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Physical Therapy Interventions and Functional Outcomes for an 80-Year-Old Female Following Total Knee Replacement and Subsequent Infection: A Case Report

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PHYSICAL THERAPY INTERVENTIONS AND FUNCTIONAL OUTCOMES FOR AN 80-YEAR-OLD FEMALE FOLLOWING TOTAL KNEE REPLACEMENT AND SUBSEQUENT INFECTION: A CASE REPORT

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ABSTRACT

Background and Purpose: The purpose of this case study is to describe the interventions and outcomes of a physical therapy (PT) episode of care in an inpatient skilled nursing facility (SNF) for a subject following a left total knee replacement and subsequent infection.

Case Description: The subject was an 80-year-old Caucasian female who was status post left total knee replacement (TKR) with subsequent infection. The subject presented with left knee pain, limited range of motion (ROM), and impaired function.

Outcomes: Increased active range of motion (AROM) of left knee, increased balance, increased ambulation distance, improved performance on Tinetti-POMA, and increased independence with bed mobility, transfers, and ambulation.

Discussion: PT interventions focused on increasing functional mobility, ROM and strength of involved lower extremity (LE), and ambulation distance and independence may be effective in increasing functional independence and knee mobility of patients following TKR and infection.

BACKGROUND AND PURPOSE

A total knee replacement is an effective surgical intervention commonly used for osteoarthritis (OA) and other knee joint disorders associated with chronic knee pain and dysfunction in individuals over the age of 60.[1] The surgical procedure varies by the surgeon, but is generally characterized by surgical removable of the articulating surfaces of the femur and tibia and replacement of these articulating surfaces with various materials such as metal or plastic in order to reduce friction.[1] The procedure typically results in decreased pain associated with OA and increased function of the knee.[1]

In the U.S. in 2013, the estimated prevalence of people over 50 years old living with a TKR was 4.2%. It was found to be more common in women than in men, and it was estimated that at least half of those diagnosed with knee osteoarthritis will undergo a total knee replacement.[2] It is estimated that 6.1% of TKR result in complications during their hospital stay and 7.5% result in complications within 90 days of surgery. Of these complications, postoperative infections occurred during the hospital stay in 1.1% of patients and 1.8% of patients after 90 days.[3]

After a TKR, patients with osteoarthritis reported significant improvements in overall physical functioning on the Short Form 36 (SF-36) and demonstrated significant improvements in objective knee outcome

measures of the Oxford Knee Score (OKS) and the Knee Society Clinical Rating Scale (KSS).[4] However, no significant improvements were reported in social functioning, general health, and mental health.[4] Approximately 95% of patients are satisfied with their knee replacement surgery. However, in 2013, 0.2% of patients required revisions after 90 days, 3.7% after 18 months, 6% after 5 years, and 12% after 10 years of the initial knee replacement surgery.[3]

After surgery, patients often present with many impairments including reduced strength, reduced knee active and passive ROM, and decreased functional mobility. On average, quadriceps strength is reduced by 62%, voluntary muscle activation was reduced by 17%, and cross-sectional area of the quadriceps muscles was reduced by 10% postoperatively.[5] In a study by Bade *et al*., average knee flexion ROM in the acute stage following TKR was reduced by approximately 53° and knee extension was reduced by approximately 10° on average.[6] The average time to complete the Timed Up and Go (TUG) was significantly increased in the acute phase following TKR, which demonstrates significant impairment in functional mobility.[6]

A postoperative rehabilitation program has been shown to significantly improve knee flexor and extensor strength in patients with a TKR due to OA.[7] A walking-skill program compared to standard PT resulted in increased performance on Six-Minute Walk Test (6MWT) and thus greater functional mobility.[8] PT has become a standard of care following total knee

replacements due to the risk of permanent functional deficits that are common after the acute phase of recovery has passed. ROM, strength, and balance deficits that are common after a TKR all impact functional mobility and the quality of life of the patients postoperatively. PT has been shown to improve all of these impairments. However, little research on the effect of postoperative infection on the overall recovery following TKR. The subject discussed in this case report provides insight into the length of stay and functional outcomes of PT in the inpatient subacute rehabilitation setting following a TKR and subsequent infection.

CASE DESCRIPTION: PATIENT HISTORY AND SYSTEMS REVIEW

Patient History

The subject was an 80-year-old Caucasian female who received a scheduled left TKR 6 days prior to her initial evaluation at a SNF. Prior to her surgery, she was living alone in an independent living facility. Her apartment was on the second floor with elevator access. She was widowed in 2012 and has no children or other family members. The subject elected the TKR due to increasing arthritic pain in her left knee. Unfortunately, early in her stay at the facility, the subject developed an infection in the operative knee and received intravenous antibiotics. Her current medical history included hypertension, hyperlipidemia, gastro-esophageal reflux disease,

B12 deficiency, and decreased vision, requiring glasses. Her past medical history included rheumatic heart disease and anxiety.

The subject was discharged from the hospital to a SNF due to an inability to walk and perform activities of daily living (ADLs) safely and independently. Her entire length of stay at the SNF was 50 days in addition to the 6-day acute stay in the hospital immediately postoperatively. The subject was referred to PT in order to increase joint ROM, increase gait distance and quality, and improve overall function, independence, and safety. Prior to surgery, the subject was at the level of modified independent (MI) in using a rolling walker with all functional mobility at home and in the community, but did not use stairs due to elevator access. The subject was knowledgeable of her condition and understood her limitations. Approximately two years prior to this admission, she received a previous TKR of her right knee without complications and was able to return home safely and independently. The subject stated her goal for therapy as to be able to walk as she did prior to this surgery in order to safely get around her apartment complex, at the time of the initial evaluation.

Systems Review

Musculoskeletal

Upon initial evaluation, the subject demonstrated limitations in ROM and strength of the left lower extremity, especially of the left knee joint.

Neuromuscular

Upon initial evaluation, the subject demonstrated impairments in all aspects of standing balance.

Cardiopulmonary

Upon initial evaluation, the subject's blood pressure was 137/71 mmHg, her heart rate was 83bpm, respiratory rate was 18bpm, and percent oxygen saturation was 91% at rest.

Integumentary

Upon initial evaluation the left knee surgical site was covered with a dressing, with staples in place, and without discharge. She had 1+ pitting edema of the left knee region. Over the course of treatment, the subject presented with increasing erythema, edema, and temperature upon palpation of the surgical knee due to a developing infection.

