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Balance and Gait Training to Reduce Fall Risk in a Patient with Bilateral Foot and Hand Deformities Secondary to Rheumatoid Arthritis: A Case Report

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The patient signed an informed consent allowing the use of medical information for this report and received information on the institution’s policies regarding the Health Insurance Portability and Accountability Act.

The author acknowledges Cheryl Milton PT, MS, for her supervision and guidance while collecting data and treating this patient as well as Amy Litterini PT, DPT, for manuscript conceptualization. The author also acknowledges the patient for graciously dedicating her time and personal information to make this case report possible.

27 **ABSTRACT**

28 **Background and Purpose** – Falls are the leading cause of death from injury in persons greater
29 than 65 years of age. The risk of suffering a fall increases with age, but falls are not an
30 unavoidable aspect of the aging process. By maximizing an individual’s balance, gait and
31 strength, their risk for future falls can be decreased. The purpose of this case report is to provide
32 an overview of the physical therapy (PT) plan of care for a patient at high risk for falls.

33 **Case Description** - The patient was an 84 year old female who suffered a fall likely due to
34 structural deformities secondary to rheumatoid arthritis that impaired her balance and ability to
35 safely ambulate. Her fall resulted in a right olecranon fracture and subsequent open reduction
36 internal fixation for surgical repair. Once medically stable, the patient was transferred to a skilled
37 nursing facility for continued care. She presented with deficits in strength, endurance, balance,
38 coordination and overall functional mobility which heightened her fall risk. Procedural
39 interventions focused on balance and gait training while accommodating for the patient’s
40 bilateral foot and hand deformities secondary to rheumatoid arthritis.

41 **Outcomes** - The patient improved her endurance, strength, balance, bed mobility, transfers and
42 gait which subsequently decreased her fall risk. She was discharged to an Assisted Living
43 Facility as she was not an appropriate candidate to return home independently. It was highly
44 recommended that she continue to receive PT through home-health services to continue
45 improving her function.

46 **Discussion** - Patient-centered PT, with a focus on balance and gait training, appeared to make
47 significant improvements in this patient’s overall function and decrease their fall risk.

48 **Manuscript Word Count: 3,500**

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50

51 **BACKGROUND and PURPOSE**

52 Each year, one out of three adults over the age of 65 sustains a fall, with less than half of
53 those seeking follow-up care with their healthcare provider. Of those who suffer a fall, thirty
54 percent will sustain moderate to severe injuries which can result in decreased functional mobility
55 and independence as well as increase their risk for early death and future falls.¹ Although the risk
56 of suffering a fall increases with age, falls are not an unavoidable aspect of the aging process. An
57 individualized exercise program that includes interventions to maximize a patient's balance, gait
58 and strength can decrease their fall risk.²

59 When medical comorbidities impact the physiological senses which help maintain
60 balance, fall risk can be heightened. One such medical comorbidity is rheumatoid arthritis (RA)
61 which is a chronic inflammatory disorder that affects the lining of the joints and causes painful
62 swelling that can eventually result in bone erosion and joint deformity.³ One study found the fall
63 incidence rate in individuals with RA to be 0.62 falls per person per year as compared to a fall
64 incidence rate of 0.45 falls per person per year in healthy elderly individuals.⁴ These alarming
65 statistics elude to a heightened fall risk in patients with RA, which seems to be an
66 underestimated problem due to the lack of literature targeting this population. Although there is
67 extensive literature and resources regarding the importance of remaining active and participating
68 regularly in exercise groups or exercise programs that focus on balance, gait and strength, there
69 is limited research regarding fall risk specific training in individuals with RA.^{5,6} More
70 specifically, there is a substantial lack of literature regarding gait training (GT) and
71 neuromuscular re-education techniques in individuals who present with skeletal deformities
72 secondary to RA.

73 This particular patient was selected for a case report due to her complex medical
74 presentation. The purpose of this case report was to emphasize the intervention aspect of patient
75 care for a patient who was at high risk for falls due to her history of previous falls and her severe
76 foot and hand deformities (Figure 1) which made it difficult for her to perform functional tasks,
77 ambulate and safely use an assistive device (AD). Due to the unique patient presentation and
78 limitations, modifications to existing accepted approaches for GT and neuromuscular re-
79 education were developed and applied in hopes to improve the patient's overall functional
80 mobility and independence as well as decrease her fall risk.

