EFFECT OF A PHYSICAL THERAPIST SUPERVISED EXERCISE PROGRAM ON TYPE II DIABETES

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APPROVAL SHEET

This case report is submitted in partial fulfillment of
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The final copy of this case report has been examined by the signatories, and we find that both the content and the form meet acceptable presentation standards of scholarly work in the above mentioned discipline

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ABSTRACT

Background and Purpose: Type II Diabetes affects approximately 29 million people and is the 7th leading cause of death in the United States. Current treatment is focused on medication and education for dietary and lifestyle change. The focus of this case report is to investigate the potential effect of a physical therapist supervised exercise program on type II Diabetes, specifically HBA1c. **Case Description:** A 67 year old male was transitioned from typical physical therapy care to a supervised exercise program focused on improving muscular strength and endurance for a period of 12 weeks. The patient had blood tests taken pre and post intervention to evaluate for change of HBA1c. **Outcomes:** The patient had a decrease in HgbA1c of .4 over the 12 week period of intervention in spite of no weight loss. The patient also had a decrease in Tug score, increased distance in the 6 minute walk test, and increased repetitions with the 30 second sit to stand test. **Discussion:** A physical therapist directed supervised exercise program may have assisted with lowering HgbA1c. The full effect of physical therapy based intervention in this population is yet to be determined. More research in this area will elucidate the full potential of physical therapy on this population.

INTRODUCTION

According to the centers for disease control and prevention (CDC), 29.1 million people are diabetic. Of the 29.1 million people afflicted with this condition, 8.1 million are undiagnosed. Type II Diabetes Mellitus (DM2) is also ranked number 7 for cause of death in the United States..[1] Life expectancy is reduced by approximately 8 years when diagnosed with DM2 over the age of 50.[2] The number of people with diabetes has been estimated to double from the year 2000-2030, supporting the claim that DM2 is an epidemic.[3]

DM2 can affect many different systems. Heart disease, stroke, blindness, kidney failure, and lower-limb amputation are some of the complications that arise from DM2. The likelihood of complications from DM2 can be reduced with proper glucose control.[1] It is well established in the literature that lifestyle changes including dietary modifications and increased physical activity can affect glucose control.[4-9]

The treatment plan for diabetes consists of pharmacological management and/or lifestyle change. The Look AHEAD (Action for Health in Diabetes) study is a good representation of what can be achieved with lifestyle modification. A one-year outcome yielded 8.6% weight loss, 20.9% improvement in fitness, and a decrease of 0.7% hemoglobin AlC (HbA1C) from a baseline of 7.3%, as well as decreases in blood pressure and lipid profile.[10] Although pharmacological management can be effective in the treatment of DM2,[11] it has been suggested that lifestyle change with resultant weight reduction is cornerstone to affecting change.[12] The use of physical exercise therapy is currently being evaluated for approval as prescribed medication by the Food and Drug Administration (FDA).[13]

Most treatment plans for patients diagnosed with diabetes are determined by a primary care physician. Priorities in the treatment of newly diagnosed patients with DM2 from a sample of physicians from Italy were to teach the patient how to cope with the disease and to achieve

target HbA1C. Barriers to achieving the goals were listed as lack of time and long waiting lists.[14] Lack of attention to lifestyle modification can only be attributed to time constraints. Giving enough information to inspire life change cannot be met by an average 16.3 minutes spent with a physician.[15] A shift in the treatment paradigm is necessary to more effectively treat the disease.[13]

As with most medical disorders, prevention is the key. The primary focus at this time for prevention is evolving from a more focal individualized based effort to a community based effort focused on improving behavioral change in the population as a whole.[16] While this could be effective in theory, it doesn't adequately address the issue related to motivating lifestyle change in the already diagnosed population of people with DM2.