CLINICAL IMPRESSION 1

The findings from the patient history and systems review indicated that the subject was appropriate for PT intervention based on her prior level of function and ability to participate in the PT evaluation without incident. At the initial evaluation, the subject did not present with any contraindications

for PT intervention. In addition, PT is now considered a standard of care for patients receiving joint replacements and is prescribed for almost all patients following a total joint replacement.

According to the findings from the systems review, further and more specific tests and measures should be performed to assess strength of the left knee, ROM of the left knee, girth of the left knee, balance, bed mobility, transfers, and gait in order to formulate a complete initial evaluation of the subject.

TESTS AND MEASURES

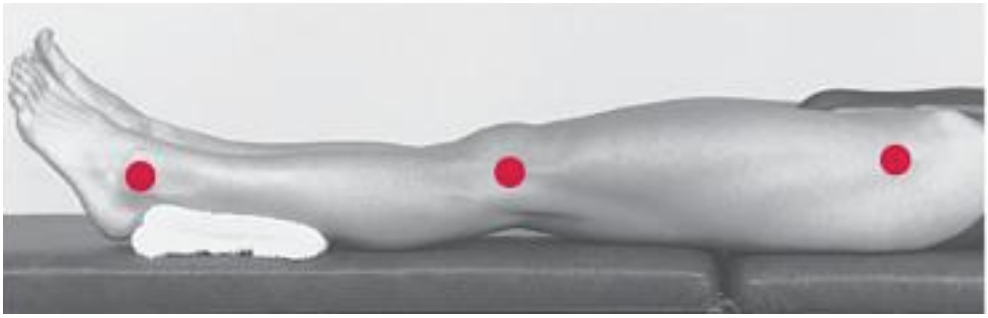
Initial data of all tests and measures are reported in Table 3.

Range of Motion (AROM)

The subject's left knee AROM was measured at initial evaluation using a standard goniometer. This measure was repeated every 10 days throughout the subject's episode of care. The measurements were taken with the subject in supine position. The subject was told to "push the back of your knee down into the mattress" after which the PT measured knee extension AROM. The subject was then told to "bend your knee and bring your heel as close to your buttocks as tolerable" after which the physical therapist measured knee flexion AROM. The stationary arm of the goniometer was in line with the subject's greater trochanter of the femur,

the axis was placed at the lateral epicondyle of the femur, and the moveable arm was in line with the lateral malleolus of the fibula. The landmarks are displayed in Figure 1.

Figure 1: Bony Landmarks for Goniometer Placement for Measurement of Knee Flexion and Extension.[9]



A study by Jakobsen *et al*. [10] determined that goniometric measurements of are reliable and valid joint ROM measures for patients after TKR. The testers compared measurements taken by experienced testers and inexperienced testers, which is applicable to this case report that incorporated measures from both the student PT and the licensed and experienced PT. For knee ROM the intra-tester reliability ranged from 0.78 to 0.98 (SRD = 4.5–6.6°) and 0.89 to 0.97 (SRD = 4.0–6.5°) for the inexperienced and experienced tester, respectively. The inter-tester reliability (ICC2,1) ranged from 0.70 to 0.96 (SRD = 5.8–15.7°), and 0.72 to 0.96 (SRD = 5.8–12.3°) for the first and second test round, respectively.[10]

Muscle Strength

Manual muscle testing of the left lower extremity was performed at initial evaluation, but was not formally assessed throughout the episode of care due to increased focus on functional measures of strength such as gait distance and transfers. All manual muscle testing was performed with the subject in a seated position.

A study by Pua *et al*. determined the relationship between knee ROM and strength, knee extension ROM and physical function, and knee strength and physical function. Improvement in knee extension ROM was positively associated with increased knee extensor strength ($r = 0.22$, $P < 0.001$). Increased SF-36 physical function was positively associated with improvement in knee extension ROM ($r = 0.15$, $P < 0.001$) and with increased knee strength ($r = 0.27$, $P < 0.001$).

Standing Balance

The subject's standing balance was tested in two different conditions at initial evaluation and approximately every 10 days throughout the episode of care. The two conditions were static standing balance and dynamic standing balance, and they were graded according the scales in Table 1 and Table 2.

Table 1: Static Standing Functional Balance Grades

Normal	Able to maintain standing balance against maximal resistance
Good	Able to maintain standing balance against moderate resistance

Good-/Fair+ (G-/F+)	Able to maintain standing balance against minimal resistance
Fair	Able to stand unsupported without UE support and without balance loss for 1-2 min
Fair-	Requires Min A or UE support in order to stand without balance loss
Poor+	Requires Mod A and UE support to maintain standing without balance loss
Poor	Requires Max A and UE support to maintain standing balance without loss

Table 2: Dynamic Standing Functional Balance Grades

Normal	Stand independently unsupported, able to weight shift and cross midline maximally
Good	Stand independently unsupported, able to weight shift and cross midline moderately
Good-/Fair+ (G-/F+)	Stand independently unsupported, able to weight shift and cross midline minimally
Fair	Stand independently unsupported, weight shift and reach ipsilaterally, difficulty crossing midline without balance loss
Fair-	Able to stand with supervision and reach ipsilaterally, unable to weight shift
Poor+	Able to stand with Min A and reach ipsilaterally, unable to weight shift
Poor	Able to stand with Mod A and minimally reach ipsilaterally, unable to cross midline

There is limited research on the reliability and validity of these balance grading scales, however, they are widely used scales with definitive standards of use as explained above.[11]

Bed Mobility

The subject's bed mobility evaluation included rolling, bridging, scooting, and supine to and from sitting tasks. The tester measured the amount of assistance required to complete these tasks at initial evaluation, every 10 days, and at discharge using the following grading scale: Independent (I), Modified Independent (MI), Supervision (Sup), Set Up Assist (S/U), Standby Assist (SBA), Contact Guard Assist (CGA), Min Assist-25% (Min A), Mod Assist-50% (Mod A), Max Assist-75% (Max A), Totally Dependent Plus <100% (TD+), or Totally Dependent- 100% (TD).

Transfers

The subject's bed mobility evaluation included sit to and from stand, stand pivot, and chair to bed transfers. The following grades were assigned based on the subject's assistance requirements for transfers at initial evaluation, every 10 days, and discharge: Independent (I), Modified Independent (MI), Supervision (Sup), Set Up Assist (S/U), Standby Assist (SBA), Contact Guard Assist (CGA), Min Assist-25% (Min A), Mod Assist-

50% (Mod A), Max Assist-75% (Max A), Totally Dependent Plus <100% (TD+), or Totally Dependent- 100% (TD).

