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Treatment Post Total Knee Arthroplasty with Common Peroneal Nerve Palsy

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TREATMENT POST TOTAL KNEE ARTHROPLASTY WITH COMMON PERONEAL NERVE PALSY

by

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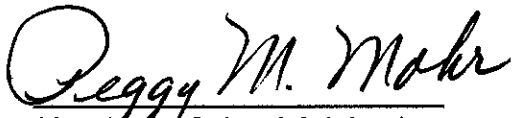

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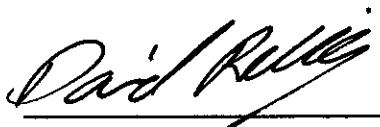

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I would like to thank the patient in this case, the faculty and staff of UND Physical Therapy, my clinical instructor, and my fellow classmates for their support and the educational tools necessary to benefit this patient during physical therapy treatment.

ABSTRACT

Introduction. With more than 600,000 knee replacements performed each year in the United States,[1] functional exercise is necessary post-surgery. Patients who undergo knee replacements often attend physical therapy after surgery, which has been found to have significant effects on functional outcomes. In rare cases, patients experience a post-surgical complication of common peroneal nerve palsy (CPNP), and interventions must be adjusted based on the patient's specific needs.

Purpose. This is a case report describing the interventions for a patient with a right total knee arthroplasty ([R] TKA), multiple co-morbidities, and a post-surgical complication of CPNP.

Methods. A 78-year-old female had a (R) TKA after end-stage osteoarthritis (OA). She was referred to physical therapy for evaluation and treatment post-TKA surgery, with a goal of returning to her prior level of function. The plan of care included hip and knee musculature strengthening in weight-bearing (WB) and non-WB, balance training, functional mobility training specific to the patient's goals, and a home exercise program (HEP) to address functional limitations.

Results. Exercise intervention lasted 5 weeks, and the patient displayed improved clinical outcomes in (R) lower extremity (LE) strength and range of motion (ROM), decreased verbal pain rating, and improved functional measures. The Lower Extremity Functional Scale (LEFS) score was reduced from 98%

impaired to 46%; however, the patient's further progress in therapy was limited by co-morbidities, specifically the OA in her left knee and her CPNP.

Conclusion. A combination of strength, balance, and functional training led to improved functional outcomes for this patient.

CHAPTER I

BACKGROUND AND PURPOSE

According to the Agency for Healthcare Research and Quality (AHRQ), there are more than 600,000 knee replacements performed each year in the United States, and joint replacements are going to become the most common elective surgical procedures by 2030.[1,2] Joint replacement surgery has been completed since 1968 and has shown to be a reliable procedure, 'improving patients' quality of life by reducing pain and allowing return to daily functional activities.[2]

Arthritis is the most common cause of chronic knee pain which often leads to the need for a Total Knee Arthroplasty (TKA). There are 3 main subtypes of arthritis contributing to knee pain: osteoarthritis, rheumatoid arthritis, and post-traumatic arthritis. Osteoarthritis (OA) usually occurs in people over 50-years-old and is a "wear and tear" type of arthritis. With OA, cartilage that cushions the bones of the knee wears down and, eventually, the bones rub against their surfaces leading to knee pain, stiffness, and swelling.[2] Treatment of OA with TKA has shown to be effective with more than 90% of people who undergo TKA experiencing a dramatic reduction of knee pain.[3]

George et al[4] found that Medicare patients with OA, who received TKA, improved on 3 different self-reported physical functioning scales, whereas patients with OA who did not undergo TKA declined over time. A recent

systematic review and meta-analysis by Artz et al[5] found that physiotherapy and exercise interventions after TKA provided evidence for short-term effectiveness; however, long-term effectiveness was well not established. These authors highlighted the importance of the need for more sufficiently powered studies on this topic and recommended that future studies address patients' post-surgical expectations. By understanding patient expectations, interventions may be adjusted to include patient education to ensure they have realistic expectations for after their TKA surgery.

Although TKA surgery provides numerous positive benefits for individuals with severe OA, there are also possible complications from surgery. These include infection, blood clots, implant problems, continued pain, and neurovascular injury.[2] Other major medical complications such as heart attack or stroke occur even less frequently.[2] Factors that have been associated with an increased risk of cardiac complications following total joint replacement surgery include a history of arrhythmia; a history of coronary artery disease, myocardial infarction, congestive heart failure, or valvular heart disease; revision surgery; and bilateral surgery.[6]

Even though surgery generally has favorable outcomes, a rare complication following TKA is common peroneal nerve palsy (CPNP) resulting in an acute onset of foot drop. Previous studies[7, 8] have found the incidence to range from 0.5%-1.3%. Factors that have been found to contribute to this injury are compression of the common peroneal nerve at the fibular neck, positioning during anesthesia, compression wrapping around the knee, correction of valgus

or flexion contracture at the knee, rheumatoid arthritis, previous spinal pathology, and a high body mass index (BMI).[7] The initial recommended treatment for CPNP is a conservative approach including physical therapy for range of motion exercises and the use of an ankle-foot orthoses (AFO).[7,8] One study[7] that looked at time to recovery found that CPNP resolved completely for two-thirds of patients by one year; however, surgical decompression is recommended if improvements are not seen with conservative treatments for 3 months.[9]

In this case report, the patient had several co-morbidities, including the post-surgical complication of CPNP, bilateral knee OA, and early symptoms of congestive heart failure (CHF). While skilled physical therapy interventions post-TKA surgery have been found to have positive effects on outcomes, the complication of CPNP can potentially inhibit progress with rehabilitation. This made it important to tailor physical therapy interventions to meet the specific needs of this patient. In a systematic review by Pozzi et al,[10] the authors recommended that outpatient physical therapy protocols include strengthening and intensive functional exercises; and to progress the program as patients tolerate. Lin et al[11] found that for patients with knee OA, non-weight-bearing exercises for strength and balance training significantly improved outcomes for muscle strength and proprioceptive function. Due to the patient's bilateral knee OA, several interventions were adapted based on this evidence.

Since there are various factors that influence a patient's progress in physical therapy, to view the individual holistically and account for factors other than just their disease or pathology, the International Classification of

Functioning, Disability, and Health (ICF) Model was utilized. The ICF is beneficial in organizing information from all aspects of a patient's life and predicting outcomes. The ICF is a classification system developed by the World Health Organization (WHO), which provides a common language among health professionals to describe the different elements of human functioning.[12] This model takes the emphasis off the diagnosis or disease and focuses on the abilities of an individual based on the situation, environmental factors, and personal factors. The ICF Model was used in this case to assist with the decision-making process for this patient throughout the course of her physical therapy.