81 **CASE DESCRIPTION**

82 **Patient History and Systems Review**

83 The patient signed an informed consent to allow use of her personal medical information
84 for this case report. The patient was a nulliparous elderly Caucasian female who was never
85 married and lived independently in a one-story condominium without stairs. The patient reported
86 that she often remained rather sedentary due to her limitations in mobility, use of a rolling walker
87 (RW) for ambulation and her inability to drive secondary to her diagnosis of RA. She reported
88 the need of assistance to perform activities of daily living (ADL) including housework, meal
89 prep, bathing and additional instrumental activities of daily living (IADL). Additionally, she
90 noted that she had experienced previous falls within the past year for which she did not seek
91 medical treatment.

92 The patient was admitted to the hospital after suffering a fall at home where she
93 sustained a right (R) olecranon fracture. Surgical intervention was initially postponed at which
94 point she was discharged from the hospital and admitted to a skilled nursing facility (SNF) for
95 nursing care as well as physical therapy (PT), occupational therapy (OT) and speech therapy

96 (ST). Once the swelling decreased and she was able to undergo surgery, the patient was
97 discharged from the SNF and re-admitted to the hospital for a R olecranon open reduction
98 internal fixation. The following day the patient was discharged from the hospital and re-admitted
99 to the SNF with non-weight-bearing (NWB) precautions on her R upper extremity (UE). Upon
100 re-admission, she continued to receive skilled therapy services to address her impairments and
101 maximize her functional mobility.

102 Her past medical history was significant for diabetes mellitus type II, anxiety, coronary
103 artery disease, carotid stenosis, chronic urinary obstruction, hyperlipidemia, hypothyroidism,
104 cerebrovascular accident, deep vein thrombosis, gastroesophageal reflux disease and RA. Her
105 longstanding diagnosis of RA was managed pharmacologically; however, she presented with
106 significant bilateral foot and hand deformities secondary to the chronic inflammatory disorder.
107 Her past surgical history included a total abdominal hysterectomy, cholecystectomy, bilateral
108 mastectomy, skin grafting, hemi-arthroplasty of the R hip and cataract surgery. Her extensive
109 medication list can be found in Appendix 1.

110 The systems review (please see Appendix 2) revealed impaired musculoskeletal,
111 neuromuscular and integumentary systems. The patient's bilateral gross UE and lower extremity
112 (LE) strength and range of motion (ROM) were impaired as well as her posture. Impaired
113 coordination, balance and locomotion were noted in review of the neuromuscular system. In
114 regards to the integumentary system, the patient presented with bruising and swelling in her R
115 fingers and hand likely as a result of the fracture and surgical repair. The surgical incision site
116 was unobservable as the patient was in a cast at the time of her evaluation.

117 The patient’s chief complaint was her inability to perform ADL’s successfully and safely
118 without the assistance of others. Her primary goal for PT was to return home independently and
119 to return to her prior level of function (PLF).

120 **CLINICAL IMPRESSION 1**

121 The patient presented with impairments including deficits in strength, ROM, endurance,
122 coordination, gait and balance. She was unable to return home independently due to mobility and
123 ADL limitations which included, but were not limited to, bed mobility, transfers, ambulation,
124 cooking, cleaning, bathing and dressing. Due to her activity limitations, she was unable to safely
125 participate in community activities. She was at high risk for future falls, skin breakdown,
126 contractures and deconditioning if her deficits were not addressed. Due to the patient’s reported
127 occasional “dizziness” there was potential for a differential diagnosis of vestibular involvement
128 or possible cardiopulmonary problem that could have been the underlying cause of her
129 unspecified dizziness. However, there were no documented instances of orthostatic hypotension
130 and no diagnosed vestibular issues to date. Benign paroxysmal positional vertigo was also ruled
131 out as demonstrated by a negative Dix-Hallpike maneuver performed by the author. The patient’s
132 physician at the SNF attributed her occasional dizziness to dehydration, medication side-effects
133 or possible polypharmacy drug interactions.

134 The examination included tests and measures that would further quantify and qualify the
135 patients impairments noted during the systems review. This included manual muscle testing
136 (MMT), ROM measurements, coordination assessments, light touch sensation testing,
137 proprioception testing, observation of functional mobility and transfers, gait analysis, posture
138 analysis, activity tolerance and balance testing. Additionally the examination included a Timed

139 Up and Go (TUG), Tinetti Performance Oriented Mobility Assessment (POMA) and the Falls
140 Efficacy Scale (FES) to further quantify her fall risk.

141 The patient was an excellent candidate for case report because she was highly motivated
142 to return to her PLF and was always willing to participate with PT. Her presentation was
143 relatively complex, which required a somewhat unique approach to her plan of care (POC) to
144 facilitate patient-centered GT and neuromuscular re-education specific interventions.

