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## **Proprioceptive Neuromuscular Facilitation And Overground Gait Training For A Patient Following A Left Central Medullary Stroke: A Case Report**

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2                   **Proprioceptive Neuromuscular Facilitation and Overground**  
3                   **Gait Training for a Patient Following a Left Central Medullary**  
4                   **Stroke: A Case Report**

5

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12

13                   The patient signed an informed consent form allowing the use of medical information for the  
14                   case report. She was informed on the institution’s policies regarding the Health Insurance  
15                   Portability and Accountability Act (HIPAA).

16

17                   The author acknowledges the patient for her participation in this case report,  
18                   Molly Collin, PT, RYT, for guiding, editing, and conceptualization, and Tim Harvey, PT, DPT,  
19                   for the supervision and guidance of patient care.

20

21                   Key Words: Proprioceptive Neuromuscular Facilitation, Overground Gait Training, Left Central  
22                   Medullary Stroke

Stegemann, Proprioceptive Neuromuscular Facilitation and Overground Gait Training for a Patient Following a Left Central Medullary Stroke: A Case Report

23

24 **ABSTRACT**

25 **Background and Purpose:** Central medullary stroke is a rare type of stroke that is characterized  
26 by contralateral hemiplegia sparing the face, contralateral loss of deep sensation, and ipsilateral  
27 hypoglossal paralysis. It makes up a small percentage of the types of strokes that affect nearly  
28 795,000 Americans every year. While there has been extensive research on rehabilitation  
29 principles for the general treatment of stroke, there has been little research on rehabilitation for  
30 patients following a central medullary stroke. The purpose of this case report was to describe a  
31 multifaceted intervention program with the emphasis on proprioceptive neuromuscular  
32 facilitation (PNF) and overground gait training (OGT) for a patient following a left central  
33 medullary stroke.

34 **Case Description:** The patient was a 71-year-old female who received daily physical therapy  
35 (PT) for six weeks at an inpatient rehabilitation facility. The interventions included coordination,  
36 balance, gait, and functional mobility, with focus on PNF and OGT. Her progress was tracked  
37 using the Function in Sitting Test (FIST), Barthel Index (BI), and the Encompass Health  
38 Rehabilitation Functional Skills Assessment (EHRFSA).

39 **Outcomes:** The patient experienced significant improvement in all three outcome measures. Her  
40 score for the FIST improved from 29/56 to 56/56, while her score on the BI improved from  
41 45/100 to 70/100. On her initial examination the patient was dependent for all aspects of  
42 mobility, but at discharge required only minimum/no assistance.

43 **Discussion:** Interventions such as PNF, OGT, and functional mobility exercises may have been  
44 beneficial for this patient in regard to the improvement in gait and decreased need for assistance.

Stegemann, Proprioceptive Neuromuscular Facilitation and Overground Gait Training for a Patient Following a Left Central Medullary Stroke: A Case Report

45 More research on PNF and OGT, along with other beneficial interventions for patients with  
46 central medullary stroke is warranted.

47 Manuscript word count: 3,246

48 **BACKGROUND AND PURPOSE**

49 A cerebrovascular accident (CVA), or more commonly known as a stroke, is caused by  
50 blockage of blood flow to the brain (ischemic stroke) or when a blood vessel in the brain bursts  
51 (hemorrhagic stroke).<sup>1</sup> Approximately 795,000 Americans experience a stroke every year and it  
52 is the leading cause of long-term disability.<sup>1</sup> Strokes are also responsible for more than 130,000  
53 deaths in the United States every year.<sup>1</sup>

54 The severity, size, and location of the stroke can be a big predictor in a patient's  
55 prognosis. Depending on the location of the stroke, a person can have different impairments. If a  
56 stroke occurs on the left (L) side of the brain, a person can experience paralysis on the right (R)  
57 side of their body, speech or language problems, short-term memory impairments, and are often  
58 hyper-aware of their deficits.<sup>2</sup> If a stroke occurs on the R side of the brain, a person can  
59 experience paralysis on the L side of their body, vision problems, memory loss, and impulsive  
60 behavior.<sup>2</sup>

61 Central medullary stroke, also known as Dejerine syndrome, is a rare type of stroke (less  
62 than 1% of ischemic strokes) that is characterized by three symptoms: contralateral hemiplegia  
63 sparing the face, contralateral loss of deep sensation, and ipsilateral hypoglossal paralysis.<sup>3,4</sup> This  
64 stroke affects the medullary pyramid, which is supplied by the vertebral arteries (upper third of  
65 medullary pyramid) and the anterior spinal artery (lower two thirds of medullary pyramid).  
66 Prognosis is usually good if the lesion occurs at the upper third of the medullary pyramid, as  
67 hypoglossal paralysis is commonly absent.<sup>5</sup> However, if the lesion occurs at the lower two thirds

Stegemann, Proprioceptive Neuromuscular Facilitation and Overground Gait Training for a Patient Following a Left Central Medullary Stroke: A Case Report

68 of the medullary pyramid, prognosis is poor due to respiratory weakness.<sup>5</sup> Risk factors for this  
69 type of stroke include hypertension, diabetes, hyperlipidemia, cigarette smoking, and atrial  
70 fibrillation.<sup>6</sup>

71       Regardless of the location, people who have strokes often have balance and gait impairments,  
72 which can increase their chance of falling and limits their ability to participate independently in  
73 activities of daily living (ADLs).

74       Physical therapy (PT) can be effective at improving mobility in patients who have had a  
75 stroke, especially PT at an inpatient rehabilitation facility (IRF). In a study of 222 patients who  
76 experienced a stroke, Chan et al<sup>7</sup> found that patients who went to an IRF scored eight points  
77 higher on the Activity Measure for Post-Acute Care (AM-PAC), a test that measures a patient's  
78 functional abilities, in comparison to patients who went to a skilled nursing facility (SNF) or  
79 received home health or outpatient therapy. This is significant because individuals with higher  
80 AM-PAC scores are at a lower risk of being readmitted to the hospital.

