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**Functional Training in a Patient with Middle Cerebral Artery Stroke and
Multiple Comorbidities: A Case Report**

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

The author acknowledges Michael Fillyaw, PT, MS, for his assistance with case report
conceptualization, as well as the patient for participating in this Case Report.

25 **ABSTRACT**

26

27 **Background and Purpose:** Strokes affecting the middle cerebral artery (MCA) cause
28 impairments of strength, sensation, coordination, and balance of the contralateral side, with
29 recovery affected by the patient’s premorbid status. Although there is a significant amount of
30 research detailing physical therapy (PT) interventions for patients with hemiplegia, there is a lack
31 of evidence supporting interventions for patients with hemiplegia following stroke that have
32 multiple comorbidities. The purpose of this case report is to describe a progressive PT plan of
33 care (POC) for a patient following MCA stroke with multiple comorbidities in the skilled nursing
34 setting.

35 **Case Description:** The patient was a 71-year-old male admitted to the skilled nursing facility
36 (SNF) 50 days following a subacute right MCA infarct, non-ST elevation myocardial infarction,
37 type II, and multiple significant comorbidities. The patient received PT five days a week for 35
38 days, with PT interventions focused on bed mobility, transfers, lower extremity strength, activity
39 tolerance and balance.

40 **Outcomes:** Throughout his POC, the patient improved his sitting and supported standing
41 balance, rolling in bed from moderate-maximum assist to supervision-minimum assist, and his
42 transfers, progressing from a hooyer lift to a sit-to-stand lift. Caregiver training was provided for
43 the patient’s family, prior to the patient’s discharge from the SNF, to aid in his transition home
44 with home health services.

45 **Discussion:** Recovery from MCA stroke, complicated by several comorbidities, proves to be a
46 difficult journey for patients. Despite several insurance denials and cessation of funding from the
47 family, the patient demonstrated improved independence and function following the PT POC.
48 Future studies should be conducted to further examine ideal PT interventions to improve
49 functional outcomes for patients following stroke with multiple comorbidities.

50 **BACKGROUND and PURPOSE**

51 Approximately 795,000 individuals experience a stroke annually, making it the leading
52 cause of long-term disability of adults in the United States, costing an estimated \$34 billion each
53 year.^{1,2} Strokes affecting the middle cerebral artery (MCA) cause impairments of strength,
54 sensation, coordination, and balance of the contralateral side, with recovery affected by the
55 patient's premorbid status.³ Cardiovascular disease is the cause of a majority of strokes, with
56 cardiovascular impairments worsened by increased age, comorbidities, and medications.

57
58 The premorbid functional status of a patient who has had a stroke has been shown to be
59 an important predictor of functional recovery, and survival rates are dramatically decreased for
60 those with increased age, hypertension, heart disease, and diabetes.^{1,3} Additional factors that
61 affect the patient's mortality include loss of consciousness at stroke onset, size of the lesion,
62 having multiple neurologic deficits, persistent severe hemiplegia, and history of prior stroke.
63 Deconditioning as a result of hospitalization, bed rest, depression, and impaired activity may
64 occur following a stroke or cardiac event, further complicating the patient's course of recovery.¹

65
66 Utilizing a task-oriented approach to intervention for patients following stroke has been
67 shown to increase functional outcomes.¹ Although there is a significant amount of research
68 detailing physical therapy (PT) interventions for patients with hemiplegia following stroke, there
69 is a lack of evidence supporting interventions for patients following stroke who have multiple
70 complicated comorbidities.^{1,4-6} Postural control has been shown to be an important determinant
71 of function upon discharge from a skilled nursing facility (SNF),⁷ with post-stroke patients with
72 multiple comorbidities demonstrating postural imbalance and poorer outcomes when compared
73 to similar patients with better postural control.⁸ The purpose of this case report is to describe a

74 progressive PT plan of care (POC) for a patient following MCA stroke with multiple
75 comorbidities in the skilled nursing setting.