145 **EXAMINATION**

146 Tests and measures were completed at initial evaluation and at discharge (Table 1) to
147 gain an objective measurement of the patient's progress throughout her episode of care (EOC).
148 Observational functional task analysis was a large aspect of the patient's examination which
149 subjectively assessed her performance of functional tasks, such as bed mobility and transfers, as
150 well as balance and endurance through careful observation.

151 MMT is a standardized assessment used commonly by physical therapists to measure
152 muscle strength. Muscle strength is graded on a 0-5 scale with 0 representing no detectable
153 muscle contraction and 5 representing "normal" strength.⁷ In addition to strength testing,
154 standardized outcome measures to assess fall risk were also utilized throughout the EOC. The
155 TUG is a standardized test that assesses mobility, balance, walking ability and fall risk in older
156 adults by measuring the time it takes for a patient to rise from a chair, walk three meters at a
157 comfortable and safe pace, turn, walk back to the chair and sit down. The test permits use of an
158 AD, which must be documented along with level of assistance needed to complete the test.^{8,9}
159 Similarly, the POMA is a standardized tool that assesses fall risk through measures of balance
160 and gait abilities through nine balance oriented tasks and seven gait oriented tasks.¹⁰ Lastly, fear
161 of falling was examined utilizing the FES, a 10-item questionnaire that assesses perception of

162 balance and stability during ADL's. Patients are asked to rate their confidence in their ability to
163 perform ten daily tasks without falling, with each item rated from 1 ("very confident") to 10
164 ("not confident at all").¹¹ Relevant psychometric properties and cut-off scores can be found in
165 Appendix 3.

166 **CLINICAL IMPRESSION 2**

167 **Evaluation**

168 The patient presented with strength deficits, ROM deficits, balance deficits, impaired
169 safety awareness, impaired proprioception, gait abnormalities, endurance deficits and a history of
170 falls. These impairments ultimately contributed to her limited ability to perform bed mobility,
171 transfers, and ambulation, and likely contributed to her fall. Additionally, due to her body
172 function and structure impairments, the patient had difficulty with all mobility tasks, dressing,
173 toileting and bathing which restricted her participation in community activities and limited her
174 access to resources and social relationships outside of her home. Her impairments and limitations
175 deemed the patient unfit to live independently. She continued to be an appropriate candidate for
176 the case report and would benefit from skilled PT services in order to return to her PLF and
177 reduce her risk for future falls.

178 The patient's anxiety and fluctuating ability to medically control her RA was anticipated
179 to have a negative influence on the patient's prognosis, goals and expected outcomes.
180 Additionally, it was unlikely that an improvement would be made in the extent of the patient's
181 structural deformities which would likely impact her POC and limit PT interventions that could
182 be performed successfully. Her structural deficits were also anticipated to impact the extent to
183 which particular interventions would influence a positive change in her impairments.

184

185 **Physical Therapy Diagnosis**

186 In accordance with ICD-9 Codes, the patient's primary PT diagnosis was Decreased
187 Functional Mobility (780.99) with additional secondary PT diagnoses of Gait Abnormality
188 (781.2), Muscular Weakness (728.87) and Difficulty Walking (719.7).¹²

189 **Prognosis**

190 The author anticipated the patient would benefit from PT to help improve her strength,
191 balance, endurance and gait in order to maximize her overall functional mobility, decrease her
192 fall risk and return home with a status of modified independent using the least restrictive device
193 (LRD). Given the patient's PLF, when she successfully functioned as an independent household
194 ambulator with a RW, the patient had good potential to make functional gains and prevent the
195 onset of secondary complications. However, her postural and gait instability caused by bilateral
196 foot deformities would negatively impact her therapy progress, as well as her bilateral hand
197 deformities and NWB status on her RUE which limited the available options for an appropriate
198 AD.

199 Additionally, due to the patient's long-standing RA and lack of responsiveness to medical
200 management, the patient had frequent RA flare ups. The likelihood of increased deformity
201 severity was high, which could severely compromise the resulting function of her hands and feet
202 due to permanent joint damage.¹³ The patient was unlikely to fully return to her PLF upon
203 discharge due to the lengthy post-surgical NWB precautions for her R elbow which remained for
204 a minimum of six weeks.¹⁴ As a result, she likely would require home health services upon her
205 return home. Her family support and strong motivation to improve was anticipated to positively
206 impact her recovery time and progress.

207 Plans for referral or consultation were not indicated at the time of the initial evaluation.
208 Follow-up examinations were planned on a weekly basis to monitor the patient's progress and
209 response to treatment.

