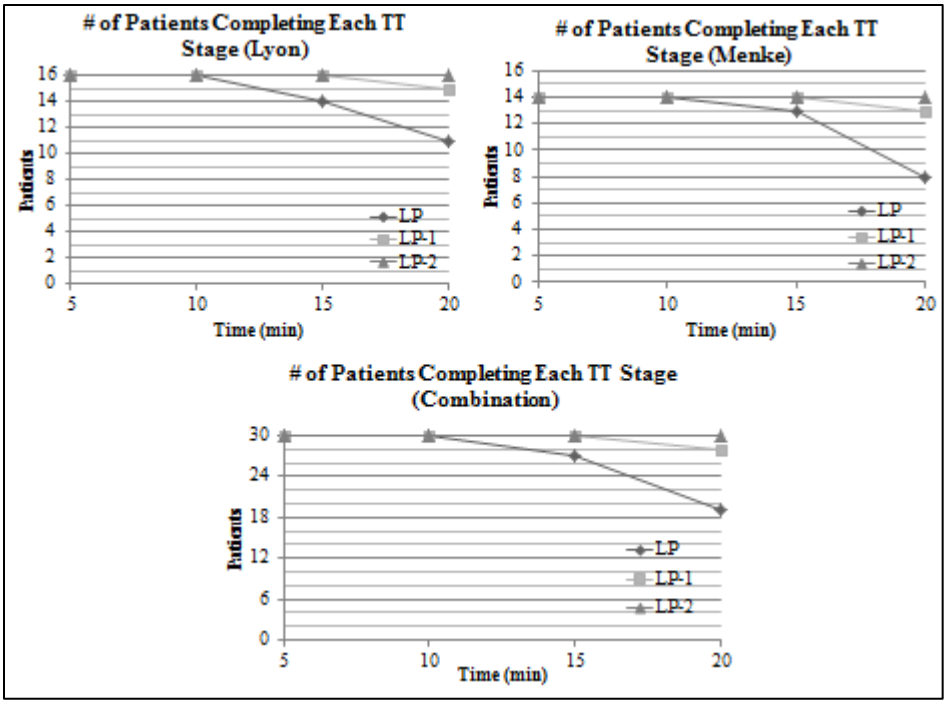

Figure 1. Number of subjects completing each of the TT stages in the Lyon study, Menke study, and in both of the studies when data is combined

In the present study, 16 patients completed the same protocol, with the exception of the EQ steady state bouts. Figure 1 shows the number of patients that completed each of the three stages of the steady-state bouts. All 16 patients were able to complete the entire 20-minute LP-2 trial. During the LP-1 trial, 15 patients were able to complete the entire 20-minute bout, but one patient ended at 15 minutes. During the LP trial, all of the patients made it through 10 minutes, however, only 14 patients completed 15 minutes of the trial, and 11 patients completed the entire 20-minute bout. Figure 2 shows the average calculated METs at each of the steady state bouts.

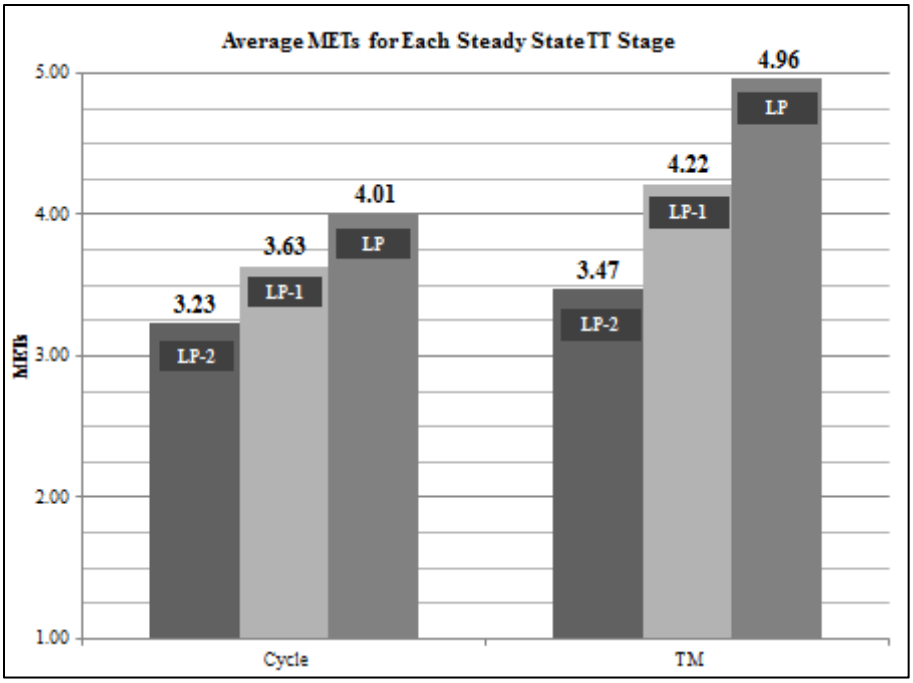

Figure 2. Average calculated MET values for each mode at each TT stage

The measurements taken over the course of the trials included HR, RPE, and TT response. HR responses in LP-2, LP-1, and LP trials were recorded. The mean HR of all of those that completed all trials was the highest in the LP trial as seen in Figure 3. The LP-1 trial elicited the second highest HR and the LP-2 trial produced the lowest means of HR. The mean HR (± SD) of patients that completed each trial fully is shown in Table 3.