One of the main factors to consider in the treatment of DM2 is patient compliance. Adherence rates to treatment plans including taking medications as prescribed and attending scheduled appointments for chronic illness are 50%.[17] Adherences to lifestyle based interventions were substantially lower, reported to be 19%.[18] Frequent contact between the patient and healthcare provider[19], and availability of a support team to patients from the health care team[20] are both important aspects to improving patient compliance. Additionally, patient satisfaction with their physician[21] and organizational factors such as appointment reminder mailings and phone calls about upcoming appointments, and appointments that start on time[17] also have a positive effect on patient compliance.

Programs have been established to assist with patient compliance with lifestyle modifications post diagnosis with DM2. These programs are typically collaborative, involving MD's, nurse practitioners, nurses, exercise physiologists, and/or personal trainers. The role of the physical therapist has not yet been utilized as recommended by the American Physical Therapy Association (APTA). The APTA supports physical therapists' in their role as promoters of

healthy lifestyle change[22], and advocates for increasing physical activity.[23] Additionally, in accordance with vision 2020, the APTA recognizes the role of the physical therapist as a front line provider in health care reform prevention initiatives and implementation of wellness and prevention programs implemented at the community level.[24]

This care report illustrates an opportunity for a physical therapist directed wellness program implemented as an adjunct to care for total hip arthroplasty (THA) in the home care setting.

HISTORY

The patient was a 67 year old male presenting for home health physical therapy approximately 3 days post right THA. The patient had a 5 year history of progressively worsening bilateral hip pain that eventually lead to right hip replacement with plans for the second hip surgery to be performed when the patient was able to fully support his body weight with the right hip. Past medical history was significant for hypertension, hyperlipidemia, type 2 diabetes mellitus, and arthritis. The patient spent two days in the hospital and returned home with an evaluation for home health nursing and physical therapy. The patient presented with difficulties with use of two wheeled walker (2ww) for ambulation with home navigation, ascending and descending small steps that were throughout the home, and difficulty with chair, bed, car, and shower transfers. The patient's weight bearing status was 50% weightbearing until the 2 week follow-up with the physician.

The patient was retired, and had goals of being able to participate in a daily walking program with use of a cane, and to participate in recreational boating. He had been somewhat inactive for the past 5 years reporting his hip pain as the cause of decline in activity, but had goals of being more active. The patient was also morbidly obese with a previous diagnosis of DM2. Repeated discussions with the patient regarding the importance of establishing a wellness

program resulted in an agreement to participate in a physical therapist directed wellness program at the conclusion of formal physical therapy. This will be discussed as phase two of the case report.

PHASE ONE SYSTEM REVIEW

The system review was completed post-operative day 3. The medication review revealed to patient to be taking the following medications: Atenolol 50 MG, Atorvastatin Calcium 10 MG, Coumadin 2 MG, Losartan Potassium-HCTZ 100-25 MG, Metformin HCL 500 MG, Oxycodone HCL 5 MG, and Tamsulosin HCL .4 MG. Cardiovascular and pulmonary systems were within normal limits, indicated by normal values obtained for heart rate, blood pressure, and respiratory rate. His height was 6 feet and weight was 400 pounds (Body Max Index (BMI) 54.2). The integumentary system had typical moles, freckles, and post-surgical incision in the right postero-lateral hip closed with staples, extending 26.5 cm. There was minimal drainage from the incision on the old dressing with no active areas of drainage or signs of infection.

The musculoskeletal exam was significant for range of motion (ROM) and strength limitations in bilateral hips. The right hip limitations were due to the recent surgery, and the left hip limitations were most likely due to previous diagnosis of end stage arthritis. The patient denied any tingling or numbness, and demonstrated no deficit with 2 point discrimination testing to distal extremities.

Endocrine system examination was significant for diagnosis of DM2. The patient did not monitor blood glucose levels regularly, but had hgba1c checked periodically by his primary care physician. The last blood test revealed hgba1c of 6.4 approximately 1 month prior to the surgery. According to the American Diabetes Association, hgba1c levels should be less than 5.5. 5.5-6.5% are considered prediabetic, and anything above 6.5% is considered diabetic.

Neuromuscular screen was impaired secondary to balance issue related to the recent surgery and arthritic changes to the uninvolved hip.