Gait Assistance

The subject's assistance requirement for gait was assessed at initial evaluation, every 10 days, and at discharge using the following scale: Independent (I), Modified Independent (MI), Supervision (Sup), Set Up Assist (S/U), Standby Assist (SBA), Contact Guard Assist (CGA), Min Assist-25% (Min A), Mod Assist-50% (Mod A), Max Assist-75% (Max A), Totally Dependent Plus <100% (TD+), or Totally Dependent- 100% (TD).

There is limited research on the reliability and validity of the bed mobility, transfer, and gait assistance grading scales; however, they are similar to the Functional Independence Measure which is reliable and valid in determining functional mobility and independence. These scales are widely used to describe the assistance needed for these particular functional skills.[12]

Gait Distance

The distance, in feet, that the subject walked was measured at initial evaluation, every 10 days, and at discharge. The subject used a rolling walker for all ambulation. However, the subject's gait speed was not assessed.

According to Bohannon *et al.*, distance walked without stopping is a reliable and responsive measure of gait performance and is easily assessed in the subacute rehabilitation setting.[13] However, this study stopped the patients from walking further after 2 minutes, whereas the subject in this case report was asked to walk as far as tolerated. Bohannon *et al.* found good test-retest reliability (ICC = 0.948,
range 0.927-0.963) for distance walked at admission and at discharge.[13] The effect size for distance walked at admission and discharge was 2.36, which is considered very large and the MCID ranged from 28.8m - 43.6m.[13]

Knee Girth

The subject's knee girth was measured at day 10 and at discharge. The subject was in the supine position for both measurements and the circumference was taken using a rolling tape measure at mid patella of the left knee. The measurements were taken and recorded in centimeters.

A study by Jakobsen *et al*.[10] determined that circumferential measurements of the knee are reliable and valid measures for patients after TKR. The authors compared measurements taken by experienced testers and inexperienced testers, which is applicable to this case report that incorporated measures from both the student PT and the licensed and experienced PT. The intra-tester reliability was 0.99 (SRD = 0.95–1.00 cm) for both the inexperienced and the experienced tester (Table 4). The inter-

tester reliability (ICC2,1) ranged from 0.98 to 0.99 (SRD = 1.47–1.63 cm. The inexperienced tester systematically recorded a larger knee circumference than the experienced tester. All knee ROM measurements (except passive knee extension) correlated significantly ($p < 0.05$) with knee circumference ($r = 0.22–0.49$).[10]

Tinetti-Performance Oriented Mobility Assessment (POMA)

The Tinetti-POMA was chosen as a functional outcome measure of balance and gait stability to determine fall risk. The Tinetti-POMA was administered by giving verbal instructions to the subject for each task and recording observations as prompted on the universal score sheet. There are two main sections of the Tinetti-POMA, the balance assessment and the gait assessment. Each task is scored individually from 0-2 points, with a higher score indicating a more desirable outcome of a lower fall risk. The total score is summed out of a possible 28 points, with a score of 19 or less indicating high fall risk in the subject, scores between 19-24 indicating medium fall risk, and scores greater than 24 indicating low fall risk. The subject's performance on the Tinetti-POMA was assessed at day 46 and at discharge.

A study by Faber *et al.* sought to determine the clinimetric properties of the Tinetti-POMA in older adult subjects living under their own self care or nursing care facilities. The authors found a poor ceiling effect for POMA-Gait (G) but found no floor effects in these subjects. Test-re-test reliability for

the total assessment ranged from 0.82-0.86, intra-rater reliability for the total ranged from 0.91-0.93. The authors found that minimal detectable change (MDC) ranged from 4.0-4.2 points for the tested individuals. Total sensitivity of the assessment tool was 64% and specificity was 66.1%. [14]

Table 3: Initial Examination Tests and Measures

Knee Flexion AROM (degrees)	35-65
Knee Extension AROM (degrees)	65-35
Static Standing Balance	Poor +
Dynamic Standing Balance	Poor +
Bed Mobility	Min A
Transfers	Mod A
Gait Distance (ft)	15
Gait Assistance	Min A
Tinetti-POMA *on day 46*	20
Knee Girth (cm) *on day 10*	36.5

CLINICAL IMPRESSION 2

The findings from the systems review and examination led to an overall understanding of the subject's functional limitations and inability to return to her prior living environment at the time of the initial evaluation. The subject was appropriate and in need of PT intervention to improve functional mobility, independence, and safety in order to return to her prior living environment safely and independently. The interventions for this subject were focused on improving function and independence. The subject's performance and independence on all measures of functional

mobility, knee ROM, and fall risk stratification according to the Tinetti-POMA determined the subject's outcome and discharge date.

DIAGNOSIS AND PROGNOSIS

At the time of the initial evaluation, the subject's medical diagnosis was osteoarthritis and status-post total knee joint replacement. Early in the subject's episode of care, she was also diagnosed with a localized infection of the surgical knee. The subject's PT diagnosis was impaired knee ROM, difficulty with walking, and impaired overall functional mobility.

The subject's prognosis was good due to her prior level of function, response to previous knee replacement surgery of contralateral limb, accessibility of the home, and the nature of the diagnosis and surgical outcome.

PLAN OF CARE/GOALS

The short-term goals, upon initial evaluation, were increased left knee flexion AROM to 100°, increased left knee extension AROM to 0°, increased transfer mobility to MI, and increased gait independence to MI.

The long-term goals upon initial evaluation were increased dynamic standing balance to G-/F+ using ankle hip and stepping strategies 100% of the time and with decreased risk of falls, and normalized gait pattern while

safely ambulating unlimited (greater than 350ft) on level surfaces with supervision and use of assistive device.

INTERVENTIONS

The subject participated in therapy 6 days per week for 7 weeks for a total of 42 PT sessions. Treatment sessions were between 30 and 75 minutes per session. The exercise intensity ranged from light to moderate and was dependent upon the subject's activity tolerance at each session. The majority of the interventions provided were implemented with an emphasis on increasing the subject's function.

The interventions provided to the subject are described in Table 4 and the frequency of the seven most pertinent interventions at each session is provided in Table 5.