81       There are several areas of dysfunction that a physical therapist can address, such as deficits in  
82 balance, motor control, strength, gait, and range of motion. One of the PT treatment plans used to  
83 address these deficits is proprioceptive neuromuscular facilitation (PNF). PNF can be done in  
84 order to increase range of motion (ROM) and increase muscular strength and power.<sup>8</sup> In 2019, a  
85 case report by Alagappan<sup>9</sup> looked at the effects of PNF on balance and gait of a patient with  
86 hemiparesis. The patient performed PNF patterns for his upper limb, lower limb, and trunk. After  
87 treatment, he had improvements in his Berg Balance Score (BBS), weight bearing symmetry,  
88 functional ambulation category, and Fugle-Meyer scale (lower extremity component), indicating  
89 that PNF might be a useful treatment option to improve balance and gait in patients who have  
90 had a stroke.

Stegemann, Proprioceptive Neuromuscular Facilitation and Overground Gait Training for a Patient Following a Left Central Medullary Stroke: A Case Report

91 Overground gait training (OGT) can also be beneficial in increasing a person's functional  
92 mobility and independence following a stroke. According to States et al,<sup>10 (p.627)</sup> overground gait  
93 training was defined as "a physical therapist's observation and cueing of a patient's walking  
94 pattern along with related exercises but does not include high-technology aids such as electrical  
95 stimulation or body weight support." Although there was some clinical support for the use of  
96 body weight supported treadmill training (BWSTT) for patients who have had a stroke, a  
97 randomized controlled trial by Lura et al<sup>11</sup> found that OGT and BWSTT garnered similar results  
98 in acute stroke gait rehabilitation. Both groups resulted in an average increase of their Functional  
99 Independence Measure (FIM) by 3.4, indicating a positive change in patient status in response to  
100 treatment and also indicates a decrease in disability. One of the only significant differences was  
101 that gait speed increased in the OGT group. This is promising as OGT may be a viable treatment  
102 option for patients following a stroke, especially if the therapy facility does not have the funds to  
103 afford a BWSTT device.

104 There have been several studies that have looked at the benefits of OGT in stroke  
105 rehabilitation, but there was limited research regarding the use of a combination of both OGT  
106 and PNF, especially for patients with the diagnosis of L central medullary stroke. The purpose of  
107 this article was to describe the use of PNF and OGT in an inpatient rehabilitation setting for a 71-  
108 year-old female following a L central medullary stroke.

109 **PATIENT HISTORY AND SYSTEMS REVIEW**

110 The patient provided written informed consent to participate in this case report. She was a  
111 71-year-old Caucasian female who experienced a CVA. Her magnetic resonance angiogram  
112 (MRA) indicated that she had a L central medullary stroke. She scored a 14 on the National  
113 Institutes of Health Stroke Scale (NIHSS). This scale ranges from 0-42, with a higher score

Stegemann, Proprioceptive Neuromuscular Facilitation and Overground Gait Training for a Patient Following a Left Central Medullary Stroke: A Case Report

114 indicating greater severity, so the patient's score indicated she had a moderately severe stroke.<sup>12</sup>  
115 Her past medical history included type II diabetes, hypertension, Graves' disease, and  
116 hyperthyroidism. See Table 1 for a full medication list. She was retired and lived in a one level  
117 home with her daughter since her husband had recently passed away. The patient's main  
118 impairments were R sided weakness, poor activity tolerance, and deficits in gait, which were  
119 affecting her long-term goal of returning home with as little assistance as necessary. She had  
120 notable deficits in multiple systems; refer to Table 2 for a full systems review. She did not have  
121 any family history of stroke, nor had she had any previous interventions regarding her current  
122 condition. From the patient's perspective, she did not have extensive knowledge of her condition,  
123 but she was motivated to return home. She was receptive to her medical team's guidance and  
124 recommendations and adhered to her plan of care (POC). Her primary problem was mobility  
125 deficits due to R sided weakness. There were no other potential differential diagnoses that  
126 needed to be addressed, as her deficits were consistent with her medical diagnosis of L central  
127 medullary CVA. The plan for examination included the Function in Sitting Test (FIST), the  
128 Encompass Health Rehabilitation Hospital Functional Abilities Scale, and the Barthel Index, in  
129 addition to gross strength and sensation testing. This patient was a good candidate for a case  
130 report because she had good potential of making progress with skilled therapy using PNF and  
131 OGT as primary interventions. Due to the lack of research involving patients who have had a  
132 central medullary stroke, the implications of this case report could guide future research about  
133 this type of CVA.

134 **EXAMINATION: TESTS AND MEASURES**

135 The FIST was used to assesses the patient's sitting balance. See Appendix 1. This 14-  
136 item test was designed for patients who are non-ambulatory at the time and have challenges with

Stegemann, Proprioceptive Neuromuscular Facilitation and Overground Gait Training for a Patient Following a Left Central Medullary Stroke: A Case Report

137 maintaining their sitting balance.<sup>13</sup> The Barthel Index has been shown to be a reliable and valid  
138 measure that evaluates a patient's independence with activities of daily living (ADLs), as well as  
139 measure a patient's rehabilitation potential.<sup>14-16</sup> See Appendix 2. The Encompass Health  
140 Rehabilitation Functional Abilities Scale was also performed. This was a mandatory assessment  
141 tool administered on all patients admitted to this IRF. It was used for billing purposes, writing PT  
142 goals, and for comparing patient outcomes from initial treatment to discharge. See Appendix 3.

143 The patient's gross strength was tested in her R and L lower extremities (LE). Sensation  
144 testing included light touch, proprioception, deep pressure, and localization. Refer to Table 3 for  
145 all tests and measures, including psychometric properties.