PHASE ONE EXAMINATION

Gait assessment was observed upon initial assessment. The patient was able to ambulate 75 feet with 2ww utilizing a step to gait pattern leading with the right lower extremity. The patient had a significant decrease in stride length, narrow base of support, and self-reported adherence to the 50% weight bearing restriction. Manual muscle testing was performed in sitting and supine as described by Kendall, Mcreary, and Provance[25] (table 1).

Table 1. Manual muscle testing strength grades as tested at examination.

Body part	Strength Grade	Body part	Strength Grade
Right hip flexion	2/5	Left hip flexion	3/5
Right hip abduction	1/5	Left hip abduction	2/5
Right knee extension	3/5	Left knee extension	4/5
Right knee flexion	3/5	Left knee flexion	4/5
Right ankle dorsiflexion	5/5	Left ankle dorsiflexion	5/5
Right ankle plantarflexion	5/5	Left ankle plantarflexion	5/5

Range of motion measurements were performed in supine as described by Norkin and White[26] (table 2).

Table 2. Range of motion measurements.

Body part	AROM	Body part	ROM
Right hip flexion	50 degrees	Left hip flexion	70 deg
Right hip abduction	5 deg	Left hip abduction	15 deg
Right knee extension	0 deg	Left knee extension	0 deg
Right knee flexion	125 deg	Left knee flexion	125 deg
Right ankle dorsiflexion	15 deg	Left ankle dorsiflexion	15 deg
Right ankle plantarflexion	40 deg	Left ankle plantarflexion	40 deg

The patient reported pain at a 7/10 visual analog scale (VAS) at rest at the time of evaluation with a reported range of 3-8/10 at best and worst within the past 24 hours. The patient reported the pain to be worse with weight bearing activities and after prolonged periods of sitting or inactivity. The patient was taking pain medication as prescribed.

Three standardized tests were attempted at the time of evaluation. The patient was unable to complete both the timed up and go (TUG) and the 30 second sit to stand test secondary to inability to rise from a chair of standard height. The patient was also evaluated for risk of falls utilizing the MAHC-10 fall risk assessment and was determined to be a high risk of falls. These tests have previously been validated as tools for assessment in the home health environment.[27-31]

PROGNOSIS

The patient was determined to have a good prognosis for recovery based on his age and likelihood of adhering to the prescribed exercise regimen. Although the patient did not have a good history of compliance with lifestyle related changes related to DM2 management, it was felt that he would adhere well to the prescribed exercise regimen as reductions in hip pain and improved hip mobility would provide short term reinforcement that would motivate adherence with the prescribed exercise program.

PLAN OF CARE

The patient was seen 1 time the first week for initial evaluation. Follow-up appointments were scheduled 3 times a week for 2 weeks, and 2 times a week for 2 weeks for right lower extremity strengthening, range of motion activities, gait and transfer training, and education for home exercise program to address identified hip weakness and normalize gait pattern. At the conclusion of the regimented therapy plan of care, the patient was transitioned to a wellness program.

PHASE ONE INTERVENTION

The initial goals of treatment following THA in the home health setting were to improve hip ROM, strength, and distance/quality of gait while managing the post-operative pain associated with the surgery. Patient and family education was provided regarding post-

operative precautions, weight bearing restrictions, incision care, fall risk reduction, transfer training, gait training, diabetes education, and weight reduction strategies. The patient was seen for a total of 11 visits over a 5 week period. The patient participated in a two times daily exercises per physician protocol for the first 2 weeks (table 4). The 2 times daily frequency was selected because twice-daily physical therapy has shown a trend toward earlier achievement of functional milestones.[35] Education was also provided to ensure proper gait mechanics with an emphasis for erect posture with gait, and adherence to 50% weight bearing status. A daily walking program was initiated, with a generalized recommendation given to walk a little farther every day to improve gait and cardiovascular endurance. The initial prescribed repetitions were to familiarize the patient with the exercises and ensure proper form and technique. Instructions were given to progress the exercises to the point of fatigue as progressive exercise according to the overload principle has been shown to improve outcome following THA.[36-38]