76

77 **CASE DESCRIPTION**

78 **Patient History and Systems Review**

79 The patient is a 71-year-old male presenting to the SNF following a subacute right MCA
80 infarct, further affecting the anterior aspect of the right insular cortex, as seen by CT scan, as
81 well as a type II non-ST elevation myocardial infarction. The patient fell, hitting his head on a
82 bathtub, and was found several hours later with inability to move his left side. The patient was
83 given tissue plasminogen activator initially, and remained in the hospital for two weeks before
84 being admitted to acute rehab. The patient intermittently spent 50 days between acute care and
85 acute rehabilitation in the hospital before being discharged to the skilled nursing setting.

86

87 Upon the initial PT examination at the SNF, the patient presented with significant left
88 sided hemiparesis and neglect. Systems review findings can be found in Table 1. Other notable
89 past medical history included: gross hematuria and urinary retention, left buttock cellulitis with
90 stage II decubitus, significant carotid stenosis, type II diabetes, previous discectomy at L4-L5,
91 spinal stenosis, pernicious anemia, recurrent urinary tract infections, depression, anxiety, obesity,
92 bilateral total knee replacements greater than 10 years old, left plantar foot hematoma with
93 pressure ulcer, rhabdomyolysis, acute kidney injury, hypernatremia, and hyperkalemia. The
94 patient was admitted to the SNF with 25 medications.

95

96 The patient reported that his primary goal for PT was to walk. Other PT goals made with
97 the patient and his family included performing independent bed mobility and transfers without

98 the use of a hoyer lift.

99

100 **Clinical Impression 1**

101 Based on the location of the stroke it was expected that the patient would have
102 impairments of strength, sensation, coordination, and balance of the left arm and leg. His
103 limitations of gait, wheelchair mobility, bed mobility, transfers, self-care, and activities of daily
104 living (ADL) resulted from the impairments following the stroke. Further complicating these
105 impairments were several comorbidities, including 12 year-old bilateral total knee replacements,
106 a stage II decubitus ulcer with cellulitis on the patients buttocks, and a pressure ulcer and plantar
107 hematoma on the left foot. Examination goals for this patient included obtaining objective
108 information on bed mobility and transfers, sitting balance, lower extremity (LE) strength,
109 sensation, and range of motion (ROM). Special care was given to avoid adding undue pressure or
110 friction to areas of impaired skin integrity.

111

112 Having spent several weeks in the hospital and in acute rehabilitation, the patient was
113 highly motivated to participate in therapy. Being in the skilled nursing setting, he received
114 evaluations for speech and occupational therapy, as well as physical therapy, and was scheduled
115 to see each five days a week. Due to his complicated medical history, significant impairments,
116 strong family support system, and high level of motivation to participate in therapy, the patient
117 was selected for this case report.

118

119 **Examination**

120 To compare the hemiparetic LE to the unaffected side, a gross assessment of ROM,
121 manual muscle testing (MMT), light touch sensation, tone and pitting edema were completed

122 with the patient sitting in his wheelchair. The patient's left LE passive ROM (PROM) was found
123 to be within functional limits, while his left active ROM (AROM) was limited in all motions by
124 impaired strength. Right LE AROM was also found to be within functional limits. Gross strength
125 was examined via MMT, which has been found to have good reliability and validity for patients
126 with neuromusculoskeletal dysfunction.⁹ His right LE strength was grossly 4-/5. His left hip
127 flexion was 1/5, with all other left LE motions rated as 0/5. LE light touch sensation was intact
128 on the right LE, and impaired on the left. To grade edema, a 4+ scale was utilized, which
129 Brodovicz and colleagues¹⁰ have found to have low inter-examiner agreement. The patient had
130 bilateral lower leg edema, with 1+/4+ on the right and 2+/4+ on the left. Finally, the patient's
131 LE tone was found to be normal on the right and hypotonic on the left. Utilizing a task oriented
132 approach, rolling to both sides, moving from supine to sit and sit to supine, and sitting balance at
133 the edge of his bed were all performed, giving a gross assessment of his functional status. (Table
134 2) No psychometric properties were available for the remaining initial examination procedures;
135 however, the methodology used was standard for the facility and in agreement with the
136 impairments noted during his hospital stay.

