5-2021

Acute Care Physical Therapy Rehabilitation of an 85-year-old Male with Three Lower Extremity Amputations: A case study

Ashley Bergerson

ACUTE CARE PHYSICAL THERAPY REHABILITATION OF AN 85-YEAR-OLD MALE WITH THREE LOWER EXTREMITY AMPUTATIONS: A CASE STUDY

by

Ashley Marie Bergerson
University of North Dakota, 2021

A Scholarly Project Submitted to the Graduate Faculty of the

Department of Physical Therapy

School of Medicine

University of North Dakota

in partial fulfillment of the requirements for the degree of

Doctor of Physical Therapy

Grand Forks, North Dakota
May
2021

This Scholarly Project, submitted by Ashley Bergerson in partial fulfillment of the requirements for the Degree of Doctor of Physical Therapy from the University of North Dakota, has been read by the Advisor and Chairperson of Physical Therapy under whom the work has been done and is hereby approved.

(Graduate School Advisor)

(Chairperson, Physical Therapy)

PERMISSION

Title Acute Care Physical Therapy Rehabilitation of an 85-year-old Male with Three Lower Extremity Amputations: A Case Study

Department Physical Therapy

Degree Doctor of Physical Therapy

In presenting this Scholarly Project in partial fulfillment of the requirements for a graduate degree from the University of North Dakota, I agree that the Department of Physical Therapy shall make it freely available for inspection. I further agree that permission for extensive copying for scholarly purposes may be granted by the professor who supervised my work or, in her absence, by the Chairperson of the department. It is understood that any copying or publication or other use of this Scholarly Project or part thereof for financial gain shall not be allowed without my written permission. It is also understood that due recognition shall be given to me and the University of North Dakota in any scholarly use which may be made of any material in this Scholarly Project.

Signature _____

Date _____

TABLE OF CONTENTS

LIST OF FIGURES vi

LIST OF TABLES vii

ABSTRACT viii

CHAPTER

I. BACKGROUND AND PURPOSE 1

Diabetes Mellitus 1

Diabetic Ulcer Pathophysiology... 4

Ulcer Prevention... 6

Ulcer Classification... 7

Ulcer Treatment 9

Amputation... 12

II. CASE DESCRIPTION 20

Surgical Timeline and Transfer of Care 21

Hospitalization One 21

Hospitalization Two 21

Hospitalization Three 22

Examination and Evaluation... 22

Hospitalization One 27

Hospitalization Two... 28

Hospitalization Three 28

Diagnosis 29

Prognosis and Plan of Care 29

III. INTERVENTION 31

Hospitalization One 31

Hospitalization Two 33

Hospitalization Three 34

IV. OUTCOMES 36

Hospitalization One 36

Hospitalization Two 37

Hospitalization Three 38

V. DISCUSSION 39

Reflective Practice 41

REFERENCES 44

LIST OF FIGURES

1. The Patient Client Management Model Utilized for Physical Therapy Evaluation and Rehabilitation 23

LIST OF TABLES

1. AM-PAC 6- Clicks Assessment (Hospitalization One)..... 25

2. AM-PAC 6-Clicks Assessment (Hospitalization Two)..... 25

3. AM-PAC 6-Clicks Assessment (Hospitalization Three)..... 25

4. Review of Systems 26

5. Physical Therapy Interventions Hospitalization One (1)..... 32

6. Physical Therapy Interventions Hospitalization One (2)..... 33

7. Physical Therapy Interventions Hospitalization Two..... 34

8. Physical Therapy Interventions Hospitalization Three..... 35

ABSTRACT

Background and Purpose. This case report describes the acute care management of an 85-year-old male with three consecutive lower extremity amputations and one associated revascularization procedure at attempt of limb salvage. The purpose of this report is to describe the effects of chronic conditions on various body systems and how they relate to physical therapy rehabilitation post-amputation since limited research is present in this area of physical therapy practice.

Case Description. The patient had a very extensive and complicated medical history which included type II diabetes mellites, chronic kidney disease and peripheral artery disease. His primary goal was to return home to his wife; however, the sequence of three amputations and respective hospitalizations had negatively affected his physical and emotional status. This resulted in the patient's discharge to a subacute rehabilitation setting after all three amputations and respective acute care hospitalizations.

Intervention. Interventions of transfer training, bed mobility, assistive device/gait training, patient education, strengthening, activity pacing, energy conservation and neuro-reeducation were all included at some point in the patients' plan of care.

Outcomes. Throughout the patients' acute care hospitalization with physical therapy intervention, the patient displayed a steady progression of increased pain, decreased

strength, decreased endurance, decreased ability to independently perform activities of daily living and decreased ability to perform self-care tasks.

Discussion. The prognosis following each subsequent amputation and respective hospitalization had declined drastically. Although acute physical therapy helped the patient improve physically post-amputation , the prognosis for the patient was still less than optimal moving forward.

CHAPTER I

BACKGROUND AND PURPOSE

In 2005, a study was conducted that there were an estimated 1.6 million individuals living with an amputation in the United States. In relation to the population, that equates to be one in every 190 Americans. Further, amputation and associated limb loss in the United States is estimated to more than double by the year 2050.[1] This assumption will have an unprecedented impact on health care resources; resources such as costs and expenditures, staffing, facility spaces, and intervention approaches towards rehabilitation will have to improve to keep up with the estimated rise in this specific population of individuals. It is estimated that 82% of lower extremity (LE) amputations in the United States are a consequence of vascular diseases including peripheral artery disease (PAD), diabetes mellitus (DM) and chronic venous insufficiency. Other causes of LE amputations- at a much lower prevalence- include cancer and malignancies, trauma and congenital deficiencies.[2] Further, in those with DM, LE amputations are preceded by an ulcer approximately 85% of the time.[3] The subsequent information in this case study will focus on DM, related comorbidities and ulceration in correlation to LE amputation in the acute care physical therapy (PT) rehabilitation setting.

Diabetes Mellitus

The United States healthcare system has seen an extensive impact from DM. A study by the American Diabetes Association claims that currently 9.7% of the adult

population are living with DM and that there is an expected 11% growth by the year 2050. The study further expands on healthcare expenditure and approximate that one in every seven population healthcare dollars is allocated to the treatment of DM.[4]

Diabetes mellitus is an umbrella term that encompasses a group of metabolic conditions. All the various types of DM have one thing in common; they all affect how the body uses the sugar called glucose. Glucose is a carbohydrate that comes from food. It is an important source of energy for the body; however, too much glucose in the bloodstream can become problematic. In an optimal homeostatic environment, the body uses insulin (a hormone secreted by the pancreas into the bloodstream) to lower high glucose levels in the bloodstream. In type one diabetes mellitus (DM I) the body loses its ability to make insulin. It is not known exactly what causes DM I, but a combination of genetic susceptibility and the environment are thought to be causal factors. Type one diabetes mellitus is sometimes referred to as juvenile onset while type two diabetes mellitus (DM II) is sometimes referred to as adult onset from earlier and later diagnosis in life, respectively. In DM II, cells in the body will overtime become resistant to the action of insulin. Similar to the mechanism behind DM I, it is not known exactly why this happens but genetics and the environment seem to be contributing factors as well as obesity, fat distribution, inactivity, familial history, race, age and having prediabetes.[5]

In all subtypes of DM sugar will often build up in the bloodstream, causing glycemic levels to elevate if the condition is left untreated.[5] The elevated glucose levels in the bloodstream creates an increased risk for microvascular and macrovascular complications.[6] If left untreated, these microvascular and macrovascular abnormalities

can cause further complications such as diabetic peripheral neuropathy (DPN) and cardiovascular diseases (not all inclusive).[5]

Diabetic peripheral neuropathy, one symptom of DM, is essentially a symptom that arises from damage to peripheral nerves (the nerves outside of the brain and spinal cord) from the high levels of glucose in the bloodstream. It is hypothesized that over time the high blood sugar damages nerves and interferes with their ability to send signals. Further, high blood sugar is known to weaken capillary walls that could possibly inhibit blood flow. Blood acts as a transporter for needed oxygen and nutrients to nerves to function efficiently. The damage to the nerves, decreased conductive capability, and lack of needed oxygen and nutrients from the peripheral arteries puts the nerves at a less than optimal state for functioning properly. Symptoms from DPN can be described as stabbing, burning, and/or tingling and depend on the type(s) of nerves that is/are affected. Sensory nerves (sensation, temperature, vibration, touch), motor nerves (muscle movements), and/or autonomic nerves (blood pressure, heart rate, digestion, bladder function) can all be affected and will cause variations in symptoms. Damage to these nerves can therefore lead to weakness, numbness, pain, extreme sensitivity to touch, lack of coordination, and even paralysis to the location/innervation of the respective peripheral nerve.[7]