Much of the research for TKA has excluded patients with comorbidities which is not always generalizable to most patients who undergo joint replacement surgery.[10] The purpose of this case study is to describe the plan of care and clinical decision making involved with a patient post-TKA surgery who had multiple co-morbidities and a surgical complication of CPNP.

CHAPTER II

CASE DESCRIPTION

The patient, a 78-year-old Caucasian female, was referred to physical therapy for evaluation and treatment after (R) TKA with cement, which was performed 5 days prior to her physical therapy examination. The patient showed signs of CPNP the day of surgery, which was observed during her physical therapy session in the hospital, as she had minimal ability to dorsiflex her (R) ankle. She could bear full weight on the leg which she had surgery on, but the precaution was to not twist her leg while her foot was planted on the ground. Past medical history included bilateral knee OA for the "past several years," hypertension (controlled with medications), early symptoms of congestive heart failure (checked regularly by her cardiac physician), obesity, asthma, spinal stenosis, and gastroesophageal reflux disease (GERD). She stated her left (L) knee was "in worse shape but the doctors decided to do the right one first."

Using the Numeric Pain Rating Scale (NPRS),[13] the patient chose a whole number from 0-10 (0 = no pain, 10 = worst pain) that best reflected her pain. This scale was used throughout her course of treatment. The NPRS has been found to have high test-retest reliability.[14] Prior to the examination, the patient rated her pain as 5-6/10. She reported that she had been taking her pain medications regularly and using her polar ice machine to help relieve pain. The ice machine

was included with the cost of surgery, and it circulates ice water through a tube into a "bladder" that wraps around the knee joint. The patient stated her pain increased when she would bend and straighten her knee and when she wore the ankle-foot orthosis (AFO) prescribed to her the day after surgery.

Prior to surgery, the patient could complete most daily activities independently, with minimal modifications of using her assistive devices and allowing for more time to complete activities. Occasionally, her husband helped her with dressing, cooking, and climbing stairs to get to the bedroom and bathroom. She could walk short distances in the community with a four-wheeled-walker and used two canes in the house. Otherwise, the patient's husband pushed her in a wheelchair (WC) when out in the community. After surgery, the patient had been receiving assistance from her husband with getting dressed, transferring, and bathing with a sponge bath.

The patient lived with her husband in a house which had 3 stairs with handrails to enter the house. She reported there were 15 stairs with handrails to reach their bedroom and the only bathroom in the house. The patient's husband stated he made modifications so that there was a bed and commode on the main level of the house. The patient and her husband were retired and a typical day for them included "driving into town to go out for breakfast, going to the grocery store, driving around the country side, and going back to the house to relax and work on crossword puzzles."

The patient was appropriate to complete an examination to determine her functional limitations after TKA surgery. Since she was less than a week out of

surgery, the plan was to modify the examination procedure to the patient's tolerance.

Examination, Evaluation and Diagnosis

Examination. The examination was based on components of Magee's Orthopedic Physical Assessment of the knee[15] and modified due to the patient's post-surgical status. When the patient arrived at the physical therapy clinic, she filled out a history form, consent forms, and the Lower Extremity Functional Scale (LEFS). The LEFS is a patient self-reported tool used to measure lower extremity musculoskeletal function. There are 20 items which are scored on a 5-point scale that ranges from 0 to 4. Total score ranges from 0 to 80 points, with higher scores indicating higher levels of function.[16] Sensitivity and specificity have not been established for knee disorders, but reliability was found to be .85 for TKA.[17] The patient completed the LEFS with a score of 2/80, 98% impaired.

She was wheeled in on her WC by her husband. The patient was in apparent distress, and she reported she had 'nausea from pain medication' and 'pain from the ankle orthosis.' The patient was obese but appeared well-nourished. Skin integrity of the surgical incision, which was covered with the surgical bandage, was assessed, and there were no apparent signs of infection.

Functional mobility was assessed through transfers, gait, bed mobility, and the LEFS. The patient transferred from sitting in her wheelchair, with her front-wheeled-walker (FWW) in front, to standing with minimal assist (Min. Assist) (patient can perform 75% or more of task) to moderate assist (Mod. Assist) (patient can perform 50-74% of task) of 1 person with cueing on hand positioning

for safety, leaning forward, and pushing through her upper extremities. The patient initially grasped her FWW when she was standing and stated it made her "feel more secure." She was educated on the proper transfer technique by placing her hands on the stable surface (armrests of the WC) and pushing through her upper extremities to prevent a fall. The patient ambulated 50 feet with Min. to Mod. Assist of 1 person, a gait belt, and her FWW, demonstrating a step-to antalgic gait pattern to the right. She displayed decreased safety as she would lean onto the walker on her forearms, due to complaints of low back pain, so she required cueing on placing her hands on the handles and standing up straight. The patient then transferred from sitting to supine on the plinth with Mod. Assist of 1 person for help lifting her lower extremities and lowering her upper trunk onto the table. She completed bed mobility with Min. Assist for moving the operated lower extremity (LE); however, she was independent with this at home with the use of a leg lifter strap. Stair negotiation was not assessed at that time due to the patient's pain level.

Knee range of motion (ROM) was measured in supine with a standard goniometer and was based on techniques from the *Cram Session in Goniometry and Manual Muscle Testing* book.[18] Active knee flexion was performed by asking the patient to bend her leg and slide her foot up towards her buttocks as far as she could go. For knee extension, the patient placed her ankle on a bolster and was asked to push her knee down towards the table. Measurements can be found in Table 1. The patient reported knee pain with both knee flexion and extension.

Formal manual muscle testing[18] was not completed on the (R) knee secondary to the patient's acute post-operative status. Left hip flexion was 4+/5 (holds test position against moderate to strong resistance) and hip extension and hip internal/external rotation, abduction, and knee flexion/extension were all 4/5 (holds test position against moderate resistance).[18] All manual muscle testing was completed in supine as the patient was unable to tolerate side-lying or prone positions. The patient reported some numbness/tingling in her (R) LE and stated she was 'not able to control' her (R) foot.