137

138 **Clinical Impression 2**

139 Impairments found during the initial examination were consistent with those expected
140 with MCA stroke, supporting the initial clinical impression of the patient. The patient's
141 impairments, including reduced strength and sensation of the involved side, edema, and
142 decreased tone, contributed to his loss of function and demonstrated a continued need for PT
143 services. Further, the patient's course of recovery was complicated by his extensive medical and
144 surgical history, making him an appropriate patient for this case report. The ICD-10 code chosen
145 for this patient was hemiplegia and hemiparesis following unspecified cerebrovascular disease

146 affecting left non-dominant, I69.954.

147

148 Based on the impairments the patient had from his stroke, paired with his existing
149 impairments from other comorbidities, his prognosis for improvement with PT was limited.
150 According to Balaban and colleagues,³ there are several factors that affect the recovery of
151 patients following a first time MCA stroke. The authors found that the functional status of the
152 patient at admission was an important predictor of functional recovery, and that functional
153 outcomes do not necessarily increase with increased duration of inpatient rehabilitation.³ Upon
154 his admission to the facility, there were several factors that added complexity to the primary
155 impairment of left sided hemiplegia. For example, the patient's obesity, previously existing
156 bilateral knee pain from 12-year-old total knee replacements, low back pain, type II diabetes,
157 pressure ulcers on his buttocks and left heel, and depression all increased the burden of care, and
158 further complicated how interventions and treatments would be administered. Further, the patient
159 was admitted to the SNF 39 days following his stroke, having experienced several medical set
160 backs during his acute care stay.

161

162 The proposed PT POC for this patient included interventions for sitting balance and trunk
163 control, bilateral LE strengthening, standing balance in parallel bars and with the use of
164 mechanical lifts, wheelchair mobility, and task-oriented training for bed mobility. The patient
165 received further services and interventions from nursing, occupational therapy (OT), speech
166 therapy (ST), and social services while in the SNF. A progress note was completed for each
167 week that the patient was at the facility, which monitored his progress towards PT goals and any
168 changes in his status. Short term and long term goals for the patient's POC are listed in Table 3.

169

170 **Intervention**

171 The patient's care was coordinated with OT, ST, wound care, nursing, and social
172 services. Each of the therapies saw the patient, on average, five times a week, nursing saw the
173 patient daily, and other disciplines interacted with the patient as needed. OT, PT, and ST worked
174 together to coordinate the patient's therapy schedule to be as advantageous to the patient as
175 possible. Communication regarding the patients level of fatigue, any increased pain or nausea,
176 and how long he had been sitting up in his wheelchair or lying in bed aided therapy in choosing
177 treatment times that allowed him to participate to the fullest extent possible. Referrals to
178 different disciplines were made as necessary throughout the patient's POC, and the patient was
179 compliant with attending all outside appointments. All pertinent information between disciplines
180 was shared via electronic medical records, as well as during weekly patient progress meetings.
181 The patient's family was updated on his progress several times per week. Prior to discharge, the
182 patient and his family were provided with a LE home exercise program.

183
184 Interventions aimed to improve functional mobility, LE strength, and balance, and were
185 provided for 35-80 minutes per session, five times a week. Procedural interventions chosen
186 included therapeutic exercise, therapeutic activities, and neuromuscular re-education, including
187 the use of electrical stimulation. Functional training that is task-specific, focused on improving
188 the patient's motor control and strength was included, and has been reported to be a fundamental
189 aspect of PT for patient's who have had a stroke.¹ Caregiver training with the patient's family
190 was an integral aspect of interventions as well, and took place throughout the POC. Interventions
191 were adjusted to facilitate the patient's full participation during therapy. Finally, compensatory
192 training strategies were emphasized based on the patient's expected amount of motor recovery.