Table 4: Intervention Descriptions and Research

Intervention	Description
1. Gait Training	Verbal and tactile cues were given to the subject to improve posture with walking, facilitate normal gait pattern, and increase safety. All ambulation was performed indoors in the hallways, and out doors on uneven surfaces, over curbs, and on ramps.[8]
2. Bed Mobility Training	Verbal and tactile cues were given to the subject to improve bed mobility and safety with all bed mobility.
3. Transfer Training	Verbal and tactile cues were given to the subject to improve transfer mobility and safety with all transfers.
4. NuStep	Recumbent reciprocal upper and lower limb locomotion trainer used for aerobic

	training and muscle activation of all extremities. The NuStep is fully adjustable and resistance can be modified. Has been shown to improve balance is patients following stroke.[15]
5. Omnicycle™ Elite	Aerobic exercise machine for all extremities. It has 3 assistance modes: assisted (full mechanical assistance), partial assisted (full assist mechanical assist with low patient active motion), and active (no mechanical assistance). The machine encourages ROM, strengthening, and motor training for all extremities depending on the subject's activity tolerance and strength.[16]
6. Balance Training	Balance exercises included but were not limited to static standing tolerance, dynamic standing balance training, single leg balance activities, balance on uneven surfaces, tandem walking, weaving around cones and bending to pick them up, braiding, side-stepping, etc. Balance exercises have been shown to increase lower extremity function in older adults following TKA.[17]
7. LE Progressive Resistance Training	The principles of progressive resistance training are to perform a small amount of repetitions until fatigue, allow rest between sets, and to increase the resistance as appropriate. PRE has been shown to increase force production ability which could possibly carry over to overall functional improvements.[18]
8. Patient Education	Education was provided in the form of handouts for home exercise programs, and verbal instruction on energy conservation techniques, diaphragmatic breathing, proper exercise technique, proper functional mobility techniques, assistive device education, safety, etc.
9. Kinesio® Taping	Kinesio® Tape was applied to the subject's left knee using an edema reducing, or fanning, technique.[19]
10. Open Kinetic Chain LE	Lower extremity therapeutic exercise of

Therapeutic Exercise	which the distal end of the leg is free moving. Exercises included but were not limited to seated knee flexion, knee extension knee flexion, ankle dorsiflexion, and ankle plantarflexion.
11. Contract Relax/Hold Relax	Contract-relax: Isotonic contraction of a muscle against moving resistance followed by stretch toe and range of that muscle.[20] Hold-Relax: Isometric contraction of a muscle at end range, then passively taken to end range.[21]
12. Co-Treatment with OT	A portion of a treatment session or the entire session occurred with occupational therapy and included occupational therapy exercises or specific upper extremity exercises depending on the OT providing treatment.
13. Stair Training	Verbal and tactile cues and physical assistance were given to the subject when necessary to facilitate independence and safety when negotiating stairs.
14. Closed Kinetic Chain LE Therapeutic Exercise	Lower extremity therapeutic exercise of which the distal end of the leg is fixed. Exercises included but were not limited to squats, lunges, and lateral squats.
15. Stretching	Static elongation of soft tissues was performed passively by the PT and was self administered by the subject after education was provided.
16. Soft Tissue Massage	Soft tissue massage was applied to the surrounding muscle, ligamentous, and fascial tissue of the knee to reduced edema. Cross friction massage was also applied to the incision site once the staples were removed and there was no infection present.
17. Proprioceptive Neuromuscular Facilitation	Diagonal patterns of movement that facilitate functional strength and flexibility in functional patterns of movement. Found to improve balance and knee extension torque, primarily due to central nervous system adaptations.[22]
18. TheraBand ® Resisted LE Exercise	Lower extremity therapeutic exercise with TheraBands ® as resistance to increase

	strength and motor control.

Table 5: Interventions for each PT session: The 7 most pertinent interventions were listed, some sessions had greater than 7 interventions used.

Date	Int 1	Int 2	Int 3	Int 4	Int 5	Int 6	Int 7
6/24	1	3					
6/26	1						
6/27	1	9	5	11			
6/30	1	5	6	7			
7/1	10	1	3				
7/2	1						
7/3	1	2	3	8	9	4	10
7/4	1	3	4	11	9		
7/5	1	6	4	12			
7/7	1	13	7	11	14	4	12
7/8	1	14	4	13	12		
7/9	1	12	4				
7/10	1	13	4	10	7	12	
7/11	1	4	14				
7/12	1	4	3				
7/14	4	7	12				
7/15	1	13	6	7	14	4	
7/16	1	4	3				
7/17	1	4	7				
7/18	1	2	4				
7/19	1	4	3				
7/21	15	8	11				
7/23	10	1	8	6	12		
7/24	1	2					
7/25	1	13	6	4	15	16	
7/26	4	1					
7/28	1						
7/29	1	12					
7/30	1	6	3	2	4	16	12
7/31	10	14	7	1	13	12	
8/1	1	10	17	4	7	18	
8/2	6	2	3	4	10		
8/4	1	6	7	8	4	18	14
8/5	14	6	1	4	2	10	
8/6	1	6	14	4	18		
8/7	1	6	10	14			

8/8	1	2	3	12	4		
8/9	1	10	14	4			
8/11	1	13	4	8			
8/12	1	13	6	4			

OUTCOMES

The subject's outcomes were assessed throughout the plan of care. Progress notes were taken approximately every 10 days throughout the plan of care and the discharge measures were taken during the subject's last PT visit.

Range of Motion

The subject's active knee flexion ROM measurements throughout the plan of care are summarized in Figure 2. At discharge, the subject was unable to reach full knee flexion, but knee flexion within functional limits.[23] The subject's active knee extension ROM measurements throughout the plan of care are summarized in Figure 3. At discharge, the subject was able to reach full knee extension.

Figure 2: AROM Knee Flexion Over Time: The change in the subject's knee flexion AROM throughout the plan of care.