210 **Plan of Care**

211 Short term and long term PT goals were established in accordance with the patient's
212 values as well as impairments and limitations found during the examination (Table 2). The
213 patient's primary goal was to return home independently at her PLF. At the time of her initial
214 evaluation, the POC included procedural interventions, patient related instructions, coordination,
215 communication and documentation, short term goals (two weeks), long term goals (four weeks)
216 and discharge plans. Discharge plans were initially established in hopes of the patient returning
217 home safely at a modified independent level for all functional tasks and age appropriate ADL's
218 with the LRD for ambulation.

219 The patient received PT at the frequency of six sessions per week with treatment sessions
220 ranging in duration from 40 to 60 minutes. Changes were made to the POC as necessary
221 throughout her EOC based on patient response and progress. Her EOC lasted 20 days before she
222 was discharged to an assisted living facility (ALF) as she was deemed unfit to safely return home
223 independently.

224 **INTERVENTIONS**

225 **Coordination, Communication, Documentation**

226 Care coordination and communication among all therapy disciplines was maintained
227 throughout the EOC. The patient's status, as well as alterations to the POC, were discussed at
228 weekly facility team meetings which included the therapy team, nursing staff, physicians, social
229 work and other members of the care team. Additional communication with family, nursing staff,

230 physicians and social work related to patient progress, POC changes and discharge planning
231 occurred as needed and was documented appropriately. Documentation was completed at the
232 initial evaluation, during daily treatment sessions, at weekly intervals to evaluate the patient's
233 progress and update the POC accordingly, and at discharge to evaluate the patient's overall
234 progress throughout the entirety of her EOC.

235 **Patient Related Instructions**

236 The patient was educated on safety while ambulating with a hemi-walker*, the
237 importance of ambulating with supervision and the value of participating with therapy in order to
238 improve her overall functional mobility and decrease her risk for secondary impairments and
239 future falls. The patient was also educated regarding proper hand placement while performing
240 transfers and the importance of abiding by her NWB restrictions on her RUE. At discharge,
241 further education was provided to the patient for a safe transition into an ALF and the importance
242 of continued participation in mobility tasks and facility recreational activities.

243 **Procedural Interventions**

244 Addressing modifiable musculoskeletal risk factors through interventions that address
245 balance, GT and strength have demonstrated effectiveness in decreasing falls and fall-related
246 injuries in the community and nursing home setting.² In accordance to these findings, PT
247 procedural interventions provided throughout the EOC included therapeutic exercise, therapeutic
248 activities, GT, neuromuscular re-education and group exercise therapy. Therapeutic exercises
249 included utilization of a recumbent bike[†] and progressive resistance exercises with ankle
250 weights[‡] and resistance bands[§] to address LE strength deficits and enhance activity tolerance and

* Invacare Model #6252, Invacare Corporation Worldwide Headquarters, 1 Invacare Way, Elyria, OH 44035-4190

† SciFit Model #ISO7000R, SciFit Corporate Headquarters, 5151 S. 110th E. Ave, Tulsa, OK 74146

‡ Haussman Series 5580, Hausmann Industries, Inc., 130 Union Street, Northvale, NJ 07647

§ Thera-Band Latex Resistance Bands 20010, The Hygenic Corporation, 1245 Home Ave, Akron, OH 44310

251 endurance. Therapeutic activities included bed mobility, transfer training and patient education.
252 GT consisted of ambulation with a hemi-walker and verbal cueing for an improved gait pattern
253 and posture. Neuromuscular re-education addressed balance deficits in both sitting and standing
254 in order to improve patient safety during functional tasks. Balance deficits were also addressed
255 utilizing exercises that incorporated dynamic weight shifting in lateral and anterior/posterior
256 planes, dynamic reaching tasks, varying UE support, varying visual feedback and varying
257 surfaces in order to challenge the patient's different sensory systems. The patient also
258 participated in group exercise therapy which allowed her to perform exercises and activities in a
259 group setting with patients of similar functional level. Interventions were progressed based on
260 patient tolerance and improvements as to continue progressing towards her goals. Detailed
261 interventions can be found in Table 3.

262 The patient was seen at the frequency of six PT sessions per week, ranging in duration
263 from 40 minutes to 60 minutes. She was an active participant in all PT sessions and did not
264 refuse therapy on any occasion during her EOC. Outside of PT, the patient also received
265 procedural interventions through participation with OT and ST.