Table 3. Initial exercise program and prescribed repetitions

Exercise	**Prescribed Repetitions**
Ankle pumps	20, throughout the day
Quad sets	20
Glut sets	20
Heel slides	20
Short arc quad	10, progressing to fatigue
Supine hip abduction	5 with assistance progressing to fatigue
Sitting knee extension	10, progressing to fatigue

At the 2 week follow-up with the physician, the patient was instructed to maintain 50% weight bearing through 6 weeks post-op secondary to possible settling of the femoral prosthesis. At this time standing exercises were added to the daily program (table 5) to be performed only with the surgical (right) hip.

Table 4. Standing exercises initiated 2 weeks post-operatively.

Exercise	**Prescribed Repetitions**
Hip Flexion	10, progressing to fatigue
Hip abduction	10, progressing to fatigue
Hip Extension	10, progressing to fatigue

Exercise	Prescribed Repetitions
Knee flexion	10, progressing to fatigue
Calf raises	10, progressing to fatigue
Sit to Stand	3, progressing to fatigue, progressively declining height

The patient was instructed to progress the standing exercises to twice daily and decrease the previously prescribed exercises to one time per day while continuing to perform the activities to the point of fatigue. The daily walking program continued as previously described.

Toward the conclusion of home health intervention, the patient was educated for appropriate sequencing with use of a standard cane, but was unable to practice ambulation as the patient was not able to progress weight bearing status until 6 weeks post-op.

Outcome studies have shown patient and physician satisfaction following THA.[39] Despite the evidence of positive satisfaction, there is a large body of evidence that indicates a continued limitation in the short and long term with strength and functional abilities.[40-43] The strongest evidence for improving function following THA utilizes ergometer cycling, and a progressive resistive exercise program in the early phase of rehabilitation.[44] In this case, ergometer cycling was not selected secondary to restricted hip ROM in the non-operative (L) hip, and progressive resistance was achieved through continually adjusting exercise repetition and increasing the ROM of the strengthening activities.

PHASE ONE OUTCOME

By the end of the conventional physical therapy sessions the patient was able to demonstrate independence with bed mobility, shower transfers, car transfers, and gait activities with use of a two wheeled walker. The patient was able to ambulate with improved base of support, but continued to have limitations with stride length due to continued weight bearing restriction. Muscle strength and ROM also were improved (see Table 8).

Table 5. Outcome measures for strength and ROM.

Body part	AROM	Strength Grade
Right hip flexion	90 deg	3+/5
Right hip abduction	20 deg	3/5
Right knee extension	0 deg	4+/5
Right knee flexion	125 deg	4/5
Right ankle dorsiflexion	15 deg	5/5
Right ankle plantarflexion	40 deg	5/5

Reported pain at rest was 0/10 (VAS) at the time of discharge with a reported range of 0-2/10 at best and worst within the past 24 hours. Standardized test scores were also improved (see table 9).

Table 6. Outcome measures for standardized tests.

Test	Evaluation	Discharge
Tug	Unable to complete	13.5 seconds with use of 2ww
30 second sit to stand	Unable to complete	4 repetitions
MAHC 10	High risk of falls (6/10)	Medium risk of falls (3/10)

PHASE TWO EXAMINATION

After completing formal physical therapy the patient agreed to participate in a wellness program with a focus of optimizing glucose control and weight loss to preserve the integrity of the recent joint replacement and already arthritic hip. The patient was scheduled to have another THA approximately 3 months after the first, and wanted to start a program to lose weight and hopefully better control his diabetes. Recommendations for exercise assessment and prescription have been previously outlined by Hansen et al.[32] The patient's medical history has been described above, and therefore, was referenced prior to initiating the program. Use of the physical activity readiness questionnaire (PAR-Q) was recommended by Hansen et al.[32] The patient's functional levels and abilities were previously demonstrated through the time spent with typical physical therapy intervention, and it was felt by the investigator that enough information had been obtained to determine appropriate intensity levels for the patient. Therefore, the PAR-Q was not administered. Pre participation data is listed in table 3.