Table 1

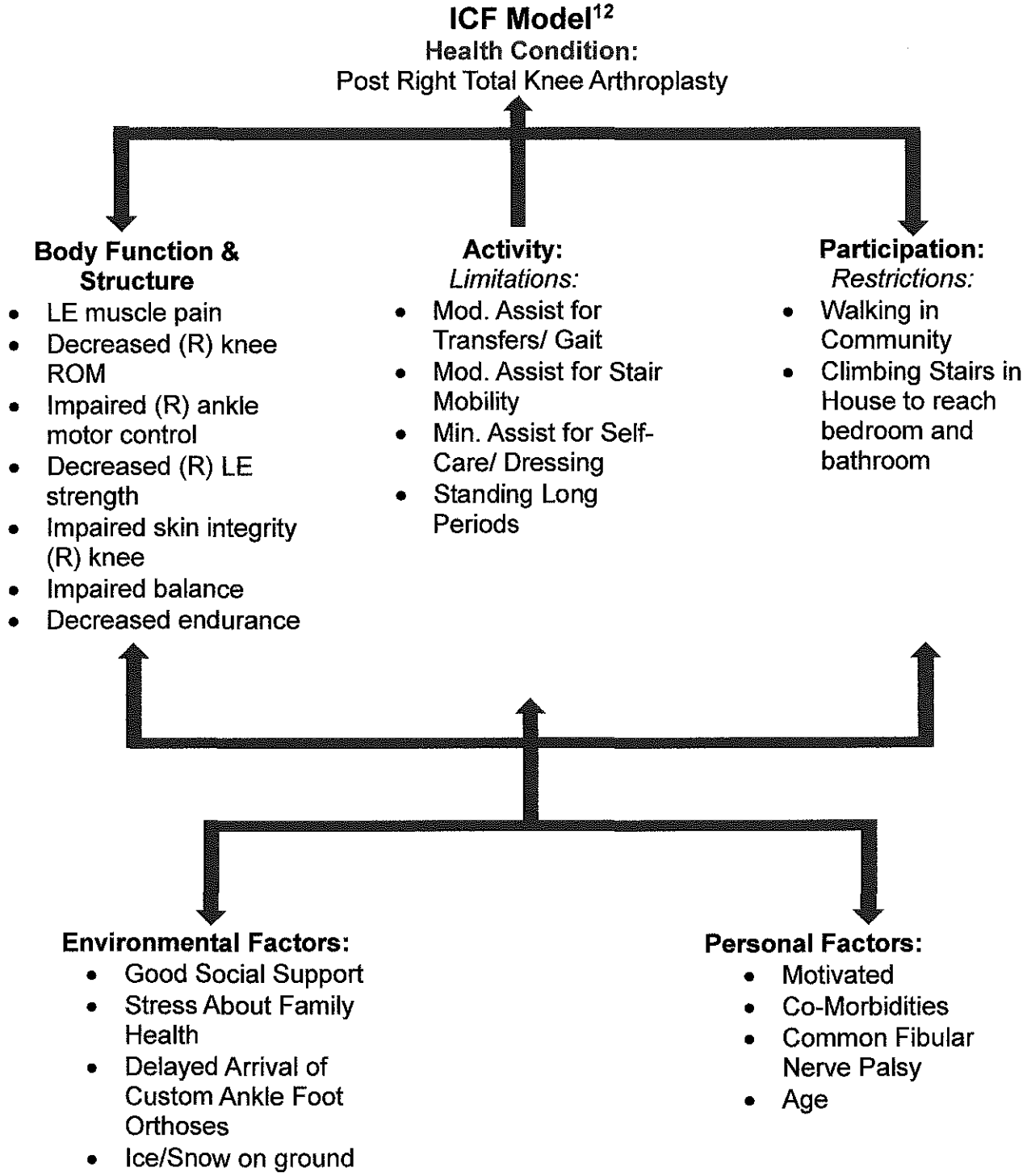
Initial Knee Range of Motion (in Degrees)

	Right	Left
Flexion	92	106
Extension	12 (lacking)	7 (lacking)

Evaluation. Based on the examination, the patient presented with impaired transfers and activities of daily living, impaired balance/proprioception, decreased endurance/tolerance, decreased hip and knee strength bilaterally, decreased knee range of motion bilaterally, impaired motor control of (R) ankle, increased edema of (R) knee, impaired stair mobility, impaired standing balance, and pain which limited function. Impairments and functional limitations were summarized in the ICF Model[12] to assist the decision-making process and can be found in Figure 1.

Figure 1

Decision Making Model



Diagnosis. The patient was status post right total knee arthroplasty using cement.

Prognosis and Plan of Care

The patient's rehabilitation prognosis was fair due to several co-morbidities and potential barriers which included CPNP limiting (R) ankle function, bilateral knee pain, low back pain when standing or walking long periods of time, and an overly helpful husband. Her husband tended to try to do everything for her which could have limited the patient from maximizing functional independence. On the other hand, her husband was also beneficial to the patient as a good support system.

The patient was appropriate for skilled physical therapy interventions due to her limitations listed above and agreed to complete physical therapy. The patient was seen 3 days a week for 3 weeks and then 2 days a week for 2 weeks for 1-hour sessions. The patient's short term goals were to be met within 2 weeks and included being able to carry out her home exercise program (HEP) independently for increased tolerance of daily activities and continued strengthening and to increase strength to 3+/5 for (R) knee flexion and extension for increased stability during gait and transfers. Long term goals were to bet met within 6 weeks and included being able to: 1) decrease pain to 1-2/10 to carry out HEP with minimal pain and for increased tolerance of daily activities, 2) be independent in HEP to continue progress made in therapy at home, 3) increase ROM on (R) knee to 115 degrees of flexion and 0 degrees of extension for increased mobility during gait and transfers, 4) demonstrate strength of at least

4/5 for (R) knee flexion and extension for increased stability during daily activities, gait, and transfers, and 5) score at least 50% or less impaired on the Lower Extremity Functional Scale (LEFS) for increased tolerance of daily activities.

CHAPTER III

INTERVENTION

The patient attended physical therapy for 13 sessions over the course of 5 weeks. Interventions were based upon a Total Knee Arthroplasty Protocol provided to the patient by the hospital, prior to surgery, current evidence, and the patient's specific needs. A detailed outline of the Plan of Care can be found in Table 2 in the Appendix. The patient's HEP consisted of hip and knee strengthening exercises,[19,20] ankle ROM, stretching hamstrings and calf musculature, pain management techniques and modalities for edema, balance training,[21,22] and increased ambulation distance in her house and in the community as appropriate. A gait belt was always used with this patient during physical therapy treatment due to decreased balance with ambulation and transfers. Pictures of and instructions for exercises and transfers were provided in the binder that was given to the patient when she attended a class at the hospital prior to surgery.

