Cardiopulmonary Rehabilitation for a Patient with Myasthenia Gravis

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Abstract: Purpose: The purpose of this case study was to determine the effects of a 13 week physical therapy cardiopulmonary endurance program on aerobic capacity, and muscle strength in a patient with myasthenia gravis (MG). **Methods:** The patient was a 61 year old female who presented to the clinic with generalized muscle weakness and decreased aerobic capacity. The patient reported to the outpatient physical therapy clinic 3 times a week for a total of 13 weeks with an average session time of 60 minutes. Rate of Perceived Exertion (RPE), heart rate, blood pressure, and EKG monitoring occurred throughout the physical therapy sessions. **Results**: Before premature discharge from physical therapy secondary to emergency surgery for reversal of colostomy, the patient demonstrated tolerances to aerobic activity as evidenced by a reduced heart rate during activity, and also lower ratings on the RPE during exercise. The patient also subjectively reported enjoyment of the program and also had greater self-esteem with functional ADLS and IADLS. **Conclusion:** This data suggests that a physical therapy cardiopulmonary endurance training may promote gains in functional ADL's and IADL's, gross motor strength, and aerobic capacity in patients with MG.

Keywords: myasthenia gravis, cardiopulmonary rehabilitation, aerobic capacity, fatigue, muscle weakness, endurance

Introduction

Myasthenia gravis (MG) is classified as a neuromuscular transmission disorder caused by antibody-mediated blockade of muscle nicotinic acetylcholine receptors.[1] MG affects 2 to 7 out of every 10,000 in western countries, occurring one and half times more often in women than in men.[2] Early in its course, MG tends to target ocular muscles affecting eye and facial movement which in 75% to 90% of patients leads to generalized MG. Symptoms of ophthalmoparesis includes diplopia, and ptosis.[3] MG becomes generalized usually within 3 years after onset of ocular degeneration. In 85% of the patients, axial muscular groups, coupled with facial and bulbar musculature are primarily affected first causing loss of facial expressions, speech impairments, mastication and swallowing problems.[4] MG is characterized by weakness of voluntary muscles; repetitive activity heightens this response.[5] Muscle weakness and fatigue target proximal muscle groups more so than distal muscle groups, causing significant loss of functional activity in patients with MG.[6]

Patients diagnosed with MG have a decrease in respiratory strength and endurance. Respiratory muscle degeneration results in compensatory breathing patterns. Inspiratory muscle training has been linked to improving respiratory muscle function in illnesses in which muscular weakness determines morbidity and mortality.[6] Patients with MG may have a reduction of maximal voluntary ventilation (MVP) at rest. Patients who have MG have a decreased ability to sustain increased ventilation with physical activity may be reduced. Additional deterioration of the patient's functional capacity may result in respiratory failure. Bronchopneumonia and other infections are the most common precipitating factors for respiratory failure.[7] It is suggested that improvement in muscle function should be focused on in therapy.[8] A small number of studies have concluded the effects of respiratory muscle training in patients with MG, suggesting that resistive inspiratory muscle training coupled with specific expiratory muscle training resulted in a significant increase in respiratory muscle strength and endurance as well as alleviation of dyspnea.[9]

The pharmacological management of MG is targeted at minimizing the autoimmune response and maximizing acetylcholine (ACH). Research has shown that moderate daily doses of prednisone in patients with MG for 4-6 weeks, followed by low dose alternate day therapy as needed, controlled diplopia.[10] Pyridostigmine is a long acting reversible acetylcholinesterase inhibitor. ACH inhibitors increase the amount of available ACH in the junction leading to contractility gains. ACH inhibitors lead to enhanced cholinergic activities tissues and major organs other than skeletal muscles. Enhanced cholinergic activity elsewhere can lead bronchospasm, bradycardia, salivation, hidrosis, miosis, nausea, and diarrhea.[4] In addition to the primary line of pharmacological treatment, immunosuppressive are often prescribed. Examples of immunosuppressive drugs include corticosteroids, azathioprine, cyclophosphamide, cyclosporine, and meteorite.[4] Corticosteroids work to decrease autoantibody synthesis, and are effective in 80% of patients.[10] Immunosuppressive drugs target many areas of the immune system inhibiting cellular and hormonal mechanisms which in turn reduces damage caused by MG.[4]