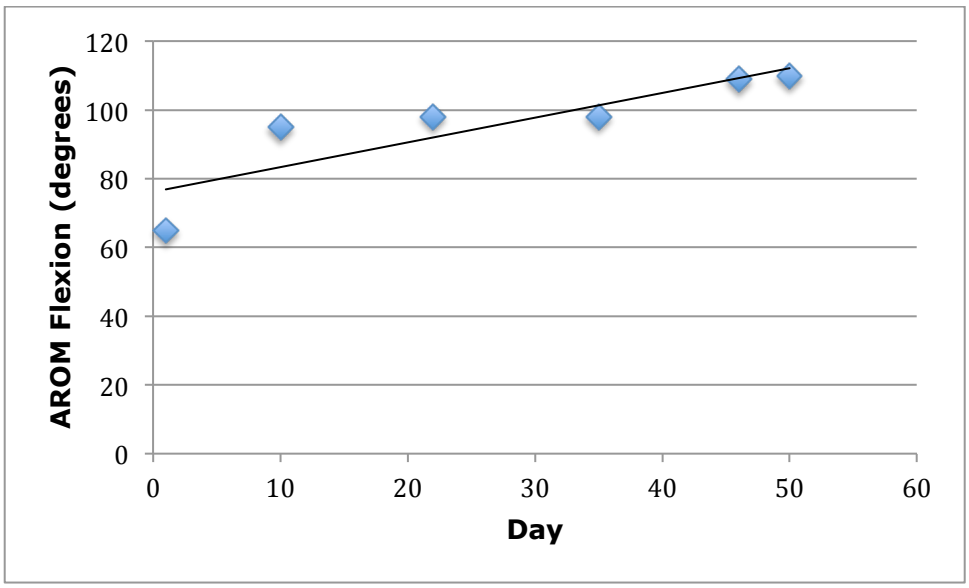
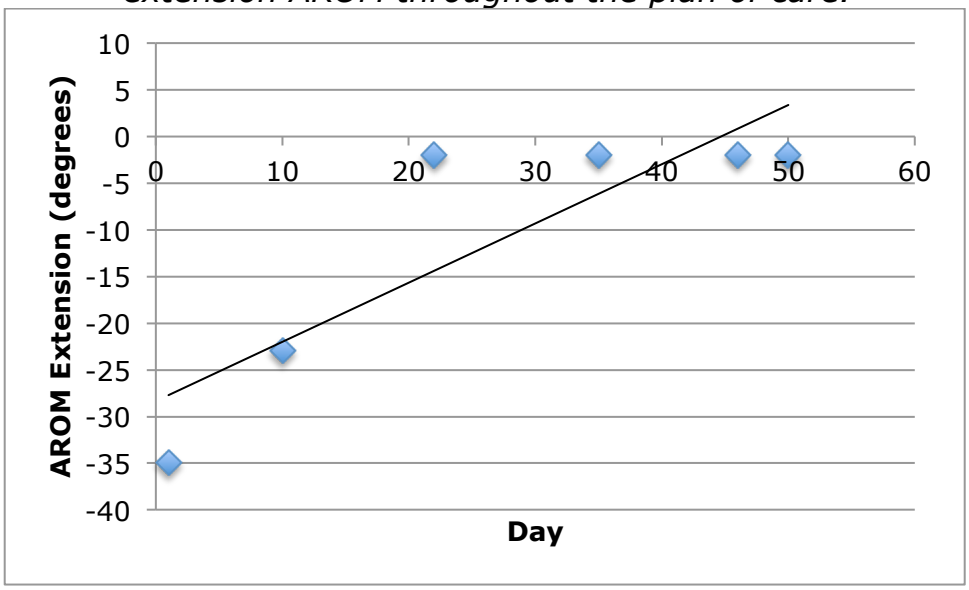


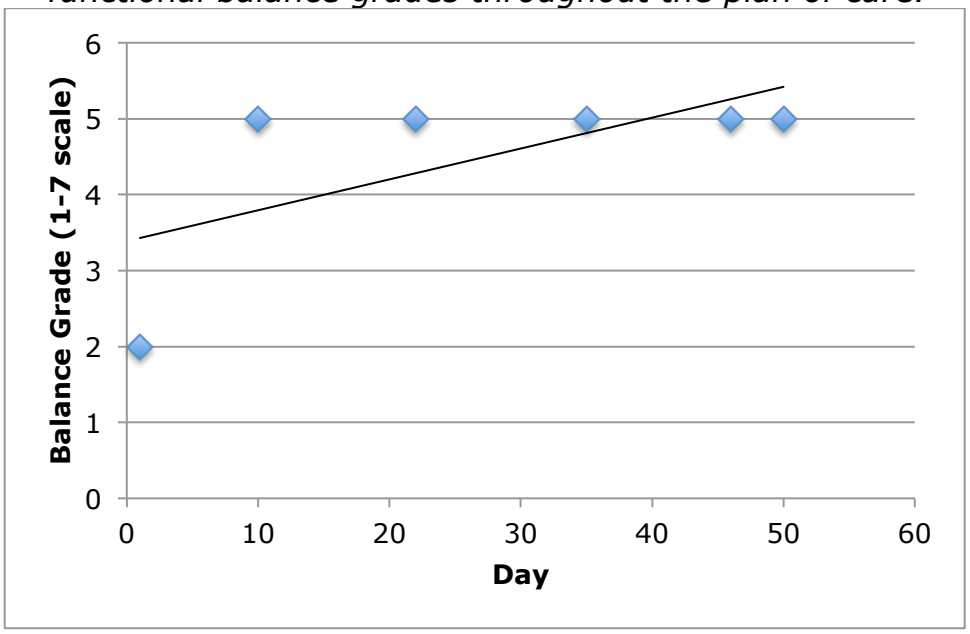
Figure 3: AROM Knee Extension Over Time: The change in the subject's knee extension AROM throughout the plan of care.



Static and Dynamic Standing Balance

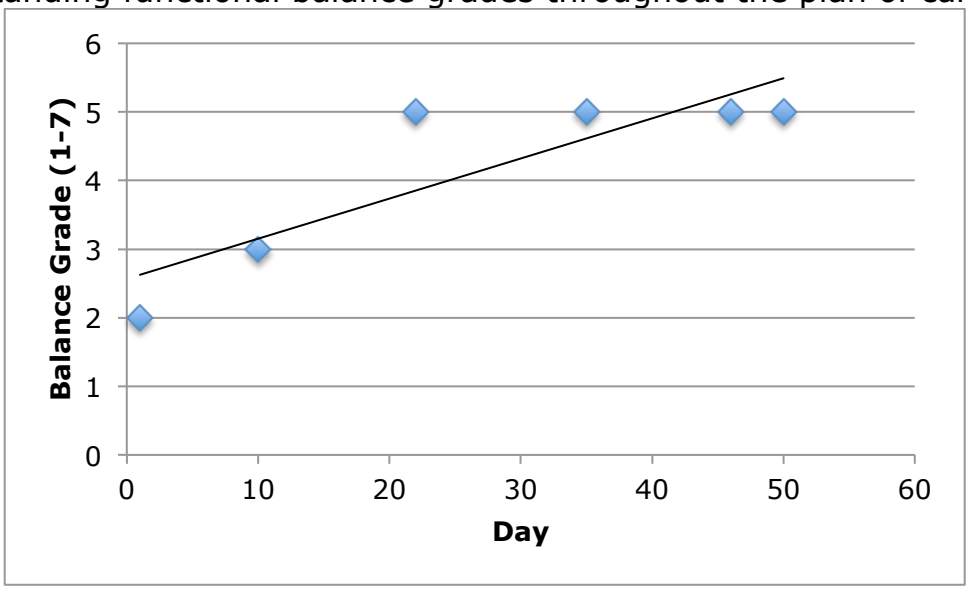
The subject's static standing balance and dynamic standing balance are summarized in Tables 4 and 5 respectively. The subject was able to reach good-/fair+ standing balance upon discharge.