266 **OUTCOMES**

267 At discharge the patient had met all of her short term goals and had made significant
268 progress towards all of her long term goals. She was able to safely ambulate inside and outside of
269 her bedroom with a hemi-walker and distant supervision. Her sitting and standing balance
270 improved as did her activity tolerance and endurance. She successfully performed bed mobility
271 independently, sit to stand transfers with a hemi-walker and stand-by assist (SBA) as well as
272 stand to sit transfers modified independent with a hemi-walker. She improved her TUG score
273 from 73 seconds with a hemi-walker and minimal assistance for sit to stand to 48 seconds with a

274 hemi-walker and SBA for sit to stand. Additionally, her POMA score improved from 10/28 to
275 18/28. Although both scores still categorized her as a high fall risk, the patient did demonstrate
276 significant improvement in regards to her balance and fall risk. Refer to Table 1 for all discharge
277 examination results.

278 Due to her continued NWB status of her RUE as well as her remaining instability and fall
279 risk, there was concern for the patient's safety with return to independent living. Due to her
280 continued R elbow post-surgical restrictions and her remaining limitations with ADL's, the
281 patient was discharged to an ALF where she continued PT services.

282 **DISCUSSION**

283 This case report demonstrated its intended purpose of providing the framework for
284 procedural interventions to improve gait and balance while reducing fall risk in a patient with a
285 history of falls and skeletal deformities secondary to RA. Due to the existing literature utilizing
286 individualized exercise programs to target balance, gait and strength to decrease fall risk, a great
287 deal of treatment time was focused on interventions to address correlating deficits.² Slight
288 modifications to existing accepted approaches for GT and neuromuscular re-education were
289 developed and utilized to tailor to the patient's unique presentation. The implementation of valid
290 and reliable outcome measures to assess and monitor fall risk was crucial in this case as
291 individuals with RA have a higher incidence of falls per year as compared to healthy elderly
292 individuals.⁴ In addition to gains in overall function, strength, balance and endurance, the patient
293 greatly reduced her fall risk as demonstrated by her improved TUG, POMA and FES scores.

294 The patient made steady progress throughout her EOC. She showed significant
295 improvements in functional mobility as demonstrated by her ability to perform bed mobility,
296 transfers and ambulation with less assistance and less energy expenditure. The combination of

297 functional task-specific training and LE strengthening seemed to positively influence her ability
298 to perform functional tasks.

299 At discharge the patient's gait had improved as demonstrated by increased step length,
300 increased cadence, continuous stepping, increased stability and a more erect posture while
301 ambulating with her hemi-walker using a three-point gait pattern. Her ambulation endurance
302 improved from 20 feet with a hemi-walker and contact guard assist to 2 x 200 feet with a hemi-
303 walker and distant supervision. Individualized GT with verbal cueing, dynamic gait obstacle
304 courses and dual cognitive-gait tasks appeared to positively influence the patient's gait and
305 endurance. Although a four-point walker would have been more appropriate for the patient in
306 regards to added stability, a hemi-walker was utilized as she did not have adequate bilateral
307 finger and hand ROM as well as NWB precautions on her RUE which limited her ability to
308 achieve an appropriate grip with a four-point walker.

309 Neuromuscular re-education specific interventions also seemed to positively influence
310 the patient's progress in regards to her balance. The addition of weight shifting, dynamic
311 reaching, varying UE support, and varying visual and somatosensory input while performing
312 functional tasks during balance exercises appeared to be beneficial for the patient. Altering the
313 sensory feedback the patient received during exercises was likely a contributing factor to her
314 balance-specific improvements as her foot deformities and impaired proprioception influenced
315 her stability greatly.

316 The positive outcomes of patient-centered balance and GT reflected upon the patient's
317 improved TUG, POMA and FES scores. Although her TUG and POMA scores still categorized
318 the patient as a fall risk, her risk was greatly reduced. Furthermore, her significantly reduced FES
319 score signified improved confidence in performing ADL's without the fear of falling.

320 Overall, this patient was an excellent candidate for PT. Through a combination of
321 intervention approaches as well as OT and ST, the patient was able to be discharged to an ALF
322 with great improvements made towards her PLF. The patient was pleased with her progress and
323 understood the importance of remaining active through participation with continued PT and
324 facility exercise programs.

325 In conclusion, patient-centered PT with a focus on balance and GT appeared to make
326 significant improvements in this patient's overall function and decrease her fall risk. Future
327 research studies analyzing the efficacy of particular GT and neuromuscular re-education
328 interventions targeting fall risk in a population of individuals experiencing instability secondary
329 to RA related structural changes are necessary in order to generalize the results to different
330 patients.