Cardiovascular disease is also another complication often associated with DM as high blood sugar can cause atherosclerosis of small and/or large arteries throughout the body. Normally, healthy arteries are flexible and elastic which allow blood to easily flow through them. When someone develops atherosclerosis, there is a buildup of fat, cholesterol and other substances within and on the arterial walls, called plaque. The

plaque buildup occludes blood flow and the nutrients and oxygen within that blood. Decreased blood flow to the heart may cause angina (chest pain), shortness of breath, and/or myocardial infarctions. Decreased blood flow to the kidneys may lead to high blood pressure and/or kidney failure. Decreased blood flow to the brain may cause orthostatic hypotension, transient ischemic attacks and/or stroke. Lastly, in PAD, with decreased blood flow to the periphery, one may experience claudication (pain most often in the lower legs with activity), numbness, weakness, hair loss, shiny skin, and weak pulses in the extremities. When peripheral tissues do not receive adequate blood flow supplied by the peripheral arteries, there can be decreased nutrients for tissues, decreased healing for ulcers/wounds, increased rates of infection, tissue necrosis (tissue death), and amputation if sufficient healing is not present in wounds. The plaque that forms because of atherosclerosis not only occludes blood flow, but in more severe cases can break free and can cause other complications. The broken free plaque deposit, called a blood clot, can travel and occlude other vessels in other locations such as the lungs, heart, and even brain triggering other complications such as a heart attack or a stroke.[5]

Diabetic Ulcer Pathophysiology

A diabetic foot ulcer, according to the American Podiatric Medical Association, is an open sore or wound that commonly occurs on the bottom of the foot of an individual who has diabetes.[8] Diabetes can affect the entire body, but it frequently involves the feet first.[6] A small percentage of ulcers present in the population with diabetes are purely ischemic; rather, most diabetic ulcers are neuropathic or neuro-ischemic in origin.[9] In other words, most diabetic ulcers are due to DPN or DPN combined with vascular insufficiencies rather than vascular insufficiency alone.

The presence of DPN ranges from 16% to as high as 66% in patients with DM[10] and is the primary risk factor for the development of diabetic foot ulcers.[11] Although the clinical presentation of DPN can be quite variable,[6] many develop a lack of sensation in the feet which can be quite detrimental for the patient. Pain tells us to stay off our feet when they hurt, to rest, to pull pebbles out of our shoes and ultimately protects our feet from damage and tissue breakdown. In DPN, with a lack of protective sensation, tissue damage and injury can occur without the person even knowing.[6] Mentioned earlier, ulcer formation can be solely neuropathic in origin, however, ulcers can also be caused by vascular insufficiencies coupled with DPN.[9]

Peripheral artery disease, generally caused by atherosclerosis, is present in up to 50% of patients with a diabetic foot ulcer.[9] With the lack of blood flow to the extremities, there can be decreased nutrients for tissues, decreased healing for ulcers/wounds, and increased rates of infection which may result in amputation if sufficient healing is not present in ulcerations.[5] A study by Fowkes et al.[12] claims that the strongest risk factors for PAD are DM and smoking, with an odds-ratio of 2.72 and 1.88, respectively. In other words, if you have diabetes, you have 2.72 greater odds of having PAD compared to the general population. This further accentuates undesirable conditions for ulcer healing with the added comorbidity of PAD present in a high portion of the population with diabetes.

Without intervention, the natural history of diabetic ulcers progresses from an ulcer to infection to a deep infected ulcer to osteomyelitis (bone infection) and then will progress to amputation or death if left untreated.[6] It is estimated that 56% of ulcers become infected and once infected, 15% of those will require some level of amputation, according to Ramsey, SD.[13] Taking into consideration the large proportion that become

infected and the detrimental downstream consequences, it is therefore extremely important that prevention and proper management of diabetic ulcers is a priority.

Ulcer Prevention

There are still many gaps in knowledge regarding the best approaches to ulcer prevention for the patient population with DM. Prevention of ulcers is key because once an ulcer is present, 15% will result in LE amputation.[13] It is therefore important to prevent their development in the first place. Prevention of diabetic ulcers includes five key elements according to the International Working Group on the Diabetic Foot (IWGDF) for individuals with DM.[9]

The IWGDF proposes the following: (1) Identify the at-risk foot. Many individuals with DM experience asymptomatic neuropathy, PAD, pre-ulcerative signs, and even ulcers themselves. At least annually, a skilled professional should perform a history, vascular status with palpation of pedal pulses and check for loss of protective sensation in anyone with DM. Assessing loss of protective sensation can be done through a few techniques including the Semmes-Weinstein 10-gram monofilament for pressure perception, a 128 Hz tuning fork for vibration perception, or tactile sensation if the aforementioned testing instruments are not available. (2) Regularly examine the at-risk foot if PAD and/or peripheral neuropathy are present. The comprehensive examination includes taking a thorough history, palpation of pedal pulses for vascular status, assessing the skin for pre-ulcerative signs, checking for any bone/joint deformities, assessing for any loss of protective sensation, checking footwear and checking foot hygiene. (3) Educate the patient, family and healthcare professionals about foot care. (4) Ensure routine wear of appropriate footwear. (5) Treat risk factors for ulceration. The

aforementioned elements proposed by the IWGDF not only highlight the preventative aspect of ulcers, but they also further describe the assessment and classification if an ulcer is present.[9]

Ulcer Classification

The IWGDF proposes that health care professionals follow a consistent and standardized strategy for evaluating foot ulcers. The group proposes that various ulcer characteristics should be addressed that include the type of ulcer, the cause of the ulcer, the location and depth, any signs of infection, and identification of any related factors that could negatively affect wound healing.[9]

By evaluating the type of ulcer, a health care professional should address if the ulcer is purely neuropathic, neuro-ischemic, or purely ischemic in origin. Loss of protective sensation is characteristic for a neuropathic ulcer. Explained earlier, in DNP, the nerves lose their ability to identify pain, a protective sensation. Determining if the ulcer is ischemic in origin is tougher as no signs or symptoms reliably predict ulcer healing. Instead, the IWGDF suggests examination of arterial pedal wave forms and obtaining an ankle brachial index, using a Doppler instrument. "The presence of an [ankle brachial index] 0.9-1.3 or a triphasic pedal pulse largely excludes PAD, as does a toe brachial index > .75. "[9(p10)] Another study conducted in 2013 by Xu et al.[14] found that the test of [ankle brachial index] ≤ 0.90 can be used to identify PAD with serious stenosis in clinical practice (sensitivity 75%, specificity 86%). A neuro-ischemic ulcer will have both neuropathic and ischemic characteristics described above.[9]

Second, assessment of an ulcer should also include the cause of the ulcer which may include ill-fitting shoe wear or walking barefoot.[9] Discrepancies in optimal mechanics for the feet can lead to friction and damage that may lead to these ulcers. Mentioned earlier, DPN plays a major role due to lack of sensation and knowing when to offload the foot, when there is tissue breakdown, and when there may be pebbles or detrimental conditions that may lead to ulceration.[6]

Third, the site and depth of the ulcer should be examined and assessed. Neuropathic ulcers typically develop on the plantar surface of the foot or in areas with bony deformity or prominences. Ischemic and neuro-ischemic ulcers typically develop in the tips of the toes or on the lateral borders of the foot. The depth of the ulcer can sometimes be difficult as ulcers sometimes have calluses or necrotic tissue that make a true assessment difficult. Calluses, thick and hardened layers of skin, develop as a protective strategy against friction and pressure. The calluses may cause a challenge to true depth assessment as the skin layers build. Necrotic tissue can also cause slight challenge to the assessment of the true depth of an ulcer as the dead tissue first needs to be removed/debrided for the most accurate assessment. Debridement of an ulcer should be done in the presence of neuropathic or neuro-ischemic wounds, but not ulcers with severe ischemia as the debridement process may negatively affect optimal healing.[9]

Fourth, potential signs of infection should be assessed[9] as 56% of ulcers become infected and once infected, 15% of those will require some level of amputation.[13] Presenting a serious threat to the affected foot and limb, infection needs to be evaluated and treated promptly. Inflammatory signs of redness, warmth, induration, pain/tenderness, and/or purulent secretions should be assessed as these signs all indicate

the possibility of infection. Infections should be classified using a standardized classification; the IWGDF and Clinical Practice Guidelines on the Diabetic foot propose the use of the Infectious Diseases Society of America classification scale to grade the ulcer on infection.[6, 9,15] The standardized classification scale also helps guide what type of antibiotics to use as well as where to further treat the patient after discharge (in-patient setting or out-patient setting).[6]

Lastly, patient related factors should be taken into consideration as many factors could potentially affect wound healing. End stage renal disease, malnutrition, poor metabolic control, psycho-social problems,[9] PAD, alcohol and tobacco use, and longer duration of having diabetes may all negatively affect optimal ulcer healing.[6] The aforementioned consistent and standardized evaluation approach should then help guide further rehabilitation of ulcers.

Ulcer Treatment

Approaches to ulcer treatment are limited in research in patients with diabetes. Although not all-inclusive, treatment may include pressure offloading and ulcer protection, restoration of tissue perfusion, treatment of infection, metabolic control, treatment of co-morbidities, local ulcer care, and educating the patient, family, and friends.[9]

Pressure offloading/ulcer protection is one of the cornerstones for ulcer treatment, especially in ulcers where biomechanical stress was thought to influence its development. For neuropathic plantar ulcers, a non-removable knee-high offloading device such as a total contact cast is optimal. If the total contact cast is not tolerated or if it is contraindicated for the individual, an ankle-high offloading device can be used instead.