Exercise prescription principles in the management of neuromuscular disorders involve maintenance management of muscle strength within the limitations caused by the disease process to minimize atrophy. Exercise may be beneficial in slowly progressive neuromuscular diseases such as MG. Research suggests that low impact aerobic exercise is an effective management strategy for some people with MG. Prescriptive walking programs have decreased patient fatigue, and also encouraged patients to return to previous activities.[3] Physiological benefits received from walking include increased number and density of mitochondria, along with skeletal mass increase.[11] Walking benefits stem further than physiological affects, other benefits include improved body image, mood, and well being.[3]

A study completed by Normandin et al[12], suggests that exercise training is a necessary component in the comprehensive pulmonary training in patients with respiratory disorders such as COPD. The study concludes, both high intensity and lower extremity endurance training and low intensity calisthenics led to similar short term improvements in questionnaire related dyspnea functional performance, and health status. No significant difference was suggested when comparing unsupported and supported arm exercise in patients with severe chronic airflow obstruction. However, the 12 Minute Walk Test, bicycle ergometer power output, and respiratory muscle function improved.[12] Martinez et al[13] suggest pulmonary rehabilitation programs improves lower extremity strength and respiratory muscle function. Also, arm exercise training will result in greater increases in unsupported arm activity.[13] The beneficial effects of strength training, endurance training, and a combination training of both on dyspnea and quality of life in patients with decreased respiratory capacity. Improvements persisted 3 months after the intervention training. Increases in sub maximal exercise capacity for the endurance group were significantly higher than those in the strength group, but were similar in magnitude to the combined training group.[14] Examining the efficacy of program utilizing symptom limited interval training combined with strength training suggests significant increases in six minute walk results, peak exercise tolerance, and quality of life.[15]

Skeie et al[16], reported respiratory muscle training and strength training in patients with MG beneficial. A study completed in 2000, suggested that resistance exercise plus creatine supplementation promote gains in strength and fat-free mass in patients with MG.[17]

Persistent muscular weakness, fatigue, and respiratory impairments are the primary physical characteristics of this disease, however, impairments stem further into other aspects of life such as psychological and family problems. The combination of those factors is potentially lethal to the patient's health-related quality of life. The relationship between lung function and health-related quality of life are directly related. Concluding, increased muscle deterioration and respiration will result in a lower perceived quality of life.[18] Muscle weakness, fatigue, and respiratory impairments are also contributing factors to decreased quality of life in patients who have MG.

Outcome Measures

The Six Minute Walk Test (SMWT) is used as a clinical indicator of functional capacity in patients with cardiopulmonary impairments.[19] The SMWT is often used in clinical practice and studies of cardiopulmonary rehabilitation because it relates better with symptoms and quality of life than most maximum exercise tests. It is also used in cardiopulmonary rehabilitation programs as an outcome measure to determine the effects of exercise training on functional exercise capacity.[20] Research has supported a significant increase in walking distance when a SMWT was performed a second time after completion of cardiopulmonary rehabilitation program. The increase in the SMWT distance ranged from 7% to 14.9% after completion of the cardiopulmonary rehabilitation program.[20] In the SMWT the patient is asked to walk as far as he/she could in 6 minutes, at a comfortable walking pace. Vitals are taken before midway and after the SMWT. The SMWT is useful in the assessment of cardio pulmonary rehabilitation therapy, the tests also has a greater value in patients with more advanced disease processes.[21]

Pulse Oximetry

Measurement of respiratory gas exchange during exercise is essential in cardiopulmonary rehabilitation. Changes in blood oxygenation are useful in detecting lung disease by evaluating the response to therapy.[22] Pulse oximeters are commonly used during exercise in clinical and research settings to provide a noninvasive, continuous estimate of the oxyhemoglobin.[23] Oxygen saturation measurements are taken before during and after each intervention. If oxygen saturation dropped below 88% exercise needs to be stopped immediately. Based on recommendations of the Nocturnal Oxygen therapy Trial[24], supplemental O2 is indicated for patients with a SAO2 of 88% while breathing room air. The same guidelines apply when considering supplemental oxygen during exercise training. The flow rate for O2 should be titrated to maintain SAO2 at 90% or more throughout the training.[24]