Table 3. Heart rate (mean ± SD) of subjects that completed each stage in its entirety

Time (min)	LP HR (bpm) N=19	LP-1 HR (bpm) N=19	LP-2 HR (bpm) N=19
0	68 ± 13	65 ± 13	66 ± 10
5	92 ± 13	86 ± 11	85 ± 12
10	95 ± 10	87 ± 11	87 ± 12
15	95 ± 11	89 ± 11	88 ± 12
20	95 ± 11	89 ± 12	87 ± 11

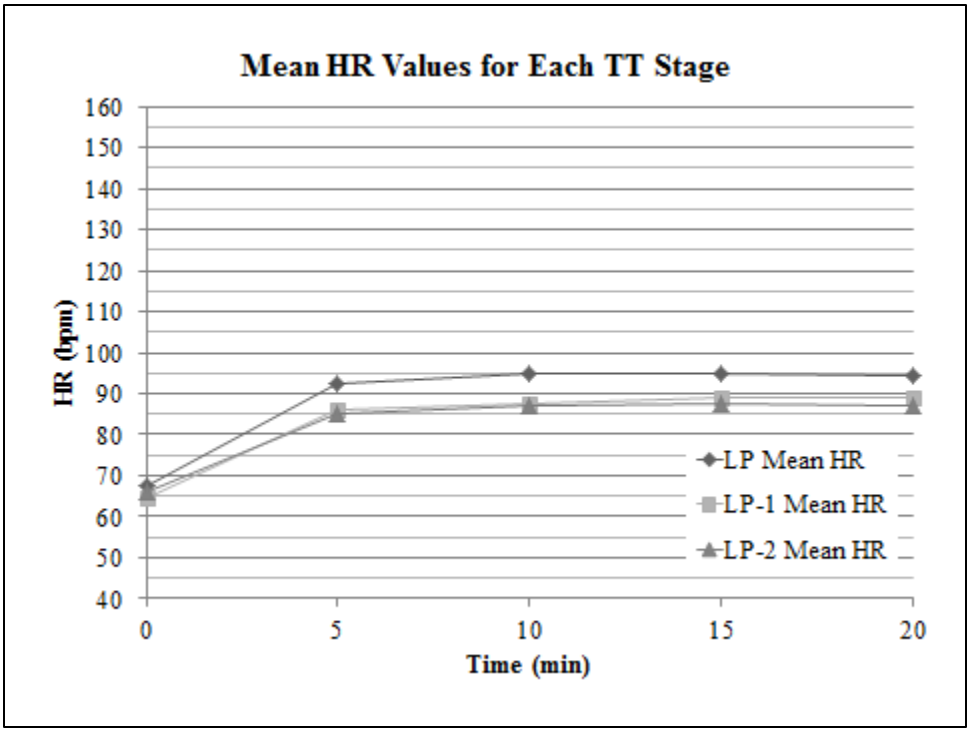

Figure 3. Mean heart rate responses in each TT stage

The patients' RPE responses from each of the steady state trials were also recorded. RPE values of the subjects that completed all of the trails were the highest in the LP stage, followed by the second highest values given in the LP-1 stage, and the lowest responses given in LP-2. The average of all of the RPE responses of the patients that completed all of the trials in their entirety is shown in Figure 4. The RPE mean (± SD) values are shown in Table 4.

Table 4. RPE values (mean ± SD) of subjects that completed each stage in its entirety

Time (min)	LP RPE N=19	LP-1 RPE N=19	LP-2 RPE N=19
0	6.0 ± 0	6.0 ± 0	6.0 ± 0
5	11.5 ± 1.3	10.8 ± 1.7	9.9 ± 1.6
10	12.1 ± 1.4	11.6 ± 1.5	11.0 ± 1.5
15	12.5 ± 1.5	11.9 ± 1.7	11.3 ± 1.7
20	12.9 ± 1.6	12.3 ± 1.8	11.6 ± 1.9