On the first day of treatment, the examination and evaluation process was completed, the patient was educated on pertinent anatomy and healing time frames, signs of infection, modalities for edema and pain control, correct execution of exercises, and her active role and participation with therapy. The patient's incision was inspected and showed no signs of infection. She completed

strengthening exercises given to her in the hospital to assure correct performance and was instructed in hamstrings and calf stretches which were added to the HEP. The patient was instructed to complete passive range of motion (PROM) and active-assistive range of motion (AAROM) of her (R) ankle for treatment of her CPNP. For specific interventions, see Table 2 in the Appendix. Since the patient and her husband reported one of their main concerns was the AFO, which was "causing her more pain," it was recommended that she discuss her concerns with the surgeon at the follow-up appointment.

At the second visit, the patient rated her pain as 8/10 (scale of 0 – 10), but she agreed to participate in therapy. She noted that she had seen her primary care provider that day and had been tested for a possible deep vein thrombosis, which was negative. The patient began endurance training by warming-up on the NuStep® bike without any resistance. During ambulation, she continued to display decreased safety observed in the initial evaluation. She required cueing on posture and keeping the FWW close to her body, and she was reminded of the importance of safe hand positioning on the stable surface rather than the FWW during sit-to-stand transfers. Strengthening exercises were performed in supine and in sitting and heel slides were completed on a sliding board with a pillow case. The patient was educated on progressing strengthening exercises by first increasing number of repetitions and then adding a resistance band. Functional training of sit-to-stands from a standard height chair were completed for lower extremity strengthening and to increase independence.[23] Patient

education was given on carrying out the transfer safely with correct hand positioning and slowly lowering herself to the chair.

At the third visit, the patient reported she was going to be fitted for a custom AFO the following week, but she continued to not wear the brace sent home from the hospital at time of discharge because it caused her pain. Weight-bearing (WB) exercises were added to treatment so the patient could progress the amount of time spent on her feet. The patient completed WB exercises with the FWW in front of her for increased balance. She was instructed to hold onto a counter when she completed these exercises at home with her husband standing beside her for safety. She required several seated rest breaks throughout the course of therapy with any WB exercises due to pain in her back and (L) knee and decreased endurance.

At the fourth visit, the patient reported she had her staples removed the day before and that she had been "walking more around the house." There were no signs of infection upon inspection of the incision and it appeared to be healing well. The patient increased resistance and time completed on the NuStep®. See Table 2 in the Appendix for resistance levels and additional interventions. A static knee extension stretch with a towel roll under the ankle was added to the HEP to aid the patient in progressing towards full extension of her (R) knee.

On the day of the fifth treatment session, the patient still rated pain in her (R) knee as 8/10. She expressed concern about the incision site stating that it showed some drainage and that her knee felt "warm" that day. The incision site was inspected. The patient was educated that slight drainage was normal;

however, she and her husband still felt concerned. The patient had an appointment 4 days prior to this treatment session and reported that everything looked good after her staples were removed. To ease the patient's concerns, we asked the surgeon's nurse to inspect the incision site. The nurse reported that the incision "look[ed] even better than the last time [they] saw the patient," and that it was normal to have some drainage. The patient stated she had not climbed the staircase to reach the second floor of her house yet, so stair training was incorporated into the treatment session on a 4-inch step. To progress strength, she was educated on increasing repetitions and resistance with exercises, as able.

At the sixth treatment session, the patient rated her (R) knee pain as 5/10, and she noted her (L) knee was starting to bother her more. She stated she had an appointment for fitting of an AFO later that morning. Due to fatigue and complaints of increased pain with activity, the patient completed mostly non-WB exercises during this treatment session.[11]

At the seventh visit, the patient rated her overall pain as 8/10 but stated that her (R) knee did not "feel that bad." She noted most of the pain was in her back and her (L) knee and felt that this was limiting her activity the most. The patient stated that she increased walking distances at home at that she practiced 4 steps on the indoor staircase (8-inch steps with 2 handrails), with Mod. Assist from her husband for balance and lifting (R) foot onto the step. Additional repetitions and resistance were added to exercises, per the patient's tolerance.

Step-ups were completed in the parallel bars with bilateral upper extremity support.

On day of the eighth visit, she reported that she had climbed the flight of stairs in her house, with help from her husband for placement of her (R) foot as she still had "no control" over it. The patient increased resistance and repetitions with exercises, and balance exercises were added to treatment. Although her (R) knee pain was not limiting her and she was progressing with strengthening exercises, the patient continued to display decreased endurance with ambulation and stated that her knee "does not want to hold up for longer walking distances."

At the ninth treatment session, the patient noted she "hardly had any pain" in her (R) knee but that her (L) knee pain ranged from 6-8/10. With ambulation, the patient showed increased gait speed and decreased antalgic pattern to the (R) LE, but the antalgic pattern was more notable on the left.

At the 10th visit, treatment was lessened due to complaints of pain in both knees and a "burning" feeling in her (R) knee. The surgical incision was inspected and there were no signs of infection. The patient did note that her (R) knee felt better after completing her exercises and applying a cold pack to her knee after this therapy session.

At the 11th visit, the patient was reminded to complete her HEP on both lower extremities, per patient tolerance, for increased strengthening and stability. She stated that her (L) knee pain increased to 8/10 after completing exercises. It was recommended that the patient discuss with her surgeon the increased pain in her (L) knee at her upcoming appointment.

At the 12th visit, the patient reported she had "hardly any pain in the (R) knee" but that her (L) knee pain had "gotten worse with the weather." She noted that she had been completing AAROM ankle exercises every day but that she still did not have much control over her (R) foot. The patient was evaluated for stair mobility and she climbed up and down 1 flight of stairs with 1 handrail, handheld assist, and occasional assist with her (R) foot to clear the step. Initially, the patient ascended the stairs leading with her (L) LE and complained of increased pain. She was instructed to try leading with her (R) LE, and she required less assistance and had decreased pain. The patient was also instructed to kick out her (L) LE when transferring from sit-to-stand on low surfaces to decrease compressive forces at her (L) knee. It was recommended that the patient continue progressing exercises by using ankle weights or household products, such as a bag of sugar, wrapped around her ankle for continued strengthening.