Rate of Perceived Exertion

The Borg CR-10 rating scale was applied to assess perceived exertion before, during, and following interventions. The Borg CR-10 is a 10-point psychophysical assessment scale, where 0 represents “nothing at all” and 10 “maximal”. The subject used this 10-point scale to express the total feeling of exertion which combines all sensation and feeling of physical stress, effort, and fatigue.[25] Rating of perceived exertion (RPE) which is a scale of ratings ranging between 6 to 20, with 6 being no exertion at all, and 20 being equivalent to maximal exertion. Perceived exertions ratings from 12-14 suggests that cardiovascular activity is being performed at a moderate level of intensity.[26] RPE scales have been traditionally used as a subjective index of exercise intensity for both exercise testing and exercise prescription. Hu et al.[27], report that RPE during exercise changed in both a linear and quadratic manner as intensity increased. Also, self- assessment was a predictor of both patterns of change. The use of RPE measures in an exercise prescription in older adults suggests that exercise self-efficacy is implicated in patterns of RPE change.[27] The day to day variability between the lactate to RPE and did not vary substantially over a three day period. These results suggest that the RPE is a reliable, useful, and practical marker that can be used to monitor training.[28]

Objective monitoring purposes suggest both healthy individuals, and individuals with cardiopulmonary disorders, should train at a target heart rate (THR), in order to exercise in a safe range, and to attain appropriate training responses. Traditionally, when prescribing exercise for patient's with cardiac and or pulmonary conditions the HR has been used as an estimate of intensity, because of the linear relationship between HR and minute oxygen consumption (VO_2) during incremental exercise.[29] VO2 maximum is directly related to frequency of intensity training. VO2 improvements for normal healthy individuals usually range between 10-15%. Results with greater than 30% increase in VO2 max are typically occurring in individuals with larger losses of total body mass, in cardiac patients, and patients with low initials level of fitness.[30] Maximal HR is most commonly used as a basis for prescribing exercise intensity in both rehabilitation and disease prevention programs.[31] Maximal HR is also used a criterion for achieving peak exertion in the determination of maximal aerobic capacity. Hirofumi, Monahan, and Douglas[32] suggest, the age predicted equation for calculating Maximal HR (220-age), is predicted by age alone, and is independent of gender and physical activity status. Furthermore, it has an effect of the underestimating the true level of physical stress imposed, during exercise intensity.

Therefore, aerobic exercise interventions, based on traditional methods, would result in a target heart rate below the recommended intensity for achieving optimal gains and health benefits.[32]

The purpose of this study was to examine the functional outcomes of a cardiopulmonary rehabilitation program for a patient with MG to improve aerobic capacity, strength, SMWT distances, and self-reported quality of life. This study was approved by the Institutional Review Board at The Sage Colleges in Troy, NY.

Case Description

Medical History/Risk Factors

Patient (pt) is a 61 year old female diagnosed with MG and was symptomatic presenting with muscle weakness and debility. The pt was treated in an outpatient cardiopulmonary unit. Past medical history includes colostomy, hiatal hernia with, gastro-esophageal reflux disease, high blood pressure and melanoma of the right hip. The pt also reports being physically inactive, deconditioned and experiences labored breathing on exertion. The pt currently denies any pain. The pt is currently taking Cellcept for prophylaxis of organ rejection which can occur in patients receiving allergenic renal, cardiac or hepatic transplants, Prednisone for suppressing the immune system and inflammatory response, Fosamax for prevention postmenopausal osteoporosis and steroid-induced osteoporosis, Lopressor for high blood pressure, and Zoloft for treatment of depression and anxiety as prescribed by her primary physician.

Examination

Tests and Measures

The pt's resting blood pressure was 132/74, heart rate was 81 beats per minute, and hemoglobin oxygen saturation (SaO2) was 95%. The patient weighed 186 pounds and was

5’3” tall. The patient ambulated independently with an antalgic gait pattern, with decreased anterior advancement of bilateral tibias. The patient had a decreased step length, increased stride variability, and decreased cadence. The patient was able to transfer from sit to stand independently with use of chair armrests. The patient was able to transfer from supine to sit independently with excessive compensatory strategies, and increased upper extremity dependency. The patient was able to transfer from stand to sit with independently with decreased eccentric core control.