146 **CLINICAL IMPRESSION: EVALUATION, DIAGNOSIS, PROGNOSIS**

147 Based on the examination data, the patient's impairments were consistent with a L CVA.  
148 She continued to be appropriate for this case report due to her motivation and potential for  
149 recovery. The patient's ICD-10 medical diagnosis was I69.351: Hemiplegia and hemiparesis  
150 following cerebral infarction affecting right dominant side. Her PT diagnosis was Z74.09: Other  
151 reduced mobility. Based on the patient's current level of function at the time of examination, her  
152 prognosis for improvement with PT was good. The patient had lived a previously healthy  
153 lifestyle and also had a very supportive family that was willing to physically assist her upon  
154 discharge. However, the patient's age was a negative prognostic factor,<sup>17</sup> as well as the severity  
155 of her stroke. Her past medical history of hypertension and diabetes also served as negative  
156 prognostic factors.<sup>18</sup>

157 While the patient was at the IRF, it was planned that she would receive PT, occupational  
158 therapy (OT), and speech therapy. It was also planned that she would be referred to an orthotist,  
159 provided she made progress in her walking ability. Upon discharge, the patient was going to be

Stegemann, Proprioceptive Neuromuscular Facilitation and Overground Gait Training for a Patient Following a Left Central Medullary Stroke: A Case Report

160 re-tested on all of the initial evaluation tests (FIST, Barthel Index, Encompass Health  
161 Rehabilitation Functional Abilities Scale). Her interventions would include neuromuscular re-  
162 education, LE strengthening, trunk strengthening, balance training, and gait training. Refer to  
163 Table 4 for short and long-term goals.

164 **INTERVENTION AND PLAN OF CARE**

165 Coordination of the patient's care was done with OT, nursing, PT, social work, and the  
166 rehabilitation doctor. The patient was seen by a speech language pathologist for swallowing  
167 difficulties, which resolved, and she was discharged after four visits. The patient's upper  
168 extremity deficits and activities of daily living (ADL) were addressed by the OT. Her diabetes  
169 and pain management were managed by the nursing staff. There was clear communication  
170 among her healthcare team of therapists, doctors, nurses, social worker, and family members.  
171 There was a weekly team meeting with the patient's healthcare team where her progress,  
172 discharge plan, and any barriers to a safe discharge were discussed. Documentation was  
173 completed for each treatment session using an electronic documentation system. In the daily  
174 documentation, therapists described the patient's progress during her session and noted any  
175 changes to the patient's POC.

176 Patient education was provided throughout her time at the rehabilitation center. She was  
177 instructed on the importance of stretching her R wrist and fingers to avoid a contracture, to keep  
178 her R arm in a neutral position in her wheelchair arm trough to avoid shoulder subluxation, and  
179 to weight shift periodically in her wheelchair to avoid pressure sores. She was also educated on  
180 the correct use of her hemiwalker and how to verbally direct her caregivers to assist with

Stegemann, Proprioceptive Neuromuscular Facilitation and Overground Gait Training for a Patient Following a Left Central Medullary Stroke: A Case Report

181 donning and doffing her custom ankle-foot orthosis (AFO). Her son and daughter received  
182 family training on how to safely assist her with bed mobility, car transfers, gait, and stairs.

183 Over the course of six weeks, the patient received 30 PT treatment sessions, five times a  
184 week. These sessions lasted one and a half hours. Based on her tolerance, she either had the full  
185 hour and a half session, or it was split up into a morning (one hour) and afternoon (30 minute)  
186 session. She was compliant during her rehabilitation stay and participated in all sessions. The  
187 treatment sessions for this patient focused on PNF patterns (see Appendix 4), OGT, and  
188 functional mobility training. See Table 5 for interventions.

189 PNF

190 PNF has been shown to be a useful technique for facilitating muscle activity in patients  
191 with acute stroke.<sup>19</sup> This therapeutic intervention utilizes several biomechanical principles, such  
192 as “the use of gravity to facilitate weak muscles, the use of eccentric contractions to facilitate  
193 agonist muscle activity, and the use of diagonal movement patterns to facilitate the activation of  
194 bi-articular muscles”<sup>19 (p.102)</sup> The purpose of PNF for this patient was to facilitate muscle  
195 activation of the patient’s R quadriceps and hamstrings in order to improve her LE strength and  
196 motor control. PNF patterns were also utilized to facilitate muscle activation at her trunk to  
197 improve her independence with rolling and getting in and out of bed. Emphasis was given on  
198 strengthening the hip flexors, knee flexors, and knee extensors of her paretic limb in order to  
199 progress her gait ability and tolerance. In a systematic review of gait training strategies by Eng  
200 and Tang,<sup>20</sup> the strength of these muscle groups was moderately to highly correlated ( $r= 0.5-0.8$ )  
201 to self-selected or fast walking speed.

Stegemann, Proprioceptive Neuromuscular Facilitation and Overground Gait Training for a Patient Following a Left Central Medullary Stroke: A Case Report

202 Overground Gait Training

203 OGT was done to improve the patient’s walking tolerance, balance, and functional  
204 mobility. In the beginning of OGT, one of the patient’s biggest limitations was decreased R  
205 ankle dorsiflexion strength, which prohibited her from being able to independently complete the  
206 swing-through phase of gait. This problem was addressed by using an elastic bandage to create a  
207 dorsiflex-assist wrap. See Figure 1. She was later fitted with a custom AFO. Her training  
208 program included elements of balance, repetitive task training, and motor planning. See Table 5  
209 for more detail of OGT progression. The patient originally relied heavily on verbal cues for the  
210 sequencing of her gait, for example, “Move walker forward, lean to the L, R foot step, L foot  
211 step.” As she progressed, she required fewer verbal cues from the therapist. She also required  
212 several tactile cues in the beginning for weight shifting, blocking R knee buckling, and later  
213 blocking R knee hyperextension. At week four, she regained adequate strength and motor control  
214 to independently prevent her R knee from buckling. By week five and six, she required less  
215 assistance until she was eventually able to walk up to 200 feet with her hemiwalker with only  
216 supervision/touch assistance. Walking ability can be an important predictive factor in people  
217 who have experienced a stroke. People who are unable to independently walk after their stroke  
218 have an increased probability of death, a lower chance of reintegrating into the community, and  
219 have a higher chance of secondary complications common after a stroke, such as osteoporosis  
220 and heart disease.<sup>21</sup>