Felted foam can also be used in combination with appropriate footwear but is less desirable. Bedrest, a wheelchair, crutches, and wedged shoes may also be used.[6] When the ulcer is non-plantar in origin, other offloading and protection techniques can be followed which include footwear modifications, toe spacers, and other various orthoses.[9] Surgery can also be used as a method of offloading with Achilles tendon lengthening or metatarsophalangeal joint arthroplasties.[16]

Restoration of tissue perfusion also needs to be addressed as poor circulation may not facilitate optimal tissue healing. In patients with an ankle pressure less than 50 mmHg or an ankle brachial index < .5 imaging should be acquired to identify need for revascularization. Revascularization should also be considered when the toe pressure is less than 30 mmHg, if the ulcer has extensive tissue loss, if the ulcer is infected and/or if the ulcer shows no signs of healing by six weeks.[9] Although there are no specific quantitative cutoffs/guidelines, the "aim of revascularization is to restore direct blood flow to at least one of the foot arteries, preferably the artery that supplies the anatomical region of the wound."[9(p12)] However, if the risk-benefit is unfavorable, the healthcare team and patient should consider avoiding a revascularization attempt.[9]

Infection of a diabetic ulcer should also be treated and should be the first and most urgent step in the treatment of an ulcer.[15] Clinicians should use the Infectious Diseases Society of America grading scale to grade the infection as well as to help guide antibiotic treatment and place of treatment.[6] For superficial ulcers with mild infection/limited soft tissue infection, treatment should consist of cleansing and debriding all necrotic tissue and starting oral antibiotic therapy targeted at *Staphylococcus aureus* and *streptococci*. For deep infections that may be potentially life threatening, urgent

evaluation for surgical intervention to remove necrotic tissue should be conducted as well as assessment for PAD and/or revascularization and adjustment of antibiotic regimens.[6]

Metabolic control and treatment of comorbidities are also part of the comprehensive care for individuals with a diabetic ulcer. Optimization of glycemic control – if necessary, with insulin – and treatment of malnutrition should be managed by the interdisciplinary team.[9] A study conducted in 2019 by Xiang Jiali et al.[17] found that having a reasonable HbA1c target between 7.0% and 8.0% during treatment for diabetic foot ulcers could facilitate ulcer healing. The HbA1c test is a common test used to monitor how well someone is managing their DM. A study by Vatankhah et al.[18] also supports management of diabetes and found that insulin therapy had a positive effect on wound healing in people with DM.

Local ulcer care should also be incorporated into the comprehensive treatment for individuals with diabetic foot ulcers. Regular inspection of the wound, debridement of necrotic tissue with sharp surgical instruments, using appropriate dressings, and possible negative pressure therapy are all possibilities with early care. If a non-infected ulcer fails to heal in 4-6 weeks' time, the healthcare team should consider other options outlined by the IWGDF.[9]

Lastly, patient education should be a routine and continuously integrated part of the comprehensive treatment in patients with a diabetic foot ulcer. Instruction of appropriate footwear, signs and symptoms of infection, proper positioning, and variable patient-specific information should be addressed to the patient and/or any caretaker(s) or pertinent family and friends. During periods of bedrest, instruction on prevention of ulcers elsewhere should also be reinforced to prevent any further complications for the

patient.[9] Unfortunately, not all ulcers will be able to be treated conservatively and some will need to end with amputation to prevent any further downstream complications such as higher level amputation or death.

Amputation

There are many assessment scores available that help medical personnel, especially surgeons, in deciding whether to amputate or attempt salvage of a limb. "Patient selection for limb salvage versus amputation remains subjective and based on anecdotal observations without clear guidelines from the old and recent literature."[19(p3)] However, with the present lack of clear guidelines in patient selection, there are still amputations being performed in high numbers.[2]

Rehabilitative care for patients with amputation in both the diabetic and general population follows the same guidelines; however, care should be individualized based on treatment goals, the patient's health status, level of amputation, and any personal and/or environmental factors.[20] Recommendations for all phases of amputation rehabilitation (including pre-operative), include patient education, assessments of behavioral and psychological functioning, pain assessment (intensity and interference with function should be assessed separately), offering peer support interventions, and a multi-modal, transdisciplinary individualized approach to pain management.[21] Brigham and Women's Hospital, Physical Therapy Department, further outlines a standard of care for LE amputation and they emphasize medical and physical assessment, patient education, functional prognosis, discussion about phantom limb pain (PLP), and realistic short- and long-term goals before amputation.[22] Clinical Practice Guidelines on below knee amputation (BKA) also suggest of the initiation of mobility training as soon as feasibly

possible post-amputation and having treatment in an acute inpatient rehabilitation setting over a skilled nursing facility if applicable/possible.[21]

During the acute phase of PT rehabilitation, goals and associated treatment include optimizing range of motion(ROM)/preventing contractures, treating/addressing any PLP, treating pain other than PLP, functional mobility training, various interventions to improve wound healing and shaping, neuro-reeducation and strength interventions.[20]

Optimizing ROM is important throughout post-amputation rehabilitation for many reasons. First and foremost, optimizing ROM will prevent any contractures that may develop in soft tissue. A contracture is essentially soft tissue tightness or muscle tightness that may negatively affect joint motion. In patients with a BKA, the most common contracture is one in which the knee becomes flexed and is unable to fully extend. If adequate ROM is not maintained, contractures can develop and can sometimes become permanent. These contractures can then lead to difficulty in obtaining or adequately being able to use a prosthesis, making walking more difficult, increasing the need for an assistive device, and may even put the LE in an undesirable position that may cause tissue breakdown. A physical therapist and other healthcare professional should teach the patient gentle stretching ROM exercises as well as positioning to prevent contractures.[23]

Phantom limb pain is still a poorly understand and difficult medical condition to treat. Phantom limb pain is described as pain in an area where a body part is no longer there and can occur in up to 90% of individuals with an amputation.[24] It is not known entirely why this happens, although more recently proposed mechanisms have shifted the past psychogenic thought of origin to a now more peripheral and central neural origin.[25] Current treatment approaches involve a multidisciplinary approach with

pharmacotherapy, surgical procedures, and adjuvant therapy as there is currently no single best treatment for PLP. Adjuvant therapy such as transcutaneous electrical nerve stimulation and mirror therapy are sometimes used by physical therapists.[25] A systematic review published in 2015 stated that there were ultimately no randomized controlled trials to judge the effectiveness and support in using transcutaneous electrical nerve stimulation for the treatment of PLP,[26] however some studies have supported its use in the past. Mirror therapy, proposed in the late 1900s, is aimed to solve the visual-proprioceptive dissociation in the brain. The intervention also has mixed effectiveness across studies with most studies being small sample sizes.[27] A more recent systematic review conducted in 2016 found that there is insufficient evidence to recommend mirror therapy as a first-line treatment and stated that more randomized control trials are needed to back the effectiveness of the intervention.[28] There have also been other studies with various proposed interventions, however, most have been short-term assessments of small sample sizes.[29]

Residual limb pain is also another post-operative characteristic that needs to be treated by physical therapists and the healthcare team. Unlike PLP, residual limb pain - sometimes called "stump pain"- is a pain that is felt in the limb that is still present on the persons' body. It occurs in about half of individuals who have had an amputation and is described as a pressing, throbbing, burning, squeezing, and/or a stabbing sensation.[30] According to the Mayo Clinic, treatment focuses on treating the underlying cause of the pain which may include problems in the bone or soft tissue, infection, poor blood supply to the limb, neuromas (tumors involving nerve endings),[30] reflex sympathetic dystrophy, bursitis, and tendinosis at the end of the residual limb.[31] Treatment may include pain

relievers, antidepressants, anticonvulsants, massage, hypnosis, nerve blocks, and rehabilitative therapy by physical therapists and/or occupational therapists.[30] A physical therapist in specific may integrate treatments such as soft tissue mobilizations, massage, TENS, passive stretching,[31] and desensitization[32] to alleviate pain symptoms.

Post amputation, one of the biggest responsibilities of the physical therapist in an acute care setting is to get individuals moving safely and more independently to reach certain functional goals. During the acute phase of rehabilitation, is has been shown that early mobility correlates to improved functional outcomes, greater independence on discharge, and decreased mortality rates in the general population.[33] In the population with an amputation, research supports early mobilization as well, however the research includes small sample sizes.[34] Unfortunately, research is still lacking to support if early mobilization is beneficial in patients who have underwent an amputation procedure. A systematic review conducted in 2017 included five studies on the effect of early mobilization after vascular major lower limb amputations and found that there is a current lack of evidence to determine whether or not early mobilization is beneficial to the amputee patient population.[35]

However, whether or not early mobilization is beneficial, the physical therapist still plays a vital role in the patients' mobility goals. It is important to note that specific mobility goals and interventions are incorporated on a per-patient basis as functional levels vary per person, as well as contraindications and precautions. Interventions including bed mobility, transfer training from supine positioning to sitting, static posture training, isometrics, transfer training from sitting to standing, gait training with an

assistive device, ascending/descending stairs, wheelchair mobility and much more are all interventions that may be included in a patients plan of care post-surgery.