Six Minute Walk Test Values

The pt performed the SMWT in the physical therapy department. The patient’s resting HR,BP and SaO2 was 86bpm, 132/74, and 95% respectively. The pt’s HR, BP, and SaO2 were 92 bpm, 128/80, and 97% respectively when measured at 3 minutes. The pt reported mild SOB at 5:20. After completion of the SMWT the pt’s HR, BP, and SaO2 were 83 bpm, 120/72, and 95%. The pt ambulated a total of 1050ft and rated 15/20 on the RPE.

EKG and Target Heart Rates:

The THR of the patient was established prior to the start of every intervention session. The THR was achieved by adding 20-30 bpm above the pt’s resting HR. The THR was also re-established prior to the start of each additional intervention. During intervention week 1, session 1, the pt’s THR throughout the duration of the cardiopulmonary interventions was 70-130 bpm (Figure 1). Intervention week 4, session 12, the THR throughout the intervention period was established at 98-108 bpm (Figure 2). Intervention week 8, session 23, the THR throughout the intervention period was also 98-108 bpm (Figure 3).

Functional Limitations

The pt reported that her walking speed was decreasing and it was noticeable in everyday activities especially grocery shopping. The pt also reported having trouble with home maintenance such as working in her garden, taking care of her lawn, and household cleaning. Due to reported limitations in breathing the patient reported taking longer breaks during meal preparation. Due to muscle debility and shortness of breath the pt also has decreased her travel to places outside of her home.

Evaluation

The pt presented to the clinic with decreased aerobic tolerance to exercise as evidenced by reaching maximum heart rate with minimal exercise. The pt also had gross motor weakness in the bilateral upper and lower extremities. The pt ambulated 1050ft during the SMWT. The pt's reported functional limitations include; increased bouts of SOB, decreased ability to perform ADL's, decreased ability to partake in recreational activities, decreased walking distance, decreased ability to exercise.

Diagnosis

The pt was placed into the Guide to Physical Therapist's Practice Preferred Practice Pattern 6B: Impaired Aerobic Capacity/Endurance Associated with Deconditioning.[33]

Prognosis

MG is a neuromuscular disorder commonly precipitates respiratory failure, despite underlying primary lung disease. Due to the nature of the disorder, the patient's prognosis is fair when considering MG disease process and relative co-morbidities.

Plan of Care

The pt was seen in the outpatient cardiopulmonary unit 3 times a week for 13 weeks which included a pre-mature discharge secondary to reversal of colostomy surgery.

Short Term Goals:

Pt will increase tolerance to aerobic capacity by regulating HR throughout treatment sessions in 4 weeks.

Pt will improve the SMWT from 1050 feet to 1500 feet in 4 weeks.

Pt will self monitor heart rate and pulse oximetry in 4 weeks.

Long Term Goals

Pt will improve the SMWT from 1050 feet to 2000 feet in 12 weeks.

Pt will return to her level of prior function regarding daily activities, recreational activities, or occupational functions in 12 weeks.

Pt will have a higher quality of life as measured by the questionnaire in 12 weeks.

Intervention

The pt enrolled in cardiopulmonary physical rehabilitation program at an outpatient setting in July of 2008. A target heart rate (HR) was established of 20-30 beats per minute above resting heart rate (RHR). Each session was approximately one hour in length including warm up and cool down. Initial interventions began at low level settings, and minimal time durations, progressing through the programs levels and time were increased as per pt tolerance. During the first 8 sessions the pt completed the following therapeutic exercises with EKG monitoring; NU-STEP Recumbent Stepper (NS), Upper Body Cycle (UBC), Rower (R), Chest Press (CP), and treadmill (TM). All of the above exercises increase cardiovascular endurance, and promote strengthening of associated musculature (see Table).

Strength training was performed using the patient's own body weight with the addition of dumbbells, and thera-bands as tolerated. The specific strengthening techniques used were the chest press and the upper extremity row. Initially the patient completed 10 repetitions of each exercise for 3 sets. Initially the patient was able to tolerate the upper extremity row using 15 pounds completing 3 sets of 10 repetitions with a RPE of 13. The patient also initially completed the chest press using a weight of 10 pounds completing 3 sets of 10 repetitions with a RPE of 14. The patient was able to progress to 3 sets of 15 repetitions lifting the same weight for the upper extremity row, and the chest press at intervention week 4. The progression was made according to the patient's subjective reports of RPE, which decreased to 10 by intervention week 3. The upper extremity row and chest press were held from intervention week 5 to intervention week 8 secondary to patient fatigue, and request. Weight training was not again incorporated in the exercise regime secondary to premature discharge of the program due to co-morbidities.