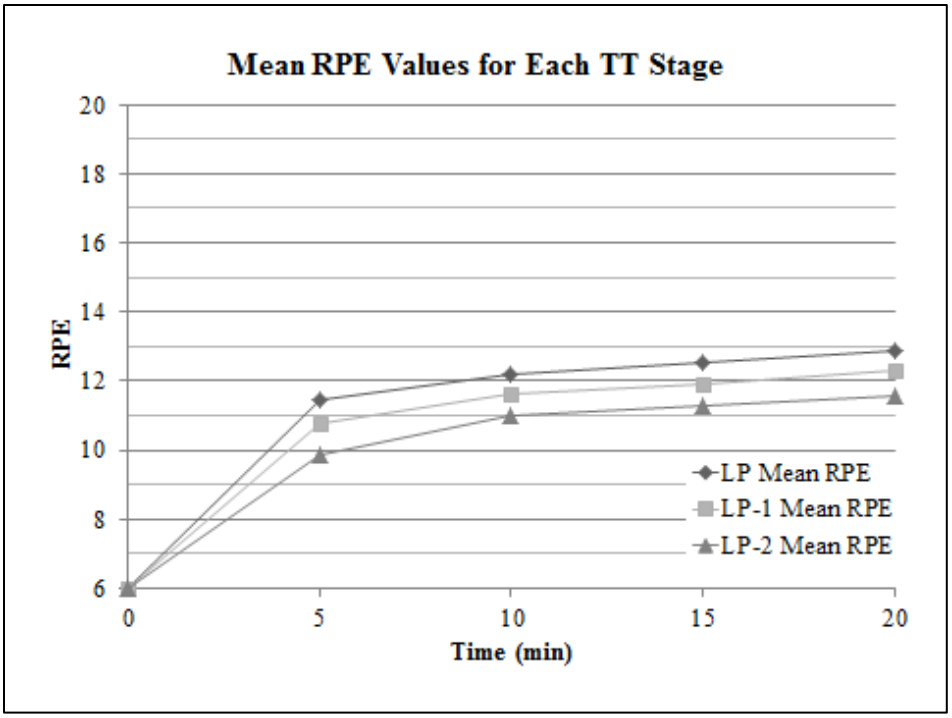

Figure 4. Mean RPE responses in each TT stage

The TT responses of each patient in the LP-2, LP-1, and LP stages were also recorded. Figure5 shows the mean TT responses of the subjects that completed all trials. As seen in the figure, the highest TT responses, which represent more difficulty talking, were elicited in the LP stages. Lower difficulty responses were given in the LP-1 stage and were yet lower in the LP-2 stage.

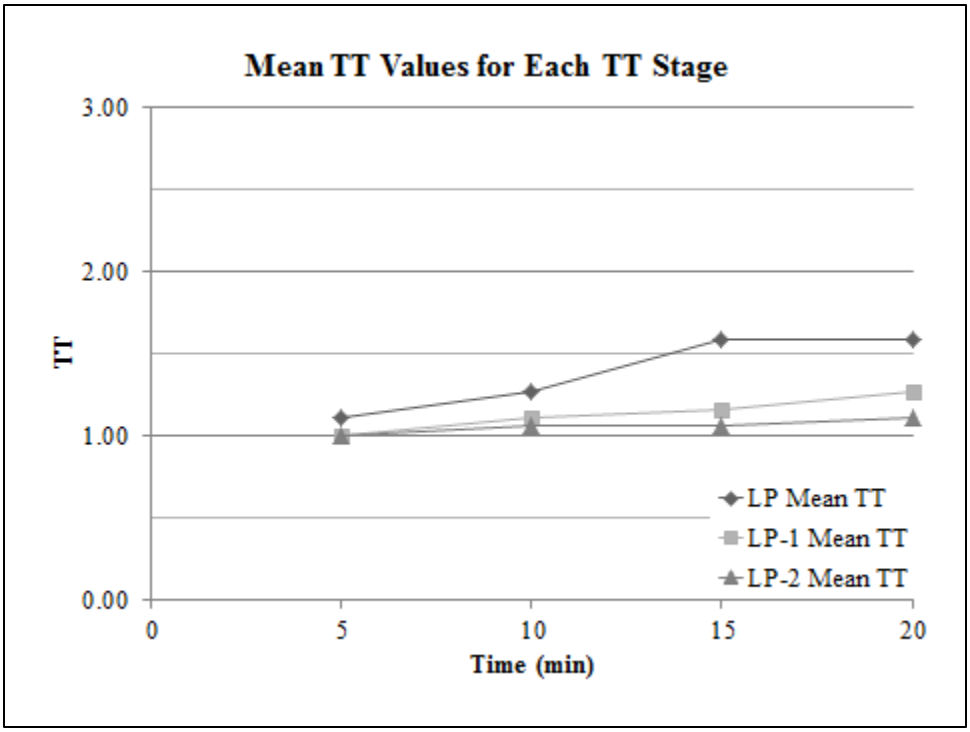

Figure 5. Mean TT responses in each TT stage

DISCUSSION

Previous studies (Voelker et al., 2002 & Zanettini et al., 2012) have shown that the TT is a viable method of predicting ventilatory threshold in patients with cardiovascular disease, therefore, making it a reliable means of prescribing appropriate intensities to cardiac patients. In this study, the purpose was to find the amount of workload reduction needed in a clinical population to sustain a 20-minute exercise bout from data collected from a submaximal, incremental exercise test and have appropriate exercise responses. By combining the data of Menke and colleagues along with the current study, more significance was able to be given to the purpose of the studies. Considering the patients' ability to complete the 20-minute steady-state exercise bout, speak comfortably, and maintain adequate RPE and HR responses, it was determined that the LP-1 stage of the TT would be the preferred level of intensity to prescribe an exercise program to a cardiac patient. Ninety-three percent of the subjects completed the entire 20-minute bout of the LP-1 intensity, while all of the subjects were able to complete the 20-minute bout at the LP-2 intensity. With these results, it was also concluded that the LP-2 stage would also be an appropriate workload for new or deconditioned patients. Because the results were comparable, the conclusion of the Menke study was strengthened.

A study which closely relates to this study is by Zanettini et al. (2012). The study found that the LP TT stage is the optimal training intensity for low risk cardiac patients. The subjects were tested at only three TT stages, LP, EQ, and the first negative stage. Zanettini and colleagues had 88% of the subjects in their optimal training zone when the

training intensity was below the anaerobic threshold (LP). It should be noted that with a more deconditioned or higher risk population, a lower intensity such as the LP-1 or LP-2 stage of the TT may be most suitable.