193

194 Therapeutic exercises in sitting and supine were performed to increase LE strength,⁵
195 maintain ROM, and improve motor control. The patient performed strengthening exercises
196 actively with his right LE, but required substantial assistance for his left LE. Throughout his time
197 at the SNF, the patient was able to actively perform hip flexion and hip adduction on the left
198 side, allowing for active-assist ROM (AAROM) exercises for those motions, while all other left
199 LE motions were brought through PROM. In an effort to enhance the muscle activity of the left
200 quadriceps and hamstring muscles, electrical stimulation was used in conjunction with
201 performing supine and sitting exercises.¹¹ An Omnistim Fx² Pro Electrical Stimulation unit
202 (Model Number: 100FX2C, Accelerated Care Plus Corporation, Reno, NV) was utilized for these
203 treatment sessions, using a Patterned Electrical Neuromuscular Stimulation (PENS) waveform.
204 Four pads were placed on the patient's left leg: proximally on the anterior quadriceps, distally
205 over the antero-medial quadriceps, proximally on the hamstrings, and distally on the hamstrings.
206 Initially, the patient performed one set of 10 repetitions for each of the exercises in either supine
207 or sitting. Over the course of his POC, the number of sets and reps increased to two sets of 15
208 repetitions as the patient's strength and motor control improved.

209
210 Therapeutic activities included bed mobility, transfers using a variety of lifts, and
211 wheelchair mobility. A task-oriented approach was utilized for bed mobility and transfer
212 training, breaking the tasks down to their component parts, which has been shown to improve
213 functioning after stroke.⁶ Bed mobility included rolling to both sides, moving from supine to
214 sitting at the edge of bed, moving from sitting to supine, and repositioning for pressure relief and
215 alignment in bed. At the start of care, the patient required a hooyer lift with the assist of two staff
216 members to transfer from bed to wheelchair. By week two, the patient could assist the staff in
217 transfers by pulling himself up with his right hand, and weight bearing through both LEs using

218 the Smart Stand (Product Number: S400PN, EZ Way, Inc., Clarinda, IA). Training was done
219 with the patient and his family on the safe and proper use of the lift. The patient and his family
220 were also instructed in proper repositioning in the wheelchair. Due to the severity of the patient's
221 hemiparesis, it was expected that wheelchair use would be the primary mode of mobility in the
222 future, with the patient performing independent wheelchair mobility using his right upper and
223 lower extremities. Verbal cues related to obstacle negotiation, safety awareness of the paretic left
224 upper extremity, and energy conservation techniques were all utilized during the intervention.

225

226 Neuromuscular re-education techniques were performed to encourage body awareness in
227 space, proprioception, and to increase sitting and standing tolerance. Early on, the patient
228 performed sitting balance at edge of bed with varying levels of upper extremity support and
229 external assistance, working towards unsupported sitting for several minutes. Starting at week
230 two, interventions targeting standing tolerance were initiated. With impaired strength, knee and
231 low back pain, and hemiparesis, the patient was unable to stand unassisted, thus requiring the
232 utilization of three different methods to achieve his standing tolerance goals. Mechanically, the
233 patient utilized both the Smart Stand (Product Number: S400PN, EZ Way, Inc., Clarinda, IA)
234 and a standing frame. To come to standing in the parallel bars the patient required the assist of
235 three therapists. For all standing, the patient utilized a mirror for visualization, along with verbal
236 and tactile cues for postural alignment. Initially, the patient's standing tolerance was limited to
237 transferring with the Smart Stand (Product Number: S400PN, EZ Way, Inc., Clarinda, IA);
238 however, this progressed to several minutes of supported standing in the parallel bars with the
239 assist of two therapists and supervision of a third. Although it was not expected that the patient
240 would be ambulatory, standing was used as an intervention to improve the patient's transfers,
241 and improve his body awareness in space.

242
243

OUTCOMES

244 The patient spent 35 days in the SNF and demonstrated improvements in all areas of
245 functional mobility, despite insurance denials, funding difficulties, and complications related to
246 his comorbidities. The patient increased his independence with bed mobility, transfers between
247 his bed, wheelchair, and commode were done with a sit-to-stand lift, he performed wheelchair
248 mobility with supervision, and his sitting balance and standing tolerance had improved. (Table
249 2.) Due to the unexpected timing of his discharge, formal measurements of ROM, MMT,
250 sensation, tone, and edema were not reassessed.