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Stegemann, Proprioceptive Neuromuscular Facilitation and Overground Gait Training for a Patient Following a Left Central Medullary Stroke: A Case Report

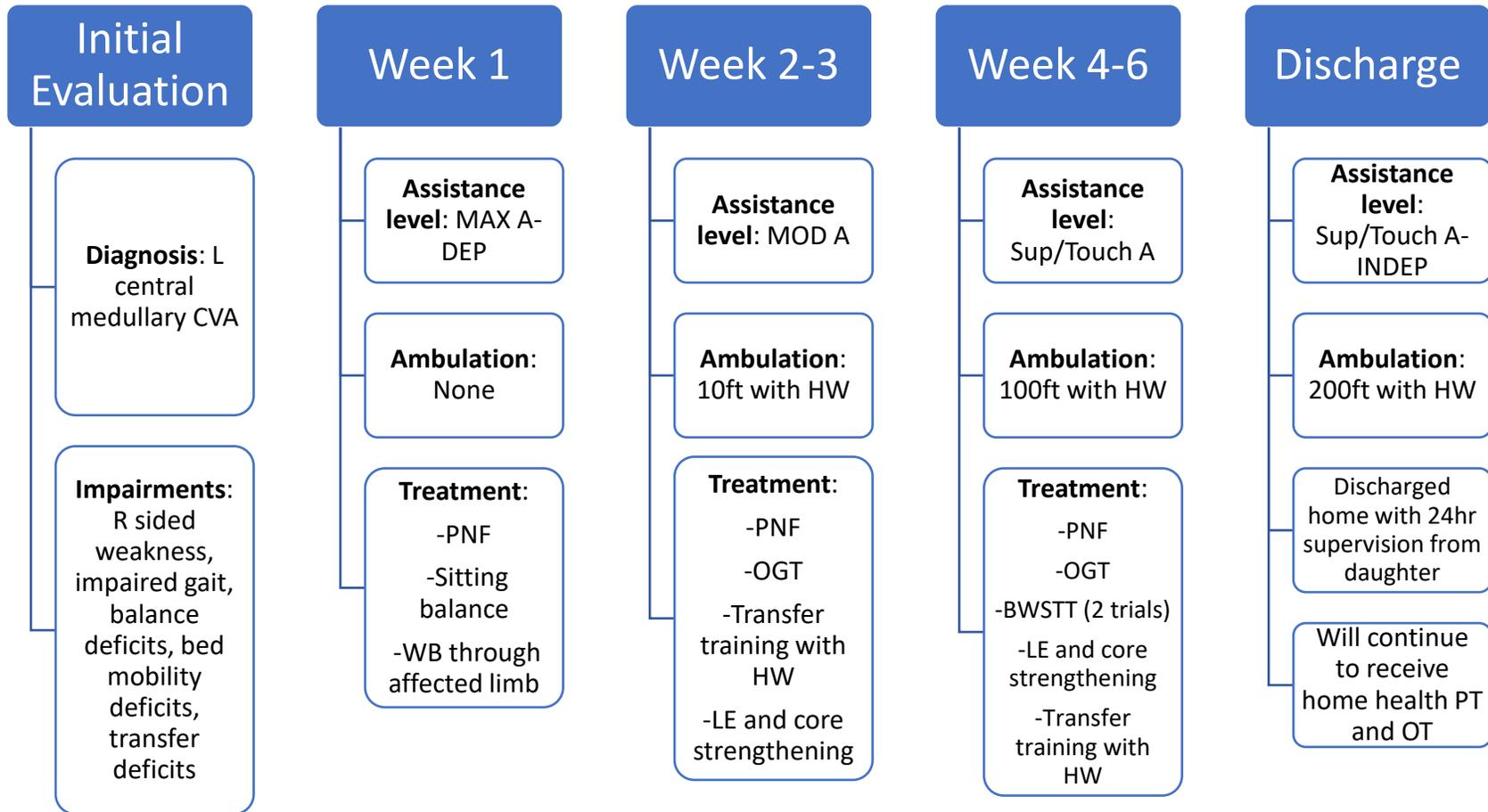
223 Body Weight Supported Treadmill Training (BWSTT)

224           During her stay, the patient trialed the BWSTT system (LiteGait, Tempe, AZ), however,  
225 this treatment technique was discontinued after two trials, as she expressed frustration and R  
226 shoulder pain. It was decided that the patient would be more appropriate for conventional gait  
227 training than continued trials of BWSTT. A systematic review suggested that while BWSTT can  
228 be successful for certain types of patients, it is not superior to conventional gait training.<sup>22</sup>

229 Functional Mobility Training

230 The purpose of functional mobility training was to increase the patient's independence with  
231 ADLs and decrease caregiver burden. This training focused on activities such as bed mobility  
232 and transfers. To accomplish this training, the motor learning principle of task-specific training  
233 was applied. This principle emphasizes repetitive, intensive practice of activities that are  
234 meaningful to the patient, and it has been shown to improve activities such as transfers and gait  
235 after stroke.<sup>23</sup>

236 **TIMELINE**



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L= left, CVA= cerebral vascular accident, R= right, MAX A= maximum assistance, PNF= proprioceptive neuromuscular facilitation, WB= weight bearing, MOD A= moderate assistance, HW= hemiwalker, OGT= overground gait training, LE= lower extremity, Sup/Touch A= supervision/touch assistance, BWSTT= body weight supported treadmill training, INDEP= independent

240 **OUTCOMES**

241           Upon admission, the patient’s biggest limiting factors were R sided inattentiveness, poor  
242 safety awareness, and poor insight into her deficits. She often let her R arm dangle out of her  
243 wheelchair and would sit on it. This was addressed with consistent verbal cues from the PT  
244 and ongoing patient education from her healthcare team. With continued therapy and  
245 education, the patient became more attentive to her R side and demonstrated better safety  
246 awareness and insight into her deficits. The patient tolerated her interventions well and was  
247 motivated to work hard. She never refused a session and adhered to her POC. The patient  
248 showed significant improvements from her initial evaluation to discharge. See Table 4. She  
249 improved her Barthel Index score by 30 points, indicating that she had made functional gains  
250 with ADLs. She improved her FIST score from 27/56 to 56/56, indicating that she had  
251 regained her sitting balance and could sit unsupported without risk of falling.