One tool that many physical therapists use is called the AM-PAC 6 Clicks Basic Mobility Instrument to measure functional domains of basic mobility, daily activities, and applied cognition. The assessment was originally developed in 2011 and has been used by rehabilitative professionals across Cleveland Clinic's health system.[36] In 2014, a published study validated the instruments accuracy and its beneficial application in the usage for therapy need and for predicting appropriate discharge setting for patients.[37] The AM-PAC 6-Clicks Basic Mobility instrument is a standardized assessment tool designed to be used in every PT and occupational therapy visit for every treatment with a patient. There is one form for physical therapists and one form for occupational therapists. In the PT functional measurement assessment, the physical therapist evaluates the patients' level of assistance in six functional tasks. These six tasks include the patients ability to (1) turn over in bed, (2) move from supine to sitting position, (3) transfer from a bed to a chair, (4) transfer from a seated position to standing position, (5) ambulate in their room, and (6) ascend/descend 3-5 steps on a staircase with a railing. Documentation further is graded 1-4 with 1 being unable to perform, 2 being moderate assist, 3 being minimal assist, and 4 being that the patient is independent with mobility. A maximum score of 24 is fully independent (with or without an assistive device) and a minimal score of 4 indicates full dependence on external support.[37]

Post-operative, it is also normal to experience swelling of the residual limb and a physical therapist and/or other medical professionals will help with reducing that swelling. Maintaining compression on the limb will control swelling and will help the

limb heal. Common compression interventions include elastic bandage wrapping or an elastic shrinker sock. Both of the compression approaches, as well as others, will help reduce the swelling and will also help prepare an individual for a prosthesis. Sometimes a rigid dressing or plaster cast will be used instead of elastic bandages, however, the method of choice is on a per-person basis and the healthcare team providing the care.[23]

Strengthening and incorporating neuromuscular reeducation is also another crucial part of post-surgical amputation rehabilitation. Neuromuscular reeducation consists of various techniques of which a physical therapist may use to restore normal movement patterns that may have been disrupted by an amputation.[23] Amputation and other various trauma often negatively affect muscle movement patterns that the brain, nerves, and muscles all produce together. Manual techniques such as proprioceptive muscular facilitation, activities for muscular control and therapeutic exercises can all be used to restore neuromuscular dysfunction after an amputation. For an individual with a BKA, interventions of strengthening and neuromuscular reeducation should focus on the gastrocnemius soleus muscle group, peroneal muscle group, and the pretibial muscles.[20] If a patient has trouble with residual limb muscle firing patterns, neuromuscular electrical stimulation can be considered to help guide initial muscle activation.[38]

With acute rehabilitation post-amputation, there are many issues specific to LE amputation that may negatively impact PT intervention. Potential early post-operative complications include blood loss [and associated orthostatic hypotension], deep vein thrombosis, pulmonary embolism, cardiac complications, systemic complications, complications at the surgical site, and PLP. "If a patient presents during the first few days post-operatively with increased pain, excessive swelling, decreased muscle strength

or sensation along a motor and/or sensory nerve distribution, sudden shortness of breath and decreased oxygen saturation along with increased resting heart rate, PT interventions must be stopped, and the medical team consulted.[22(p8)] A review of 2,879 individuals with amputation demonstrated the "most common post-surgical complications included pneumonia (22%), acute kidney injury (15%), deep venous thrombosis (15%), acute lung injury/acute respiratory distress syndrome (13%), osteomyelitis (3%) and flap failure (6%).[39(p2)]

The prognosis for individuals with an amputation is quite unsettling, statistically. The statistics further accentuate that much more research in the prevention and treatment of DM and amputation are needed to better the outcomes for these individuals. A study by Aulivol et al.[40] found that that post LE amputation 30-day mortality was 8.6%, overall one-year survival was 69.7%, and overall five-year survival was only 34.7%. They also found that overall survival was negatively affected by DM and end-stage renal disease. Also noted, the more proximal (closer to the body) the amputation was, the more functionally impaired than those with a more distal (closer to the feet) amputation.[40,41]

It is obvious that continued case studies and research regarding LE amputations are needed to best prevent, understand and rehabilitate this patient population. The prognosis post-amputation for individuals is not good and needs to become better and more optimistic. On top of the limited knowledge and undesirable prognoses, the United States is seeing a rise in the diabetic population as well as an expected increase in the number of amputations that will take place in the future. The purpose of this case study is to describe an individual with chronic vascular impairments, specifically DM and PAD,

in association with LE amputation as well as the role of the physical therapist and interdisciplinary team in the patients' rehabilitative journey.

CHAPTER II

CASE DESCRIPTION

The patient –an 85-year old male—lived at home with his wife in a one-story house in the country. There were a few steps that he was easily able to manage with a railing to get into the home. He was still very active in the community with a cane for ambulation. The patient mentioned he was able to walk without a cane but that the extra support made him feel more at ease with balance and safety. His hobbies included fishing, golfing, cooking, and feeding the birds in his backyard. He was still independently driving, grocery shopping, managing his own medication, cooking, and cleaning. The patient also owned and operated a Christmas tree farm with his wife and two children where he helped out with the less physically demanding tasks.

His past medical history consisted of controlled DM II, hyperlipidemia, long term opiate use, chronic kidney disease II, hypertension, insomnia, coronary artery disease, PAD, congestive heart failure, chronic pain, low back pain and anemia. There was also a surgical history of a coronary angioplasty approximately four years prior and knee replacements on both LEs ten and twelve years prior.

After medical chart review and speaking with the patient and the patients' family, there was no indication of any psychological involvement that prompted medications or treatment of any sort. The patient and family indicated that the patient was always cheerful, active with his family, golfing or getting coffee with his friends on a daily basis.

When the patient himself initially came into the hospital, he did not necessarily present as the cheerful, outgoing, and responsible person that was portrayed by his family. He was quiet, in denial of his current state and expressed multiple times that his family did not need to be so "worried all the time" and that he felt like a "burden to them."

Surgical Timeline and Transfer of Care

Hospitalization One

The patient stubbed his toe in early October. About two weeks after the initial injury he was admitted to the hospital with a non-healing right foot gangrene infection. The same day of admission, the patient underwent a revascularization procedure. He was seen by PT twice post-revascularization procedure. However, the revascularization attempt failed which prompted a fourth and fifth toe amputation two days after the revascularization attempt. The patient was seen by a physical therapist post-operative day one as well as three more sessions over two consecutive days. He was discharged to a swing bed for continued subacute care and rehabilitation services.

Hospitalization Two

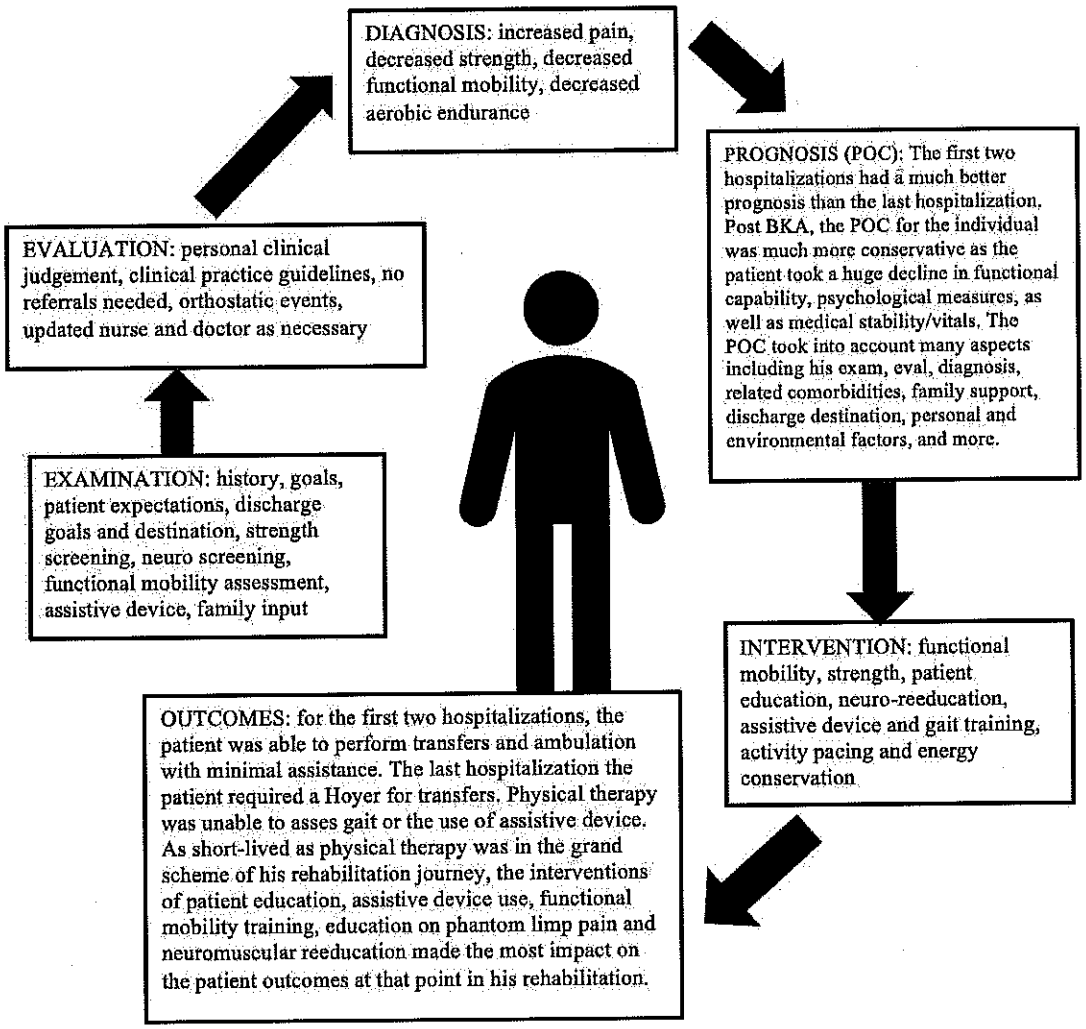
Three weeks after discharge the patient was readmitted with a non-healing wound from the previous amputation procedure with an associated infection. At this time, he underwent a transmetatarsal amputation (TMA) the day after readmission. No revascularization attempt was performed prior to the TMA surgical procedure. A physical therapist worked with him post-operative day one and three more sessions over four consecutive days. Again, he was discharged to a swing bed for subacute care and rehabilitation services after his acute care rehabilitation post-amputation.