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434 **TABLES and FIGURES**

435 **Table 1: Tests and Measures at Initial Evaluation and Discharge**

436

<i>Tests & Measures</i>	<i>Initial Evaluation Results</i>			<i>Discharge Results</i>		
Pain						
VAS Scale	4/10 in R elbow			1/10 in R elbow		
AROM						
Upper Extremities	R	L	B	R	L	B
Shoulder	50-75% of normal	WFL		75-100% or normal	WFL	
Elbow	Not assessed due to cast	WFL		Not assessed due to brace	WFL	
Wrist	Not assessed due to cast	25% of normal		Not assessed due to brace	25% of normal	
Hand/Fingers	Not assessed due to cast	25% of normal	Severe deformities secondary to RA	Not assessed due to brace	25% of normal	Severe deformities secondary to RA
Lower Extremities	R	L	B	R	L	B
Hip	WFL	WFL		WFL	WFL	
Knee	WFL	WFL		WFL	WFL	
Ankle	25% of normal	25% of normal		25% of normal	25% of normal	
Foot/Toes	25% of normal	25% of normal	Severe deformities secondary to RA	25% of normal	25% of normal	Severe deformities secondary to RA
Strength	R		L	R		L
UE	NWB until cleared by surgeon		4-/5 for all motions	Remains NWB		4/5 for all motions
LE	B			B		
	Hip abduction 3+/5			Hip abduction 4/5		
	Hip adduction 3+/5			Hip adduction 4/5		
	Hip flexion 4-/5			Hip flexion 4-/5		
	Knee flexion 4/5			Knee flexion 4/5		
	Knee extension 4/5			Knee extension 4/5		
Ankle dorsiflexion 4/5			Ankle dorsiflexion 4/5			
Sensation	Intact to light touch bilateral LE's			Intact to light touch bilateral LE's		
Proprioception	Diminished in bilateral ankles			Diminished in bilateral ankles		
Edema	None noted			None noted		
Coordination						
Finger to Nose	L UE: Decreased accuracy			L UE: Increased accuracy with increased time		
Finger Opposition	L UE: Decreased accuracy			L UE: Decreased accuracy, likely due to hand deformities		
Ankle Circles (Clockwise and Counter-Clockwise)	B LE's: Decreased accuracy			B LE's: Decreased accuracy, likely due to foot deformities		
Bed Mobility						
Sit to Supine	MinA to lift trunk from supine position			Independent		
Supine to Sit	MinA for upper body and trunk			Independent		
Transfers						
Sit to Stand	MinA with hemi-walker, used L UE to push from surface			SBA with hemi-walker, used L UE to push from surface		

Stand to Sit	MinA for controlled descent, verbal cues to reach back for surface with L UE after feeling the surface on the back of her legs	Modified Independent with hemi-walker
Ambulation		
With hemi-walker	1 x 20ft with hemi-walker and CGA	2 x 200ft with hemi-walker and distant supervision
Gait Analysis	With hemi-walker. Unsteady gait, foot-flat contact, decreased step length, decreased cadence, forward trunk lean, out-toeing bilaterally. Patient wore specialized shoes recommended from her doctor to help improve her gait pattern and lessen the influence of her foot deformities (Appendix 4).	With hemi-walker. Unsteady gait at times, improved step length, improved cadence, continuous stepping, slight forward trunk lean, out-toeing bilaterally. Patient continued to wear special shoes recommended by her doctor for all ambulation (Appendix 4).
Posture		
Sitting	Posterior pelvic tilt, rounded shoulders, forward head	Posterior pelvic tilt, rounded shoulders, forward head
Standing	Rounded shoulders, forward head, out-toeing stance with wide BOS	Rounded shoulders, forward head, out-toeing stance with normal BOS
Balance	Sitting	Standing
Static	Good	Fair+
Dynamic	Good-	Fair
Activity Tolerance /Endurance	Minimal limitations, sustained ordinary activities cause fatigue	Age appropriate activities do not cause increased fatigue
Safety Awareness	Impaired. Needs verbal cueing for hand placement during transfers. Unaware of her deficits and fall risk.	Intact. Aware of deficits and safety measures that will decrease her risk for future falls.
Cognition	Alert and oriented to person, place, time and situation	Alert and oriented to person, place, time and situation
Timed Up and Go (TUG)	73 seconds with hemi-walker and MinA for sit<>stand	48 seconds with hemi-walker and SBA for sit<>stand
Tinetti Performance Oriented Mobility Assessment (POMA)	10/28	18/28
Falls Efficacy Scale (FES)	70/100	37/100