Table 7. Phase two wellness program examination measurements.

Height	6' (72 inches)
Weight	382 pounds
BMI	51.8
HgbA1c	6.4 (3/15/14)
Waist Circumference	60 inches (Measured above the Iliac Crests)
Tug	13.5 seconds (using 2ww)
6 Minute Walk Test	180 feet (Using the cane, discontinued after 1:40 seconds)
30 Second Sit to Stand	4 repetitions

These measures were selected based on the recommendations of Hansen et al[32], but are not comprehensive of everything that was recommended. Bioelectrical impedance was not readily available at the time of initiation, and therefore, BMI and waist circumference were selected as outcome measures for body composition. Waist circumference was measured at the level above the iliac crests, as this has been shown to be the most valid location for measurement.[33] The TUG test has been shown as being a good tool for fall prediction, and was selected to assess the patient's current fall risk.[27] The patient opted to use a two wheeled walker to perform the test. Exercise endurance was measured via the 6 minute walk test. During the assessment the patient opted to use a standard cane instead of the two wheeled walker which had been his primary means of assistance with ambulation. The test was discontinued secondary to pain in the arthritic hip and patient reports of fatigue (Rating of perceived exertion (RPE)16).

Dynamometry is considered the gold standard for strength testing, however, a dynamometer was not readily available for use. There has been data to suggest no correlation between outcome of the 30 second sit to stand test and quadriceps strength.[34] In spite of this evidence, it was believed that as a pretest/post-test measure, the 30 second sit to stand test would effectively evaluate changes with regards to lower extremity function as it relates to fitness related changes.

PHASE TWO INTERVENTION

Phase two intervention was based on the recommendations of Hansen et al.[32] A supervised exercise program was initiated which consisted of 2 home visits, followed by 10 weekly phone calls. The total duration of intervention was 12 weeks. Additional home visits were scheduled in the event of unanticipated event, or significant lack of compliance with the prescribed program. The initial session was used to outline desired exercise frequency, intensity, duration, and to discuss options for altering the current nutrition plan. Exercise intensity was to be estimated utilizing Borg's rating of perceived exertion. The patient was educated regarding the importance of decreasing caloric intake through whichever "diet plan" that he (the patient) could comply with. Additionally, the patient was instructed in a home resistance program utilizing resistance bands. To ensure safety with the exercise program, the patient was also encouraged to monitor vital signs and glucose levels daily utilizing a home glucometer. The second visit was spent reinforcing educational information from the initial session, and reviewing the prescribed strengthening program to ensure safety and proper form with the exercises. The patient agreed to the following goals:

1. Participate in a walking program most days of the week, increasing duration until able to tolerate 30 minutes of walking utilizing whichever assistive device necessary to complete the desired time (walker vs. cane). The patient was educated to achieve moderate intensity (12-16 RPE's).
2. Participate in strength training consisting of prescribed exercises 3 sets of 10 repetitions, increasing to 3 sets of 15 when able with a medium strength exercise band. When able to complete 3 sets of 15 without achieving a rating of at least 12 RPE's, the patient was to progress to a heavy band for

the exercises, decreasing repetitions to ten and progressing to 15 when able. See Table 6 for exercise descriptions.

3. Participate in an aquatic program at minimum 2 days per week performing 5 exercises in a circuit fashion with 30 seconds of work coupled with 30 seconds of rest for 5 cycles.
4. Seek a total of 250 minutes of exercise per week.

Table 8. Resistance exercises as part of phase two intervention. Exercises were suggested to be performed as a circuit with 30 seconds to 1 min rest in between sets.