Hospitalization Three

The patient was readmitted roughly three and half weeks after discharge with a non-healing wound and associated infection post-operative TMA surgical procedure . At this time the patient underwent a right guillotine BKA for lifesaving measures due to the presence of necrotizing fasciitis at the time of admission to the acute care facility. He was seen by acute PT post-operative day two as well as one other session before being discharged to a swing bed for subacute care and rehabilitation services.

Examination and Evaluation

Subsequent examination and evaluation for this patient focused on functional mobility following each amputation and can be outlined in the patient-client management model (see figure 1). As a background, the patient-client management model is a model that can describe PT evaluation and treatment heavily focused on the patient being in the center of the rehabilitative process. Through application and accomplishment of this process, a physical therapist can determine an individualized plan of care in collaboration with the patient.[42]



Adapted from Dutton M. Patient/client management. In Weitz M, Kearns B eds. Introduction to Physical Therapy and Patient Skills. Pittsburg, PA: McGraw-Hill; 2014[42]

Figure 1. The Patient-Client Management Model for Physical Therapy Rehabilitation

The examination and evaluation utilized the AM-PAC 6-Clicks Basic Mobility instrument to measure functional domains of basic mobility, daily activities, and applied cognition. Again, the patient was found to have decreased functional mobility throughout the course of his hospitalizations. Refer to tables 1, 2, and 3 for 6-Clicks Assessment scores for each acute care hospitalization and the associated PT sessions. The examination and evaluation for each amputation also focused on the patient's and

family's goals for discharge as well as knowledge and education on his amputation and related comorbidities in conjunction to his functional mobility and prognosis moving forward. Since each amputation and respective hospitalization had a predetermined discharge destination of further subacute rehabilitation at a subacute rehabilitation facility, the patient did not need full independence as further rehabilitation would be conducted with assistance and/or supervision.

Table 1. AM-PAC 6-Clicks Assessment (Hospitalization One)

Dates	Score
Session One	21
Session Two	21
Session Three	20
Session Four	20
Session Five	20
Session Six	20

Table 2. AM-PAC 6-Clicks Assessment (Hospitalization Two)

Dates	Score
Session One	16
Session Two	16
Session Three	18
Session Four	18

Table 3. AM-PAC 6-Clicks Assessment (Hospitalization Three)

Dates	Score
Session One	9
Session Two	9

A brief review of symptoms (see table 4) for each evaluation was conducted by a physical therapist. Other professionals in the patients' interdisciplinary team took responsibility of the objective integumentary specifics (podiatry/surgical team/orthotics) as well as a majority of the objective cardiopulmonary specifics (respiratory therapist/physician assistant/nursing). Physical therapy in specific focused on the musculoskeletal system as well as a brief neurological screening while following precautions, contraindications and post-surgical protocols. Sensation screening was assessed via a 10-gram Semmes-Weinstein monofilament on ten sites on the bottom, sides, and top of each foot.[43] Only LE ROM and strength were assessed as occupational therapy assessed the upper extremity. Range of motion was assessed via a goniometric measurement with a goniometer. Only specific LE knee ROM was assessed with a goniometric measurement. Knee joint measurement with a goniometer is both reliable (r = .98, ICC = .99) and valid (r = .97-.98, ICC =.98-.99).[44] Lower extremity strength was assessed and graded based off the Kendall and Kendall manual muscle testing scoring of grades 0-5.[45]

Table 4. Review of Systems

	Musculoskeletal	**Neurological**	**Cardiopulmonary**
Evaluation One	Hip ROM WFL bil Right knee flexion 125° Left knee flexion 118° Right knee extension 0° Left knee extension 0° Ankle ROM WFL bil Knee extension strength 5/5 bil Knee flexion strength 5/5 bil Plantarflexion 5/5 bil Dorsiflexion 5/5 bil	Sensation 3/10 right foot Sensation 4/10 left foot	BP 137/93 SpO2 95% resting
Evaluation Two	Hip ROM WFL bil Knee ROM WFL bil Ankle ROM WFL bil Knee extension strength 4/5 bil Knee flexion strength 5/5 bil Plantarflexion at least 3/5 bil Dorsiflexion at least 3/5 bil	NA	BP 142/89 resting SpO2 94% resting
Evaluation Three	Hip ROM WFL bil Knee ROM WFL bil Ankle ROM WFL bil Knee extension strength 4/5 bil Knee flexion strength 5/5 bil Right Plantarflexion at least 3/5 bil Right Dorsiflexion at least 3/5 bil Left plantarflexion 5/5 Left dorsiflexion 5/5	NA	BP 143/90 resting BP 111/80 with activity SpO2 94% resting
Evaluation Four	Hip ROM WFL bil Left knee flexion ROM WFL Left knee extension ROM WFL Right knee extension AROM -10° Right knee extension PROM 0° Right knee flexion AROM 95° Right knee extension at least 3/5 Right knee flexion at least 3/5 Left knee flexion strength 4/5 Left knee extension strength 4/5	NA	BP 130/81 resting BP 102/71 with activity SpO2 93% resting SpO2 86% with activity

Abbreviations: ROM, range of motion; WFL, within functional limitations; bil, bilateral; AROM, active range of motion; PROM, passive range of motion; NA, not applicable; BP, blood pressure; SpO2, oxygen saturation

Hospitalization One

The patient was seen by PT for two visits post-revascularization procedure and prior to his fourth and fifth toe amputation. His two daughters were present during each session. For the initial encounter a thorough history was taken as well as questions about current symptoms and concerns, functional mobility at home and in the community and about any personal and environmental factors. An AM-PAC 6 Clicks mobility evaluation was performed with a front wheeled walker, heel weight-bearing precautions (no weight should be placed anywhere but through the heel), and oxygen saturation to remain above 88%. The patient was given an AM-PAC 6 Clicks score of 21. Contact guard assist (1-2 hands on patient for balance and safety purposes only)[46] was deemed appropriate for tasks of ambulation in the room, transferring from the bed to the chair and with ascending/descending 3-5 steps on a staircase with a bilateral railing. He noted pain/fatigue in his calves with ambulation after 30 seconds as well as oxygen saturation monitoring between 89-91% throughout most active participation and between 93-95% at rest.

The revascularization attempt failed and prompted the need for surgical amputation. The patient was seen on post-operative day one following the right fourth and fifth toe amputation by PT. Precautions/contraindications of heel-bearing in a DARCO MedSurg Shoe had to be followed as well as vitals of oxygen saturation above 88%. The DARCO MedSurg Shoe is a shoe designed to provide added protection for the toes of the foot and also support to the metatarsal region when walking. During this time the patient demonstrated an AM-PAC 6 Clicks score of 20 with a front wheeled walker. The patient displayed the need of minimal assistance (up to 25% assistance with a

mobility task) to contact guard assist[46] with functional tasks of transferring from a bed to a chair, transferring from a seated position to standing, ambulating in his room and ascending/descending 3-5 steps on a staircase with a bilateral railing. The patient noted pain/fatigue in his calves after 30 seconds of ambulation. Oxygen saturation monitoring fluctuated in the low 90% range throughout active participation and in the mid 90% range at rest.

Hospitalization Two

The patient was seen by PT post-operative day one following the right TMA surgical procedure. The same precautions/contraindications of heel-weight bearing in the DARCO MedSurg Shoe and oxygen saturation to be maintained above 88% needed to be followed during PT intervention. During the initial evaluation the patient demonstrated an AM-PAC 6 Clicks score of 16. The patient required moderate assistance (up to 50% help with mobility task)[46] with transferring from a seated position to standing and ascending/descending 3-5 steps on a staircase with a bilateral railing. Minimal assistance[46] was required in all other four mobility tasks of turning over in bed, transferring from supine to a seated position, transferring from the bed to a chair and ambulating in the room. During the evaluation, the patient noted pain/fatigue in the calves and legs within 10-15 seconds of activity.