Another study by Foster et al. (2009) demonstrates the effectiveness of using the LP-1 stage of the TT as an appropriate training zone for a sedentary population completing a 20-minute steady-state bout. For these healthy, sedentary individuals, a reduction of 10-12% in absolute workload from the exercise test was needed once it was translated to exercise training. The results suggest that having appropriate HR, RPE, and TT responses in sedentary individuals is seen when exercise is prescribed approximately one stage below the LP of the TT.

Furthermore, Jeans et al. (2011) found that the LP and LP-1 TT stages delivered appropriate exercise responses amongst active adult subjects completing a 40-minute steady-state bout. The LP-1 and LP had the percent of maximum HR and RPE values within the recommended range for exercise training. This was equivocal to a 5% reduction in workload established from the TT for a steady-state bout of exercise.

Although the studies by Foster et al. (2009) and Jeans et al. (2011) did not include subjects that were considered a clinical population, the greater reduction in in absolute workload from an initial exercise test seemed to be associated with the lower level of exercise capacities of the subjects. This supports the notion that a greater reduction associated with the LP-1 or LP-2 would be most appropriate for those with the lowest level of exercise capacity, a clinical population.

A recurrent concern that occurred throughout testing was the subjects' ability to correctly identify the appropriate RPE at which they were exercising, as well as

determining the stage of the TT in which speech was at an equivocal point. Even though the subjects had completed three weeks of rehabilitation prior to testing, enough time to become accustomed to the RPE scale, the subjects had been habitualized to report a RPE between 11 and 13 to meet rehabilitation goals. Many patients also appeared to be unwilling to admit that they were working as hard as they were and therefore underestimated their RPE and overestimated the equivocal stage of the TT at which they were exercising. For this reason, it would be appropriate to have a cardiac patient begin their exercise prescription at a LP-1 or LP-2 level of intensity and progress over time according to the patient's health status and comfort level with exercise.

Some studies, such as by Rotstein, Meckel, and Inbar (2004), may argue that these inaccuracies are proof that the TT would not be a viable way of prescribing exercise, but the significant amount of data reporting the success of the TT (specifically in its correlation with objective physiologic markers which aide in determining exercise intensities) is dominant in this argument.

The cardiac rehabilitation program at GLMC uses the Karvonen Equation to prescribe exercise intensities when a patient has undergone an entry exercise stress test. As previously stated, many inaccuracies are present when basing exercise prescriptions off of a maximal or submaximal exercise test. However, majority of their patients do not have an entry stress test. Therefore, these patients are prescribed exercise in rehab based on their RPE of 11-13 on the Borg Scale. It is true that some patients' perception of their RPE can be inaccurate in comparison to their workload due to habituation of these levels. With these notions in mind, and the results from this study, it is suggested that incorporating the TT in cardiac rehabilitation programs would be an effective, simple,

and safe alternative to graded exercise testing that provides outcome measures as well as accurately selecting correct intensities for prescribing exercise to cardiac patients.

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APPENDIX A

INFORMED CONSENT

Proposal Title: Translation of Exercise Test Responses to Exercise Training in a Clinical Population

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Purpose and Procedure

- The purpose of this study is to determine how much absolute intensity (treadmill speed and grade) decreases from the intensity during an exercise test to determine a 20-minute training bout that still allows for comfortable speech in cardiac rehabilitation patients.
- The first test required consists of an exercise test on either a treadmill or cycle ergometer during which the workload will increase until I cannot talk comfortably. During this test I will be asked to recite the ‘Pledge of Allegiance’ every two minutes during the test.
- The subsequent three tests will be at varying exercise intensities established from the first test. They will be performed in random order lasting for 20 minutes. Throughout each test the Talk Test will be measured every 5 minutes by reciting the 'Pledge of Allegiance.'
- These tests will all be done during my scheduled time at GLMC as part of my normal rehabilitation program.

Potential Risks

- The risks incurred during this study are minimal even though I am a cardiac rehabilitation patient.
- If an emergency occurs, persons with CPR and Advanced Cardiac Life Support (ACLS) will be present. All of the tests will be performed in GLMC and I will be monitored continuously.
-

- The likelihood of serious complications during exercise is very low with this protocol and with the staff and monitoring system present.

Rights and Confidentiality

- My participation in this study is voluntary and I may withdraw from the study at any time and for any reason without penalty. If I choose to not participate in the study I would continue to participate in the cardiac rehabilitation program as prescribed by my physician.
- The data will only be accessible to the principal investigator and faculty advisor and the cardiac rehabilitation staff at GLMC.
- Information collected during the study will be coded with numbers and not labeled by personal information.

Possible Benefits

- My participation in this study will help validate that the Talk Test is a simple and practical way to measure exercise intensity for a clinical population.

Questions

If any questions arise from this study they may directed towards the principal investigator (Ellen Lyon, 920-676-9778) or her faculty advisor (Dr. Carl Foster, 608-785-8687). Questions regarding the protection of human subjects may be addressed to the UWL Institutional Review Board for the Protection of Human Subjects (608-785-8124).