252           The patient made significant functional gains on the Encompass Health Rehabilitation  
253 Functional Abilities Skills assessment. Upon admission, the patient required maximum to  
254 total assistance for all functional mobility tasks, but upon discharge, she improved to a  
255 modified independent/minimum assist level. See Table 4. Despite these great improvements,  
256 she was not safe to be discharged independently due to her inconsistent safety awareness and  
257 memory deficits. It was recommended that she have 24-hour supervision and receive  
258 continued OT and PT at home. She was discharged to her daughter’s home. Both her  
259 daughter and son received family training to provide the proper care needed to assist her.

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Stegemann, Proprioceptive Neuromuscular Facilitation and Overground Gait Training for a Patient Following a Left Central Medullary Stroke: A Case Report

262 **DISCUSSION**

263 This case report demonstrated the intended purpose of providing an overview of a  
264 comprehensive inpatient rehabilitation POC for a patient who experienced a L central medullary  
265 stroke. Her treatment sessions focused on PNF, OGT, and functional mobility training. While  
266 there have been some studies that discussed the pathology and identification of central medullary  
267 strokes, there has been limited research on therapeutic treatment options for patients with this  
268 rare type of stroke.

269 One of the strengths of this case report was the amount of time the patient spent at the  
270 IRF. The patient was at risk for early discharge due to a decision by her insurance company,  
271 however the therapy team advocated for two extra weeks, which were approved. These added  
272 days were followed by immense improvement in the functional abilities of the patient. She made  
273 gains in ambulation distance, sitting and standing balance, transfer ability, and required less  
274 overall assistance with tasks compared to her baseline. Neuroplasticity principles such as early  
275 treatment, repeated bouts of meaningful activity, and appropriate intensity appeared to be  
276 beneficial for this patient as she regained motor control of her R LE.<sup>23</sup> PNF patterns also  
277 contributed to the patient's strength gains, as it encouraged stronger muscular contractions of the  
278 agonist and antagonist muscles of her R LE.<sup>19</sup>

279 Future research on treatment options such as BWSTT or the use of functional electrical  
280 stimulation (FES) could be explored. The patient in this case report trialed BWSTT with very  
281 little success, but this does not indicate that it could be a viable treatment option for someone  
282 with a central medullary stroke. Dobkin and Dunkin<sup>22</sup> suggested that BWSTT could be a  
283 potentially beneficial tool for severely disabled patients who require more external support.

Stegemann, Proprioceptive Neuromuscular Facilitation and Overground Gait Training for a  
Patient Following a Left Central Medullary Stroke: A Case Report

284 The patient also participated in FES training of her UE with the OT, where she experienced gains  
285 in motor control of her shoulder, elbow, and finger flexors. It could be hypothesized that she  
286 could have potentially benefitted from FES on her R LE as well. It would be appropriate to  
287 explore this treatment method to see if similar results would be found at the LE.

288         This case report suggests that a multifactorial treatment approach for patients who have  
289 experienced a L central medullary stroke may be beneficial to one's recovery. The combination  
290 of PNF, OGT, and functional mobility training appeared to be beneficial to this patient's  
291 outcomes, as she made improvements from her baseline function. There has been extensive  
292 research on treatment options for stroke, but there needs to be further research on whether there  
293 are superior treatment methods for patients who have experienced this rare type of stroke.

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Stegemann, Proprioceptive Neuromuscular Facilitation and Overground Gait Training for a  
Patient Following a Left Central Medullary Stroke: A Case Report

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Stegemann, Proprioceptive Neuromuscular Facilitation and Overground Gait Training for a Patient Following a Left Central Medullary Stroke: A Case Report

395 **TABLES and FIGURES**

396 **Table 1. Medications List**

<b>Medication</b>	<b>Purpose</b>
Acetaminophen	Provide pain relief
Amlodipine	Control high blood pressure
Ascorbic acid	Treat low levels of Vitamin C
Atorvastatin	Treat high cholesterol
Calcium-Vitamin D	Treat low levels of Vitamin D
Clopidogrel	Blood thinner
Collagenase	Treat wound on shin
Diclofenac topical	Provide pain relief
Donepezil	Cognition enhancing drug
Fluoxetine	Treat anxiety and depression
Glipizide	Treat Type 2 diabetes
Linagliptin	Treat Type 2 diabetes
Metformin	Treat Type 2 diabetes
Omeprazole	Treat acid reflux
Potassium Chloride	Treat low levels of potassium
Pregabalin	Nerve pain medication

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401 **Table 2. Systems Review**

<b>System</b>	<b>Intact/Impaired</b>	<b>Notes</b>
<b>Cardiovascular/Pulmonary</b>	Intact	
<b>Musculoskeletal</b>	Impaired	Gross R UE and LE strength were impaired; R shoulder subluxation of 1cm
<b>Neuromuscular</b>	Impaired	Balance, motor control, gait, transfers, and coordination were impaired
<b>Integumentary</b>	Impaired	Wound on R shin as a result from her fall; bruising on R sided ribs 7-9
<b>Communication</b>	Intact	
<b>Affect, Cognition, Language, Learning Style</b>	Intact	

402 R= right, UE= upper extremity, LE= lower extremity

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**Table 3. Test and Measures**