Hospitalization Three

The patient was seen by PT post-operative day two following the right BKA. During this time, the patient exhibited a drastic decline in functional mobility with an AM-PAC 6 Clicks assessment score of 9 with non-weight bearing precautions (no weight allowed to be placed on limb) and oxygen saturation to remain above 88%. The patient

required moderate assist with turning over in bed, transferring from a supine to a seated position and transferring from a seated position to standing position. The patient required maximal assistance (up to 75% help with mobility task) to total assist (100% help with mobility task)[46] with the use of a Hoyer to transfer from the bed into a chair. Physical therapy was unable to assess ambulation or ascending/descending stairs at that point in time and total assist was inferred with these functional mobility tasks.

Diagnosis

Throughout the course of acute care hospitalization, the patient found functional mobility difficult and secondary to that, activities of daily living and self-cares became progressively more difficult and his overall life satisfaction had progressively declined as well. For the aforementioned reasons the patient was given PT diagnoses of decreased activity tolerance, decreased strength, decreased functional mobility, and increased pain. The medical diagnoses consisted of fourth and fifth toe amputation, TMA, and BKA for each successive hospitalization, respectively.

Prognosis and Plan of Care

The prognosis for the client for the acute rehabilitation period along with the associated plan of care was much more optimistic for the first and second hospitalization compared to the third. For the first two hospitalizations, his functional mobility and goals were very similar; one goal that was consistent for both was "following PT intervention and heel weight bearing precautions, in one week, the patient will be able to safely ambulate on level surface 50 feet modified independent with a front wheeled walker to be able to navigate around the home independently for activities of daily living." During the first two hospitalizations, the plan was for the patient to continue subacute rehabilitative

care at a swing bed and then return home after functional independence and wound healing were optimal and safe.

The third hospitalization, however, the patient exhibited an even greater decline in functional mobility which promoted a change in prognosis and associated plan of care. One goal during this hospitalization was as follows, "following PT intervention and right LE non weight bearing precautions, in one week, the patient will be able to independently perform a supine to sit transfer in a hospital bed (without siderails) for proper positioning in bed to prevent pressure wounds and to perform siting activities of daily living." Post BKA the goals took a shift; the goals shifted from independence with the idea of returning home to a more preventative approach for worsening conditions in a subacute rehabilitation facility.

The patient was referred to PT for services following each post-operative amputation. Various interventions in the patients plan of care for each hospitalization included functional mobility training, assistive device/gait training, patient education, strengthening, activity pacing and energy conservation, and neuro-reeducation. These interventions were intended to reach the goals that the patient, family, and physical therapist had developed at a frequency of services 4x/week for this patient.

CHAPTER III

INTERVENTION

Interventions during all three hospitalizations followed the same principles with the goal of increasing safe functional mobility and increasing independence. Interventions of transfer training, bed mobility, assistive device/gait training, patient education, strengthening, activity pacing, energy conservation, and neuro-reeducation were all incorporated in the patients plan of care at some point in the patient's rehabilitative journey. The patient had to follow right LE heel-weight bearing precautions for the first two hospitalizations. Right LE non-weight bearing precautions had to be followed post-operative BKA. Assistance by a certified nursing assistant, physical therapist assistant, or a nurse was occasionally utilized with interventions of ambulation and transfers as some interventions required extra assistance at times.

Hospitalization One

Post revascularization attempt and prior to the first amputation procedure, the patient was seen by a physical therapist for two sessions. During the first two treatment sessions, intervention consisted mainly of transfer training, gait training with an assistive device and patient education. Each session consisted of one billed unit of gait training and one billed unit of therapeutic activities. Transfer training consisted of instruction and demonstration on proper mechanics to perform bed mobility and transfers from sitting to

and from standing. Gait training consisted of instruction and patient demonstration of ambulation with a front wheeled walker as well as 3-5 steps ascending and descending stairs with bilateral handrails. Patient education on various topics were covered during this time as well. Refer to table 5 for specific interventions and their descriptions during this point in the patient's rehabilitation.

Table 5. Physical Therapy Interventions Hospitalization One (1)

Physical Therapy Interventions	**Description**
Gait Training	• Verbal instruction and demonstration on proper ambulation, with step-to gait pattern with a front wheeled walker following heel-weight precautions • The patient demonstrated ambulation with verbal cues and guidance by the therapist • The patient was instructed to ambulate as far as he could until fatigue or request to stop
Transfer Training	• Verbal instruction and demonstration on proper sit to stand transfers was given with heel-weight bearing precaution • Instruction was given to push off the bed/chair with one hand while holding the front-wheeled walker with his other and to use his legs as best as he could for transferring • Cues and guidance were provided by the therapist for proper positioning and steps as needed
Patient Education	• Education on bed heel-weight precautions was given • Education on the healing process of the ulcer was provided per patient request • Education on proper functional tasks at the patients' home were also verbally given (getting into and out of bed, getting into and out of the bathtub, showering, and also stair climbing)

Post-operative fourth and fifth toe amputation, the patient was seen by a physical therapist for four sessions over the course of two days. During these four treatment sessions, interventions consisted of transfer training, gait training with an assistive device

and patient education. The first two sessions had one billed unit of gait training and one billed unit of therapeutic activities. The last two sessions had only one billed unit of therapeutic activities for each. The specific interventions of transfer training and gait training with an assistive device correlated strongly to the same interventions before his surgical operation. Refer to table 6 for specific interventions and their descriptions during this point in the patient's rehabilitation.

Table 6. Physical Therapy Interventions Hospitalization One (2)

Physical Therapy Interventions	Description
Gait Training	Refer to table 3
Transfer Training	Refer to table 3
Patient Education	• Education on bed mobility and heel-weight precautions was given • Education on proper functional tasks at the patients' home were also verbally given (getting into and out of bed, getting into and out of the bathtub, showering, and also stair climbing) • Education on energy conservation was also stressed heavily at this time with information on activity modifications and spacing activities out throughout the day, transitioning slower to reduce any light-headedness, relying more on an assistive device around the home and breathing techniques

Hospitalization Two

Post-operative TMA, the established plan of care with PT was very similar to post-surgical fourth and fifth toe amputation. The patient was given increasingly similar interventions as well as incorporating more specific strengthening exercises during this time as his strength had slightly decreased since the first hospitalization weeks prior. Four sessions with a physical therapist over the span of four days consisted of transfer training,

gait training with an assistive device, patient education, and LE strengthening. Refer to table 7 for specific interventions and their descriptions during this point in the patient's rehabilitation.

Table 7. Physical Therapy Interventions Hospitalization Two

Physical Therapy Interventions	Description
Gait Training	Refer to table 3
Transfer Training	Refer to table 3
Patient Education	• Patient education on the healing process of the TMA was given • Per patient request, education on orthostatic hypotension was given
Lower Extremity Strengthening	• Quadricep strengthening with long arc quadricep exercises and short arc quadriceps exercises in a seated position • Hamstring strengthening with heel slides in a seated position • Gluteal strengthening with gluteal squeezes and seated abductions on a sliding board in a seated position • Dorsiflexor strengthening and plantarflexion strengthening against a yellow resistance band in a seated position with therapist assistance holding the band

Hospitalization Three

Post-operative BKA the patient demonstrated a dramatic decline in functional mobility which consequently changed the plan of care. The patient was seen for only two PT sessions during this time and was billed one unit of neuro-reeducation and one unit of therapeutic activities for each session with the physical therapist. During this time interventions consisted mainly of bed mobility, LE neuro-reeducation, and patient

education. Refer to table 8 for specific interventions and their descriptions during this point in the patient's rehabilitation.

Table 8. Physical Therapy Interventions Hospitalization Three

Physical Therapy Interventions	Description
Neuro- Reeducation	• Muscle neuro-reeducation of the LE was incorporated with quadriceps contractions, adductor contractions, hamstring contractions, and abductor contractions in a seated position.
Bed Mobility	• Instruction and demonstration on the proper technique and sequencing for bed mobility with non-weight bearing precautions. The patient was taught how to log roll, how to use the bedrail to assist, and how to use his upper extremities to help safely move around and reposition in bed.
Patient Education	• Education on PLP was verbally and physically given to the patient • Education on the healing process of the amputation

CHAPTER IV

OUTCOMES

The outcomes for the patient following each subsequent amputation had progressively declined in respect to his functional mobility and also his motivation. For each hospitalization/amputation the patient's subjective and objective information were used to judge the effectiveness of PT intervention. Subjective information included everything that the patient told us about the effectiveness of therapy, pain he was experiencing and any other pertinent information provided by the patient. Objective information included mainly functional mobility evaluation using the AM-PAC 6-Clicks functional mobility assessment tool, screenings, and musculoskeletal measurements including ROM and manual muscle testing.

Hospitalization One

Post-surgical fourth and fifth toe amputation the patient had only slightly decreased functional mobility compared to before the initial admission based on subjective information provided by the patient and family. Before the surgery he was using a quad cane with contact guard assist, for safety, and was able to perform transfers and short ambulation distances. Post-surgically he used a front wheeled walker with minimal assist to contact guard assist for functional activities of moving from the bed to a chair, transferring from a seated to a standing position, ambulating in the room, and

ascending/descending 3-5 steps on a staircase with a bilateral railing. Similar to before amputation, the patient was only able to tolerate ambulation for roughly 30 seconds until his legs became weak and shaky. Although the patient did not meet full independence with functional mobility on discharge, he was very close to meeting this stated goal for PT of "following PT intervention and heel weight bearing precautions, in one week, the patient will be able to safely ambulate on level surface fifty feet modified independent with a front wheeled walker to be able to navigate around the home independently for activities of daily living."