The patient's husband stated he was "doing the same exercises with her at home" and that he thought she was ready to be discharged from therapy. The patient had a session scheduled at the end of the week, after a follow-up visit with the surgeon. At the last visit, the patient was instructed in transfer training to/from the floor. She demonstrated the transfers with Min. Assist to contact guard assist (CGA) for balance. The patient showed progress with balance exercises as she tolerated increased time with each exercise; however, (L) knee pain and minimal function of her (R) foot continued to limit progress towards increased endurance with ambulation and during weight-bearing activities. See

Table 2 in the Appendix for more detailed interventions. The patient decided she wanted to be discharged from physical therapy and continue with her HEP independently at home. We spoke with the physician assistant (PA) about the patient's progress with therapy and the factors that limited her from further progress. The PA noted they would follow-up with the patient regarding her (L) knee pain and (R) ankle function to discuss the next course of treatment.

CHAPTER IV

OUTCOMES

The patient was discharged after 5-weeks of physical therapy intervention as she had met all her current goals. Throughout the course of treatment, the patient was dedicated to completing her HEP, and her husband remained a strong support system as he motivated and encouraged her to complete her exercises multiple times per day. She was only able to ambulate household distances and short distances in the community; however, she had initially reported that she was not an avid community walker before she had surgery.

The patient gained adequate range of motion in her (R) knee to carry out daily tasks. According to Brotzman,[24] to descend stairs reciprocally, without hip or trunk substitution, the patient needs to achieve 115-117 degrees of knee flexion. This was an important goal that this patient surpassed because she had 15 stairs to reach her bedroom and the only bathroom in her house. The patient achieved a weekly progression of range of motion, which is shown in Table 3. Pain in the patient's (R) knee decreased in severity from 8/10 to "no pain" on the NPRS, but she experienced increased pain in the (L) (non-operated) LE. The custom fit AFO did not arrive during the 5 weeks of physical therapy, but the patient faithfully completed AAROM exercises for ankle dorsiflexion and stretching of the gastrocnemius and soleus musculature in the HEP. She

required occasional assistance with climbing stairs, as her ankle function did not show improvements during treatment. Increased (R) hip and knee strength was evident as the patient tolerated increased repetitions and resistance with exercises. She also demonstrated more independence with transfers and gait. Strength was tested in supine and sitting and was increased to 4-4+/5 for the (R) hip and knee.

The patient made functional gains with transfers. She originally required Min.-Mod. Assist with all transfers and gait. After therapy, she could independently complete all transfers and gait with the use of her FWW and minimal help from her husband with setting-up her assistive device and climbing stairs safely. The patient reported she could climb the flight of stairs to reach their bedroom and the bathroom. Additionally, she improved her score on the LEFS from 2/80 (98% impaired) to 43/80 (46% impaired). The minimal detectable change (MDC) for TKA patients is an increase of total score by 9 points which this patient exceeded.[17]

Table 3

Weekly Right Knee Range of Motion Progress (in Degrees)

	Week 1	Week 2	Week 3	Week 4	Week 5
Flexion	104	112	116	118	121
Extension	15 (lacking)	7 (lacking)	4 (lacking)	2 (lacking)	1 (lacking)

CHAPTER V

DISCUSSION

Total knee arthroplasty surgeries are predicted to become one of the most common elective surgical procedures performed in the future.[1] While benefits of this procedure have included significantly reducing pain and in turn improving patient satisfaction and quality of life, it has been found that people who have undergone TKA show decreased activity levels compared people who were the same age.[25] Disuse of the muscles after a TKA and lack of quadriceps contraction can lead to muscle atrophy and have lasting effects on an individual's functional mobility. In the current case, an outpatient physical therapy treatment plan was implemented within a week after the patient's TKA surgery. At the end of treatment, which consisted of hip and knee progressive resistive strengthening in WB and non-WB positions, endurance training, balance training, and functional mobility training, the patient showed improvements in lower extremity strength from 3/5 to 4-4+/5, increased knee range of motion to functional levels, decreased pain in the surgical extremity from 8/10 with activity to "no pain," and increased independence with functional activities.

Ciolac et al[26] compared older women with knee OA, who had TKA, to older and young women groups, who did not have musculoskeletal diseases, in a resistance training program. They found that the program helped to rebuild

functional, balance, and lower-limb load deficits that were found in the TKA group at baseline. Bade and Stevens-Lapsley[27] found that a high intensity rehabilitation program initiated after TKA resulted in improved functional performance outcomes and strength in the short- and long-term compared to a lower intensity program. Even though the patient's pain in this case decreased in her (R) knee, her (L) knee pain increased throughout treatment. Due to this and a co-morbidity of chronic back pain, interventions were adjusted based on patient tolerance. Due to these factors, Lin et al[11] found that non-WB interventions for strength training and balance training both improved outcomes of knee strength and proprioceptive function.

Another area that limited further progress with therapy for this patient was a post-surgical complication of CPNP. Zywiel et al[28] found that lower extremity nerve decompression surgery improved sensation and decreased pain. These authors proposed that this course of treatment should be considered if improvements are not seen with conservative management of an AFO and physical therapy interventions. Park et al[7] reported that CPNP completely resolved in over three-fourths of patients with partial nerve palsy and one-fifth in those with complete palsy. Poage and Scott[9] recommended that patients with CPNP complete nonsurgical interventions for at least three months.

Treatment areas that were not included in this case, but that could be utilized in future cases like the current one include Kinesio Taping® for pain and edema, and neuromuscular electrical stimulation (NMES) to the quadriceps musculature for increased activation initially.

Based on outcomes of the current case, it is recommended that a combination of therapeutic exercise, balance training, and functional mobility training be used post-TKA; however, interventions should be customized based upon each patient's needs. In the rare case of common peroneal nerve injury, it is recommended that patients complete conservative treatments including physical therapy and the use of orthotic devices. Patients should consider seeking surgical treatment if they experience lasting difficulties interfering with function.

Reflective Practice

Even though this patient showed improved function and outcomes, there are aspects of this patient's examination and physical therapy that could have been done differently. In the history portion of the examination, I could have asked more specific questions about the amount and types of exercises the patient completed each week. For the examination procedures, I would have measured girth not only to have an objective measure of whether edema was decreasing, but also to keep track of if her heart problems were becoming worse resulting in an increased swelling in the legs. This patient was limited in the distance and amount of time she could walk/stand; however, it would have been useful to include more objective measures such as the Stair Climb Test, Timed "Up & Go," and the 6-Minute Walk Test (or a modified version of the test).