_____	_____	
Subject Name (Please Print)	Signature	Date
_____	_____	
Researcher Name (Please Print)	Signature	Date

APPENDIX B

TREADMILL PROTOCOL

Balke Treadmill Protocol

Stage	Time (min)	Speed (mph)	Grade (%)	METs Achieved No HRS	HRS
1	1	2.0/2.5/3.0/3.5	0		
	2			2.2/2.5/2.8/3.2	2.1/2.4/2.7/3.0
2	1	2.0/2.5/3.0/3.5	2.5		
	2			2.8/3.3/3.7/4.2	2.7/3.2/3.6/4.1
3	1	2.0/2.5/3.0/3.5	5.0		
	2			3.4/4.0/4.6/5.3	3.3/3.9/4.5/5.1
4	1	2.0/2.5/3.0/3.5	7.5		
	2			4.0/4.8/5.5/5.3	3.9/4.6/5.3/6.1
5	1	2.0/2.5/3.0/3.5	10.0		
	2			4.6/5.5/6.4/7.4	4.4/5.3/6.2/7.1
6	1	2.0/2.5/3.0/3.5	12.5		
	2			5.2/6.3/7.3/8.4	5.0/6.0/6.8/7.7
7	1	2.0/2.5/3.0/3.5	15.0		
	2			5.8/7.0/8.2/9.5	5.6/6.6/7.5/8.5
8	1	2.0/2.5/3.0/3.5	17.5		
	2			6.4/7.8/8.1/10.5	6.1/7.2/8.3/9.4
9	1	2.0/2.5/3.0/3.5	20.0		
	2			7.0/8.5/10.0/11.6	6.5/7.8/9.0/10.2
10	1	2.0/2.5/3.0/3.5	22.5		
	2			7.6/9.3/10.9/12.6	7.0/8.4/9.7/11.0
11	1	2.0/2.5/3.0/3.5	25.0		
	2			8.2/10.0/11.8/13.7	7.5/9.0/10.4/11.9
12	1	2.0/2.5/3.0/3.5	27.5		
	2			8.8/10.7/12.7/14.7	8.0/9.6/11.1/12.8
13	1	2.0/2.5/3.0/3.5	30.0		
	2			9.4/11.4/13.6/15.7	8.5/10.2/11.8/13.7

Reference: C Foster et al. Med Sci Sports Exerc 28: 752, 1996
T McConnell et al. J Card Rehabil 11 :225, 1991

APPENDIX C

CYCLE ERGOMETER PROTOCOL

Cycle Ergometer Protocol

Stage	Time (min)	Watts	VO2 (ml/min)
1	1	15	485.5
	2		
2	1	30	667
	2		
3	1	45	851
	2		
4	1	60	1034
	2		
5	1	75	1218
	2		
6	1	90	1402
	2		
7	1	105	1585
	2		
8	1	120	1769
	2		
9	1	135	1952
	2		
10	1	150	2136
	2		

APPENDIX D

RATING OF PERCEIVED EXERTION (RPE) SCALE

Borg RPE Scale

6	
7	Very, very light
8	
9	Very light
10	
11	Fairly light
12	
13	Somewhat hard
14	
15	Hard
16	
17	Very hard
18	
19	Very, very hard
20	Maximal

APPENDIX E

PLEDGE OF ALLEGIANCE

“Pledge of Allegiance”

“I pledge allegiance to the flag of the United States of America and to the Republic for which it stands, one Nation under God, indivisible with liberty and justice for all.”

APPENDIX F

REVIEW OF LITERATURE

Introduction

It is common knowledge that exercise is beneficial for all populations. Many times, however, when a person begins to exercise, they are unclear how hard they need to be working. This is true whether they be an athlete or a sedentary person.

According to Foster and Porcari in 2001, keeping exercise intensity at a specific level is critically important in the safety of exercise training. Exercise-related death in young people is primarily related to undiagnosed congenital abnormalities, drug use, or trauma. On the other hand, cardiac events or sudden death in adults have been associated with undiagnosed coronary artery disease and immediately preceded heavy exertion during exercise. Although rare, the risk of having a complication during exercise training is approximately .08 per 10,000 hours in cardiac patients (Van Camp & Peterson, 1986). In order to avoid this risk altogether, it is essential to make aware to all people, especially those at higher risks, the level of intensity they should be working at when exercising.

When prescribing exercise to an individual, the exercise intensity is determined in the FITT principle established by the American College of Sports Medicine (ACSM) in 2010. The FITT principle is used to determine frequency, intensity, time (or duration), and type (or mode) of exercise of an exercise prescription for various populations. Although frequency, duration, and type are relatively easy to define for an individual, finding an accurate intensity can be the most difficult to prescribe.

ACSM (2010) named various methods to quantify exercise intensity such as heart rate reserve (HRR), oxygen uptake reserve (VO_2R), rating of perceived exertion (RPE), the omnibus scale (OMNI), the talk test (TT), affective valence, absolute energy expenditure per minute, percent age-predicted maximum heart rate (HR max), percent oxygen uptake (VO_2), and metabolic equivalents (MET). However, objective measures

including HRR, and VO_2R, percent age-predicted HR max, percent estimated VO_2 max are the focal methods most commonly used in exercise prescriptions for all populations. One reason for this is because these means can easily be used to identify activities within the desired intensity range using a compendium of physical activities. Though, Foster and Thompson in 1991 found that published MET values may over predict the actual intensity of exercise experienced during many of these recreational activities. Using a nomogram, each recreational activity was predicted to be either too easy, adequate, or too hard. The majority of the activities in this study were easier than predicted. Therefore, by using a compendium of physical activities to prescribe exercise, an individual may not always be exercising at a high enough intensity to see training effects, at least when performing recreational activities.