Overall, the patient expressed satisfaction with PT efforts and had thought that his overall mobility was not hindered much from his first surgery. He was looking forward to finishing up his rehabilitation at a subacute facility without verbal expression of any disappointment.

Hospitalization Two

Post-surgical TMA the patient had shown an even greater decrease in his functional mobility. He was still using a front wheeled walker to ambulate but with minimal assist for ten second increments as his legs became shaky and weak at an earlier point in ambulation. He also required moderate assist of one person for sit to stand transitions during this time which he was able to do with minimal assist to contact guard assist beforehand. His goals for the second hospitalization were the same as the first hospitalization however, he now required much more assistance in completing the stated goals.

During this time the patient discussed multiple times that he was happy with the multidisciplinary team and their roles with his care. He thought that the care was

exceptional, but that his own personal circumstance was hindering his response to the interventions. He expressed multiple times he was tired, his muscles were sore, and that he was having more pain during this hospitalization compared to the first.

Hospitalization Three

Post-surgical BKA the patient had shown the greatest decline in his functional mobility. After the BKA, the patient had a non-weight bearing restriction on the amputated limb, whereas before the patient was able to put weight through the limb in a DARCO Medshoe through his heel. He was unable to perform bed mobility without moderate assistance at this point in time as well. He required the use of a Hoyer to get into and out of bed, on/off commode, and into and out of the chair. He attempted sit to stand transfers, however, he was unable to progress more than clearance of his pelvis off of the bed with moderate assistance of two people. His goals for this hospitalization of independent bed mobility were not reached on discharge.

The patient also developed symptoms correlating to PLP two days after the BKA which likely had a negative influence on his mentality as well as the functional impairments he was demonstrating. He expressed that he was not happy with his scenario and that he wanted to go home. The patient refused PT services two times after his BKA which further highlighted how his emotional state played a major barrier at this point in time on top of his functional impairments.

CHAPTER V

DISCUSSION

Throughout the three hospitalizations the patient demonstrated a progressive decline regarding his functional mobility. During the first hospitalization the patient was perceived to have a good prognosis moving forward as he was close to being independent with mobility tasks. On discharge he required minimal assistance to contact guard assist for functional activities. However, after the BKA, the patients' prognosis progressed to poor and he demonstrated need for moderate to maximal assistance with functional mobility tasks. Although the patient was not able to return home, nor did he meet his goals on discharge, there was confidence in both the patient and physical therapist that he would progress independence in functional mobility tasks at a subacute rehabilitation facility.

There are a few hypothesized reasons as to why the patient took a progressive decline in functional mobility throughout the course of the hospitalizations. First and most obvious, the patient was getting more complex surgeries at each subsequent hospitalization which may have played a role in both his physical and perceived emotional states. Secondly, the patient had a few sessions where he demonstrated symptoms of orthostatic hypotension. Physical therapy had to adjust the interventions more conservatively during these hypostatic events. Third, even though the patient was

receiving continuous rehabilitation from acute or subacute PT, the prolonged effects of *bed rest* may have included rapid reductions in muscle mass, reduction in bone mineral density, and impairments in other body systems which are further exacerbated by other critical illnesses.[47] Fourth, the patient had a massive shift in weight bearing precautions following his BKA which most likely influenced his functional mobility negatively as he was unable to use both LEs to help move after the operation. Lastly, and most notable to the patients third hospitalization, symptoms correlating to PLP were evident.

However, contrary to his decrease in overall functional mobility, the patient did excel and progress in certain areas of PT interventions. He demonstrated good ability to follow weight bearing precautions throughout intervention with utilization of a front wheeled walker during transfers and ambulation. While properly following precautions, the patient was able to prevent any consequences of damaging and/or re-injuring the wound. The patient also demonstrated adequate cognition and insight into his current condition and plan of care which positively affected treatment and progression of exercises and functional tasks.

Comparing and contrasting the patient with other related case studies, it was not unexpected that he took a dramatic decline in functional mobility following the BKA. With his age of 85 years, his extensive list of comorbidities and other related factors he did not have an optimal prognosis at the start of therapy. A study conducted in 2004 found that the survival rate post-operative BKA of one year was 74.5% and the survival rate past five years was only 37.8%,[40] which does not give any patient a good prognosis.

Reflective Practice

There were a couple obvious limitations to this case. First and foremost, research for rehabilitative care for patients with an amputation (prevention, rehabilitation post-operative, treatment of PLP) is significantly lacking. More research needs to be conducted to get a better grasp on the best methods to approach care for these individuals. Phantom limb pain, specifically, was a huge barrier and not being able to treat this impairment properly was a negative influence on not only the individual's physical health, but emotional health as well. Abundant research is needed in this aspect of rehabilitation. Another limitation to the study was the short time frame in which rehabilitation was given to the patient in an acute care setting. The short time frame did not adequately judge the effectiveness of all interventions, especially since decreased strength and endurance alone was a huge barrier and could not have been built up enough in that short amount of time.

There are areas in this case study that would be done differently, if done again. The main areas include the aspects of communication, established goals for the patient, and using more subjective data to evaluate the patient's stance and progression throughout treatment. More communication would have been optimal; more communication on being on the same page with the interdisciplinary team and also knowing how he genuinely felt. This would have been useful to help the patient have an even greater understanding of what he was going through. Additional questions would have been asked regarding the patients' knowledge overall on his comorbidities and prognosis moving forward so we were all on the same page. Goals for the patient were also another aspect I would change if I had done things differently. I had many goals of

functional mobility – which were appropriate –however, goals related to patient education were not established in the PT plan of care . Lastly, subjective scales would have been incorporated to a greater extent throughout the hospitalizations. Specifically, a scale judging the patients happiness or perceived improvement from PT intervention would have been useful to get a better perspective, subjectively.

The examination and interventions done with the patient were followed for all patients post-surgical with the main aspects of assessing mobility, implementing early mobilization and also correlated interventions to progress functional mobility on a per-person basis. Personally, I do believe that the interventions conducted with PT were appropriate and feasible for the overall cost to the patient and/or third-party payer. The specific operations the patient had coupled with his comorbidities and presentation granted need for rehabilitation to safely return home. Physical therapy helped with his progression to return home and without PT, the hospitalization and subacute rehabilitation may have been prolonged in time. I do not necessarily believe that any of the interventions could have been reduced or taken out since they were specifically geared towards improving his independence and return home. If anything, some of the interventions such as general ambulation or strengthening could have been conducted by a nurse or physical therapist assistant, respectively.

Reflecting back on the case study and research that went into it, the personal development that went into this was more than I had anticipated at first. Moving forward and even now, I have much more of an interest in the preventative and proactive approach to therapy in this specific population of individuals. Knowing the extensive and dramatic consequences of diabetes and related factors worries me for the future.

Regarding personal development goals, I see myself as more of an advocate in this particular realm of healthcare. Continuing education, expansion on personal knowledge, pushing public health reforms and many other aspects are what I can see myself advocating for in the future.

The therapy that was provided for this patient was limited by research, the patients' comorbidities, physical state, emotional state, as well as the short time frame for improvement with acute care PT services. However, during acute PT rehabilitation, patient education, proper gait training, and progression of functional mobility was achieved by the patient. Further research does need to be conducted to get a better grasp on the management of diabetes, prevention of ulcers, amputation, and also rehabilitation post-surgical amputation. With an increase in the prevalence of both diabetes and amputation, further research is needed to support and best treat this specific patient population in the PT healthcare setting.

REFERENCES

1. Ziegler-Graham K, MacKenzie EJ, Ephraim PL, Travison TG, Brookmeyer R. Estimating the Prevalence of Limb Loss in the United States: 2005 to 2050. *ARCH PHYS MED REHAB.* 2008;89(3):422-9.

2. Dillingham TR, Pezzin LE, MacKenzie EJ. Limb amputation and limb deficiency: epidemiology and recent trends in the United States. *SOUTH MED J.* 2002;95(8):875-883.

3. Reiber, Gayle & Boyko, Edward & Smith, Douglas. *Diabetes in America.* 2nd ed. Bethesda, MD: National Institute of Diabetes and Digestive and Kidney Disease; 1995.

4. American Diabetes Association. Economic Costs of Diabetes in the U.S. in 2017. *DIAB CARE.* 2018; 41:917-928.

5. Mayo Clinic Web site. Diabetes. https://www.mayoclinic.org/diseases-conditions/diabetes/symptoms-causes/syc-20371444. Accessed May 20, 2020.

6. Ibrahim A, Jude E, Martinez-De Jesus FR et al. *International Diabetes Federation: Clinical Practice Recommendations on the diabetic foot: a guide for health care professionals: International Diabetes Federation, 2017.* Brussels, Belgium: International Diabetes Federation; 2017.

7. Mayo Clinic Web site. Diabetic Neuropathy. https://www.mayoclinic.org/diseases-conditions/diabetic-neuropathy/symptoms-causes/syc-20371580. Accessed April 10, 2020.