Throughout her physical therapy, the patient was faithful in completing her exercises and always willing to work hard during the sessions, but her pain often limited her. Treadmill training could have been a beneficial intervention to try for

additional gait training and cardiovascular exercise. I also would have liked to incorporate NMES into the treatments to try and enhance ankle function, but, unfortunately the facility did not have all the correct equipment at that time. Further research on the mirror imaging techniques would also be beneficial.

APPENDIX

Table 2

Plan of Care

	Treatment	HEP
Day 1	Initial Evaluation Patient Education: • Anatomy/Healing time frames • Infections signs • Modalities for edema/pain control • Active role in PT • Correct execution of exercises Strengthening Exercises: • Ankle Pumps 1x20 • PROM/AAROM (R) Ankle 1x20 • Short Arc Quads 10x3 sec hold • Quad Sets 10x5 sec • Supine Hamstring Sets 10x5 sec • Straight Leg Raises (SLRs) 10x2 sec • Heel Slides 1x10 Stretching Exercises: • Static Stretches Hamstrings and Calf 1x20 sec	• Static Stretch Hamstrings and Calf with Sheet 3x30 sec hold, 3x/day • Continued Strengthening Exercises 2 sets x 10 repetitions, 2x/day • Increased Household/Community Ambulation as able • Ice machine to (R) knee 20 mins, 4-5x/day
Day 2	Ambulation: • 100 ft. Total with Min. Assist and FWW (50 ft. consecutive) NuStep® x5 mins Level 1 Strengthening Exercises: • Ankle Pumps, AAROM on (R) 1x20 Bilateral • Heel Slides 10x5 sec • Quad Sets 10x5 sec • SLRs 10x3 sec • Seated Hamstring Curls with Yellow Resistance Band (3.0-4.3 lbs.) 1x10 • Long Arc Quads (LAQs) 10x3 sec Functional Mobility:	• Progressed repetitions and resistance of exercises as able • Increased Ambulation as able • Ice machine to (R) knee 20 mins, 3-5x/day

	• Sit-to-Stands from bed-height table 1x10 with FWW and Min. Assist • Supine to/from Sit with Min. Assist Vasopneumatic Pressure Device to (R) Knee x12 mins	
Day 3	Ambulation: • 135 ft. Total with Min. Assist and FWW (80 ft. longest distance) NuStep® x5 mins Strengthening Exercises: • Ankle Pumps, AAROM on (R) 1x20 Bilateral • Heel Slides 10x5 sec • SAQs 10x5 sec • SLRs 10x3 sec • Seated Hamstring Curls with Yellow Resistance Band (3.0-4.3 lbs.) 1x10 • Standing Heel/Toe Raises in FWW 1x10 each • Standing Hip Abduction in FWW 1x10 • Standing Hip Extension in FWW 1x10 Stretching Exercises: • Static Stretches Hamstrings and Calf with Sheet 3x30 sec ea. Functional Mobility: • Sit-to-Stands from bed-height 1x10 with FWW and Min. Assist	• Added WB Exercises: Heel/Toe Raises, Hip Abduction, and Hip Extension with FWW 2x10, 2x/day • Increased Ambulation as able
Day 4	Ambulation: • 210 ft. Total (100 ft. longest distance) with FWW and Contact Guard Assist (CGA) NuStep® x7 mins Level 2 Strengthening Exercises: • Ankle Pumps, AAROM on (R) 1x20 Bilateral • Heel Slides 10x5 sec • Quad Sets 10x5 sec • SAQs 10x5 sec • SLRs 10x3 sec	• Static Stretch Knee Extension with Towel Roll 1 min, 3x/day • Added WB Exercises with FWW: Standing Marches Bilateral, Hamstrings Curls Bilateral, Heel/Toe Raises 1x10, 2x/day • Increased Ambulation as able

	• Seated Hamstring Curls with Yellow Resistance Band (3.0-4.3 lbs.) 10x5 sec • LAQs 10x3 sec • Standing Marches with FWW 1x7 Bilateral • Standing Hamstrings Curls with FWW x10 Bilateral • Standing Heel/Toe Raises with FWW x10 each Stretching Exercises: • Knee Extension on bolster x1 min • Static Stretching Hamstrings and Calf with Sheet 3x20 sec ea. Functional Mobility: • Sit-to-Stands from standard chair with armrests 2x5 with FWW	
Day 5	Ambulation: • 245 ft. Total (95 ft. consecutive) with FWW and Standby-CGA NuStep® x10.5 mins Level 2-4 Functional Mobility: • Sit-to-Stand with CGA • Supine to/from Sit with Min. Assist-CGA • Stairs up/down 4-in. step x10 Bilateral with parallel bars and Standby Assist Strengthening Exercises: • Ankle Pumps, AAROM on (R) 1x20 Bilateral • Heel Slides 1x11 • Quad Sets 10x5 sec • SAQs 10x5 sec • SLRs 10x5 sec • Seated Hamstring Curls with Orange Resistance Band (3.7-5.5 lbs.) 1x12 • LAQs 10x3 sec Stretching Exercises: • Static Knee Flexion and Extension x1 min each	• Patient Education on Progressing Exercises • Increased Ambulation as able
Day 6	Ambulation:	• Increased Ambulation as able

	• 100 ft. consecutive with FWW and CGA NuStep® x10 mins Level 3 Strengthening Exercises: • Seated AAROM Ankle Pumps with Manual Stretch by Therapist 1x20 Bilateral • Seated Knee Flexion with scooter board • Quad Sets 10x5 sec • LAQs 10x5 sec • Heel Slides 1x10 with slide board • Hip Abduction 1x10 with slide board • SAQs 10x5 sec Stretching Exercises: • Seated Calf Stretch on wedge board • Static Knee Extension on bolster x2 mins Cold Pack x10 mins (R) Knee	
Day 7	Ambulation: • 145 ft. Total with FWW and Standby-CGA Functional Mobility: • Sit-to-Stand with Standby Assist • Supine to/from Sit with Min. Assist • Step-ups 6 in. step x10 Bilateral NuStep® x8 mins Levels 4-5 Strengthening Exercises: • Ankle Pumps, AAROM on (R) 1x20 Bilateral • Heel Slides x10 • Quad Sets 15x5 sec • SAQs 15x5 sec • SLRs 15x2 sec • Hamstring Curls with Green Resistance Band (4.6-6.7 lbs.) 1x15 • LAQs 15x3 sec • Standing Hip Abduction 1x15 • Standing Hip Extension 1x15	• Increased repetitions/ resistance for exercises • Increased Ambulation as able