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438 **R** = right, **L** = left, **B** = bilateral, **AROM** = active range of motion, **MMT** = manual muscle test (0-5 scale, 5 =
439 normal), **MinA** = minimal assist, **CGA** = contact guard assist, **RA** = rheumatoid arthritis, **sit<>stand** = to and from
440 sit to stand, **NWB** = non-weight-bearing, **UE** = upper extremity, **LE** = lower extremity, **WFL** = within functional
441 limits, **BOS** = base of support, **SBA** = stand-by assist
442 **Timed Up & Go** – Cut-Off Scores: community-dwelling adults >13.5 seconds = fall risk
443 **Tinetti Performance Oriented Mobility Assessment** – Cut-Off Scores: <19 = high fall risk, 19-24 = medium fall
444 risk, 25-28 = low fall risk
445 **Falls Efficacy Scale** – A total score greater than 70 indicates that the person has a fear of falling
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454 **Table 2: Physical Therapy Goals**
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Short Term Goals: Time Frame 2 weeks	Long Term Goals: Time Frame 4 weeks
1. The patient will ambulate 50ft x 2 with hemi-walker and SBA in order to improve her gait endurance.	1. The patient will improve her TUG score to 45 seconds or less in order to improve her safety with transfers and ambulation.
2. The patient will perform sit<>stand transfers with hemi-walker and SBA in order to improve independence within her room.	2. The patient will perform all bed mobility and sit<>stand transfers Mod I with bed rails and LRD respectively in order to return home safely.
3. The patient will improve static standing balance to Good- in order to improve safety with sit<>stand transfers.	3. The patient will ambulate 200ft x 2 Mod I with LRD in order to ambulate to and from the dining room for meals.
4. The patient will complete bed mobility with CGA in order to improve her functional mobility and independence within her room.	4. The patient will improve bilateral hip flexion, abduction and adduction strength to 4/5 (MMT) in order to improve her efficiency with gait and transfers.

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 457 **SBA** = stand-by assist, **CGA** = contact guard assist, **Mod I** = modified independent, **LRD** = least
 458 restrictive device, **sit<>stand** = sit to stand and stand to sit, **TUG** = Timed Up & Go, **MMT** = manual
 459 muscle test

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Table 3: Interventions

	Type/Conditions	Week 1	Week 2	Week 3
Therapeutic Exercise	Strengthening	-Seated LE strengthening exercises with 1# ankle weights and orange theraband	-Seated LE strengthening exercises with 1.5-2.0# ankle weights and green theraband	-Seated LE strengthening exercises with 2.5# ankle weights and blue theraband
	Activity Tolerance/Endurance		-Recumbent bike, 10 minutes at level 1 resistance	-Recumbent bike, 20 minutes at level 1 resistance
Therapeutic Activities	Bed Mobility	-Supine <> sit -Rolling L and R	-Supine <> sit -Rolling L and R	-Supine <>sit without bed rails or HOB inclined -Rolling L and R without bed rails
	Transfers	-Sit <> stand	-Sit <> stand altering surfaces and surface height	-Sit <> stand altering surfaces, surface height and armrests
	Patient education	-Safety measures to take while ambulating by asking staff for assistance -Importance of maintaining NWB status on R UE	-Proper hand placement to ensure safety during transfers	-Proper hand placement during transfers to ensure safety -Patient/family education regarding discharge to ALF -encourage patient to remain active -encourage patient to participate with facility exercise groups and activities -Decreasing fall risk within her living environment
Gait Training	With Hemi-Walker	-50ft x 3 with 3-point gait pattern, CGA and verbal cueing	-200ft x 1 with 3-point gait pattern, close supervision and verbal cueing -Dynamic gait obstacle course with verbal cueing	-200ft x 2 with 3-point gait pattern and distant supervision -Dynamic gait obstacle course -Dual task ambulation with cognitive task
Neuromuscular Re-education	Balance training	-Static sitting at EOB -Dynamic sitting with weight shifting laterally and A/P -Static standing with single UE support and no UE support	-Dynamic sitting with weight shifting laterally and A/P -Static standing with single UE support and no UE support -Dynamic standing with single UE support and no UE support while reaching 25% outside of her BOS	-Static standing with single UE support and no UE support on firm surface and foam surface -Dynamic standing with single UE support and no UE support on firm and foam surfaces while reaching 50-75% outside of her BOS to perform functional tasks
Group Exercise Therapy	Therapeutic exercise, therapeutic activities, neuromuscular re-education	-Seated LE strengthening with 1# ankle weights and orange theraband -Seated dynamic balance training -Standing dynamic balance training with single UE support -Sit <> Stand transfer training	-Seated LE strengthening with 1# ankle weights and orange theraband -Seated core strengthening -Seated dynamic balance training -Standing dynamic balance training with no UE support	-Seated LE strengthening with 2# ankle weights and green theraband -Seated core strengthening -Seated dynamic balance training -Standing dynamic balance training with no UE support -Sit <> Stand transfer training -Dynamic gait obstacle course