8. American Podiatric Medical Association web site. https://www.apma.org/diabeticwoundcare. Accessed May 17, 2020.

9. Schaper NC, Netten JJ, Apelqcist BA et al. *IWGDF practical guidelines on the prevention and management of diabetic foot disease.* IWGDF; 2019.

10. Singh N, Armstrong DG, Lipsky BA. Preventing foot ulcers in patients with diabetes. *JAMA.* 2005; 293(2):217-28.

11. Armstrong DG, Lavery LA, Nixon BP, Boulton AJ. It's not what you put on, but what you take off: techniques for debriding and off-loading the diabetic foot wound. *Clin Infect Dis*. 2004; 39(suppl 2):S92-9.

12. Fowkes FG, Rudan D, Rudan I, Aboyans V, Denenberg JO, McDermott MM, Norman PE, Sampson UK, Williams LJ, Mensah GA, Criqui MH. Lancet. Comparison of global estimates of prevalence and risk factors for peripheral artery disease in 2000 and 2010: a systematic review and analysis. *The Lancet*. Oct 2013; 382(9901):1329-40.

13. Ramsey SD, Newton K, Blough D, et al. incidence, outcomes, and cost of foot ulcers in patients with diabetes. *Diabetes Care*. 1999; 22(3): 382-387.

14. Xu D, MD, PhD, Zou L, PhD, Xing Y, MD, PhD, et al. Diagnostic Value of ankle brachial index in peripheral arterial disease: A meta-analysis. *CAN JOURN CARD*. 2013. 29(4): 492-498.

15. Lavery LA, Armstrong DG, Murdoch DP, Peters EJ, Lipsky BA. Validation of the Infectious Diseases Society of America's diabetic foot infection classification system. *Clin Infect Dis*. 2007 Feb 15;44(4):562-5.

16. Rogers LC, Armstrong DG. Podiatry care. In: Cronenwett JL, Johnston KW, eds. *Rutherford's Vascular Surgery*. 7th Ed. Philadelphia, PA: Saunders Elsevier; 2010:1747-1760.

17. Xiang J, Wang S, He Y, Xu L, Zhang S, Tang Z. Reasonable Glycemic Control Would Help Wound Healing During the Treatment of Diabetic Foot Ulcers. *Diabetes Ther*. 2019;10(1):95-105. doi:10.1007/s13300-018-0536-8

18. Vatankhah N, Jahangiri Y, Landry GJ, Moneta GL, Azarbal AF. Effect of systemic insulin treatment on diabetic wound healing. *Wound Repair Regen*. 2017;25(2):288-291. doi:10.1111/wrr.12514

19. Brown BJ, Attinger CE. The Below-Knee Amputation: To Amputate or Palliate? *Adv Wound Care (New Rochelle)*. 2013;2(1):30-35. doi:10.1089/wound.2011.0317

20. Esquenazi A, DiGiacomo R. Rehabilitation after amputation. *J Am Podiatr Med Assoc*. 2001;91(1):13-22.

21. Webster, Joseph B. MD; Crunkhorn, Andrea DPT; Sall, James PhD; Highsmith, M. Jason PhD; Pruziner, Alison DPT; Randolph, Billie J. PhD Clinical Practice Guidelines for the Rehabilitation of Lower Limb Amputation. *Am J Phys Rehabil* : Sept 2019; 98(9):820-829 doi: 10.1097/PHM.0000000000001213

22. Brigham and Women's Hospital: Department of Rehabilitation Services. *Standard of care: lower extremity amputation.* 2011. https://www.brighamandwomens.org/assets/BWH/patients-and-families/rehabilitation-services/pdfs/general-le-amputation-bwh.pdf. Accessed May 20, 2020.

23. Physical Therapy Guide to Below-Knee Amputation (Transtibial Amputation). ChoosePT Guide. https://www.choosept.com/symptomsconditionsdetail/physical-therapy-guide-to-belowknee-amputation-2. Accessed May 15, 2020.

24. Melzack R. Phantom limbs and the concept of a neuromatrix. *Trends Neurosci* 1990;13:88-92.

25. Subedi B, Grossberg GT. Phantom limb pain: mechanisms and treatment approaches. *Pain Res Treat.* 2011;2011:864605. doi:10.1155/2011/864605

26. Johnson, M, Mulvey MR, Bagnall A. Transcutaneous electrical nerve stimulation (TENS) for phantom pain and stump pain following amputation in adults. *Cochrane Library.* August 18, 2015.

27. Black LM, Persons RK, Jamieson. Clinical inquiries. What is the best way to manage phantom limb pain? *J Fam Pract.* 2009 Mar; 58(3):155-8.

28. Barbin J, Seetha V, Casillas JM, Paysant J, Perennou D. The effects of mirror therapy on pain and motor control on phantom limb in amputees: a systematic review. *Phys Rehab Med.* 2016; 59(4): 270-275. doi.org/10.1016/j.rehab.2016.04.001

29. Sherman RA, Sherman CJ, Gall NG. A survey of current phantom limb pain treatment in the United States. *Pain.* 1980;8(1):85-99. doi:10.1016/0304-3959(80)90092-5

30. Mayo Clinic Web site. Residual limb pain. https://www.mayoclinic.org/diseases-conditions/residual-limb-pain/cdc-20447167#:~:text=Neuromodulation.,help%20relieve%20residual%20limb%20pain. Accessed June 13, 2020.

31. Knetsche RP, Leopold SS, Brage ME. Inpatient management of lower extremity amputations. *Foot Ankle Clin.* 2001;6(2):229-241.

32. Fairview Web site. Preparing your residual limb for a prosthesis. https://www.fairview.org/patient-education/88864#:~:text=Desensitization%20can%20help.,tolerance%20improves%2C%20slowly%20increase%20pressure. Accessed June 13, 2020.

33. Schoppon T, Boonstra A, Groothoff J et al. Physical, mental and social predictors of functional outcome in unilateral lower-limb amputees. *Phys Med Rehab*. 2003; 84(6):803-811.

34. Marzen-Groller KD, Tremblay SM, Kaszuba J, et al. Testing the effectiveness of the Amputee Mobility Protocol: a pilot study. *J Vasc Nurs*. 2008;26(3):74-81.

35. Madsen UR, Hommel A, Bottcher Berthelson C, Baath C. Systematic review describing the effect of early mobilization after dyvascular major lower limb amputations. JOUR CLIN NURS. 2017; 26(21).

36. Cleveland Clinic Website. 6 clicks functional measurement tool: why it's drawing crowds at conferences far and wide. Sept 12, 2017. https://consultqd.clevelandclinic.org/6-clicks-functional-measurement-tool-why-its-drawing-crowds-at-conferences-far-and-wide/. Accessed June 12, 2020.

37. Diane U. Jette, Mary Stilphen, Vinoth K. Ranganathan, Sandra D. Passek, Frederick S. Frost, Alan M. Jette, Validity of the AM-PAC "6-Clicks" Inpatient Daily Activity and Basic Mobility Short Forms, *Physical Therapy*, March 2014; 94(3):379–391, https://doi.org/10.2522/ptj.20130199

38. DeVahl J: "Neuromuscular Electrical Stimulation," In: MR Gersh, eds. *Electrotherapy in Rehabilitation*. Philadelphia, PA: FA Davis; 1992

39. Low EE, Inkellis E, Morshed S. Complications and revision amputation following trauma-related lower limb loss. *Injury*. Feb 2017;48(2):364-370.

40. Aulivola B, Hile CN, Hamdan AD, et al. Major Lower Extremity Amputation: Outcome of a Modern Series. *ARCH SURG*. 2004;139(4):395–399. doi:10.1001/archsurg.139.4.395

41. Peters EJ, Childs MR, Wunderlich RP, Harkless LB, Armstrong DG, Lavery LA. Functional status of persons with diabetes-related lower-extremity amputations. *Diabetes Care*. 2001;24(10):1799-1804. doi:10.2337/diacare.24.10.1799

42. Dutton M. Patient/client management. In Weitz M, Kearns B eds. *Introduction to Physical Therapy and Patient Skills*. Pittsburg, PA: McGraw-Hill; 2014. Accessed September 2, 2020. https://accessphysiotherapy-mhmedical-com.ezproxylr.med.und.edu/content.aspx?bookid=1472&sectionid=86199898

43. Smieja M, Hunt DL, Edelman D, Etchells E, Cornuz J, Simel DL. Clinical examination for the detection of protective sensation in the feet of diabetic patients. International Cooperative Group for Clinical Examination Research. *J Gen Intern Med*. 1999;14(7):418-424. doi:10.1046/j.1525-1497.1999.05208.x

44. Gogia PP, Braatz JH, Rose SJ, Norton BJ. Reliability and validity of goniometric measurements at the knee. *Phys Ther.* 1987; 67:192-195.

45. Kendall F.P., Kendall McCreary E., Provance P.G. Muscles—testing and function. 4th ed. Baltimore: Williams and Wilkins; 1993: 179–190.

46. Guide for the Uniform Data Set for Medical Rehabilitation: Adult Functional Independence Measure (FIM), Version 4.0. Buffalo, NY 14214: State University of New York at Buffalo, 1993.

47. Parry SM, Puthucheary ZA. The impact of extended bed rest on the musculoskeletal system in the critical care environment. *Extrem Physiol Med.* 2015;4:16. doi:10.1186/s13728-015-0036