Figure 4: Static Standing Balance Over Time: The subject's static standing functional balance grades throughout the plan of care.



Poor = 1, Poor+ = 2, Fair- = 3, Fair = 4, G-/F+ = 5, Good = 6, Normal = 7.

Figure 5: Dynamic Standing Balance Over Time: The subject's dynamic standing functional balance grades throughout the plan of care.

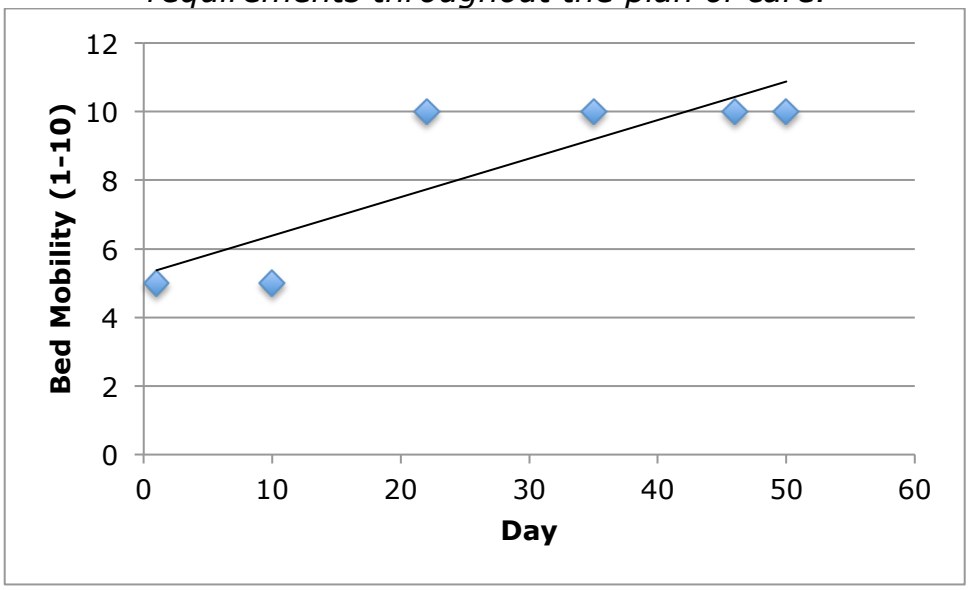


Poor = 1, Poor+ = 2, Fair- = 3, Fair = 4, G-/F+ = 5, Good = 6, Normal = 7.

Bed Mobility

The subject's improvements in bed mobility throughout the plan of care are provided in Figure 6. The subject improved her bed mobility to a level of MI upon discharge.

Figure 6: Bed Mobility Over Time: The subject's bed mobility or assistance requirements throughout the plan of care.

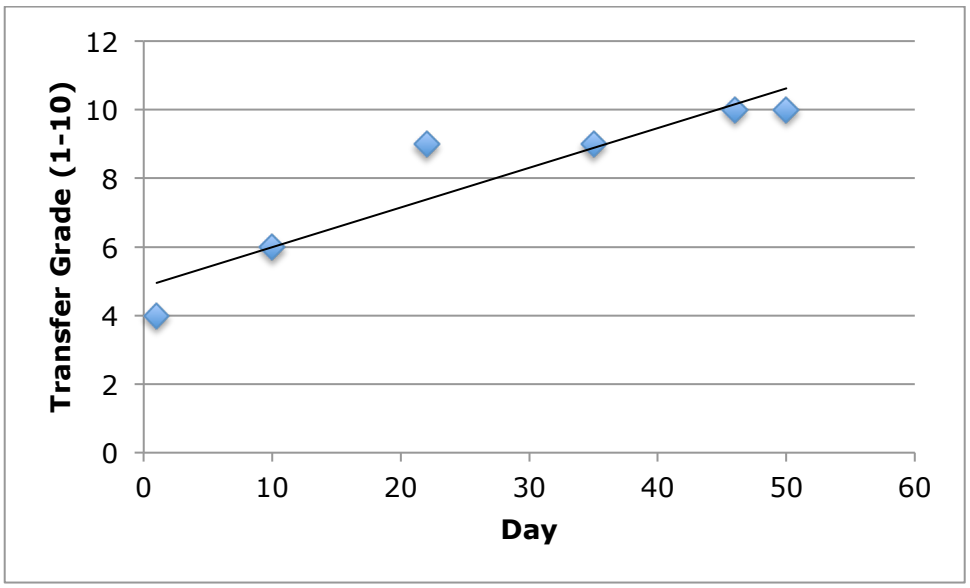


Dependent = 1, Dependent+ = 2, Max A = 3, Mod A = 4, Min A = 5, CGA = 6, SBA = 7, S/U = 8, Sup = 9, Mod I = 10, Independent = 11.

Transfer Mobility

The subject's improvements in transfer mobility and independence throughout the plan of care are summarized in Figure 7. The subject improved her transfer mobility from requiring Mod A to a level of MI.

Figure 7: Transfer Mobility Over Time: The subject's transfer mobility or assistance requirements throughout the plan of care.