Cardiovascular endurance was targeted by having the pt exercise on the motorized TM, NS, and the UBC. Initially the patient completed 5 minutes on each the NS, and UBC. During the initial introduction to the cardiovascular endurance equipment the patient's RPE for all 3 activities was 14. The TM was added in session 2 when the patient was asked to walk at 1.5-2.0 mph for 5 minutes. The patient was able to increase duration on the Nu-step to 15 minutes L2 , the UBC to 6 minutes 60/40, and the TM to 10 minutes, with an overall RPE of 13, and SOB of 4, during intervention week 2. Intervention week 4, the patient was able to increase durations of the TM to 20 minutes with a walking speed of 2.0 mph, The UBC to 10 minutes, and the Nu-step to 25 minutes at Level 3 with a RPE of 13 and a SOB of 4. During this session the patient also reported SOB of 1 secondary to humidity. Increases again were added to the duration of cardiovascular exercise in intervention week 6. The pt completed 30 minutes on the TM with a 2.2 mph walking speed, 12 minutes on the UBC with an increased resistance from 60/40 to 70/50, and 30 minutes on the Nu-Step level 4. During intervention week 8 the pt's RPE was 15 with reported SOB of 2 while on the Nu-step. The final session of the cardiopulmonary rehabilitation program completed by the patient was during week 8, session 23. The patient completed 25 minutes on the TM at level 2.5 mph walking speed, 25 minutes on the Nu-Step level 5, with a RPE of 13. 5 minutes were completed on the UBC level 70/50 with a reported RPE of 16. The patient reported that she enjoyed the program and it gave her great motivation. The pt called to cancel her next scheduled appointment secondary to having an emergency reversal of colostomy surgery. Cardiovascular exercise intensity was increased by increasing the duration, and increasing the walking speed while walking on the TM, also increasing pedaling resistance on the NS, and upper body resistance on the UBC. The intensity was increased as patient tolerated measured by the Rate of Perceived Exertion (RPE).[26] HR, BP, SaO2, and EKG readings were monitored while the patient was participating in the exercise program.

Educational topics covered during visits included: overview of MG and muscle debility, energy conservation techniques with activities of daily living, and biomechanics associated with activities of daily living.

Outcomes

The pt was unable to complete the 12 week cardiopulmonary rehabilitation secondary to emergency reversal of colostomy surgery. The pt completed 8 weeks of the cardiopulmonary rehabilitation program. The pt improved tolerance to aerobic activity, increased in functional mobility, increased walking distance, and decreased shortness of breath with ADL's and IADL's.

Discussion

The effects of rehabilitation on MG in the literature are minimal. Patients with neuromuscular diseases nonspecific to MG have positive projected outcomes when treated in the clinic.[15] Based on the available literature high intensity training appears to be an advantage with patients who require pulmonary rehabilitation.[34] A patient with MG who also has a restrictive pulmonary complication is considered at risk for succumbing to reduced mobility and other negatively associated cardiopulmonary problems.[35] Further, without proper intervention neuromuscular conditions lead to progressive deterioration of respiratory musculature.[36] The goal of cardiopulmonary rehabilitation is to prevent the need for mechanical ventilation because their prognosis for weaning once cardio-respiratory failure has occurred is poor. Patients with associated neuromuscular disorders are living longer, secondary to preventative cardiopulmonary rehabilitation. Therefore, the already weakened cardiopulmonary insufficiency will be heightened by age related changes.[37]

The pt presented similarly to the findings of Keenan, et al[1], displaying muscle weakness and fatigue primarily in the proximal muscle groups, with significant loss of daily functional activities. Subjectively, the pt reported increased in tolerance to daily activities, such as grocery shopping, cleaning, preparing meals, and walking after completion of an 8 week cardiopulmonary rehabilitation.

Throughout the 8 week rehabilitation program the pt's complaints of dyspnea declined. The pt initially presented with decreased ability to sustain increased ventilation during functional activities, however, upon completion the pt's ability to sustain increased ventilation during most functional activities increased.