	Stretching Exercises: • Static Knee Flexion Stretch with Manual Hold by Therapist x1 min • Knee Extension with bolster x1 min Cold Pack x10 mins (R) Knee	
Day 8	Ambulation: • 200 ft. Total with FWW and CGA Functional Mobility: • Sit-to-Stand with Standby Assist • Supine to/from Sit with CGA • NuStep® x10 mins Level 5 Strengthening Exercises: • Ankle Pumps, AAROM on (R) 1x20 Bilateral • Heel Slides x12 • Quad Sets 15x5 sec • SLRs 15x2 sec • Hamstring Curls Green Resistance Band (4.6-6.7 lbs.) 1x15 • LAQs 20x3 sec • Standing Hip Abduction and Extension with Yellow Resistance Band (3.0-4.3 lbs.) 1x15 Bilateral each Balance: (on foam mat) • Standing Feet Shoulder Width x30 sec • Standing Feet Together x10 sec and x25 sec • Stride Step x25 sec (L) foot forward, x12 sec (R) foot forward Stretching Exercises: • Knee Flexion with Manual Hold x1 min • Knee Extension on Bolster x1 min	• Increased Ambulation as able • Added Resistance Band to WB Exercises: Standing Hip Abduction and Extension, 2x10, 2x/day
Day 9	Ambulation: • 300 ft. Total (150 ft. consecutive) with FWW and Standby Assist NuStep® x8 mins Level 4, Bilateral LE only	• Increased to Blue Resistance Band (5.8-8.6 lbs.) for HS Curls, 2x10, 2x/day • Increased Ambulation as able

	Strengthening Exercises: • Ankle Pumps, AAROM on (R) 1x20 Bilateral • Heel Slides x12 • Quad Sets 20x5 sec Bilateral • SLRs 1x15 • Hamstring Curls 1x20 Green Resistance Band (4.6-6.7 lbs.), 1x10 Blue Resistance Band (5.8-8.6 lbs) • LAQ x10 Bilateral with Yellow Resistance Band (3.0-4.3 lbs.) • Standing Hip Abduction and Extension 1x15 Bilateral with Yellow Resistance Band (3.0-4.3 lbs.) • Heel Raises 1x10 Bilateral with B UE Assist Balance: (on foam mat) • Stride Step 2x45 sec Bilateral Stretching Exercises: • Knee Flexion with Manual Hold x30 sec • Knee Extension on bolster x1 min	
Day 10	Ambulation: • 320 ft. Total (160 ft. consecutive) with FWW and Standby Assist/ Setup NuStep® x8.5 mins Level 1 Strengthening Exercises: • Heel Slides with Isometric Hip Abduction 1x15 • Quad Sets 10x5 sec • SAQs 15x3 sec • SLRs 15x2 sec • Hamstring Curls with Blue Resistance Band (5.8-8.6 lbs.) 1x15 • LAQs with 1 lb. 1x15 • Seated Hip Abduction with Orange Resistance Band (3.7-5.5 lbs.) x15 Bilateral	• Increased Ambulation as able

	• Seated Ankle Pumps with Mirror Imaging 2x15 Bilateral Stretching: • Calf Stretch on wedge board x30 sec Cold Pack to (R) Knee x15 mins	
Day 11	Ambulation: • 250 ft. Total (100 ft. consecutive) with FWW and Standby Assist NuStep® x8 mins Level 4 Functional Mobility: • Sit-to-Stand Modified Independent (Mod. I.)-Setup • Step-ups 6-in. step x5 Bilateral with 2 handrails and Min. Assist Strengthening Exercises: • Ankle Pumps, AAROM on (R) 1x20 Bilateral • Heel Slides on slide board x15 • Quad Sets 15x5 sec • SAQs 20x3 sec • SLRs 1 lb. x10 • Hamstring Curls Blue Resistance Band (5.8-8.6 lbs.) x15 • LAQs 1 lb. 15x2 sec • Standing Hip Abduction and Extension with Yellow Resistance Band (3.0-4.3 lbs.) x10 B Balance: • Single Leg Stance 1x30 sec with 1 handrail Stretching: • Knee Flexion with Manual Hold x1 min	• Patient Education on completing exercises on both lower extremities • Increased Ambulation as able
Day 12	Ambulation: • 350 ft. Total (125 ft. consecutive) with FWW and Standby-CGA Trial Recumbent Bike x1 min NuStep® x8 mins Levels 3-5 Functional Mobility:	• Patient Education on use of household products for strengthening exercises • Joint Protection Strategies for (L) Knee

	• Ascended/Descended 1 Flight of Stairs with Handheld Assist, 1 handrail, and Min. Assist for (R) Foot • Sit-to-Stands with (L) LE kicked out x8 Strengthening Exercises: • Heel Slides on slide board 1x16 • SAQs 2 lb. 1x6, 1 lb. 10x2 sec • SLRs 1 lb. 1x15 • Hamstring Curls Green Resistance Band (4.6-6.7 lbs.) with Isometric Quad Hold (L) LE 1x15 • LAQs Green Resistance Band (4.6-6.7 lbs.) with Isometric Hamstring Hold (L) LE 1x15 Stretching: • Knee Flexion with Manual Hold x2 mins	– Sit-to-Stands and Climbing Stairs with • Increased Ambulation as able
Day 13	Ambulation: • 350 ft. Total (170 ft. consecutive) with FWW and Standby Assist Functional Mobility: • Transfer Training to/from Floor with Min. Assist-CGA Balance: • Rocker Board Anterior-Posterior Taps with 2 handrails, 1 HR, and No HR • Static Standing with Wide and Narrow BOS and Stride Step on Foam Mat	• Patient Education on continuing strengthening exercises on Bilateral LEs, per tolerance, 2 sets x 10-20 reps, 2x/day • Continue progressing ambulation and endurance training as able – walk around house/community at least 5x/day • Balance Exercises: Static Standing with Wide and Narrow BOS, Stride Step, SLS – 2x30 seconds, 2x/day

REFERENCES

1. AHRQ Study: Joint Replacement To Become the Most Common Elective Surgical Procedure in the Next Decades. AHRQ--Agency for Healthcare Research and Quality: Advancing Excellence in Health Care. https://www.ahrq.gov/news/newsletters/e-newsletter/503.html. Published February 2, 2016. Accessed June 20, 2017.
2. Total Knee Replacement-OrthoInfo - AAOS. Total Knee Replacement-OrthoInfo - AAOS. http://orthoinfo.aaos.org/topic.cfm?topic=A00389. Published August 1, 2015. Accessed June 20, 2017.
3. Total Knee Replacement Surgery By the Numbers. A Nation in Motion. http://www.anationinmotion.org/value/total-knee-replacement-surgery-numbers/. Accessed June 20, 2017.
4. George LK, Ruiz D, Sloan FA. The effects of total knee arthroplasty on physical functioning in the older population. Arthritis & Rheumatism. 2008;58(10):3166-3171. doi:10.1002/art.23888.
5. Artz N, Elvers KT, Lowe CM, Sackley C, Jepson P, Beswick AD. Effectiveness of physiotherapy exercise following total knee replacement: systematic review and meta-analysis. BMC Musculoskeletal Disorders. 2015;16(1). doi:10.1186/s12891-015-0469-6.