Tests & Measures	Initial Evaluation	Discharge	Psychometric Properties
<b>Function in Sitting Test<sup>12</sup></b>	29/56	56/56	Test-retest reliability (ICC=0.97) <sup>23</sup> Intra-rater reliability (ICC=0.99) <sup>23</sup> Inter-rater reliability (ICC=0.99) <sup>23</sup>
<b>Barthel Index<sup>15</sup></b>	45/100	70/100	Inter-rater reliability (ICC=0.94) <sup>24</sup> Correlation to Berg Balance Scale and Fugl Meyer motor assessment (Pearson's $r > 0.78$ , $p < 0.0001$ ) <sup>24</sup>
<b>Encompass Health Functional Abilities Scale</b>			No available psychometric properties
Roll Left and Right	MAX A	INDEP	
Sit to Lying	DEP	INDEP	
Lying to Sitting on Side of Bed	DEP	SUP/TOUCH A	
Sit to Stand	DEP	SUP/TOUCH A	
Chair, Bed to Chair Transfer	DEP	SUP/TOUCH A	
Car Transfer	Not Att MC	SUP/TOUCH A	
Picking Up Object	Not Att MC	IND (with reacher)	
Walk 10 Feet	Not Att MC	SUP/TOUCH A	
Walk 50 Feet with Two Turns	Not Att MC	SUP/TOUCH A	
Walk 150 Feet	Not Att MC	SUP/TOUCH A	
1 Step (Curb)	Not Att MC	SUP/TOUCH A	
4 Steps	Not Att MC	SUP/TOUCH A	
12 Steps	Not Att MC	Not Att MC	
Wheel 50 Feet with Two Turns	MOD A	INDEP	
Wheel 150 Feet	MAX A	MOD A	

Patient Following a Left Central Medullary Stroke: A Case Report

<b>RLE Gross Strength</b>	<b>Initial Evaluation</b>	<b>Discharge</b>	
Hip Flexion	1/5	3+/5	
Hip Extension	1/5	3/5	
Hip Abduction	1/5	3+/5	
Hip Adduction	1/5	3+/5	
Knee Flexion	1/5	3/5	
Knee Extension	1/5	3/5	
Ankle Dorsiflexion	0/5	1/5	
Ankle Plantarflexion	1/5	1/5	
<b>RLE Sensation</b>	<b>Initial Evaluation</b>	<b>Discharge</b>	
Light Touch	Impaired on plantar aspect of R foot	Not tested	
Proprioception	Intact	Not tested	
Deep Pressure and Localization	Impaired throughout LE below knee	Not tested	

INDEP= independent, SUP/TOUCH A= supervision/touch assistance, MOD A= moderate assistance, MAX A= maximum assistance, DEP= dependent, Not Att MC= not attempted due to medical concern

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**Table 4: Short and Long-Term Goals**

	<b>Short-Term Goals</b>	<b>Long-Term Goals</b>	<b>Goal Met/Not Met</b>
Bed Mobility (Rolling L and R, Sit to Lying, Lying to Sitting on Side of Bed)	MOD A	INDEP	Not Met
Sit to Stand	N/A	INDEP	Not Met
Chair, Bed to Chair Transfer	MOD A w HW	INDEP	Not Met

Stegemann, Proprioceptive Neuromuscular Facilitation and Overground Gait Training for a

Patient Following a Left Central Medullary Stroke: A Case Report

Car Transfer	MOD A w HW	INDEP	Not Met
Picking Up Object	N/A	SUP/TOUCH A	Met
Walk 10 Feet	N/A	SUP/TOUCH A	Met
Walk 50 Feet with Two Turns	MOD A w HW	SUP/TOUCH A	Met
Walk 150 Feet	N/A	SUP/TOUCH A	Met
Walk 10 Feet Uneven Surface	N/A	SUP/TOUCH A	Met
1 Step (Curb)	N/A	SUP/TOUCH A	Met
4 Steps	N/A	SUP/TOUCH A	Met
12 Steps	N/A	SUP/TOUCH A	Not met
Wheel 50 Feet with Two Turns	N/A	INDEP	Met
Wheel 150 Feet	INDEP	INDEP	Not met

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MOD A= moderate assistance, w HW= with hemiwalker, INDEP= independent, SUP/TOUCH A= supervision/touch assistance N/A= not applicable

423 **Table 5: Interventions**

Interventions	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
<b>Sitting Balance/Standing Balance</b>	Sitting on mat without UE support, reaching outside BOS	Static standing in // bars (2 min x 3)	Static standing with HW (2min x 3)	Static standing w/o UE support (30s x 5)		
<b>Transfers</b>	Sit ⇌ stand (PRN)  Bed ⇌ chair (squat pivot)	Sit ⇌ stand in // bars (2 x 3)  Bed ⇌ chair (stand pivot)	Sit ⇌ stand from raised treatment table (2x5)  Bed ⇌ chair (stand step with HW)  Toilet transfer (stand step with grab bar)	Sit ⇌ stand from wheelchair (2x5 and PRN)  Bed ⇌ chair (stand step with HW)  Toilet transfer (stand step with grab bar)	Sit ⇌ stand from wheelchair (2x5 and PRN)  Bed ⇌ chair (3x3; stand step with HW)  Toilet transfer (stand step with grab bar)	Sit ⇌ stand from wheelchair (2x5 and PRN)  Bed ⇌ chair (3x3 stand step with HW)  Toilet transfer (stand step with grab bar)  Car transfer (stand step with HW)
<b>Bed Mobility</b>	Supine ⇌ Sit (PRN)	Supine ⇌ Sit (PRN)	Modified supine⇌ sit (part task training; 3x5)  Supine ⇌ Sit (PRN)  Rolling (3x)	Supine⇌ sit (3x)  Rolling (3x)	Supine⇌ sit for paretic and non-paretic side (3x)  Rolling (3x)	Supine⇌ sit for paretic and non-paretic side (3x)  Rolling (3x)
<b>Proprioceptive Neuromuscular Facilitation (PNF)</b>	D1 and D2 FL/EXT rhythmic initiation of R LE (3x5)	D1 and D2 FL/EXT rhythmic initiation of R LE (3x5)	D1 and D2 FL/EXT rhythmic	D1 and D2 FL/EXT rhythmic	D1 and D2 FL/EXT rhythmic	D1 and D2 FL/EXT rhythmic