The objective measurements like HRR and VO_2R are most accurately determined from a graded exercise test (GXT). ACSM currently prescribes 40-80% of HRR, VO_2, or VO_2 Peak for the apparently healthy adult population. Nevertheless, there are multiple limitations present when using a GXT as the basis of an exercise prescription. In many fitness settings, a physician is not available for supervision, which according to ACSM's guidelines in 2010, is necessary in moderate and high risk cases. Patients using the handrail on the treadmill and taking specific medications can obscure the results of the test, and symptoms can limit the patient reaching their true maximal level of intensity (ACSM, 2010; Berling, Foster, Gibson, Doberstein, & Porcari, 2006).

Another concern with obtaining these measurements from a GXT is that the protocol used during a GXT is an incremental one, and most exercise training sessions are steady-state.

Foster et al. (1986) stated that absolute exercise intensity can be determined from the heart rate response during a maximal exercise test, however, due to cardiac drift, there is a need in reduction of workload when taking the results from an incremental test to a steady-state exercise training. This study tested cardiac rehab patients and participants in exercise programs on either a treadmill or cycle ergometer. It was found that on both the treadmill and cycle ergometer there is a linear relationship between training pace or power output and the GXT's equivalent heart rate time. This means a reduction rate can be used to prescribe an exercise training intensity from GXT results. The question still remained though, of whether or not this reduction was applicable to all modes of exercise. A study conducted by Foster, Thompson, and Bales in 1991 wanted to determine the equation for translating exercise testing results to exercise training on an arm-leg ergometer. It observed healthy subjects who completed a maximal test as well as three 20-minute trials at selected intensities of easy, medium, and hard. The results showed that the reduction from exercise testing to exercise training for the arm-leg ergometer is less than that of the reduction rate previously found for the arm ergometer. Though the reduction rates were different they were both still close to the generalized prediction made that the reduction rate will be about 25% less than that of the GXT equivalent.

Talk Test

With the aforementioned limitations of a GXT in mind, it seems advantageous for clinicians, as well as for patients, that there be an alternative method to translate an exercise test to an exercise prescription. Within the past few decades, many studies have been conducted presenting the validity of the TT as a means of prescribing exercise

(Dehart-Beverly, Foster, Porcari, Fater, & Mikat, 2000; Foster et al., 2008; Foster et al., 2012; Foster et al., 2009; Jeans, Foster, Porcari, Gibson, & Doberstein, 2011; Persinger, Foster, Gibson, Fater, & Porcari, 2004; Zanettini et al., 2012). The TT is usually derived from an incremental submaximal exercise test. After each stage of the selected protocol, the subject is instructed to read a standard paragraph. Usually the 'Pledge of Allegiance' is chosen, as it is a passage well-known to most Americans. After the statement is read, the subject is then asked by the tester, "Can you speak comfortably?" A "yes" answer is considered the positive stage, any answer other than "yes" is considered the equivocal stage (EQ), and a "no" answer is considered the negative stage.

The concept of the TT was thought of as early as 1937 by Professor John Grayson. While mountain climbing in Scotland, he instructed his climbers to "climb no faster than you can talk" (Goode, Mertens, Shaiman, & Mertens, 1998). An early study conducted by Goode et al. (1998) suggested that once a person exercising can "hear their breathing" they are working at appropriate levels. Male subjects first participated in three tests on cycle ergometer. The workload was increased by 25 Watts at 60-second intervals. As soon as the subject could "hear their breathing", they were instructed to continue pedaling, with no change in load, for 5 minutes. Heart rate was continually monitored and recorded. On a subsequent day, the subjects then were asked to jog at a pace such that they could "hear their breathing". Once that pace was reached, the subject maintained this pace for 10 minutes in which heart rate was continuously monitored and recorded. The heart rates measured corresponding with intensities appropriate for training effects at 60-90% of maximum heart rate.

The TT was also included in the Fourth Edition of ACSM's Guidelines for Exercise and Training in 1991, as well as set as an exercise guideline by the American College of Exercise in 1997. However, the TT has not gained the respect like that of the Karvonen Method, VO_2max, ventilatory threshold (VT), or techniques based on analysis of blood lactate (ACE Sponsored Research, 2012).

Even though the TT has not yet achieved a highly respected status in the exercise physiology field, the TT has been highly correlated with objective physiological markers. In early studies first involving the TT done by Brawner, Vanzant, and Ehrman (1995), Czaplicki, Keteyian, Brawner, and Weingarten, (1997), and Porcari, Kelso, and Foster (2002), it was found that HR responses from different strategies used with the TT (including reciting a passage or answering recorded interview questions) achieved training intensities of 60-90% HRR or VO_2max, correlating with ACSM exercise guidelines.

Furthermore, a study by Jeanes and Foster (2010) had physically active participants perform three incremental tests (VO_2 max, and two max with TT for reproducible results), and three steady state tests (steady state LP, steady state LP-1, steady state EQ). The results showed that heart rates and RPEs were at appropriate intensity levels for LP and LP-1 trials (appropriate levels were exceeded in the EQ trials), and concluded that a person can speak comfortably at the LP of the TT and be working at appropriate levels for exercise.