6. Basilico FC, Sweeney G, Losina E, et al. Risk factors for cardiovascular complications following total joint replacement surgery. Arthritis & Rheumatism. 2008;58(7):1915-1920. doi:10.1002/art.23607.
7. Park JH, Restrepo C, Norton R, Mandel S, Sharkey PF, Parvizi J. Common Peroneal Nerve Palsy Following Total Knee Arthroplasty. The Journal of Arthroplasty. 2013;28(9):1538-1542. doi:10.1016/j.arth.2013.02.025.
8. Schinsky MF, Macaulay W, Parks ML, Kiernan H, Nercessian OA. Nerve injury after primary total knee arthroplasty. The Journal of Arthroplasty. 2001;16(8):1048-1054. doi:10.1054/arth.2001.26591.
9. Poage C, Roth C, Scott B. Peroneal Nerve Palsy. Journal of the American Academy of Orthopaedic Surgeons. 2016;24(1):1-10. doi:10.5435/jaaos-d-14-00420.
10. Pozzi F, Snyder-Mackler L, Zeni J. Physical exercise after knee arthroplasty: A systematic review of controlled trials. Eur J Phys Rehabil Med. 2013;49(6):877-892.
11. Lin D-H, Lin C-HJ, Lin Y-F, Jan M-H. Efficacy of 2 Non-Weight-Bearing Interventions, Proprioception Training Versus Strength Training, for Patients With Knee Osteoarthritis: A Randomized Clinical Trial. *Journal of Orthopaedic & Sports Physical Therapy*. 2009;39(6):450-457. doi:10.2519/jospt.2009.2923.
12. Bellamy J. Background on ICF. APTA. http://www.apta.org/ICF/Background/. Accessed June 20, 2017.

13. Numeric Pain Rating Scale. Numeric Pain Rating Scale - Physiopedia. http://www.physio-pedia.com/Numeric_Pain_Rating_Scale#cite_note-p8-4. Accessed June 20, 2017.
14. Ferraz MB, Quaresma MR, Aquino LR, Atra E, Tugwell P, Goldsmith CH. Reliability of pain scales in the assessment of literate and illiterate patients with rheumatoid arthritis. J Rheumatol 1990;17:1022–4
15. Magee DJ. *Orthopedic physical assessment.* 6th ed. United States: Elsevier - Health Sciences Division; January 14, 2014:765–887chap 12.
16. The Lower Extremity Functional Scale (LEFS): Scale Development, Measurement Properties, and Clinical Application. *Physical Therapy.* January 1999. doi:10.1093/ptj/79.4.371.
17. Stratford PW, Kennedy DM, Riddle DL. New study design evaluated the validity of measures to assess change after hip or knee arthroplasty. *Journal of Clinical Epidemiology.* 2009;62(3):347-352. doi:10.1016/j.jclinepi.2008.06.008.
18. Ost LV. *Cram Session in Goniometry and Manual Muscle Testing: a Handbook for Students and Clinicians.* Thorofare: SLACK Incorporated; 2013.
19. Alnahdi AH, Zeni JA, Snyder-Mackler L. Hip Abductor Strength Reliability and Association With Physical Function After Unilateral Total Knee Arthroplasty: A Cross-Sectional Study. *Physical Therapy.* 2014;94(8):1154-1162. doi:10.2522/ptj.20130335.

20. Piva SR, Teixeira PE, Almeida GJ, et al. Contribution of Hip Abductor Strength to Physical Function in Patients With Total Knee Arthroplasty. *Physical Therapy.* 2011;91(2):225-233. doi:10.2522/ptj.20100122.

21. Jogi P, Overend TJ, Spaulding SJ, Zecevic A, Kramer JF. Effectiveness of balance exercises in the acute post-operative phase following total hip and knee arthroplasty: A randomized clinical trial. *SAGE Open Medicine.* 2015;3:205031211557076. doi:10.1177/2050312115570769.

22. Liao C-D, Liou T-H, Huang Y-Y, Huang Y-C. Effects of balance training on functional outcome after total knee replacement in patients with knee osteoarthritis: a randomized controlled trial. *Clinical Rehabilitation.* 2013;27(8):697-709. doi:10.1177/0269215513476722.

23. Liu C, Shiroy DM, Jones LY, Clark DO. Systematic review of functional training on muscle strength, physical functioning, and activities of daily living in older adults. *European Review of Aging and Physical Activity.* 2014;11(2):95–106. doi:10.1007/s11556-014-0144-1.

24. Brotzman BS, Manske RC, Daugherty K, Robert dos Remedios MA CSCS. *Clinical Orthopaedic rehabilitation: An evidence-based approach - expert consult: Print and online.* 3rd ed. Philadelphia, PA: Elsevier Mosby; May 6, 2011:chap 6.

25. Lützner C, Kirschner S, Lützner J. Patient Activity After TKA Depends on Patient-specific Parameters. *Clinical Orthopaedics and Related Research®.* 2014;472(12):3933-3940. doi:10.1007/s11999-014-3813-5.

26. Ciolac E, Silva J, Greve J. Effects of resistance training in older women with knee osteoarthritis and total knee arthroplasty. *Clinics*. 2015;70(1):7-13. doi:10.6061/clinics/2015(01)02.

27. Bade MJ, Stevens-Lapsley JE. Early High-Intensity Rehabilitation Following Total Knee Arthroplasty Improves Outcomes. *Journal of Orthopaedic & Sports Physical Therapy*. 2011;41(12):932-941. doi:10.2519/jospt.2011.3734.

28. Zywiel MG, Mont MA, Mcgrath MS, Ulrich SD, Bonutti PM, Bhave A. Peroneal Nerve Dysfunction After Total Knee Arthroplasty. *The Journal of Arthroplasty*. 2011;26(3):379-385. doi:10.1016/j.arth.2010.03.020.