251

252 Upon discharge, the patient returned home with his wife and home health services, as
253 well as a sit-to-stand lift, manual wheelchair with left arm trough and elevating leg rest, hospital
254 bed, and commode. His wife and daughter were educated on safety and technique for aiding in
255 his bed mobility, safe use of the lift for transfers, and how to assist with repositioning in bed and
256 in his wheelchair. They were also educated on the implementation and importance of his home
257 exercise program to maintain his strength and mobility. 24-hour supervision in the home was
258 recommended by all disciplines.

259

DISCUSSION

261 This case report describes a progressive PT POC for a patient following MCA stroke with
262 multiple comorbidities in the skilled nursing setting. For this patient, interventions and therapy
263 sessions were based on his day-to-day status, with accommodations made in instances of pain,
264 nausea, incontinence, and fatigue. For instance, a significant amount of the bed mobility and
265 transfer training that the patient received was done in conjunction with toileting and caregiver

266 training. Though this is not unlike therapy sessions in many inpatient settings, the number of
267 adaptations made to each of the tasks to accommodate for his comorbidities added a level of
268 complexity to their execution.

269

270 As the patient progressed through his POC, and as his discharge became more imminent
271 following repeated insurance denials for further coverage, the emphasis on caregiver training for
272 the patient's family took precedence. Several weeks of PT treatment sessions were spent with the
273 patient's wife and daughter, educating them on the importance of maintaining his skin integrity,
274 especially during bed mobility and transfers when his buttock pressure ulcer was most
275 vulnerable. Collaboration with OT, ST, and social work was also utilized for patient education,
276 to ensure that the family understood the magnitude of his condition, and had a clear
277 understanding of what to expect upon their return home. Despite the challenges that the patient
278 faced, he appeared to make functional improvements following several weeks of PT treatments,
279 specifically related to interventions that followed the task-oriented approach.

280

281 The patient in this case report resembles, to some extent, many of the patients who are
282 admitted to SNFs, and is of special interest as the population of the United States continues to
283 age. The projected growth of the population of older adults, aged 65+, is expected to reach 88.5
284 million by 2050, more than two times the same age population of 2010.¹² The National Institute
285 on Aging¹³ has found that as the population ages there is a higher incidence of those with
286 chronic and degenerative diseases, including cardiovascular disease, cancer, and diabetes,
287 ultimately increasing healthcare costs. These findings indicate the importance of exploring
288 treatment plans for patients with multiple comorbidities. Though there is a multitude of existing
289 research detailing appropriate interventions for patients with a singular condition, such as

290 hemiparesis following stroke^{1, 4-6}, there is a growing need for research detailing interventions
291 and treatment plans for patients affected by several conditions or impairments. Recovery from
292 MCA stroke, complicated by several comorbidities, proves to be a difficult journey for patients.
293 Future studies should be conducted to further examine ideal PT interventions to improve
294 functional outcomes for patients following stroke with multiple comorbidities.

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Table 1. Systems Review

Cardiovascular/Pulmonary	Impaired: Hypertension controlled with medication, type II non-ST elevation myocardial infarction, carotid stenosis, first degree atrioventricular block, hyperlipidemia, pernicious anemia, patent foramen ovale, edema is present in left and right feet and ankles
Musculoskeletal	Impaired: Gross strength impairments of left upper and lower extremity
Neuromuscular	Impaired: Flaccid left upper and lower extremity, decreased sitting balance, decreased/absent sensation of left lower extremity
Integumentary	Impaired: Left buttock cellulitis with stage II decubitus, left plantar foot hematoma with pressure ulcer
Communication	Impaired: Aphasia
Affect, Cognition, Language, Learning Style	Impaired: Diagnosis of depression, able to follow single step instructions