Exercises	**Prescribed Repetitions**
Chest Press, Row, Tricep Press	3 sets of 10, performed as a circuit with 30 seconds to 1 minute rest between sets
Military Press, Sit to Stand	3 sets of 10, performed as a circuit with 30 seconds to 1 minute rest between sets
4 inch step up (Bilaterally), Bicep Curl, Standing hip Abduction	3 sets of 10, performed as a circuit with 30 seconds to 1 minute rest between sets

The exercise frequencies and intensities are based on clinical guidelines,[45] and relevant studies,[5,9,10,11,45] as reported by Hansen et al.[32] Hansen et al[32] suggests exercise training to start at a frequency of 3 times per week and build up to 5 days per week within a few months, at a low to moderate exercise intensity (40-70% VO_2Max), achieving a minimal exercise duration >150 minutes/week. Resistance exercise is also recommended (5-10 exercises/week, 3 series session, 10-15 repetitions/session). In the case of this patient, aquatic exercises were given as another opportunity for increasing physical activity. The patient reported liking the pool secondary to benefits of buoyancy and offloading principles, and it was considered as another opportunity for increasing physical activity and creating a caloric deficit. Another difference between the prescribed program and the previously described recommendations was increased volume (250 min/week vs. 150 min/week). This goal was based on the recommendation of Donnelly et al,[47] reporting that increased duration of exercise (250 min/week) may be necessary for patients that are seeking weight loss.

Weekly phone calls were placed to discuss limitations with adhering to the prescribed program, and offer encouragement for continued activity and progress toward goals.

PHASE TWO OUTCOMES

12 weeks of a physical therapist directed wellness program was completed by the patient. See Table 10 for outcome measures.

Table 9. Comparison measures for phase two intervention.

Measure	Initial	Post intervention
Weight	382	382
BMI	51.8	51.8
HgbA1C	6.4	6.0
Waist Circumference	60 inches	60 inches
TUG	13.5 seconds	12.4
6 Minute Walk Test	180 feet (using the cane, discontinued after 1:40 seconds)	300 feet (without assistive device discontinued after 3:30" secondary to left hip pain)
30 Second Sit to Stand	4 repetitions	8 repetitions

The patient reported performing an average of 30 minutes of strength training, 30 minutes of walking, and 120 minutes of pool activities per week over the course of 12 weeks. However, the absence of weight loss is not synchronous with the reported level of activity. This could be potentially explained by the patients self reporting of activities. The patient was requested to keep a daily exercise log, but was not compliant with record keeping. In spite of the lack of weight loss, the patient did have a decrease in HgbA1C from 6.4 to 6.0, supporting the findings that benefit from an exercise program can be achieved independent of weight loss.[8]

DISCUSSION

According to the APTA, the physical therapist education allows appropriate intervention selection for the reduction of body mass, improvement in health status, and the reduction of chronic disease.[24] Treatment for DM2 typically centers around medication management and lifestyle change.[4-9] Following rehabilitation for total hip arthroplasty, this patient was able to

show a decrease in HgbA1C of .4 over a 12 week period. The patient did not achieve weight loss during the same period of time, but exercise intensity and duration were self-reported, which could have been a confounding variable. In this case, the supervision of exercise was achieved through weekly phone calls to assist with encouragement and adherence to the recommended exercise program. In hindsight, a weekly face to face meeting may have been more appropriate. This would have allowed a better opportunity to ensure appropriate record keeping and accountability for the prescribed exercise program. The patient reported issues with compliance secondary to organization issues within the home such as his wife taking the car when he was supposed to go to the gym to walk. Other issues were unrealistic goal setting, initiative to perform the exercises that were more taxing, and general motivational issues. The weekly phone calls were an attempt to provide accountability for adherence to the program, and to offer assistance with alterations to the exercise program in the event of increased pain or inability to perform an exercise. In this case, the patient was limited secondary to left hip arthritis which ultimately lead to another hip replacement surgery. The exercise program was modified to focus more on the strengthening in weight bearing for the right hip, and to increase the pool activities to offload the arthritic left hip. Despite the limitations encountered in this investigation with motivation, adherence, and left hip pain, the patient lowered his HgbA1c by .4 over a 12 week period. More research is needed to further identify the impact of physical therapy intervention to assist with the management of DM2.

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