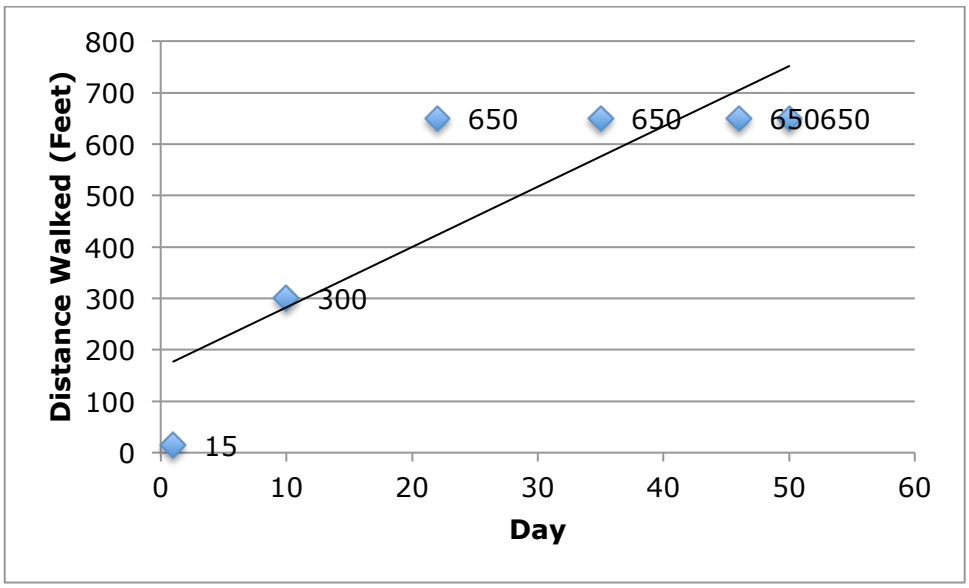


Dependent = 1, Dependent+ = 2, Max A = 3, Mod A = 4, Min A = 5, CGA = 6, SBA = 7, S/U = 8, Sup = 9, Mod I = 10, Independent = 11.

Gait Distance

The subject's increasing ability to walk longer distances was measured throughout the plan of care and the increasing distances are provided in Figure 8. Upon discharge, the subject was able to walk unlimited distances, which according to the documentation software used at the facility, is any distance greater than 650 ft. For the last two measurement days, on days 46 and 50, the subject was able to walk greater than 650ft, but the exact distance in feet was not measured, thus conservatively plotted as 650ft in Figure 8. This increase in gait distance was clinically significant according to the MCID determined by Bohannon et al. to be between 94ft and 143.6ft.[13]

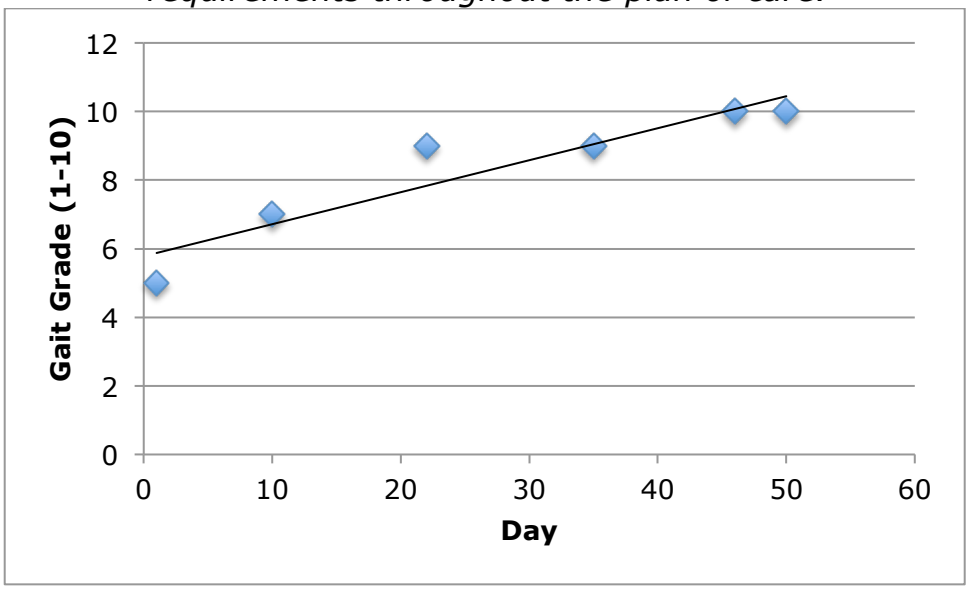
Figure 8: Gait Distance Over Time: The distance the subject walked in feet throughout the plan of care.



Gait Assistance

The subject's increasing independence with gait is summarized in Figure 9. The subject increased her gait independence from minimal assistance to a level of MI upon discharge.

Figure 9: Gait Independence Over Time: The subject's gait assistance requirements throughout the plan of care.

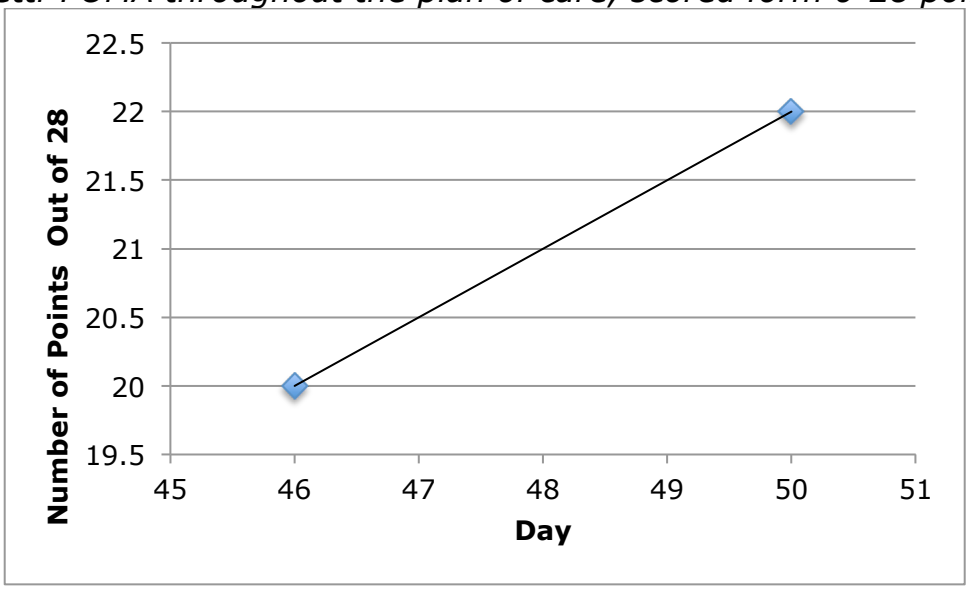


Dependent = 1, Dependent+ = 2, Max A = 3, Mod A = 4, Min A = 5, CGA = 6, SBA = 7, S/U = 8, Sup = 9, Mod I = 10, Independent = 11.