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Medullary Stroke: A Case Report

			initiation of R LE (2x5)	initiation of R LE (2x5)  D1 and D2 rhythmic initiation of scapula and pelvis	initiation of R LE (1x5)  D1 and D2 rhythmic initiation of scapula and pelvis	initiation of R LE (1x5)
<b>LE Strengthening</b>  <b>Core strengthening</b>		Supine isometric hip ADD (maintaining hook lying position for 10s x 3)  Modified sit ups (3x5)	Hip FL/EXT in sidelying with slip sheet under leg (3x5)  Knee FL/EXT in sidelying with slip sheet under leg (3x5)  Modified sit ups (3x5)	Hip FL/EXT in sidelying with slip sheet under leg (3x5)  Knee FL/EXT in sidelying with slip sheet under leg (3x5)  Bridges (3x5)  Trunk twists (3x10)	Bridges (2x10)  Trunk twists (3x10)	
<b>Overground Gait Training (OGT)</b>	Weight shifts in // bars (UE support)	Walking in // bars (5ft x 2 → 10ftx2)  Weight shifts with HW  Repetitive stepping in // bars	Repetitive stepping w HW  Walk 10ft x 2 w HW  MAX VC's and tactile cues for swing through phase of R LE, sequencing of step pattern	Walk 50ft x 2 w HW  MOD VC's for sequencing step pattern, increasing step length  Trialed platform step w HW	Walk 100ft x 2 w HW  Ascend/descend two platform steps w HW	Walk 200ft SUP/TOUCH A with HW  Ascend/descend two platform steps with HW

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Medullary Stroke: A Case Report

			ACE wrap implemented on R LE for increased ankle dorsiflexion			
<b>Body Weight Supported Treadmill Training (BWSTT)</b>				25% BWS at 1.0mph for 1min x 2 bouts	25% BWS at 1.0mph for 1min x 2 bouts	

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PRN = as needed; UE = upper extremity; BOS = base of support; HW = hemiwalker; PRN = as needed; FL/EXT = flexion/extension; R LE = right lower extremity; MAX VC's = maximum verbal cues; MOD VC's = moderate verbal cues; SUP/TOUCH A= supervision/touch assistance; BWS = body weight support

426 **Figure 1: Dorsiflex Assist Wrap**<sup>27</sup>



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450 APPENDICES

451 Appendix 1: Function in Sitting Test<sup>12</sup>

FUNCTION IN SITTING TEST (FIST) RESULTS			
FIST Test Item	Date:	Date:	Date:
<small>½ Inmate on surface, hips &amp; knees flexed to 90°                      0 Used step/stool for positioning &amp; foot support</small>			
Randomly Administered Once	Anterior Nudge: superior sternum		
	Posterior Nudge: between scapular spines		
	Lateral Nudge: to dominant side at acromion		
Static sitting: 30 seconds			
Sitting, shake 'no': left and right			
Sitting, eyes closed: 30 seconds			
Sitting, lift foot: dominant side, lift foot 1 inch twice			
Pick up object from behind: object at midline, hands breadth posterior			
Forward reach: use dominant arm, must complete full motion			
Lateral reach: use dominant arm, clear opposite ischial tuberosity			
Pick up object from floor: from between feet			
Posterior scooting: move backwards 2 inches			
Anterior scooting: move forward 2 inches			
Lateral scooting: move to dominant side 2 inches			
<b>TOTAL</b>	/ 56	/ 56	/ 56
Administered by:			
Notes/comments:			
<small>Scoring Key:                      4 = Independent (completes task independently &amp; successfully)                      3 = Verbal cues/facilitated time (completes task independently &amp; successfully and only needs more time/cues)                      2 = Upper extremity support (must use UE for support or assistance to complete successfully)                      1 = Needs assistance (unable to complete w/o physical assist; document level: min, mod, max)                      0 = Dependent (requires complete physical assist; unable to complete successfully even w/physical assist)</small>			

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 Patient Following a Left Central Medullary Stroke: A Case Report

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460 **Appendix 2: Barthel Index<sup>15</sup>**

**THE  
 BARTHEL  
 INDEX**

**Patient Name:** \_\_\_\_\_  
**Rater Name:** \_\_\_\_\_  
**Date:** \_\_\_\_\_

Activity	Score
<b>FEEDING</b> 0 = unable 5 = needs help cutting, spreading butter, etc., or requires modified diet 10 = independent	_____
<b>BATHING</b> 0 = dependent 5 = independent (or in shower)	_____
<b>GROOMING</b> 0 = needs to help with personal care 5 = independent face/hair/teeth/shaving (implements provided)	_____
<b>DRESSING</b> 0 = dependent 5 = needs help but can do about half unaided 10 = independent (including buttons, zips, laces, etc.)	_____
<b>BOWELS</b> 0 = incontinent (or needs to be given enemas) 5 = occasional accident 10 = continent	_____
<b>BLADDER</b> 0 = incontinent, or catheterized and unable to manage alone 5 = occasional accident 10 = continent	_____
<b>TOILET USE</b> 0 = dependent 5 = needs some help, but can do something alone 10 = independent (on and off, dressing, wiping)	_____
<b>TRANSFERS (BED TO CHAIR AND BACK)</b> 0 = unable, no sitting balance 5 = major help (one or two people, physical), can sit 10 = minor help (verbal or physical) 15 = independent	_____
<b>MOBILITY (ON LEVEL SURFACES)</b> 0 = immobile or < 50 yards 5 = wheelchair independent, including corners, > 50 yards 10 = walks with help of one person (verbal or physical) > 50 yards 15 = independent (but may use any aid, for example, stick) > 50 yards	_____
<b>STAIRS</b> 0 = unable 5 = needs help (verbal, physical, carrying aid) 10 = independent	_____
<b>TOTAL (0-100):</b>	_____

*Provided by the Internet Stroke Center — www.strokecenter.org*

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462 **Appendix 3: Encompass Health Rehabilitation Functional Abilities Scale**