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348

349 **Table 2. Patient Function at Initial Examination and Discharge**

Tests & Measures	Initial Examination	Discharge
Rolling	ModA – MaxA	S – MinA
Supine to Sit/Sit to Supine	MaxA	ModA – MaxA
Transfers	Hoyer Lift	Sit-to-Stand Lift
Wheelchair Mobility	Dependent	S
Gait	Not assessed	Not assessed
Balance	Static sitting: CGA Dynamic sitting: MinA Standing: Not assessed	Static sitting: Close S Dynamic sitting: CGA Standing: in Sit-to-Stand Lift with CGA – MinA

ModA= moderate assistance, MaxA= maximum assistance, S= supervision, MinA= minimum assistance, CGA= contact guard assist

350

351

Table 3. Physical Therapy Goals

Short Term Goals (Within 2 Weeks)	Long Term Goals (Within 8 Weeks)
Rolling in bed with minA with use of bed rail and verbal cues for technique	Modified independence with bed mobility
Supine-to-sit with modA with use of bed rail and verbal cues for safety and technique	Modified independence with transfers with caregivers
Participation in dynamic sitting balance unsupported with S for 10 minutes	Performance of LE HEP with modified independence with caregiver
Performance of sit to stand in parallel bars with modA x2 with verbal cues for safety and technique	Performance of wheelchair mobility for household distances with modified independence

352 minA= minimum assistance, modA = moderate assistance, S = supervision, LE HEP = lower
353 extremity home exercise program

354

355

Table 4. Physical Therapy Interventions

	Therapeutic Exercises	Therapeutic Activities	Neuromuscular Re-education
Supine	<p>Weeks 1-5</p> <ul style="list-style-type: none"> • Straight leg raise • Heel slides • Hip abduction • Short-arc quads • Quad sets • Gluteal sets • Ankle pumps <p>Weeks 2-5</p> <ul style="list-style-type: none"> • Supine exercises paired with PENS <p>1-2 sets of 10-15 reps</p>	<p>Bed Mobility: Weeks 1-5</p> <ul style="list-style-type: none"> • Rolling to L and R • Supine ⇔ Sit • Repositioning 	
Sitting	<p>Weeks 2-5</p> <ul style="list-style-type: none"> • Hip flexion (marching) • Hip abduction • Long-arc quads • Hip adduction • Ankle dorsiflexion • Ankle plantarflexion • Seated exercises paired with PENS <p>1-2 sets of 10-15 reps</p>	<p>Transfers</p> <ul style="list-style-type: none"> • Week 1: Hoyer Lift: bed ⇔ wheelchair • Weeks 2-5: Sit-to-Stand Lift: bed ⇔ wheelchair, wheelchair ⇔ commode or mat table <p>Wheelchair Mobility</p> <ul style="list-style-type: none"> • Weeks 2-5: Right UE and LE 	<p>Sitting Balance:</p> <p>Weeks 1-5</p> <p>Edge of bed</p> <ul style="list-style-type: none"> • Feet supported on ground and right UE support • Feet supported without UE support

Standing			<p>Standing Tolerance:</p> <p>Standing Frame: Week 1</p> <ul style="list-style-type: none"> • Hip harness with right UE support <p>Sit-to-Stand Lift: Weeks 2-5</p> <ul style="list-style-type: none"> • Trunk harness with right UE support <p>Parallel Bars: Weeks 1-5</p> <ul style="list-style-type: none"> • Assist of 3, with left knee blocking, right UE support
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PENS= patterned electrical neuromuscular stimulation, L= left, R= right, LE= lower extremity, UE= upper extremity

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A. The patient utilized his right arm to assist in pulling himself upright, while his left hemiplegic arm was supported in a sling. His knees were blocked to facilitate extension of the legs and upright standing posture.



B. The patient's trunk is supported with an underarm sling. The patient had a mirror placed in front of him to allow him to visualize his posture during this activity.

360 **Figure 1.** The pictures depict the patient utilizing a sit-to-stand lift as seen from the side (A), and
 361 the back (B).
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