Tinetti-POMA

The subject's performance on the Tinetti-POMA was assessed on day 46 and day 50. The improvement in her score from these days is reported in Figure 10. She was able to improve her score from 20/28 to 22/28, however, a 2-point increased is not clinically significant according to the MDC of 4.0-4.2 points found by Faber *et al.*[14]

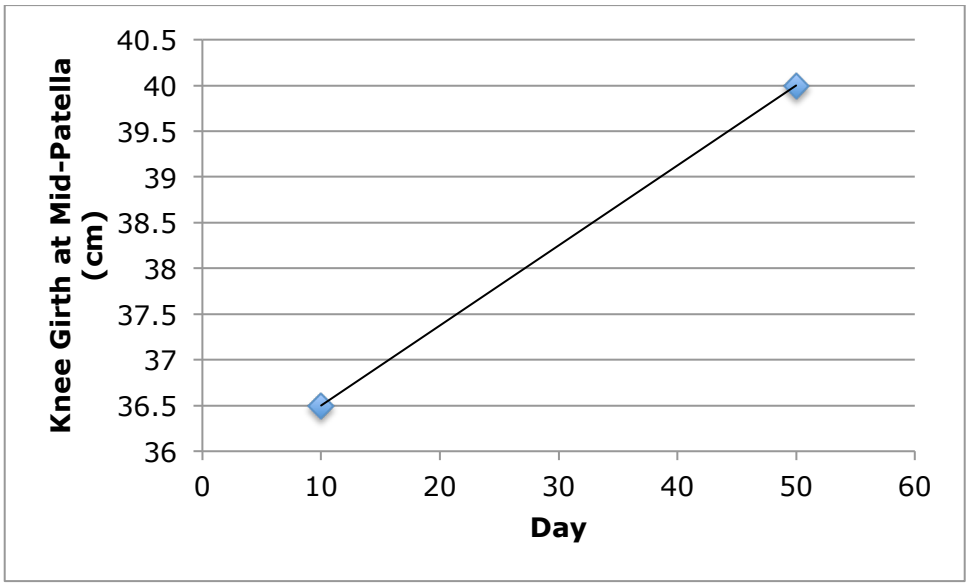
Figure 10: Tinetti-POMA Score Over Time: The subject's performance on the Tinetti-POMA throughout the plan of care, scored form 0-28 points.



Knee Girth

The subject knee girth, or knee circumference, of the left knee at mid-patella changes are summarized in Figure 11. The subject's left knee girth increased from 36.5 cm on day 10 to 40 cm on day 50.

Figure 11: Knee Girth Over Time: The subject's left knee girth measurements at mid-patella throughout the plan of care, measured in centimeters.



DISCUSSION

The purpose of this case report was to highlight the interventions and outcomes of an 80-year-old female who was status-post TKR and who presented to a SNF with a postoperative infection.

The interventions implemented in this case emphasized increasing function, independence, and safety. The most frequent interventions provided included gait training, bed mobility training, transfer training, and balance training. These interventions were necessary for the patient in order for her to be safe and functional in her prior living environment. The other interventions were also important and contributed to the patient's overall rehabilitation with an emphasis on increasing strength and range of motion of the operative knee.

There is little evidence reporting the average length of stay in inpatient rehabilitation after TKR with complications and even less recent research on the distribution of discharge location of TKR patients. Dauty *et al*. found the average length of stay in inpatient rehabilitation following TKR without complication to be 24 days and ranged from 9-59 days in their subjects.[24] In 1995, a study by Munin *et al*. found that 40% of their subjects were discharged to inpatient rehabilitation facilities and the other 60% were discharged home. They also found that those discharged to inpatient rehabilitation services tended to live a lone, be of older age, had comorbid conditions, and had greater pain postoperatively.[25] However, further research on the effect of infection after TKR on PT interventions and outcomes is needed. The subject of this case report stayed at a SNF for 50 days in addition to the 6 days she spent in the hospital immediately after her surgery. Her extended length of stay, far greater than the average reported by Dauty *et al*., could be attributed to many different factors.

The subject in this study did not reach functional knee range necessary for many activities of daily living until 46 days into her stay at a SNF. Some of the tasks that require greater than 98 degrees of flexion include sitting in a low chair, for some sitting in a standard chair, getting in and out of the tub, and ascending stairs.[23] Since the subject's AROM took the most time to regain, this was the primary determinant for her discharge.

The subject improved her functional mobility, in terms of bed mobility and transfers, to a level of MI at discharge from the SNF. Her bed mobility was graded as MI due to the increased time it took her to complete the tasks. She was graded as MI with transfers due to increased time to complete the task and her use of a rolling walker. Once the subject was MI in these tasks, she was able to return home independently to complete those tasks.

At the initial examination, the subject was able to ambulate 15ft, but by discharge, she was able to walk greater than 650ft with MI and using a rolling walker. However, one limitation of this study was that at the facility, if the subject walked further than 650ft, it was labeled as "unlimited distances". Though this is a limitation, it does demonstrate that the subject was able to ambulate around her home and most distances in her community safely and without difficulty.

The subject was able to reach a medium fall risk classification on the Tinetti-POMA with a final score of 22/28 at discharge. The classification of medium fall risk is not ideal but is sometimes unavoidable when the patient uses a walking aid. However, according to Ko *et al*., the average female living in Korea, aged 80 years and older scored an average of 17.2/28.[26] This places the subject above average, compared to community-dwelling Korean women, at the time of discharge. There is limited research on the average Tinetti-POMA score for community-dwelling American females,

however, the fact that the subject of this case report was living in an independent senior living facility and scored higher than community-dwelling women in a different country may demonstrate a significant difference form the average. Another limitation of this case report is that the Tinetti-POMA was not tested or recorded before day 46 of the subject's plan of care, which limits the amount of improvement from the start of the plan of care.

The subject's knee girth actually increased according to the measurement at discharge. However, there are two possible explanations for this unexpected increase. One possible explanation is that the measurements were taken by two different testers, which could account for the difference in the subject's knee girth. Another possibility for this increased knee girth could be due to the increased joint effusion around the patella bone at initial examination that made palpation of the mid-patella difficult or inaccurate.

Due to these limitations, the author would recommend consistent outcome measures at each progress note for complete data collection purposes. Also, it would be beneficial to have the same tester or testers who have been trained together to reach adequate inter-tester reliability. It would also be beneficial to have the subject's pre-operative knee joint ROM, because this would give greater insight into the impact of the joint replacement on the function of the knee. Also, preoperative knee range has been shown to be predictive of postoperative knee ROM.[27] Another

recommendation to improve this case study, would be to have exact dates of when the infection began and was no longer being treated because this would demonstrate the direct impact of the infection on the subject's impairments and functional limitations while the joint was infected.

CONCLUSIONS

This case report provides insight into the interventions and outcomes of an 80-year-old female after total knee replacement and subsequent infection. The subject had an inpatient SNF stay that was longer than the average patient who received a TKR without complication. This report demonstrates that a comprehensive inpatient PT program focused on improving functional performance and safety positively impacts the subject returning to preoperative living environment.

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