**Mobility/Transfers**

Mobility/Transfers

	Ind	SU/CU	Sup/Touch A	Partial/Mod A	Substantial/ Max A	Dep	Pat Ref	Not App	Not Att EL	Not Att MC	TBE	Comment
GG0170 Roll Left and Right	<input checked="" type="radio"/>											
GG0170 Sit to Lying												
GG0170 Lying to Sitting on Side of Bed												
GG0170 Sit to Stand												
GG0170 Chair, Bed to Chair Transfer												
GG0170 Car Transfer												
GG0170 Picking Up Object												

Ind - Independent  
 SU/CU - Set Up/Clean Up Only  
 Sup/Touch A - Supervision Touch  
 Partial/Mod A - Partial/ Moderate  
 Substantial/ Max A - Substantial/  
 Dep - Dependent  
 Pat Ref - Patient Refused  
 Not App - Not Applicable/Not Pe  
 Not Att EL - Not Attempted Du  
 Not Att MC - Not Attempted Du  
 TBE - To Be Evaluated

GG0170 Walk 10 Feet

- Ind
- SU/CU
- Sup/Touch A
- Partial/Mod A
- Substantial/ Max A
- Dep
- Pat Ref
- Not App
- Not Att EL
- Not Att MC
- TBE

GG0170 Walk 50 Feet with Two Turns

- Ind
- SU/CU
- Sup/Touch A
- Partial/Mod A
- Substantial/ Max A
- Dep
- Pat Ref
- Not App
- Not Att EL
- Not Att MC
- TBE

GG0170 Walk 150 Feet

- Ind
- SU/CU
- Sup/Touch A
- Partial/Mod A
- Substantial/ Max A
- Dep
- Pat Ref
- Not App
- Not Att EL
- Not Att MC
- TBE

GG0170 Walking 10 Feet Uneven Surfaces

- Ind
- SU/CU
- Sup/Touch A
- Partial/Mod A
- Substantial/ Max A
- Dep
- Pat Ref
- Not App
- Not Att EL
- Not Att MC
- TBE

GG0170 1 Step (Curb)

- Ind
- SU/CU
- Sup/Touch A
- Partial/Mod A
- Substantial/ Max A
- Dep
- Pat Ref
- Not App
- Not Att EL
- Not Att MC
- TBE

GG0170 4 Steps

- Ind
- SU/CU
- Sup/Touch A
- Partial/Mod A
- Substantial/ Max A
- Dep
- Pat Ref
- Not App
- Not Att EL
- Not Att MC
- TBE

GG0170 12 Steps

- Ind
- SU/CU
- Sup/Touch A
- Partial/Mod A
- Substantial/ Max A
- Dep
- Pat Ref
- Not App
- Not Att EL
- Not Att MC
- TBE

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INDEP = independent; SU/CU= set up/clean up only; Sup/Touch A= supervision/touch assistance; Partial/MOD A= moderate assistance; Substantial/MAX A= maximum assistance; DEP= dependent; Pat Ref= patient refused; Not App= Not Applicable; Not Att EL= not attempted due to environmental living situation; Not Att MC= not attempted due to medical concern; TBE= to be evaluated

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466 **Appendix 4: Lower Extremity D1 and D1 Flexion Extension PNF Pattern Videos**<sup>25,26</sup>

467 <https://youtu.be/c7qx1r6adb4>

468 <https://youtu.be/-MYCNj-5cDk>

469 **CARE checklist**

<b>CARE Content Area</b>	<b>Page</b>
<b>1. Title</b> – The area of focus and “case report” should appear in the title	1
<b>2. Key Words</b> – Two to five key words that identify topics in this case report	1
<b>3. Abstract</b> – (structure or unstructured) <ul style="list-style-type: none"> <li>a. Introduction – What is unique and why is it important?</li> <li>b. The patient’s main concerns and important clinical findings.</li> <li>c. The main diagnoses, interventions, and outcomes.</li> <li>d. Conclusion—What are one or more “take-away” lessons?</li> </ul>	2
<b>4. Introduction</b> – Briefly summarize why this case is unique with medical literature references.	3
<b>5. Patient Information</b> <ul style="list-style-type: none"> <li>a. De-identified demographic and other patient information.</li> <li>b. Main concerns and symptoms of the patient.</li> <li>c. Medical, family, and psychosocial history including genetic information.</li> <li>d. Relevant past interventions and their outcomes.</li> </ul>	5
<b>6. Clinical Findings</b> – Relevant physical examination (PE) and other clinical findings	6
<b>7. Timeline</b> – Relevant data from this episode of care organized as a timeline (figure or table).	12
<b>8. Diagnostic Assessment</b> <ul style="list-style-type: none"> <li>a. Diagnostic methods (PE, laboratory testing, imaging, surveys).</li> <li>b. Diagnostic challenges.</li> <li>c. Diagnostic reasoning including differential diagnosis.</li> <li>d. Prognostic characteristics when applicable.</li> </ul>	7
<b>9. Therapeutic Intervention</b> <ul style="list-style-type: none"> <li>a. Types of intervention (pharmacologic, surgical, preventive).</li> <li>b. Administration of intervention (dosage, strength, duration).</li> <li>c. Changes in the interventions with explanations.</li> </ul>	8
<b>10. Follow-up and Outcomes</b> <ul style="list-style-type: none"> <li>a. Clinician and patient-assessed outcomes when appropriate.</li> <li>b. Important follow-up diagnostic and other test results.</li> <li>c. Intervention adherence and tolerability (how was this assessed)?</li> <li>d. Adverse and unanticipated events.</li> </ul>	13
<b>11. Discussion</b> <ul style="list-style-type: none"> <li>a. Strengths and limitations in your approach to this case.</li> <li>b. Discussion of the relevant medical literature.</li> </ul>	14

Patient Following a Left Central Medullary Stroke: A Case Report

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c. The rationale for your conclusions. d. The primary “take-away” lessons from this case report.	
<b>12. Patient Perspective</b> – The patient can share their perspective on their case.	6
<b>13. Informed Consent</b> – The patient should give informed consent.	5