Multiple studies have shown that results from the TT correspond with a subject's VT and respiratory compensation threshold (RCT). In a study by Dehart-Beverly et al. (2000), the relationship between the TT and VT in healthy adults was determined.

Twenty-eight healthy subjects completed two maximal tests. The first test was completed using a gas exchange machine to measure VO_2, while the second test was done without the machine and used the TT protocol in which the subjects completed the "rainbow passage" at the end of each stage until they could no longer talk comfortably. The results of this study showed no significant differences in the variable between the Equivocal stage of the TT and VT while showing significant differences between the first negative stage and VT. The study confirmed that if one can talk comfortably, they are below their VT, if one is unsure if they can talk comfortably, they are at their VT, and being unable to talk means one is past their VT. In continuation with the previous study, Shafer, Foster, Porcari, and Fater (2000) completed a study to find the relationship between the TT and VT in the sedentary population. Ten subjects completed three randomized exercise tests including one measuring gas exchange while the other two completed the TT reciting the long rainbow passage and then the shorter "Pledge of Allegiance." The study found that at the last positive stage (LP) of the rainbow passage test, as well as the "Pledge of Allegiance" test, VO_2 was found to be above VT. This suggests that as the subject was starting to become uncomfortable talking, they were past VT unlike the study of Dehart-Beverly et al., where they were at or close to VT. Recalde, Foster, Skemp-Arlt, and Porcari (2002) expanded upon this notion and decided to test the TT on a new population, highly-trained adults. Sixteen well-trained subjects participated in three trials; the first being a practice session, which was then followed by a VO_2 max test and a TT. The study found that the TT's last positive stage (LP), EQ, and negative stage all correlated to the VO_2 at VT. The most closely correlated to the VO_2 at VT was the EQ

stage of the TT. This supports previous findings that TT stages below EW are below VT, the EQ is close to being at VT, and any intensity beyond the negative stage is beyond VT.

In 2008, Foster and colleagues performed a study which examined the manipulations of either the VT or exercise protocol to test that the TT and VT are related to one another. Healthy young adults participated in four experiments designed to decrease or increase VT by blood donation or training, respectively. These responses were then matched to the outcomes of the TT. The study confirmed the relationship between the TT and VT, although there is greater error in correlation if the intensity is pushed beyond VT.

A recent study conducted by Rodriguez-Morroyo and Foster (In press), also extend the range of populations where the TT could be used as a marker of various physiologic thresholds. This study observed eighteen cyclists who underwent two incremental tests. One test measured ventilator and respiratory compensation threshold using respiratory gas exchange, and the other was a TT using the same protocol. The end result of this study showed that for highly trained athletes, the EQ and negative stages of the TT can be used as surrogates of the VT and RCT, respectively.

Persinger et al. in 2004 performed a study to test the consistency of the TT on different modes of exercise. Sixteen healthy and active subjects performed four exercise tests, two on a treadmill, and two on a cycle ergometer. The results showed that the VT for both the treadmill and cycle ergometer were similar by means of the TT. The study also supported the notion that the LP and EQ stages are within intensity guidelines while the negative stage exceeded the recommendation.

All of these studies have concluded that subjects could speak comfortably when exercising at intensities below their VT, correlating with ASCM exercise guidelines. Foster and Cotter (2005) stated from their observational study, that markers of sustainable exercise capacity may be the changes that occur in VT. Accordingly, since the TT is closely related to VT, using results from TT to prescribe exercise would be logical.

Yet, there have been studies that have been uncertain of the consistency of the TT. Rotstein, Meckel, and Inbar (2004) performed a study to observe the results to the TT and its responses to changes in HR, VO_2, anaerobic threshold, and ventilation. Fourteen healthy subjects completed a resting pulmonary assessment and an incremental treadmill exercise test. The TT was performed for the first half of the treadmill test. The subjects would continuously read a passage and rate the speech difficulty based on a scale made for this study. Once they could no longer comfortably speak, they continued the test without speech until exhaustion. The study came to the conclusion that there is a relationship between exercise intensity and our perceived speech difficulty, most likely due to the relationship between speech control and VT. It was also found that there was a very wide range of perceived speech difficulty for a given VO_2. This wide range of rating for a single VO_2 decreases the effectiveness of using the TT as a means of prescribing exercise workloads. A reason for the dissimilarity of this study to others supporting the TT could be that the subjects continuously read a passage during the exercise test, while other studies usually have an intermittent passage read at the end of each stage of an incremental exercise test.

Likewise, an earlier study by Rotstein et al. (2004) indicated that estimating exercise intensity by measuring speech difficulty is not valid. During an incremental running test performed by fourteen healthy students, VO_2 max and VT were established. The students were also asked to read a written text and grade their perceived speech production difficulty. It was found that individual perception of speech difficulty varies greatly, making the variability between physiological factors such as VO_2, pulmonary ventilation, and HR and the rating very large. Because of these findings, Rotstein suggests that the TT is a questionable substitute for prescribing individual training exercise intensity. Although both of these studies make valid points in their arguments against the TT, it seems that the ample amount of supportive evidence for the TT makes it an adequate method in determining exercise intensity.