According to Davidson, et al[3], exercise prescription in the management of neuromuscular diseases should be directed to management of muscle strength, coupled with low impact aerobic exercise to slow the progressive of the disease. The pt completed both low impact aerobic exercise and muscle strengthening. The pt's results after 8 weeks of the program included increased functional mobility, and increased tolerance to aerobic and strengthening exercise.

The beneficial effects of strength training, endurance training, and a combination of training of both have increased quality of life in pt's with decreased respiratory capacity according to Martinez, et al[13]. After completion of the 8-week cardiopulmonary rehabilitation program the pt increased quality life verbally with examples of being able to play with her grandchildren, taking her dogs for walks, and increased appreciation for health and wellness. In comparison to the entry of the program, with pt reported decreased quality of life, and decreased tolerance to functional activities, and reported bouts of depression secondary to low self-esteem.

Baseline THR's were established prior to each treatment session, as well as prior to each intervention. Intervention week 1, session, 1 the pt's THR was ranged 70-130 bpm. The wide range of accepted THR was secondary to the pt's decreased tolerance to aerobic and strength training exercises and the decreased ability of the heart to respond to increased intensity(Figure 1). This finding is congruent with the findings of Klissouras et al[30], in that pt's with initial low levels of fitness will also have increased variability of corresponding HR's, secondary to decreased tolerance to exercise. Intervention week 4, session 12, THR's range was from 98-108 bpm(Figure 2). The pt was able to achieve and maintain the THR throughout the entire intervention session. Roberto et al[29], suggest training at within the set range of the THR, allows pt's to exercise safely, and still attain a benefits from training responses. Intervention week 8, session 23, the pt's THR range was between 98 bpm and 108 bpm (Figure 3). During this session the pt's HR was variable and the pt rarely trained within the suggested THR range. The variability in HR's achieved during this intervention session could have been due physiological processes secondary to co-morbidities beyond the scope of the cardiopulmonary intervention. After session 23 the pt was admitted into the hospital to have a reversal of colostomy surgery. The pt was discharged from the cardiopulmonary physical therapy rehabilitation program, secondary to the change in the pt's health status.

Limitations to this study included pre-mature discharge secondary to surgery for reversal of colostomy. The SMWT was not performed before discharge, therefore limiting the objective data in this study. A quality of life questionnaire may have been used to objectively document increases in quality of life and self-worth.

Future studies should include, a larger sample size, along with control and treatment groups. The population should not be a sample of convenience, but rather a sample selected from specific inclusion/exclusion criteria. The research should address functional capacity, along with aerobic tolerance to activity. Also the research should also focus on pt reported quality of life.

Conclusion

Pt's with generalized MG may benefit from cardiopulmonary rehabilitation in the following ways; increased tolerance to aerobic activity, increased walking distances, increased functional mobility, decreased bouts of shortness of breath, and increased strength of the cardiopulmonary system.

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Table. Cardiopulmonary Rehabilitation

<u>Intervention Weeks</u>	2	3	4	5	6	7	8
Recumbent Stepper	15', L2	16',L2	25',L3	25',L3	30',L4	25',L5	25',L5
Upper Body Cycle	6', 60/40	6', 60/40	10',60/40	10',60/40	12',70/50	15',70/50	5',70/50
Treadmill	10', 2.0mph	15', 2.0mph	20',2.0mph	20',2.0mph	30',2.2mph	30',2.2mph	25',2.5mph
Upper Extremity Row	3x10, 15#	3x10, 15#	3x15,15#				
Chest Press	3x10, 10#	3x10, 10#	3x15,10#				