490 **Supine <> sit** = supine to sit and sit to supine, **HOB** = head of bed, **sit <> stand** = sit to stand and stand to sit, **side-lying <> sit** = side-lying to sit and sit to side-lying,
491 # = pounds, **NWB** = non-weight-bearing, **R** = right, **UE** = upper extremity, **ALF** = assisted living facility, **EOB** = edge of bed, **A** = anteriorly, **P** = posteriorly, **CGA** = contact
492 guard assist, **BOS** = base of support

493 **Figure 1: Bilateral Foot and Hand Deformities**
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495 **A and B:** Resting position of the patient's bilateral foot and hand deformities. She presented with grossly
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497 25% of normal active range of motion in her hands and feet bilaterally.
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535 **Appendix 1: Medications at Admission**

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Medication	Indication
Dexamethasone	Rheumatoid arthritis
Docusate	Constipation
Lorazepam	Anxiety
Oxycodone	Pain
Acetaminophen	Pain
Zofran	Nausea
Prednisone	Rheumatoid arthritis
Levothyroxine	Hypothyroidism
Mirabegron	Urinary urgency
Mometasone Furoate	Seasonal allergic rhinitis
Naphazoline-Pheniramine	Dry eyes
Polyethyl Glycol-Propyl Glycol 0.4% solution	Extremely dry eyes
Polyethylene Glycol 3350	Constipation
Omeprazole	Gastroesophageal reflux disease
Folic Acid	Nutritional support
Vitamin C	Supplement
Vitamin D	Supplement
Calcium	Hypocalcemia
Multivitamin	Nutritional support
Rectal Suppository as needed	Constipation

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561 **Appendix 2: Systems Review**
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Cardiovascular/Pulmonary	Unimpaired. HR, RR and BP within normal limits, no edema
Musculoskeletal	Strength: -gross UE strength impaired -gross LE strength impaired
	ROM: -gross UE ROM impaired -gross LE ROM impaired
	Posture: Impaired seated and standing posture
	Gross Symmetry: Impaired
	Height/Weight: Unimpaired, within normal limits
Neuromuscular	Impaired coordination, impaired balance, impaired locomotion
Integumentary	Impaired Bruising noted in right fingers likely as a result of fracture and surgery, all other skin intact, normal color, integrity, pliability
Communication	Unimpaired
Affect, Cognition, Language, Learning Style	Unimpaired, Alert and Oriented to person, place, time and situation The patient reports that she prefers demonstration and/or pictures when learning a new activity

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 564 **HR** = heart rate, **RR** = respiratory rate, **BP** = blood pressure, **UE** = upper extremity, **LE** = lower
 565 extremity, **ROM** = range of motion
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593 **Appendix 3: Psychometric Properties**

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	Reliability	Validity	Additional Notes
Manual Muscle Testing	-Good intra-rater reliability: ICC = 0.63 – 0.98 -Inter-rater reliability: ICC = 0.11 – 0.94	-Adequate concurrent validity: ICC = 0.59 – 0.94	-Subjectivity and clinical experience can influence the psychometric properties of MMT
Timed Up & Go	-Excellent test re-test reliability: ICC = 0.97 -Excellent inter-rater reliability: ICC = 0.99	-Adequate construct validity: r = -0.55 (POMA Balance), r = -0.53 (POMA Gait)	-The fall risk cut-off score for a community dwelling adult is >13.5 seconds
Tinetti Performance Oriented Mobility Assessment	-Excellent test-retest reliability: ICC = 0.72 – 0.86 -Excellent interrater reliability: ICC = 0.84	-Excellent construct validity: r = 0.689 – 0.736 (Activities Specific Balance Confidence Scores)	-Cut-off scores: <19 = high fall risk, 19-24 = medium fall risk, 25-28 = low fall risk
Falls Efficacy Scale	-Adequate test-retest reliability: r = 0.71	-Excellent construct validity: r = 0.66 (balance), r = 0.67 (gait), r = 0.71 (mobility)	-A score $\geq 70/100$ indicates a fear of falling

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MMT = manual muscle testing, **POMA** = Performance Oriented Mobility Assessment, **ICC** = intraclass coefficient

623 **Appendix 4: Specialized Shoes**
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625 **A:** Frontal view of the patient’s specialized shoes worn during all ambulation per physician
626 recommendation.
627 **B:** Side view of the patient’s specialized shoes worn during all ambulation per physician
628 recommendation.
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