Talk Test and Clinical Population

In 1995, a clinical study was performed by Meyer, Samek, Pinchas, Baier, Betz, and Roskamm who discovered that the VT of a CAD patient is below ischemic threshold. Twenty-seven males with CAD were assessed by cardiopulmonary exercise testing. VO_2, HR, rate-pressure-product, and blood lactate were measured and/or calculated every 30 seconds during exercise. The onset of ischemia was viewed on an electrocardiogram. With this research, it has helped develop the notion that as long as a patient is exercising at an intensity below their VT, they are unlikely to experience exertional ischemia.

Voelker et al. in 2002 indicated that the TT correlates to VT in cardiac rehabilitation patients. This research has helped support the idea that the TT can be used to prescribe exercise in individuals with cardiovascular disease.

Cannon et al. (2004) performed a study to determine if the TT is an appropriate method for avoiding ischemia. The study took 19 patients with abnormalities related to ischemia and had them perform an exercise TT while recording measurements for ischemia, blood pressure, and HR. The results of the study showed that generally the LP of the TT preceded the onset of ischemia. Therefore, when a cardiac patient is able to speak comfortably, they are unlikely to have exertional ischemia.

Brawner et al. (2006) focused on studying the ability to use the TT to prescribe exercise in patients with Coronary Artery Disease (CAD). Twenty-four patients with CAD completed one maximal and two sub-maximal exercise tests. The two sub-maximal tests were both TTs with one being completed on a treadmill and the other on an indoor track. The protocol on the treadmill followed the protocol stages of the maximal test while the track TT protocol was set for the subjects to walk/jog at the fastest pace that still allowed them to talk comfortable. The results of this study revealed that at the LP on the treadmill, 48% of the patients were above VT and at the EQ of the TT, 89% of the patients were above VT. During the self-paced track TT, 62% of the patients were above VT and in general, there were no significant differences between the two TT protocols. This study also helped to further support the validity and consistency of the TT between different protocols. However, it has hinted that a reduction from the LP may be necessary to avoid being too close to VT for some people.

A study by Zanettini et al. (2012) wanted to validate what was the optimal level of training intensity in patients with recent myocardial revascularization. Fifty patients were enrolled in a cardiac rehab program and underwent three TTs to evaluate the with-in patient and between-operators reliability in assessing the workload at TT thresholds.

These parameters and the data from a final cardiopulmonary exercise test were then compared, and the workload range between the patient's aerobic threshold and anaerobic threshold was considered the optimal training zone at the LP of the TT. The reliability in assessing workloads by the patient and physiotherapist was found to be satisfactory as well.

Translation of the Talk Test to Steady State Exercise

Amongst all the studies relating the TT to exercise prescription to various populations, including clinical, there is still a need for more studies that focus on how absolute exercise intensity translates when TT responses are applied to a steady-state exercise bout. Earlier studies have noted that due to cardiac drift, the exercise response of HR found from a maximal exercise test is delayed, and therefore higher than is necessary during a steady state exercise bout (Foster et al., 1986; Foster & Thompson, 1991). This concept can also be applied to the TT responses suggesting that due to the delay in physiological responses during an exercise test, applying a desired workload to a steady-state exercise bout must be reduced (Foster et al., 2008).

In a study conducted by Foster et al. (2009), it was found that for healthy, sedentary individuals, a reduction of 10-12% in absolute workload from the exercise test was needed once it was translated to exercise training. These fourteen participants performed an incremental exercise test in which HR, RPE and TT were evaluated. They then subsequently performed three 20 minute exercise bouts with the workload found from the LP-1 of the TT, LP of the TT, and EQ of the TT. The results suggest that to get appropriate HR, RPE, and TT responses in sedentary individuals, exercise should be prescribed approximately one stage below the LP of the TT.

Another study by Jeans, Foster, Porcari, Gibson, and Doberstein (2011) wanted to find similar information as to the translation of absolute exercise intensity to a steady bout except pertaining to a more athletic population. Using methods similar to the study performed by Foster et al. (2009), it was found that in this population, that the LP-1 and LP had the percent of maximum HR and RPE values within the recommended range for exercise training. This is equivocal to a 5% reduction in workload established from the TT for a steady-state bout of exercise.

Foster et al. conclusions to their study completed in 2012 supported the findings from Jeans et al. (2011). HR, blood lactate, RPE, and speech comfort were observed in fourteen competitive runners who performed an incremental TT. The workload corresponding with intensities relative to the ability to speak comfortably were then performed at steady state exercise bouts. It was found that the subjects demonstrated appropriate conditions during the LP of the TT but were outside these conditions at the EQ of the TT, similar to the well trained subjects of the Jeans et al. (2011) study. However, these findings are different from those of Foster et al. 2008, when sedentary individuals had reached steady state condition in the LP-1 stage. This supports the notion that different levels in intensity, or reduction from absolute exercise intensities, exists between various populations in order to meet suitable exercise guidelines.

Summary

As previously stated, prior studies have found that the desired exercise intensity to meet training recommendations for a steady state exercise bout is below the intensity experienced during an incremental exercise test which allows for comfortable speech. There is sufficient evidence that the TT is a simple, cost-effective, and accurate method

in determining the desired training intensity for a steady state bout of exercise. However, there is an absence of data when wanting to apply these findings to a clinical population.

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