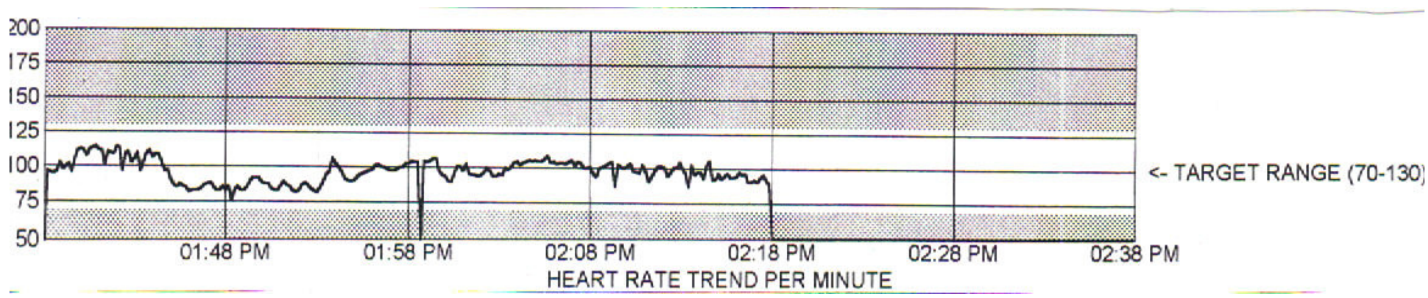

Figure 1. HR Variable Prior to PT.

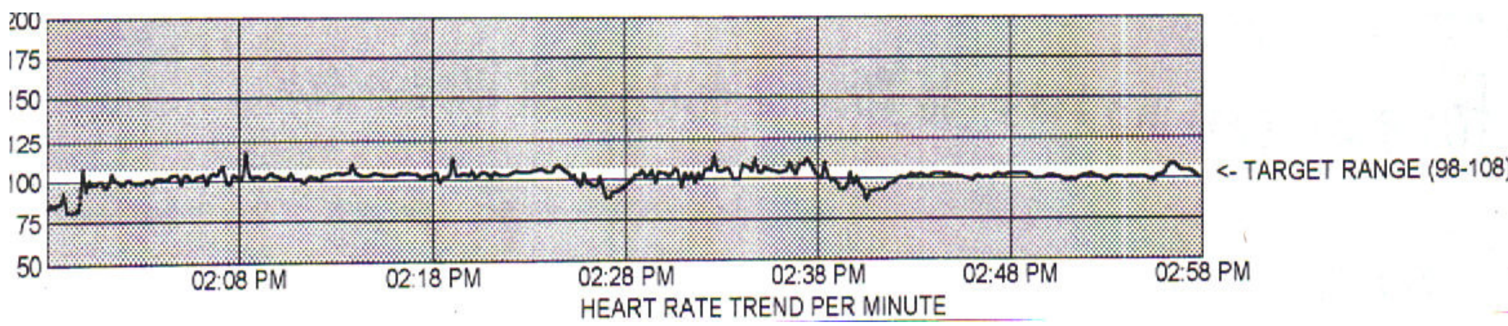

Figure 2. HR Stable after 4 Weeks of PT

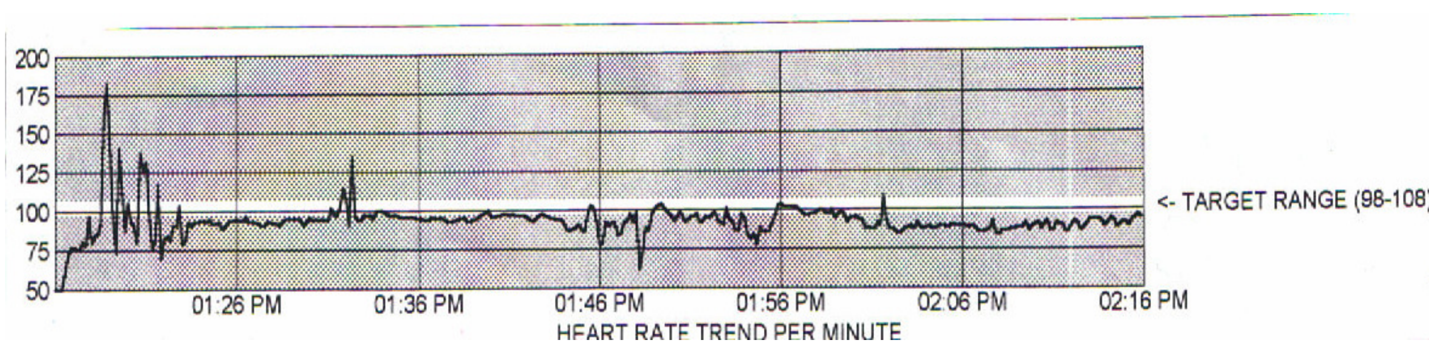

Figure 3. HR Variable at Week 8